U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NUREG-1437
Supplement 21
Second Renewal

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 21, Second Renewal

Regarding Subsequent License Renewal of Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

Draft Report for Comment

Office of Nuclear Material Safety and Safeguards

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Regarding Subsequent License Renewal of Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

Draft Report for Comment

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Office of Nuclear Material Safety and Safeguards

COMMENTS ON DRAFT REPORT

Proposed Action Issuance of subsequent renewed facility operating licenses DPR-33, DPR 52, and DPR-68 for Browns Ferry Nuclear Plant Units 1, 2, and 3, respectively, in Limestone County, Alabama

Type of Statement Draft Supplemental Environmental Impact Statement

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ABSTRACT

The U.S. Nuclear Regulatory Commission (NRC or the Commission) prepared this supplemental environmental impact statement in response to an application submitted by Tennessee Valley Authority to renew the operating licenses for the Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 (Browns Ferry), for an additional 20 years. This supplemental environmental impact statement includes the preliminary analysis that evaluates the environmental impacts of the proposed action and environmental impacts of a combination of replacement energy generating capacity as part of the no-action alternative.

The NRC staff's preliminary recommendation is that the adverse environmental impacts of subsequent license renewal for Browns Ferry are not so great that preserving the option of license renewal for energy-planning decision-makers would be unreasonable. This NRC preliminary recommendation is based on:

- the analysis and findings in NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants
- the Environmental Report submitted by Tennessee Valley Authority, as revised
- the Environmental Impact Statement prepared by Tennessee Valley Authority
- the NRC staff's consultation with Federal, State, local, and Tribal, and local agencies
- the NRC staff's independent environmental review
- the NRC staff's consideration of public comments received during the scoping process

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Background

By letter dated January 19, 2024 (TVA 2024-TN11042), as revised on February 18, 2025 (TVA 2025-TN11355), Tennessee Valley Authority (TVA), submitted to the U.S. Nuclear Regulatory Commission (NRC or the Commission) an application for subsequent license renewal of Renewed Facility Operating License No. DPR-33, DPR-52, and DPR-68, for Browns Ferry Nuclear Plant (Browns Ferry), Units 1, 2, and 3, respectively, for an additional 20 years of operation (TVA 2024-TN11042).

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 51.20(b)(2) (TN10253), the renewal of a power reactor operating license requires preparation of an environmental impact statement (EIS) or a supplement to an EIS. In addition, 10 CFR 51.95(c) (TN10253) states that, in connection with the renewal of a power reactor operating license, the NRC shall prepare an EIS, which is a supplement to the Commission's NUREG-1437, Revision 2, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Final Report*, dated August 2024 (LR GEIS) (NRC 2024-TN10161).

The current facility operating license for Browns Ferry Unit 1, expires at midnight on December 20, 2033, Unit 2 expires at midnight on June 28, 2034, and Unit 3 expires at midnight on July 2, 2036. The subsequent license renewal (SLR) application was submitted pursuant 10 CFR Part 54 (TN4878), "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," and seeks to extend the facility operating license for Unit 1 to midnight on December 20, 2053, Unit 2 to midnight on June 28, 2054, and Unit 3 to midnight on July 2, 2056. A notice of receipt and availability of the application was published in the *Federal Register* (FR) on February 8, 2024 (89 FR 8725-TN11353).

The NRC staff reviewed the TVA SLR application and determined that it was acceptable for docketing on March 21, 2024 (89 FR 20254-TN11356).

Separately, as a federally owned electric utility corporation, TVA prepared an EIS (TVA 2023-TN11043) to support its decision to pursue SLR. Accordingly, the NRC staff will consider and incorporate portions of TVA's EIS by reference, as appropriate.

The NRC staff began the environmental review process described in 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions" (TN10253), by publishing a notice of intent to prepare a supplemental environmental impact statement (SEIS) to the LR GEIS and to conduct scoping for Browns Ferry license renewal on April 3, 2024 (89 FR 23056-TN11357). Thereafter, the NRC staff:

- considered public comments received during the two public scoping meetings as online webinars on April 11 and 18, 2024 (NRC 2024-TN11381)
- conducted virtual and onsite audits during the weeks of July 22 (NRC 2024-TN11379), September 30, and October 7, 2024 (NRC 2024-TN11380)
- reviewed TVA's environmental report (ER) (TVA 2024-TN11042), as revised (TVA 2025-TN11355), and compared it to the LR GEIS
- reviewed TVA's EIS (TVA 2023-TN11043)

- consulted with Federal, State, Tribal, and local agencies
- conducted a review of the application following the guidance set forth in NUREG-1555, Supplement 1, Revision 2, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Operating License Renewal, Final Report*, dated August 2024 (NRC 2024-TN10251)

Proposed Action

The proposed Federal action (issuance of subsequent renewal of the Browns Ferry operating licenses, DPR-33, DPR-52, and DPR-68) was initiated by TVA's submittal of an SLR application on January 19, 2024 (TVA 2024-TN11042). The current renewed Browns Ferry operating licenses are set to expire at midnight on December 20, 2033 for Unit 1, June 28, 2034 for Unit 2, and July 2, 2036 for Unit 3. The NRC's Federal action is to determine whether to issue subsequent renewed operating licenses for Browns Ferry for an additional 20 years. If the NRC renews the facility operating licenses, TVA would be authorized to operate Browns Ferry Unit 1 until December 20, 2053, Unit 2 until June 28, 2054, and Unit 3 until July 2, 2056.

Purpose and Need for Action

The purpose and need for the proposed agency action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of the current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, system, and, where authorized, Federal agencies (other than the NRC) decision-makers. This definition of purpose and need reflects the Commission's recognition that, absent findings in the safety review required by the Atomic Energy Act of 1954, as amended (TN663), or in the environmental review required by the National Environmental Policy Act of 1969, as amended (TN661) that would lead the NRC to reject a license renewal application, the NRC has no role in the energy-planning decision of power plant owners, State regulators, system operators, and, in some cases, other Federal agencies, as to whether a particular nuclear power plant should continue to operate (61 FR 28467-TN4491; NRC 2024-TN10161).

Environmental Impacts of Subsequent License Renewal

This SEIS evaluates the potential environmental impacts of the proposed action and reasonable alternatives to that action. The environmental impacts of the proposed action and reasonable alternatives are designated as SMALL, MODERATE, or LARGE.

> **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.

Resource-specific effects or impact definitions from applicable environmental laws and executive orders, other than SMALL, MODERATE, and LARGE, are used where appropriate.

The LR GEIS evaluates 80 environmental issues related to plant operation and classifies each issue as either a Category 1 issue (generic to all or a distinct subset of nuclear power plants as

described below) or a Category 2 issue (specific to individual power plants). Category 1 issues are those that meet all the following criteria:

- The environmental impacts associated with the issue apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for offsite radiological impacts of spent nuclear fuel and high-level waste disposal and offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste).
- Mitigation of adverse impacts associated with the issue is considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For Category 1 issues, no additional nuclear plant-specific (hereafter, plant-specific) analysis is required in this SEIS unless new and significant information is identified. Chapter 4 of this SEIS presents the process for identifying new and significant information.

Category 2 issues are plant-specific issues that do not meet one or more of the criteria for Category 1 issues; therefore, a SEIS must include additional plant-specific review for these non-generic issues.

Table 3-1 in Chapter 3 lists the Category 1 issues that are applicable to Browns Ferry, and the significance levels of their impacts. TVA and the NRC staff have identified no information that is both new and significant related to Category 1 issues that has the potential to affect the conclusions in the LR GEIS. This conclusion is supported by the NRC staff's review of TVA's, environmental report, Environmental Impact Statement, and other documentation relevant to the applicant's activities, the public scoping process, and the findings from the NRC staff's site audits. Therefore, the NRC staff relied upon the conclusions of the LR GEIS for all Category 1 issues applicable to Browns Ferry Nuclear Plant.

In this SEIS, the NRC staff evaluated Category 2 issues applicable to Browns Ferry, as well as cumulative effects. Table ES-1 summarizes the Category 2 issues relevant to Browns Ferry Nuclear Plant and the NRC staff's findings related to those issues. If the NRC staff determined that there were no Category 2 issues applicable for a particular resource area, then the findings of the LR GEIS, as documented in Table B-1 in Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of 10 CFR Part 51 (TN10253), are incorporated for that resource area.

Table ES-1 Summary of U.S. Nuclear Regulatory Commission Conclusions Relating to Site-Specific Impacts of License Renewal at Browns Ferry Nuclear Plant

Resource Area	Relevant Category 2 Issue	Impact[(a)]
Groundwater Resources	Radionuclides released to groundwater	SMALL
Terrestrial Resources	Non-cooling system impacts on terrestrial resources	SMALL
Terrestrial Resources	Water use conflicts with terrestrial resources (plants with cooling ponds or cooling towers using makeup water from a river)	SMALL

Table ES-1 Summary of U.S. Nuclear Regulatory Commission Conclusions Relating to Site-Specific Impacts of License Renewal at Browns Ferry Nuclear Plant (Continued)

Resource Area	Relevant Category 2 Issue	Impact[a]
Aquatic Resources	Impingement mortality and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)	SMALL
Aquatic Resources	Effects of thermal effluents on aquatic organisms (plants with once-through cooling systems or cooling ponds)	SMALL
Aquatic Resources	Water use conflicts with aquatic resources (plants with cooling ponds or cooling towers using makeup water from a river)	SMALL
Federally Protected Ecological Resources	Endangered Species Act: Federally listed species and critical habitats under U.S. Fish and Wildlife Service jurisdiction	May affect but is not likely to affect gray bat, Indiana bat, whooping crane, monarch butterfly, slackwater darter, pink mucket, rough pigtoe, sheepnose, spectaclecase, critical habitat for spectaclecase, Tennessee pigtoe, Anthony's riversnail, armored snail, slender campeloma. No effect on eastern hellbender, spring pygmy sunfish, birdwing pearlymussel, cracking pearlymussel, Cumberlandian combshell, dromedary pearlymussel, fluted knidneyshell, organgefoot pimpleback, ring pink.
Federally Protected Ecological Resources	Endangered Species Act: Federally listed species and critical habitats under National Marine Fisheries Service jurisdiction	No effect.
Federally Protected Ecological Resources	Magnuson-Stevens Act: essential fish habitat	No effect.
Federally Protected Ecological Resources	National Marine Sanctuaries Act: sanctuary resources	No effect.
Historic and Cultural Resources	Historic and cultural resources	See Section 3.9 of this SEIS.
Human Health	Microbiological hazards to the public	SMALL
Human Health	Electromagnetic fields (EMFs)[b]	Uncategorized (Uncertain Impact)
Human Health	Electric shock hazards	SMALL
Greenhouse Gas Emissions and Climate Change	Climate change impacts on environmental resources	See Section 3.16 of this SEIS.
Cumulative Effects	Cumulative effects	See Section 3.17 of this SEIS.

DPS = distinct population segments; SEIS = supplemental environmental impact statement.

(a) Impact determinations for Category 2 issues based on findings described in Sections 3.2 through 3.16, as applicable, for the proposed action.

(b) This issue was not designated as Category 1 or Category 2 and is discussed in Section 3.11.4.

Sources: Table B-1 in Appendix B, Subpart A, to 10 CFR Part 51-TN10253; NRC 2024-TN10161.

Alternatives to the Proposed Action

As part of its environmental review, the NRC relied on the description of alternative sources of replacement energy in Appendix D of the LR GEIS (NRC 2024-TN10161), and incorporated by reference the replacement energy alternatives evaluated in TVA's 2023 Browns Ferry SLR SEIS (TVA 2023-TN11043) and the alternatives described in TVA's ER (TVA 2024-TN11042). TVA's SLR SEIS eliminated stand-alone replacement energy alternatives from detailed study, and instead analyzed the environmental impacts of a combination of replacement energy generating capacity as part of the no-action alternative (should TVA not obtain SLRs for "all three Browns Ferry units"). The alternatives analysis in TVA's SLR SEIS and in this SEIS are consistent with NEPA Section 102(2)(C)(iii), which states, "[…] a reasonable range of alternatives to the proposed agency action, including an analysis of any negative environmental impacts of not implementing the proposed agency action in the case of a no-action alternative, that are technically and economically feasible, and meet the purpose and need of the proposal."

Preliminary Recommendation

The NRC staff's preliminary recommendation is that the adverse environmental impacts of license renewal for Browns Ferry are not so great that preserving the option of license renewal for energy-planning decision-makers would be unreasonable. This preliminary recommendation is based on:

- the analysis and findings in the LR GEIS
- the applicant's ER
- the applicant's EIS
- the NRC staff's consultation with Federal, State, Tribal, and local agencies
- the NRC staff's independent environmental review
- the NRC staff's consideration of public comments

ABBREVIATIONS AND ACRONYMS

°C	degree(s) Celsius
°F	degree(s) Fahrenheit
ac	acre(s)
ACHP	Advisory Council on Historic Preservation
AD	Anno Domini
ADAMS	Agencywide Documents Access and Management System
ADEM	Alabama Department of Environmental Management
AEA	Atomic Energy Act of 1954
ALARA	as low as reasonably achievable
APE	area of potential effects
AQCR	air quality control region
ARERR	annual radioactive effluent release report
BA	biological assessment
BC	Before Christ
BFARF	Browns Ferry Aquatic Research Facility
Browns Ferry	Browns Ferry Nuclear Plant
BMP	best management practice
BP	before present
BTA	best technology available
BWR	boiling water reactor
CAA	Clean Air Act
CFR	*Code of Federal Regulations*
CH_4	methane
cm	centimeter(s)
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CWA	Clean Water Act
CWIS	cooling water intake structure
dBA	decibels in A-weighted scale

DDT	dichloro-diphenyl-trichloroethane
DOE	U.S. Department of Energy
ECHO	Enforcement and Compliance History Online
EFH	essential fish habitat
EIS	environmental impact statement
EMF	electromagnetic field
ER	environmental report
ESA	Endangered Species Act of 1973
EXPN	non-essential experimental population
fps	feet per second
FPT	proposed for Federal listing as threatened
FR	*Federal Register*
FRN	*Federal Register Notice*
ft	feet/foot
ft^3/s	cubic foot/feet per second
FWS	U.S. Fish and Wildlife Service
GEIS	generic environmental impact statement
GHG	greenhouse gas
GIS	geographic information system
gpm	gallons per minute
GWP	global warming potential
h	hour(s)
ha	hectare(s)
ha-m	hectare-meter(s)
hp	horsepower
Hz	hertz
IM	impingement mortality
in.	inch(es)
IPaC	Information for Planning and Consultation
IPCC	Intergovernmental Panel on Climate Change
IRP	Integrated Resource Plan
ISFSI	independent spent fuel storage installation

km	kilometer(s)
kV	kilovolt
Leq	equivalent sound intensity level
LLRW	low level radioactive waste
lpd	liters per day
lpm	liters per minute
LR	license renewal
LRA	LR application
LR GEIS	*Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Final Report*
m	meter(s)
m^3/s	cubic meter(s) per second
MBTA	Migratory Bird Treaty Act
MGD	million gallons per day
mi	mile(s)
msl	mean sea level
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MW	megawatt
MWe	megawatts electric
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NGCC	natural gas-fired combined cycle
NGCT	natural gas-fired combustion turbine
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NO_x	nitrogen oxide
NPDES	National Pollutant Discharge Elimination System
NRC or Commission	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places

NWR	National Wildlife Refuge
OSHA	Occupational Safety and Health Administration
Pb	lead
PBF	physical and biological features
pCi/L	picocurie per liter
PFOS	perfluorooctane sulfonate
pH	potential of hydrogen
PILOT	payments in lieu of taxes
PM_{10}	particulate matter with aerodynamic diameters of 10 microns or less
$PM_{2.5}$	particulate matter with aerodynamic diameters of 2.5 microns or less
PSM	partial status mussels
RCP	representative concentration pathways
RCRA	Resource Conservation and Recovery Act
rem	Roentgen Equivalent Man
REMP	Radiological Environmental Monitoring Program
ROI	region of interest
ROW	right-of-way
SAMA	severe accident mitigation alternatives
SEIS	supplemental environmental impact statement
SHPO	State historic preservation officer
SLR	subsequent license renewal
SMR	small modular reactor
SO_2	sulfur dioxide
spp.	species (plural)
SSC	systems, structures, and component
SWPPP	stormwater pollution prevention plan
TRM	Tennessee River Mile
TVA	Tennessee Valley Authority
UDEC	Universal Distinct Element Code
U.S.	United States
U.S.C.	*United States Code*

1	USACE	U.S. Army Corps of Engineers
2	USCB	U.S. Census Bureau
3	USEPA	U.S. Environmental Protection Agency

1 INTRODUCTION AND GENERAL DISCUSSION

The U.S. Nuclear Regulatory Commission (NRC or the Commission) environmental protection regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51 (TN10253), "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," implement the National Environmental Policy Act of 1969 (NEPA), as amended (42 *United States Code* [U.S.C.] 4321 et seq.-TN661). The regulations in 10 CFR Part 51 (TN10253) require, in part, that the NRC staff prepare an environmental impact statement (EIS), which is a supplement to the Commission's NUREG-1437, Revision 2, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Final Report* (LR GEIS), dated August 2024 (NRC 2024-TN10161), for the renewal of a nuclear power plant operating license.

The Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.-TN663), specifies that licenses for commercial nuclear power reactors can be granted for up to 40 years. The NRC regulations in 10 CFR Part 54 (TN4878), "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," allow for an option to renew such licenses for terms of up to an additional 20 years. The initial 40-year licensing period was based on economic and antitrust considerations rather than on technical limitations of the nuclear facility.

The decision to seek a license renewal (LR) rest entirely with nuclear power facility owners and, typically, is based on the facility's economic viability and the investment necessary to continue to meet NRC safety and environmental requirements. The NRC makes the decision to grant or deny a license renewal application (LRA) based on whether the applicant has demonstrated that the safety and environmental requirements in the agency's regulations can be met during the period of extended operation.

1.1 Proposed Federal Action

The proposed Federal action (issuance of subsequent renewal of the Browns Ferry operating licenses, DPR-33, DPR-52, and DPR-68) was initiated by Tennessee Valley Authority's (TVA's) submittal of a subsequent LR (SLR) application on January 19, 2024 (TVA 2024-TN11042). The current renewed Browns Ferry operating licenses are set to expire at midnight on December 20, 2033 for Unit 1, June 28, 2034 for Unit 2, and July 2, 2036 for Unit 3. The NRC's Federal action is to determine whether to issue subsequent renewed operating licenses for Browns Ferry for an additional 20 years. If the NRC renews the facility operating licenses, TVA would be authorized to operate Browns Ferry Nuclear Plant Unit 1 until December 20, 2053, Unit 2 until June 28, 2054, and Unit 3 until July 2, 2056.

1.2 Purpose and Need for the Proposed Action

The purpose and need for the proposed action (renewal of the facility operating licenses) is to provide an option that allows for power generation capability beyond the term of the current nuclear power plant operating licenses to meet future system generating needs, as such needs may be determined by State, utility, system, and where authorized, Federal (other than NRC) decision-makers. The above definition of purpose and need reflects the NRC's recognition that, unless there are findings in the staff review that would lead the NRC to reject an LRA, the NRC does not have a role in the energy-planning decisions as to whether a particular nuclear power plant should continue to operate.

If renewed licenses are issued, power plant owners, State regulators, system operators, and, in some cases, other Federal agencies will ultimately decide whether the nuclear power plant will continue to operate based on economics, energy reliability goals, and other factors within their jurisdiction or the owners' purview. If the operating licenses are not renewed, the nuclear power plant must shut down on or before the expiration dates of the current operating licenses or once the NRC has made the final determination to not approve the LRA if the plant is in timely renewal.

1.3 Major Environmental Review Milestones

The NRC has established an LR process that can be completed in a reasonable period of time with clear requirements to ensure safe plant operation for up to an additional 20 years of the nuclear power plant's life. The NRC staff conducts a safety review simultaneously with an environmental review and documents the findings of the safety review in a safety evaluation report and the findings of the environmental review in a supplemental environmental impact statement (SEIS). The safety evaluation report and the SEIS are both factors in the NRC's decision to either grant or deny the issuance of renewed licenses. The safety evaluation report and the SEIS schedules for the Browns Ferry SLR application (NRC 2025-TN11383) are provided in the project website: https://www.nrc.gov/reactors/operating/licensing/renewal/applications/browns-ferry-subsequent.html.

By letter dated January 19, 2024 (TVA 2024-TN11042), TVA submitted an SLR application to the NRC for Browns Ferry, which included an environmental report (ER) (TVA 2024-TN11042). On February 8, 2024, after reviewing the SLR application and ER for sufficiency, the NRC staff published a notice of acceptance for docketing and opportunity to request a hearing in the *Federal Register* (FR) (89 FR 8725-TN11353). On April 3, 2024, the NRC staff published a notice of intent to conduct an environmental scoping process, which began a 30-day scoping comment period, and to prepare a SEIS (89 FR 23056-TN11357).

The NRC staff held two virtual public scoping meeting on April 11, 2024 (NRC 2024-TN11349), and April 18, 2024 (NRC 2024-TN11358). On October 24, 2024, the NRC staff issued a scoping summary report for the Browns Ferry environmental review (NRC 2024-TN11350), which included the comments received during the scoping process (Appendix A of this SEIS).

To independently verify the information provided in TVA's Environmental Report, the NRC staff conducted a series of audits. The first audit, a virtual limited-scope environmental audit, took place during the week of July 21, 2024 (NRC 2024-TN11379). This was followed by another virtual audit during the week of September 30, 2024 (NRC 2024-TN11380). On October 3, 2024, the NRC staff conducted a virtual audit focused on severe accident mitigation alternatives (SAMA) (NRC 2024-TN11380). The following week, beginning October 7, 2024, the NRC staff carried out an onsite environmental audit (NRC 2024-TN11380). Throughout these audits, the NRC staff held meetings with nuclear power plant personnel and reviewed site-specific documentation and photos. The findings from these audits were captured in a summary dated January 15, 2025 (NRC 2025-TN11382).

By letter dated February 18, 2025,TVA submitted Revision 1 of the Environmental Report (TVA 2025-TN11355) to address additional information needs identified during the audit (NRC 2025-TN11382) and support the preparation of this SEIS.

Upon the completion of the scoping period and site audits, the NRC staff compiled its assessments and initial findings in this draft SEIS. This document is made available for public comment for 45 days. During that time, the NRC staff will host public meetings and collect public comments. Based on the information gathered, the NRC staff will amend the draft SEIS findings, as necessary, and publish a final SEIS. Figure 1-1 shows the major milestones of the NRC's SLR application environmental review process.

Figure 1-1 Environmental Review Process for Subsequent License Renewals of Nuclear Power Plants

1.4 Generic Environmental Impact Statement

To improve the efficiency of its LR environmental review process, the NRC staff assessed the overall environmental effects of license renewal. The LR GEIS (NRC 2024-TN10161), documents the results of the NRC's systematic approach to evaluating the environmental consequences of renewing the licenses of individual nuclear power plants and operating them for an additional 20 years. In the LR GEIS, the NRC staff analyzed in detail and determined the impact of those environmental issues that could be resolved generically.

The LR GEIS establishes separate environmental impact issues for the NRC staff to independently evaluate in LR environmental reviews. Of these issues, the NRC staff determined that some issues are generic to all plants or a specific subset of plants (Category 1). Other issues do not lend themselves to generic consideration and are nuclear plant site-specific (Category 2 or uncategorized). For each LRA, the NRC staff evaluates these issues in a SEIS to the LR GEIS. Table B-1 in Appendix B to Subpart A of 10 CFR Part 51, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," (TN10253) provides a summary of the staff's findings for environmental issues as evaluated in the LR GEIS.

On August 6, 2024, the NRC published a final rule (89 FR 64166-TN10321) revising its environmental protection regulations in 10 CFR Part 51. Specifically, the final rule updated the

potential environmental impacts associated with the renewal of an operating license for a nuclear power plant for up to an additional 20 years, which could either be an initial or subsequent LR. The LR GEIS was also revised (NRC 2024-TN10161) as an update to the 2013 LR GEIS (NRC 2013-TN2654), and provided the technical basis for the final rule. The 2024 LR GEIS specifically supported the revised list of environmental issues and associated environmental impact findings for LR contained in Table B-1 in Appendix B to Subpart A of the revised 10 CFR Part 51 (TN10253). The LR GEIS and final rule reflect lessons learned, knowledge gained, and experience from LR environmental reviews performed since the development of the 2013 LR GEIS; consider changes to applicable laws and regulations; and factor in new scientific data and methodology with respect to the assessment of potential environmental impacts of a nuclear power plant LR. The LR GEIS and final rule identify 80 environmental issues (i.e., 59 Category 1, 20 Category 2, and 1 issue that remains uncategorized) that may be associated with nuclear power plant operation and refurbishment during the renewal term.

For the NRC staff, the final rule became effective 30 days after its publication in the FR and thereafter the staff considers the new and modified issues, as applicable, in its LR SEISs. Compliance with the final rule by LR applicants is not required for up to 1 year following the publication in the FR (i.e., LR ERs submitted later than 1 year after publication must be compliant with the new rule).

For each environmental issue addressed in the LR GEIS, the NRC staff does the following:

- describes the activity or aspect of plant operations or refurbishment that affects the environment
- identifies the population or resource that is affected
- assesses the nature and magnitude of the impact on the affected population or resource
- characterizes the significance of both beneficial and adverse effects
- determines whether the results of the analysis apply to all or a specific subset of nuclear plants
- considers whether additional mitigation measures would be warranted for impacts that would have the same significance level for all plants

In considering whether the incremental environmental effects (impacts) of the NRC's proposed action (SLR) are significant, the NRC staff analyzes the geographic area and intensity of the effects. The geographic area consists of the characteristics of the area and its resources, such as proximity to unique or sensitive resources. For nuclear power plant-specific (hereafter, plant-specific) environmental issues, significance depends on the effects in the relevant geographic area, including, but not limited to, consideration of short- and long-term effects, as well as beneficial and adverse effects. The NRC staff's analysis of the intensity of effects includes consideration of the degree to which the action may (1) adversely affect public health and safety; (2) adversely affect unique characteristics of historic or cultural resources, parks, Tribal sacred sites, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas; (3) violate relevant Federal, State, Tribal, or local laws or other requirements protecting the environment or be inconsistent with Federal, State, Tribal, or local policies designed for the protection of the environment; (4) have potential effects on the human environment that are highly uncertain; (5) adversely affect resources listed or eligible for listing in the National Register of Historic Places (NRHP); (6) adversely affect an endangered or threatened species or its habitat, including habitat that has been determined to be critical under the Endangered

Species Act of 1973 (TN1010); and (7) adversely affect rights of Tribal Nations that have been reserved through treaties, statutes, or Executive Orders. Based on this, the NRC established three levels of significance for potential impacts—SMALL, MODERATE, and LARGE, in a footnote to Table B-1 of 10 CFR Part 51 (TN10253), Appendix B to Subpart A, which are defined below.

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

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

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

These levels are used for describing the environmental impacts of the proposed action as well as for the impacts of a range of reasonable alternatives to the proposed action. Resource-specific effects or impact definitions from applicable environmental laws and executive orders, other than SMALL, MODERATE, and LARGE, are used where appropriate.

The LR GEIS determines whether the analysis of the environmental issue could be applied to all nuclear power plants and whether additional mitigation measures would be warranted. Issues are assigned a Category 1 (generic to all or a distinct subset of plants) or Category 2 (plant-specific) designation. As established in the LR GEIS, Category 1 issues are those that meet the following three criteria:

- The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants that have a specific type of cooling system or other specified plant or site characteristics.
- A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for offsite radiological impacts of spent nuclear fuel and high-level waste disposal and offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste).
- Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

For generic issues (Category 1), the SEIS requires no additional plant-specific evaluation unless new and significant information has been identified.

- **New information** can be identified from many sources, including the applicant, the NRC, other agencies, or public comments. If a new issue is revealed, the NRC staff will first analyze the issue to determine whether it is within the scope of the LR environmental evaluation. If the NRC staff determines that the new issue bears on the proposed action, the staff will then determine the significance of the issue for the plant and analyze the issue in the SEIS.
- **New and significant information**. To merit additional review, information must be both new and significant, and it must bear on the proposed action or its impacts.

Section 3.14 further describes the process for identifying new and significant information for plant-specific analysis. Plant-specific issues (Category 2) are those that do not meet one or more of the three criteria of Category 1 issues; therefore, the SEIS requires additional plant-specific review for these issues.

The LR GEIS (NRC 2024-TN10161), evaluates 80 environmental issues, provides generically applicable findings for numerous issues (subject to the consideration of any new and significant information on a site-specific basis), and concludes that a plant-specific analysis is required for 20 of the 80 issues. Figure 1-2 illustrates the LR environmental review process. The results of that plant-specific review are documented in this SEIS.

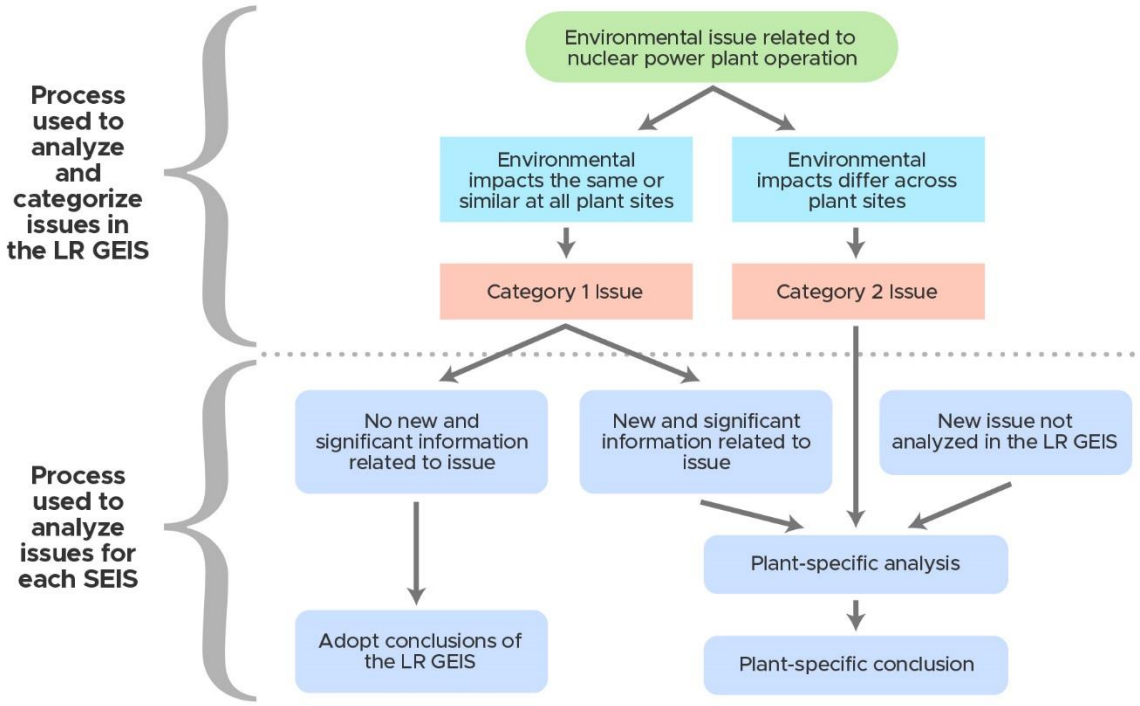

Figure 1-2 Environmental Issues Evaluated for License Renewal of Nuclear Power Plants

1.5 Supplemental Environmental Impact Statement

This SEIS presents an analysis that considers the environmental effects of the continued - operation of Browns Ferry during the LR term, alternatives to LR, and mitigation measures for minimizing adverse environmental impacts. Chapter 2 describes the proposed action and alternatives to the proposed action and a comparison of the alternatives to the proposed action. Chapter 3 contains analysis of the potential environmental impacts from the proposed action. Chapter 4 presents the preliminary recommendation of the NRC staff on whether the adverse environmental impacts of LR for Browns Ferry are so great that preserving the option of LR for energy-planning decision-makers would be unreasonable. The final recommendation will be made after consideration of comments received on the draft SEIS during the public comment period.

The NRC staff based its preliminary recommendation on:

- the analysis and findings in the LR GEIS
- the applicant's ER
- TVA's EIS
- the NRC staff's consultation with Federal, State, Tribal, and local agencies
- the NRC staff's independent environmental review
- the NRC staff's consideration of public comments

1.6 Decision to Be Supported by the EIS

The decision to be supported by this SEIS is whether to renew the Browns Ferry Units 1, 2, and 3 operating licenses for an additional 20 years. The regulation in 10 CFR 51.103(a)(5) (TN10253) that specifies the NRC's environmental review decision standard states:

In making a final decision on a license renewal action pursuant to Part 54 of this chapter, the Commission shall determine whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decision-makers would be unreasonable (10 CFR 51.103(a)(5) [TN10253]).

There are many factors that the NRC takes into consideration when deciding whether to renew the operating license of a nuclear power plant. The analyses of environmental impacts evaluated in the LR GEIS, as supplemented by this SEIS, will provide the NRC's decision-maker (the Commission) with important environmental information for consideration in deciding whether to renew the Browns Ferry operating licenses.

1.7 Cooperating Agencies

During the scoping process, the NRC staff did not identify any Federal, State, Tribal, or local agencies as cooperating agencies for this SEIS.

1.8 Consultations

License renewal environmental reviews may require consultation with other Federal, State, regional, and local agencies and Indian Tribes. For license renewal, the NRC staff must consider the effects of its actions on ecological resources protected under Federal statutes, including the Endangered Species Act of 1973, as amended (ESA) (TN1010), and the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. § 1801-TN9966). Section 106 of National Historic Preservation Act of 1966, as amended (NHPA) (TN4839) requires Federal agencies to take into account the effects of their undertakings on historic properties. See Appendix C for a list of the agencies and groups with which the NRC staff consulted and a description of the consultations and related correspondence.

1.9 Correspondence

Appendix D chronologically lists correspondence the NRC staff sent and received with external parties as part of the agency's environmental review of the Browns Ferry SLR application, excluding the consultation correspondence listed in Appendix C and public comments referenced in Appendix A.

1.10 Status of Compliance

TVA is responsible for complying with all NRC regulations and other applicable Federal, State, and local requirements. Appendix F to the LR GEIS describes some of the major applicable Federal statutes (NRC 2024-TN10161). Numerous permits and licenses are issued by Federal, State, and local authorities for activities at Browns Ferry. Appendix B contains further information about TVA's status of compliance.

1.11 Related State and Federal Activities

The NRC staff reviewed the possibility that activities (projects) of other Federal agencies might impact the renewal of the Browns Ferry operating licenses. Such activities could result in reasonably foreseeable environmental effects and the possible need for the Federal agency to become a cooperating agency for preparing this SEIS. The NRC staff has determined that there are no Federal projects that would make it necessary for another Federal agency to be a cooperating agency in the preparation of this SEIS (10 CFR 51.10(b)(2) [TN10253]). Projects and actions considered in the cumulative impacts analysis are provided in Section 3.17.

Separately, as federally owned electric utility corporation, TVA prepared an EIS (TVA 2023-TN11043) to support its decision to pursue SLR. Accordingly, the NRC staff will consider and incorporate relevant portions of TVA's EIS by reference, as appropriate. The NRC has a long-standing Commission policy regarding TVA applications. Under this approach, the staff prepares an independent EIS for the proposed action (Staff Requirements – SECY-07-0096 – Possible Reactivation of Construction and Licensing Activities for the Watts Bar Nuclear Plan Unit 2; NRC 2007-TN11783).

The NRC is required under Section 102(2)(C) of NEPA (TN661) to consult with and obtain comments from any Federal agency that has jurisdiction by law or special expertise with respect to any environmental impact involved in the subject matter of the NRC's EISs. For example, during the preparation this SEIS, the NRC consulted with the U.S. Fish and Wildlife Service. Appendix C contains a list of key consultation correspondence.

2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

Although the NRC's decision-making authority is limited to deciding whether to renew a nuclear power plant's operating license, the agency's implementation of NEPA (TN661) requires consideration of the environmental impacts of that action as well as the environmental impacts of reasonable alternatives to that action. Although the ultimate decision about which alternative (or the proposed action) to implement falls to the power plant owners and State, utility, system, and, where authorized, Federal (other than NRC) energy-planning decision-makers, comparing the environmental impacts of renewing the operating license to the environmental impacts of alternatives allows the NRC to determine whether the environmental impacts of LR are so great that preserving the option of LR for energy-planning decision-makers would be unreasonable (10 CFR 51.95(c)(4)) (TN10253).

Energy-planning decision-makers and power plant owners ultimately decide whether the nuclear power plant will continue to operate, and economic and environmental considerations play important roles in this decision. In general, the NRC's responsibility is to ensure the safe operation of nuclear power plants, not to formulate energy policy, promote nuclear power, or encourage or discourage the development of alternative power generation. The NRC does not engage in energy-planning decisions and makes no judgment as to which sources of replacement power would be selected.

This chapter describes (1) the Browns Ferry site and its operation, (2) the proposed action (renewal of the Browns Ferry operating licenses), (3) reasonable alternatives to the proposed action (including the no-action alternative), and (4) alternatives eliminated from detailed study.

2.1 Description of Nuclear Power Plant Facility and Operation

Browns Ferry is a three unit nuclear power plant located on the north shore of Wheeler Reservoir in Limestone County, Alabama. TVA began construction on Browns Ferry Units 1, 2, and 3 in 1967. It began commerical operation for Unit 1 in 1974, Unit 2 in 1975 and Unit 3 in 1977. The current renewed facility operating licenses for Units 1, 2, and 3, expire at midnight on December 20, 2033, June 28, 2034, and July 2, 2036, respectively. Unless otherwise noted, the NRC staff drew information about Browns Ferry facilities and operation from TVA's ER (TVA 2024-TN11042,TVA 2025-TN11355).

2.1.1 External Appearance and Setting

Browns Ferry is located on approximately 880 acres (ac) (356 hectors [ha]) along the north shore of Wheeler Reservoir at Tennessee River Mile (TRM) 294, approximately 10 miles northwest of the center of Decatur, Alabama, and 10 miles southwest of Athens, Alabama.

The Browns Ferry site area includes a reactor, turbine, service, maintenance, and two diesel generator buildings. One generating building serves Units 1 and 2 and the other is dedicated to Unit 3. Additional structures within the site include a radioactive waste building, administration buildings, a Diverse and Flexible Coping Strategies equipment storage building, an intake pumping station, a 161-kilovolt (kV) switchyard and capacitor yard, a 500-kV switchyard, an off-gas stack, wastewater lagoons, and two independent spent fuel storage facility installation (ISFSI) pads.

Northwest of the central site area, the hot water and cold water discharge channels are located alongside seven mechanical draft “helper” cooling towers. Features east of the site area, include a meteorological tower, the Training Center, an employee physical fitness center, low-level radioactive waste and hazardous waste storage areas, and a materials and procurement complex. Figure 2-1 provides an overview of the facility’s general layout and site boundary. Figure 2-2 and Figure 2-3 show the Browns Ferry site with a 6-mile radius and a 50-mile radius respectively.

The Browns Ferry site comprises three General Electric boiling water reactors (BWRs) and associated turbine generators, which together produce approximately 3,900 megawatts of electric power (MWe) for the TVA transmission and distribution system (TVA 2025-TN11355). Each of the Browns Ferry three nuclear reactors is paired with a dedicated generator.

2.1.2 Nuclear Reactor Systems

Browns Ferry Nuclear Plant (Browns Ferry) Units 1, 2, and 3 are General Electric Type 4 BWR/4 equipped with Mark I containment systems. The units have a combined maximum thermal power output of 11,856 megawatts thermal and an approximate net electrical generation capacity of 3,900 MWe, including power uprates.

The BWR/4 reactor systems at Browns Ferry operate with a reactor vessel that houses a reactor core, where nuclear fission within uranium dioxide fuel pellets generates heat, causing the coolant water to boil. The resulting steam and water droplets are separated by steam separators and steam dryers, ensuring that only dry steam is directed to the turbines. The turbines convert thermal energy into mechanical energy, which drives generators to produce electricity.

After passing through the turbines, the steam is cooled in the condenser, where it is converted back into liquid coolant and recirculated through the preheaters before returning to the reactor core. Off-gases produced during reactor operation are processed through the off-gas treatment system before being discharged through the Browns Ferry plant stack.

2.1.3 Cooling and Auxiliary Water Systems

Section 2.2.3 of TVA’s ER (TVA 2025-TN11355), submitted as part of its SLR application, provides a description Browns Ferry Nuclear Plant’s condenser circulating water and residual heat removal water systems. Browns Ferry’s circulating and auxiliary water systems are fully described in Sections 10 and 11 of the UFSAR (TVA 2023-TN11360). The NRC staff incorporates this information here by reference. Except as otherwise cited for clarity, the staff summarizes below the information incorporated here by reference and considers any new and potentially significant information since the NRC staff issued NUREG-1437, Supplement 21 (NRC 2005-TN5192).

BWRs, such as the three reactors at Browns Ferry, generate high pressure steam directly within the reactor vessel. Browns Ferry uses a once-through cooling loop (circulating water system) to dissipate heat from the turbine condensers. Sections 3.1.2 and 3.1.3 of the LR GEIS describe reactor and associated cooling systems for BWRs (NRC 2024-TN10161).

Browns Ferry has a number of cooling and auxiliary water systems, all of which use water from Wheeler Reservoir on the Tennessee River. Two of the main systems are the Condenser Circulating Water System and the Raw Cooling Water System.

Figure 2-1 Browns Ferry Nuclear Power Plant Layout. Adapted From: TVA 2024-TN11042.

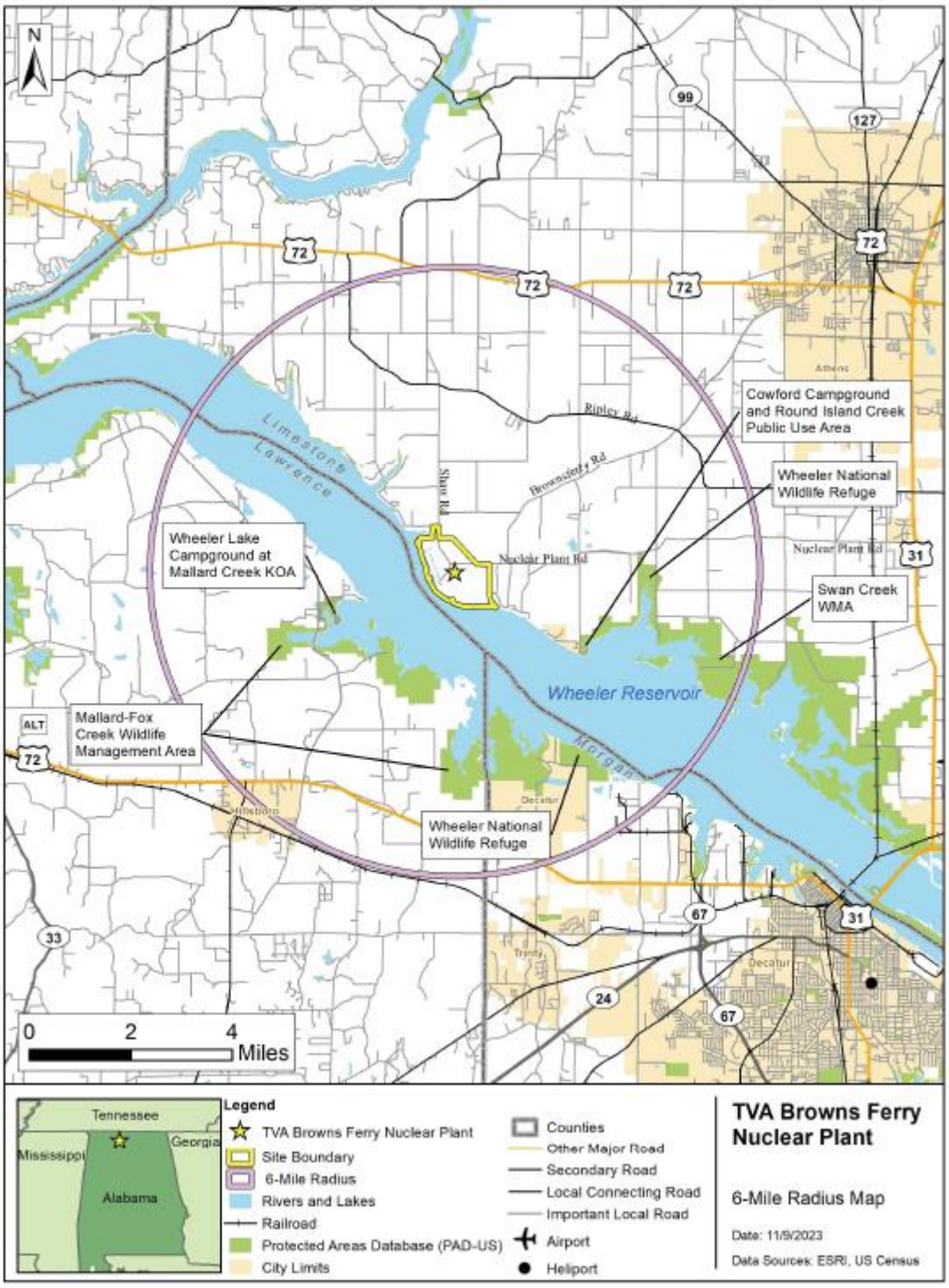

Figure 2-2 Browns Ferry Nuclear Power Plant Site and 6 mi Radius. Adapted From: TVA 2024-TN11042.

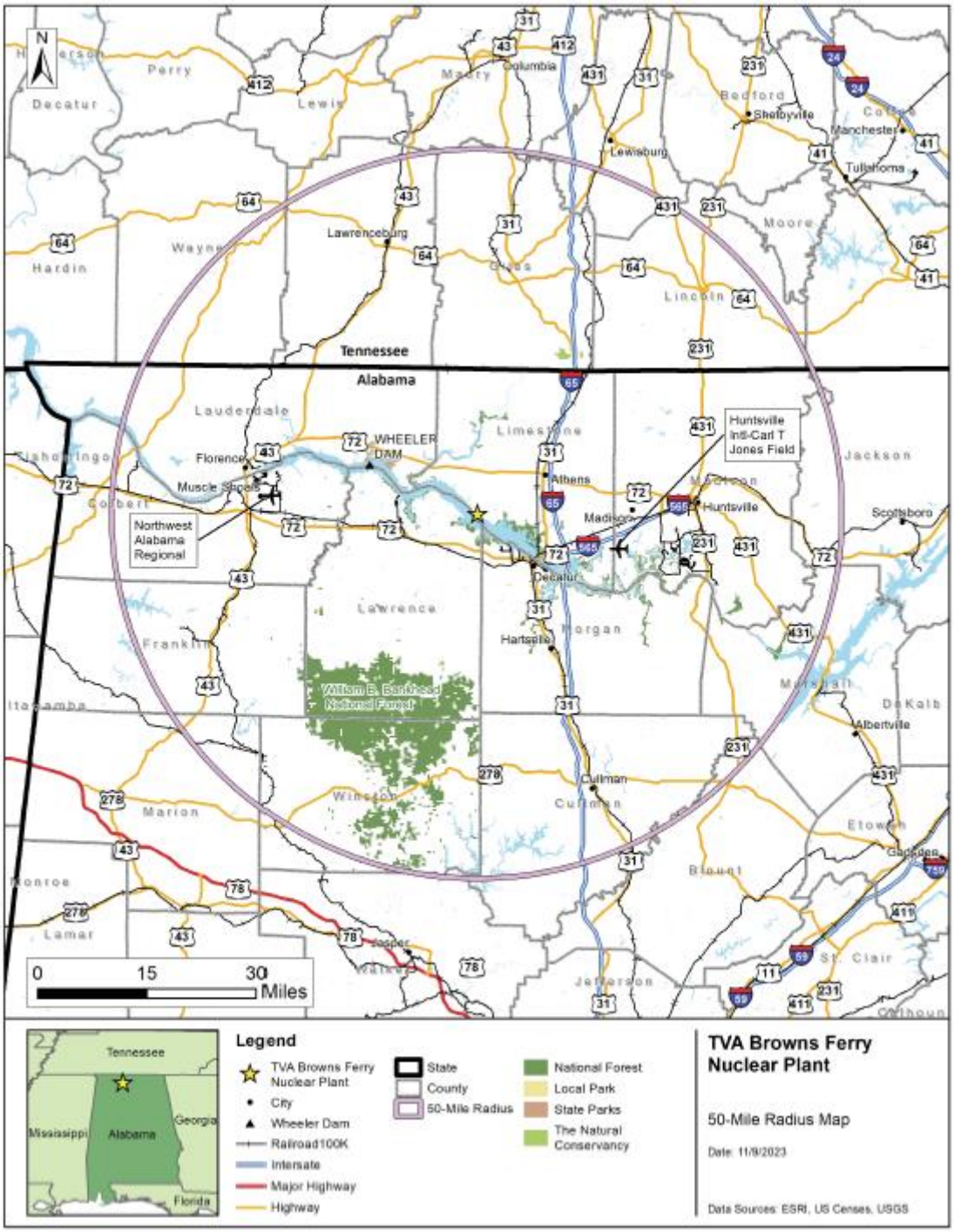

Figure 2-3 Browns Ferry Nuclear Power Plant Site and 50 mi Radius. Adapted From: TVA 2024-TN11042.

The Condenser Circulating Water System has two objectives: remove waste heat from the power generating and associated apparatus and provide water to the Raw Cooling Water System. Normal operation of the Condenser Circulating Water System is a once-though (open cycle) process. Water is withdrawn from Wheeler Reservoir through nine circulating water pumps (which work in groups of three); and strained through trash stacks, traveling screens,

and a debris filter before being channeled to the condenser. The Condenser Circulating Water System is designed to provide a flow of approximately 675,000 gallons per minute (gpm) (2.5 million liters per minutes (lpm)) to the condenser during open cycle operation, and a flow of approximately 25,000 gpm (94,625 lpm) to Raw Cooling Water System of each unit during open cycle operation. Discharge from the Condenser Circulating Water System is either to the seven cooling towers, the Wheeler Reservoir, or a combination of both depending on compliance with thermal discharge limits.

The Raw Cooling Water System has 12 main pumps and provides a continuous supply of cooling water to the Reactor Building Closed Cooling Water System (three 1,700 gpm [6,434 lpm] pumps) which cools designated plant equipment located in the primary and secondary containments. This includes various coolers, compressors, and heat exchangers associated with reactor and power generating operations.

Additional water withdrawals by Browns Ferry from Wheeler Reservoir include providing water to the Emergency Equipment Cooling Water System, the Residual Heat Removal Service Water System, the Fire Protection System, the Intake Screen Wash System, and the Raw Service Water System. The Emergency Equipment Cooling Water System distributes cooling water to essential equipment during normal and accident conditions. It also acts as a backup to the Raw Cooling Water System. The Emergency Equipment Cooling Water System's required design flow for the three-unit plant is met by pumps with a rated capacity of 4,500 gpm (17,032 lpm) at a 275-ft (84 m) head. The Residual Heat Removal Service Water System is a twelve-pump, four-header system that supports heat removal from the primary water of the residual heat removal systems. It also provides standby core and containment cooling and supplies water to the Emergency Equipment Cooling Water System. The Raw Service Water System has four pumps (one each for Units 1 and 2, two for Unit 3) that supply water for yard-watering, cooling for plant equipment which the Raw Cooling Water System may not conveniently serve and maintains the water supply for the Fire Protection System.

2.1.4 Radioactive Waste Management Systems

The NRC licenses nuclear power plants with the expectation that they will release a limited amount of radioactive material to both the air and water during normal operations.

Browns Ferry uses liquid, gaseous, and solid waste processing systems to collect and treat, as needed, radioactive materials produced as a byproduct of nuclear power plant operations. Section 2.2.4 of the TVA revised ER (TVA 2025-TN11355), submitted as part of its SLR application, provides an expanded description of Browns Ferry's radioactive waste management systems, the NRC staff incorporates this information by reference (TVA 2025-TN11355). The NRC staff discusses the radioactive waste management systems in Section 3.13.1 of this SEIS.

2.1.5 Nonradioactive Waste Management Systems

Browns Ferry generates nonradioactive waste as a result of nuclear power plant maintenance, cleaning, and operational processes. Browns Ferry manages nonradioactive wastes in accordance with applicable Federal and State regulations, as implemented through its corporate procedures. Section 2.2.5 of the TVA ER (TVA 2025-TN11355), submitted as part of its SLR application, provides an expanded description of Browns Ferry's nonradioactive waste management systems, the NRC staff incorporates this information by reference. The NRC staff discusses the nonradioactive waste management systems in Section 3.13.2 of this SEIS.

2.1.6 Utility and Transportation Infrastructure

The utility and transportation infrastructure at nuclear power plants typically interfaces with public infrastructure systems available in the region. Such infrastructure includes utilities, such as suppliers of electricity, fuel, and water, as well as roads and railroads that provide access to the site. The following sections briefly describe the existing utility and transportation infrastructure at Browns Ferry. Site-specific information in this section is primarily derived from TVA's ER (TVA 2025-TN11355), unless otherwise cited.

2.1.6.1 Electricity

Nuclear power plants generate electricity for other users; however, they also use electricity to operate. Offsite power sources provide power to engineered safety features and emergency equipment in the event of a malfunction or interruption of power generation at the nuclear power plant. Planned independent backup power sources provide power, if power from both the nuclear power plant itself and offsite power sources is interrupted.

2.1.6.2 Fuel

Browns Ferry utilizes low-enriched uranium dioxide fuel with enrichments below 5.0 percent by weight uranium-235, with peak fuel-rod burn-up levels less than 62,000 megawatt-days per metric ton uranium. Refueling of the reactor is performed every 22 to 24 months with approximately 30 percent of the fuel being replaced during each refueling outage. Browns Ferry stores spent fuel in the spent fuel pool located in the reactor building or in dry cask storage containers at the onsite ISFSI (TVA 2025-TN11355).

2.1.6.3 Water

Browns Ferry withdraws water from Wheeler Reservoir on the Tennessee River for condenser cooling, service water cooling, screen washing, and fire protection purposes. The potable water used for consumption and sanitary systems at Browns Ferry is provided by the Athens Municipal Water Supply (TVA 2023-TN11360). In this EIS, Section 2.1.3 "Cooling and Auxiliary Water Systems," describes the Browns Ferry industrial water systems.

2.1.6.4 Transportation Systems

Nuclear power plants are served by controlled access roads that are connected to U.S. highways and Interstate highways. In addition to roads, many nuclear power plants also have railroad connections for moving heavy equipment and other materials. Nuclear power plants located on navigable waters may have facilities to receive and ship loads on barges. Section 3.10.6, "Local Transportation," describes the Browns Ferry transportation systems.

2.1.6.5 Power Transmission Systems

For LR and SLR actions, the NRC staff evaluates, as part of the proposed action, the continued operation of those Browns Ferry power transmission lines that connect to the substation where it feeds electricity into the regional power distribution system. The transmission lines that are in scope for the Browns Ferry SLR environmental review are onsite and are not accessible to the general public (TVA 2025-TN11355). The NRC staff also considers, as part of the proposed action, the continued operation of the transmission lines that supply outside power to the nuclear plant from the grid. Section 3.11.4, "Electromagnetic Fields," describes these transmission lines.

2.1.7 Nuclear Power Plant Operations and Maintenance

Maintenance activities conducted at Browns Ferry include inspection, testing, and surveillance to maintain the current licensing basis of the facility and to ensure compliance with environmental and safety requirements (TVA 2025-TN11355). These activities include in-service inspections of safety-related structures, systems, and components; quality assurance and fire protection programs; and radioactive and nonradioactive water chemistry monitoring.

Additional programs include those implemented to meet technical specification surveillance requirements and those implemented in response to NRC generic communications. Such additional programs include various periodic maintenance, testing, and inspection procedures necessary to manage the effects of aging on structures and components. Certain program activities are performed during the operation of the units, whereas others are performed during scheduled refueling outages (TVA 2025-TN11355).

2.2 Proposed Action

As stated in Section 1.1, the proposed Federal action is to determine whether to renew the Browns Ferry operating licenses for an additional 20 years. Section 2.2.1 describes normal nuclear power plant operations during the SLR term.

2.2.1 Nuclear Power Plant Operations during the Subsequent License Renewal Term

Nuclear power plant operation activities during the SLR term would be the same as, or similar to, those occurring during the current license term.

Section 2.1, “Description of Nuclear Power Plant Facility and Operation,” describes the general types of activities carried out during nuclear power plant operations.

As part of its SLR application, TVA submitted an ER stating that Browns Ferry will continue to operate during the SLR term in the same manner as it would during the current license term except for additional aging management programs, as necessary (TVA 2025-TN11355). Such programs would address structure and component aging in accordance with 10 CFR Part 54 (TN4878), “Requirements for Renewal of Operating Licenses for Nuclear Power Plants.”

2.2.2 Refurbishment and Other Activities Associated with License Renewal

Refurbishment activities include replacement and repair of major structures, systems, and components. Most major refurbishment activities are actions that would typically take place only once in the life of a nuclear power plant, if at all. For example, reactor vessel head replacement is a refurbishment activity. Refurbishment activities may have an impact on the environment beyond those that occur during normal operations and may require evaluation, depending on the type of action and the nuclear power plant-specific design.

In preparation for its LRA, TVA evaluated major structures, systems, and components in accordance with 10 CFR 54.21 (TN4878), “Contents of Application--Technical Information,” to identify major refurbishment activities necessary for the continued operation of Browns Ferry during the proposed 20-year period of extended operation (TVA 2025-TN11355).

TVA has no plans for refurbishment or replacement activities, outside of normal maintenance at Browns Ferry associated with SLR (TVA 2025-TN11355).

2.2.3 Termination of Nuclear Power Plant Operations and Decommissioning after the License Renewal Term

NUREG-0586, Supplement 1, Volumes 1 and 2, *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Regarding the Decommissioning of Nuclear Power Reactors* (the decommissioning generic environmental impact statement [GEIS]) (NRC 2002-TN665), describes the environmental impacts of decommissioning. The majority of nuclear power plant operation activities would cease with reactor shutdown. Some activities (e.g., security and oversight of spent nuclear fuel) would remain unchanged, whereas others (e.g., waste management, administrative work, laboratory analysis, surveillance, monitoring, and maintenance) would continue at reduced or altered levels. Systems dedicated to reactor operations would cease. However, if these systems are not removed from the site after reactor shutdown, their physical presence may continue to impact the environment. Impacts associated with dedicated systems that remain in place, or with shared systems that continue to operate at normal capacities, could remain unchanged.

Decommissioning could occur whether Browns Ferry is shut down at the end of its current renewed operating license or at the end of subsequent license renewal period of extended operation 20 years later.

2.3 Alternatives

As stated above, NEPA requires the NRC to consider reasonable alternatives to the proposed action of renewing the Browns Ferrys operating licenses. For a replacement energy generating source to be considered reasonable, it must be either (1) commercially viable on a utility scale and operational before the plant's operating licenses expire or (2) expected to become commercially viable on a utility scale and operational before the plant's operating licenses expire.

In this SEIS, NRC relies upon the description of alternative sources of replacement energy in Appendix D of the LR GEIS (NRC 2024-TN10161), and incorporates by reference the replacement energy alternatives evaluated in TVA's 2023 Browns Ferry SLR SEIS (TVA 2023-TN11043) and the alternatives described in TVA's ER (TVA 2024-TN11042). TVA's SLR SEIS eliminated stand-alone replacement energy alternatives from detailed study, and instead analyzed the environmental impacts of a combination of replacement energy generating capacity as part of the no-action alternative (should TVA not obtain SLRs for "all three Browns Ferry units"). The alternatives analysis in TVA's SLR SEIS and in this SEIS are consistent with NEPA Section 102(2)(C)(iii), which states, "[…] a reasonable range of alternatives to the proposed agency action, including an analysis of any negative environmental impacts of not implementing the proposed agency action in the case of a no-action alternative, that are technically and economically feasible, and meet the purpose and need of the proposal."

2.4 No-Action Alternative

Under the no-action alternative, the NRC would not renew the Browns Ferry operating licenses, and the reactor units would shut down on or before the expiration of the current license expiration dates: December 20, 2033, for Unit 1; June 28, 2034, for Unit 2; and July 2, 2036, for Unit 3.

After permanent termination of reactor operations, nuclear power plant operators would initiate decommissioning in accordance with NRC regulations in 10 CFR 50.82 (TN249), "Termination

of License". The NRC's decommissioning GEIS (NRC 2002-TN665) describes the environmental impacts of decommissioning activities at a nuclear power plant. The analyses and findings in the decommissioning GEIS bounds the environmental impacts of most of the site-specific decommissioning activities after TVA terminates reactor operations at Browns Ferry. A licensee must also assess in its post-shutdown decommissioning activities report whether the environmental effects of planned site-specific decommissioning activities would be bounded by the impacts described in previously issued EISs. Section 2.2.3 describes the incremental environmental effects of SLR on decommissioning activities.

TVA's 2019 Integrated Resources Plan (IRP) forecasts TVA's energy generating asset requirements over time (TVA 2019-TN11046). Scenario 6 of this plan evaluated strategies in response to a situation where the three Browns Ferry units cease operation. In Scenario 6 of the IRP, TVA assumed that if the three Browns Ferry operating licenses are not renewed (no-action alternative), a combination of replacement energy generating and storage capacity would be developed using natural gas-fired combined cycle (NGCC), natural gas-fired combustion turbine (NGCT), solar (with and without battery storage), standalone battery storage units, and new nuclear small modular reactors (SMRs). While TVA would need to replace Browns Ferry's 3,900 megawatt (MW) generating capacity with one or more of these energy sources, the specific locations and size of these facilities would be determined by TVA and cannot be quantified. NRC staff reviewed TVA's proposed qualitative combination of replacement energy generating and storage capacity to represent a reasonable combination of replacement generating capacity associated with the current Browns Ferry 3,900 MW generating capacity.

With respect to the energy sources included in the combination, NRC staff considered specific attributes of each energy source, as described in Appendix D of the LR GEIS (NRC 2024-TN10161). For example, NGCC facilities have a relatively high capacity factor of 87 percent (EIA 2022-TN10537) and can produce a large amount of baseload electricity in a relatively small project footprint, but require large capital costs for construction and can result in high air quality emissions during operations. Renewable energy generating sources such as solar have lower capacity factors of around 25 percent (DOE/EIA 2023-TN8821), and while such faciltities have no or limited air quality emissions during operations, the lower capacity factor and higher land use requirements could result in substantial land use and ecological resource impacts during construction and decommissioning. Some of the impacts could be mitigated or reduced with battery storage.

Section 2.5 briefly describes the energy replacement alternatives eliminated from detailed study and provides a basis for their elimination. Section 2.6 summarizes the environmental effects of the proposed action and the no-action alternative, including impacts of Browns Ferry shutdown as well as construction and operation of replacement energy sources.

2.5 Alternatives Considered but Eliminated from Detailed Review

As discussed in Section 2.4, the environmental impacts of replacement energy alternatives were evaluated as a consequence of the no-action alternative, not implementing the proposed agency SLR action. As discussed in TVA's 2019 IRP, if the Browns Ferry licenses are not renewed and the three units cease operation, TVA would replace lost generating capacity with a combination of NGCC, NGCT, solar, storage, and new nuclear SMRs. As such, the following sources of replacement energy were eliminated from detailed study.

2.5.1 Purchased Power

Electric power can be purchased and imported from outside the region. Although purchasing power from existing sources would have no new impact, environmental impacts could be occurring where the electricity is generated, depending on the technology used to generate the power.

Importing power can be economically adverse because purchasing power from a third-party supplier costs more than generating the electric power (NRC 2024-TN10161). In addition, purchased power agreements carry the inherent risk that a supplier may not be able to deliver all of the contracted power. Therefore, purchased power, due to its higher cost and lower reliability, is not a reasonable alternative to Browns Ferry SLR.

2.5.2 Delayed Retirement of Other Generating Facilities

Delaying the retirement of a power plant enables it to continue supplying electricity. Because some power generators are required to adhere to regulations requiring significant reductions in power plant emissions, some owners may opt to retire older, less efficient units rather than incur the cost for compliance. Retirements also may be driven by low competing commodity prices (such as low natural gas prices), slow growth in electricity demand, and EPA Mercury and Air Toxics Standards for fossil-fueled power plants (DOE/EIA 2015-TN4585; EPA 2020-TN8379). Because of these conditions, delayed retirement of older power generating units is not a reasonable alternative to Browns Ferry SLR.

2.5.3 Demand-Side Management

Demand-side management refers to energy conservation and efficiency programs that do not require the addition of new generating capacity. Demand-side management programs can include reducing energy demand through consumer behavioral changes or through altering the characteristics of the electrical load. These programs can be initiated by a utility, transmission operators, the State, or other load serving entities. In general, residential electricity consumers have been responsible for the majority of peak load reductions, and participation in most demand-side management programs is voluntary (NRC 2024-TN10161).

Therefore, the existence of a demand-side management program does not guarantee that reductions in electricity demand will occur. The LR GEIS concluded that, although the energy conservation or energy efficiency potential in the United States is substantial, there have been no cases in which an energy efficiency or conservation program alone has been implemented expressly to replace or offset a large baseload generation station (NRC 2024-TN10161). Therefore, demand-side management programs alone are not a reasonable alternative to Browns Ferry SLR. However, in combination with other power generating technologies, demand-side management could be a reasonable alternative to Browns Ferry SLR.

2.6 Comparison of Alternatives

The NRC assigns a significance level of SMALL, MODERATE, or LARGE for most site-specific issues. Resource-specific effects or impact definitions from applicable environmental laws and executive orders, other than SMALL, MODERATE, and LARGE, are used where appropriate. For ecological resources subject to the ESA (TN1010) and the MSA (TN9966), and for historic and cultural resources subject to the NHPA (TN4839), the impact significance determination language is specific to the relevant law. The order in which the different alternatives are

presented does not imply increasing or decreasing level of impact; nor does the order imply that an energy-planning decision-maker would be more (or less) likely to select any alternative.

Table 2-1 compares the environmental impacts of the proposed action and the no-action alternative at Browns Ferry. The no-action alternative in particular incorporates by reference the alternatives analysis in the TVA SEIS (TVA 2023-TN11043), the staff also incorporates by reference Section 7.2.3, "Environmental Impacts of Alternatives," of the TVA ER (TVA 2024-TN11042). In this section of the ER, TVA provides a qualitative analysis of the environmental impacts of the combination of NGCC, NGCT, solar, storage, and SMR generation. The NRC staff considered the analysis and conclusions of the impacts associated with the new generating assets and the general description of these alternative energy sources presented in Appendix D of the LR GEIS for the individual alternative energy source for each resource and has summarized the impacts in Table 2-1. For certain resources, based on NRC staff analyses and review of the LR GEIS, the no-action alternative contains a different conclusion as to the types and significance of environmental impacts than those discussed in the TVA SEIS.

Table 2-1 Comparison of Environmental Impacts of the Proposed Action and No-Action Alternative at Browns Ferry

Resource	Proposed Action – License Renewal	No Action
Land Use	SMALL	*Impacts of Browns Ferry shutdown:* SMALL. Onsite land use would remain similar to onsite land use under the proposed SLR. Plant structures and other facilities would remain in place until decommissioning. Transmission lines and ROWs would remain in place after the cessation of reactor operations. *Impacts of new generating assets:* SMALL to LARGE, depending on the location and type of new energy generation facility. Some of the new generation could be on the Browns Ferry site or offsite. New transmission line and pipeline construction could also result in a potential for land use impacts; use of existing infrastructure would minimize these impacts during construction.
Visual Resources	SMALL	*Impacts of Browns Ferry shutdown:* SMALL. Termination of reactor operations because the operating license is not renewed would not immediately change the visual appearance of the Browns Ferry site. The most visible structures would likely remain in place for some time during decommissioning until they are eventually dismantled. *Impacts of new generating assets:* SMALL to LARGE, depending on the location and type of new energy generation. Some new generation could be on the Browns Ferry site or offsite.

Table 2-1 Comparison of Environmental Impacts of the Proposed Action and No-Action Alternative at Browns Ferry (Continued)

Resource	Proposed Action – License Renewal	No Action
Air Quality	SMALL	*Impacts of Browns Ferry shutdown:* SMALL. The permanent cessation of Browns Ferry operations would reduce overall air emissions (e.g., from boiler, diesel generators, and vehicle traffic) *Impacts of new generating assets:* SMALL to LARGE. Depending on the type of new energy generation (i.e., fossil fuel or renewable), air emissions can be significant. New NGCCs and NGCTs would result in substantial new pollutant emissions. Other generating assets, including solar, storage, and SMRs, would have minimal emissions.
Noise	SMALL	*Impacts of Browns Ferry shutdown:* SMALL. The permanent cessation of Browns Ferry operations would result in a reduction in noise associated with emergency diesel generators and from vehicle traffic (e.g., workers, deliveries). As site activities are reduced, the NRC staff expects the impact on ambient noise levels to be lower than those from current plant operations. *Impacts of new generating assets:* SMALL to MODERATE. Noise associated with new generation would occur during construction. Depending on the distance between the facility site and transmission line corridor to noise sensitive receptors, noise levels may be noticeable during construction. During operation of new NGCCs and NGCTs, noise from pipeline blowdowns could constitute a new noise source. Depending on the distance of noise sensitive receptors to the pipeline corridor, noise from pipeline blowdowns may be noticeable
Geologic Environment	SMALL	*Impacts of Browns Ferry shutdown:* SMALL. There would be few or no incremental impacts on site geology and soils associated with the shutdown of Browns Ferry. In this case, before beginning decommissioning activities, little or no new ground disturbance would occur at the plant site while operational activities were being reduced and eventually terminated. *Impacts of new generating assets:* SMALL to MODERATE. Ground disturbance would occur during construction of new generating facilities, regardless of whether the new facility is sited on a brownfield or greenfield site. Depending on the location of the facilities, impacts to prime or important farmlands could occur.
Water Resources	SMALL	*Impacts of Browns Ferry shutdown:* SMALL. Water withdrawals would greatly decrease and eventually cease. Stormwater would continue to be discharged from the site, but wastewater discharges would be reduced considerably.

Table 2-1 Comparison of Environmental Impacts of the Proposed Action and No-Action Alternative at Browns Ferry (Continued)

Resource	Proposed Action – License Renewal	No Action
		Impacts of new generating assets: SMALL to LARGE. Impacts would occur associated with construction of all new generating facilities. SMRs and natural gas facilities could have cooling water requirements similar to those of the existing Browns Ferry plant. Use of existing infrastructure would minimize construction impacts.
Terrestrial Resources	SMALL	*Impacts of Browns Ferry shutdown:* SMALL. Much of the operational noise and human activity at Browns Ferry would cease, thereby reducing disturbances to wildlife in forest cover and other natural vegetation on and near the site. Reducing human activity and frequency of operational noise may constitute minor beneficial effects on wildlife inhabiting nearby natural habitats. *Impacts of new generating assets:* SMALL to MODERATE. Impacts would depend on the location and footprint of the new generating facility and would be minimized through the use of best management practices and adherence to applicable regulations. Use of existing infrastructure would minimize construction impacts.
Aquatic Resources	SMALL	*Impacts of Browns Ferry shutdown:* SMALL. Some withdrawal of water would continue during the shutdown period to provide cooling to spent fuel in the spent fuel pool until that fuel could be transferred to dry storage. The amount of water withdrawn for these purposes would be a small fraction of water withdrawals during operations, would decrease over time, and would likely end within the first several years following shutdown. The reduced demand for cooling water would substantially decrease the effects of impingement, entrainment, and thermal effluent on aquatic organisms, and these effects would entirely cease following the transfer of spent fuel to dry storage. *Impacts of new generating assets:* SMALL to MODERATE. Impacts would depend on the location and footprint of the new generating facility and would be minimized through the use of best management practices and adherence to applicable regulations. Use of existing infrastructure would minimize construction impacts.
Federally Protected Ecological Resources	May affect but is not likely to affect federally protected species[(a)]	*Impacts of Browns Ferry shutdown:* Overall, the effects on federally listed species would likely be smaller under the no-action alternative than the effects under continued operation but would depend on the specific shutdown activities as well as the listed species present. *Impacts of new generating assets:* NO EFFECT to NOT LIKELY TO ADVERSELY AFFECT. Impacts on federally protected species would depend on the

Table 2-1 Comparison of Environmental Impacts of the Proposed Action and No-Action Alternative at Browns Ferry (Continued)

Resource	Proposed Action – License Renewal	No Action
		location of the new generating facilities, the effects of these facilities on protected species (e.g., cooling water discharges), and the presence of protected species on such sites. Consultation with appropriate agencies would be conducted and would minimize impacts.
Historic and Cultural Resources	No adverse effect to historic properties	*Impacts of Browns Ferry shutdown:* No immediate effect on historic properties or historic and cultural resources. *Impacts of new generating assets:* NO EFFECT to NOT LIKELY TO ADVERSELY AFFECT. Impacts would depend on the presence of historic properties on sites selected for new generating facilities and would likely be lessened for projects proposed on brownfield sites. Compliance with best management practices and Section 106 of the National Historic Preservation Act and consultation with applicable Tribal Historic Preservation Officers would minimize impacts.
Socioeconomics	SMALL	*Impacts of Browns Ferry shutdown:* SMALL to LARGE. The loss of jobs, income, and tax revenue would have an immediate noticeable socioeconomic impact. As jobs are eliminated, some, but not all, workers could leave. Income from the buying and selling of goods and services needed to maintain the nuclear power plant would also be reduced. In addition, loss of tax revenue could affect the availability of public services. If workers and their families move away, increased vacancies and reduced demand for housing would likely cause property values to fall. *Impacts of new generating assets:* SMALL to MODERATE. The closure of Browns Ferry would result in a loss of jobs in the surrounding area and potentially adverse indirect impacts on taxes, housing, land use, and public services. Construction and operation of new energy generating facilities could offset negative impacts, and would be dependent on the location, type, and size of the energy replacement facilities.
Human Health	SMALL and UNCERTAIN[(b)]	*Impacts of Browns Ferry shutdown:* SMALL. Human health risks would be smaller following nuclear power plant shutdown. The reactor unit, which currently operates within regulatory limits, would emit less radioactive gaseous, liquid, and solid material to the environment. In addition, following shutdown, the variety of potential accidents at the nuclear power plant (radiological or industrial) would be reduced to a limited set associated with shutdown events and fuel handling and storage. *Impacts of new generating assets:* SMALL and UNCERTAIN. Construction of new generating facilities could result in temporary human health impacts.

Table 2-1 Comparison of Environmental Impacts of the Proposed Action and No-Action Alternative at Browns Ferry (Continued)

Resource	Proposed Action – License Renewal	No Action
		Operation of these facilities could have human health impacts that would be mitigated by adherence to best management practices, safety standards, and applicable regulations. Given the regulatory oversight exercised by the EPA and State agencies, the NRC staff concludes that the human health impacts from the alternatives presented in the ER would be SMALL, except for "chronic effects of electromagnetic fields (EMFs)," for which the impacts are UNCERTAIN. Human health impacts are discussed in Section D.4.8 of the LR GEIS (NRC 2024-TN10161).
Waste Management	SMALL[(c)]	*Impacts of Browns Ferry shutdown:* SMALL. The variety of potential accidents at the nuclear power plant (radiological and industrial) would be reduced to a limited set associated with shutdown events and fuel handling and storage. *Impacts of new generating assets:* SMALL. The amount and types of waste generated would depend on the size and type of the new generating facility. Impacts would be minimized by adherence to best management practices and proper onsite management and offsite disposal management.
Greenhouse Gas Emissions	SMALL	*Impacts of Browns Ferry shutdown:* SMALL. The closure of Browns Ferry would result in a loss of 3,900 MW of baseload generation having minimal GHG emissions. *Impacts of new generating assets:* SMALL to MODERATE. Replacement of the 3,900 MW of baseload generation having minimal GHG emissions at Browns Ferry with new generating facilities would result in temporary increases in GHG emissions associated with construction, and potential ongoing operational emissions associated with NGCC and NGCT facilities.
Fuel Cycle	SMALL	*Impacts of Browns Ferry shutdown:* Uranium fuel cycle impacts associated with the shutdown of Browns Ferry are expected to be similar to those described in Section 3.15.1 of this SEIS and summarized in Table 3-1 of this SEIS. *Impacts of new generating assets:* Impacts would depend on the source and specific technology of the replacement power generation facility. If new nuclear generation were selected, the plant would be subject to the same requirements for the uranium fuel cycle. The environmental impacts of the uranium fuel cycle are referenced in Section 3.15.1 of this EIS and are expected to be SMALL. Potential alternative fuel cycle impacts from construction and

Table 2-1 Comparison of Environmental Impacts of the Proposed Action and No-Action Alternative at Browns Ferry (Continued)

Resource	Proposed Action – License Renewal	No Action
		operation of other replacement generation would vary depending on the source. Replacement power plant fuel cycle impacts are discussed in Section D.4.12 of the LR GEIS (see subsection, "Replacement Energy Alternative Fuel Cycles") (NRC 2024-TN10161).
Termination of Operations/ Decommissioning	SMALL	*Impacts of Browns Ferry shutdown:* The environmental impacts of decommissioning a nuclear power plant are evaluated NUREG-0586, *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors* (NRC 2002-TN665). Additionally, Section 4.14.2.1 of the LR GEIS (NRC 2024-TN10161) summarizes the incremental environmental impacts associated with nuclear power plant decommissioning activities. The NRC staff incorporates the information in NUREG-0586, Supplement 1, and NUREG-1437, Revision 1, Section 4.14.2.1 (NRC 2024-TN10161: pp.4-164–4-171), herein by reference. *Impacts of new generating assets:* The range of possible decommissioning considerations and impacts, depending on the energy alternative considered, is discussed in Section D.4.13 of the LR GEIS (see subsection, "Termination of Operations and Decommissioning of Replacement Power Plants") (NRC 2024-TN10161).

EMF = electromagnetic field; EPA = U.S. Environmental Protection Agency; GHG = greenhouse gas; LR GEIS = *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Final Report*; NGCC = natural gas-fired combined cycle; NGCT = natural gas-fired combustion turbine; NRC = U.S. Nuclear Regulatory Commission; ROW = right-of-way; SLR = subsequent license renewal; SMR = small modular reactor.

(a) May affect but is not likely to affect gray bat, Indiana bat, whooping crane, monarch butterfly, slackwater darter, pink mucket, rough pigtoe, sheepnose, spectaclecase, critical habitat for spectaclecase, Tennessee pigtoe, Anthony's riversnail, armored snail, slender campeloma. No effect on eastern hellbender, spring pygmy sunfish, birdwing pearlymussel, cracking pearlymussel, Cumberlandian combshell, dromedary pearlymussel, fluted knidneyshell, organgefoot pimpleback, ring pink. No effect on federally protected resources and critical habitats under National Marine Fisheries Service jurisdiction No effect on essential fish habitat (EFH). No effect on sanctuary resources of national marine sanctuaries.

(b) Human Health – Electromagnetic fields (EMFs) have an UNCERTAIN impact and is discussed in Section 3.11.4.

(c) NUREG-2157, Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel (NRC 2014-TN4117), discusses the environmental impacts of spent fuel storage for the timeframe beyond the licensed life for reactor operations.

3 AFFECTED ENVIRONMENT, ENVIRONMENTAL CONSEQUENCES, AND MITIGATING ACTIONS

3.1 Introduction

In conducting its review of the environmental effects of renewing the Browns Ferry operating licenses, the NRC staff defines and describes the environment that could be affected by the proposed action (renewing the operating licenses authorizing an additional 20 years of operation). The NRC staff also evaluates the environmental consequences of the proposed action as well as reasonable alternatives to the proposed action.

In this chapter, the affected environment is the environment that currently exists at and around Browns Ferry. Because existing conditions are at least partially the result of past construction and nuclear power plant operations, this chapter considers the nature and impacts of past and ongoing operations and evaluates how, together, these actions have shaped the current environment. This chapter also describes reasonably foreseeable environmental trends. The effects of ongoing reactor operations at Browns Ferry have become well-established as environmental conditions have adjusted to the presence of the facility.[1]

Sections 3.2 through 3.13 describe the affected environment for each resource area, followed by the NRC staff's evaluation of the environmental consequences of the proposed action. In Section 2.6, the NRC staff compares the environmental impacts of SLR with those of the no-action alternative including the environmental impacts of a combination of replacement energy generating capacity as part of the no-action alternative to determine whether the adverse environmental impacts of SLR are so great that it would be unreasonable to preserve the option for energy-planning decision-makers.

The NRC staff's evaluation of environmental consequences includes the following:

- impacts associated with continued operations during the period of extended operation
- impacts of the reasonable power replacement alternatives to the proposed action as part of the no-action alternative (not issuing the renewed licenses)
- impacts common to all alternatives: (1) fuel cycle including uranium fuel cycle, (2) terminating power plant operations and decommissioning, and (3) greenhouse gas emissions and climate change
- impacts associated with the uranium fuel cycle
- impacts of postulated accidents (design-basis accidents and severe accidents)
- cumulative impacts of the proposed action
- resource commitments associated with the proposed action, including unavoidable adverse impacts, the relationship between short-term use and long-term productivity, and irreversible and irretrievable commitment of resources
- new and potentially significant information about environmental issues related to the impacts of operation during the renewal term

[1] Where appropriate, the NRC staff has summarized referenced information (incorporated information by reference) in this supplemental environmental impact statement. This allows the NRC staff to focus on new and potentially significant information identified since previous NEPA documentation available for Browns Ferry.

As stated in Sections 1.4 and 1.5, this SEIS documents the NRC staff's environmental review of issues applicable to Browns Ferry's ER. Table 3-1 lists the Browns Ferry SLR environmental issues and the impact findings related to these issues. This EIS considers the environmental impacts of each license renewal issue on a site-specific basis. Section 1.4 provides the definitions of SMALL, MODERATE, and LARGE impact significance.

Table 3-1 Applicable Category 1 (Generic) Conclusions Regarding the Browns Ferry Nuclear Power Plant License Renewal

Environmental Issue	LR GEIS Section	Impact
Land Use – Onsite land use	4.2.1.1.1	SMALL
Land Use – Offsite land use	4.2.1.1.2	SMALL
Visual Resources – Aesthetic Impacts	4.2.1.2.1	SMALL
Air Quality – Air quality impacts	4.3.1.1.1	SMALL
Air Quality – Air quality effects of transmission lines	4.3.1.1.2	SMALL
Noise – Noise impacts	4.3.1.2.1	SMALL
Geologic Environment – Geology and soils	4.4.1.1	SMALL
Surface Water Resources – Surface water use and quality (non-cooling system impacts)	4.5.1.1.1	SMALL
Surface Water Resources – Altered current patterns at intake and discharge structures	4.5.1.1.2	SMALL
Surface Water Resources – Altered thermal stratification of lakes	4.5.1.1.4	SMALL
Surface Water Resources – Scouring caused by discharged cooling water	4.5.1.1.5	SMALL
Surface Water Resources – Discharge of metals in cooling system effluent	4.5.1.1.6	SMALL
Surface Water Resources – Discharge of biocides, sanitary wastes, and minor chemical spills	4.5.1.1.7	SMALL
Surface Water Resources – Surface water use conflicts (plants with once-through cooling systems)	4.5.1.1.8	SMALL
Surface Water Resources – Effects of dredging on surface water quality	4.5.1.1.10	SMALL
Surface Water Resources – Temperature effects on sediment transport capacity	4.5.1.1.11	SMALL
Groundwater Resources – Groundwater contamination and use (non-cooling system impacts)	4.5.1.2.1	SMALL
Groundwater Resources – Groundwater use conflicts (plants that withdraw less than 100 gallons per minute [gpm])	4.5.1.2.2	SMALL
Terrestrial Resources – Exposure of terrestrial organisms to radionuclides	4.6.1.1.2	SMALL
Terrestrial Resources – Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds)	4.6.1.1.3	SMALL
Terrestrial Resources – Cooling tower impacts on terrestrial plants	4.6.1.1.4	SMALL
Terrestrial Resources – Bird collisions with plant structures and transmission lines	4.6.1.1.5	SMALL
Terrestrial Resources – Transmission line right-of-way (ROW) management impacts on terrestrial resources	4.6.1.1.7	SMALL

1

Table 3-1 Applicable Category 1 (Generic) Conclusions Regarding the Browns Ferry Nuclear Power Plant License Renewal (Continued)

Environmental Issue	LR GEIS Section	Impact
Terrestrial Resources – Electromagnetic field effects on terrestrial plants and animals	4.6.1.1.8	SMALL
Aquatic Resources – Impingement mortality and entrainment of aquatic organisms (plants with cooling towers)	4.6.1.2.2	SMALL
Aquatic Resources – Entrainment of phytoplankton and zooplankton	4.6.1.2.3	SMALL
Aquatic Resources – Effects of thermal effluents on aquatic organisms (plants with cooling towers)	4.6.1.2.5	SMALL
Aquatic Resources – Infrequently reported effects of thermal effluents	4.6.1.2.6	SMALL
Aquatic Resources – Effects of nonradiological contaminants on aquatic organisms	4.6.1.2.7	SMALL
Aquatic Resources – Exposure of aquatic organisms to radionuclides	4.6.1.2.8	SMALL
Aquatic Resources – Effects of dredging on aquatic organisms	4.6.1.2.9	SMALL
Aquatic Resources – Non-cooling system impacts on aquatic resources	4.6.1.2.11	SMALL
Aquatic Resources – Impacts of transmission line right-of-way (ROW) management on aquatic resources	4.6.1.2.12	SMALL
Socioeconomics – Employment and income, recreation and tourism	4.8.1.1	SMALL
Socioeconomics – Tax revenue	4.8.1.2	SMALL
Socioeconomics – Community services and education	4.8.1.3	SMALL
Socioeconomics – Population and housing	4.8.1.4	SMALL
Socioeconomics – Transportation	4.8.1.5	SMALL
Human Health – Radiation exposures to plant workers	4.9.1.1.1	SMALL
Human Health – Radiation exposures to the public	4.9.1.1.1	SMALL
Human Health – Chemical hazards	4.9.1.1.2	SMALL
Human Health – Microbiological hazards to plant workers	4.9.1.1.3	SMALL
Human Health – Physical occupational hazards	4.9.4.1.5	SMALL
Postulated Accidents – Design-basis accidents	4.9.1.2.1	SMALL
Postulated Accidents – Severe accidents	4.9.1.2.1	SMALL
Waste Management – Low-level waste storage and disposal	4.11.1.1	SMALL
Waste Management – Onsite storage of spent nuclear fuel	4.11.1.2	SMALL
Waste Management – Offsite radiological impacts of spent nuclear fuel and high-level waste disposal	4.11.1.3	(a)
Waste Management – Mixed-waste storage and disposal	4.11.1.4	SMALL
Waste Management – Nonradioactive waste storage and disposal	4.11.1.5	SMALL
Greenhouse Gas Emissions and Climate Change – Greenhouse gas impacts on climate change	4.12.1	SMALL
Uranium Fuel Cycle – Offsite radiological impacts—individual impacts from other than the disposal of spent fuel and high-level waste	4.14.1.5	SMALL
Uranium Fuel Cycle – Offsite radiological impacts—collective	4.14.1.5	(b)

Table 3-1 Applicable Category 1 (Generic) Conclusions Regarding the Browns Ferry Nuclear Power Plant License Renewal (Continued)

Environmental Issue	LR GEIS Section	Impact
impacts from other than the disposal of spent fuel and high-level waste		
Uranium Fuel Cycle – Nonradiological impacts of the uranium fuel cycle	4.14.1.5	SMALL
Uranium Fuel Cycle – Transportation	4.14.1.5	SMALL
Termination of plant operations and decommissioning	4.14.2.1	SMALL

ROW = right-of-way.

(a) The ultimate disposal of spent fuel in a potential future geologic repository is a separate and independent licensing action that is outside the regulatory scope of this review. Per 10 CFR Part 51 (TN10253) Subpart A, the Commission concludes that the impacts presented in NUREG-2157 (NRC 2014-TN4117) would not be sufficiently large to require the NEPA conclusion, for any nuclear power plant, that the option of extended operation under 10 CFR Part 54 (TN4878) should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent nuclear fuel and high-level waste disposal, this issue is considered generic to all nuclear power plants.

(b) There are no regulatory limits applicable to collective doses to the general public from fuel cycle facilities. The practice of estimating health effects on the basis of collective doses may not be meaningful. All fuel cycle facilities are designed and operated to meet the applicable regulatory limits and standards. As stated in the LR GEIS, "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."

Sources: Table B-1 in Appendix B, Subpart A, to 10 CFR Part 51-TN10253; NRC 2024-TN10161.

The NRC staff analyzed the applicable Category 2 (site-specific) issues for Browns Ferry and assigned a significance level for each issue as shown in Table 3-2.

Table 3-2 Applicable Category 2 (Site-Specific) Conclusions Regarding the Browns Ferry Nuclear Power Plant License Renewal

Environmental Issue	LR GEIS Section	Impact[(a)]
Groundwater Resources – Radionuclides released to groundwater	4.5.1.2.7	SMALL
Terrestrial Resources – Non-cooling system impacts on terrestrial resources	4.6.1.1.1	SMALL
Terrestrial Resources – Water use conflicts with terrestrial resources (plants with cooling ponds or cooling towers using makeup water from a river)	4.6.1.1.6	SMALL
Aquatic Resources – Impingement mortality and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)	4.6.1.2.1	SMALL
Aquatic Resources – Effects of thermal effluents on aquatic organisms (plants with once-through cooling systems or cooling ponds)	4.6.1.2.4	SMALL
Aquatic Resources – Water use conflicts with aquatic resources (plants with cooling ponds or cooling towers using makeup water from a river)	4.6.1.2.10	SMALL

Table 3-2 Applicable Category 2 (Site-Specific) Conclusions Regarding the Browns Ferry Nuclear Power Plant License Renewal (Continued)

Environmental Issue	LR GEIS Section	Impact[a]
Federally Protected Ecological Resources – Endangered Species Act: Federally listed species and critical habitats under U.S. Fish and Wildlife Service jurisdiction	4.6.1.3.1	May affect but is not likely to affect federally protected species[b] No effect on federally protected species[c]
Federally Protected Ecological Resources – Endangered Species Act: federally listed species and critical habitats under National Marine Fisheries Service jurisdiction	4.6.1.3.2	No effect
Federally Protected Ecological Resources – Magnuson-Stevens Act: essential fish habitat	4.6.1.3.3	No effect
Federally Protected Ecological Resources – National Marine Sanctuaries Act: sanctuary resources	4.6.1.3.4	No effect
Historic and Cultural Resources – Historic and cultural resources	4.7.1	No Adverse Effect to historic properties and no impact to historic and cultural resources
Human Health – Microbiological hazards to the public	4.9.1.1.3	SMALL
Human Health – Electromagnetic fields (EMFs)[d]	4.9.1.1.4	Uncategorized (Uncertain Impact)
Human Health – Electric shock hazards	4.9.1.1.5	SMALL
Greenhouse Gas Emissions and Climate Change – Climate change impacts on environmental resources	4.12.2	See Section 3.16 of this SEIS.
Cumulative Effects – Cumulative effects	4.13	See Chapter 3 of this SEIS.

DPS = distinct population segments; SEIS = supplemental environmental impact statement.

(a) Impact determinations for Category 2 issues based on findings described in Sections 3.2 through 3.6, as applicable, for the proposed action.

(b) Gray bat, Indiana bat, whooping crane, monarch butterfly, slackwater darter, pink mucket, rough pigtoe, sheepnose, spectaclecase, critical habitat for spectaclecase, Tennessee pigtoe, Anthony's riversnail, armored snail, slender campeloma.

(c) Eastern hellbender, spring pygmy sunfish, birdwing pearlymussel, cracking pearlymussel, Cumberlandian combshell, dromedary pearlymussel, fluted knidneyshell, organgefoot pimpleback, ring pink.

(d) This issue was not designated as Category 1 or Category 2 and is discussed in Section 3.11.4.

Sources: Table B-1 in Appendix B, Subpart A, to 10 CFR Part 51-TN10253; NRC 2024-TN10161.

3.2 Land Use and Visual Resources

This section describes current onsite and offsite land use and visual resources on or near the Browns Ferry site, including potential land use and visual impacts from the proposed action (SLR). The TVA's ER (TVA 2024-TN11042, TVA 2025-TN11355), Section 4.1, and responses to requests for additional information (TVA 2025-TN11354) support the NRC's analysis of the impacts of the proposed action.

3.2.1 Land Use

3.2.1.1 Onsite Land Use

The Browns Ferry site is located on approximately 880 ac (356 ha) along the north shore of Wheeler Reservoir in Limestone County, Alabama. The nearest metropolitan areas to Browns Ferry are Decatur, Alabama to the southeast and Athens, Alabama to the northeast. Both areas are 10 mi (16 kilometers [km]) away (TVA 2024-TN11042).

As shown in Table 3-3, the primary land cover identified by satellite within the site boundary is hay/pasture (27 percent). However, no hay/pasture or cultivated crops are grown within the Browns Ferry site boundary. Other predominant land cover includes developed areas (44 percent), herbaceous (7.5 percent) and deciduous forest (4 percent) (TVA 2025-TN11355).

Table 3-3 Land Use/Land Cover, Browns Ferry Nuclear Plant Site

Category	Acres	Percentage
Hay/Pasture	232.88	26.66
Developed, Medium Intensity	176.02	20.15
Developed, High Intensity	93.17	10.67
Developed, Low Intensity	86.76	9.93
Herbaceous	65.86	7.54
Deciduous Forest	32.45	3.72
Open Water	41.90	4.80
Developed, Open Space	32.30	3.70
Cultivated Crops	29.98	3.43
Mixed Forest	28.23	3.23
Woody Wetlands	24.91	2.85
Barren Land (Rock/Sand/Clay)	16.81	1.92
Shrub/Scrub	5.38	0.62
Evergreen Forest	4.79	0.55
Emergent Herbaceous Wetlands	1.96	0.22
Total	**873.39[(a)]**	**100.0**

(a) Fee acreage for the Browns Ferry tract is approximately 880 ac. A land survey has not been conducted to create a Geographic Information System (GIS) shapefile of the property. The GIS shapefiles of the Browns Ferry tract used for this analysis includes 873.72 ac of the property.
As shown in Figure 3.0-2 of the TVA ER (TVA 2024-TN11042), access to the Browns Ferry site is via Shaw Road from the north and Nuclear Plant Road from the east. Shaw Road is accessible by U.S. Highway 72 and Nuclear Plant Road is accessible by U.S. Highway 31 (TVA 2024-TN11042). Browns Ferry does not have direct rail service, however there is a railroad spur into the turbine building that has not been used since construction. Traffic near Browns Ferry on the Wheeler Reservoir includes both commercial and recreational vessels. The Guntersville Lock and Dam and the Wheeler Dam handle river traffic, including barge deliveries to Browns Ferry. A barge facility, located near the northwest corner of the Browns Ferry site, is used for shipping and receiving via the Tennessee river (NRC 2005-TN5192).

Source: TVA 2025-TN11355.

3.2.1.2 Offsite Land Use

The 6 mi (10 km) radius surrounding the Browns Ferry site is within Limestone, Lawrence, and Morgan counties in Alabama and includes a mix of agricultural lands and wetlands with interspersed forested and natural areas. The primary land cover in the 6 mi (10 km) radius surrounding the Browns Ferry is cultivated crops (32.5 percent). Other predominant land cover includes open water (22 percent), hay/pasture (15 percent), and woody wetlands (12.6 percent) (TVA 2025-TN11355) (Table 3-4).

Table 3-4 Land Use/Land Cover, 6 mi Radius of the Browns Ferry Nuclear Plant Site

Category	Acres	Percentage
Cultivated Crops	23,489.12	32.45
Open Water	15,952.28	22.04
Hay/Pasture	10,955.91	15.14
Woody Wetlands	9,085.53	12.55
Deciduous Forest	3,022.02	4.18
Developed, Open Space	2,326.06	3.21
Emergent Herbaceous Wetlands	1,396.18	1.93
Developed, Low Intensity	1,210.79	1.67
Evergreen Forest	1,091.18	1.51
Developed, Medium Intensity	1,038.41	1.43
Developed, High Intensity	812.05	1.12
Mixed Forest	700.27	0.97
Shrub/Scrub	563.60	0.78
Herbaceous	535.46	0.74
Barren Land (Rock/Sand/Clay)	202.71	0.28
Total	**72,381.59**	**100.0**

Source: TVA 2025-TN11355.

Limestone County, located on the northern shore of the Wheeler Reservoir, is approximately 358,000 ac (145,000 ha) of which 225,000 ac (91,000 ha) is farmland. The Wheeler National Wildlife Refuge within Limestone and Morgan counties consist of 35,000 ac (14,000 ha) used to manage and protect natural habitats and provide recreational activities. There are six cities within Limestone County, of which the city of Athens acts as the county seat (TVA 2024-TN11042). In 2013, Athens published a Land Use and Development Plan (CAA 2013-TN11359) regarding urban development in the community, looking at the expected continued increase in population in the county.

Lawrence County, located along the southern shore of Wheeler Reservoir, is approximately 444,000 ac (180,000 ha), of which 214,000 ac (86,600 ha) is farmland. There are also natural features present in Lawrence County including Bankhead National Forest, Joe Wheeler State Park, wilderness areas, and recreation parks. There are six cities within Lawrence County and the City of Moulton acts as the county seat. There are no zoning, building, or occupancy permits outside of local municipalities (TVA 2024-TN11042).

Morgan County, located along the southern shore of Wheeler Reservoir, is approximately 371,000 ac (150,000 ha), of which 96,600 ac (39,000 ha) is farmland. Natural features in the county include the Wheeler National Wildlife Refuge, Point Mallard Park, trails and wildlife areas. There are seven cities in Morgan County, with Decatur as the largest (TVA 2024-TN11042).

Section 307(c)(3)(A) of the Coastal Zone Management Act of 1972, as amended (16 U.S.C. 1456(c)(3)(A)) (TN1243) requires that applicants for Federal licenses who conduct activities in a coastal zone provide a certification to the licensing agency (in this case the NRC) that the proposed activity complies with the enforceable policies of the State's coastal zone program. The Federal regulations that implement the Coastal Zone Management Act indicate that this requirement is applicable to renewal of Federal licenses for actions not previously reviewed by the State (15 CFR 930.51(b)(1)) (TN4475).

The Alabama Coastal Area Management Program enforces Coastal Zone Management Program policies in portions of Baldwin and Mobile counties in Alabama. Neither Browns Ferry nor surrounding areas are within these two counties; as a result, the Coastal Zone Management Act does not apply to the Browns Ferry site or this SLR application.

3.2.2 Visual Resources – Aesthetic Impacts

As noted earlier in Section 3.2.1, the Browns Ferry site is located on the northern shore of Wheeler Reservoir in Limestone County, Alabama. Prominent visual features at Browns Ferry include the off-gas stack, reactor building, turbine building, transmission towers and lines, and cooling towers. The tallest structure on the Browns Ferry site is the off-gas stack. The area surrounding Browns Ferry is relatively flat with surrounding agricultural and forested areas and sparce residential areas. The Browns Ferry structures are visible from certain areas surrounding the site and from Wheeler Reservoir (TVA 2024-TN11042).

3.2.3 Proposed Action

As described in the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-1 of this SEIS, for generic issues related to land use and visual resources, the impacts of nuclear power plant SLR and continued operations would be SMALL. The NRC staff's review did not identify any new and significant information that would change the conclusion in the LR GEIS with respect to Browns Ferry SLR, as further described below.

3.2.3.1 Onsite Land Use

Operational activities during the SLR term would be similar to those already occurring at Browns Ferry. The industrial nature of onsite land use would continue unchanged. However, installation of a third ISFSI storage pad is under consideration for onsite storage of the spent nuclear fuel generated during the SLR term, but plans are still in the conceptual stage and potential impacts from this expansion will be assessed in a separate licensing action. There are no additional changes in land use impacts expected during the license renewal term (TVA 2024-TN11042).

3.2.3.2 Offsite Land Use

License renewal activities have had little to no effect on population or tax revenue in communities near nuclear power plants. Employment levels at Browns Ferry have remained the same with no increased demand for housing, infrastructure improvements, or services. Operational activities during the SLR term would be similar to those already occurring at Browns Ferry and would not affect offsite land use beyond what has already been affected.

3.2.3.3 Visual Resources

The nuclear plant operations at Browns Ferry have not changed appreciably with time, and there are no plans for new construction or refurbishment that would result in new visual impacts

during the renewal term (TVA 2024-TN11042). The visual appearance of Browns Ferry and associated transmission lines has become well-established during the current licensing term and is not likely to change appreciably over time.

3.3 Meteorology, Air Quality, and Noise

3.3.1 Meteorology and Climatology

Alabama's climate is humid subtropical characterized by relatively mild winters, hot summers, and year-round precipitation. The State is exposed to warm, moist air from the Gulf of America and dry continental air masses (Runkle et al. 2022-TN11580). The regional climate is influenced by a semipermanent high-pressure system, known as the Bermuda High, in the North Atlantic that causes a persistent southernly flow of air off the gulf during half of the year. The immediate terrain in the vicinity of Browns Ferry is flat or slightly undulating with scattered 400 to 600 feet (ft) (0.12 to 0.18 km) foothills and ridges located 20 to 25 mi (32 to 40 km) to the east of the site; there are no local physiographical features to cause significant climatological anomalies at the site (TVA 2023-TN11043).

TVA maintains a meteorological monitoring system comprised of two (300 ft [91 m] and 33 ft [10 m]) meteorological towers. The meteorological towers measure wind speed and direction, temperature, dewpoint, and rainfall. TVA provided meteorological observations (temperature, wind conditions, and precipitation) from the onsite meteorological system for the 2018–2023 period (TVA 2025-TN11355). The NRC obtained meteorological observations from the Huntsville, Alabama (located at the Huntsville International Airport) weather station. The station is approximately 25 mi (40 km) east from Browns Ferry and used to characterize the region's climate because of its relative location and long period of record.

The mean annual temperature from Browns Ferry's onsite meteorological tower for the 2018–2023 period is 62.6°F (17.1°C) with a mean monthly ranging from a low of 43.4°F (6.3°C) in January and high of 79.3°F (26.3°C) in July. The mean annual temperature from Huntsville's weather station for the 1959–2022 period is 61.3°F (16.3°C) with a mean monthly ranging from a low of 40.3°F (4.6°C) in January and high of 79.9°F (26.6°C) in July (NOAA 2022-TN11386). The mean total precipitation from Browns Ferry's onsite meteorological tower for the period is 58.96 in. (1.50 meters [m]), with a mean monthly ranging from 2.79 in. (7.08 centimeters [cm]) in November and in 8.63 in. (21.92 cm) in February. The mean total precipitation from Huntsville's weather station for the 1959–2022 period is 56.03 in. (1.42 m), with a mean monthly ranging from 3.38 in. (8.58 cm) in October and 6.12 in. (15.54 cm) in March (NOAA 2022-TN11386). The prevailing wind direction at Browns Ferry's onsite meteorological tower is from the Southeast. The prevailing wind direction at the Huntsville weather station for the 1984–2022 period of record is from the east-southeast (NOAA 2022-TN11386).

Limestone County experiences severe weather. The following number of severe weather events have been reported in Limestone County from January 1950 through September 2024 (NOAA 2025-TN11666):

- tornadoes: 71 events
- hail: 185 events
- flash food: 65 events
- thunderstorm wind: 475 events

3.3.2 Air Quality

U.S. Environmental Protection Agency (EPA) has set primary and secondary National Ambient Air Quality Standards (NAAQSs) (40 CFR Part 50-TN1089) for six common criteria pollutants to protect sensitive populations and the environment. The NAAQS criteria pollutants include carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), and particulate matter (PM). Particulate matter is further categorized by size—PM_{10} (diameter of 10 micrometers or less) and $PM_{2.5}$ (diameter of 2.5 micrometers or less).

The EPA designates areas of attainment and nonattainment with respect to meeting NAAQSs. Areas for which there are insufficient data to determine attainment or nonattainment are designated as unclassifiable. Areas that were once in nonattainment, but are now in attainment, are called maintenance areas; these areas are under a 10-year monitoring plan to maintain their attainment designation status. States have primary responsibility for ensuring attainment and maintenance of the NAAQSs. Under Clean Air Act (CAA) Section 110 (Clean Air Act-TN1141) and related provisions, States are to submit, for EPA approval, State implementation plans (SIPs) that provide for the timely attainment and maintenance of the NAAQSs.

In Alabama, air quality designations are made at the county level. For the purpose of planning and maintaining ambient air quality with respect to the NAAQSs, EPA has developed air quality control regions (AQCRs). AQCRs are intrastate or interstate areas that share a common airshed. Browns Ferry is located in Limestone County, which is part of the Tennessee River Valley-Cumberland Mountains Interstate AQCR (40 CFR 81.72) (TN7226). With respect to NAAQs, EPA designated Limestone County is in unclassifiable/attainment for all NAAQS (80 CFR 81.301).

CAA permitting in Alabama is the shared responsibility of the Alabama Department of Environmental Management, the Jefferson County Department of Health, the City of Huntsville Department of Natural Resources and Environmental Management, and EPA Region 4. The Alabama Department of Environmental Management regulates air emissions at Browns Ferry under a synthetic minor operating permit (SMOP No. 708-0003-X005) and a minor source air permit (No. 708-0003-Z003) (TVA 2025-TN11355: Attachments 2 and 3). Browns Ferry's permitted air emission sources include two 4,678 horsepower (hp) diesel-fired emergency generators, two 2,922 hp diesel-fired emergency generators, eight 3,820 hp diesel-fired emergency generators, seven small diesel-fired emergency generators, one 95 hp propane fired emergency generator, sandblast/paint shop, three 62 MMbtu/h auxiliary boilers, and a gasoline dispensing facility (TVA 2025-TN11355). Browns Ferry's synthetic minor operating permit limits emissions of nitrogen oxides, carbon monoxide, particulate matter, and volatile organic compounds for the entire facility to 95 tons per pollutant during any consecutive 12-month period (TVA 2025-TN11355). Table 3-5 presents annual air emissions for 2020 through 2024 for Browns Ferry. TVA reports that it has not received any notices of violation or noncompliance regarding Browns Ferry synthetic minor source permit or minor source air permit between 2020 and 2024 (TVA 2025-TN11355 and TVA 2025-TN11647). The NRC staff reviewed EPA's Enforcement and Compliance History Online (ECHO) 3-year (1/2022 through 12/2024) compliance history for Browns Ferry and no violations were identified with respect to its air permits (EPA 2024-TN11352). Browns Ferry's air emissions represent less than 1 percent of Limestone County's 2020 annual air emissions.

Table 3-5 Browns Ferry Nuclear Plant Annual Air Emissions (tons)

Year	PM	SO_2	NO_X	CO	VOC
2020	2.4	0.05	21.1	5.5	27.4[(a)]
2021	1.0	0.03	15.1	4.1	9.3
2022	1.7	0.09	23.9	7.5	8.8
2023	1.1	0.03	18.1	6.7	6.9
Limestone County 2020 Emissions	5,900	60	2,850	15,600	17,110

PM= particulate matter; SO_2= sulfur dioxide; NO_X= nitrogen oxides; CO= carbon monoxide; VOC= volatile organic compounds.
(a) 2020 VOC emissions based on potential emissions, not actual emissions.
Sources: TVA 2025-TN11355; EPA 2023-TN11492.

In addition to the permitted sources listed in Table 3-5, additional sources of air emissions at Browns Ferry include mechanical draft cooling towers and transmission lines. Mechanical cooling towers emit particulate matter. TVA estimates that approximately 17 tons/year of particulate matter are emitted from operation of the cooling towers (TVA 2025-TN11355). Small amounts of ozone and substantially smaller amounts of nitrogen oxide (NO_x) are produced during corona, a phenomenon that occurs when air ionizes near isolated irregularities on the conductor surface of transmission lines. During corona, ozone is approximately 90 percent of the oxidants generated, and NO_x are approximately 10 percent (BLM 2010-TN9626; TVA 2025-TN11355). TVA has not conducted field tests of ozone or nitrogen oxide emissions generated by Browns Ferry's three 500 kV and two 161 kV in-scope transmission lines (TVA 2025-TN11355). However, design standards employed by TVA requires components to be free of corona under fair-weather conditions and installation of corona rings, to prevent corona discharge, for non-ceramic insulators for voltages above 161 kV (TVA 2025-TN11355). Additionally, field studies have shown that high voltage lines up to 765 kV do not generate emissions above ambient measurements (Lee et al. 1989-TN7481; TVA 2013-TN7899; NRC 2015-TN5842).

The EPA promulgated the Regional Haze Rule to improve and protect visibility in national parks and wilderness areas from haze, which is caused by numerous, diverse air pollutant sources located across a broad region (40 CFR Part 51-TN1090). Specifically, 40 CFR Part 81 (TN7226), Subpart D lists mandatory Federal areas where visibility is an important value. The Regional Haze Rule requires States to develop State implementation plans to reduce visibility impairment at Class I Federal Areas. Federal land management agencies that administer Federal Class I areas consider an air pollutant source that is located greater than 31 mi (50 km) away to have negligible impacts on these areas if the total SO_2, NO_X, PM_{10}, and sulfuric acid annual emissions from the source are less than 500 tons per year (70 FR 39104-TN8374; NPS 2010-TN7925). The nearest Class I Federal Area to Browns Ferry Nuclear is the Sipsey Wilderness area located southwest of the site and approximately 33 mi (53 km) away (TVA 2025-TN11355). Given this distance, emission levels from Browns Ferry Nuclear (see Table 3-5), and wind direction at the Browns Ferry site (from the southeast), Browns Ferry Nuclear would not adversely affect the air quality of Class I Federal Areas.

3.3.3 Noise

Noise is unwanted sound and can be generated by many sources. Sound intensity is measured in logarithmic units called decibels (dB). A dB is the ratio of the measured sound pressure level to a reference level equal to a normal person's threshold of hearing. Another characteristic of

sound is frequency or pitch. Noise may be composed of many frequencies, but the human ear does not hear very low or very high frequencies. To represent noise as closely as possible to the noise levels people experience, sounds are measured using a frequency-weighting scheme known as the A-scale. Sound levels measured on this A-scale are given in units of A-weighted decibels (dBA). Levels can become annoying at 80 dBA and very annoying at 90 dBA. Noise levels attenuate rapidly with distance. When distance is doubled from a point source, noise levels decrease by 6 dBA (DOT 2017-TN6567). Generally, a 3 dBA change over existing noise levels is considered to be a "just noticeable" difference, a 5 dBA increase is readily perceptible, and a 10 dBA increase is subjectively perceived as a doubling in loudness (DOT 2017-TN6567).

Several different terms are commonly used to describe sounds that vary in intensity over time. The equivalent sound intensity level (Leq) represents the average sound intensity level over a specified interval, often 1 hour. The day-night sound intensity level is a single value calculated from hourly Leq during a 24 h period, with the addition of 10 dBA to sound levels from 10 p.m. to 7 a.m. This addition accounts for the greater sensitivity of most people to nighttime noise. Statistical sound level is the sound level that is exceeded n Percent of the time during a given period. For example, L90, is the sound level exceeded 90 percent of time and is considered the background level.

Primary offsite noise sources in the immediate vicinity of Browns Ferry includes agriculture equipment and vehicular traffic (TVA 2024-TN11042). Primary noise sources at Browns Fery include diesel generators, transformers, and cooling towers. TVA reports that the cooling towers can periodically be heard offsite (TVA 2024-TN11042). There are seven mechanical draft cooling towers at Browns Ferry and they are primarily used in the summer months (TVA 2025-TN11355). The nearest resident is located in the Paradise Shores Community, approximately 1,500 ft (0.28 mi) from the site boundary (TVA 2025-TN11355). On August 8, and September 6, 2012, TVA conducted a 24 hour ambient noise study at the nearest residence. The day-night sound levels with the cooling towers in operation was 61.9 dBA (measured on August 8, 2012) and without the cooling towers in operation (measured September 6, 2012) was 59.7 dBA (TVA 2024-TN11042); therefore, less than a 3 dBA difference. As discussed above, most people barely notice a 3 dBA difference. In 2020 and 2022, TVA conducted additional 24 hour ambient noise studies at the nearest resident with the cooling towers in operation. The day-night sound levels measured at the nearest residence were 62.5 dBA (in 2020) and 61.4 dBA (in 2022). The 2012, 2020, and 2022 sound levels at the nearest resident are all very similar and indicative that the noise levels have remained unchanged. TVA has no records of noise complaints associated with Browns Ferry operation (TVA 2025-TN11355).

3.3.4 Proposed Action

3.3.4.1 Air Quality Impacts

As described in the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-1 of this SEIS, for generic issues related to air quality, the impacts of nuclear power plant license renewal and continued operations would be SMALL. The NRC staff's review did not identify any new and significant information that would change the conclusion in the LR GEIS. As discussed in Section 3.3, air emissions from sources at Browns Ferry represent a small fraction of the annual emissions from Limestone County. TVA does not anticipate future upgrades or replacement activities of air emission sources during the SLR term to support plant operation. However, TVA plans to replace and upgrade cooling tower number 2 by 2027. In June 2020, TVA conducted an environmental assessment that documented the environmental impacts from replacing and operating upgraded cooling tower number 2 (TVA 2020-TN11365). TVA concluded that

operation of upgraded cooling tower number 2 would not result in air emissions greater than those compared to current operations of the cooling towers. Therefore, the NRC staff does not anticipate particulate emissions during the SLR period from operation of the cooling towers to significantly differ from current emissions. Thus, as concluded in the LR GEIS, for these Category 1 (generic) issues, the impacts of continued operation of Browns Ferry on air quality would be SMALL. There are no plant-specific (Category 2) air quality issues applicable to Browns Ferry (Table 3-2).

3.3.4.2 Noise Impacts

As described in the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-1 of this SEIS, for generic issues related to noise, the impacts of nuclear power plant license renewal and continued operations would be SMALL. The NRC staff's review did not identify any new and significant information that would change the conclusion in the LR GEIS. TVA does not anticipate future upgrades or replacement activities during the SLR term to support plant operation that could introduce new noise sources or increases in sound levels. TVA plans to replace and upgrade cooling tower number 2 by 2027. In June 2020, TVA conducted an environmental assessment that documented the environmental impacts from replacing and operating upgraded cooling tower number 2 (TVA 2020-TN11365). TVA concluded that operation of upgraded cooling tower number 2 would not result in significant noise-related impacts to nearby sensitive receptors. Furthermore, TVA plans to conduct an ambient noise study following completion of the replacement cooling tower in order to determine whether there is a need to mitigate any potential impacts from operation of the replaced cooling tower (TVA 2020-TN11365). Therefore, the NRC staff does not anticipate that noise levels during the SLR period that would differ from what is currently experienced at noise sensitive receptors. Thus, as concluded in the LR GEIS, for the Category 1 (generic) noise issue, the impacts of continued operation of Browns Ferry on noise would be SMALL.

3.4 Geologic Environment

This section describes the geologic environment of the Browns Ferry site and vicinity, including regional geology and physiography, site geology (stratigraphy and surficial deposits), geologic resources, soils (onsite soils, erosion potential, and prime farmland soils), and seismic setting and history. The analysis by the NRC staff related to potential environmental impacts on geology and soils from the proposed action follows the information summary. Except as otherwise cited for clarity, the NRC staff's summary in the subsections below is based on information provided in Section 3.4 of the ER (TVA 2024-TN11042) and Section 2.5 of the UFSAR (TVA 2023-TN11360). The NRC staff did not identify any new and significant information regarding the geologic environment during the site audit and the scoping process or as the result of its review of available information as cited in this SEIS.

3.4.1 Physiography and Geology

Browns Ferry is located in northern Alabama within the southernmost portion of the Highland Rim section of the Interior Low Plateaus physiographic province. This province extends from southern Indiana and Ohio to northern Alabama and lies south of the furthest extent of glaciation during the Quaternary Period. The province is characterized by moderate relief and relatively flat-lying, consolidated sedimentary rocks (sandstone, limestone, dolomite, and shale) of Paleozoic age extending to depths greater than 5,000 ft (1,500 m). A north-south trending structural arch occurs in the southern portion of the province as a large structural dome centered near Nashville, Tennessee. The Highland Rim section of the province surrounds this

dome. Surficial deposits in the Browns Ferry region consist of varying thicknesses of unconsolidated material of residual and alluvial origin. Little structural deformation has occurred and no major faults or folds are present. Rock strata are nearly flat-lying.

Browns Ferry is on the north shore of Wheeler reservoir, an impoundment of the Tennessee River. The site is on a river terrace representing an historic floodplain with a plant grade elevation of 565 ft (172.2 m) msl. Elevations increase moderately to the north, reaching about 800 ft (243.8 m) north of Athens, approximately 13 mi (21 km) northeast of the plant.

Three stratigraphic units are present at the Brown Ferry site. Surficial deposits consist of clays with some residual chert boulders and lenses of sand and gravel. The average thickness of these unconsolidated deposits in the site area is 54 ft (16.5 m). The uppermost bedrock unit at the site is the Tuscumbia limestone; this unit is about 50 ft (15.2 m) thick at the northwest portion of the site, gradually thinning to the southeast. Nearly all the solution cavities encountered during development of the site were in the Tuscumbia limestone and a persistent weathered zone was encountered along the base of the Tuscumbia. The Tuscumbia unit was excavated across the majority of the plant area, but is present under the eastern portions of the turbine and Unit 1 reactor buildings and all structures to the west (TVA 2025-TN11647). Underlying the Tuscumbia is the Fort Payne Formation, a silty dolomite and siliceous (cherty) limestone with thin shale horizons. This unit is about 145 ft (44.2 m) thick at the site and less susceptible to development of solution channels than the Tuscumbia. Much of the fill materials used at the site were derived from the surficial deposits, so little distinction was made between the backfill and the natural sediments, with the exception of crushed rock and sand used around underground utilities and building foundations (TVA 2025-TN11647). Sediments described as gravel, weathered rock, or a slurry of sand, silt, and clay were identified at several monitoring wells near the power block and may indicate a hydraulic connection between the overburden and bedrock or be attributed to the presence of coarse fill materials (TVA 2025-TN11647).

3.4.2 Geologic Resources

Some crushed stone production occurs in Limestone County, but mining is restricted within 10 mi (16 km) of the Browns Ferry plant (AL Code § 45-42-TN11366). No rare or unique geological features or resources have been identified on or adjoining the Browns Ferry site (TVA 2025-TN11355). No mineral deposits, resources or mines are located on or in the vicinity of the site (USGS 2024-TN11483).

3.4.3 Soils

The upper 15 to 20 ft (4.6 to 6.0 m) of alluvial river terrace deposits on the Browns Ferrry site were characterized during site investigation as sandy to silty clays and designated as the preferred borrow material. The natural soils developed from these sediments were mapped by the Natural Resources Conservation Service as fine sandy loam, silt loam, silty clay loam, and clay loam. These natural soils were extensively disturbed during construction of the plant as a result of excavation, grading and because the original ground surface was approximately 15 ft (4.6 m) above the final plant grade. Most of the soil series mapped at the site are classified as prime farmland, with more than half of the site area having this classification (TVA 2024-TN11042: Table 3.4-1 and Figure 3.4-2).

Besides from the areas of relatively steep slopes, soils at the site generally have low potential for erosion due to the moderate relief. Specific incidents of erosion that may affect plant structures are identified and addressed by the plant. During the last 5 years (2019–2024) there

have been 10 condition reports documenting minor erosion at multiple plant locations (TVA 2025-TN11354). Site procedures require corrective actions for documented condition reports and corrective actions have been taken, or open work orders are in place, to address the identified incidents of erosion. In addition, as required by the Alabama generic permit for stormwater discharges from construction activities (No. ALR100000), TVA would prepare and implement a stormwater pollution prevention plan (SWPPP) before undertaking any ground disturbing activities. The SWPPP identifies best management practices (BMPs) that would be used to minimize erosion and transport of sediments in stormwater discharges (TVA 2024-TN11042).

3.4.4 Seismic Setting

Earthquake activity in the Browns Ferry region has historically been low. TVA conducted a study in 2014 to evaluate the seismic hazard at the site and identified the closest areas of significant earthquake activity: the New Madrid area in the Mississippi Valley; the Lower Wabash Valley of Indiana and Illiniois; the Charleston, South Carolina area; and the Southern Applalachian area of western North Carolina and eastern Tennessee (TVA 2024-TN11042). These areas are all more than 150 mi (240 km) from the Browns Ferry site. The nearest mapped fault is about 20 mi (32 km) from the site in southern Tennessee (USGS 2024-TN11483). Between 1970 and 2024, 26 earthquakes with a magnitude equal to or greater than 3.0 on the Richter scale have been recorded within a 100 mi (161 km) radius of the Browns Ferry site (USGS 2024-TN11581). The closest of these occurred near Florence, Alabama, about 25 mi (40 km) from the Browns Ferry site.

Seismic hazard (i.e., peak ground acceleration) for a specific location due to shaking induced by an earthquake is expressed as a percentage of *g*, the gravitational acceleration near the Earth's surface, to assess the potential impact of the earthquake on engineered structures. Several factors, including the properties of rock and sedimentary materials through which the earthquake waves travel, as well as earthquake magnitude and location, control the level of ground shaking that can occur. Based on the 2023 seismic hazard maps published by the USGS, Browns Ferry is in an area with a predicted peak horizontal ground acceleration between 0.2 and 0.3 *g* for a 2 percent probability of exceedance in 50 years, corresponding to a return period of about 2,500 years (Petersen et al. 2023-TN11233). The estimated Modified Mercalli Intensity level for the same return period is VII (very strong shaking), which is projected to result in negligible damage to buildings of good design and construction, slight to moderate damage in well-built ordinary structures, and considerable damage to poorly built or badly designed structures. This indicates a low risk for damaging ground shaking at Browns Ferry in the next 50 years.

The impacts of natural phenomena associated with geologic and seismic hazards on nuclear power plant systems, structures, and components are outside the scope of the NRC staff's LR environmental review. Browns Ferry was originally sited, designed, and licensed with due consideration for applicable geologic and seismic criteria. Seismic issues at operating nuclear power plants are assessed as part of the NRC's ongoing regulatory oversight. Furthermore, the NRC requires all licensees to consider seismic activity to maintain safe operating conditions at all nuclear power plants. When new seismic hazard information becomes available, the NRC staff evaluates that information to determine whether any changes are necessary at existing nuclear power plants. This reactor oversight process, which considers seismic safety, is separate and distinct from the NRC staff's LR environmental review.

3.4.5 Proposed Action

As described in the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-1 of this SEIS, for the geology and soils issue, the impact of SLR and continued operations for Browns Ferry on geology and soils would be SMALL. The finding in 10 CFR Part 51 (TN10253), Subpart A, Appendix B, Table B-1 related to geology and soils indicates that this generic Category 1 issue would result in a SMALL impact for all nuclear power plants.

The NRC staff independently reviewed applicable information for geology and soils in TVA's ER (TVA 2024-TN11042) and associated references therein, considered information discussed during site audits and the scoping process, and independently reviewed pertinent information about the seismic setting. The NRC staff did not identify any new and significant information related to geology and soils that would change the environmental impact determination stated in the LR GEIS for this Category 1 generic issue. No significant impacts on geology and soils are anticipated during the LR term that would be different from those occurring during the current license term. Thus, the NRC staff concludes that the impacts of LR related to the geology and soils issue would be SMALL for Browns Ferry. There are no Category 2 issues related to the geologic environment that require consideration.

3.5 Water Resources

This section describes surface water and groundwater resources at and around the Browns Ferry site. The description of the resources is followed by the NRC staff's analysis of the potential impacts on surface water and groundwater resources of the proposed action (SLR).

3.5.1 Surface Water Resources

Surface water encompasses all water bodies that occur above the ground surface, including rivers, streams, lakes, ponds, oceans, and human-made reservoirs or impoundments.

3.5.1.1 Surface Water Hydrology

Section 3.5.1.1 of TVA's ER (TVA 2024-TN11042), as revised (TVA 2025-TN11355), provides a detailed description of the surface water environment of the Browns Ferry site including the Tennessee River system, the Wheeler Reservoir, flooding potential, and onsite surface water features (TVA 2025-TN11355). The NRC staff incorporates TVA ER Revision 1 Section 3.5.1.1 in its entirety here by reference.

Local and Regional Hydrology

Browns Ferry is situated on the northern shore of Wheeler Reservoir (see Figure 2-2) at TRM 294.0 in Limestone County, Alabama. Wheeler Dam is located downstream at TRM 274.9, while Guntersville Dam is upstream at TRM 349.0. For reference, TRM 0.0 is situated downstream where the Tennessee River meets the Ohio River in Paducah, Kentucky (TVA 2025-TN11355).

Wheeler Reservoir is part of a series of 9 reservoirs that facilitate navigation along the 652 mi (1,049 km) Tennessee River system from Knoxville, Tennessee, to Paducah, Kentucky. Wheeler Reservoir covers 67,070 ac (27,142 ha), with a water volume of 1.05 million ac-feet (1.8 million hectare-meters [ha-m]), and a hydraulic retention time of 10.7 days. As shown in Figure 3-1, the typical summer pool elevation is 556 ft (169 m) above mean sea level, with a minimum level of 550 ft (168 m) above mean sea level. The reservoir usually reaches its

summer elevation by mid-April, and the fall drawdown typically begins after Labor Day in preparation for winter rains. The average daily flow in Wheeler Reservoir past Browns Ferry is approximately 47,600 cubic feet per second (ft^3/s) (1,350 cubic meters per second [m^3/s]). (TVA 2025-TN11355).

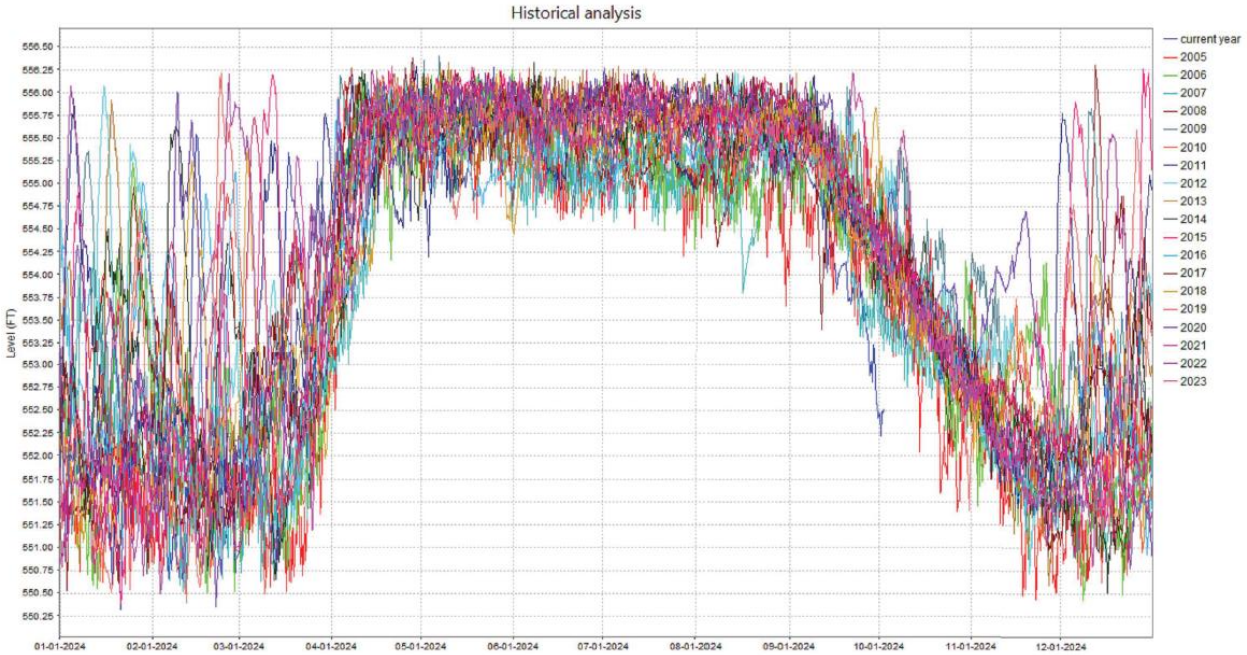

Figure 3-1 Annual Cycle of Wheeler Reservoir Elevation Between 2005 and 2024. Source: TVA 2025-TN11355.

TVA conducted field assessments of surface water features at the Browns Ferry site in September 2021 to evaluate the presence, extent, and condition of streams, drainage areas, ponds, and wetlands. Streams were delineated using methods outlined in the U.S. Army Corps of Engineers Jurisdictional Determination Form Instructional Guidebook (USACE 2007-TN11601).

As shown in Figure 3-2, TVA delineated two constructed ditches, seven ponds, two ephemeral streams, three intermittent streams, and three perennial streams.

Browns Ferry uses a once-through cooling system that is supplemented by cooling towers to assist in meeting discharge water temperature limits specified in the National Pollutant Discharge Elimination System (NPDES) permit. The helper cooling towers are located along water channels (Figure 3-2 and Figure 3-3). Waters discharged from the cooling towers in the helper mode flow into the cold water channel over a discharge control structure and is then discharged to the Wheeler Reservoir through the diffuser system (TVA 2025-TN11355). East of the discharge control structure, a portion of the cold water return channel is separated from the intake bay (Figure 3-3). The intake bay is categorized as waters of the United States.

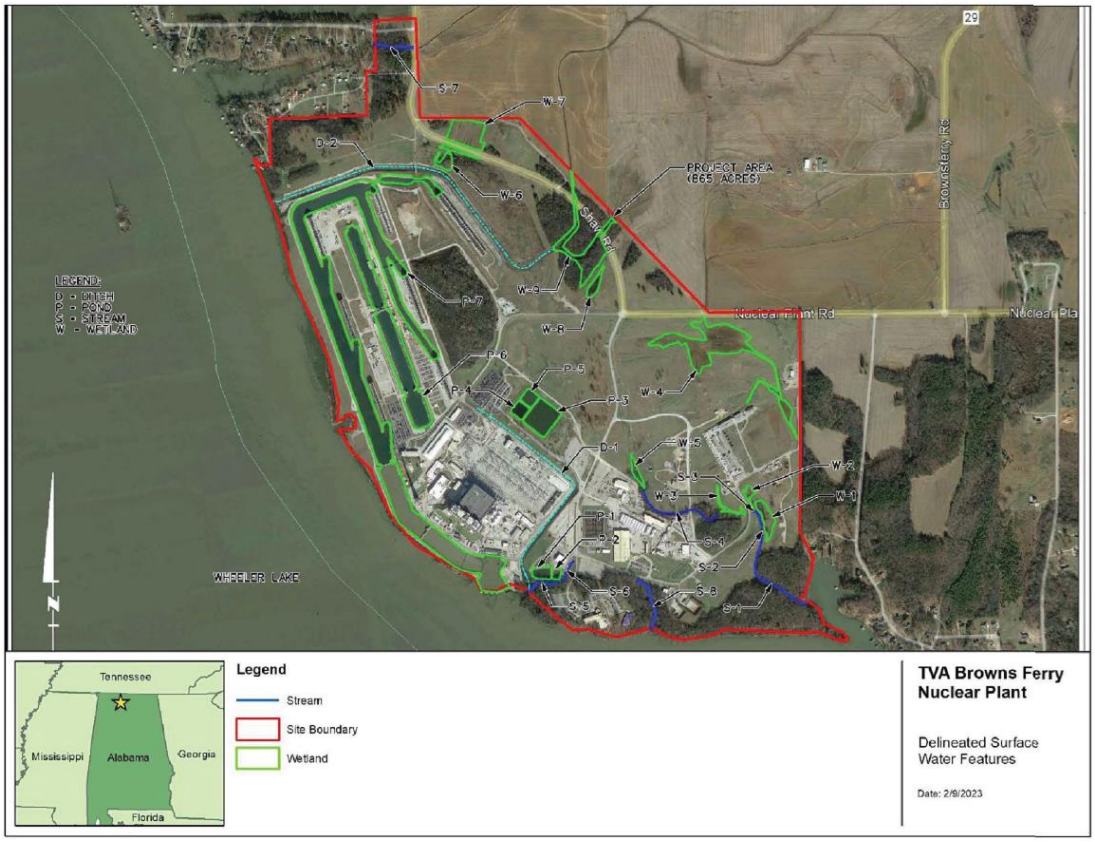

Figure 3-2 Delineated Surface Water Features (e.g., Streams, Ditches, and Ponds) and Wetlands Within the Browns Ferry Nuclear Plant Site. Source: TVA 2025-TN11355.

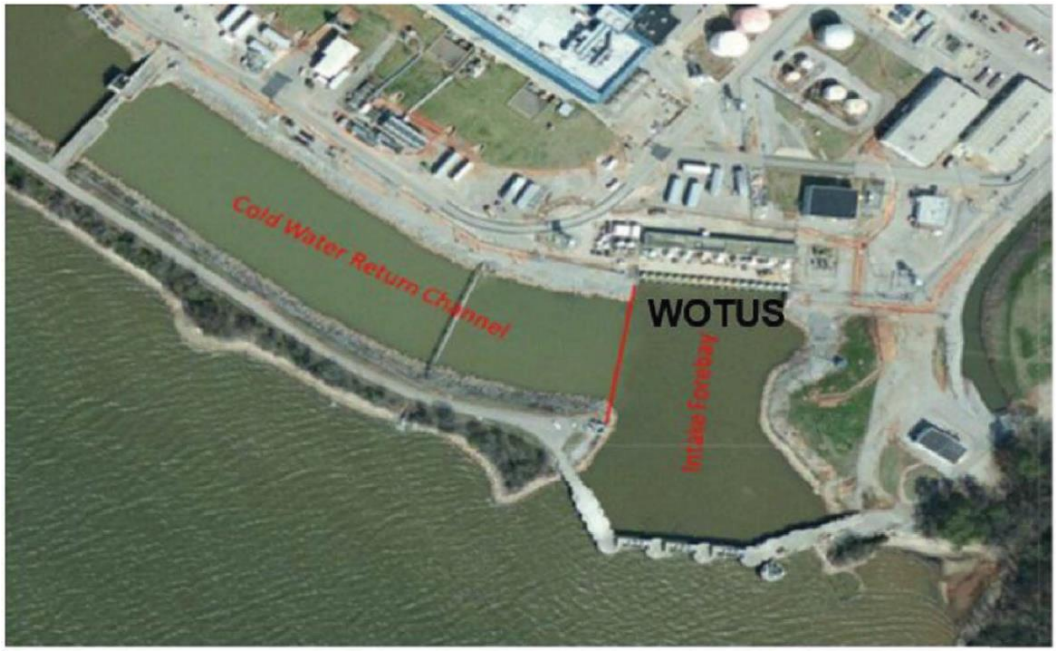

Figure 3-3 Delineation Between Browns Ferry Nuclear Plant Site Waters and Waters of the U.S. (WOTUS). Source: TVA 2025-TN11355.

3.5.1.2 Surface Water Use Last 5 years

3.5.1.2.1 Onsite Surface Water Use

TVA described the plant water use in ER Section 3.5.1.2 (TVA 2025-TN11355). The NRC staff incorporate the information in TVA ER Revision 1, Section 3.5.1.2 here by reference. When all three units are operational in once-through mode, approximately 4,400 ft^3/s or 2 million gpm (125 m^3/s or 7.6 million lpm) of water is withdrawn from Wheeler Reservoir and pumped through the plant (TVA 2025-TN11355).

Typically, 2 to 3 percent of water circulating in mechanical draft cooling towers, is lost to evaporation and drift, when the plant is cooled in helper mode. At Browns Ferry, helper mode is generally used in the summer months, with peak usage in July and August (TVA 2025-TN11355).

Tables 2.2-1 and 2.2-2 of TVAs ER (TVA 2025-TN11355) present daily average water withdrawals and consumption from Wheeler Reservoir by month from 2016 through 2023, respectively. The NRC staff incorporates that information here by reference. Between 2016 and 2023, Browns Ferry withdrew an average of about 2,875 million gallons per day (MGD) (10,880 million liters per day (lpd)) and evaporation and drift losses averaged about 3.01 MGD (11.4 million lpd), or 0.11 percent of the total withdrawal (TVA 2025-TN11355).

Browns Ferry's use of Wheeler Reservoir water is managed according to the TVA Reservoir Operations Study from 2004 (TVA 2004-TN4913), which guides the daily operations of the Tennessee River system. In mid-2004, TVA revised its Reservoir Operating Policy, altering the duration that most reservoirs remain at summer pool levels. TVA manages winter and spring flood events by lowering the reservoir pool in the fall by about 4 ft (1.2 m) to allow greater flood storage. Figure 3-1 shows the Wheeler Reservoir yearly water surface elevations during 2005 through 2024. Summer pool levels are maintained for water supply and recreation.

A schematic illustration of Browns Ferry's site water balance is presented in Figure 3-4 (TVA 2025-TN11355).

Browns Ferry obtains its potable water from the Athens Municipal Water Supply and had a total consumption of approximately 1 million gallons in 2022 (TVA 2025-TN11355).

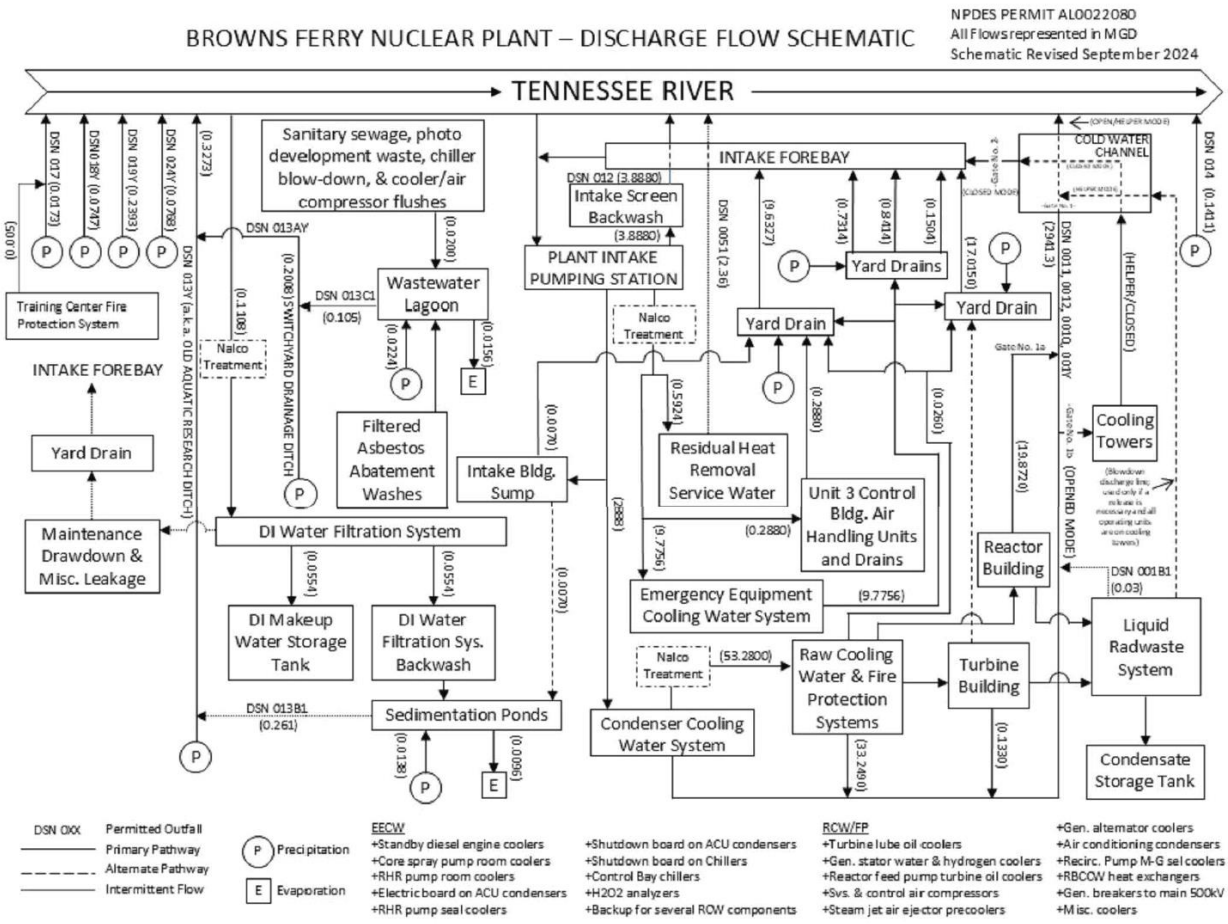

Figure 3-4 Schematic of Browns Ferry Nuclear Plant Site Water Balance. Source: TVA 2025-TN11355.

3.5.1.2.2 Offsite Surface Water Use

TVA described the offsite surface water use in ER Section 3.5.1.2 (TVA 2025-TN11355). The NRC staff incorporate the information in TVA ER Revision 1 Section 3.5.1.2 here by reference.

The closest upstream surface water supply is located in Decatur, Alabama, 12 mi (19.3 km) from Browns Ferry and the closest downstream surface water supply is the West Morgan-East Lawrence Water Authority intake, located 7.5 mi (12.1 km) from Browns Ferry (TVA 2025-TN11355). There are several industrial surface water withdrawals within 15 mi (24.1 km) of Browns Ferry. The closest upstream industrial surface water withdrawal is for Amoco Chemicals Corporation, approximately 5.5 mi (8.9 km) from Browns Ferry. The closest downstream industrial surface water withdrawal is for Champion International, approximately 11.4 mi (18.3 km) from Browns Ferry.

Since 1995, surface water withdrawals and net usage in the Wheeler area have declined significantly, primarily due to reductions in thermoelectric power production use. This trend is expected to continue, with overall water withdrawals in the Tennessee River Watershed projected to decrease by 11 percent by 2045 (Sharkey and Springston 2022-TN11361).

Although irrigation and public supply uses are expected to rise, thermoelectric withdrawals and net usage are projected to decline, minimizing future conflicts over water availability.

3.5.1.3 Surface Water Quality and Effluents

3.5.1.3.1 Water Quality Assessment and Regulation

TVA described the water quality of surface water bodies in the region in ER Section 3.5.1.3 (TVA 2025-TN11355). The NRC staff incorporate the information in TVA ER Revision 1 Section 3.5.1.3 here by reference.

To operate a nuclear power plant, NRC licensees must meet State water quality certification requirements under Section 401 of the Clean Water Act (CWA) (TN662). The EPA or the States, not the NRC, sets the limits for effluents and operational parameters in plant-specific NPDES permits. Nuclear power plants cannot operate without a valid NPDES permit and a current Section 401 Water Quality Certification or waiver of the certification. TVA applied for a State Water Quality Certification from Alabama Department of Environmental Management (ADEM) on June 12, 2024, and the ADEM issued a waiver of the certification on July 3, 2024 (TVA 2024-TN11362).

Subsequently, on January 8, 2025, pursuant to CWA § 401(a)(2), the EPA notified Mississippi Department of Environmental Quality and Tennessee Department of Environment and Conservation that discharges from Browns Ferry may affect the quality of water under their jurisdiction (EPA 2025-TN11363, EPA 2025-TN11582). The Mississippi Department of Environmental Quality and the Tennessee Department of Environment and Conservation did not provide a written response objecting to the proposed action within 60 days from the receipt of the EPA's notification, therefore the neighboring jurisdiction process as described in 40 CFR Part 121 is concluded.

Discharges from Browns Ferry are regulated under the ADEM NPDES Permit No. AL0022080, which establishes discharge limitations and monitoring requirements for specific constituents by outfall. Although the permit expired on August 31, 2023, it remains under timely renewal, as BF submitted the renewal request on December 28, 2022, prior to the expiration date (TVA 2025-TN11354). Monitored constituents include discharge water temperature, pH, temperature differential between upstream and downstream monitoring locations, flow rates, chlorine levels, chronic toxicity levels, total suspended solids, oil and grease, chemical oxygen demand, biological oxygen deman, and benzenoids (TVA 2025-TN11355). Locations of the NPDES external outfalls are shown in Figure 3-5.

The locations of the Browns Ferry river monitoring stations, submerged cooling water diffuser pipes, and mixing zone are shown in Figure 3-6 (TVA 2025-TN11355).

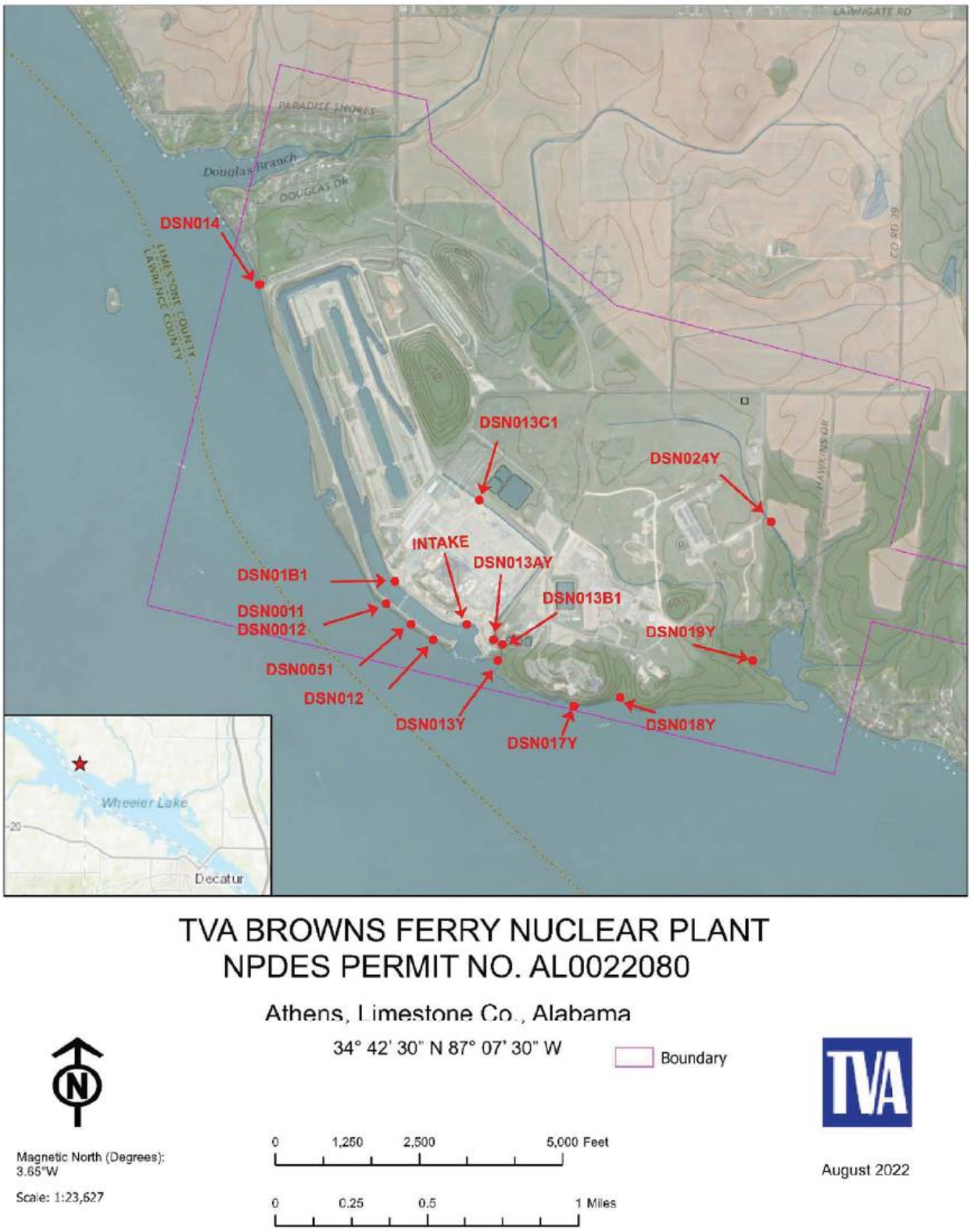

Figure 3-5 Locations of Browns Ferry Nuclear Plant Site National Pollutant Discharge Elimination System (NPDES) External Outfalls. Source: TVA 2025-TN11355.

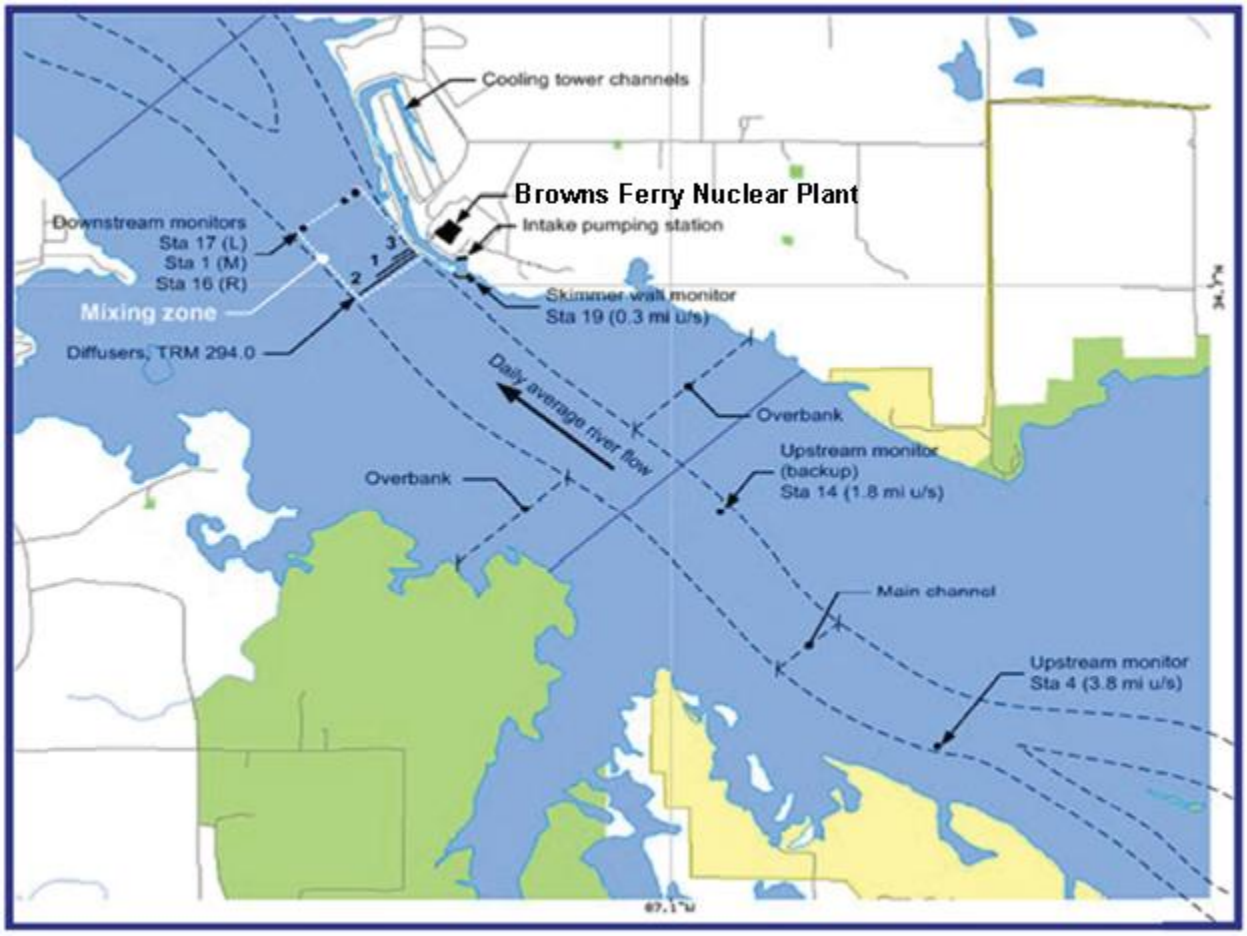

Figure 3-6 Locations of Browns Ferry Nuclear Plant River Monitoring Stations, Diffuser Pipes, and Mixing Zone. Adapted from: TVA 2025-TN11355.

Water temperatures in Wheeler Reservoir vary with meteorological and flow conditions. Monthly average water temperature between 2005 and 2023 for the upstream and downstream locations are shown in Figure 3-7 and Figure 3-8, respectively (TVA 2025-TN11355).

Most of Wheeler Reservoir is classified by ADEM for uses that include public water supply, swimming, other water-contact sports, and fish and wildlife. Wheeler Reservoir, Tennessee River, and several creeks that contribute flow to the Wheeler Reservoir are listed on Alabama's 2024 CWA Section 303(d) list of impaired waters for nutrients from agricultural sources, mercury from atmospheric deposition, perfluorooctane sulfonate (PFOS) from industrial sources, and pH from crop production and grazing (ADEM 2024-TN11364). The Alabama Department of Public Health has issued fish consumption advisories for certain areas of Wheeler Reservoir due to elevated mercury levels and PFOS contamination. PFOS, a man-made chemical used in various industrial and commercial products, is no longer manufactured in the U.S. and is being phased out (EPA 2025-TN11801).

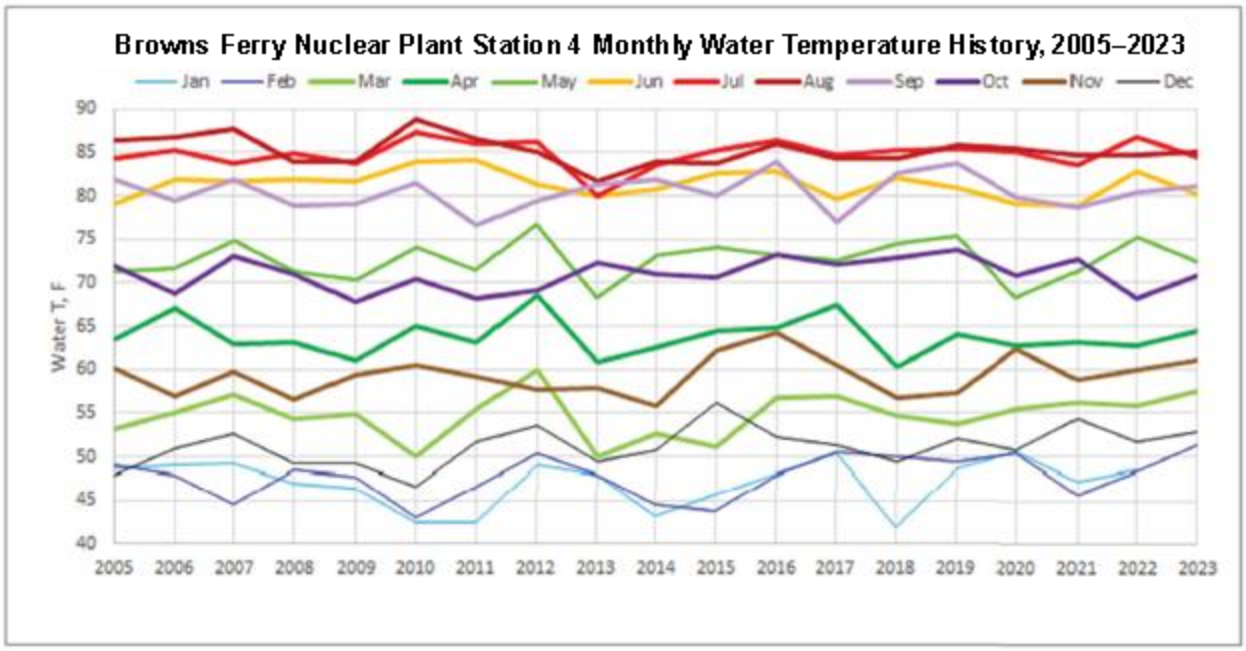

Figure 3-7 Monthly Average Water Temperature History Upstream of Browns Ferry Nuclear Plant. Adapted from: TVA 2025-TN11355.

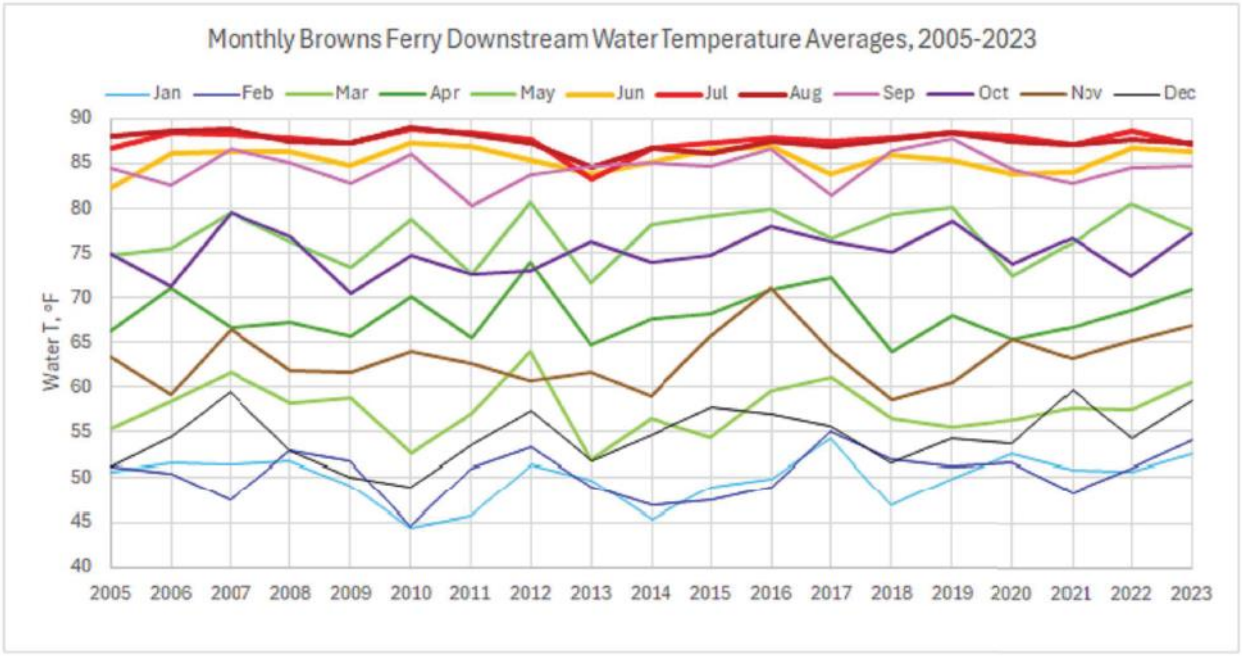

Figure 3-8 Monthly Average Water Temperature History Downstream of Browns Ferry Nuclear Plant. Source: TVA 2025-TN11355.

Regulated Releases to Surface Water

TVA described the radiological monitoring under the plant's Radiological Environmental Monitoring Program (REMP) and non-radiological releases to surface waters under the plant's

NPDES permit in ER Revision 1 Section 3.5.1.3 (TVA 2025-TN11355). The NRC staff incorporate the information in TVA ER Section 3.5.1.3 here by reference.

Abnormal releases of tritium occurred in both gaseous and liquid forms on either single or multiple instances each year between 2019 and 2023 as documented in their respective Annual Radioactive Effluent Release Reports (NRC 2024-TN11583). In 2019 and 2021 releases reached the Wheeler Reservoir (TVA 2025-TN11355). In general, the radioactive measurements in environmental samples in the Browns Ferry program are primarily attributed to naturally occurring radioactive materials, with no significant increase in background radiation levels due to Browns Ferry activities.

A cross-contamination incident in 2023 resulted in an unmonitored release of reactor water to the Tennessee River. As discussed in Section 3.13.1.5, the release did not exceed 10 CFR Part 50, Appendix I criteria or 10 CFR 20.1301 limits and was evaluated as having very low safety significance (green finding) by NRC (NRC 2024-TN11604).

For the monitoring period of April 1 to June 30, 2020, the ADEM NPDES/SID Non-Compliance Notification Form dated July 20, 2020 (TVA 2025-TN11355: Section 4.6.2.8) reports a noncompliance event on May 7, 2020, from 9:50 AM to 12:15 PM CDT. The noncompliance was due to exceedance of the maximum allowable Total Residual Chlorine (TRC) at the Unit 3 CCW outfall (DSN001Q), with recorded values of 0.14 mg/L and 0.16 mg/L, exceeding the permit limit of 0.031 mg/L.

Injection of sodium hypochlorite (bleach) was stopped once the violation was confirmed by the Chemistry laboratory technician, and the bisulfite feed pump was found not rotating (i.e., not pumping). The shift manager, environmental, and station duty manager were notified. The fix-it-now and Browns Ferry Nuclear Chemistry teams investigated and found the pump had tripped on low flow. It was reset, restarted, and returned to normal operation. To prevent recurrence, Browns Ferry is implementing a design change to install a radio-controlled system that will automatically shut off sodium hypochlorite injection if low bisulfite flow is detected at the injection point.

For the monitoring period January 2024, the NPDES/State Indirect Discharge Noncompliance Notification Report (Form 421) indicated no effluent violations. However, there was one monitoring/reporting violation due to exceeding the 48-hour maximum hold time for biochemical oxygen demand analysis (TVA 2025-TN11354). As per the report (i.e., Form 421):

- A biweekly biochemical oxygen demand sample from outfall DSN13C1, collected on January 2, 2024, at 7:34 a.m. Central Tim, was not analyzed until January 4, 2024, at 2:30 p.m. Central Time, exceeding the allowable hold time.
- The following biweekly sample (i.e., the next sampling in January 2024 after the noncompliance on January 2, 2024) was collected and analyzed as required.
- To prevent recurrence, TVA completed corrective actions under the Browns Ferry corrective action program, including (TVA 2025-TN11354):
  - Assessing feasibility of in-house biological NPDES parameter analysis.
  - Adjusting biweekly DSN13C1 monitoring frequency from monthly to weekly.
  - Ensuring same-day sample delivery to the lab unless prior arrangements are made.

- Reviewing extent of conditions and sharing relevant findings with environmental operations.
- Evaluating Southern Environmental Testing's contract for improved communication on sample issues.

Flooding

In accordance with the NRC's general design criteria specified in Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50 (TN249), nuclear power plant structures, systems, and components important to safety must be designed to withstand the effects of natural phenomena, such as flooding, without loss of capability to perform safety functions.

Additionally, the NRC staff evaluates nuclear power plant operating conditions and physical infrastructure to ensure ongoing safe operations through its Reactor Oversight Process, which is separate from the NRC's license renewal review process. If new information about changing environmental conditions becomes available, the NRC staff will evaluate the new information to determine whether any safety-related changes are needed. The NRC staff also evaluates new information important to flood projections and independently confirms that a licensee's actions appropriately consider potential changes in flooding hazards at the site.

The nine dams on the mainstem Tennessee River regulate streamflow in the river for flood damage reduction. Wheeler Reservoir is created by the Wheeler Dam, which is the sixth most downstream of the nine dams on the mainstem Tennessee River. Browns Ferry does not have a history of onsite flooding and as shown in Figure 3-9, is located outside the 100-year floodplain as delineated by the Federal Emergency Management Agency (TVA 2025-TN11355). Additionally, Browns Ferry safety-related structures can withstand the effects of flood conditions up to 5.5 ft (1.7 m) above that resulting from a probable maximum flood (TVA 2025-TN11355).

3.5.2 Groundwater Resources

This section of the SEIS describes the groundwater flow systems (aquifers), groundwater use, and groundwater quality in and around the Browns Ferry site. An aquifer is a geologic formation, group of formations, or part of a formation that contains sufficient saturated, permeable material to yield significant quantities of water to wells and/or springs.

3.5.2.1 Local and Regional Groundwater Resources

Sections 3.4 and 3.5.2 of the ER (TVA 2024-TN11042) describe the geologic environment and groundwater resources, respectively, in the vicinity of the Browns Ferry site. The NRC staff reviewed the ER and other information related to groundwater resources during the site audit, the scoping process, and as cited in this SEIS.

The Browns Ferry site, located in Limestone County, is in the southernmost section of the Interior Low Plateaus physiographic province. This province was unglaciated during the Quaternary period and is characterized by gently rolling terrain and dissected plateaus. Surface geology comprises flat-lying, indurated (hardened), sedimentary rocks of Paleozoic age. Limestone, sandstone, and shale rocks predominate with limestone formations of Mississippian age comprising the principal aquifers in the region (USGS 1990-TN6648). The Tuscumbia and Fort Payne limestone units described in Section 3.4.1 form the principal aquifer system in the region. No sole source aquifers have been designated in Alabama or Tennessee (EPA 2020-TN6709).

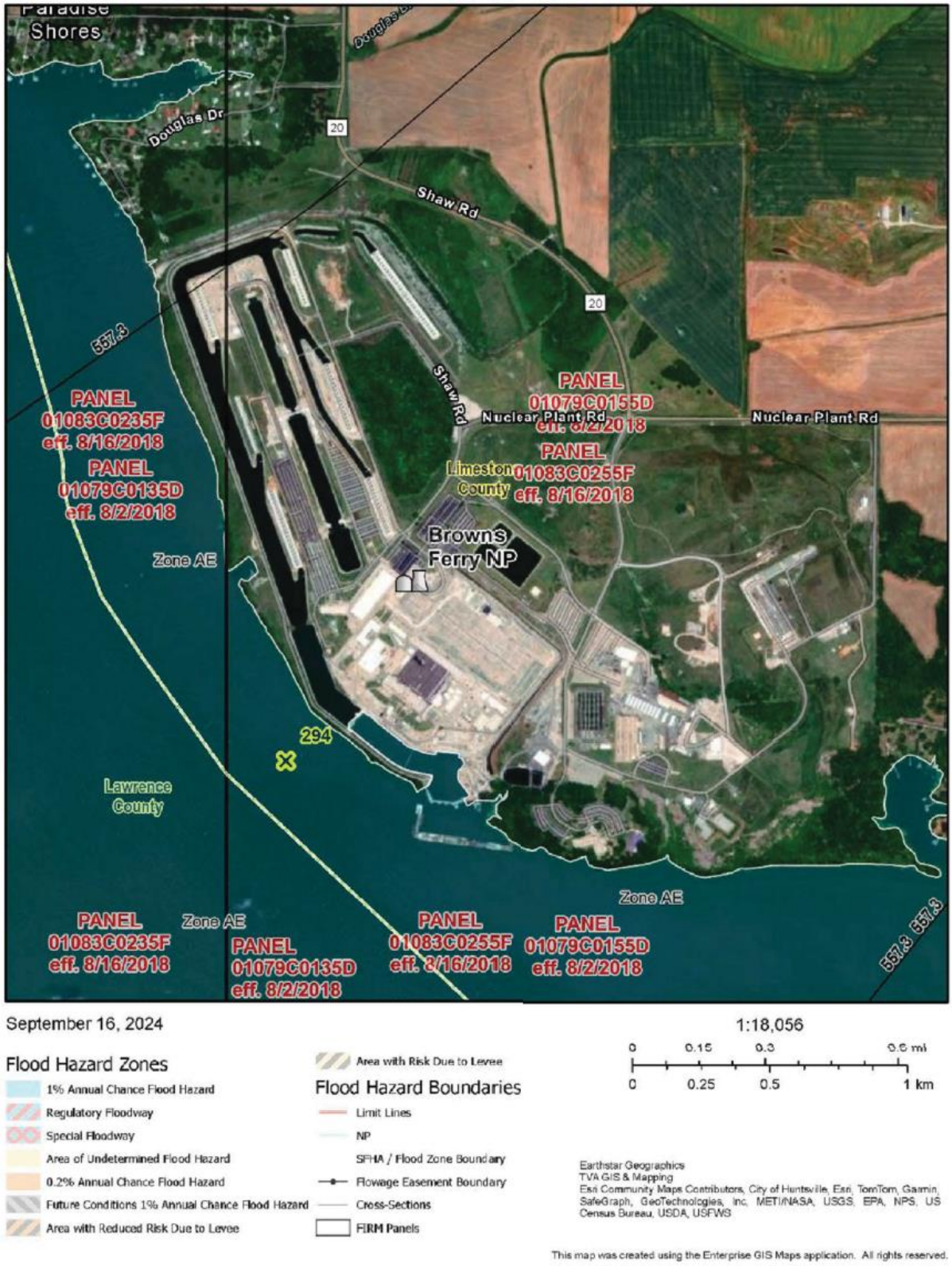

Figure 3-9 Delineation of the Federal Emergency Management Agency Floodplain Zones at the Browns Ferry Nuclear Plant Site. Source: TVA 2025-TN11355.

Physiographic features of the Browns Ferry site include the Wheeler Reservoir on the Tennessee River and the river terrace on which the plant is sited. Topography generally rises gently from the river, with several small streams and wetlands located on and adjacent to the site. As described in Section 3.4.1, Browns Ferry site geology includes: unconsolidated surficial deposits, primarily clays with some sand and gravel lenses; the Tuscumbia limestone unit, which exhibits weathering and some development of solution channels and was excavated over most of the plant area; and the Fort Payne Formation, a siliceous limestone that is more resistant to dissolution and served as the excavation base for the plant's major structures. Other unconsolidated subsurface materials present at the Browns Ferry site include crushed rock and sand, used around underground utilities and building foundations, and fill, largely derived from the local surficial deposits. Figure 3-10 shows a cross-section through the Browns Ferry reactor and turbine buildings that illustrates the occurrence of subsurface materials at the site (TVA 2025-TN11354).

Groundwater at the Browns Ferry site occurs in the unconsolidated overburden materials and the bedrock, which are assumed to be hydraulically connected (TVA 2024-TN11042). Accessible groundwater in the bedrock occurs in fractures, bedding planes, and areas of weathered rock or solution channels (where present). In the Browns Ferry site region, recharge to groundwater is from precipitation, with water moving through the overlying residual deposits into the limestone and through the bedrock toward regional discharge points. Groundwater flow is affected by topography and the presence and orientation of fractures, bedding planes, and solution channels (USGS 1990-TN6648). Groundwater near the Browns Ferry site generally flows to the southwest toward the Tennessee River/Wheeler Reservoir where it discharges. Local groundwater discharge may also occur to wetlands, small streams, and springs.

Information about Browns Ferry site groundwater conditions is obtained from a network of 33 wells installed in the overburden deposits and in the bedrock (see Figure 3-11) (TVA 2025-TN11647). Local groundwater flow paths on the Browns Ferry site are influenced by building foundations, buried infrastructure, and the presence of transmissive materials or geologic features (e.g., fractures and solution channels). Groundwater flow is locally affected by the elevation of Wheeler Reservoir, which varies from about 556 ft (169 m) msl in the summer to 551 ft (168 m) msl in the winter (TVA 2024-TN11042, TVA 2025-TN11355). Groundwater elevations for wells installed around the power block buildings are similar to or slightly above the reservoir elevation and show a similar seasonal variation of 4 to 5 ft (1.2 to 1.5 m), indicating a hydraulic connection between groundwater and the river/reservoir (TVA 2025-TN11354). Groundwater elevations generally increase with distance from the reservoir, consistent with the general pattern of groundwater flow towards Wheeler Reservoir (see Figure 3-12). The horizontal hydraulic gradient based on well data is about 0.01 between the power block and the intake channel (TVA 2025-TN11354). Unlined surface water bodies at the plant (hot water channel, cold water channel, intake channel, wastewater lagoons, and sediment ponds) may also affect local groundwater conditions (TVA 2024-TN11042). Groundwater elevations in wells near the low-level radioactive waste storage facility appear to be influenced by the local topographic variations in this area of the site. Six well pairs installed at shallow and intermediate depths (see Figure 3-12) show that vertical groundwater gradients are generally small (TVA 2025-TN11354). This indicates that the unconsolidated materials and the shallow bedrock function as a single aquifer and that groundwater flow is primarily horizontal.

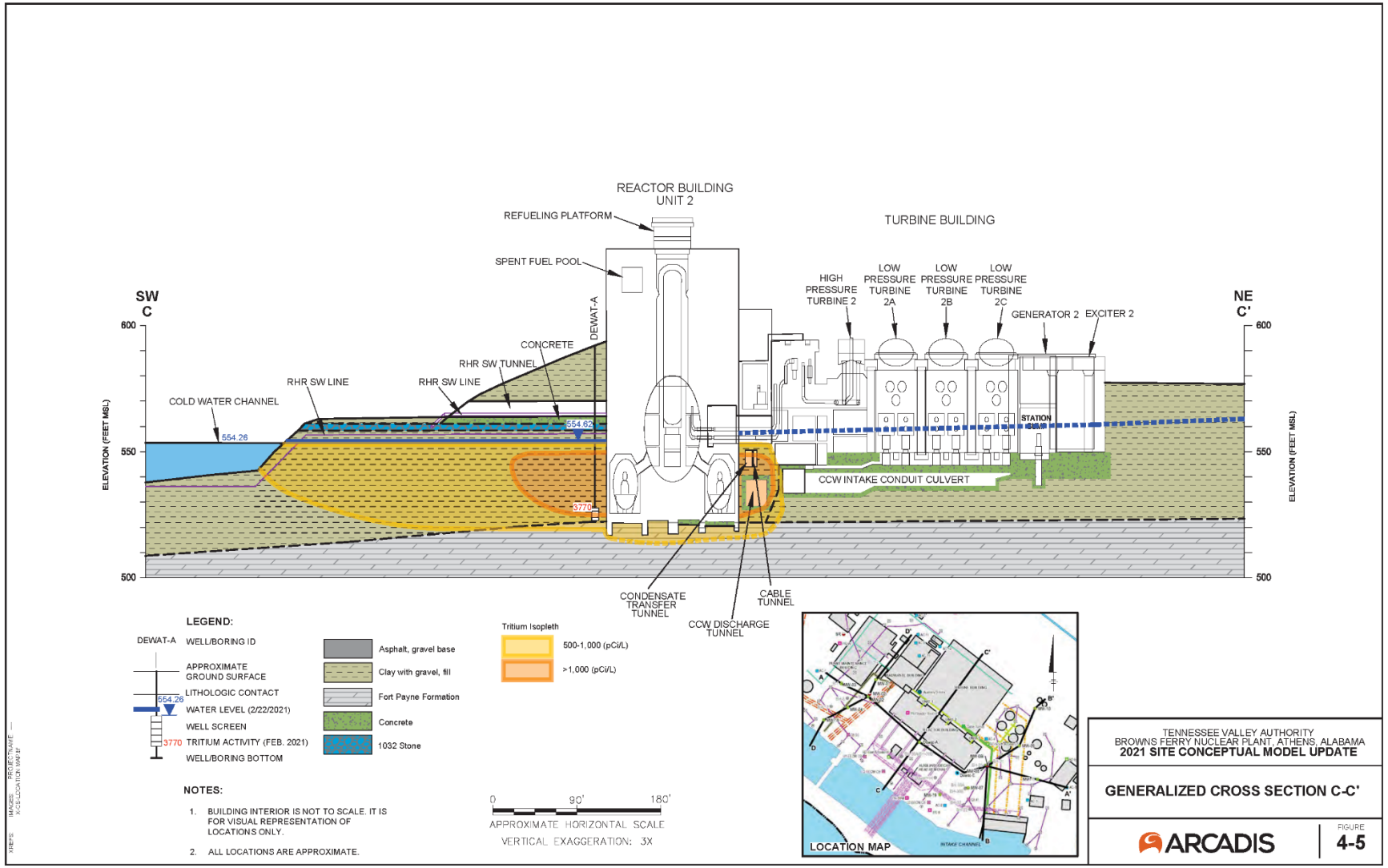

Figure 3-10 Generalized Cross Section of Browns Ferry Nuclear Plant Site. Source: TVA 2025-TN11647.

To evaluate saturated hydraulic conductivities at the site, rising and falling head slug tests were conducted in wells screened in unconsolidated sediments and fill materials (MW-01, MW-03, MW-04, MW-07, MW-08, MW-09, and MW-10) and in a well screened in bedrock (6R) (TVA 2025-TN11354). Three saturated hydraulic conductivity values were estimated for each well from four tests (two falling head and two rising head) conducted in each well. Average hydraulic conductivity for the overburden materials ranged from 0.1 ft/day (0.03 m/day) to 193 ft/day (58.8 m/day). The lowest value is for compact clay with trace coarse sand and gravel; hydraulic conductivity estimates increased with the percentage of coarse sand, gravel, and weathered bedrock present at the tested wells. Average hydraulic conductivity for the bedrock well was 7.2 ft/day (2.2 m/day), attributed to the fine-grained, competent Tuscumbia Limestone.

Groundwater velocities and transport pathways in the plant area are difficult to estimate due to the variable subsurface materials, site infrastructure, and limited data. In addition, transport in groundwater is affected by the variations in Wheeler Reservoir elevation and may be affected in the vicinity of the radwaste building by plant processes (TVA 2025-TN11354). Because porosity of the intact bedrock is low, the NRC staff expect that groundwater flow and the transport of any contaminants in bedrock would occur mainly along fractures, bedding planes, and areas of weathered rock or solution channels. In addition, the NRC staff expect that flow and transport within overburden materials would mainly occur where the percentage of coarse sand and gravel is relatively high, and where crushed rock and sand were used near underground utilities and foundations. Based on the groundwater conditions summarized in this section, transport pathways from the plant buildings would likely discharge to the intake channel (TVA 2024-TN11042). Using the maximum estimated hydraulic conductivity for the overburden materials and an assumed porosity of 0.3, the NRC staff estimated a conservative (minimum) groundwater travel time between the power block and the intake channel of about 50 days. Actual travel times could be greater than this depending on the location of a contaminant release and the local groundwater conditions at the time of release.

3.5.2.2 Local and Regional Water Consumption

Browns Ferry does not use groundwater for operations. Dewatering occurred between 1969 and 1984 to support construction of the plant and to mitigate leakage into plant substructures. Dewatering ceased in 1984 due to movement of soil fines into the dewatering wells and settlement of plant systems, structures, and components (SSCs). Leakage is currently mitigated using methods other than dewatering and there are currently no plans for future groundwater dewatering at the site (TVA 2025-TN11354).

The Tuscumbia-Fort Payne aquifer system provides sufficient water in Limestone County for domestic, irrigation, and public supply use. Withdrawal of fresh groundwater in Limestone County totaled 7.53 MG/day (28.5 million liters/day) in 2015 (Dieter et al. 2018-TN9686). Of this total, the largest uses were for public water supply, 3.85 MG/day (14.6 million liters/day; 51.1 percent), irrigation, 2.47 MG/day (9.3 million liters/day; 32.8 percent), and domestic use, 0.99 MG/day (3.7 million liters/day; 13.1 percent). About one-third of the public supply in Limestone County was provided by groundwater in 2015 and groundwater was the source of water for about 40 percent of the population. TVA identified the nearest known public water supply well located approximately 2 mi (3.2 km) north of the Browns Ferry site (TVA 2024-TN11042) and more than 60 private wells located within 2 mi (3.2 km) of the Browns Ferry stack (TVA 2023-TN11360, TVA 2025-TN11355). Typical depths of the private wells were less than 100 ft (30 m); with many of the private wells being indicated to not be in use at the time of the survey (1995) (TVA 2023-TN11360).

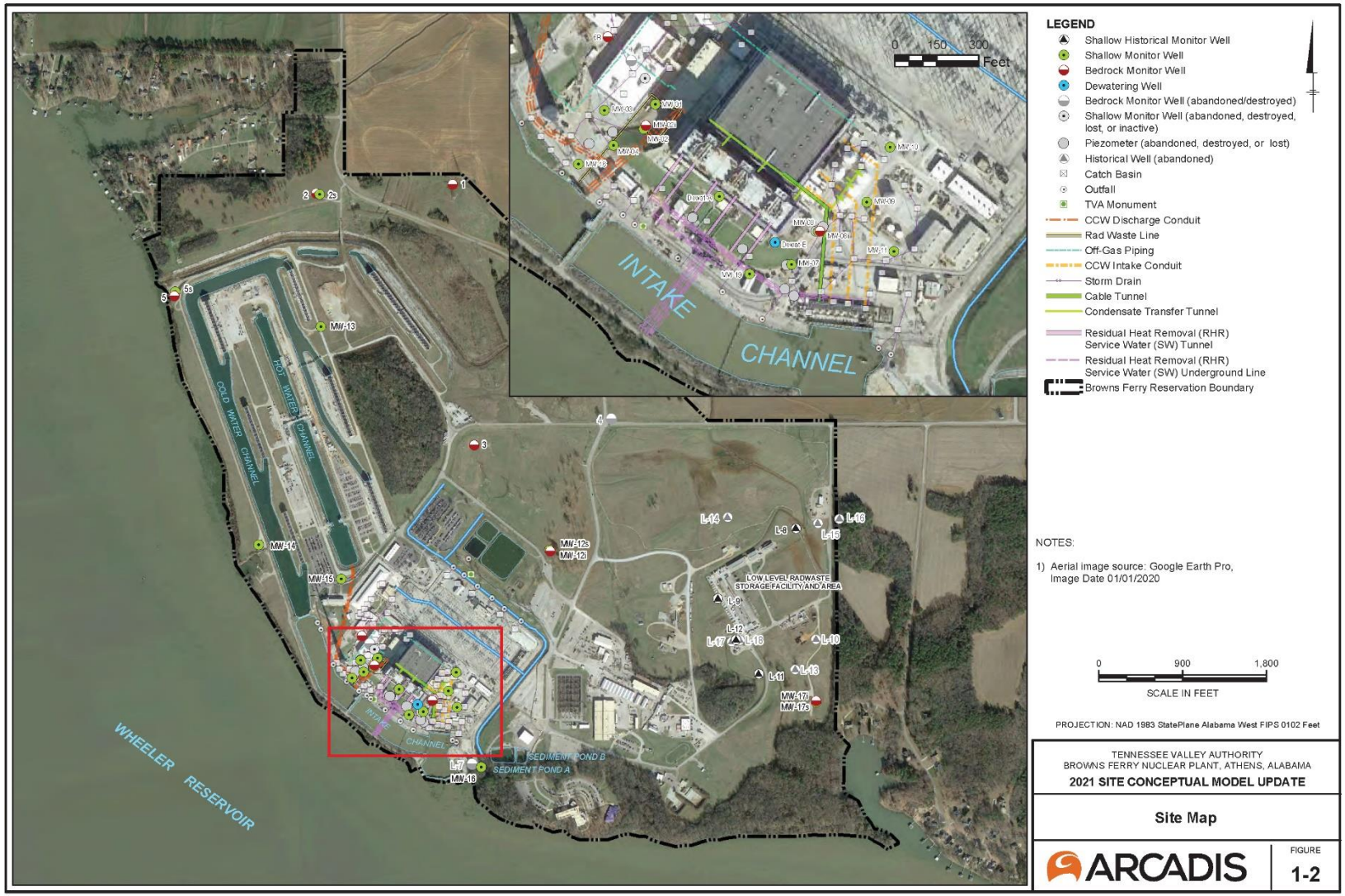

Figure 3-11 Browns Ferry Nuclear Plant Site Map with Wells. Source: TVA 2025-TN11647.

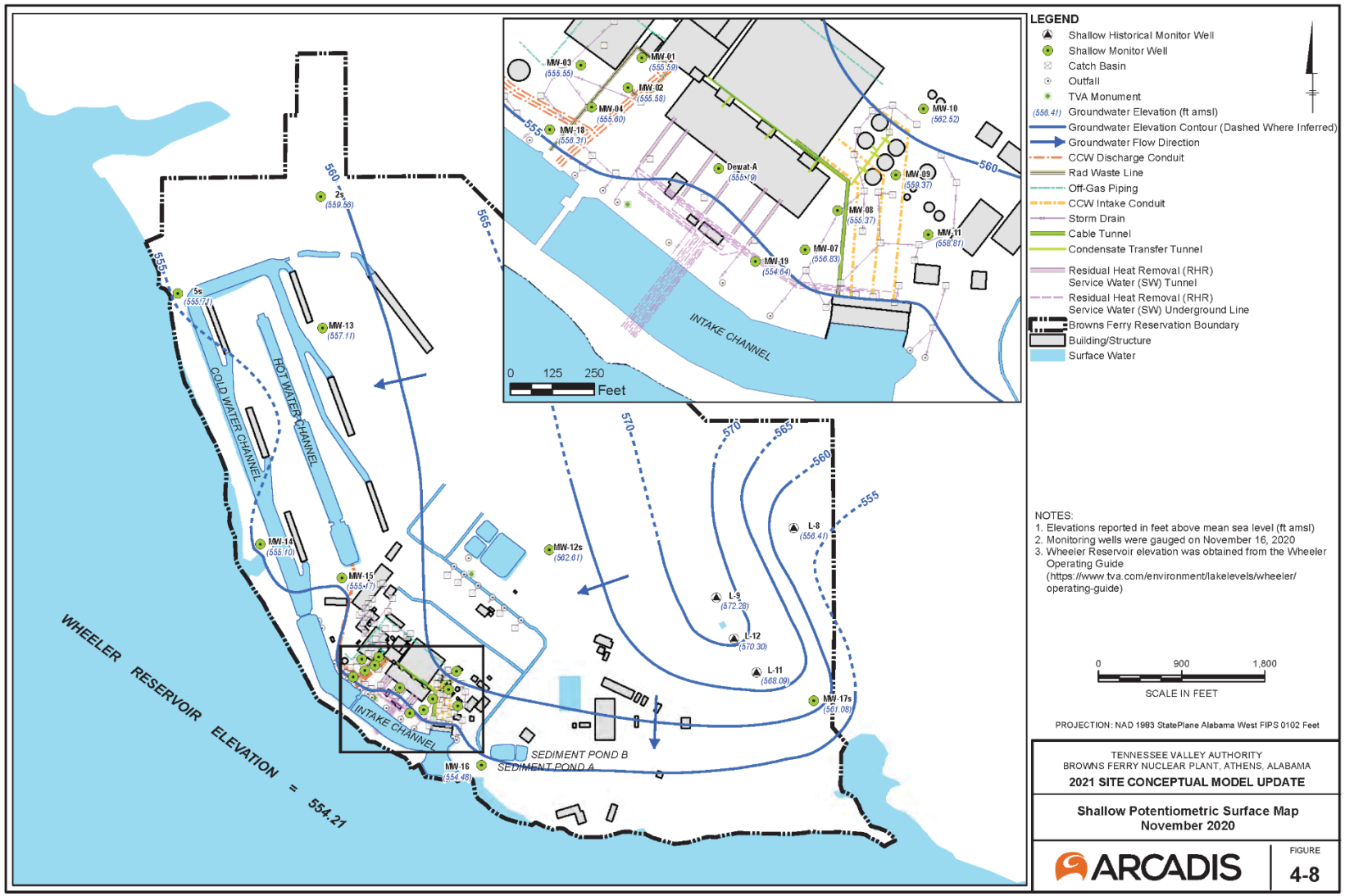

Figure 3-12 Shallow Potentiometric Surface Map of the Browns Ferry Nuclear Plant Site with Wells. Source: TVA 2025-TN11647.

3.5.2.3 Groundwater Quality

Groundwater quality in Limestone County is generally good as evidenced by its prevalent use for irrigation, public supply, and domestic purposes. Historical water quality data from several Limestone County wells nearest the Browns Ferry site showed groundwater in the Tuscumbia aquifer to be of the calcium-carbonate type with neutral pH (6.6–7.2) (USGS 2025-TN11541). Well depths were about 40 ft (12 m) bgs. One sample from the Fort Payne aquifer had a lower pH (5.1) and a higher magnesium content and was of the calcium-chloride type. The well depth was about 60 ft (18 m) bgs. Water hardness was soft for all samples. Water quality of the Mississippian aquifers of the Highland Rim physiographic province is generally good (DeSimone et al. 2014-TN11367).

Nonradiological Spills

TVA controls the use and storage of chemicals associated with Brown Ferry maintenance and operations in accordance with the applicable Federal, State, and county authorizations (TVA 2025-TN11355). In addition, Brown Ferry maintains an integrated pollution prevention plan to minimize the inadvertent release of hazardous materials, which includes a spill prevention control and countermeasure plan and the use of best management practices (TVA 2025-TN11355). No inadvertent releases or spills of nonradioactive contaminants known to have affected groundwater quality occurred at the site between 2014 and 2024 (TVA 2025-TN11354).

Historical Radiological Spills and Tritium in Groundwater

Groundwater Protection Program

Browns Ferry has adopted procedures to implement the Industry Groundwater Protection Initiative (GPI) (NEI 2019-TN6775). A groundwater study conducted in 2006 to identify the source of tritium detected in onsite groundwater attributed the contamination to historical leaks and spills related to the radioactive waste line and condensate transfer tunnel. A review of the site conceptual model was completed in 2021 to satisfy requirements of the GPI (TVA 2025-TN11647). The SSCs at highest risk for releasing radioactive materials to groundwater included the condensate storage tanks, supply lines, and transfer tunnel; the cable tunnel; feedwater roughing coolers; condenser circulating water lines; and the auxiliary decay heat removal system (TVA 2025-TN11647). The locations of groundwater monitoring wells are selected to provide early detection of leaks from high risk SSCs, to monitor the movement of existing and potential contamination, and to detect contaminants before they migrate offsite. Groundwater monitoring wells are sampled either semiannually or quarterly depending on the purpose of the well. More frequent monitoring may be used in response to specific conditions such as a sustained or significant increase in contaminant levels. Samples are routinely analyzed for tritium and gamma emitting radionuclides; select samples are analyzed for hard to detect radionuclides. Surface water sources, storm drains and catch basins, and rainwater are sampled to support groundwater protection. Notification of spills, leaks, or discovery of contamination are made to the NRC and other outside agencies when these meet specified criteria. Groundwater protection monitoring results and spills/leaks that were communicated to the NRC are reported in the annual radioactive effluent release reports (ARERR), available to the public from the NRC (e.g., TVA 2024-TN11368).

Radiological Releases

Twenty-one inadvertent releases of tritium are known to have occurred at Browns Ferry between April 2000 and March 2023 (TVA 2024-TN11042: Table 3.5-2). These releases were

primarily small in volume and their impacts were typically addressed through containment of the released liquid and excavation of impacted soils. Of the most recent 6 releases (December 2016 through March 2023), 5 did not meet the criteria for reporting because they were determined to be less than the voluntary reporting limit of 100 gallons (NEI 2019-TN6775). Browns Ferry provided notification to the NRC, State of Alabama, and local officials for an inadvertent release from a demineralized water storage tank and cooling coil in March 2023 (TVA 2024-TN11042). No inadvertent releases or spills of radioactive contaminants occurred at the site in 2024 (TVA 2025-TN11354).

The maximum observed tritium activity in a groundwater sample at Browns Ferry was 36,444 picocurie per liter (pCi/L) during March 2016 (NRC 2024-TN11047), which occurred at well MW-01 (see Figure 3-11). Detectable levels of tritium have consistently been detected at MW-01 and at other wells between the power block and the intake channel (MW-02, MW-03, MW-04, MW-07, MW-08, MW-18, MW-19, and well Dewat-A). Most of the reported groundwater tritium levels have been below the EPA's drinking water standard (20,000 pCi/L) since 2016. Tritium activity in some wells exhibits significant fluctuation and has exceeded 20,000 pCi/L at well MW-01 during 2016 and 2018, well MW-08 during 2016, and well Dewat-A during 2018, 2019, and 2020 (TVA 2025-TN11647). The cause of the tritium fluctuations in well Dewat-A and other wells has not been determined (TVA 2025-TN11647). The maximum tritium activity in groundwater samples during 2021 through the third quarter of 2024 was 7,100 pCi/L at well MW-01; tritium activity fluctuations continued during this period (TVA 2022-TN11369, TVA 2023-TN11370, TVA 2024-TN11368, TVA 2025-TN11354).

3.5.3 Proposed Action

3.5.3.1 Surface Water Resources

As documented in the LR GEIS (NRC 2024-TN10161) and cited in Table 3-1 of this SEIS, for generic surface water resources issues, the impacts of nuclear power plant SLR and continued operations would be SMALL for Category 1 issues applicable to Browns Ferry. The LR GEIS includes the following Category 1 issues

- surface water use and quality (non-cooling systems)
- altered current patterns at intake and discharge structures
- altered thermal stratification of lakes
- scouring caused by discharged cooling water
- discharge of metals in cooling system effluent
- discharge of biocides, sanitary wastes, and minor chemical spills
- surface water use conflicts (plants with once-through cooling systems)
- effects of dredging on surface water quality
- temperature effects on sediment transport capacity

These applicable Category 1 issues were determined to result in SMALL impact in 10 CFR Part 51 (TN10253), Subpart A, Appendix B, Table B-1.

The NRC staff's review did not identify any new and significant information related to Browns Ferry that would change the conclusion in the LR GEIS. This includes a review of the

exceedances and violations related to Browns Ferry's NPDES permit. These exceedances and violations were resolved upon appropriate actions taken by Browns Ferry. Thus, as concluded in the LR GEIS, for these Category 1 (generic) issues, the impacts of continued operation of Browns Ferry on surface water resources would be SMALL. The one generic surface water resources issue listed in the LR GEIS (NRC 2024-TN10161) that does not apply to Browns Ferry is "Altered Salinity Gradients." LR GEIS Section 4.5.1.1.3 states that this issue is related to plants located on estuaries where cooling system water withdrawals and discharges may cause changes in salinity. As discussed in Section 3.5.1, Browns Ferry is located on a reservoir on the Tennessee River, rather than an estuary, therefore the "Altered Salinity Gradients" issue does not apply.

The LR GEIS lists one Category 2 issue for surface water resources—surface water use conflicts (plants with cooling ponds or cooling towers using makeup water from a river) (NRC 2024-TN10161). Browns Ferry uses a once-through cooling system that is supplemented by helper cooling towers to assist meeting thermal discharge limits. Even with helper cooling towers in operation, Browns Ferry continues to function in an open-cycle, once-through mode, returning nearly all the withdrawn water to the Wheeler Reservoir. Between 2016 and 2023, Browns Ferry water consumption averaged about 0.11 percent of the total withdrawal (TVA 2025-TN11355). Given that the Browns Ferry cooling system operates without the use of a cooling pond or closed-cycle cooling towers, the Category 2 issue surface water use conflicts (plants with cooling ponds or cooling towers using makeup water from a river) is not applicable.

3.5.3.2 Groundwater Resources

As documented in the LR GEIS (NRC 2024-TN10161) and cited in Table 3-1 of this SEIS, for generic groundwater resources issues, the impacts of nuclear power plant LR and continued operations would be SMALL for the Category 1 issues applicable to Browns Ferry. These issues are:

- groundwater contamination and use (non-cooling system impacts)
- groundwater use conflicts (plants that withdraw less than 100 gpm [379 lpm])

These applicable Category 1 issues were determined to result in a SMALL impact in 10 CFR Part 51 (TN10253), Subpart A, Appendix B, Table B-1. No significant groundwater impacts with respect to Category 1 (generic) issues are anticipated during the LR term that would be different from those occurring during the current license term. As discussed in Section 3.5.2 of this SEIS, the NRC staff performed a review of groundwater use and quality. This review, including the independent review of the ER, the scoping process, the audit, and evaluation of available information, did not identify any new and significant information that would change the conclusion reached in the LR GEIS. Based on this review, the NRC staff concludes the following:

- No dewatering is currently used for control of groundwater levels or for remediation and no dewatering is expected during the renewal period. No discharges to groundwater requiring permits by regulatory agencies are expected during the renewal period. There are currently no regulated discharges to groundwater, and none were identified by the applicant to occur during the renewal period.
- Groundwater is not currently used by the plant and no groundwater use is expected during the renewal period.

As a result, as concluded in the LR GEIS (NRC 2024-TN10161) for these Category 1 (generic) issues that are reported in Table 3-1, the impacts on groundwater resources of continued operation of Browns Ferry would be SMALL.

As shown in Table 3-2, the NRC staff identified one site-specific Category 2 issue related to groundwater resources applicable to Browns Ferry during the LR term. This Category 2 issue is radionuclides released to groundwater and it is analyzed below.

Radionuclides Released to Groundwater

The issue of radionuclides released to groundwater was added for consideration as part of the groundwater review for LR in the 2024 LR GEIS revision (NRC 2024-TN10161) because of the inadvertent releases of liquids containing radioactive material into the groundwater at power reactor sites (NRC 2024-TN11047). Most of the inadvertent releases that have occurred at operating plants involved leaks of water containing tritium or other radioactive isotopes from spent fuel pools, buried piping, or failed valves on effluent discharge lines. In 2006, the NRC released a report titled, “Liquid Radioactive Release Lessons Learned Task Force Report,” documenting lessons learned from a review of these incidents that ultimately concluded that these instances had not adversely affected public health and safety (NRC 2006-TN1000). This report concluded, in general, that groundwater affected by radionuclide releases is expected to remain onsite, but that instances of offsite migration have occurred. Therefore, the LR GEIS (NRC 2024-TN10161) determined that impacts on groundwater quality from the release of radionuclides could be SMALL or MODERATE, depending on the magnitude of the leak, the radionuclides involved, hydrogeologic factors, distance to receptors, and the response time of plant personnel to identify and stop the leak. Consistent with the LR GEIS, this is a Category 2 issue requiring a site-specific evaluation, which is provided below for Browns Ferry.

The issue of radionuclides released to groundwater was discussed in Section 4.5.2.8 of the ER (TVA 2024-TN11042). TVA monitors groundwater at Browns Ferry as part of its groundwater protection program, implemented to conform with Nuclear Energy Institute (NEI) 07-07 (NEI 2019-TN6775) and to satisfy the requirements of 10 CFR 20.1501 (TN283). Section 3.5.2.3 of the ER describes the detection of tritium in samples from wells located between the power block buildings and the intake channel. Tritium activities in these wells have fluctuated over time and have exceeded the EPA’s drinking water standard (20,000 pCi/L) in one or more wells during 2016, 2018, 2019, and 2020. The current site conceptual model, prepared for the Groundwater Protection Program, concluded that the persistence of groundwater with elevated tritium levels indicated a potentially recurring source of tritium, although the location and continued presence of such a source were unclear (TVA 2025-TN11647). Groundwater conditions in the area directly between the reactor building and the intake channel are uncertain, in part, because only two active wells are located in the area. Tritium levels in groundwater samples from wells near the power block buildings have been less than 7,100 pCi/L during 2021 through 2023. All samples from monitoring wells on the remainder of the site have been very low (less than about 300 pCi/L).

Based on the information reviewed, the NRC staff determined that elevated tritium activity occurs in a substantial portion of the groundwater in the area between the power block and the intake channel. Tritium is present in the overburden materials but has also been observed at low levels in the three bedrock wells closest to this area. Tritium activity most recently exceeded the drinking water standard (20,000 pCi/L) in one well (Dewat-A) during 2020, with a peak value of 35,400 pCi/L. However, tritium activity in this well fluctuates significantly and only two of eight samples from well Dewat-A exceeded the drinking water standard during 2020. Groundwater impacted by the plant is not used as a drinking water source. In addition, groundwater at the

Browns Ferry site flows toward Wheeler Reservoir and discharges to the intake channel, the cold water channel, or directly to the reservoir. Upon discharge, tritium levels in groundwater would be significantly diluted by the relatively large flows of these surface water bodies. Offsite users of groundwater are unlikely to be affected by any inadvertent releases of radionuclides to groundwater because the contamination is localized to the area of the power block and the site groundwater flow paths are towards the river and not in the direction of the nearby domestic groundwater wells. Therefore, the NRC staff concludes that groundwater resources impacts due to the release of radionuclides to groundwater would be SMALL during the Browns Ferry SLR term.

3.6 Terrestrial Resources

This section describes the terrestrial resources of the Browns Ferry site and the surrounding landscape. Following the description, the NRC staff analyzes the potential impacts on terrestrial resources from the proposed action of SLR. Information in this section is based on the NRC's initial Browns Ferry LR GEIS from 2005 (NRC 2005-TN5192), the applicant's ER (TVA 2024-TN11042), and other publicly available information.

3.6.1 Ecoregion

The Browns Ferry site lies within the Interior Plateau Ecoregion (TVA 2024-TN11042). The EPA (EPA 2013-TN8737) characterizes this ecoregion (Level III Ecoregion 71) as a diverse ecoregion extending from southern Indiana and Ohio to northern Alabama. Topography consists of open hills, irregular plains, and tablelands. Presettlement vegetation consists of oak-hickory forests with some areas of bluestem prairie and cedar glades. Many of the historic bottomland hardwood forests have been inundated by impounded waters across the State. The Eastern Highland Rim is the only Level IV ecoregion occurring within 6 mi (10 km) of Browns Ferry site. Presettlement vegetation of Eastern Highland Rim consists of predominately oak-hickory forest, with xeric oak-hickory forests to the west and mixed mesophytic forests of the Appalachian ecoregions to the east (EPA Undated-TN11387).

The U.S. Army Corps of Engineers defines wetlands as areas either inundated or saturated by surface or groundwater at a frequency and duration sufficient to support (and that under normal circumstances do support) a prevalence of vegetation typically adapted for life in saturated soil conditions (33 CFR Part 328-TN1683). The NRC staff used the National Wetlands Inventory to identify wetlands within the 6 mi (10 km) vicinity of the Browns Ferry site (FWS 2025-TN11388):

- freshwater emergent wetlands 755 ac (305 ha)
- freshwater forested/shrub wetlands 10,926 ac (4,421 ha)
- freshwater ponds 174 ac (70 ha)
- lakes 15,885 ac (6,428 ha)
- riverine waters 117 ac (47 ha)

3.6.2 Browns Ferry Site

The Browns Ferry site consists of about 880 ac (356 ha) of land along the northern shores of Wheeler Reservoir in Limestone County, Alabama (TVA 2024-TN11042). Approximately 44 percent of the site consists of developed land covers, approximately 5% is open water, and 51 percent are other vegetated types (Table 3-3). Developed types consist of lands occupied by the Browns Ferry plant, supporting facilities, roads, and paved and gravel parking lots. Most of the vegetated land covers are non-forested, previously cultivated areas maintained by mowing.

Existing vegetation in the industrial area around the plant is mainly early successional grasses and forbs. Approximately 2.5 mi (4 km) of the site occurs along the Wheeler Reservoir shoreline.

The descriptions, presented in TVA's ER (TVA 2024-TN11042), characterize the terrestrial habitats within the site boundary. Habitat descriptions of the associated tree, shrub, and herbaceous strata are incorporated here by reference:

- upland mixed forest deciduous
- upland mixed forest evergreen
- grassland and early successional habitats
- emergent wetlands
- scrub/shrub wetlands
- forested wetlands

Browns Ferry site boundaries contain a total of 24.1 ac (9.75 ha) of wetlands, lakes, ponds, and riverine waters (TVA 2024-TN11042). Table 3-6 summarizes the area and percentage of wetlands and surface water features on the Browns Ferry site as delineated according to the 1987 U.S. Army Corps of Engineers wetland delineation manual (USACE 1987-TN2066).

Table 3-6 Wetlands and Surface Water Features on the Browns Ferry Nuclear Plant Site

Wetland or Water Feature	Area	Percent of Onsite Wetland Habitat
Freshwater Forested/Shrub Wetlands	6.15 ac	25.52%
Freshwater Emergent Wetlands	17.95 ac	74.48%
Total	24.1 ac	100.00%

Source: TVA 2024-TN11042.

Figure 3-13 shows the location of delineated wetlands on a map of the Browns Ferry site. Wildlife species occurring on the Browns Ferry site consist of species typically found in Alabama forests, croplands, developed areas, and riparian areas. Section 3.6.1.1 in the ER presents a list of the terrestrial wildlife species likely to occur on Browns Ferry site from site visits; this list includes 11 mammals, 48 birds, 6 amphibians, and 8 reptiles. Common animals include toads (American toad [*Anaxyrus americanus*]), frogs (upland chorus frog [*Pseudacris feriarum*]), snakes (eastern black kingsnake [*Lampropeltis nigra*], gray rat snake [*Pantherophis spiloides*]), songbirds (house finch [*Haemorhous mexicanus*], mourning dove [*Zenaida macroura*], American robin [*Turdus migratorius*], Carolina wren [*Thryothorus ludovicianus*], eastern wood pewee [*Contopus virens*]), waterfowl (Canada goose [*Branta canadensis*], various ducks), shorebirds (killdeer [*Charadrius vociferus*]), birds of prey (red-tailed hawk [*Buteo jamaicensis*], red-shouldered hawk [*Buteo lineatus*]), and many small mammals (gray squirrel [*Sciurus carolinensis*], raccoon [*Procyon lotor*], white-tailed deer [*Odocoileus virginianus*]).

Birds on the Browns Ferry site include a mix of resident bird species that may breed or overwinter, be onsite seasonal residents, or species that stop briefly during migration. The Browns Ferry site is located within the Mississippi flyway, an important bird migration route which extends from the Mississippi, Missouri, and lower Ohio rivers to Canada (FWS 2024-TN10908). Migrant birds often fly at night, landing to rest early in the morning. Suitable habitats that allow migratory birds to feed, rest, and avoid predators are called stopovers. Large natural

barriers may create crowded stopover locations because flights over the barriers mean long stretches without opportunities to rest or feed. Along the Mississippi flyway, mountains or large bodies of water are major barriers. Many species of migratory birds likely use the Brown Ferry site and vicinity during the spring and fall migrations.

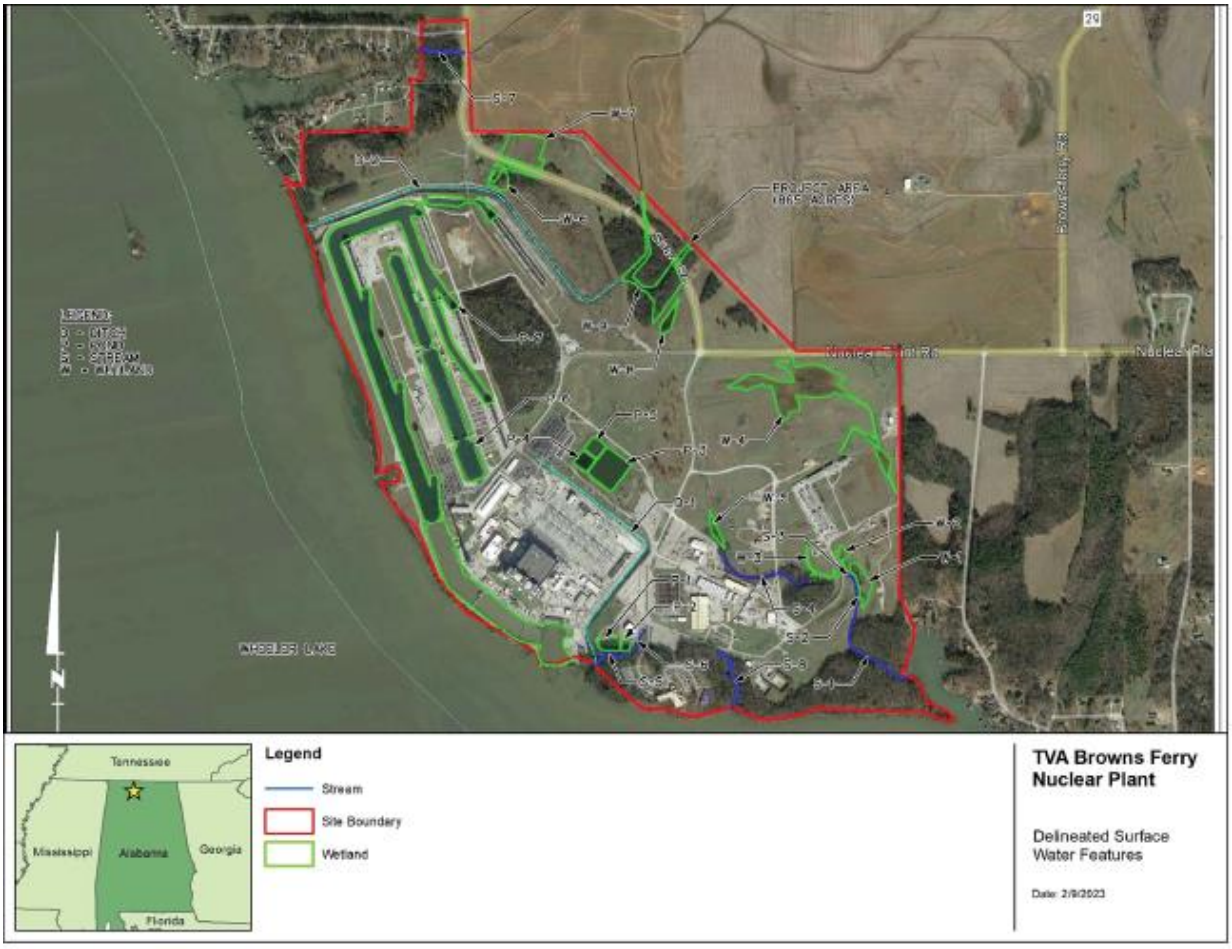

Figure 3-13 Delineated Wetlands Located Within the Browns Ferry Nuclear Plant Site as Mapped. Source: TVA 2024-TN11042.

Important terrestrial species discussed further in this section include those protected by State and Federal laws, those that are culturally important, and those that are particularly affected by the continued operation of the nuclear power plant. In particular, ospreys (*Pandion haliaetus*) are known to nest on the Browns Ferry site on a TVA transmission tower (TVA 2024-TN11042). Section 3.6.3.4 discusses birds, such as ospreys, that are protected by the Migratory Bird Treaty Act.

3.6.3 Important Species and Habitats

3.6.3.1 Federally Listed Species

For a discussion of terrestrial species and habitats that are federally protected under the Endangered Species Act of 1973, as amended, see Section 3.8.

3.6.3.2 State-Listed Terrestrial Species

TVA provided a list of animal species that the State of Alabama has listed as threatened or endangered and that are known to occur or potentially occur in within 6 mi (10 km) vicinity of the Browns Ferry site (TVA 2024-TN11042, TVA 2025-TN11354). The NRC staff supplemented TVA's list with the Alabama Natural Heritage Program list of occurrences within Limestone, Lawrence, and Morgan counties as those counties are within 6 mi (10 km) of the Browns Ferry site (ANHP 2022-TN11384). Alabama does not have a State law equivalent to the Federal Endangered Species Act, but the Alabama regulations on Game, Fish, and Fur Bearing Animals protect some species. While the Alabama Natural Heritage Program does not assign a State protected status to plants; it does assign ranks based on rarity (ANHP 2023-TN11385). Of the 178 State-protected species that can occur in Limestone, Lawrence, or Morgan counties, 6 are also federally listed by the U.S. Fish and Wildlife Service as endangered, threatened, or candidates for Federal listing, and 81 are aquatic species. The NRC addresses all federally-listed species in Section 3.8 and State-listed aquatic species in Section 3.7. Table 3-7 summarizes the 30 terrestrial species that are State protected (but not also federally listed) or ranked critically imperiled (S1) or imperiled (S2) for plant species, and are known to occur in Limestone, Lawrence, or Morgan counties.

For species in Table 3-7, the applicant's ER contains species occurrence information within 6 mi (10 km) of the Browns Ferry site (TVA 2024-TN11042, TVA 2025-TN11354: Enclosure 1), which the NRC incorporates here by reference. The TVA Regional National Heritage database does not have any records of State-ranked S1 (critically imperiled) or S2 (imperiled) plants occurring within a 6 mi (10 km) radius of the site. Of the five State-protected terrestrial species that are not also federally listed (Table 3-7), three are birds, one is a reptile, and one is a mammal. Of the State ranked plants within Limestone, Lawrence, and Morgan counties, 71 of them are ranked for S1 (critically imperiled) or S2 (imperiled).

Of the 30 State-protected terrestrial species and critically imperiled (S1) or imperiled (S2) ranked plant species with potential habitat onsite (Table 3-7), only ospreys are known to occur on the Browns Ferry site.

The osprey (*Pandion haliaetus*) is a State-protected nongame species under Alabama Administrative Code Rule 220-2-.092, "Protected Nongame Species" (ADCNR 2022-TN11390). The widespread decrease observed in osprey population numbers in the early 1950s to 1970s was mainly from the use of the pesticide dichloro-diphenyl-trichloroethane (DDT). Osprey feed almost exclusively on fish. Nests are built in open areas, on tall trees, snags, cliffs, or human-built structures. In 2021, Browns Ferry staff observed osprey nests onsite at two locations: a cell tower and a transmission tower (TVA 2024-TN11042). Due to maintenance conflicts, the nest on the cell tower was removed when it was inactive in 2021. Ospreys continue to nest on structures within Browns Ferry site, such as a transmission tower north of the site and water monitoring stations within the Tennessee River. TVA has a contract with U.S. Department of Agriculture-Animal and Plant Health Inspection Service wildlife services if a nest removal is necessary (TVA 2025-TN11354: Enclosure 1). In addition, TVA will call the U.S. Fish and Wildlife Service (FWS) or Alabama Department of Conservation and Natural Resources if it observes any dead or injured species of concern onsite. TVA is currently drafting a memorandum of agreement with FWS that will include an avian protection plan (TVA 2025-TN11354: Enclosure 1).

Table 3-7 State-Listed Terrestrial Species (That Are Not Also Federally Listed) for Limestone, Morgan, and Lawrence Counties, That Potentially Have Habitat Within the Browns Ferry Nuclear Plant Site

Common Name	Scientific Name	Class	State Legal Status and Rank[c]
Bald eagle[a,b]	*Haliaeetus leucocephalus*	Bird	Protected; S4B
Osprey[a,b]	*Pandion haliaetus*	Bird	Protected; S4
Lark sparrow[a]	*Chondestes grammacus*	Bird	Protected; S3B
Coal skink	*Plestiodon anthracinus*	Reptile	Protected; S3
Eastern spotted skunk	*Spilogale putorius*	Mammal	Protected; S2, S3
Alabama snow-wreath[a]	*Neviusia alabamensis*	Plant	Not protected; S2
Ragged fringe orchid[a]	*Platanthera lacera*	Plant	Not protected; S2
Mohr's rosin-weed[a]	*Silphium mohrii*	Plant	Not protected; S1
Sessile trillium[a]	*Trillium sessile*	Plant	Not protected; S2
Duck river bladderpod[a]	*Lesquerella densipila*	Plant	Not protected; S1
Northern prickly-ash[a]	*Zanthoxylum americanum*	Plant	Not protected; S1
Log fern[a]	*Dryopteris celsa*	Plant	Not protected; S2
Ozark wakerobin[a]	*Trillium pusillum* var. *ozarkanum*	Plant	Not protected; S2
Puttyroot[a]	*Aplectrum hyemale*	Plant	Not protected; S2
Prairie Indian plantain[a]	*Arnoglossum plantagineum*	Plant	Not protected; S1
Dutchman's breeches[a]	*Dicentra cucullaria*	Plant	Not protected; S2
Harper's umbrella plant[a]	*Eriogonum longifolium* var. *harperi*	Plant	Not protected; S1
White trout lily[a]	*Erythronium albidum*	Plant	Not protected; S1, S2
Carolina gentian[a]	*Frasera caroliniensis*	Plant	Not protected; S2
Spring avens[a]	*Geum vernum*	Plant	Not protected; S1
Eggert's sunflower[a]	*Helianthus eggertii*	Plant	Not protected; S2
Large whorled pogonia[a]	*Isotria verticillata*	Plant	Not protected; S2
Canada lily[a]	*Lilium canadense*	Plant	Not protected; S2
Cumberland rosinweed[a]	*Silphium brachiatum*	Plant	Not protected; S2
Water stitchwort[a]	*Stellaria fontinalis*	Plant	Not protected; S1
Southern meadowrue[a]	*Thalictrum debile*	Plant	Not protected; S2
Prairie trillium[a]	*Trillium recurvatum*	Plant	Not protected; S2
Field horsetail[a]	*Equisetum arvense*	Plant	Not protected; S2
Miterwort[a]	*Mitella diphylla*	Plant	Not protected; S1
Yellowleaf tinker's-weed[a]	*Triosteum angustifolium*	Plant	Not protected; S1

(a) Species with potential habitat on the Browns Ferry site.
(b) Species known within 6 mi of the Browns Ferry site
(c) Plant State rank code—S1 is critically imperiled due to extremity where five or fewer occurrences of individuals or other factors that make the species vulnerable to extirpation in Alabama. Plant State rank code—S2 is imperiled species that are at a high risk of extirpation due to either very restricted range, very few populations, steep declines, or other factors. Plant State rank code—S3 is vulnerable species that is rare or uncommon in Alabama that is at moderate risk of extirpation due to restricted range, relatively few populations, recent and widespread declines, or other factors. Plant State rank code—S4 is apparently secure in the State though the species may be uncommon, but not rare. In addition to State rank code, there are breeding status qualifiers for species that have distinct breeding and/or non-breeding populations in the State. B is the code for breeding population the species in the State.

Sources: TVA 2024-TN11042; ANHP 2022-TN11384, ANHP 2023-TN11389.

- Potential habitat occurs within the forests, forest edges, and grassy areas onsite for the lark sparrow (*Chondestes grammacus*), white trout lily (*Erythronium albidum*), and Carolina gentian (*Frasera caroliniensis*). Lark sparrows inhabit a variety of habitats including open grassy areas with scattered trees, open woodlands, and during migration and winter, pine-oak forests and agricultural areas (Cornell 2025-TN11391). Similarly, white trout lily and Carolina gentian prefer areas of forest floors, particularly areas of disturbance such as clearings and margins (NatureServe 2025-TN11392).
- The dry to mesic upland forests dominated by oak-hickory or maple-oak assemblage and forest edges and fragmented forest habitats could be potential habitat for northern prickly-ash (*Zanthoxylum americanum*), Harper's umbrella plant (*Eriogonum longifolium* var. *harperi*), Cumberland rosinweed (*Silphium brachiatum*), prairie trillium (*Trillium recurvatum*), eastern spotted skunk (*Spilogale putorius*), and Eggert's sunflower (*Helianthus eggertii*) (NatureServe 2025-TN11394, NatureServe 2025-TN11395, NatureServe 2025-TN11397; USDA 2014-TN11398; NCBG 2025-TN11400; NatureServe 2025-TN11401; iNaturalist 2025-TN11404).
- Southern meadowrue (*Thalictrum debile*) prefers floodplains forests and ragged fringed orchid prefers damp areas and is known to inhabitant anthropogenic habitats, riverbanks, and wetland margins (NAOCC 2025-TN11405; NatureServe 2025-TN11406). The listed species for the September 2021 wetland delineation did not specifically note the presence of the ragged-fringed orchid or Southern meadowrue; however, these species could potentially be found along riverbanks onsite.
- Damp hardwood forests onsite are potential habitat for puttyroot (*Aplectrum hyemale*), dutchman's breeches (*Dicentra cucullaria*), spring avens (*Geum vernum*), Canada lily (*Lilium canadense*), water stitchwort (*Stellaria fontinalis*), field horsetail (*Equisetum arvense*), miterwort (*Mitella diphylla*), and coal skink (*Plestiodon anthracinus*) (ADCNR 2025-TN11408; LBJWC 2025-TN11409; USDA 2014-TN11410; NatureServe 2025-TN11411; NPT 2025-TN11413; FNAA 2020-TN11414; Keener et al. 2025-TN11415; NAOCC 2025-TN11416). Zone 1 forest onsite has hardwood species and a stream adjacent to the southern boundary of the forest.
- Pastures and disturbed roadsides onsite are potential habitat for the prairie Indian plantain (*Arnoglossum plantagineum*) (Keener et al. 2025-TN11417).

3.6.3.3 Species Protected under the Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (16 U.S.C. 668 and 668c-TN1447) extends regulatory protections to the bald eagle and golden eagle. The Act prohibits anyone without a permit from the U.S. Secretary of the Interior from "taking" bald eagles or golden eagles, including their parts, nests, or eggs.

TVA summarizes eagle occurrences and nesting in the vicinity and on the Browns Ferry site (TVA 2024-TN11042). Bald eagles have been spotted within 3 mi (4.8 km) of the Browns Ferry site and have known nests 5.4 mi (8.69 km) away from the site. Wheeler Reservoir provides good foraging habitat for bald eagles. While suitable bald eagle nesting habitat occurs within the Browns Ferry site within the fragmented forest sections; no bald eagle nests have been documented onsite. Although golden eagles are known to winter within Alabama (Cornell 2025-TN11418), they are not known to nest within the State. Furthermore, FWS did not list golden eagles as a species of concern for the site within the Information for Planning and Consultation (IPaC) report (FWS 2025-TN11420). Currently, TVA does not keep records for avian collisions onsite (TVA 2025-TN11354: Enclosure 1).

3.6.3.4 Species Protected under the Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) makes it illegal for anyone to take, possess, import, export, transport, sell, purchase, barter, or offer for sale any migratory bird or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued under Federal regulations. TVA is drafting an MOA with FWS that will include a corporate avian protection plan to address migratory birds that may be present, injured, or killed on TVA property (TVA 2024-TN11042).

In its independent review, the NRC staff determined that 59 bird species have the potential to occur onsite, based on the list of species known to occur in Lawrence, Morgan, and Limestone counties (TVA 2024-TN11042), the IPaC report (FWS 2025-TN11420), and its independent review of State-listed species (Table 3-7). Of these 59 bird species, 56 are protected by the MBTA (50 CFR Part 10-TN5490). All three State-protected birds that have potential to occur onsite (Table 3-7) are also protected by the MBTA, as are eagles and Birds of Conservation Concern species. Section 3.8 addresses whooping cranes, which are endangered.

TVA lists 59 bird species that were observed during field visits and are known in Limestone County or listed in the IPaC report (TVA 2024-TN11042). In addition, 11 of these migratory birds are Birds of Conservation Concern, a FWS designation for species of highest conservation priority that are not already federally listed as threatened or endangered (FWS 2021-TN8740): Bobolink (*Dolichonyx oryzivorus*), brown-headed nuthatch (*Sitta pusilla*), chimney swift (*Chaetura pelagica*), field sparrow, Kentucky warbler (*Oporornis formosus*), Prairie warbler (*Dendroica discolor*), prothonotary warbler (*Protonotaria citrea*), red-headed woodpecker (*Melanerpes erythrocephalus*), wood thrush (*Hylocichla mustelina*), lesser yellowlegs (*Tringa flavipes*), and rusty blackbird (*Euphagus carolinus*).

If Browns Ferry staff encounter an injured or dead species of concern onsite, the standard procedure is to call FWS or the Alabama Department of Conservation and Natural Resources (TVA 2025-TN11354: Enclosure 1).

Tall structures and buildings can pose a collision hazard to migratory birds. TVA has 5 structures and buildings onsite that are 100 ft (30.5 m) higher or more (TVA 2025-TN11354: Enclosure 1). This includes a 298.6 ft (91 m) guyed-MET tower, a 600 ft (182.9 m) off-gas stack, a 230 ft (70.1 m) free-standing cell phone communication tower, a 143 ft (43.6 m) reactor building, and a 104 ft (31.7 m) turbine building. The MET tower has a medium-intensity flashing light on top and a solid marker light on the middle of the tower. Similarly, the communication tower has a red flashing beacon at the top and red non-flashing lights in the middle. The off-gas stack has four sets of lights alternating between red flashing lights and non-flashing red lights.

3.6.3.5 Invasive Species

Invasive species are identified as nonnative organisms whose introduction causes or is likely to cause economic or environmental harm or to cause harm to human, animal, or plant health (81 FR 88609-TN8375). Executive Order 13112 (64 FR 6183-TN4477) directs Federal agencies to not authorize, fund, or carry out actions likely to cause or promote the introduction or spread of invasive species unless they determine that the benefits of the action clearly outweigh the harm from invasive species and that all feasible and prudent measures to minimize risk of harm are taken (64 FR 6183-TN4477: Section 2). Alabama Department of Agriculture and Industries lists 28 plant species as common noxious weeds in Alabama Administrative Code Rule 80-10-14-.04 (AL Admin. Code 80-10-14-TN11432), in addition to the 112 plant species listed on the Federal noxious weed list (7 CFR Part 360-TN11433).

Within its environmental report, TVA lists the invasive terrestrial and aquatic species observed in the immediate vicinity of Browns Ferry that are continually monitored and managed as needed (TVA 2024-TN11042). Browns Ferry does not have a formal invasive species management plan, but if a species becomes problematic, the NRC staff will issue a condition report and develop a correction action program to manage the species (TVA 2025-TN11354: Enclosure 1).The aquatic species, striped bass, yellow perch, hybrid striped bass and white bass, grass carp, Atlantic needlefish, redbreast sunfish, Mississippi silverside, common carp, tubificid worm, amphipod, and Asian clam are covered in Section 3.7.1. The remaining invasive plant species (TVA 2024-TN11042) have the potential to occur within the site and are addressed here as terrestrial species, with full species biology and occurrence information incorporated by reference from the applicant's ER. The following invasive terrestrial species are reported to occur within 6 mi (10 km) of the site, as documented in research records from iNaturalist and TVA's environmental report (iNaturalist 2024-TN11489,TVA 2024-TN11042):

1. Within the cleared transmission corridor, on the edges of the forest, and roadsides multiflora rosa (*Rosa multiflora*), Chinese lespedeza (*Lespedeza cuneata*), and Japanese honeysuckle (*Lonicera japonica*) have the potential to occur onsite. Records of these species occur approximately 1 mi (1.6 km) from the Browns Ferry site and the seeds of these species can be distributed widely by wildlife and human disturbances (Swearingen et al. 2010-TN11434; PSU 2020-TN11441).
2. Within forests, roadsides, and utility corridors Japanese stiltgrass (*Microstegium vimineum*) and Japanese honeysuckle (*Lonicera japonica*) have the potential to occur onsite. Records of these species occur approximately 1 mi (1.6 km) from the Browns Ferry site and the seeds of these species can be distributed widely by wildlife and human disturbances (PCA 2025-TN11443; Swearingen et al. 2010-TN11434).

3.6.3.6 Important Habitats

Important habitats include any wildlife sanctuaries, refuges, preserves, or habitats identified by State or Federal agencies as unique, rare, prioritized for protection, wetlands and floodplains, and land areas identified as critical habitat for species listed by the FWS as threatened or endangered. Important habitats on and around the Browns Ferry site include the wetlands discussed in Sections 3.6.1 and 3.6.2. No critical habitat for federally protection species occurs within the Browns Ferry site (Section 3.8).

In addition, nearby Federal lands provide important terrestrial habitats (TVA 2024-TN11042). Wheeler National Wildlife Refuge contains a diverse range of habitats that support numerous species including federally listed, threatened, or endangered species (FWS 2025-TN11419).

Nearby State lands also provide important terrestrial habitats (TVA 2024-TN11042). Swans Creek State Wildlife and Mallard-Fox Creek State Wildlife Management Areas are managed for waterfowl, mourning doves, and small game (ABT 2025-TN11444, ABT 2025-TN11445).

3.6.4 Proposed Action

As described in the LR GEIS (NRC 2024-TN10161) and cited in Table 3-1 of this SEIS, the impacts of all generic terrestrial resources would be SMALL. The NRC staff's review did not identify any new and significant information that would change the conclusion in the LR GEIS with respect to Browns Ferry SLR.

Table 3-2 identifies two Category 2 issues that require site-specific analysis. These issues are (1) non-cooling impacts and (2) water use conflicts with terrestrial resources (plants with once-through cooling systems or cooling ponds using makeup water from a river). The following sections analyze these issues.

3.6.4.1 *Non-Cooling System Impacts on* Terrestrial Resources

According to the LR GEIS (NRC 2024-TN10161), non-cooling system impacts on terrestrial resources can include impacts that result from site and landscape maintenance activities, stormwater management, elevated noise levels, and other ongoing operations and maintenance activities that would occur during the LR period on and near a plant site. The NRC staff based its analysis in this section on information derived from TVA's ER (TVA 2024-TN11042) unless otherwise cited. TVA has not identified any refurbishment activities during the proposed relicensing term (TVA 2024-TN11042). No further analysis of potential impacts from refurbishment activities is therefore necessary.

In its ER (TVA 2024-TN11042), TVA states that it will conduct ongoing operational and maintenance activities at Browns Ferry throughout the SLR term, including landscape maintenance activities and stormwater management. The NRC staff expects that physical disturbances would be limited to paved or disturbed areas or to areas of mowed grass or early successional vegetation and not encroach into wetlands or into the remaining areas of forest. The NRC staff concludes that the anticipated activities would have only minimal effects on terrestrial resources, based on information presented in the ER and the staff's independent analysis.

TVA (TVA 2024-TN11042) states that it has "A Guide for Environmental Protection and Best Management Practices for Tennessee Valley Authority Construction and Maintenance Activities, Revision 4, 2022" (TVA 2022-TN10340) in place at Browns Ferry to minimizes environmental impacts through BMPs. TVA further states that regulatory programs for issues like stormwater management, spill prevention, dredging, and herbicides further minimize impacts on terrestrial resources (TVA 2024-TN11042). In addition, TVA is currently drafting a memorandum of agreement with the FWS that will include an avian protection plan (TVA 2024-TN11042, TVA 2025-TN11354). The NRC staff concludes that continued adherence to environmental management practices and BMPs already established for Browns Ferry and the forthcoming avian protection plan approved by FWS would protect terrestrial resources during the SLR period.

Operational noise from the Browns Ferry site facilities extends into the remaining natural areas on the site. However, Browns Ferry has exposed these habitats to similar operational noise levels since it began operating in 1974. The NRC staff therefore expects that wildlife in the affected habitats have long ago acclimated to the noise and human activity of Browns Ferry operations and adjusted their behavior patterns accordingly. Extending the same level of operational noise levels during the 20-year SLR period is therefore unlikely to noticeably change the patterns of wildlife movement and habitat use.

Based on its independent review, the NRC staff concludes that the landscape maintenance activities, stormwater management, elevated noise levels, and other ongoing operations and maintenance activities that TVA might undertake during the SLR term would primarily be confined to already disturbed areas of the Browns Ferry site. These activities would neither have noticeable effects on terrestrial resources nor would they destabilize any important attribute of the terrestrial resources on or in the vicinity of the site. The NRC staff expects that

TVA would continue to comply with the applicable requirements of Federal and State regulatory programs and obtain any needed permits. Accordingly, the NRC staff concludes that non-cooling system impacts on terrestrial resources during the SLR term would be SMALL.

3.6.4.2 Water Use Conflicts with Terrestrial Resources (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a River)

Water use conflicts occur when the amount of water needed to support riparian communities is diminished as a result of demand for agricultural, municipal, or industrial use or decreased water availability due to droughts, or a combination of these factors. The NRC staff describes how this issue has been addressed historically and then provides a site-specific evaluation for the Browns Ferry SLR term.

The LR GEIS (NRC 2024-TN10161) determined that water use conflicts with terrestrial resources would be SMALL at most nuclear power plants with cooling ponds or cooling towers that withdraw makeup from a river, but may be MODERATE at some plants, so require a site-specific review.

In the 2005 Browns Ferry LR SEIS (NRC 2005-TN5192), the NRC staff reviewed the available information, including the rate of evaporative water loss associated with the plant's operations, maintenance of minimum flow conditions of the Tennessee River, and past operation information and concluded impacts were SMALL for Browns Ferry initial license renewal. The NRC staff analyzes surface water resource use conflicts in Section 3.5.3.1 and water use conflicts regarding aquatic resources in Section 3.7.2.3.

Browns Ferry typically utilizes open-cycle, once-through cooling water system, and does not use cooling ponds. Flow is occasionally conducted through helper cooler towers to reduce discharge water temperatures to meet the thermal discharge temperature limits outlined in the NPDES permit standards (TVA 2024-TN11042). When the helper towers are in operation, Browns Ferry continues to operate in open-cycle mode and return most of the water withdrawn back to the river. In the NRC staff's analysis of surface water conflicts (Section 3.5.3.1), the staff estimated that less than 3 percent of the Tennessee River flows are permanently removed by Browns Ferry when the plant is cooled in helper mode using MCDTs. In Section 3.5.3.1, the NRC staff concluded that surface water use conflicts would be SMALL due to returning nearly all the withdrawn water to the Wheeler Reservoir.

Terrestrial riparian communities that could be impacted by diminished water availability are the terrestrial resources associated with the wetlands and surface water habitats on the Browns Ferry site (Table 3-6, Figure 3-13). Onsite there is approximately 24.1 ac (9.75 ha) of wetlands, which mostly consist of freshwater emergent wetlands (74.48 percent of onsite wetlands). No riverine or lacustrine wetlands are onsite.

The proposed SLR term for Browns Ferry would continue current operating conditions and environmental stressors rather than introduce wholly new impacts. Therefore, the impacts of current operations and SLR on terrestrial resources would be similar. For the reasons explained above, water use conflicts with terrestrial resources from SLR either would not occur or would be so minor that the effects on terrestrial resources would be undetectable. The NRC staff concludes that water use conflicts with terrestrial resources during the Browns Ferry SLR term would be SMALL.

3.7 Aquatic Resources

This section describes the aquatic resources of the affected environment, which are associated with Wheeler Reservoir on the Tennessee River. The NRC previously characterized these resources in Section 2.2.5 of the 2005 *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 21 Regarding Browns Ferry Nuclear Plant, Units 1, 2, and 3* (NRC 2005-TN5192) and Section 5.0 of the 1977 *Environmental Assessment, of Operation of Browns Ferry Nuclear Plant* (TVA 1977-TN11045), which analyzed impacts to the aquatic environment. Key, new, and updated information are summarized in the sections below. Following the description of the aquatic environment, the NRC staff analyzes the potential impacts on these resources that would occur from the proposed action (SLR).

3.7.1 Wheeler Reservoir and Tennessee River

The Wheeler Reservoir portion of the Tennessee River was constructed by the TVA for hydroelectric generation, flood control, and navigation in 1936 (TVA 2025-TN11402). The lake is about 60 mi (97 km) long, has a surface area of 67,070 ac (27,142 ha) and a maximum volume of 1.05 million ac-ft (129,515 ha-m). Wheeler Reservoir is bookended between Guntersville dam upstream and Wheeler dam downstream. The maximum depth in the lake is 57 ft (17 m) with an average depth of 16 ft (4.9 m). To ensure the ability of commercial vessels (e.g., barges) to navigate the lake, depth never varies by more than 5 ft (1.5 m). The dams above and below the lake have locks which allow for some fish passage. The Browns Ferry Nuclear Plant is located at TRM 294.

TVA has monitored the ecological health of Wheeler Reservoir since 1994 using five metrics: dissolved oxygen, chlorophyll, sediment quality, benthic macroinvertebrate community (bottom life), and fish assemblage (TVA 2025-TN11403). They monitor at four locations: the forebay (TRM 277.0); the middle part of the reservoir (TRM 295.9); the Elk River embayment (Elk River Mile 6.0); and the extreme upper end of the reservoir (TRM 348.0) every other year. The middle station at TRM 295.9 is the closest monitoring location to Browns Ferry and the forebay at TRM 277 is the closest downstream location. In 15 years of monitoring (since 1994) and assigning ecological health scores, 3 years scores were “good” (1994, 1997, 2005), 2 years scores were “bad” (2007, 2011), and the remaining years were “fair” (1995, 1999, 2001, 2003, 2009, 2013, 2015, 2017, 2019, 2021) (TVA 2025-TN11403). The most recent data from 2021 listed all the criteria at the mid-reservoir site closest to the plant as good except for sediment which was fair (TVA 2025-TN11403). Downstream at the forebay, fish and sediment were good, dissolved oxygen was fair, and chlorophyll and bottom life was poor. Fair dissolved oxygen ratings are due to concentrations less than 2 mg/L in the lower water column during summer months. The rest of the metrics are discussed in the following sections.

A cross-contamination incident in 2023 resulted in an unmonitored release of reactor water to the Tennessee River. As discussed in Section 3.13.1.5, the release did not exceed 10 CFR Part 50, Appendix I criteria or 10 CFR 20.1301 limits and was evaluated as having very low safety significance (green finding) by NRC (NRC 2024-TN11604).

3.7.1.1 Biological Communities

The trophic structure of Wheeler Reservoir includes primary producers (plankton, macrophytes, and periphyton), primary consumers (zooplankton and benthic macroinvertebrates), and bottom feeding, planktivorous, and piscivorous fish that serve as secondary and tertiary consumers. Primary producers are organisms that capture solar energy and synthesize organic compounds

from inorganic chemicals. They form the trophic structure's foundation by producing the organic nutrients and energy used by consumers. Primary producers in lake systems include phytoplankton, aquatic macrophytes, and periphyton. Of the three, phytoplankton are the major producers in all but very shallow lakes. Figure 3-14 illustrates the trophic structure of Wheeler Reservoir.

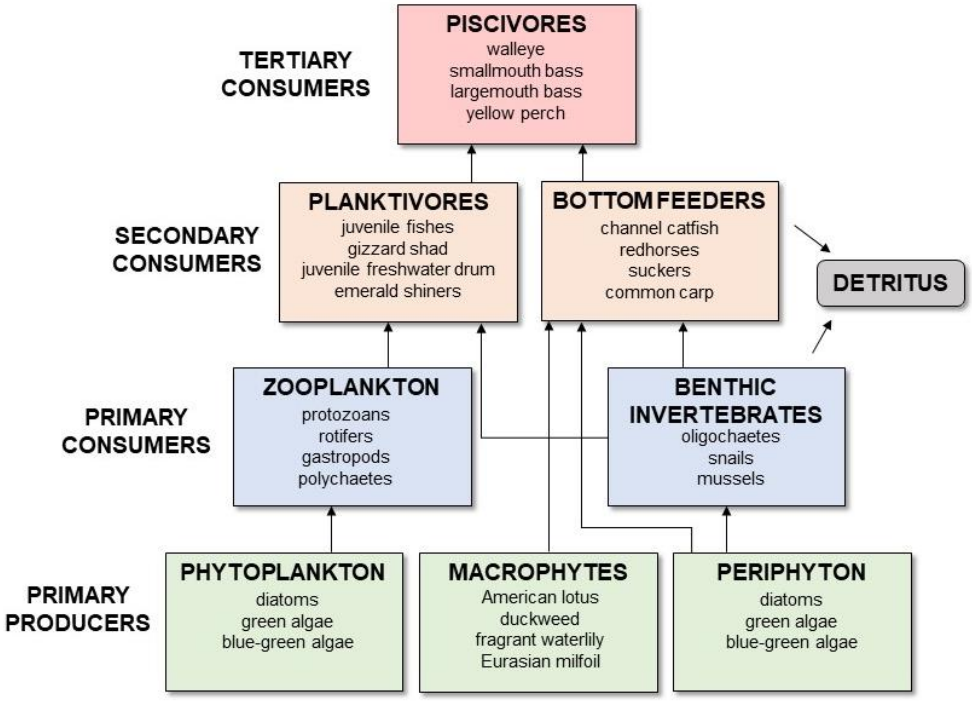

Figure 3-14 Trophic Structure of Wheeler Reservoir's Aquatic Ecosystem

Plankton

Plankton are small and often microscopic organisms that drift or float in the water column. Phytoplankton are single-celled plant plankton and include diatoms (single-celled, yellow algae) and dinoflagellates (a single-celled organism with two flagella). Phytoplankton live suspended in the water column and occur in the limnetic (open water) zone of a lake.

TVA monitors chlorophyll as one of its metrics of reservoir health (TVA 2025-TN11403), using chlorophyll-a as an indicator of phytoplankton biomass. A good rating suggests normal algal growth, while low or high levels can impact food availability or oxygen levels. In 2021, TVA rated chlorophyll levels as "good" at the mid-reservoir location across from Browns Ferry, but "poor" at the Elk River location a few miles downstream and at the site further downstream by the dam (TVA 2025-TN11403). In the two areas rated as "poor," elevated chlorophyll concentrations are common, and dry periods result in even higher chlorophyll concentrations due to reduced flow. Higher levels of algal growth can lead to a decrease in dissolved oxygen levels which were noted in the same report at the Elk River location at the bottom of the water column during the hottest summer months (TVA 2025-TN11403). This low oxygen condition is not unexpected in summer with low flow conditions in lakes because of the development of a thermocline, which decreases water mixing, as temperatures rise.

The ADEM also monitors Wheeler Reservoir as part of their integrated water quality monitoring and assessment report (ADEM 2022-TN11393). In 2019, using Carlson's trophic state index, which measures chlorophyll-a, turbidity, and total phosphorus, ADEM determined that Wheeler Reservoir is eutrophic (ADEM 2022-TN11393). Eutrophic water bodies contain an excess of nutrients, usually from runoff, leading to dense phytoplankton growth and can cause low dissolved oxygen levels for other organisms like fish.

Zooplankton are animals that either spend their entire lives as plankton (holoplankton) or exist as plankton for a short time during development (meroplankton). Zooplankton include rotifers, isopods, protozoans, marine gastropods, polychaetes, small crustaceans, and the eggs and larval stages of insects and other aquatic animals. A 2020 analysis of biological monitoring showed that phytoplankton and zooplankton communities were similar both upstream and downstream of Browns Ferry during most years of operation (TVA 2025-TN11354: Enclosure 2, Attachment 8).

Macrophytes and Periphyton

Aquatic macrophytes are large plants, both emergent and submerged, that inhabit shallow water areas. Periphyton consists of single-celled or filamentous species of algae that attach to benthic or macrophytic surfaces. Macrophytes and periphyton occur in the littoral (nearshore and shallow) zone. They tend to be highly productive because they have more access to nutrients through their roots than do phytoplankton. Some common aquatic plants found in Wheeler Reservoir include native plants like American lotus, duckweed, frog's bit, mosquito fern, and fragrant waterlily; and non-native plants like water hyacinth, water lettuce, common and giant salvinia, hydrilla, Eurasian milfoil, eelgrass, and alligator weed (TVA 2025-TN11396; Shorelines 2025-TN11399).

Benthic Invertebrates

Benthic invertebrates inhabit the bottom of rivers and mainly consume periphyton. They include certain zooplankton and macroinvertebrates such as insects, mussels, crayfish, snails, clams, and polychaetes. Benthic invertebrates are primary consumers and are an important indicator of the health of an aquatic system.

The Wheeler National Wildlife Refuge Complex's comprehensive conservation plan and environmental assessment lists 38 species of mussels that can be found in Wheeler Reservoir or its tributaries, four of which are endangered, the rough pigtoe (*Pleurobema plenum*), the sheepnose (*Plethobasus cyphyus*), Spectaclecase (*Cumberlandia monodonta*), and the pink mucket or pearly mussel (*Lampsilis abrupta*) (see Table 3-8) (FWS 2007-TN11407). The plan also lists 26 species of freshwater snail, three of which are endangered (FWS 2007-TN11407).

In July 2021, TVA conducted a mussel survey to assess freshwater mussels immediately adjacent to Browns Ferry (TVA 2024-TN11042: Attachment 5). The survey found 11 species of mussel in the overbank habitat but none in the channel slope or channel habitat adjacent to Browns Ferry, and four snail species (see Table 3-8). The most abundant mussel species was the washboard (*Megalonaias nervosa*), surpassing the elephant-ear (*Elliptio crassidens*) which was the most abundant species during a 1991 survey (TVA 1992-TN11412; TDPH TSPCB 1961-TN11425). The difference in the number of species of mussels found upriver within the Wheeler National Wildlife Refuge (NWR) is likely due to the presence of more riverine environments in tributaries within the NWR versus a more lacustrine environment around the Browns Ferry site. TVA also surveyed six locations downstream of the plant and five upstream, all within Wheeler Reservoir, discovering the invasive Asian clam (*Corbicula fluminea*). Researchers did not find any endangered species of mussel present.

Table 3-8 Benthic Invertebrates That May Occur in or near Wheeler Reservoir

Type	Common Name	Scientific Name	Special Status	Wheeler NWR	TVA 2021	TVA 1991
Mussels	black sandshell	*Ligumia recta*	PSM	P	-	-
Mussels	butterfly	*Ellipsaria lineolata*	PSM	P	-	-
Mussels	ebonyshell	*Fusconaia ebena*	PSM, CH	P	-	-
Mussels	elephant ear	*Elliptio crassidens*	PSM, CH	P	P	P
Mussels	fanshell	*Cyprogenia stegaria*		-	-	R
Mussels	fawnsfoot	*Truncilla donaciformis*	PSM	P	P	-
Mussels	flat floater	*Utterbackiana suborbiculata*	PSM	P	-	-
Mussels	fragile papershell	*Leptodea fragilis*	PSM	P	P	P
Mussels	giant floater	*Pyganodon grandis*	PSM	P	-	-
Mussels	kidneyshell	*Ptychobranchus fasciolaris*	PSM	P	-	-
Mussels	lilliput	*Toxolasma parvus*	PSM	P	-	-
Mussels	longsolid	*Fusconaia subrotunda*	PT, PSM	P	-	-
Mussels	mapleleaf	*Quadrula quadrula*	PSM, CH	P	P	P
Mussels	monkeyface	*Quadrula metanevra*	PSM	P	-	-
Mussels	mountain creekshell	*Villosa vanuxemensis*	PSM	P	-	-
Mussels	Ohio pigtoe	*Pleurobema cordatum*	PSM	P	-	-
Mussels	paper pondshell	*Utterbackia imbecillis*	PSM	P	-	-
Mussels	pimpleback	*Quadrula pustulosa*	PSM	P	P	P
Mussels	pink heelsplitter	*Potamilus alatus*	PSM, CH	P	P	P
Mussels	pink mucket	*Lampsilis abrupta*	LE, SP	P	-	-
Mussels	pink papershell	*Potamilus ohiensis*	PSM	P	-	-
Mussels	pistolgrip	*Tritogonia verrucosa*	PSM, CH	P	-	P
Mussels	pocketbook	*Lampsilis ovata*	PSM	P	-	-
Mussels	purple lilliput	*Toxolasma lividus*	UR, PSM	P	-	-
Mussels	purple wartyback	*Cyclonaias tuberculata*	PSM	P	-	P
Mussels	pyramid pigtoe	*Pleurobema rubrum*	UR, SP	P	-	-
Mussels	rainbow	*Villosa iris*	PSM	P	-	-
Mussels	rock pocketbook	*Arcidents confragosus*	PSM	P	P	-
Mussels	rough pigtoe	*Pleurobema plenum*	LE, SP	P	-	-
Mussels	round pigtoe	*Pleurobema sintoxia*	PSM	P	-	-
Mussels	sheepnose	*Plethobasus cyphyus*	LE, SP	P	-	-
Mussels	southern mapleleaf	*Quadrula apiculata*	-		P	-
Mussels	spectaclecase	*Cumberlandia monodonta*	LE, SP	P	-	R
Mussels	spike	*Elliptio dilatata*	PSM	P	-	-
Mussels	Tennessee pigtoe	*Fusconaia barnesiana*	UR, SP	P	-	-
Mussels	threehorn wartyback	*Obliquaria reflexa Rafinesque*	PSM	P	P	P
Mussels	threeridge	*Amblema plicata*	PSM, CH	P	P	P
Mussels	washboard	*Megalonaias nervosa*	PSM, CH	P	P	P

Table 3-8 Benthic Invertebrates That May Occur in or near Wheeler Reservoir (Continued)

Type	Common Name	Scientific Name	Special Status	Wheeler NWR	TVA 2021	TVA 1991
Mussels	white heelsplitter	*Lasmigona complanata*	PSM	P	-	-
Mussels	yellow sandshell	*Lampsilis teres*	PSM	P	-	-
Snails	acute elimia	*Elimia acuta*	UR	P	-	-
Snails	Anthony's riversnail	*Athearnia anthonyi*	LE, SP	P	-	-
Snails	aminicola sp.	*Aminicola sp.*	-	P	-	-
Snails	armored snail	*Pyrgulopsis pachyta*	LE, SP	P	-	-
Snails	ash gyro	*Gyraulus parvus*	-	P	-	-
Snails	banded mysterysnail	*Viviparus georgianus*	-	P	-	-
Snails	disc sprite	*Micromenetus Dilatatus*	-	P	-	-
Snails	dusky ancylid	*Laevapex fuscus*	-	P	-	-
Snails	engraved elimia	*Elimia perstriata*	UR	P	-	-
Snails	furrowed lioplax	*Lioplax sulculosa*	-	P	-	-
Snails	ghost marstonia	*Pyrgulopsis*	-	P	-	-
Snails	golden fossaria	*Fossaria obrussa*	-	P	-	-
Snails	lyogyrus sp.	*Lyogyrus sp.*	-	P	-	-
Snails	mimic lymnaea	*Pseudosuccinea columella*	-	P	-	-
Snails	musculim spp.	*Musculim spp.*	-	P	-	-
Snails	noble hornsnail	*Pleurocera nobilis*	-	-	P	-
Snails	olive mysterysnail	*Viviparus subpurpureus*	-	P	P	-
Snails	onyx rocksnail	*Leptoxis praerosa*	-	P	-	-
Snails	pisidium spp.	*Pisidium spp.*	-	P	-	-
Snails	pointed campeloma	*Campeloma decisum*	-	P	P	-
Snails	silty hornsnail	*Pleurocera canaliculatum*	-	P	P	-
Snails	skirted hornsnail	*Pleurocera pyrenellum*	UR	P	-	-
Snails	slender campeloma	*Campeloma decampi*	LE, SP	P	-	-
Snails	sphaerium spp.	*Sphaerium spp.*	-	P	-	-
Snails	tadpole physa	*Physella gyrina*	-	P	-	-
Snails	two-ridge rams-horn	*Helisoma anceps*	-	P	-	-
Snails	varicosa rocksnail	*Lithasia verrucosa*	-	P	-	-

CH = commercial harvest allowed except in PSM areas; LE = listed endangered; NWR = National Wildlife Refuge; P = Present; PSM = partial status mussels; PT = proposed threatened; R = Relict only; SP = State protected; TVA = Tennessee Valley Authority; UR = under review for candidate.
"-" denotes no entry in table cell.
Sources: ANHP 2023-TN11385; FWS 2007-TN11407; TVA 2024-TN11042, TVA 1992-TN11412 (did not sample for snails).

TVA monitors bottom-dwellers as one of its metrics of reservoir health. A "good" rating means there are plenty of worms, insects, and snails living on the lake bottom (TVA 2025-TN11403). While the two upper sites, including the site across from the plant, received a "good" rating, two downstream stations rated "poor," due to sparse populations that could be a result of low dissolved oxygen concentrations during the summer.

The Alabama Game, Fish, and Fur Bearing Animals regulations provide partial protection for all mussel species not specifically listed as protected under the Invertebrate Species regulation (ADCNR 2024-TN11720). Regulation 220-2-.104 permits the commercial harvest of only 11 mussel species and bans it for all others. Regulation 220-2-.52 prohibits the taking, capturing, killing, or attempting to take, capture, or kill any freshwater mussels from Wheeler Reservoir between Guntersville Dam downstream to the mouth of Shoal Creek (approximately 347 mi [558 km] above the mouth of the Tennessee River) and from the upstream end of Hobbs Island downstream to Whitesburg Bridge. In these areas, all freshwater mussel species are protected as partial status mussels (PSM).

Ichthyoplankton

Ichthyoplankton are the eggs and larvae of fish. TVA first investigated ichthyoplankton populations in Wheeler Reservoir during the preoperational phase from 1971 to 1973 and again after startup from 1978 to 1979 (TVA 1980-TN11426). They collected samples at the intake and about 1 mi (1.6 km) downstream at TRM 293. Fish eggs collected both years were almost entirely drum (Sciaenidae), comprising 97 percent in 1978 and 99 percent in 1979. In 1978, TVA collected larval fish from 14 families, although 5 families were represented by only 1 fish. Clupeidae (shad and skipjack) was the most abundant (93 to 96 percent), followed by Percichthyidae (white and yellow bass) and Centrarchidae (crappie and sunfish). In 1979, TVA collected larval fish from 12 families, including Petromyzontidae (lampreys), which had not been previously collected. Clupeids remained the most abundant, ranging from 87 to 92 percent, followed by percichthyids and sciaenids.

From February 2018 to December 2019, TVA sampled ichthyoplankton for an entrainment characterization study (TVA 2025-TN11354: Enclosure 2, Attachment 6). Researchers collected samples weekly from February to August (spawning period) and monthly from September to January, during both day and night, near the intake channel. TVA also collected samples from three upstream locations. The researchers identified fish eggs and larvae from 11 families, including Clupeidae, Moronidae (bass), and Cyprinidae (minnows and carps). No federally or State-protected species, nor shellfish, were found near the Browns Ferry intake. Clupeids and freshwater drum eggs dominated the ichthyoplankton composition, with egg densities (mostly freshwater drum) lowest along the right bank and highest in the middle of the channel.

Juvenile and Adult Fish

TVA has been monitoring the fish community since 1978 as part of agreed upon annual monitoring for ADEM (TVA 1978-TN11427, TVA 2025-TN11354: Enclosure 2, Attachment 8). Table 3-9 provides a list of fish species that can currently be found in Wheeler Reservoir. Analyses conducted by TVA in 2020 showed that the numbers of Centrarchid species (bluegill, sunfish, bass, excluding black bass) have remained steady since 2000. The numbers of indigenous fish species collected has varied from 23 to 35 over the last 20 years, while the number of non-indigenous species ranged from 1 to 5 (TVA 2025-TN11354: Enclosure 2, Attachment 8).

TVA also monitors fish populations and fish advisories as part of its reservoir health metrics. A “good” rating indicates a large number and good variety of fish species (TVA 2025-TN11403). In 2021, a “good” rating was determined at all four locations, including across from the plant. The number and variety of fish observed at each site aligned with long-term averages. Researchers recorded a total of 51 fish species, including top carnivores like largemouth bass, benthic feeders, and species sensitive to poor water quality. Fish health was rated as “good” at the three lower sampling locations, but instances of disease and parasites were found at the uppermost site. Of note, the State protected Tuscumbia darter was found at the sampling

location closest to Browns Ferry in 2021. In addition to sampling species present, TVA also maintains a program to examine contaminants in fish fillets. All of the current fish advisories in Wheeler Reservoir are due to mercury levels in largemouth bass, past advisories have included mercury and PFOS (ADEM 2024-TN11428).

Table 3-9 List of Fish Species in Wheeler Reservoir, Alabama

Common name	Scientific name	Special Status
Atlantic needlefish	*Strongylura marina*	non-indigenous
bigmouth buffalo	*Ictiobus cyprinellus*	-
black buffalo	*Ictiobus niger*	-
black crappie	*Pomoxis nigromaculatus*	-
black redhorse	*Moxostoma duquesnei*	commercial or non-game
blackside snubnose darter	*Etheostoma duryi*	-
blackspotted topminnow	*Fundulus olivaceus*	-
blackstripe topminnow	*Fundulus notatus*	-
blue catfish	*Ictalurus furcatus*	commercial or non-game
bluegill	*Lepomis macrochirus*	-
bluntnose minnow	*Pimephales notatus*	-
bowfin	*Amia calva*	commercial or non-game
brook silverside	*Labidesthes sicculus*	-
bullhead minnow	*Pimephales vigilax*	-
central stoneroller	*Campostoma anomalum*	-
channel catfish	*Ictalurus punctatus*	commercial or non-game
chestnut lamprey	*Ichthyomyzon castaneus*	-
common carp	*Cyprinus carpio*	introduced, non-indigenous, commercial or non-game
eastern sand darter	*Ammocrypta pellucida*	-
emerald shiner	*Notropis atherinoides*	-
flathead catfish	*Pylodictis olivaris*	commercial or non-game
freshwater drum	*Aplodinotus grunniens*	commercial or non-game
gizzard shad	*Dorosoma cepedianum*	-
golden redhorse	*Moxostoma erythrurum*	-
golden shiner	*Notemigonus crysoleuca*	-
grass carp	*Ctenopharyngodon idella*	invasive, non-indigenous, commercial or non-game
green sunfish	*Lepomis cyanellus*	-
hybrid bass	*Micropterus sp.*	-
hybrid striped × white bass	*Morone saxatilis x M. chrysops*	introduced, non-indigenous
hybrid sunfish	*Lepomis sp.*	-
hybrid walleye × sauger	*Sander vitreus x S. canadensis*	-
lake sturgeon	*Acipenser fulvescens*	-
largemouth bass	*Micropterus salmoides*	-
largescale stoneroller	*Campostoma oligolepis*	-
logperch	*Percina caprodes*	-
longear sunfish	*Lepomis megalotis*	-
longnose gar	*Lepisosteus osseus*	commercial or non-game
mimic shiner	*Notropis volucellus*	-
Mississippi Silverside	*Menidia audens*	introduced, non-indigenous
mooneye	*Hiodon tergisus*	-

Table 3-9 List of Fish Species in Wheeler Reservoir, Alabama (Continued)

Common name	Scientific name	Special Status
northern hog sucker	*Hypentelium nigricans*	-
orangespotted sunfish	*Lepomis humilis*	-
paddlefish	*Polyodon spathula*	SP
quillback	*Carpiodes cyprinus*	-
redbreast sunfish	*Lepomis auritus*	introduced, non-indigenous
redear sunfish	*Lepomis microlophus*	-
river darter	*Percina shumardi*	-
rver redhorse	*Moxostoma carinatum*	commercial or non-game
rock bass	*Ambloplites rupestris*	-
saddleback darter	*Percina vigil*	-
sauger	*Sander canadensis*	-
shortnose gar	*Lepisosteus platostomus*	-
silver chub	*Macrhybopsis storeriana*	-
silver redhorse	*Moxostoma anisurum*	-
skipjack herring	*Alosa chrysochloris*	-
slackwater darter	*Etheostoma boschungi*	LT, SP
smallmouth bass	*Micropterus dolomieu*	-
smallmouth buffalo	*Ictiobus bubalus*	-
smallmouth redhorse	*Moxostoma breviceps*	-
snail darter	*Percina tanasi*	SP
snubnose darter	*Etheostoma simoterum*	-
spring pygmy sunfish	*Elassoma alabamae*	LT, SP
spotfin shiner	*Cyprinella spiloptera*	-
spotted bass	*Micropterus punctulatus*	-
spotted gar	*Lepisosteus oculatus*	commercial or non-game
spotted sucker	*Minytrema melanops*	commercial or non-game
striped bass	*Morone saxatilis*	introduced, non-indigenous
striped shiner	*Luxilus chrysocephalus*	-
stripetail darter	*Etheostoma kennicotti*	-
threadfin shad	*Dorosoma petenense*	-
Tuscumbia darter	*Etheostoma tuscumbia*	SP
walleye	*Sander vitreus*	-
Warmouth	*Lepomis gulosus*	-
White bass	*Morone chrysops*	-
White crappie	*Pomoxis annularis*	-
Yellow bass	*Morone mississippiensis*	-
Yellow bullhead	*Ameiurus natalis*	-
Yellow perch	*Perca flavescens*	introduced, non-indigenous

SP = State protected, LT = listed threatened.
"-" denotes no entry in table cell.
Source: TVA 2024-TN11042.

3.7.1.2 Important Species and Habitats of Wheeler Reservoir

This section summarizes important Wheeler Reservoir fisheries and State-protected or other special status species.

Commercially Important Fisheries

Wheeler Reservoir, the second largest lake in Alabama, supports several commercially fished species, including catfish, freshwater drum, spotted sucker, river redhorse, black redhorse, bowfin, carp, and gar and seven species of mussel in the lower reaches of the lake (220-2-.45 and 220-2-.104 [ADCNR 2024-TN11720]). In Wheeler Reservoir, it is unlawful to use any type of net for commercial fishing near Wheeler Wildlife Refuge between Interstate 65 and U.S. Highway 31, and in Limestone Bay, from October 15 through February 15 each year.

Recreationally Important Fisheries

Wheeler Reservoir is a popular recreational fishing spot as it is one of the largest lakes in Alabama. Anglers target species such as largemouth bass, smallmouth bass, spotted bass, crappie, bluegill, sunfish, and catfish (ADCNR 2025-TN11429). The Bass Angler Information Team (BAIT) has been compiling bass fishing data across Alabama for 39 years to study bass populations and bass fisheries (Henderson 2022-TN11430). In 2022, Wheeler Reservoir ranked third in the State for quality indicators and ranked sixth or better in every measured metric (Henderson 2022-TN11430).

The Alabama Department of Public Health has issued several fish consumption advisories for Wheeler Reservoir due to mercury and PFOS levels over the years (ADPH 2024-TN11451).

State-Protected and Other Special Status Species

Alabama does not have a State law equivalent to the Federal Endangered Species Act, so species do not receive regulatory protection as State-endangered or threatened. However, some species are protected under the annually updated Alabama Regulations on Game Fish and Fur Bearing Animals (ADCNR 2024-TN11720). Managed by the Alabama Department of Conservation and Natural Resources, these regulations provide the main source of State-level species protection. State-protected species, listed in Table 3-10, are covered by various regulations including Regulation 220-2-.92 (Nongame Species Regulation), 220-2-.98 (Invertebrate Species Regulation), 220-2-.26(4) (Protection of Sturgeon), 220-2-.94 (Prohibition of Taking or Possessing Paddlefish), or 220-2-.97 (Alligator Protection Regulation).

The Tuscumbia darter, found only in the Tennessee River watershed, was unexpectedly discovered near the Browns Ferry during TVA sampling in 2021, despite not typically inhabiting Wheeler Reservoir (TVA 2025-TN11403). Tuscumbia darters live among aquatic vegetation in ponded areas of limestone springs with exceptionally good water quality (ADCNR 2025-TN11458). They spawn year-round in clean gravel and sand substrates.

Snail darters, another State-protected species found in Wheeler Reservoir, inhabit gravel and sandy shoals with moderate currents in large tributaries and free-flowing rivers, like the far upper reaches of Wheeler Reservoir and some of its tributaries (ADCNR 2025-TN11459). They spawn from February to April in gravel shoals, where they deposit their eggs in the sand and gravel. State-wide sampling conducted from 2017 to 2018 found snail darter DNA in both Elk River and Shoal creek (which drain into Wheeler Reservoir), the Guntersville Dam tailrace, and the Wheeler NWR (Shollenberger 2019-TN11460).

While there have been no State-protected species of mussel found in the vicinity of Browns Ferry in recent surveys there are two areas of Wheeler Reservoir designated as State-protected

mussel sanctuaries. In these areas commercial mussel fishing is not permitted. One sanctuary extends from Guntersville Dam (TRM 349) downstream to the mouth of Shoal Creek (TRM 347); the second extends from the upstream end of Hobbs Island (TRM 337) downstream to Whitesburg Bridge (TRM 333) (Regulation 220-2-.52).

Table 3-10 State-Protected Species that May Occur in or Near Wheeler Reservoir, Alabama

Common Name	Scientific Name	Status	Type	Last Observed
paddlefish	*Polyodon spathula*	Vulnerable (State)	fish	2020
slackwater darter	*Etheostoma boschungi*	Critically imperiled (State)	fish	-
snail darter	*Percina tanasi*	Critically imperiled (State)	fish	2020
spring pygmy sunfish	*Elassoma alabamae*	Critically imperiled (State)	fish	-
Tuscumbia darter	*Etheostoma tuscumbia*	imperiled (State)	fish	2021
lake-cress	*Armoracia lacustris*	Critically imperiled (State)	aquatic plant	-
waterweed	*Elodea canadensis*	Critically imperiled (State)	aquatic plant	-
Duck River bladderpod	*Paysonia densipila*	Critically imperiled (State)	aquatic plant	-

Note: See Table 3-8 for State-protected mussels and snails.
Sources: ANHP 2023-TN11385; TVA 2025-TN11403.

3.7.1.3 Invasive and Nuisance Species of Wheeler Reservoir

In 2005, Alabama recognized the need for a comprehensive plan to address Aquatic Nuisance Species and published the Alabama Aquatic Nuisance Species Management Plan in 2021 (ADCNR 2021-TN11476). While some non-native species exist with native species in Alabama with minimal ecological impact, others are harmful and classified as Aquatic Nuisance Species. These species, introduced outside of their native ranges, thrive in or are closely associated with the aquatic environment. These species can alter, damage, or destroy these resources, affecting human health and the State's economy and/or ecology. The State identified 81 aquatic species, primarily fish and plants, that currently pose a threat to Alabama's diverse native wildlife (ADCNR 2021-TN11476). In the early 2000s, the identification of species creating the most serious problems in Alabama included bighead carp (*H. noblilis*), hydrilla (*Hydrilla verticillata*), common salvinia (*Salvinia minima*), water hyacinth (*Eichhornia crassipes*), island apple snail (*Pomacea maculata*) Cuban bulrush (*Cyperus blepharoleptus*), and blue-green algae (*Lyngbya wollei*), and silver carp.

The primary invasive species concern related to Browns Ferry operations is the biofouling of the cooling water intake system by invasive bivalves, such as Asian clams (*Corbicula fluminea*) and zebra mussels (*Dreissena polymorpha*). TVA regularly monitors potentially affected cooling system components and treats water in the system, as needed, to prevent biofouling. TVA monitors Zebra mussel and Asiatic clam densities through their veliger sampling program (TVA 2025-TN11354: AQU-6). TVA collects weekly samples at the skimmer wall of Browns Ferry intake to quantify the mean number of individuals per cubic meter entering the water intake system. Zebra mussels have not been collected in the Browns Ferry intake forebay or the Elk River Embayment (TVA 2025-TN11354: AQU-6). Chemical treatments are routinely scheduled

regardless of data, however, this data aids in notifying the treatment team of large numbers of zebra mussels and Asiatic clams during the span of time between treatments. Browns Ferry's NPDES permit also allows TVA to remove bivalves via mechanical means (e.g., scraping) and to use molluscicides in accordance with EPA regulations and NPDES permit conditions (TVA 2024-TN11042: Enclosure 2, Attachment 5; TVA 2025-TN11354; TVA 2025-TN11613). Browns Ferry typically has 3 molluscicide treatments from spring to fall, followed by two 21 to 28 day chlorination cycles, spread out 8–12 weeks (TVA 2025-TN11354: AQU-6). Raw water chemical treatments for mollusks are controlled by Browns Ferry chemistry procedure CI-137, Raw Water Chemical Treatment and regulated by the NPDES permit (TVA 2025-TN11354: AQU-6). Of note, the quagga mussel (*Dreissena bugensis*) another invasive species spreading across the United States like the zebra mussel, has not been reported in TVA's benthic community data (TVA 2025-TN11354: AQU-6).

3.7.2 Proposed Action

As described in the LR GEIS (NRC 2024-TN10161) and cited in Table 3-1 of this SEIS, the impacts of all generic aquatic resources would be SMALL. The NRC staff's review did not identify any new and significant information that would change the conclusion in the LR GEIS with respect to Browns Ferry SLR.

Table 3-2 identifies three Category 2 issues that require site specific analysis for each proposed LR. These issues are (1) impingement mortality and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds), (2) effects of thermal effluents on aquatic organisms (plants with once-through cooling systems or cooling ponds), and (3) water use conflicts with aquatic resources (plants with cooling ponds or cooling towers using makeup water from a river). The following sections address the site-specific environmental impacts of Browns Ferry SLR that relate to aquatic resources.

3.7.2.1 Impingement Mortality and Entrainment of Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)

For plants with once-through cooling systems or cooling ponds such as Browns Ferry, the NRC staff determined in the LR GEIS that impingement and entrainment of aquatic organisms is a Category 2 issue that requires site-specific evaluation (NRC 2024-TN10161).

Impingement occurs when organisms are trapped against the outer part of an intake structure's screening device (79 FR 48300-TN4488). The force of the intake water traps the organisms against the screen, and individuals are unable to escape. Impingement can kill organisms immediately or cause exhaustion, suffocation, injury, and other physical stresses that contribute to mortality later. The potential for injury or death is generally related to the amount of time an organism is impinged, its fragility (susceptibility to injury), and the physical characteristics of the screen wash and fish return systems of the intake structure. The EPA has found that impingement mortality (IM) is typically less than 100 percent if the cooling water intake system includes fish return or backwash systems (79 FR 48300-TN4488). Because impingeable organisms are typically fish with fully formed scales and skeletal structures and well-developed survival traits, such as behavioral responses to avoid danger, many impinged organisms can survive under proper conditions (79 FR 48300-TN4488).

Entrainment occurs when organisms pass through the screening device and travel through the entire cooling system, including the pumps, condenser or heat exchanger tubes, and discharge pipes (79 FR 48300-TN4488). Organisms susceptible to entrainment are of smaller size, such

as ichthyoplankton, larval stages of shellfish and other macroinvertebrates, zooplankton, and phytoplankton. During travel through the cooling system, entrained organisms experience physical trauma and stress, pressure changes, excess heat, and exposure to chemicals (Mayhew et al. 2000-TN8458). Because organisms that get entrained generally possess fragile life stages (e.g., eggs, which exhibit poor survival after interaction with cooling water intake structure; or early larvae, which lack a skeletal structure and swimming ability), the EPA has concluded that for purposes of assessing the impacts of a cooling water intake system on the aquatic environment, all entrained organisms are assumed to die (79 FR 48300-TN4488).

Entrainment susceptibility is highly dependent on life history characteristics. For example, broadcast spawners with non-adhesive, free floating eggs that drift with the water current may become entrained in a cooling water intake system. Nest building species or species with adhesive, demersal eggs are less likely to be entrained in early life stages. Susceptibility of larval life stages to entrainment depends on body morphology and swimming ability.

A species can be susceptible to both impingement and entrainment if several life stages of the species occupy the same source water. For instance, adults and juveniles of a given species of fish may be impinged against the intake screens, while larvae and eggs may pass through the screening device and be entrained through the cooling system. The susceptibility to either impingement or entrainment relates to the size of the individual relative to the size of the mesh on the screening device. The EPA considers aquatic organisms that can be collected or retained on a sieve with 0.56 in. (1.4 cm) diagonal openings to be susceptible to impingement (79 FR 48300-TN4488). This equates to screen device mesh openings of 0.5 in. × 0.25 in. (1.3 cm × 0.635 cm), which is slightly larger than the openings on the typical 0.375 in. (0.95 cm) square mesh found at many nuclear power plants. Organisms smaller than the 0.56 in. (1.4 cm) mesh are considered susceptible to entrainment.

The magnitude of the impact that impingement and entrainment create on the aquatic environment depends on the plant-specific characteristics of the cooling system as well as the local aquatic community. Relevant nuclear power plant-based characteristics include location of the cooling water intake structure, intake velocities, withdrawal volumes, screening device technologies, and the presence or absence of a fish return system. Relevant characteristics of the aquatic community include species present in the environment, life history characteristics, population abundances and distributions, special species statuses and designations, and regional management objectives.

Browns Ferry Cooling Water Intake System

The Browns Ferry cooling water intake system impinges and entrains aquatic organisms as it withdraws water from Wheeler Reservoir. Section 2.1.3 describes the Browns Ferry cooling and auxiliary water systems in detail. Features relevant to the impingement and entrainment analysis are summarized below.

Browns Ferry normally operates as a once-through (open cycle) cooling water intake system (CWIS) with Wheeler Reservoir on the Tennessee River as the source for cooling water (TVA 2024-TN11042). Water is drawn into the CWIS at the intake pumping forebay which is separated from the lake by three independent wheel gates. The bays are each 40 ft (12 m) wide by 24 ft (7.3 m) high and have a 20 ft (6 m) wide gate. The flow velocity through the gates varies from 0.6 feet per second (fps) to 1.7 fps depending on the position of the gates. Three circulating water pumps in each bay pull water from the forebay through trash racks with a 1⅝ in. (4.1 cm) bar spacing, then through traveling screens with 0.95 cm × 0.95 cm

(⅜ in. × ⅜ in.) mesh, before the water from the 3 bays is brought together in a 78 in. (2 m) diameter inlet pipe with a debris filter and finally into the condenser circulating pipe (TVA 2025-TN11354: AQU-2, AQU-3). The area of hydraulic influence on Wheeler Reservoir includes the intake region and diffuser mixing zone. This area extends from 730 m (2,400 ft) upstream of the diffuser pipe to 690 m (2,260 ft) downstream of the diffuser out approximately halfway across the river covering an area of 1.4 km^2 (0.87 mi^2) and includes any areas with a measurable flow towards the intake (Benton 2001-TN11450).

Depending on what mode Browns Ferry is operating in the cooling water discharge from the condenser may either (1) pass from the discharge tunnel out to the discharge diffusers in Wheeler Reservoir (open mode), (2) pass from the discharge tunnel then go to the cooling towers via the warm water canal before exiting out the discharge diffusers (helper mode), or (3) a combination of these (TVA 2024-TN11042).

Clean Water Act Section 316(b) Requirements for Existing Facilities

Section 316(b) of the CWA addresses the adverse environmental impacts caused by the intake of cooling water from waters of the United States. This section of the CWA grants the EPA the authority to regulate cooling water intake structures to minimize adverse impacts on the aquatic environment. Under CWA Section 316(b), the EPA has issued regulations for existing facilities, such as Browns Ferry, at 40 CFR Part 122 (40 CFR Part 122-TN2769) and 40 CFR Part 125 (TN254), Subpart J. Existing facilities include power generation and manufacturing facilities that are not new facilities as defined at 40 CFR 125.83 (TN254) and that withdraw more than 2 MGD (7.6 million lpd) of water from waters of the United States and use at least 25 percent of the water they withdraw exclusively for cooling purposes.

Under the CWA Section 316(b) regulations, the location, design, construction, and capacity of cooling water intake structures of regulated facilities must reflect the best technology available (BTA) for minimizing impingement mortality and entrainment. The EPA, or authorized States and Tribes, impose BTA requirements through NPDES permitting programs. In Alabama, the ADEM administers the NPDES program and issues NPDES permits to regulated facilities.

With respect to IM, the BTA standard requires that existing facilities comply with one of the following seven alternatives (40 CFR 125.94(c)) (TN254):

1. operate a closed-cycle recirculating system, as defined at 40 CFR 125.92(c) (herein referred to as “IM Option 1”)
2. operate a cooling water intake structure that has a maximum through screen design intake velocity of 0.5 fps (0.15 m/s)
3. operate a cooling water intake structure that has a maximum actual through screen intake velocity of 0.5 fps (0.15 m/s)
4. operate an offshore velocity cap, as defined at 40 CFR 125.92(v), that was installed on or before October 14, 2014
5. operate a modified traveling screen that the NPDES Permit Director determines meets the definition at 40 CFR 125.92(s) and that the NPDES Permit Director determines is the BTA for impingement reduction at the site
6. operate any other combination of technologies, management practices, and operational measures that the NPDES Permit Director determines is the BTA for impingement reduction (herein referred to as “IM Option 6”)
7. achieve a 12-month IM performance standard of all life stages of fish and shellfish of no more than 24 percent mortality, including latent mortality, for all non-fragile species

Options (1), (2), and (4) are essentially preapproved technologies requiring either no demonstration or only a minimal demonstration that the flow reduction and control measures are functioning as the EPA envisioned. Options (3), (5), and (6) require more detailed information to be submitted to the permitting authority before the permitting authority may specify it as BTA for a given facility. Under Option (7), the permitting authority may also review site specific data and conclude that a de minimis rate of impingement exists; and, therefore, no additional controls are warranted to meet the BTA IM standard.

With respect to entrainment, the CWA Section 316(b) regulations do not prescribe a single nationally applicable entrainment performance standard, because the EPA did not identify a technology for reducing entrainment that is effective, widely available, feasible, and does not lead to unacceptable non-water-quality impacts (79 FR 48300-TN4488). Instead, the permitting authority must establish the BTA entrainment requirement for each facility on a site-specific basis. In establishing site-specific requirements, the regulations direct the permitting authority to consider the following factors 40 CFR Part 125 (TN254):

- numbers and types of organisms entrained, including, specifically, the numbers and species (or lowest taxonomic classification possible) of federally listed, threatened and endangered species, and designated critical habitat (e.g., prey base)
- impact of changes in particulate emissions or other pollutants associated with entrainment technologies
- land availability in as much as it relates to the feasibility of entrainment technology
- remaining useful plant life
- quantified and qualitative social benefits and costs of available entrainment technologies when information on both benefits and costs is of sufficient rigor to make a decision

In support of entrainment BTA determinations, facilities must conduct site-specific studies and provide data to the permitting authority to aid in its determination of if site-specific controls would be required to reduce entrainment and which controls, if any, would be necessary.

Analysis Approach

When available, the NRC staff relies on the expertise and authority of the NPDES permitting authority with respect to the impacts of impingement and entrainment. Therefore, if the NPDES permitting authority has made BTA determinations for a facility pursuant to CWA Section 316(b) in accordance with the current regulations specified in 40 CFR Part 122 (TN2769) and 40 CFR Part 125 (TN254), which were promulgated in 2014 (79 FR 48300-TN4488), and that facility has implemented any associated requirements or those requirements would be implemented before the proposed SLR period; then, the NRC staff assumes that adverse impacts on the aquatic environment will be minimized. In such cases, the NRC staff concludes that the impacts of either impingement, entrainment, or both would be SMALL for the proposed SLR term.

In cases in which the NPDES permitting authority has not made BTA determinations, the NRC staff analyzes the potential impacts of impingement, entrainment, or both using a weight of evidence approach. In this approach, the NRC staff considers multiple lines of evidence to assess the presence or absence of ecological impairment (i.e., noticeable or detectable impact) on the aquatic environment. For instance, as its lines of evidence, the NRC staff might consider characteristics of the cooling water intake system design, the results of impingement and entrainment studies performed at the facility, and trends in fish and shellfish population

abundance indices. The NRC staff then considers these lines of evidence together to predict the level of impact (SMALL, MODERATE, or LARGE) that the aquatic environment is likely to experience during the proposed SLR term.

Baseline Condition of the Resource

For the purposes of this analysis, the NRC staff assumes that the baseline condition of the resource is the aquatic community of Wheeler Reservoir as it occurs today, which is described in Section 3.7.1. All fish and benthic invertebrate populations are self-sustaining (ANHP 2023-TN11385; Henderson 2022-TN11430; FWS 2007-TN11407; TVA 2024-TN11042, TVA 1980-TN11426, TVA 2024-TN11042, TVA 2025-TN11354: Enclosure 2, Attachment 4 and 8). While species richness, evenness, and diversity within the community may change or shift between now and when the proposed SLR period would begin, the NRC staff finds the present aquatic community to be a reasonable surrogate in the absence of fishery and species-specific projections.

3.7.3.1.1 Impingement

Impingement Mortality BTA

As of the publication of this draft EIS, Browns Ferry has not received a new NPDES permit from ADEM and is currently operating under the administratively continued permit which was originally issued on July 1, 2018. In that permit it states, “The cooling water intake structure used by the permittee has been evaluated using available information. At this time, the Department [ADEM] has determined that the cooling water intake structure represents the interim best technology available (40 CFR 125.98(b)(5)) (TN254) to minimize adverse environmental impact in accordance with Section 316(b) of the Federal Clean Water Act (33 U.S.C. Section 1326),” (TVA 2024-TN11042). In addition, it also states that, “The permittee is required to operate and maintain the CWIS in a manner that minimizes impingement and entrainment levels,” (TVA 2024-TN11042). Per 40 CFR 125.94 Browns Ferry has chosen option (5) modified traveling screens for impingement compliance (discussed in Section 3.7.2.1). TVA will be required to send ADEM the chosen impingement compliance option and a proposed schedule of when it will be implemented 180 days after Browns Ferry receives the re-issued NPDES permit. Since the permit has not been re-issued yet, Browns Ferry has proactively moved forward with option (5) modified traveling screens due to the long lead times, challenging installs, and a 2-year optimization study. The details on the design and execution dates are still in progress. TVA will likely be required to have the screens/fish return operational and optimized by the end of Browns Ferry’s next NPDES permit cycle (5 years after the new permit is received from ADEM). Since Browns Ferry has already installed modified traveling water screens, installing a fish return system that aligns with the Electric Power Research Institute’s “Design of Fish Return Systems and Operations/ Maintenance Guidelines,” and completion of an optimization study will be the main tasks for them to complete this next NPDES permit cycle (TVA 2025-TN11354: RCI AQU-5 and Enclosure 2, Attachment 5, TVA 2025-TN11613).

Impingement Studies

From September 2007 to September 2009, TVA collected data to identify the species and life stages that would be most susceptible to impingement (TVA 2025-TN11354: AQU-2). Each week, researchers collected impingement samples by washing fish or other organisms that accumulated on the ⅜ in. mesh traveling screens over a 24-hour period into a catch bucket. Fish were sorted from other debris, then identified, counted, and weighed. During the 2007 to 2009 sampling, the condenser circulating water intake impinged an estimated average of

13,942,033 fish annually, with threadfin shad comprising 95.5 percent of the total (TVA 2025-TN11354: AQU-2). Other fish impinged included gizzard shad (2.2 percent), yellow bass (0.6 percent), bluegill (0.5 percent), and freshwater drum (0.5 percent). Peak impingement occurred during the winter months (November to January), suggesting that cold shock may have caused the high shad impingement.

Historical Impingement Studies

From 1974 through 1977, during the initial years of plant operation, researchers collected 72 species of fish in impingement samples (TVA 1972-TN11614). Four species accounted for 95.8 percent of the impinged fish, threadfin shad (76.5 percent), gizzard shad (12.3 percent), freshwater drum (4.3 percent), and skipjack herring (2.7 percent). Each of the remaining 68 species comprised less than 1 percent of the total fish impinged. Juvenile fish appeared more frequently in the impingement samples than adults. Impingement levels increased in direct relation to the level of plant operation. Researchers also calculated the percentage of the standing stock impinged for each species. Yellow bass had the highest percentage (11.7 percent), followed by white bass (5.6 percent), skipjack herring (5.4 percent), and freshwater drum (3.3 percent). All other species made up less than 2 percent of their standing stocks.

The 2005 LR SEIS, determined that no major or significant spawning areas, nursery ground, feeding areas, wintering areas, or migration routes are located near Browns Ferry and fish have free access to the intake channel (TVA 2017-TN5912). The SEIS also determined that Browns Ferry had caused no measurable changes to the fish community in Wheeler Reservoir and found no indications that impingement was destabilizing fish populations (TVA 2017-TN5912).

Impingement Conclusion

The NRC staff reviewed CWA Section 316(b) BTA requirements and the results of impingement studies conducted at Browns Ferry, because Compliance IM Option 5 is a preapproved alternative under CWA Section 316(b) regulations, and because EPA and ADEM have determined that the cooling water intake structure represents the interim BTA (40 CFR 125.98(b)(5)) (TN254) to minimize adverse environmental impact in accordance with Section 316(b) of the Federal Clean Water Act (33 U.S.C. § 1326-TN4823), the NRC staff finds that the adverse impacts on the aquatic environment associated with impingement are minimized. This indicates that impingement is unlikely to cause noticeable or detectable impacts on the Wheeler Reservoir aquatic populations.

Accordingly, the NRC staff finds that the impacts of impingement during the proposed SLR term would neither destabilize nor noticeable alter any important attribute of the aquatic environment and would, therefore, result in SMALL impacts on aquatic resources.

3.7.2.1.2 Entrainment

Entrainment BTA

The CWA Section 316(b) regulations direct the permitting authority to establish BTA entrainment requirements for each facility on a site-specific basis. Studies to support an entrainment determination were submitted by TVA with its most recent NPDES permit renewal in January 2023. ADEM will use this information to make a determination and it will be provided with the re-issued NPDES permit (TVA 2025-TN11354: AQU-4). As of January 15, 2025, Browns Ferry has not received a new NPDES permit from ADEM and is currently operating

under the administratively continued permit which was originally issued on July 1, 2018. In that permit it states, “The cooling water intake structure used by the permittee has been evaluated using available information. At this time, the Department [ADEM] has determined that the cooling water intake structure represents the interim best technology available (40 CFR 125.98(b)(5)) (TN254) to minimize adverse environmental impact in accordance with Section 316(b) of the Federal Clean Water Act (33 U.S.C. Section 1326),” (TVA 2024-TN11042). In addition, it also states that, “The permittee is required to operate and maintain the CWIS in a manner that minimizes impingement and entrainment levels,” (TVA 2024-TN11042).

Entrainment Studies

From February 2018 to December 2019, TVA conducted ichthyoplankton sampling during both day and night (TVA 2025-TN11354: Enclosure 2, Attachment 5). TVA collected weekly samples from February through August and monthly samples from September through January. To determine the number and type of fish eggs and larvae entrained by the Browns Ferry intake, researchers used a 363 micron plankton net to collect samples immediately outside the intake channel and at a cross river transect 0.2 mi (0.3 km) upriver. Fish eggs and larvae were identified, counted, and the length of larvae was measured. TVA surveys confirmed that no entrainable shellfish in the vicinity of the Browns Ferry Intake (TVA 2025-TN11354: Enclosure 2, Attachment 5). The collected fish eggs belong to six families (Sciaenidae, Clupeidae, Cyprinidae, Atherinopsidae, Moronidae, and Percidae) and were dominated by freshwater drum eggs (93.9 percent) followed by Clupeidae (5.8 percent). Fish egg densities peaked in May, with similar amounts collected during day and night sampling. The collected fish larvae came from eleven families Clupeidae, Atherinopsidae, Moronidae, Centrarchidae, Sciaenidae, Cyprinidae, Catostomidae, Percidae, Ictaluridae, Fundulidae, and Poeciliidae. Clupeidae (including skipjack herring, gizzard shad, threadfin shad) were the most abundant (87.6 percent), followed by Moronidae (7.2 percent), Atherinopsidae, and Sciaenidae (both 1.4 percent). Like the fish eggs, fish larvae densities also peaked in May. Annually, approximately 4.8 billion fish eggs and 57.1 billion fish larvae drift past the Browns Ferry intake. Of these, an estimated 6.4 percent of fish eggs and 10.6 percent of fish larvae are entrained in the CWIS (TVA 2025-TN11354: Enclosure 2, Attachment 5).

Entrainment Reduction Methods

TVA reports to ADEM the following protective measures have been implemented to reduce potential entrainment (TVA 2025-TN11354: AQU-2).

(a) Location of the intake deep in the water column under the skimmer wall.

(b) Skimmer wall limits the exposure time of small or passive life stages to hydraulic influences from the CWIS.

(c) Location of the intake on the inside bend of the reservoir away from areas of greater flow.

(d) Location in a human-made reservoir where fisheries are actively managed and stocked.

(e) Reservoir fish species of recreational and commercial interest have reproductive strategies that reduces chance of entrainment.

(f) Proportion of water withdrawal is small (8.9 percent) compared to long term river flow.

Entrainment Conclusion

The NRC staff reviewed CWA Section 316(b) BTA requirements and the results of entrainment studies conducted at Browns Ferry, because water withdrawals, and the associated risk of entrainment, would remain the same under the proposed action as under the current licenses, the NRC staff anticipates similar (i.e., nondetectable) effects during the proposed SLR period. Further, the EPA and ADEM have determined that the cooling water intake structure represents the interim best technology available (40 CFR 125.98(b)(5)) (TN254) to minimize adverse environmental impact in accordance with Section 316(b) of the Federal Clean Water Act (33 U.S.C. § 1326-TN4823).

For the reasons described, the NRC staff finds that the impacts of entrainment of aquatic organisms resulting from the proposed SLR of Browns Ferry would be SMALL.

Impingement and Entrainment Conclusion

Based on the discussion summarized under “Impingement Conclusion” and “Entrainment Conclusion,” the NRC staff concludes that the impacts of impingement and entrainment on aquatic organisms resulting from the proposed Browns Ferry SLR term would be SMALL.

3.7.2.2 Thermal Impacts on Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds, Plants with Cooling Towers)

For plants with once-through cooling systems or cooling ponds such as Browns Ferry, the NRC staff determined in the LR GEIS thermal impacts on aquatic organisms is a Category 2 issue that requires site-specific evaluation (NRC 2024-TN10161).

The primary form of thermal impact of concern at Browns Ferry is heat shock. Heat shock occurs when water temperature meets or exceeds the thermal tolerance of an aquatic species for some duration of the exposure (NRC 2013-TN2654). In most situations, fish can avoid areas that exceed their thermal tolerance limits, although some aquatic species or life stages lack such mobility. Heat shock is typically observable only for fish because fish tend to float when dead. In addition to heat shock, thermal plumes resulting from thermal effluent can create barriers to fish passage, which is of particular concern for migratory species. Thermal plumes can also reduce the available aquatic habitat or alter habitat characteristics in a manner that results in cascading effects on the local aquatic community.

Browns Ferry Nuclear Plant Effluent Discharge

As described in Section 3.5.1.3, Browns Ferry’s current NPDES permit limits thermal discharge, as detected at a depth of 5 ft (1.5 m) at the end of a 2,400 ft (730 m) mixing zone downstream of the discharge diffusers, to a maximum 1-hour average of 93°F (34°C), a maximum 24-hour average of 90°F (32°C), and a maximum increase of 10°F (5.6°C) over ambient temperatures (TVA 2024-TN11042). The total mixing zone is 2,000 ft (610 m) wide and extends from 150 ft (45.7 m) upstream to 2,400 ft (732 m) downstream of the diffusers (Benton 2001-TN11450).

At 120 percent power input, the expected temperature rise of the cooling water as it passes through the condensers is expected to be 27.7°F (15.4°C) (Benton 2001-TN11450). If the intake temperature is 88°F (31.1°C) then the discharge temperature would be 115.7°F (46.5°C). When the plant operates in “helper” mode with all cooling towers fully utilized, the exiting water temperature under corresponding conditions is expected to be 92.3°F (33.5°C), which is 23.4°F (13°C) lower than without the cooling towers (Benton 2001-TN11450).

Clean Water Act of 1972 Section 316(a) Requirements for Point Source Discharges

The CWA Section 316(a) addresses the adverse environmental impacts associated with thermal discharges into waters of the United States. This section of the CWA grants the EPA the authority to impose alternative, less-stringent, facility-specific effluent limits (called "variances") on the thermal component of point source discharges. To be eligible, facilities must demonstrate, to the satisfaction of the NPDES permitting authority, that facility-specific effluent limitations will assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the receiving body of water. CWA Section 316(a) variances are valid for the term of the NPDES permit (i.e., 5 years). Facilities must reapply for variances with each NPDES permit renewal application. The EPA issued regulations under CWA Section 316(a) at 40 CFR Part 125, Subpart H (TN254).

Analysis Approach

When available, the NRC staff relies on the expertise and authority of the NPDES permitting authority with respect to thermal impacts on aquatic organisms. Therefore, if the NPDES permitting authority has made a determination under CWA Section 316(a) that thermal effluent limits are sufficiently stringent to assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the receiving body of water, and that facility has implemented any associated requirements; then, the NRC staff assumes that adverse impacts on the aquatic environment will be minimized. In such cases, the NRC staff concludes that thermal impacts on aquatic organisms would be SMALL for the proposed SLR term.

In cases in which the NPDES permitting authority has not granted a CWA Section 316(a) variance, the NRC staff analyzes the potential impacts of thermal discharges using a weight of evidence approach. In this approach, the NRC staff considers multiple lines of evidence to assess the presence or absence of ecological impairment (i.e., noticeable or detectable impact) on the aquatic environment. For instance, as its lines of evidence, the NRC staff might consider characteristics of the cooling water discharge system design, the results of thermal studies performed at the facility, and trends in fish and shellfish population abundance indices. The NRC staff then considers these lines of evidence together to predict the level of impact (SMALL, MODERATE, or LARGE) that the aquatic environment is likely to experience over the course of the proposed SLR term.

Baseline Condition of the Resource

For the purposes of this analysis, the NRC staff assumes that the baseline condition of the resource is the Wheeler Reservoir aquatic community as it occurs today, which is described in Section 3.7.1. While species richness, evenness, and diversity within the community may change or shift between now and when the proposed SLR period would begin, the NRC staff finds the aquatic community as it occurs today to be a reasonable surrogate in the absence of fishery and species-specific projections.

CWA 316(a) Thermal Variance

The ADEM regulates thermal discharge temperatures at Browns Ferry through the NPDES permit (TVA 2024-TN11042). In accordance with the current NPDES permit the following thermal limitations are in place:

- The 24-hour running average downstream river temperature shall not exceed 90°F (32°C).

- The 1-hour running average downstream river temperature shall not exceed 93°F (34°C).
- The 24-hour running average river temperature change from upstream to downstream of Browns Ferry shall not exceed 10°F (5.5°C).
- When the ambient river temperature exceeds 90°F (32°C), the change in temperature between upstream and downstream of Browns Ferry shall be zero.

These temperature limits are higher than the Alabama State standards for the Tennessee River which is normally a maximum river temperature of 86°F (30°C) (AL Admin. Code 335-6-10-TN11446). In 2005, TVA constructed a hydrothermal model of Browns Ferry to determine the impacts of uprating Units 1, 2, and 3 (TVA 2006-TN11447). The temperature downstream of the mixing zone is continuously monitored and when NPDES temperature limits are approached cooling water can be diverted to cooling towers (helper mode). The cooling towers are only operated when necessary to meet NPDES thermal limitations, usually in July and August (TVA 2024-TN11042). In 2023 helper mode was used for 108 days, in 2022 it was used for 105 days, 61 days in 2021, 55 days in 2020, and 74 days in 2019 (TVA 2025-TN11355). If the cooling towers cannot achieve the required cooling to meet NPDES temperature limits then the plant is derated (TVA 2025-TN11355). Since 2020, the Browns Ferry plant has been derated one time, in 2022 Units 1 and 3 were partially derated for approximately 2 days each to comply with NPDES permit limits (TVA 2025-TN11647: RCI AQU-13).

Thermal Impacts Conclusion

Because ADEM has granted TVA multiple, sequential NPDES permits with temperature limits that are designed to be protective of aquatic life under CWA Section 316(a) and Alabama State regulations, the NRC staff finds that the adverse impacts on the aquatic environment associated with thermal effluents are minimized. Because characteristics of the thermal effluent would remain the same under the proposed action, the NRC staff anticipates similar effects during the proposed SLR period. Further, ADEM will continue to review the CWA Section 316(a) variance with each successive NPDES permit renewal and may require additional mitigation or monitoring in a future renewed NPDES permit if it deems such actions to be appropriate to assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in the Wheeler Reservoir. The NRC staff assumes that any additional requirements that ADEM imposes would further reduce the impacts of the Browns Ferry thermal effluent over the course of the proposed SLR term. For these reasons, the NRC staff finds that thermal impacts during the proposed SLR period would neither destabilize nor noticeably alter any important attribute of the aquatic environment and would, therefore, result in SMALL impacts on aquatic organisms.

3.7.2.3 Water Use Conflicts with Aquatic Resources (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a River)

Water use conflicts occur when the amount of water needed to support aquatic resources is diminished as a result of demand for agricultural, municipal, or industrial use or decreased water availability due to droughts, or a combination of these factors.

In the 2005 LR SEIS (NRC 2005-TN5192), the NRC staff evaluated “water-use conflicts (makeup water from a small river)” as a surface water quantity issue and included impacts on ecological resources, including aquatic communities. The NRC staff determined that impacts of water use conflicts would be SMALL during the initial license renewal term. In 2013, the NRC issued Revision 1 of the LR GEIS (NRC 2013-TN2654) and separated out ecological impacts from

surface water, expanded the issue to include cooling towers, and titled the issue “water use conflicts with aquatic resources (plants with cooling ponds or cooling towers using makeup water from a river).” The separation of these issues was continued in the 2024 Revision 2 of the LR GEIS (NRC 2024-TN10161). This section of the SEIS evaluates water use conflicts as they apply to continued operation of Browns Ferry during the proposed subsequent license renewal term.

Section 3.5.3.1 describes surface water use conflicts that also apply to aquatic resources. In summary, Browns Ferry operates as a once-through cooling system even when using cooling towers (helper mode) and does not withdraw any additional makeup water from the Wheeler Reservoir.

The mechanical draft cooling towers, which run when the nuclear power plant is in helper mode, typically have a 2–3 percent water loss due to evaporation and drift when operational (TVA 2025-TN11355). Browns Ferry uses the cooling towers in summer months with July and August seeing the most use. TVA has not calculated the actual water loss from cooling tower operation, but they do track water consumption monthly. When the cooling towers are operational, 97 percent of the water taken out of the river is returned to the river (3 percent loss) and when averaged across the whole year the total water loss is approximately 0.11 percent (TVA 2025-TN11355). In 2023, helper mode was used for 108 days, in 2022 it was used for 105 days, only 61 days in 2021, 55 days in 2020, and 74 days in 2019 (TVA 2025-TN11355). From 2016 to 2023, Browns Ferry withdrew an average of about 2,875 MGD (10,880 million lpd) from Wheeler Reservoir with an average water loss of 3.01 MGD (11.4 million lpd), the rest of the water (2,872 MGD or 10,880 million lpd) was returned to Wheeler Reservoir through the discharge (TVA 2024-TN11042).

The proposed SLR would continue current operating conditions and environmental stressors rather than introduce wholly new impacts. Therefore, the impacts of current operations and SLR on this resource category would be similar. For the reasons explained in this section, water use conflicts with aquatic resources would either not occur from SLR or would be so minor that the effects on aquatic resources would be undetectable. The NRC staff concludes that water use conflicts with aquatic resources during the Browns Ferry SLR term would be SMALL.

3.8 Federally Protected Ecological Resources

The NRC must consider the effects of its actions on the ecological resources protected under several Federal statutes and must consult with the FWS or the National Oceanic and Atmospheric Administration (NOAA) prior to acting in cases where an agency action may affect those resources. These statutes include the following:

- Endangered Species Act of 1973, as amended (ESA) (16 U.S.C. § 1531 et seq.) (TN1010)
- Magnuson–Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (16 U.S.C. § 1801 et seq.) (TN1061)
- National Marine Sanctuaries Act (NMSA) (16 U.S.C. § 1431 et seq.) (TN4482)

3.8.1 Endangered Species Act

3.8.1.1 Action Area

The implementing regulations for Section 7(a)(2) of the ESA define “action area” as all areas affected directly or indirectly by the Federal action and not merely the immediate area involved

in the action (50 CFR Part 402-TN4312). The action area effectively bounds the analysis of federally listed species and critical habitats because only species and habitats that occur within the action area may be affected by the Federal action.

For the purposes of assessing the potential impacts of continued operation of Browns Ferry during the SLR term, the NRC staff considers the action area to consist of the following:

Browns Ferry Site: The terrestrial portion of the action area consists of approximately 873 ac (353 ha) of TVA property associated with the Browns Ferry site boundary (Table 3-3). The developed part of the Browns Ferry site lies along the northern shore of the Wheeler Reservoir approximately 10 mi (16 km) northwest of the center of Decatur, Alabama. The Browns Ferry site (Figure 3-10) consists of terrestrial upland and wetland habitats described in Section 3.6.2. The Browns Ferry site is large enough and contains enough undeveloped buffer areas so effects from continued operation and decommissioning would not likely be noticeable to offsite lands.

Wheeler Reservoir: The aquatic portion of the action area encompasses the areas of Wheeler Reservoir affected by cooling water withdrawals and discharges. This includes the area of hydraulic influence for the intake, which could lead to impingement or entrainment (described in Section 3.7.2.1), and the area of Wheeler Reservoir that experiences increased temperatures from the discharge of heated effluent (Section 3.7.2.2). The area of hydraulic influence on Wheeler Reservoir includes both the intake region and diffuser mixing zone. This area extends from 730 m (2400 ft) upstream of the diffuser pipe to 690 m (2260 ft) downstream of the diffuser outlet, approximately halfway across the river covering an area of 1.4 km^2 (0.87 mi^2) and includes any areas with a measurable flow toward the intake (Benton 2001-TN11450).

The NRC staff recognizes that, although the described action area is stationary, federally listed species can move in and out of the action area. For instance, a migratory bird could occur in the action area seasonally as it forages or breeds. Thus, in its analysis, the NRC staff considers not only those species known to occur directly within the action area but those species that may passively or actively move into the action area. The NRC staff then considers if the life history and habitat requirements of each species make it likely to occur in the action area where it could be affected by the proposed SLR. The following sections first discuss listed species and critical habitats under FWS jurisdiction, followed by those under National Marine Fisheries Service (NMFS) jurisdiction.

3.8.1.2 Federally Listed Species and Critical Habitats under U.S. Fish and Wildlife Service Jurisdiction

The NRC staff reviewed the ER (TVA 2024-TN11042), the FWS's Information for Planning and Conservation database (FWS 2025-TN11420), available ecological surveys, and other records to determine whether suitable habitat for each species occurs in the action area and whether the species itself may occur in the action area. The NRC staff reviewed its biological assessment (BA) for the Browns Ferry LR (NRC 2004-TN11474) and incorporates its previous analysis of species life history, habitat use, action area presence, and potential impacts by reference.

During the NRC staff's environmental review for the 2005 Browns Ferry LR (NRC 2005-TN5192), the staff evaluated the effects on federally listed terrestrial and aquatic species (NRC 2005-TN5192: Sections 2.2.5, 2.2.6, 4.6.1, and 4.6.2). They used an action area consisting of the site and 160 mi (260 km) of transmission line ROWs in 10 counties (5 in Alabama and 5 in

Mississippi). The LR GEIS (NRC 2024-TN10161: Section 3.1.7) now defines in-scope transmission lines as only those connecting the nuclear power plant to the first substation feeding into the regional grid and those that provide power to the plant from the grid. The current action area therefore only consists of the site boundaries and reservoir waters as described in Section 3.8.1 and is much smaller in area than the action area analyzed in the previous LR and BA. The NRC staff considers the site boundaries as encompassing enough peripheral undeveloped land surrounding the Browns Ferry plant to encompass those habitats potentially affected both directly and indirectly by the plant.

Table 3-11 lists the federally listed species with the potential to occur within the action area and summarizes the results of the NRC staff's evaluation, including the habitat requirements and information on the occurrence of each species within the action area, as well as information on relevant critical habitats. The NRC staff considered those species with the potential to occur as any currently listed Federal species identified in the ER (TVA 2024-TN11042), as revised (TVA 2025-TN11355: Tables 3.6-2 and 3.6-8), in the most recent FWS IPaC information (FWS 2025-TN11420), and/or species evaluated in its previous BA (NRC 2004-TN11474: Tables 1–3).

Table 3-11 Occurrences of Federally Listed, Proposed, and Candidate Species and Critical Habitats under U.S. Fish and Wildlife Service Jurisdiction in the Browns Ferry Nuclear Plant License Renewal Action Area

Species or Critical Habitat	Federal Status[(a)]	Habitat and Likelihood of Occurrence in Action Area
gray bat (*Myotis grisescens)*	FE	**Habitat:** Roost in caves year-round and migrate between summer and winter roosts (FWS 2009-TN11465). Foraging habitat consists of open waters, including rivers, streams, wetlands, lakes, and reservoirs. **Occurrence:** Seasonal and occasional. The action area falls within the general range of the species (FWS 2025-TN11420). Although one occurrence within 10 mi (16 km) of the Browns Ferry site was recorded, no observations, caves, mines, or roosting habitat are present on Browns Ferry site (TVA 2024-TN11042: Section 3.6.1.4). Foraging habitat present on site and vicinity (streams, wetlands, Wheeler Reservoir).
Indiana bat (*Myotis sodalis*)	FE	**Habitat:** In non-hibernating seasons, Indiana bats typically roost in forested areas under the exfoliating bark of dead or dying trees (FWS 2007-TN934). Winter hibernacula consist of underground caves and abandoned mines. **Occurrence:** Seasonal and occasional. The action area falls within the general range of the species (FWS 2025-TN11420). Although one occurrence within 10 mi (16 km) of the Browns Ferry site was recorded, no observations, caves or mine are present on Browns Ferry site (TVA 2024-TN11042: Section 3.6.1.4). Potential roosting habitat present on Browns Ferry site and vicinity, as is foraging habitat (forests, streams, wetlands, Wheeler Reservoir).

Table 3-11 Occurrences of Federally Listed, Proposed, and Candidate Species and Critical Habitats under U.S. Fish and Wildlife Service Jurisdiction in the Browns Ferry Nuclear Plant License Renewal Action Area (Continued)

Species or Critical Habitat	Federal Status[(a)]	Habitat and Likelihood of Occurrence in Action Area
northern long-eared bat (*Myotis septentrionalis*)	FE	**Habitat:** In non-hibernating seasons, northern long-eared bats typically roost individually or in colonies underneath bark or in cavities or crevices of both live trees and snags. Males and nonreproductive females may also roost in cooler locations, including caves and mines. Individuals may use caves and mines during fall swarming (FWS 2022-TN11245). **Occurrence:** Not present, based on most recent IPaC data (FWS 2025-TN11420). Although species listed as potentially occurring within the action area based on TVA IPaC report in 2022 (TVA 2024-TN11042: Table 3.6-2), the 2025 IPaC report (FWS 2025-TN11420) omits this species. The NRC staff interprets this change as reflecting an updated understanding of species' range.
tricolored bat (*Perimyotis subflavus*)	FPE	**Habitat:** In non-hibernating seasons, individuals roost among leaves of live or recently dead deciduous hardwood trees, but individuals may also roost in conifers, epiphytes, or culverts (FWS 2021-TN8589). Overwinters in caves, mines, trees, and occasionally culverts. **Occurrence:** Not present, based on most recent IPaC data (FWS 2025-TN11420). Although the species was listed as potentially occurring within the action area based on TVA review of IPaC report in 2022 (TVA 2024-TN11042: Table 3.6-2), the 2025 IPaC report (FWS 2025-TN11420) omits this species. The NRC staff interprets this change as reflecting an updated understanding of the species' range.
whooping crane (*Grus americana*)	EXPN	**Habitat:** Habitat for the whooping crane includes a variety of marshes, lakes, ponds, wet meadows, and agricultural fields (Cantrell and Wang 2018-TN11482). Habitat for natural populations is limited to a migration pathway connecting summer breeding grounds in south-central Canada to a specific portion of the Texas Gulf coast. **Occurrence:** Seasonal and occasional. Cranes from the experimental eastern migratory population present within the action area (FWS 2025-TN11420), in Limestone County, Alabama from mid-November through end of March at Wheeler National Wildlife Refuge, Swan Creek Waterfowl Management Area, as well as wetlands and agricultural fields along Wheeler Reservoir (eBird 2025-TN11481).
eastern hellbender (*Cryptobranchus allaganiensis allaganiensis*)	FPE	**Habitat:** Cool, fast-flowing highly oxygenated streams with boulder's providing cover and breeding sites (89 FR 100934-TN11421). **Occurrence:** Not present. Given the lack of fast-flowing stream habitat onsite (Section 3.7.1), the NRC staff expects that this species is not present in the action area. No proposed critical habitat designated for this species (FWS 2025-TN11420).
monarch butterfly (*Danaus plexippus*)	FPT	**Habitat:** Prairies, meadows, grasslands along roadsides across most of North America, especially in areas containing milkweed (FWS 2024-TN11177).

Table 3-11 Occurrences of Federally Listed, Proposed, and Candidate Species and Critical Habitats under U.S. Fish and Wildlife Service Jurisdiction in the Browns Ferry Nuclear Plant License Renewal Action Area (Continued)

Species or Critical Habitat	Federal Status[(a)]	Habitat and Likelihood of Occurrence in Action Area
		Occurrence: Seasonal and occasional. Monarchs occur in the action area from April to late October (FWS 2025-TN11420; USFWI 2025-TN11555). Migrating monarchs may use milkweeds in the action area as stopover habitat, and the species is also known to breed in Alabama. Although TVA reports no monarchs or milkweed on the Browns Ferry site (TVA 2025-TN11354), both are known to occur within 6 mi of the Browns Ferry site (iNaturalist 2024-TN11435). Consequently, the NRC staff assumes milkweed could be present within the undeveloped portions of the action area and that the monarch butterfly could occur within the action area in the spring and summer.
spring pygmy sunfish (*Elassoma alabamae*)	FT	**Habitat:** Spring pools and runs with abundant emergent and semi-emergent vegetation in two counties in Alabama (Limestone and Madison) (84 FR 24987-TN11422). **Occurrence:** Not present. Species listed as potentially occurring based on TVA review of aquatic species within 10 mi of Browns Ferry and/or within hydrologic units of Wheeler Reservoir (TVA 2024-TN11042: pp. E4-42 to E4-43 and Table 3.6-8). The three designated critical habitat units (which contain two known occupied habitats and one unoccupied habitat) do not overlap the action area (84 FR 24987-TN11422; FWS 2025-TN11420). The NRC staff examined recent aerial photography and did not observe photosignatures indicative of potential habitat for this species.
slackwater darter (*Etheostoma boschungi*)	FT	**Habitat:** Requires connectivity between non-breeding and breeding habitat (FWS 2024-TN11436). Nonbreeding habitat consists of small to moderately large gravel-bottomed pools of creeks with slow currents. Breeding habitat consists of shallow waters originating in spring seeps, spring boils, or flooded fields that slowly run off into adjacent streams. **Occurrence:** Potentially present. The action area falls within the general range of the species (FWS 2025-TN11420), and the ER states that the species is found in Wheeler Reservoir and/or within 10 mi of Browns Ferry site. Critical habitat for this species does not overlap the action area (FWS 2025-TN11420).
birdwing pearlymussel (*Lemiox rimosus*)	FE	**Habitat:** Clean, fast-flowing portions of small to large streams (riffles, gravel/sand shoals, pool/run habitats) in Alabama, Tennessee, and Virginia (FWS 2020-TN11468). **Occurrence:** Not present. Although the species was listed as potentially occurring within the action area based on TVA review of species data (TVA 2024-TN11042: Table 3.6-2), the 2025 IPaC report FWS 2025-TN11420) omits this species. The NRC staff interpret change to reflect an updated understanding of species range and note that birdwing pearlymussel does not likely occur within the action area.

Table 3-11 Occurrences of Federally Listed, Proposed, and Candidate Species and Critical Habitats under U.S. Fish and Wildlife Service Jurisdiction in the Browns Ferry Nuclear Plant License Renewal Action Area (Continued)

Species or Critical Habitat	Federal Status[(a)]	Habitat and Likelihood of Occurrence in Action Area
cracking pearlymussel (*Hemistena lata*)	FE	**Habitat:** Medium to large rivers with sand or gravel substrates within riffle habitat (FWS 2019-TN11452). **Occurrence:** Not present. Although the species is listed as potentially occurring within the action area based on TVA review of species data (TVA 2024-TN11042: Table 3.6-2), the 2025 IPaC report (FWS 2025-TN11420) omits this species. The NRC staff interpret change to reflect an updated understanding of species range and that cracking pearlymussel does not likely occur within the action area.
Cumberandian combshell (*Epioblasma brevidens*)	FE	**Habitat:** Gravel shoals of free-flowing rivers and streams in Alabama, Kentucky, Tennessee (69 FR 29569-TN11557). **Occurrence:** Not present. Species was listed as potentially occurring based on TVA review of aquatic species within 10 mi of Browns Ferry and/or within hydrologic units of Wheeler Reservoir (TVA 2024-TN11042: pp. E4-42 to E4-43, Table 3.6-8). However, the 2025 IPaC report (FWS 2025-TN11420) omits this species. The NRC staff interpret change to reflect an updated understanding of species range and that Cumberlandian combshell does not likely occur within the action area.
dromedary pearlymussel (*Dromus dromas*)	FE	**Habitat:** Inhabits small to medium, low turbidity, high to moderate gradient streams. The species is commonly found near riffles on sand and gravel substrates with stable rubble (FWS 2010-TN11453). **Occurrence:** Not present. Although the species was listed as potentially occurring within the action area based on TVA review of species data (TVA 2024-TN11042: Table 3.6-2), the 2025 IPaC report (FWS 2025-TN11420) omits this species. The NRC staff interpret this change to reflect an updated understanding of species range and that dromedary pearlymussel does not likely occur within the action area.
fluted kidneyshell (*Ptychobranchus subtentum*)	FE	**Habitat:** Inhabits shoal habitat in small to large rivers and can be found in substrates mixed with sand and gravel, occasionally under cobble or boulders (FWS 2021-TN11454). **Occurrence:** Not present. Although the species was listed as potentially occurring within the action area based on TVA review of species data (TVA 2024-TN11042: Table 3.6-2), the 2025 IPaC report (FWS 2025-TN11420) omits this species. The NRC staff interpret this change to reflect an updated understanding of species range and that fluted kidneyshell does not likely occur within the action area.
orangefoot pimpleback (*Plethobasus cooperianus*)	FE	**Habitat:** Inhabits silt-free sand or gravel in clean, fast flowing stretches of large rivers (FWS 2022-TN11455). **Occurrence:** Not present. The species is currently considered extirpated in the Tennessee River in Alabama (FWS 2022-TN11455). Although the species was listed as potentially occurring within the action area based on TVA review of species data (TVA 2024-TN11042: Table 3.6-2), the 2025 IPaC report (FWS 2025-TN11420) omits this species. The NRC staff interpret

Table 3-11 Occurrences of Federally Listed, Proposed, and Candidate Species and Critical Habitats under U.S. Fish and Wildlife Service Jurisdiction in the Browns Ferry Nuclear Plant License Renewal Action Area (Continued)

Species or Critical Habitat	Federal Status[(a)]	Habitat and Likelihood of Occurrence in Action Area
		change to reflect an updated understanding of species range and that orangefoot pimpleback does not likely occur within the action area.
pink mucket (*Lampsilis abrupta*)	FE	**Habitat:** Medium to large rivers with range of substrates (silt to boulders, rubble, gravel, and sand; FWS 1985-TN11490). Most often associated with moderate to fast flowing water but appears to have adapted to impounded rivers. **Occurrence:** Potentially present. The action area falls within the general range of the species (FWS 2025-TN11420). Known host fish present (TVA 2025-TN11355: Table 3.6.4). Seen downstream of Wilson Dam in 2024 (FWS 2024-TN11469).
ring pink (*Obovaria retusa*)	FE	**Habitat:** Inhabits medium to large rivers and is believed to prefer a mixture of silt, sand, and gravel substrate (FWS 2018-TN11456). **Occurrence:** Not present. Although the species listed as potentially occurring within the action area based on TVA review of species data (TVA 2024-TN11042: Table 3.6-2), the 2025 IPaC report (FWS 2025-TN11420) omits this species. The NRC staff interpret change to reflect an updated understanding of species range and that ring pink does not likely occur within the action area.
rough pigtoe (*Pleurobema plenum*)	FE	**Habitat:** Found in sand, gravel, and cobble substrates in the shoals of medium to large rivers (66 ft or wider) (FWS 1984-TN11457). **Occurrence:** Potentially present. Although the IPaC report did not identify this species as occurring within the action area (FWS 2025-TN11420), this species was reported as present at Wheeler National Wildlife Refuge (NWR) (FWS 2007-TN11407). Not found in 1991 or 2021 mussel survey at Browns Ferry (TVA 2025-TN11354).
sheepnose (*Plethobasus cyphus*)	FE	**Habitat:** Shallow areas of larger rivers and streams with moderate to swift currents flowing over coarse sand and gravel but occasionally areas of mud, cobble, or boulders (FWS 2012-TN11461). **Occurrence:** Potentially present. Although the IPaC report did not identify this species as occurring within the action area (FWS 2025-TN11420), the species was reported as present at Wheeler NWR (FWS 2007-TN11407). Not found in 1991 or 2021 mussel survey at Browns Ferry (TVA 2025-TN11354).
spectaclecase (*Cumberlandia monodonta*)	FE	**Habitat:** Rivers and streams with slow to swift currents, with sheltered microhabitats sheltered from main force of current (FWS 2022-TN11462). Often clusters in firm mud, beneath rocks slabs, or between boulders. **Occurrence:** Potentially present. The action area falls within the general range of the species (FWS 2025-TN11420) and known host fish present (TVA 2025-TN11355).
spectaclecase critical habitat	FPD	**Occurrence:** Present. Proposed critical habitat unit (SHNO 8: Tennessee River) for spectaclecase overlaps action area (FWS

Table 3-11 Occurrences of Federally Listed, Proposed, and Candidate Species and Critical Habitats under U.S. Fish and Wildlife Service Jurisdiction in the Browns Ferry Nuclear Plant License Renewal Action Area (Continued)

Species or Critical Habitat	Federal Status[(a)]	Habitat and Likelihood of Occurrence in Action Area
		2025-TN11420; 89 FR 101100-TN11378). SHNO 8 occupied by species and contains all physical and biological features essential for species conservation.
Tennessee Pigtoe (*Pleuronaia barnesiana*)	FPE	**Habitat:** Found in riffles, shoals, and high gradient streams with stable substrates dominated by coarse sand, gravel, and cobble often in less than 2 ft of water in small to medium sized rivers (FWS 2020-TN11470). **Occurrence:** Potentially present. Although the IPaC report did not identify this species as occurring within the action area (FWS 2025-TN11420), the species was reported as present at Wheeler NWR (FWS 2007-TN11407). Not found in 1991 or 2021 mussel survey at Browns Ferry (TVA 2025-TN11354).
tuberculed blossom (*Epioblasma torulosa torulosa*)	DE	**Habitat:** Large, shallow rivers with sandy-gravel substrate and fast currents (88 FR 71644-TN11423). **Occurrence:** Not present. Known from the Tennessee River; the species was last detected in 1969; presumed extinct throughout its range so delisted due to extinction (DE) (88 FR 71644-TN11423). The NRC staff do not make any determination for this species because of its DE status.
Anthony's riversnail (*Athearnia anthonyi*)	FE	**Habitat:** Inhabits medium to large rivers and occurs on cobble/boulder substrates in the vicinity of riffles. However, it does not always occur in strongly flowing sections (59 FR 17994-TN11542). **Occurrence:** Potentially present. Although the IPaC report did not identify this species as occurring within the action area (FWS 2025-TN11420), the species was reported as present at Wheeler NWR in Limestone Creek (FWS 2007-TN11407). Not found in 2021 mussel survey at Browns Ferry (TVA 2025-TN11354).
armored snail (*Marstonia pachyta*)	FE	**Habitat:** Inhabit submerged root masses and bryophytes along creek edges but may also be found on rocks and vegetative debris (FWS 2020-TN11471). **Occurrence:** Potentially present. Although the IPaC report did not identify this species as occurring within the action area (FWS 2025-TN11420), the species was reported as present at Wheeler NWR in Limestone Creek (FWS 2007-TN11407). Not found in 2021 mussel survey at Browns Ferry (TVA 2025-TN11354).
slender campeloma (*Campeloma decampi*)	FE	**Habitat:** It is typically found burrowing in soft sediment (sand and/or mud) or detritus (65 FR 10033-TN11473). **Occurrence:** Potentially present. Although the IPaC report did not identify this species as occurring within the action area (FWS 2025-TN11420), the species was reported as present at Wheeler NWR in Limestone Creek (FWS 2007-TN11407). Not found in 2021 mussel survey at Browns Ferry (TVA 2025-TN11354).

(a) Indicates protection status under the Endangered Species Act. DE = delisted due to extinction; EXPN = experimental population, non-essential; FE = federally endangered; FPE = proposed for Federal listing as endangered; FPT = proposed for Federal listing as threatened; FT = federally threatened.

In October 2004, the NRC prepared a BA (NRC 2004-TN11474) and submitted it the FWS for concurrence (NRC 2004-TN11474). FWS asked TVA 6 additional questions on August 12, 2005, discussed draft responses on October 27, 2005, and received written responses on April 7, 2006 (TVA 2006-TN11475). TVA responded to additional questions from FWS about (1) surveys for federally protected species in transmission line ROWs, (2) river bottom dissolved oxygen, (3) modeled thermal plumes, (4) in stream work in transmission ROWs, and (5) chemical use within stream buffer zones within transmission ROWs. On April 20, 2006, the FWS concurred with NRC's determinations (FWS 2006-TN11491), after receiving TVA's responses and obtaining TVA's commitments to track species occurrences, conduct aquatic surveys, and to follow BMPs on TVA-managed lands and transmission ROWs. Evaluations and project effect determinations for federally listed and candidate species for terrestrial and aquatic species from the BA are summarized below.

The NRC staff evaluated the effects of Browns Ferry SLR on 10 federally listed terrestrial species potentially present at that time: bald eagle (*Haliaeetus leucocephalus*), red-cockaded woodpecker (*Picoides borealis*), gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), Price's potato bean (*Apios priceana*), American hart's-tongue fern (*Asplenium scolopendrium* var. *americanum*), leafy prairie clover (*Dalea foliosa*), Eggert's sunflower (*Helianthus eggertii*), Lyrate bladder-pod (*Lesquerella lyrata*), and Tennessee yellow-eyed grass (*Xyris tennesseensis*). In addition, the NRC staff evaluated the effects of LR on a candidate species, fleshy-fruited gladecress (*Leavenworthia crassa*), which was subsequently listed as endangered in 2014 (79 FR 44712-TN11424). In its BA, the NRC staff determined that the Browns Ferry operations "*may affect but is not likely to adversely affec*t" (NLAA) eight terrestrial species: bald eagle, gray bat, Indiana bat, Price's potato bean, leafy prairie clover, Eggert's sunflower, fleshy-fruited lyrate bladder-pod, and Tennessee yellow-eyed grass. The NRC also determined that Browns Ferry operations would have "*no effect*" (NE) on red-cockaded woodpecker and American hart's-tongue fern.

In 2004, the NRC staff evaluated the effects of Browns Ferry LR on 38 aquatic species (35 federally listed; 3 candidate species). In its BA (NRC 2004-TN11474:Table 2), the NRC staff found that nine federally listed or candidate aquatic species had the potential to occur within the action area: Anthony's riversnail (*Athearnia anthonyi*), slender campeloma (*Campeloma decampi*), armored snail (*Marstonia pachyta*), Cumberlandian combshell (*Epioblasma brevidens*), pink mucket (*Lamsilis abrupta*), rough pigtoe (*Peleurobema plenum*), slackwater darter (*Etheostoma boschungi*), spectaclecase (*Cumberlandia monodonta*, and slabside pearlymussel (*Lexingtonia dolabelloides),* and that the other 29 federally listed aquatic species or candidate aquatic species did not have the potential to occur (NRC 2004-TN11474: Table 3). In its BA, the NRC staff determined that Browns Ferry LR would be NLAA for Anthony's riversnail, slender campeloma, armored snail, Cumberlandian combshell, pink mucket, rough pigtoe, slackwater darter, spectaclecase, and slabside pearlymussel and NE for all other federally protected aquatic species.

In TVA's ER (TVA 2025-TN11355: Tables 3.6-2 and 3.6-8), TVA presented lists of terrestrial and aquatic species that are federally protected under ESA that could occur within the SLR action area (TVA 2025-TN11355). The NRC staff compared these lists to its BA (NRC 2004-TN11474: Tables 1–3) and conducted an independent analysis (Table 3-11) to determine that nine of these previously evaluated ESA protected species could occur within the action area: gray bat, Indiana bat, Anthony's riversnail, slender campeloma, armored marstoma, slackwater darter, spectaclecase, pink mucket, and rough pigtoe. Six of 29 aquatic species determined to be unlikely to occur within the 2006 LR action area are now listed as potentially occurring within the current action area in TVA's ER (TVA 2025-TN11355): dromedary pearlymussel (*Dromus*

dromas), tubercled blossom (*Epioblasma torulosa torulosa*), cracking pearlymussel (*Hemistena lata*), birdwing mussel (*Lemiox rimosus*), ring pink (*Obovaria retusa*), and orangefoot pimpleback (*Plethobasus cooperianus*). Tubercled blossom was delisted due to extinction in October 2023 (88 FR 71644-TN11423) and will not be further analyzed. For the SLR, bald eagles are evaluated in Section 3.6.3.3, because they are no longer protected under ESA but remain federally protected under the Bald and Golden Eagle Protection Act. The NRC staff identified no new information during its review of the proposed SLR to indicate the presence of any other previously analyzed species (NRC 2004-TN11474: Tables 1–3) within the SLR action area.

During its independent review (Table 3-11), the NRC staff reviewed species information for additional species (TVA 2025-TN11355: Tables 3.6-2 and 3.6-8, and FWS 2025-TN11420) and determined that four other species protected under ESA had the potential to occur within the SLR action area: whooping crane (*Grus americana*), monarch butterfly (*Danaus plexippus*), sheepnose (*Plethobasus cyphus*) and Tennessee pigtoe (*Pleuronaia barnesiana*). In addition, the NRC staff determined that the SLR action area overlaps proposed critical habitat for spectaclecase. The 2005 IPaC data for the action area no longer indicated the possible presence of northern long-eared bat (*Myotis septentrionalis*) or tricolored bat (*Perimyotis subflavus*). The NRC staff also determined that the presence of eastern hellbender (*Cryptobranchus allaganiensis allaganiensis*) and spring pygmy sunfish (*Elassoma alabama*) within the action area is unlikely.

Based on its independent review (Table 3-11), the NRC staff evaluated potential impacts to 13 species that have potential to occur within the action area described in Section 3.8.1.1 (site and adjoining area of Wheeler Reservoir affected by proposed operations): gray bat, Indiana bat, whooping crane, monarch butterfly, slackwater darter, pink mucket, spectaclecase, rough pigtoe, sheepnose, Tennessee pigtoe, Anthony's riversnail, armored snail, and slender campeloma. In addition, the NRC staff evaluated the potential impacts to proposed critical habitat for spectaclecase, which overlaps the action area. No other species have designated or proposed critical habitat that overlaps the action area. The NRC staff has determined that none of the other ESA protected species outlined above potentially occur within the action area and that further analysis is not necessary to conclude that the proposed action would have no effect on these species.

3.8.1.3 Federally Listed Species and Critical Habitats Under NMFS Jurisdiction

No federally listed species or designated critical habitats under NMFS jurisdiction occur in the action area. Therefore, this SEIS does not discuss any such species or habitats.

3.8.2 Magnuson–Stevens Act: Essential Fish Habitat

No Essential Fish Habitat occurs within or near Browns Ferry. Therefore, this SEIS does not discuss any such species or habitats.

3.8.3 National Marine Sanctuaries Act: Sanctuary Resources

No National Marine Sanctuaries occur within or near Browns Ferry. Therefore, this SEIS does not discuss any such species or habitats.

3.8.4 Proposed Action

3.8.4.1 Endangered Species Act: Federally Listed Species and Critical Habitats under U.S. Fish and Wildlife Service Jurisdiction

In Section 3.8.1, the NRC staff determined that gray bat, Indiana bat, whooping crane, monarch butterfly, slackwater darter, spectaclecase, pink mucket, sheepnose, rough pigtoe, Tennesee

pigtoe, Anthony's riversnail, amored snail, and slender campeloma have the potential to occur within in the SLR action area. The SLR action area also intersects with proposed critical habitat for spectaclecase.

The NRC staff analyzes the potential impacts of the proposed Browns Ferry SLR on ESA protected species and habitat in Appendix C. Table 3-12 summarizes the NRC staff's ESA determinations for federally listed and proposed species and critical habitat.

Table 3-12 Effect Determinations for Federally Listed Species under U.S. Fish and Wildlife Service Jurisdiction

Species	Federal Status[(a)]	Potentially Present in the Action Area	Effect Determination[(b)]
gray bat	FE	Yes	NLAA
Indiana bat	FE	Yes	NLAA
northern long-eared bat	FE	No	NE
tricolored bat	FPE	No	NE
whooping crane	EXPN	Yes	NLAA
eastern hellbender	FPE	No	NE
monarch butterfly	FPT	Yes	NLAA
spring pygmy sunfish	FT	No	NE
slackwater darter	FT	Yes	NLAA
birdwing pearlymussel	FE	No	NE
cracking pearlymussel	FE	No	NE
Cumberlandian combshell	FE	No	NE
dromedary pearlymussel	FE	No	NE
fluted kidneyshell	FE	No	NE
orangefoot pimpleback	FE	No	NE
pink mucket	FE	Yes	NLAA
ring pink	FE	No	NE
rough pigtoe	FE	Yes	NLAA
sheepnose	FE	Yes	NLAA
spectaclecase	FE	Yes	NLAA
spectaclecase critical habitat	FPD	Yes	NLAA
Tennessee pigtoe	FPE	Yes	NLAA
Anthony's riversnail	FE	Yes	NLAA
armored snail	FE	Yes	NLAA
slender campeloma	FE	Yes	NLAA

DE = delisted due to extinction; EXPN = experimental population, non-essential; FPD = federally proposed designated (critical habitat); FE = federally endangered; FPE = proposed for Federal listing as endangered; FPT = proposed for Federal listing as threatened; FT = federally threatened; NE = no effect; NLAA = may affect but is not likely to adversely affect.

(a) Indicates protection status under the Endangered Species Act.

(b) The NRC staff makes its effect determinations for federally listed species in accordance with the language and definitions specified in the FWS and NMFS Endangered Species Consultation Handbook (FWS and NMFS 1998-TN1031).

3.9 Historic and Cultural Resources

This section describes the cultural background and the historic and cultural resources at Browns Ferry and its surrounding area. NEPA (TN661) requires Federal agencies to consider the potential effects of their actions on the affected human environment, which includes "aesthetic, historic, and cultural resources as these terms are commonly understood, including such resources as sacred sites" (CEQ and ACHP 2013-TN4603). Section 106 of the NHPA (54 U.S.C. § 306108-TN4839), requires Federal agencies to consider the effects of their undertakings on historic properties. While NHPA emphasizes impacts on historic properties, for NEPA compliance, impacts on cultural resources that are not eligible for or listed in the NRHP would also need to be considered (CEQ and ACHP 2013-TN4603). In accordance with 36 CFR 800.8(c) (TN513), the NRC complies with the obligations required under NHPA Section 106 through its process under the NEPA.

Historic and cultural resources describe material culture left behind from past human activity. These resources include sites, objects, landscapes, structures, or other natural features of significance to groups of people who have traditional association with it. Historic properties are defined as resources eligible for listing in the NRHP. The NRHP is the Nation's official list recognizing buildings, structures, objects, sites, and districts of national, State, or local historical significance which merit preservation. The criteria for eligibility are listed in the 36 CFR 60.4 (TN1682) and include (A) association with significant events in history; (B) association with the lives of persons significant in the past; (C) embodiment of distinctive characteristics of type, period, or construction; and (D) sites or places that have yielded, or are likely to yield, important information.

In the context of the NHPA, the proposed action is the SLR of the current renewed operating licenses, which would extend the current operating term another 20 years. The Area of Potential Effect (APE) consists of the 880 ac (356 ha) Browns Ferry site located within the site boundary, where activities associated with the operation of the facility could potentially compromise the integrity of historic properties. The APE may extend beyond the nuclear plant site when these activities may indirectly (e.g., visual and auditory) affect historic properties. This determination is made irrespective of land ownership or control.

In accordance with the NHPA, the NRC is required to make a reasonable effort to identify historic properties within the APE. If the NRC finds that either there are no historic properties within the APE or the undertaking (SLR) would have no effect on historic properties, the NRC provides documentation of this finding to the State Historic Preservation Officer (SHPO). In addition, the NRC notifies all consulting parties, including Tribes, and makes this finding public through the NEPA process prior to issuing the renewed operating licenses. Similarly, if historic properties are present and could be affected by the undertaking, the NRC is required to assess and resolve any adverse effects in consultation with the SHPO and any Tribe that attaches religious and cultural significance to identified historic properties.

In Alabama, the Alabama Historic Commission (AHC) is responsible for administering Federal and State-mandated historic preservation programs to identify, evaluate, register, and protect the State's archaeological and historic resources under the direction of the Alabama SHPO. The Office of Archaeological Research at the University of Alabama maintains the Alabama State Site File electronic database, which inventories all the registered cultural resources within the State, including those within the Browns Ferry plant.

As part of its SLR application, TVA submitted an environmental report, which contains information and an analysis of the environmental impacts of the proposed action, including the impacts of refurbishment activities, if any, associated with LR and the impacts of operation during the SLR term. In addition to its independent review, the NRC staff uses this information to support its NHPA Section 106 consultation obligations.

3.9.1 Cultural Background

This section documents the precontact, ethnographic, and historic chronology of the proposed action's region. Cultural sequences are based on those described in Anderson and Sassaman (Anderson and Sassaman 2012-TN10494). The chronology of the area is divided into the following periods: Paleoindian (13,000 to 10,000 before present [BP]), Archaic (10,000 to 3000 BP), Woodland (3000 to 1100 BP), Mississippian (Anno Domini [AD] 1100–1540), and the Contact and Historic Periods (1540 to present). The context described below helps archaeologists understand what previous research has been done in the area to inform cultural resources professionals what potential natural and cultural resources may be encountered in the project area. General patterns summarizing each time period are briefly described below.

3.9.1.1 Paleoindian Period (13,000–10,000 BP)

The Paleoindian Period is considered to represent the earliest documented human occupation in the region, extending more than 13,000 years ago to the terminal Pleistocene period. This period is typically characterized by small groups of highly mobile nomadic hunters who followed large game such as mammoths, mastodons, and bison and inhabited small semi-permanent camps. There has been ongoing dialogue in the archaeological community on what is considered the earliest documented human occupation in North America. Scholars typically associate the Clovis culture with the Paleoindian Period, although there are a number of well-known archaeological sites across North America that predate Clovis period sites. These include the Meadowcroft Rockshelter in Pennsylvania (Adovasio et al. 1990-TN10487), Paisley Caves in Oregon (Gilbert et al. 2008-TN10488), and White Sands in New Mexico (Pigati et al. 2023-TN10489).

Stone tool technologies of this era are mostly associated with the Clovis and Folsom (10,800–9,500 Before Christ [BC]) cultures. Both are known for their fluted points and large spear points made from high quality chert characterized by a groove notched out in the middle to bottom half of the point, allowing it to be attached to handles. Aside from fluted points, the Paleoindian toolkit also includes unfluted lanceolate projectile points, side scrapers, end scrapers, and drills (Adams and Young 2007-TN10490). Paleoindian varieties in the Southeast include Cumberland, Suwannee, Simpson, Dalton and Quad point types (Elliott and Sassaman 1995-TN10491).

A well-known archaeological site that dates to the Paleoindian Period is the Dust Cave site in northern Alabama. Dust Cave was occupied beginning in the Late Paleoindian period, around 10,650 calibrated BC and represents over 7000 years of human occupation. The sheltered nature of the cave has preserved significant cultural material that has allowed for the reconstruction of Paleoindian and Archaic lifeways, which is a rarity of sites contemporary to this period. Cultural material preserved includes bone, charred and uncharred plant material, and features such as hearths, cooking pits, ash lenses, and prepared surfaces (Sherwood et al. 2004-TN11464; Walker 2011-TN11467). Dust Cave's lithic inventory includes projectile point styles such as Beaver Lake, Dalton and Quad point types (dating to the Middle Paleoindian), Dalton and Hardaway Side-Notched types (Late Paleoindian), Early Side-Notched, Kirk Corner-Notched, LeCroy, Kanawha (Early Archaic), and Eva/Morrow Mountain and Benton types (Middle Archaic period).

3.9.1.2 Archaic Period (10,000–3000 BP)

The Archaic Period is documented as starting around 10,000 years ago and marks the transition from nomadic to more sedentary settlement patterns and increased subsistence on multiple resources including smaller game and plants. The Archaic period was considered to be a period of transition; a slow, progressive trend toward exploitation of forest niches, better technologies and networks of interaction and cultural diffusion that helped spread pottery, food production and customs of politics and religion (Anderson and Sassaman 2012-TN10494).

The Archaic toolkit is typified by smaller projectile points, stone grinding implements, and tools such as projectile points, knives, drills, and scrapers. This period also saw the introduction of the atlatl, a small wooden or bone stick with a hook at one end used to propel darts or spears (Bense 1994-TN10495). In the Southeast, the Archaic Period is divided into three subperiods: Early (10,000–8000 BP), Middle (8000–5000 BP), and Late Archaic (5000–3000 BP).

Early Archaic (10,000–8000 BP)

Warmer climatic conditions began to occur in the Early Archaic, resulting in changes in vegetation, fauna, seasonal temperatures, and fluctuations in sea levels (Sherwood et al. 2004-TN11464). During this period, there was a continuation of semi-nomadic hunting and gathering. Modern game species were consumed instead of megafauna, which had become extinct by that time. Early Archaic tools included end scrapers, side scrapers, gravers, adzes, and perishable items such as nets, traps, and basketry. Early Archaic typologies include Side and Corner Notched projectile points such as Hardaway, Kirk, Taylor, and Big Sandy points and bifurcate points such as MacCorkle, St. Albans, and LeCroy types (Elliott and Sassaman 1995-TN10491; Sassaman et al. 2002-TN10496).

Artifact density suggests that Dust Cave was intensely used during the Early Archaic period. Faunal subsistence indicated a shift from riverine/flood resources to more terrestrial sources (Sherwood et al. 2004-TN11464). Diagnostic artifacts found at the site included Early Side-Notched points, Kirk Corner-Notched, and LeCroy point types in addition to bone tools such as antler tines, grooved antler handle, and bone needles and awls (Sherwood et al. 2004-TN11464; Dison et al. 2022-TN11593).

Middle Archaic (8000–5000 BP)

This period coincides with the changing environmental conditions associated with the onset of the Middle Holocene Hypsithermal warming period. The climate became warmer and drier, and temperatures were comparably higher than those of today. Higher temperatures resulted in decreased rainfall and vegetation changes. Deer population increased due to the abundance of vegetation, and food resources such as mollusks and fowl increased (Anderson and Sassaman 2012-TN10494). Pollen evidence suggests that the cool temperate mixed hardwood forests were replaced by oak-hickory, mixed hardwood, and southern pine forests. Levees, swamps, and oxbow lakes also developed.

In the southeast, the Middle Archaic is marked by the regional replacement of the Early Archaic notched points with stemmed projectile points and the increased use of ground stones and bone. In the Middle Tennessee Valley, the Middle Archaic is noted by the presence of Kirk Stemmed/Serrated points, Eva/Morrow Mountain points, Sykes/White Springs points, and Benton projectile points (Sherwood et al. 2004-TN11464). Other artifacts of the Middle Archaic include stage bifaces, expedient tools, awls, axes, atlatl weights, grinding stones, nutting stones

(pitted cobbles), needles, pins, and fishhooks (Elliott and Sassaman 1995-TN10491, Sherwood et al. 2004-TN11464). At the previously mentioned Dust Cave site, excavations showed intensive human occupation during the Middle Archaic. Archaeological evidence revealed that numerous prepared surfaces and intersecting small pits were concentrated farther toward the entrance of the Cave. The repeated use of the same location within the cave for the same function across components implies a high level of spatial organization that persisted throughout time (Sherwood et al. 2004-TN11464).

Early efforts of mound building began during the Middle Archaic. Watson Brake is believed to be one of the oldest large-scale mound sites earthworks in the United States. The Watson Brake site in northeast Louisiana is a complex of 11 earthen mounds, considered to be more than 5,000 years old. Archaeological excavations at the site have recovered an abundance of fire-cracked rock and baked clay blocks, and an assemblage of animal bone dominated by fish (Anderson and Sassaman 2012-TN10494). The artifacts encountered at Watson Brake were made of local resources, indicating that long-distance trade was not yet occurring.

Late Archaic (5000–3000 BP)

The Late Archaic is described as a time increased settlement permanence, growth in population, the intensification of subsistence, and technological innovation (Adams and Young 2007-TN10490). A number of key developments emerged during this period. Axes, steatite vessels, and cooking stones appear more often in archaeological contexts. Settlement along river valleys increased, as seen in areas such as the Mississippi River valley. Settlement along rivers provided consistent food sources such as shellfish and oyster, therefore allowing settlement for longer periods of time. Late Archaic populations also consumed resources such as nuts, acorns, and squash (Anderson and Sassaman 2012-TN10494).

Ceramic pottery in the United States developed during this period (around 4,500 BP) in the Coastal Plain of the southeast (Elliott and Sassaman 1995-TN10491). The earliest versions of ceramics were thick and tempered with fiber materials from plants, such as Spanish moss or palmetto palms. Pottery styles such as Stallings Island, Bilbo, St. Simons and Orange (Florida) correspond to this time period. Further, projectile point styles were stylistically different in the Late Archaic than their predecessors from the Middle Archaic. Examples include the Savannah River Stemmed from the South Atlantic, the Ledbetter and Pickwick types of the southwestern Appalachians into the Coastal Plain areas of Tennessee, Mississippi and Alabama, and local variations such as the Cotaco Creek, Flint Creek, Little Bear Creek, and Wade styles (Dison et al. 2022-TN11593; Anderson and Sassaman 2012-TN10494).

Poverty Point in northeast Louisiana is a remarkable earthwork site dating to the Late Archaic period. The site is a 3 km^2 (1.1 mi^2) complex of nearly 1 million cubic yards (y^3) (0.8 million cubic meters [m^3]) of mounded earth in 6 concentric C-shaped ridges 4–6 ft (1.2–1.8 m) high, 2 massive effigy mounds, and several conical and flat-topped mounds (Anderson and Sassaman 2012-TN10494). Apart from being a residential and ceremonial center, Poverty Point was also the center of a huge exchange network. Artifacts encountered at the site have been sourced from areas as far north as Iowa and Indiana (LOT-TN11485) and as far east as Georgia. Poverty Point is unique in the archaeological record, but even more so during the Late Archaic Period as habitations of this era were typically small. The site is considered an engineering marvel due to the scale of construction and concerted effort to build the massive residential and ceremonial center. Midden beneath the rings showed that people were living in a semi-circular village with a central plaza before the first earth mound, Mound B, was constructed around 3700 BP. Mound construction developed over the following 600 years, until about 3100 BP

(LOT-TN11485). Despite Archaic populations living at Poverty Point, no human remains or shell middens have been encountered in archaeological excavations. The site became a UNESCO World Heritage Site in 2014 (UNESCO 2025-TN11484).

3.9.1.3 Woodland Period (3200 to 1000 BP)

The Woodland Period is represented by settled village life, more intensive plant cultivation (varieties of corn and wild rice), widespread adoption and elaborate variations of pottery, and the emergence of earthworks and associated burial complexes. Archaeologists typically consider the Woodland Period to be the era of regionalism, defined by Anderson and Sassaman (2012-TN10494) as the process of cultural differentiation leading to distinct traditions and communities across the Southeast. Similar to the Archaic, the Woodland Period is divided into three subperiods: the Early Woodland (3200–2200 BP), Middle Woodland (2200–1500 BP) and the Late Woodland (1500–1100 BP) (Anderson and Sassaman 2012-TN10494).

The development of agriculture was established in the Woodland period. Our understanding of agricultural practices of this phase is based on paleoethnobotanical evidence found in Woodland-era sites. Cultigens such as squash, sunflower, marshelder and chenopod began to be domesticated in the Late Archaic but their cultivation intensified during the Woodland period (Anderson and Sassaman 2012-TN10494). Goosefoot, marshelder and sunflower were consumed during the Woodland, and these, along with maize, became more important during the subsequent Mississippian period.

Early Woodland (3200–2200 BP)

During the Early Woodland, populations remained largely hunting and gathering societies. Pottery became more widespread; sand and grit replaced fiber for tempering pottery. Regional variations were represented by the way they were decorated. For example, cord or fabric impressions were applied to the pottery of the Middle Atlantic and Mid-south. Pottery from the South Appalachian and Gulf coastal areas exhibited more elaborate designs (Anderson and Sassaman 2012-TN10494). In the Piedmont region, Dunlap Fabric Impressed and Cord Marked pottery and Swannanoa-type ceramics were common during this period. In the Tennessee River Valley, ceramics are associated with the Alexander occupation. Alexander ceramics are sand tempered and are decorated using incised, punctated and dentated style patterns (Dison et al. 2022-TN11593). Projectile points from this era include Flint Creek points. Shellfish, which was consumed heavily during the Late Archaic, appeared to be consumed less during this phase.

Middle Woodland (2200–1500 BP)

Archaeologists distinguish the Middle Woodland Period primarily by variances in ceramics and artifacts. In the Piedmont, Pigeon, Cartersville, and Yadkin ceramics are typical Middle Woodland pottery types. Pigeon is quartz tempered and decorated with check stamped and simple stamped patterns. Cartersville pottery is tempered with either sand or grit, and is typically cord marked, although there have been some simple stamping and check stamping patterns observed (Adams and Young 2007-TN10490). Yadkin pottery is tempered with crushed quartz, and decorated with fabric impressed, check stamped, linear check stamped, and simple stamped patterns (Wellings et al. 2023-TN10497). In the Tennessee River Valley, local ceramic varieties are dominated by the Colbert ceramic traditions, which is typified by Mulberry Creek Plain and Long Branch Fabric Marked pottery (Dison et al. 2022-TN11593; Shaw 2000-TN11486). Non-pottery artifacts found from Middle Woodland cultural deposits include clay

platform pipes, ground and polished stone ornaments, bone tools, engraved shell and bone, bifacial knives, and shark tooth pendants (Wellings et al. 2023-TN10497).

One of the most defining features of this period is the emergence of burial mounds, which are characterized by monumental earth or stone works and elaborate mortuary practices (Bense 1994-TN10495). The complexes are mainly found in high locations, such as hilltops. Woodland era mounds are most associated with the Hopewell culture of Ohio. As described by Anderson and Sassaman (2012-TN10494), mound complexes in the southeast are similar to Hopewell mounds as they are typically conical with central tombs. In some cases, mound complexes include platform mounds, a trait seen with Mississippian era-mounds. Associations between the Hopewell mounds and the complexes of the Southeast are based on the presence on Hopewellian objects in the archaeological record. This includes quartz crystals, flint blades, mica cutouts, shell and pearl beads, copper and ceramic earspools, and other exotic materials like obsidian and galena (Anderson and Sassaman 2012-TN10494).

Pinson mounds in west Tennessee is the largest Middle Woodland ceremonial complex in eastern North America. The site has at least 12 mounds, a geometric enclosure, and associated temporary habitation areas distributed over an area of 395 ac (160 ha). The site is unique due to the presence of five large platform mounds, which is not typically characteristic of the Middle Woodland period but more the Mississippian period (Mainfort 1988-TN11487). Based on radiocarbon dates, the site was constructed and used between 100 BC to AD 350 (Mainfort 1988-TN11487; Anderson and Sassaman 2012-TN10494). In Alabama, the contemporary culture to the Hopewell is the Copena Mortuary Complex. The culture is marked by village settlement patterns, cave burials, and burial mounds. The Oakville Indian Mounds, about 40 mi (64 km) south of the project area, is a local example of a major Copena ceremonial center. At least 5 mounds were originally discovered during the 1920s archaeological survey for the Wilson Dam and Reservoir. Three of the mounds were eventually destroyed with the construction of the dam. The remaining two mounds are now protected by the park (AHA/EOA 2025-TN11488; AIMT 2025-TN11501).

Late Woodland (1500–1100 BP)

Cultural complexity declined during the Late Woodland. Smaller, political units began to appear and the production of elaborate burial complexes ceased. During this time, there was a shift toward smaller, more numerous dispersed habitation sites. This shift in settlement pattern appears to be a response to increased reliance on an agricultural subsistence strategy or intensification of resource procurement from upland areas (Adams and Young 2007-TN10490). Maize agriculture intensified, becoming more important by the end of the period. The bow and arrow were also introduced in the Late Woodland Period. Bow-launched points had greater impact, which further maximized wild game harvesting (Peskin 2011-TN9872). This change in technology allowed for greater hunting success over the dart and atlatl. It also may well be responsible for the dramatic increase in warfare seen in some areas (Bense 1994-TN10495; Walthall 1980-TN10498).

Increased use of ceramic vessels led to the manufacture of a variety of functional forms, such as larger storage vessels, jars, bowls, and plates. Ceramics began to be tempered with sand or grog (crushed potsherds). Late Woodland pottery in the Tennessee River Valley are consistent with the Flint River and Baytown cultures (Shaw 2000-TN11486). Ceramic types include Mulberry Creek Plain, Flint River Brushed, Flint River Cord Marked, and Flint River incised. Baytown culture ceramics are distinguished by higher percentages of Mulberry Creek Plain, Wheeler Check Stamped potteries, and Mulberry Creek Cord Marked types (Shaw 2000-TN11486).

3.9.1.4 Mississippian Period (AD 1100–1540)

The Mississippian period, which began around AD 1000 and concluded with European contact in the 16th century, is characterized by the development of complex chiefdom-level societies and intensification of agriculture (Anderson and Sassaman 2012-TN10494; Fagan 2019-TN11508). During this period, mound centers flourished, and the Southeastern Ceremonial Complex—a regional belief system—spread widely. This complex included shared artifacts, iconography, ceremonial centers, and mythology (Bense 1994-TN10495). Mississippian culture is thought to have been the fundamentally influenced by Cahokia, which was a Central Political-Administrative Complex that once existed near present day St. Louis (Anderson and Sassaman 2012-TN10494).

During the Mississippian period, societies in the region exhibited significant variation and complexity. These sociopolitical entities were characterized by several key features, including a material culture encompassing shell-tempered pottery, wall trench houses, shell beads, and flat-topped pyramidal mounds (Anderson and Sassaman 2012-TN10494; Fagan 2019-TN11508). They relied heavily on maize agriculture or adapted to environments such as oxbow lakes, riverine areas, and floodplains for subsistence. Social organization was marked by hereditary inequality between individuals and groups, indicative of an advanced societal structure. Additionally, distinct religious, ceremonial, and iconographic systems played a central role in these societies.

In Alabama, the Moundville polity located near Tuscaloosa in Hale County is recognized as one of the most important centers of the Mississippian culture, which flourished between 1250 and 1500 AD (Knight 2010-TN11509). This premier example of Native American heritage sites is situated approximately 160 mi (260 km) south of the Browns Ferry Nuclear Plant. Though the plant and the archaeological park are not in immediate proximity, they share a regional historical context significant for understanding the cultural and historical landscape of northern Alabama. The presence of other Mississippian sites throughout northern Alabama highlights the widespread influence and interconnectedness of this culture.

The De Soto expedition, conducted between 1539 and 1543, provided detailed chronicles of the various Mississippian chiefdoms encountered. These accounts offer valuable insights into Mississippian societies as they existed prior to the detrimental effects of European contact (Anderson and Sassaman 2012-TN10494). The introduction of foreign diseases by the De Soto expedition and other early European explorers had catastrophic effects on the Mississippian communities and marks the end of the period.

3.9.1.5 Contact and Historic Period (1540–present)

The Contact period marks the time when Indigenous groups in the Southeast first encountered Europeans. Initial contact was mainly coastal but expanded inland by the mid-sixteenth century through expeditions led by Hernando de Soto (1539–1543), Tristan de Luna (1559–1561), and Juan Pardo (1566–1568) (Anderson and Sassaman 2012-TN10494). Not long after initial contact was made Indigenous populations were decimated from European diseases such as smallpox, measles, and influenza, to which the Indigenous populations had no immunity.

The demographic collapse led to significant social disruption and the disintegration of complex chiefdom-level societies (Hudson 2018-TN11511). Consequently, the interconnected networks of mound centers, agricultural practices, and ceremonial traditions that characterized the Mississippian period experienced profound transformations. The long-term implications

of these demographic changes were far-reaching, fundamentally altering the cultural landscape of the region for subsequent generations.

From the 1560s through the 1790s, the Tennessee River region witnessed a series of profound transformations (Ethridge 2010-TN11518). European explorers, traders, and settlers increasingly encroached on Indigenous lands, leading to conflicts and shifts in territorial control. Indigenous communities adapted to these pressures through various means, including trade alliances and occasional warfare, while continuing to maintain their cultural practices and societal structures (Saunt 1999-TN11522). Beginning in the 1790s, the United States government pursued policies aimed at acquiring land from Indigenous Tribes living east of the Mississippi River. The first major step to relocate American Indians came with the Indian Removal Act of 1830. The Act led to the forced relocation of the Cherokee, Chickasaw, Choctaw, Creek (Muscogee), and Seminole Tribes from their Southern homelands to designated Indian Territory west of the Mississippi River (Nance 2001-TN11527). Prior to removal, the Creek (Muscogee) once controlled a vast majority of the land in the State of Alabama, whereas the Cherokee occupied the northeastern section of the State, and the Chickasaw occupied the northwest (AHA/EOA 2025-TN11553).

Archaeological explorations near the Browns Ferry Nuclear Plant in northern Alabama have uncovered significant findings that shed light on the interactions between Indigenous groups and European settlers (Blitz 2008-TN11536; Knight 2010-TN11509; Walthall 1980-TN10498). Notable discoveries include pottery, tools, and European trade goods such as glass beads and metal objects, illustrating early exchanges and cultural adaptations (Bense 1994-TN10495). Evidence of fortifications and changing settlement patterns showcases the resilience and adaptive strategies of Indigenous communities during this transformative period. These findings provide valuable insights into the socio-cultural changes that occurred as a result of European contact in the region.

After the Indian Removal Act, the area was profoundly impacted by the forced relocation of these Tribes. These Tribes endured immense hardships, with thousands perishing during their journey while traveling on the routes paralleling the Tennessee River. The Trail of Tears National Historic Trail preserves the memory of those who traveled and suffered during this tragic period. Today, the federally recognized Tribes who historically lived in the region of the Browns Ferry nuclear plant and their current locations include the Cherokee Nation, the Chickasaw Nation, and the Muscogee (Creek) Nation, all located in Oklahoma.

Following the removal of Indigenous peoples, the Tennessee River region experienced significant historical developments. During the Civil War, it served as a strategic transportation route and resource hub. In the post-war era, the establishment of the TVA in 1933 transformed the Tennessee Valley into an industrial center (Tennessee Valley Authority Act-TN5024). The TVA's extensive infrastructure projects, including dam and power plant construction, stimulated economic development and modernization, profoundly altering the region’s landscape and economy.

3.9.2 Historic and Cultural Resources at Browns Ferry

The Alabama State Site File and the Alabama Historic Preservation Map geographic information system database was reviewed by NRC staff to gain a better understanding of the historic and cultural resources within the region (UA 2025-TN11692). A 1 mi (1.6 km) radius was used to identify all historic properties that could be potentially affected by the undertaking. This information helps cultural resources professionals understand what resources may potentially be in the project area.

In total, 26 archaeological sites have been identified within 1 mi (1.6 km) of the APE. This includes 20 precontact sites, one historic site, and five multicomponent sites (containing both historic and precontact cultural material). Of the 26 sites, 15 are within the project APE. Almost all were recorded as precontact lithic scatter sites with the exception of three sites (Li536, Li918, and Li919) which included historic artifacts such as brick, glass, nails, and ceramics. Four of the 15 sites (Li23, Li284, Li287, and Li535) are potentially eligible or eligible for the NRHP. Site Li23 was registered as a village site with an associated shell midden but was destroyed by the construction of Browns Ferry. Sites Li284, Li287, and Li535 (all precontact lithic scatter sites) are outside of the building complex and should be avoided by project activities. Ten of the 15 sites (Li24, Li812, Li857, Li915, Li916, Li917, Li918, Li919, Li920, and Li921) are considered not eligible for the NRHP. Last, site Li536 is considered undetermined for the NRHP.

The Browns Ferry Aquatic Research Facility (BFARF) was the only NRHP-eligible building at Browns Ferry prior to Brockington and Associates' 2022 evaluation of the entire plant site (TVA 2025-TN11354: Enclosure 2, Attachment 9). The BFARF was a joint research effort between TVA and EPA in which BFARF monitored damage to aquatic life as a result of warm water discharges from Browns Ferry condensers. Browns Ferry was chosen as the location for the aquatic research facility because of the water temperature swings of approximately 25° F (13°C). This allowed experiments to be conducted concurrently due to the temperature swings unique to nuclear power production and in consideration that at least one of Browns Ferry's three reactor units would be operating at any given time (TVA 2025-TN11354: Enclosure 2, Attachment 9). BFARF operated from 1972 through 1995. Over the decades, research at the facility included studies into aquatic life growth, reproduction, seasonal patterns, colonization rate, and biomass estimates. At the latter end of its operation, research focused on the restoration of natural river habitats for aquatic creatures, specifically mussels, which are sensitive to environmental changes and make an excellent barometer for water quality. BFARF completely ceased operations around 2000.

In 2018, the BFARF building was evaluated by TVA's contractor Tennessee Valley Archaeological Research (TVAR) as part of plans to demolish the building. TVAR concluded that the BFARF was eligible under Criteria Consideration G (achieving significance within the past 50 years if it is of exceptional importance) for its historical association in the area of science and additionally as a contributing resource to the Browns Ferry because of its association with Browns Ferry as TVA's first nuclear power project (TVA 2025-TN11354: Enclosure 2, Attachment 10, TVA 2025-TN11355). The AL SHPO agreed with the eligible determination for BFARF in June 2018. Both agencies signed a Memorandum of Agreement for the proposed removal of the facility. Plans to remove the BFARF never came to fruition; the building remains standing today.

3.9.2.1 Browns Ferry Historic District

In 2021, a comprehensive architectural survey was conducted site-wide by Brockington and Associates to formally evaluate the facilities for potential listing on the NRHP. TVA established the period of significance for eligibility between 1966 and 1980, the year TVA began acquiring land for the project and the date by which all the buildings and structures necessary for plant operations had been constructed. Sixty-nine architectural resources were determined to be constructed during that period, with 51 of those originally completed between 1973 and 1976. Brockington's survey concluded that the Browns Ferry was eligible for the NRHP as a historic district under Criteria Consideration G (TVA 2025-TN11354: Enclosure 2, Attachment 9). The facility was also determined to be eligible under Criterion A for its association with early nuclear

energy development in Alabama and the TVA system, and under Criterion C as a representative example of nuclear energy engineering and architecture (TVA 2023-TN11043).

The district is 245 ac (100 ha) and comprises 49 buildings and structures, including the Units 1–3 containment structures, multiple diesel generator buildings, the intake pumping station, turbine buildings, discharge structure, BFARF, meteorological tower, switchyard, and warm and cool water channels. Units 1–3 were also recommended individually eligible for the NRHP. The district retains all aspects of integrity—location, association, design, workmanship, materials, setting, and feeling. Character-defining features include the concrete foundations, the striated reinforced concrete exterior walls, and the flat roof with metal mansards. Twenty facilities were determined to not contribute to the district as they were constructed after 1980 and/or have undergone extensive modifications and alterations (TVA 2025-TN11354: Enclosure 2, Attachment 9). The AL SHPO concurred with the NRHP-eligible determination in November 2022 (TVA 2025-TN11355).

3.9.2.2 Previously Recorded Archaeological Surveys

The project APE has been completely surveyed, particularly due to the Tennessee River Valley's association with larger public works projects, such as the construction of the Pickwick, Gunthersville, Wilson, and Wheeler dams and reservoirs (Dison et al. 2022-TN11593; TVA 2025-TN11354). Early archaeological work in the project area was first connected with the Smithsonian's Bureau of American Ethnography followed by Federal relief/New Deal programs such as Works Progress Administration and Civilian Conservation Corps work, then succeeded by work by TVA.

Seminal work in the project APE started in 1932 with a survey of the Wheeler Basin area. The project identified 237 sites. The following year, in 1933, as part of the construction of the Wheeler Reservoir, 19 of the 237 sites were revisited and excavated (Webb 1939-TN11497). Overall, excavations focused on Mississippian mounds, villages and cemeteries, burial mounds, and large shell middens (Shaw 2000-TN11486). In the early 1990s, the University of Alabama's Office of Archaeological Services continued the large-scale investigations by surveying over 47,000 ac (19,020 ha) of TVA-owned and controlled land in the Wheeler Reservoir for the purposes of identifying and evaluating cultural resources within their jurisdiction. Browns Ferry was briefly mentioned in the report, noting that six sites were located within the plant boundary (Li23, Li24, Li284, Li285, Li286, and Li287). Overall, the project recorded 516 new sites and revisited 240 previously recorded sites. Thirty-five sites had Paleoindian components, 401 sites represented Archaic period activity, 234 had Woodland components, 30 sites dated to the Gulf Formational period, 74 sites were dated to the Mississippian period, and 61 sites contained historic cultural material (Shaw 2000-TN11486). A total of 49 sites were considered eligible for the NRHP. Another 140 sites were considered potentially eligible pending further evaluation testing (phase II testing). Another 261 sites were considered not eligible. The remaining 306 sites were of undetermined eligibility. In 2009, the University of Tennessee's Archaeological Research Laboratory conducted a survey of various reservoirs in Alabama, Georgia, Mississippi, North Carolina, Tennessee, and Virginia for archaeological and erosion monitoring surveys for TVA's Reservoir Operations Compliance project. In total, 1690 archaeological sites, 156 isolated finds, and 50 caves/rock shelters were identified and recorded. Of those, 794 sites were recommended as potentially eligible for the NRHP. The remaining 896 were considered ineligible for the NRHP (Gage and Herrmann 2009-TN11498).

The most recent survey in the project area was conducted in 2021 by TVAR to survey all previously archaeologically unsurveyed areas within the Browns Ferry Power Plant. The Phase I

investigation surveyed 193 ac (76 ha) across 6 separate areas using a combination of pedestrian surface inspection and shovel testing at 30 m (98 ft) intervals. A total of 873 shovel tests were excavated, resulting in 61 shovel tests being positive for cultural material. TVAR registered seven new sites (Li915, Li916, Li917, Li918, Li919, Li920, and Li921), two isolates, and two rock shelters. Additionally, TVAR evaluated six previously identified sites (Li24, Li284, Li286, Li287, Li856, and Li857) and expanded the site boundaries on two sites (Li284 and Li287). Site Li284 was combined with Li286 to represent a multicomponent precontact and historic site consisting of lithic debitage and ferrous sheet metal fragments. Diagnostic cultural material was contemporary to the Paleoindian, Archaic, and Woodland periods. The historic component included six stacked and mortared limestone check dams, clear light bulb glass fragments, and construction debris. Site Li287 was expanded to encompass site Li856, now representing an extensive lithic artifact scatter. Both sites were determined to have research potential and were recommended for avoidance of project activities, if possible (Dison et al. 2022-TN11593).

3.9.2.3 Cox Cemetery

The Cox Cemetery is within the project APE. The cemetery was originally located on a terrace overlooking the Tennessee River but was relocated to its present location during the construction of the power plant, around 1966 (Gage 2001-TN11499; Dison et al. 2022-TN11593). At the time, survey crews identified seven graves belonging to individuals associated with the Cox, Lang, and Madrey families (TVA 2023-TN11043). It is unknown how many burials were eventually relocated but six burials are marked with four headstones. Burial dates range from 1836–1908. The most prominent headstone is of Colonel Bartley Cox, who died in 1851 at the age of 59. John and Robert Cox share the second headstone and Eliza J. and Mary Cox share a third headstone. The fourth headstone is slightly separated from the aforementioned burials and marks the grave of Mabelle Lang, a child who passed in 1908. The cemetery is bounded by a fence and maintained by TVA.

3.9.3 Procedures and Integrated Cultural Resources Management Plan

TVA has an established cultural resources program consisting of over 30 staff members who are overseen by a Cultural Compliance Manager. The program includes 13 archaeologists and 1 architectural historian. TVA maintains a cultural resource management system to track and document their projects. On average, they review approximately 2,000 projects a year. TVA contracts with several private cultural resources management firms to support in-field services such as Phase I and II surveys, archaeological monitoring, Section 110 compliance, and archaeological data recovery projects (TVA 2025-TN11354).

TVA has several administrative controls and environmental procedures that aim to identify, protect, and minimize potential impacts to historic properties within TVA lands. In 2019, TVA executed a Programmatic Agreement with seven Tennessee Valley States (Kentucky, Tennessee, Virginia, Mississippi, Alabama, Georgia, and North Carolina) excluding certain activities from the Section 106 process. The Programmatic Agreement also identified a second set of activities that may be carried out without consultation, if performed within specified bounding conditions, and provide identification efforts that have been completed and no historic properties were identified that would be affected.

Further, TVA has an existing Comprehensive Agreement signed with the Absentee Shawnee Tribe of Indians of Oklahoma, Alabama-Coushatta Tribe of Texas, Alabama-Quassarte Tribal Town, Cherokee Nation, the Chickasaw Nation, Eastern Band of Cherokee Indians, Eastern

Shawnee Tribe of Oklahoma, Jena Band of Choctaw Indians, Kialegee Tribal Town, Mississippi Band of Choctaw Indians, the Muscogee (Creek) Nation, Osage Nation, Poarch Band of Creek Indians, the Quapaw Nation, the Seminole Nation of Oklahoma, the Shawnee Tribe, Thlopthlocco Tribal Town, and the United Keetoowah Band of Cherokee Indians in Oklahoma for the protection of human remains. The Comprehensive Agreement establishes an efficient process under the Native American Graves Protection and Repatriation Act on the treatment of human remains and/or cultural items within TVA lands (TVA 2025-TN11354).

3.9.4 Proposed Action

As documented in the LR GEIS (NRC 2024-TN10161) and shown in Table 3-2 of this SEIS, the NRC staff identified one site-specific Category 2 issue related to historic and cultural resources applicable to Browns Ferry during the SLR term. This section provides the NRC staff's assessment of impacts and effects to historic and cultural resources and historic properties.

3.9.4.1 Environmental Audit Visit

The NRC staff visited the Browns Ferry site October 8, 2024, to tour the entirety of the plant. NRC staff visited several archaeological sites, the Cox cemetery, the BFARF, and concluded with a walkthrough of the Historic District. The NRC staff asked about potential future plans for construction, modification, or demolition activities associated with the proposed action and TVA's measures in place for the protection of the site's historic and cultural resources.

3.9.4.2 Consultation

NRC initiated Section 106 consultation with the Advisory Council on Historic Preservation (NRC 2024-TN11603), the Alabama SHPO (NRC 2024-TN11549), and 28 Tribes (NRC 2024-TN11540), including the Absentee Shawnee Tribe of Indians of Oklahoma, the Alabama-Coushatta Tribe of Texas, Alabama-Quassarte Tribal Town, Cher-O-Creek Intra Tribal Indians, Cherokee Nation, Chickasaw Nation, Choctaw Nation of Oklahoma, Coushatta Tribe of Louisiana, Eastern Band of Cherokee Indians, Eastern Shawnee Tribe of Oklahoma, Echota Cherokee Tribe of Alabama, Jena Band of Choctaw, Kialegee Tribal Town, Ma-Chis Lower Creek Indian Tribe of Alabama, Miccosukee Tribe, Mississippi Band of Choctaw, MOWA Band of Choctaw Indians, Muscogee Creek Nation, Piqua Shawnee Tribe, Poarch Band of Creek Indians, Seminole Nation of Oklahoma, Seminole Tribe of Florida, Shawnee Tribe, Southeastern Mvskoke Nation, Thlopthlocco Tribal Town, Tunica Biloxi Tribe, United Cherokee Aniyvwiya Nation, and the United Keetoowah Band of Cherokee Indians via letter sent April 15, 2024. In the letters, the NRC provided information about the proposed action, defined the APE, and indicated that the NHPA review would be integrated with the NEPA process in accordance with 36 CFR 800.8(c). The NRC extended an invitation to participate in the scoping process and in the identification of cultural resources.

The Advisory Council on Historic Preservation replied on May 7, 2024 (ACHP 2024-TN11559). The Choctaw Nation of Oklahoma replied on May 16, 2024, stating that the project was outside of their area of historic interest (Choctaw Nation 2024-TN11655). The Chickasaw Nation responded May 30, 2024, accepting the invitation to consult under Section 106, noting their support of the proposed undertaking and mentioning they do not believe there will be specific historic properties affected (Chickasaw Nation 2024-TN11615). Last, the AL SHPO responded October 16, 2024, concurring with NRC's APE (AHC 2024-TN11560). No additional responses have been received. Appendix C contains all consultation documents.

3.9.4.3 Findings

The proposed action has the potential to affect several historic properties, including sites Li284, Li287, Li535, the BFARF, and the Browns Ferry Historic District. Sites Li284, Li287, and Li535 are precontact lithic scatter sites that still retain intact cultural deposits and can contribute to our understanding of prehistory. All the sites are outside of the protected area and would not appear to be affected by current or future ongoing actions as a result of the proposed action. The BFARF is eligible under Criteria Consideration G for its historical association in the area of science and additionally as a contributing resource to the Browns Ferry Historic District because of its association with Browns Ferry as TVA's first nuclear power project. The Historic District is eligible under Criterion A for its association with early nuclear energy development in Alabama and the TVA system and eligible under Criterion C as a representative example of nuclear energy engineering and architecture. The district retains all aspects of integrity-location, association, design, workmanship, materials, setting, and feeling.

TVA confirmed that the agency has no plans to alter, repurpose, or demolish facilities as part of the proposed action (TVA 2025-TN11354). Plant operations and maintenance activities necessary to support the continued operation would be limited to previously disturbed areas and would be expected to be similar to current operations. Therefore, no impacts are anticipated for the BFARF and the historic district. For the purposes of NHPA, the proposed undertaking will result in No Adverse Effect to historic properties, as defined in 36 CFR 800.5(b) (TN513). For the purposes of NEPA, the proposed action would result in no impact to historic and cultural resources.

3.10 Socioeconomics

Socioeconomic factors that may be affected by nuclear power plant operations during the license renewal term are described in this section. Nuclear power plants and the communities that support it can be described as a dynamic socioeconomic system. Communities provide people, goods, and services needed to operate the nuclear power plant. Nuclear power plants, in turn, pay for goods and services and wages and benefits to workers. The measure of a community's ability to support a nuclear power plant depends on its ability to respond to changing socioeconomic conditions.

3.10.1 Nuclear Power Plant Employment

The socioeconomic region of influence (ROI) is defined by where Brown Ferry's workers and their families reside, spend their income, and use their benefits, thus affecting socioeconomic conditions in the region. TVA employs 2,174 workers at Browns Ferry (TVA 2024-TN11042). Approximately, 62 percent of these workers reside Lauderdale, Limestone, and Colbert counties in Alabama. The remaining TVA workers live in Alabama, Tennessee, and 35 other States (TVA 2024-TN11042). Because most of Browns Ferry's workers live in the three-county area, the greatest socioeconomics effects are likely to be experienced there. Consequently, the analysis addresses the socioeconomic effects of license renewal on these three counties which are defined as the socioeconomic ROI.

Refueling and maintenance outages for Browns Ferry are on a 24-month cycle. Refueling outages last approximately 28–45 days and an additional 900 contract workers are onsite during an outage.

3.10.2 Regional Economic Characteristics

Goods and services are needed to operate Browns Ferry, some portion of which are purchased within the socioeconomic ROI. Payments for these goods and services provide jobs and income in the local economy. This section presents information on employment and income in the socioeconomic ROI.

According to the U.S. Census Bureau's (USCB) 2018–2022 American Community Survey 5-Year Estimates, educational services, manufacturing, and retail trade represented the largest employment sectors in the socioeconomic ROI (USCB 2023-TN10186). The civilian labor force in the socioeconomic ROI was 121,766 persons and the number of individuals employed was 117,153 (USCB 2023-TN10186). Estimated income information for the socioeconomic ROI is presented in Table 3-13. As shown, people living in the Limestone County had higher median household and per capita incomes than the Alabama State average while people living Lauderdale and Colbert counties had lower median household and per capita incomes. Additionally, the percentages of individuals living below the poverty level in Colbert County is higher than the State average.

According the USCB 2018–2022 American Community Survey 5-Year Estimates, the unemployment rates in Lauderdale County, Limestone County, and Colbert County were 3.6, 4.1, and 3.4 percent, respectively. Comparatively, the unemployment rate in Alabama during the same time period was 5.2 percent USCB 2023-TN10186).

Table 3-13 Estimated Income Information for the Browns Ferry Nuclear Plant Site Socioeconomic Region of Influence, 2018–2022, 5-Year Estimates

Parameter	Lauderdale County	Limestone County	Colbert County	Alabama State
Median household income (dollars)[(a)]	$56,081	$80,146	$56,149	$59,609
Per capita income (dollars)[(a)]	$32,678	$37,504	$30,724	$33,344
Families living below the poverty level (percent)	9.5%	7.5%	11.9%	11.3%
People living below the poverty level (percent)	13.3%	11.2%	15.9%	15.7%

(a) In 2022 inflation-adjusted U.S. dollars.
Source: USCB 2023-TN10186.

3.10.3 Demographic Characteristics

According to the 2020 Census, an estimated 225,115 people lived within 20 mi (32 km) radius of the Browns Ferry site, which equates to a population density of 179 persons per square mile (persons/mi^2) (TVA 2024-TN11042). This amount translates to a Category 4, "Least sparse" population density using the LR GEIS (NRC 1996-TN288) measure of sparseness, which is defined as "greater than or equal to 120 persons per square mile within 20 mi (32 km)." An estimated 1,074,109 people live within a 50 mi (80 km) radius of the Browns Ferry site, which equates to a population density of 136 persons/mi^2 (TVA 2024-TN11042). This translates to a Category 3 proximity index. Therefore, Browns Ferry is in a "high" population area based on the LR GEIS spareness and proximity matrix (NRC 1996-TN288).

Table 3-14 shows population projections and percent growth from 2000 to 2040 for the socioeconomic ROI. During the last 2 decades, the population has increased in all 3 counties, except for a 1 percent declines in Colbert County from 2000–2010. Based on projections, all 3 counties are expected to continue to experience an increase in population through 2040.

Table 3-14 Population and Percent Growth in Browns Ferry Nuclear Plant's Socioeconomic Region of Influence

Metric	Year	Lauderdale County Population	Lauderdale County Percent Change	Limestone County Population	Limestone County Percent Change	Colbert County Population	Colbert County Percent Change	ROI Population	ROI Percent Change
Recorded	2000	87,966	-	65,676		54,984	-	208,626	-
Recorded	2010	92,709	5.4%	82,782	26.0%	54,428	-1.0%	229,919	10%
Recorded	2020	93,564	0.9%	103,570	25.1%	57,227	5.1%	254,361	11%
Projected	2030	96,368	3.0%	121,768	17.6%	58,380	2.0%	276,516	9%
Projected	2040	99,172	3.0%	139,966	15%	59,532	2.0%	298,670	8%

ROI = region of influence.
"-" denotes no content in the table cell.
Source: TVA 2024-TN11042.

The 2020 Census demographic profile of the Browns Ferry socioeconomic ROI population is presented in Table 3-15. According to the 2020 Census, minorities (race and ethnicity combined) comprised approximately 23 percent of the total population for the socioeconomic ROI. The largest minority population in the socioeconomic ROI were Black or African American population (12.4 percent of the total population and 50 percent of the total minority population). According to both the USCB's 2020 Census and 2010 Census (USCB 2021-TN7779), since 2010, minority populations in the three-county ROI were estimated to have increased by approximately 16,700 persons, and now comprise 23 percent of the population (see Table 3-15 below). The largest changes occurred in the population of people who identify themselves as two or more races or Hispanic/Latino; these populations grew by more than 7,400 and 4,300 persons, respectively, since 2010.

3.10.3.1 Transient Population

Lauderdale, Limestone, and Colbert counties also can experience seasonal transient population growth as a result of local tourism or recreational activities. Parks with campgrounds, wildlife refuges, and waterways draw visitors to the region throughout the year (TVA 2024-TN11042). According to the USCB 2018–2022 American Community Survey 5-Year Estimates (USCB 2023-TN10186), there were 2,586 seasonal housing units in the socioeconomic ROI.

3.10.3.2 Migrant Farm Workers

The Census of Agriculture is conducted every 5 years and provides a comprehensive compilation of agricultural production data for every county in the Nation. The Census of Agriculture also reports the number of farms hiring migrant workers which are defined as a farm worker whose employment required travel that prevented the worker from returning to their permanent place of residence the same day (USDA 2024-TN11532).

The 2022 Census of Agriculture includes information on migrant and temporary farm labor (i.e., working fewer than 150 days). Table 3-16 presents information on migrant and temporary farm labor in Lauderdale, Limestone, and Colbert counties. According to the 2022 Census of

Agriculture, 778 farm workers were hired to work for fewer than 150 days and were employed on 358 farms in the three-county socioeconomic ROI. However, only 3 farms in the socioeconomic ROI reported hiring migrant workers.

Table 3-15 Demographic Profile of the Population in the Browns Ferry Nuclear Plant's Socioeconomic Region of Influence, 2020

Demographic Parameter	Lauderdale County	Limestone County	Colbert County	Region of Influence
Total Population	**93,564**	**103,570**	**57,227**	**254,361**
Percent White race	81.8%	73.1%	75.6%	76.8%
Percent Black or African American race	9.8%	12.7%	16.1%	12.4%
Percent American Indian and Alaska Native race	0.3%	0.4%	0.4%	0.4%
Percent Asian race	0.8%	1.8%	0.8%	1.2%
Percent Native Hawaiian and other Pacific Islander race	0.0%	0.1%	0.0%	0.0%
Percent some other race	0.2%	0.3%	0.2%	0.3%
Percent two or more races	3.8%	4.6%	3.9%	4.1%
Hispanic, Latino, or Spanish Ethnicity of any race (total population)	3,078	7,248	1,732	12,058
Percent Hispanic, Latino, or Spanish Ethnicity of any race of total population	3.3%	7.0%	3.0%	4.7%
Total minority	17,073	27,878	13,986	58,937
Percent of total population	18.2%	26.9%	24.4%	23.2%

Source: USCB 2022-TN11503.

Table 3-16 Migrant Farm Workers and Temporary Farm Labor in the Browns Ferry Nuclear Plant's Socioeconomic Region of Influence, 2022

County	Number of Farms with Hired Farm Labor	Number of Farms Hiring Workers for Less Than 150 days	Number of Farm Workers Working for Less Than 150 days	Number of Farms Reporting Migrant Farm Labor
Total	510	358	778	3
Lauderdale	185	132	257	1
Limestone	223	150	330	1
Colbert	102	76	191	1

Source: National Agricultural Statistics Service: Quick Stats (USDA 2024-TN11532).

3.10.4 Housing and Community Services

This section presents information on housing and community services, including education and water supply.

3.10.4.1 Housing

Table 3-17 lists the total number of occupied and vacant housing units, vacancy rates, and median values in the three-county socioeconomic ROI. Based on the USCB's 2018–2022 American Community Survey 5-Year Estimates, there were 115,030 housing units in the

socioeconomic ROI, of which 100,075 were occupied. The median values of owner occupied housing units in the socioeconomic ROI range from $148,500 in Colbert County to $229,400 in Limestone County. The homeowner vacancy rate was approximately 1.2 percent in Lauderdale County, 0.5 percent in Limestone County, and 0.9 percent in Colbert County (USCB 2023-TN10186).

Table 3-17 Housing in the Browns Ferry Nuclear Plant's Region of Influence, 2018–2022

Housing Characteristic	Lauderdale County	Limestone County	Colbert County	Region of Influence
Total housing units	**44,705**	**42,616**	**27,709**	**115,030**
Occupied housing units	38,237	38,572	23,266	100,075
Total vacant housing units	6,468	4,044	4,443	14,955
Percent total vacant	14%	9%	16%	13%[(a)]
Owner-occupied units	25,815	29,968	16,520	72,303
Median value (dollars)	174,800	229,400	148,500	552,700
Owner vacancy rate (percent)	1.2%	0.5%	0.9%	0.8%[(b)]
Renter-occupied units	12,422	8,604	6,746	27,772
Median rent (dollars/month)	773	861	810	2,444
Rental vacancy rate (percent)	4.7%	8%	4.6%	5.7%[(c)]

(a) Weighted average by total housing units in Lauderdale, Limestone, and Colbert Counties.
(b) Weighted average by owner-occupied units in Lauderdale, Limestone, and Colbert Counties.
(c) Weighted average by renter-occupied units in Lauderdale, Limestone, and Colbert Counties.
Source: USCB 2023-TN10186

3.10.4.2 Education

Lauderdale County has two public school districts, with a total of 12,511 students in 24 schools (NCES 2024-TN11625). Limestone County has two public school districts, with a total of 20,927 students in 25 schools (NCES 2024-TN11626). Colbert County has four public school districts, with a total of 8,175 students in 25 schools (NCES 2024-TN11627).

3.10.4.3 Public Water Supply

The Limestone County Water and Sewer Authority supplies water and provides wastewater services to Limestone County for those not on individual wells. The source of public water is surface and ground water. Lauderdale and Colbert County also supply water from both surface and ground water.

3.10.5 Tax Revenues

TVA makes payments in lieu of taxes (PILOT) of 5 percent of gross power revenues to States in which it operates or owns property. Very small payments are made directly to counties (TVA 2024-TN11042). Payments made by TVA are not solely attributable to Browns Ferry (NRC 2005-TN5192).

These States distribute funds to counties, cities, and local governments based on a formula developed by each State. Alabama allocates 17 percent of its TVA payment to the State and 83 percent to counties served by TVA (ALRev 2025-TN11504). These counties then allocate funds to cities within their boundaries. State and local governments each receive fixed base payments that do not change year-to-year. The remainder is distributed 48.5 percent to both local governments and the State, with the final 3 percent set aside for communities in areas affected by TVA construction as well as for the Commission, the University of Tennessee's County Technical Assistance Service, and the Tennessee Central Economic Authority to assist these agencies in their work supporting local governments (TACIR 2025-TN11505). Table 3-18 presents total annual PILOT payments to Alabama and Tennessee for the years 2018 through 2024.

Table 3-18 Total Payments in Lieu of Taxes Payments by Tennessee Valley Authority, 2018–2024

Parameter	2018	2019	2020	2021	2022	2023	2024
Alabama revenues	$87,492,443	$85,761,959	$87,514,788	$79,291,166	$82,562,087	$97,772,163	$93,033,906
Tennessee revenues	$343,986,487	$363,938,934	$369,443,363	$336,145,561	$341,689,664	$93,033,906	$390,402,385

Source: TVA 2025-TN11355.

3.10.6 Local Transportation

Transportation in the region surrounding Browns Ferry includes a rural and urbanized road network, plus rail, water, and air travel. U.S. Highway 72 runs east-west through Huntsville, Athens, and Florence, Alabama, and provides plant access from the north. U.S. Highway 31 and Interstate 65 run north-south through Athens and Decatur, Alabama, and provide plant access from the east. County Road 20 and Browns Ferry Road are primary commuter routes to the plant (TVA 2024-TN11042). County Road 20 intersects U.S. Highway 72 to the north as Shaw Road and U.S. Highway 31 to the east as Nuclear Plant Road. Browns Ferry Road runs northeast-southeast from Athens and intersects Nuclear Plant Road near the plant. These access roads in the immediate vicinity of the plant are paved, two-lane roads.

Table 3-19 shows the average annual daily traffic volumes for the main plant access routes. The plant is the primary traffic generator in the vicinity of the site.

Table 3-19 Total Average Annual Daily Traffic Counts Near Key Access Points of Browns Ferry Nuclear Plant

Roadway and (Station Identification)	Annual Average Daily Traffic Volume Estimates for 2019	Annual Average Daily Traffic Volume Estimates for 2020	Annual Average Daily Traffic Volume Estimates for 2021	Annual Average Daily Traffic Volume Estimates for 2022	Annual Average Daily Traffic Volume Estimates for 2023
Shaw Road (Limestone 916)	2,020	2,020	2,455	2,481	2,497
Browns Ferry Rd (Limestone 917)	1,150	1,150	1,185	1,112	1,112
Nuclear Plant Rd (Limestone 119	1,757	1,757	2,302	2,301	2,316
U.S. Highway 72 (Limestone 812)	15,727	14,523	15,746	15,367	16,206
U.S. Highway 31 (Limestone 502)	15,928	15,611	18,871	18,938	19,041
Interstate 65 (Limestone 815)	No data	23,436	30,476	30,862	32,466

Source: ALDOT 2023-TN11533.

3.10.7 Proposed Action

As described in the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-1 of this SEIS, for generic issues related to socioeconomics, the impacts of license renewal on socioeconomic issues would be SMALL. No new or significant information was identified for these issues. Socioeconomic effects of ongoing reactor operations at Browns Ferry have become well established as regional socioeconomic conditions have adjusted to the presence of the nuclear power plant. Changes in employment and tax revenue could affect the availability of community services and housing, as well as traffic on roads near the nuclear power plant.

TVA indicated in its ER that there are no license renewal-related refurbishment activities, and that it has no plans to add additional permanent employees to support plant operations during the proposed renewal term (TVA 2024-TN11042). There are also no plans to add additional permanent operation staff to support surveillance, monitoring, inspections, testing, trending, and recordkeeping activities during the proposed renewal term (TVA 2024-TN11042). Consequently, people living near Browns Ferry would not experience any changes in socioeconomic conditions during the license renewal term beyond what is currently being experienced. Therefore, the impact of continued reactor operations during the license renewal term would not exceed the socioeconomic impacts predicted in the LR GEIS (NRC 2024-TN10161).

3.11 Human Health

Browns Ferry is both an industrial facility and a nuclear power plant. Similar to any industrial facility or nuclear power plant, the operation of Browns Ferry during the SLR period will produce various human health risks for workers and members of the public. This section describes the human health risks resulting from the operation of Browns Ferry, including from radiological exposure, chemical hazards, microbiological hazards, electromagnetic fields, and other hazards.

The description of these risks is followed by the NRC staff's analysis of the potential impacts on human health from the proposed action (SLR) and alternatives to the proposed action.

3.11.1 Radiological Exposure and Risk

Operation of a nuclear power plant involves the use of nuclear fuel to generate electricity. Through the fission process, the nuclear reactor splits uranium atoms, resulting very generally in (1) the production of heat, which is then used to produce steam to drive the nuclear power plant's turbines and generate electricity; and (2) the creation of radioactive byproducts. As required by NRC regulations at 10 CFR 20.1101 (TN283), "Radiation Protection Programs," TVA designed a radiation protection program to protect onsite personnel (including employees and contractor employees), visitors, and offsite members of the public from radiation and radioactive material at Browns Ferry. The Browns Ferry radiation protection program is extensive and includes, but is not limited to, the following:

- organization and administration (e.g., a radiation protection manager who is responsible for the program and ensures trained and qualified workers for the program)
- implementing procedures
- an as low as reasonably achievable (ALARA) program to minimize radiation dose to workers and members of the public
- dosimetry program (i.e., measure radiation dose to nuclear power plant workers)
- radiological controls (e.g., protective clothing, shielding, filters, respiratory equipment, and individual work permits with specific radiological requirements)
- radiation area entry and exit controls (e.g., locked or barricaded doors, interlocks, local and remote alarms, personnel contamination monitoring stations)
- posting of radiation hazards (i.e., signs and notices alerting nuclear power plant personnel of potential hazards)
- recordkeeping and reporting (e.g., documentation of worker dose and radiation survey data)
- radiation safety training (e.g., classroom training and use of mockups to simulate complex work assignments)
- radioactive effluent monitoring management (i.e., controlling and monitoring radioactive liquid and gaseous effluents released into the environment)
- radioactive environmental monitoring (e.g., sampling and analysis of environmental media, such air, water, groundwater, milk, food products, and sediment to measure the levels of radiation emitted into the environment that may impact human health)
- radiological waste management (i.e., controlling, monitoring, processing, and disposing of radioactive solid waste)

For radiation exposure to Browns Ferry personnel, the NRC staff reviewed the data contained in NUREG-0713, Volume 44, *Occupational Radiation Exposure at Commercial Nuclear Power Reactors and other Facilities 2022: Fifty-Fifth Annual Report* (NRC 2024-TN11165). The Fifty-Fifth Annual Report was the most recent annual report available at the time of this environmental review. It summarizes the occupational exposure data in the NRC's Radiation Exposure Information and Reporting System database through 2022. Nuclear power plants are

required by 10 CFR 20.2206 (TN283), “Reports of Individual Monitoring,” to report their occupational exposure data to the NRC annually.

NUREG-0713 contains a calculation of a 3-year average collective dose per reactor for workers at all nuclear power reactors licensed by the NRC. The 3-year average collective dose is one of the metrics that the NRC uses in the Reactor Oversight Process to evaluate the applicant’s ALARA program. Collective dose is the sum of the individual doses received by workers at a facility licensed to use radioactive material during a 1-year time period. There are no NRC or EPA standards for collective dose. Based on the data for operating boiling water reactors like the unit at Browns Ferry, the average annual collective dose per reactor year (3-year average from 2020 through 2022) was 100-person Roentgen Equivalent Man (rem) (1.0 person-Sievert [person-Sv]) (NRC 2024-TN11165). In comparison, Browns Ferry had a reported annual collective dose per reactor year of 99 person-rem (0.99 person-Sv).

This represents a decrease as compared to the 3-year average (period from 2018 through 2020) collective total effective dose equivalent for Browns Ferry reported, which was 132 person-rem (1.32 person-Sv). The national average for the 31 BWRs was approximately 106 person-rem (1.06 person-Sv) (NRC 2022-TN8530). For the 2018–2020 period, the largest contributor to Browns Ferry’s above average value was due to the extended power uprate outages with capital project upgrades. When there are extended or multiple outages in a single year, this results in higher total doses.

Section 3.13.1 of this SEIS discusses offsite dose to members of the public.

3.11.2 Chemical Hazards

State and Federal environmental agencies regulate the use, storage, and discharge of chemicals, biocides, and sanitary wastes. Such environmental agencies also regulate how facilities like Browns Ferry manage minor chemical spills. Chemical and hazardous wastes can potentially affect workers, members of the public, and the environment.

At Browns Ferry, chemical effects could result from discharge of waste, heavy metal leaching, the use and disposal of chemicals, and chemical spills. Workers may encounter chemicals when adjusting coolant systems, applying biocides, during maintenance activities on equipment containing hazardous chemicals, and when solvents are used for cleaning (TVA 2025-TN11355).

TVA currently controls the use, storage, and discharge of chemicals, biocides, and sanitary wastes at Browns Ferry in accordance with its chemical control procedures, waste management procedures, and Browns Ferry site-specific chemical accident spill prevention provisions (TVA 2025-TN11355). TVA monitors and controls discharges of chemicals, biocides, and sanitary wastes through Browns Ferry’s NPDES permit process, discussed in Section 3.5.1.3. These nuclear power plant procedures, plans, and processes are designed to prevent and minimize the potential for a chemical or hazardous waste release and, in the event of such a release, minimize the impact on workers, members of the public, and the environment.

TVA confirmed during the environmental audit that no reportable inadvertent releases or spills of nonradioactive contaminants occurred from since the ER was written (TVA 2025-TN11354).

3.11.3 Microbiological Hazards

Microbiological hazards occur when workers or members of the public come into contact with disease-causing microorganisms, also known as etiological agents. Thermal effluents associated with nuclear power plants that discharge to a river, such as Browns Ferry, have the potential to promote the growth of certain thermophilic microorganisms linked to adverse human health effects. Microorganisms of particular concern include several types of bacteria and the free-living amoeba *Naegleria fowleri* (*N. fowleri*). There are optimum growth temperatures for the microorganisms of concern as further discussed in the LR GEIS (NRC 2024-TN10161).

The public can be exposed to the thermophilic microorganisms during swimming, boating, or other recreational uses of freshwater. If these organisms are naturally occurring and a nuclear power plant's thermal effluent enhances their growth, the public could experience an elevated risk of infection when recreating in the affected waters. Public exposure to *Legionella* sp. (a thermophilic bacteria) from nuclear power plant operation is generally not a concern because exposure risk is confined to cooling towers and related components and equipment, which are typically within the protected area of the site and, therefore, not accessible to the public.

Nuclear power plant workers can be exposed to *Legionella* sp. when performing cooling system maintenance through inhalation of cooling tower vapors because these vapors are often within the optimum temperature range for *Legionella* sp. growth. Nuclear power plant personnel at Browns Ferry most likely to come in contact with aerosolized *Legionella* sp. are workers who clean and maintain the condenser tubes. Nuclear power plant workers can also be exposed to *N. fowleri* during cooling water discharges. Browns Ferry complies with all applicable Federal, State, and local environmental laws, regulations and permits to minimize the potential for microbiological hazards to impact plant workers. Browns Ferry practices good industrial hygiene practices in accordance with all requirements (TVA 2025-TN11355).

As discussed in Section 2.2.3 of the TVA ER (TVA 2025-TN11355), Browns Ferry units normally operate utilizing a once-though (open cycle) condenser circulating water system. The discharge from the condenser may either: (1) pass to the discharge tunnel to then go to cooling towers via the warm water channel; (2) pass to the discharge tunnel to the discharge diffusers in Wheeler Reservoir; or (3) a combination of these discharge paths. A plant computer chooses the optimal operating mode based on river flow, river temperature, and status of critical plant equipment to ensure cooling water discharges are within the limits of the NPDES permit.

3.11.4 Electromagnetic Fields

Electromagnetic field (EMF) are generated by any electrical equipment. All nuclear power plants have electrical equipment and power transmission systems associated with them. Power transmission systems consist of switching stations (or substations) located on the nuclear power plant site and the transmission lines needed to connect the plant to the regional electrical distribution grid. Transmission lines operate at a frequency of 60 hertz (Hz) (60 cycles per second), which is low compared with the frequencies of 55 to 890 Megahertz (MHz) for television transmitters and 1,000 MHz and greater for microwaves.

The scope of the evaluation of transmission lines includes only those transmission lines that connect the plant to the switchyard where electricity is fed into the regional power distribution system (encompassing those lines that connect the plant to the first substation of the regional electric power grid) and power lines that feed the plant from the grid are considered within the regulatory scope of the license renewal environmental review. Transmission lines in scope are

confined to the Browns Ferry site, spanning the short distance between the generating units and the switchyards, as depicted in Figure 2.2-2 of TVA's ER (TVA 2025-TN11355).

Electric fields are produced by voltage and their strength increases with increases in voltage. A magnetic field is produced from the flow of current through wires or electrical devices, and its strength increases as the current increases. Electric and magnetic fields, collectively referred to as EMFs, are produced by operating transmission lines.

Occupational workers or members of the public near transmission lines may be exposed to the EMFs produced by the transmission lines. The EMF strength varies in time as the current and voltage change, so that the frequency of the EMF is the same (e.g., 60 Hz for standard alternating current, or AC). Electrical fields can be shielded by objects such as trees, buildings, and vehicles. Magnetic fields, however, penetrate most materials, but their strength decreases with increasing distance from the source.

The EMFs resulting from 60 Hz power transmission lines fall under the category of nonionizing radiation. The LR GEIS (NRC 2024-TN10161) summarizes NRC accepted studies on the health effects of electromagnetic fields. There are no Federal standards limiting residential or occupational exposure to EMFs from transmission power lines in the United States, but some States have set electric field and magnetic field standards for transmission lines (NIEHS 2002-TN6560). A voluntary occupational standard has been set for EMFs by the International Commission on Non-Ionizing Radiation Protection (ICNIRP 1998-TN6591). The National Institute of Occupational Safety and Health does not consider EMFs to be a proven health hazard (NIOSH 1996-TN6766).

3.11.5 Other Hazards

This section addresses two additional human health hazards: (1) physical occupational hazards and (2) occupational electric shock hazards.

Nuclear power plants are industrial facilities that have many of the typical occupational hazards found at any other electric power generation utility. Nuclear power plant workers may perform electrical work, electric powerline maintenance, repair work and maintenance activities, and may be exposed to potentially hazardous physical conditions. A physical hazard is an action, agent or condition that can cause harm upon contact. Physical actions could include slips, trips, and falls from height. Physical agents could include noise, vibration, and ionizing radiation. Physical conditions could include high heat, cold, pressure, confined space, or psychosocial issues, such as work-related stress.

The Occupational Safety and Health Administration (OSHA) is responsible for developing and enforcing workplace safety regulations. Congress created OSHA by enacting the Occupational Safety and Health Act of 1970, as amended (TN4453) to safeguard the health of workers. With respect to nuclear power plants, nuclear power plant conditions that result in an occupational risk, but do not affect the safety of licensed radioactive materials, are under the statutory authority of OSHA rather than the NRC as set forth in a Memorandum of Understanding (NRC 2013-TN10165) between the NRC and OSHA. Occupational hazards are reduced when workers adhere to safety standards and use appropriate protective equipment; however, fatalities and injuries caused by accidents may still occur. TVA maintains a comprehensive industrial safety program for its workers in accordance with OSHA regulations (TVA 2025-TN11355).

Based on its evaluation in the LR GEIS (NRC 2024-TN10161), the NRC has not found electric shock resulting from direct access to energized conductors or from induced charges in metallic structures to be a problem at most operating nuclear power plants. Generally, the NRC staff also does not expect electric shock from such sources to be a human health hazard during the SLR period. However, a site-specific review is required to determine the significance of the electric shock potential along the portions of the transmission lines that are within the scope of this EIS. Transmission lines that are within the scope of the NRC's SLR environmental review are limited to: (1) those transmission lines that connect the nuclear power plant to the substation where electricity is fed into the regional distribution system, and (2) those transmission lines that supply power to the nuclear power plant from the grid (NRC 2024-TN10161).

As discussed in Section 2.1.6.5 of this SEIS, the only transmission lines that are in regulatory scope for Browns Ferry SLR are onsite. These in-scope lines are in compliance with National Electrical Safety Code clearances. TVA contracted with the Electric Power Research Institute to perform a survey to measure the EMF present under the in-scope conductors to demonstrate compliance with the National Electric Safety Code vertical line clearance for voltages exceeding 22 kV (TVA 2025-TN11355). Compliance with the safety code demonstrates there is no potential shock hazard to off-site members of the public from these on-site transmission lines.

3.11.6 Proposed Action

As described in the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-1 of this SEIS, for generic issues related to human health, the impacts of a nuclear power plant LR and continued operations would be SMALL. The NRC staff's review did not identify any new and significant information that would change the conclusion in the LR GEIS. Thus, as concluded in the LR GEIS, for these Category 1 (generic) issues, the impacts of continued operation of Browns Ferry on human health would be SMALL.

Table 3-2 identifies one uncategorized issue (EMFs) and two plant-specific (Category 2) issues (i.e., microbiological hazards to the public, and electric shock hazards) related to human health applicable to Browns Ferry SLR. These issues are analyzed below.

3.11.6.1 Microbiological Hazards to the Public

In the LR GEIS (NRC 2024-TN10161), the NRC staff determined that effects of thermophilic microorganisms on the public for nuclear power plants using cooling ponds, lakes, or canals or cooling towers that discharge to a river is a Category 2 issue that requires site-specific evaluation during each license renewal review.

The thermophilic microorganism *N. fowleri* can pose public health concerns in recreational use waters when these organisms are present in high enough concentrations to cause infection. As discussed in Section 3.9.2 of the TVA ER, the site's NPDES permit limits the daily maximum temperature to temperatures well below the optimal growth temperature for *N. fowleri*. For the period from 2015 to 2020, average water temperatures from the cooling water discharge during the warmest months of the year did not exceed 90°F (32.2°C). Maximum temperatures recorded did not exceed 91°F (32.8°C). The daily maximum temperature at the discharge canal would remain within the NPDES discharge limits and well below the optimal growth rate temperature for thermophilic organisms (TVA 2025-TN11355).

TVA consulted with the ADEM by letter dated March 28, 2024, regarding thermophilic organisms. ADEM responded by letter dated May 9, 2024, indicating the State is neither aware

of nor has experience with the presence of thermophilic organisms in receiving waters in the vicinity of the Browns Ferry Nuclear Plant. These correspondences are in Attachment 9 to the revised ER (TVA 2025-TN11355: Attachment 9).

During the proposed SLR term, the public health risk from *N. fowleri* remains extremely low and the proposed action would not result in operational changes that would affect thermal effluent temperature or otherwise create favorable conditions. The NRC staff concludes that the impacts of thermophilic microorganisms on the public due to continued nuclear power plant operations at Browns Ferry during the SLR term would be SMALL because thermal effluent discharges from Browns Ferry during the proposed SLR term would not contribute to the proliferation of microorganisms of concern in the Wheeler Reservoir.

3.11.6.2 Effects of Electromagnetic Fields

The LR GEIS (NRC 2024-TN10161) does not designate the chronic effects of 60 Hz EMFs from powerlines as either a Category 1 or 2 issue. Until a scientific consensus is reached on the health implications of electromagnetic fields, the NRC will not include them as Category 1 or 2 issues.

The potential for chronic effects from these EMFs continues to be studied and is not known at this time. The NIEHS report (TN78) contains the following conclusion:

> The NIEHS concludes that ELF-EMF (extremely low frequency electromagnetic field) exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF, passive regulatory action is warranted such as continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS does not believe that other cancers or noncancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

This statement was not sufficient to cause the NRC to change its position with respect to the chronic effects of EMFs. The NRC staff considers the LR GEIS finding of, “Uncategorized (Uncertain impact)” still appropriate and will continue to follow developments on this issue.

3.11.6.3 Electric Shock Hazards

Based on the LR GEIS (NRC 2024-TN10161), the Commission found that electric shock resulting from direct access to energized conductors or from induced charges in metallic structures has not been identified as a problem at most operating nuclear power plants and generally is not expected to be a problem during the license renewal term. However, a plant-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 Browns Ferry SLR review.

As discussed in Section 3.11.5, there are no offsite transmission lines that are in regulatory scope for Browns Ferry SLR. Therefore, there are no potential impacts on members of the public resulting from such transmission lines. There are two transmission corridors onsite containing 115 kV and 345 kV overhead transmission lines with the potential for electric shock to workers through induced currents. To address this occupational hazard, TVA adheres to the National Electrical Safety Code for clearances and OSHA compliance requirements for shock

hazard avoidance (TVA 2025-TN11355). As discussed in Section 3.11.5, Browns Ferry maintains an occupational safety program in accordance with OSHA regulations for its workers, which includes protection from acute electric shock. Therefore, the NRC staff concludes that the potential impacts from acute electric shock during the SLR term would be SMALL.

3.11.6.4 Postulated Accidents

The 2024 LR GEIS evaluates the following two classes of postulated accidents as they relate to license renewal:

- Design-Basis Accidents: Postulated accidents that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components necessary to ensure public health and safety.
- Severe Accidents: Postulated accidents that are more severe than design-basis accidents because they could result in substantial damage to the reactor core.

As shown in Table 3-1 of this SEIS, the LR GEIS (NRC 2024-TN10161) addresses design-basis accidents and severe accidents as Category 1 issues and concludes that the environmental impacts of design-basis accidents and severe accidents are of SMALL significance for all nuclear power plants.

The NRC staff did not identify any new and significant information related to design-basis accidents during its independent review of TVA's ER, through the scoping process, during the NRC staff's audit of the Browns Ferry ER (TVA 2024-TN11042) or in its evaluation of other available information (generic and plant-specific). Therefore, the NRC staff concludes there is no new and significant information on the environmental impacts of design-basis accidents at Browns Ferry during the SLR period that are not already discussed in the SEIS for initial license renewal (NRC 2005-TN5192) or generically evaluated for all nuclear power plants in the 2024 LR GEIS. Therefore, the NRC staff concludes that the potential impacts from design-basis accidents during the SLR term would be SMALL.

Additionally, as shown in Table 3-1 of this SEIS, the LR GEIS (NRC 2024-TN10161) also addressed severe accidents as a Category 1 issue and concluded that the environmental impacts from severe accidents are SMALL for all nuclear power plants. Browns Ferry was specifically included in the plants evaluated in the LR GEIS. Browns Ferry values (i.e., population dose risk, core damage frequency values) were presented in 2024 LR GEIS Tables E.3-1, E.3-10, E.3-11, and E.3-16. As provided in Table E.3-1 of the 2024 LR GEIS, the 4 person-rem/reactor year (0.04 person-Sv/reactor year) calculated in the 2005 Browns Ferry SAMA analysis is three orders of magnitude lower than the 1996 LR GEIS estimate of the Browns Ferry population dose risk value of 1,446 person-rem/reactor year (14.46 person-Sv/reactor year).

The NRC staff did not identify any new and significant information regarding severe accidents during its independent review of TVA's ER (TVA 2024-TN11042), through the scoping process, or during the NRC staff's audit (NRC 2024-TN11380) that would significantly increase the environmental impact associated with severe accidents above the values previously projected in the 1996 LR GEIS (NRC 1996-TN288). Therefore, the aggregate effect of new Browns Ferry SLR information is consistent with the expectations of the 2013 and 2024 LR GEISs (NRC 2024-TN10161, NRC 2013-TN2654) that the probability-weighted consequences of severe accidents for Browns Ferry are bounded by the 1996 LR GEIS estimates (NRC 1996-TN288). This reflects a substantial decrease in risk associated with a better understanding of new

information and the Browns Ferry Probabilistic Risk Assessments. Thus, the NRC staff conclusion is that the overall impact of new and significant information since initial LR on the environmental impacts of severe accidents at Browns Ferry continues to be well below the impact previously evaluated in the 1996 GEIS (NRC 1996-TN288). Therefore, the conclusion in the 1996, 2013, and 2024 LR GEISs that, "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" continues for Browns Ferry during the SLR period.

As part of its initial LRA submitted in 2003, the applicant included a SAMA analysis for Browns Ferry in its SLR ER (TVA 2024-TN11042). As part of its review of the initial Browns Ferry LRA, the NRC staff reviewed the analysis of SAMAs and documented its evaluation results in Supplement 21 to NUREG-1437 (NRC 2005-TN5192).

Because the NRC staff has previously considered SAMAs for Browns Ferry, TVA is not required to perform another SAMA analysis for its subsequent LRA (10 CFR 51.53(c)(3)(ii)(L) (TN10253). In its SLR application ER, TVA evaluated areas of new and potentially significant information that could affect the environmental impact of postulated severe accidents during the SLR period (TVA 2024-TN11042). TVA stated in its ER that it used the methodology in NEI 17-04, Revision 1, "Model SLR New and Significant Assessment Approach for SAMA," (NEI 2019-TN6815) to evaluate new and significant information as it relates to the Browns Ferry SLR SAMAs. NEI 17-04 is endorsed in Regulatory Guide 4.2, Supplement 1, Revision 2 (NRC 2024-TN10280).

Table 4.10-10 of the Browns Ferry SLR ER presented the quantitative screening results from the bounding SAMA evaluations. This table demonstrates that none of the quantitative screening evaluations resulted in a reduction in the aggregate Level 1 core damage frequency or Level 2 frequency greater than 50 percent.

The NRC staff reviewed Browns Ferry's onsite information process during a virtual audit (NRC 2024-TN10551) and did not find any new and significant SAMAs. Based on the NRC staff's review and evaluation of TVA's analysis of new and potentially significant information regarding SAMAs and the NRC staff's independent analyses, the staff finds that there is no new and significant information for Browns Ferry related to SAMAs.

3.12 Reserved

10 CFR Part 51 (TN10253), Subpart A, Appendix B, Table B-1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants," requires an environmental impact statement for license renewal to include an analysis for the Category 2 issue of "Environmental Justice—Impacts on minority populations, low-income populations, and Indian Tribes." Executive Order 14173 (90 FR 8633-TN11607), "Ending Illegal Discrimination and Restoring Merit-Based Opportunity," issued January 21, 2025, revoked Executive Order 12898 (59 FR 7629-TN1450), "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," issued February 11, 1994, among other things. Staff Requirements Memorandum (SRM)-COMSECY-25-0007, "Withdrawing the Environmental Justice Policy Statement and Environmental Justice Strategy," issued April 10, 2025 (NRC 2025-TN11721), approved publication of a notice in the *Federal Register* (90 FR 17887-TN11684), which explained that, in response to the policies in Executive Order 12898, the NRC had made voluntary commitments on environmental justice in its Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions (Environmental Justice Policy Statement) and Environmental Justice Strategy (69 FR 52040-TN1009). Accordingly, with

the revocation of Executive Order 12898, the NRC also withdrew its Environmental Justice Policy Statement and its Environmental Justice Strategy. Based on Executive Order 14173 and SRM-COMSECY-25-0007, and pursuant to 10 CFR 51.6 (TN10253), "Specific exemptions," the NRC staff has, upon its own initiative, determined that an exemption from the requirement to address environmental justice in this SEIS is authorized by law and otherwise in the public interest. Accordingly, this SEIS does not address that issue.

3.13 Waste Management

Like any operating nuclear power plant, Browns Ferry would produce both radioactive and nonradioactive waste during the SLR period. This section of the SEIS describes waste management and pollution prevention at Browns Ferry. The description of these waste management activities is followed by the NRC staff's analysis of the potential impacts of waste management activities from the proposed action (SLR).

3.13.1 Radioactive Waste

The NRC licenses nuclear power plants with the expectation that they will release a limited amount of radioactive material to both the air and water during normal operations. The NRC regulations require that gaseous and liquid radioactive releases from nuclear power plants meet radiation dose-based limits specified in 10 CFR Part 20 (TN283), "Standards for Protection Against Radiation," and the ALARA criteria in 10 CFR Part 50 (TN249), Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents." In other words, the NRC places regulatory limits on the radiation dose that members of the public can receive from radioactive effluents of a nuclear power plant. For this reason, all nuclear power plants use radioactive waste management systems to control and monitor radioactive wastes.

Browns Ferry uses liquid, gaseous, and solid waste processing systems to collect and treat, as needed, radioactive materials produced as a byproduct of nuclear power plant operations. Radioactive materials in liquid, gaseous, and solid effluents are reduced before being released into the environment so that the resultant dose to members of the public from these effluents is well within the NRC and EPA dose standards. Radionuclides that can be efficiently removed from the liquid and gaseous effluents before release are converted to a solid waste form for disposal in a licensed disposal facility.

TVA maintains a REMP to assess the radiological impact, if any, to the public and the environment from radioactive effluents released during operations at Browns Ferry (TVA 2025-TN11355). TVA has an Off-site Dose Calculation Manual that contains the methods and parameters for calculating offsite doses resulting from liquid and gaseous radioactive effluents. These methods ensure that radioactive material discharges from Browns Ferry meet NRC and EPA regulatory dose standards. The Off-site Dose Calculation Manual also contains the requirements for the REMP (TVA 2024-TN11368).

3.13.1.1 Radioactive Liquid Waste Management

As presented in Section 2.2.4.1 of the ER revision (TVA 2025-TN11355), the liquid radioactive waste system is fully described in the Updated FSAR Section 9.2 (TVA 2023-TN11360) and is incorporated by reference. This system collects, treats, stores, and disposes of all potentially radioactive liquid wastes. These wastes are collected in sumps and drain tanks at various

locations throughout the three Browns Ferry units and then transferred to the appropriate collection tanks in the Radioactive Waste Building for treatment, storage, discharge, or disposal. The liquid radioactive waste system includes the following:

- piping and equipment drains carrying potentially radioactive wastes
- floor drain system in controlled access areas and/or those areas which may contain potentially radioactive wastes
- tanks, piping, pumps, process equipment, instrumentation, and auxiliaries necessary to collect, process, store, and dispose of potentially radioactive wastes

During normal operation, the liquid effluent treatment systems process and control the release of liquid radioactive effluents to the environment such that the doses to individuals offsite are maintained within the limits of 10 CFR Part 20 and as low as reasonably achievable (ALARA) dose standards in Appendix I to 10 CFR Part 50. This waste management system is designed to process the waste and then recycle it within the plant as condensate, reprocess it through the radioactive waste system for further purification, or discharge it to the environment as liquid radioactive waste effluent in accordance with State and Federal regulations, such as the annual radiological liquid release limits of Appendix B to 10 CFR Part 20 (TN283).

3.13.1.2 Radioactive Gaseous Waste Management

As presented in Section 2.2.4.2 of the revised ER (TVA 2025-TN11355), the gaseous radioactive waste system is fully described in the Updated FSAR Section 9.5 (TVA 2023-TN11360) and is incorporated by reference. This radioactive waste system collects and processes gaseous radioactive wastes from the main condenser air ejectors, the startup vacuum pumps, condensate drain tank vent, and the steam packing exhauster, and controls their release to the atmosphere through the plant stack. Each Browns Ferry unit has its own gaseous radioactive waste system and the processed gases from each unit is routed to the plant stack for dilution and elevated release to the atmosphere. The stack as well as each unit's air ejector off-gas line are continuously monitored by radiation monitors to ensure compliance with annual radiological gaseous effluent release limits of Appendix B to 10 CFR Part 20 (TN283).

3.13.1.3 Radioactive Solid Waste Management

As discussed in Section 2.2.4.3 of the revised ER (TVA 2025-TN11355), the solid radioactive waste system collects, processes, and packages for onsite storage and eventual shipment in approved containers to licensed disposal site(s) and is incorporated by reference from the applicant's revised ER. Solid radioactive wastes can include dry solid wastes and wet solid wastes.

As discussed by TVA in the afore mentioned Section 2.2.4.3, dry solid wastes could include contaminated rags, paper, clothing, spent filter elements, laboratory apparatus, small parts and equipment, and tools. All such dry solid wastes are appropriately collected in suitable containers located throughout the plant and moved to an approved onsite radiological waste storage building. After a period of storage, the containers are removed from the storage area, prepared for transportation, and shipped to a low level radioactive waste (LLRW) disposal site. If required for certain radioactive dry solid wastes to ensure compliance with Department of Transportation and 10 CFR Part 72 (TN4884) regulations, shielded containers are provided for offsite shipment of high-activity waste.

TVA notes that wet solid wastes consist of spent powdered ion exchange resins, filter aid sludge, and bead-type ion exchange resins. Due to the form of the wet solid wastes, each form has its own processing, packaging, and storage procedures. Such as:

- Spent powdered ion exchange resin and filter aid sludge are accumulated and stored in phase separator tanks. Successive batches of slurried materials are accumulated, and supernatant liquid decanted, until the desired settled slurry volume has been reached.
- High-activity-level sludge from the reactor water cleanup filter-demineralizers is stored in three cleanup phase-separator tanks.
- Bead-type ion exchange resins from the waste demineralizer are stored in the spent resin tank. The spent resin remains in that tank until operations personnel determine it needs to be transferred. From that tank the spent resin is transferred to the phase separator tanks where it is mixed with other sludges. After mixing it is sent to the packaging area.

The Browns Ferry packaging system for solid radioactive wastes may use several different containers. The packaging system includes disposable tanks, shielding, and dewatering systems to package the solid radioactive wastes for onsite storage or for offsite shipments to a licensed radioactive waste processor or LLRW disposal site.

3.13.1.4 Radioactive Waste Storage

At Browns Ferry, LLRW is stored temporarily onsite at a low-level waste storage facility before being shipped offsite for processing or disposal at licensed LLRW treatment and disposal facilities. Browns Ferry has contracts in place to ship LLRW offsite for disposal at two licensed facilities (*Energy*Solutions Barnwell Operations, located in Barnwell, South Carolina and Waste Control Specialists, LLC, located near Andrews, Texas) and anticipates continued access to licensed LLRW processing and disposal facilities during the subsequent period of extended operation. LLRW is classified as Class A, Class B, or Class C (minor volumes are classified as greater than Class C). Class A includes both dry active waste and processed waste (e.g., dewatered resins). Classes B and C normally include a low percentage of the LLRW generated. Radioactive waste that is greater than Class C waste is the responsibility of the Federal government. Low-level mixed waste is managed through TVA's site procedures that meet the requirements of the State of Alabama Hazardous Waste Management Regulations. TVA uses a contractor to characterize, label, and manifest the waste, and transport it to a facility that can encapsulate, treat, or otherwise prepare the waste for disposal. As indicated in TVA's revised ER (TVA 2025-TN11355) and as discussed with the NRC staff during the virtual audit (TVA 2024-TN11042), Browns Ferry has sufficient existing capability to store all generated LLRW onsite. No additional construction of onsite storage facilities is necessary for LLRW storage during the subsequent period of extended operation.

Browns Ferry stores spent fuel in a spent fuel pool and in two onsite ISFSI storage pads. The two ISFSI pads safely stores spent fuel onsite for fuel with up to a maximum burnup rate of 62,000 megawatt-days per metric ton uranium (TVA 2025-TN11355) in licensed and approved dry cask storage containers. Spent fuel is stored in the ISFSI complies with the General License issued under 10 CFR Part 72, Subpart K (General License for Storage of Spent Fuel at Power Reactor Sites) and the conditions contained in the Certificate of Compliance for the cask system (TVA 2025-TN11355). Section 2.2.4.4 of the revised ER (TVA 2025-TN11355) states that the Browns Ferry site has adequate space onsite to accommodate the construction of two additional ISFSI pads if necessary. Section 4.12.2 of the revised ER (TVA 2025-TN11355) also notes under the existing licenses and assuming decommissioning at the end of the current license

periods, an additional 154 dry fuel storage casks will be needed to support operations and decommissioning, including emptying the Spent Fuel Pools. Under the subsequent period of extended operation and assuming decommissioning at the end of the SLR periods, an additional 266 dry fuel storage casks will be needed to support operations and decommissioning, including emptying the SFPs in the late 2050s. If a federally approved interim or long-term storage or disposal site that the spent fuel can be transported to is not available, a fourth ISFSI pad will be necessary for decommissioning. Thus, the Browns Ferry ISFSIs would have enough capacity to store the spent fuel generation for 80 years of operation.

3.13.1.5 Radiological Environmental Monitoring Program

TVA maintains a REMP to assess the radiological impact, if any, to the public and the environment from Browns Ferry operations. The REMP measures the aquatic, terrestrial, and atmospheric environment for ambient radiation and radioactivity. Monitoring is conducted for the following: direct radiation, air, precipitation, well water, river water, surface water, milk, food products and vegetation (such as edible broad leaf vegetation), fish, silt, and shoreline sediment. The REMP also measures background radiation (i.e., cosmic sources, global fallout, and naturally occurring radioactive material, including radon). As part of the REMP, TVA conducts analyses of selected wells for the presence of gamma emitters and tritium in groundwater on a quarterly basis (TVA 2025-TN11355).

The NRC staff reviewed 5 years of annual radiological environmental monitoring data from 2019 through 2023 in the ARERRs, available to the public from the NRC (TVA 2020-TN11371, TVA 2021-TN11372, TVA 2022-TN11369, TVA 2023-TN11370, TVA 2024-TN11368). This period provides a data set that covers a broad range of activities that occur at a nuclear power plant, such as refueling outages, routine operation, and maintenance that can affect the generation and release of radioactive effluents into the environment. Besides the reporting of normal operational releases (batch or continuous releases) in the five ARERRs, there could also be reporting of abnormal releases. The NRC reviewed the ARERR data for indications of adverse trends (i.e., increasing radioactivity levels) over the reporting years of 2019 through 2023. From this data, the NRC staff notes that each of the reviewed ARERR years note that there were liquid and gaseous abnormal releases. The abnormal liquid and gaseous releases were reported as being from several identified sources, such as multiple steam leaks in the Steam Jet Air Ejector Rooms, off-gas recombiner rooms, and from main steam leak-by to the Auxiliary Boiler System. In February 2023, TVA discovered cross-contamination of the demineralized water system with reactor water due to backflow through a temporary connection, resulting in an unmonitored release of up to 13,000 gallons to the Tennessee River (NRC 2024-TN11604). A similar event occurred in 2005, and corrective actions from that time were not fully implemented. Although the licensee did not meet regulatory expectations for minimizing site contamination, no regulatory limits were exceeded, and the event was classified as a very low safety significance (green) finding. However, the total radiological dose to a member of the public from normal and abnormal releases for each year have been a small fraction of the 10 CFR Part 20, Appendix B and 10 CFR Part 50, Appendix I limits, typically less than 1 percent of the regulatory limits. Thus, there were no limits exceeded as specified in 10 CFR Part 20, Appendix B and 10 CFR Part 50, Appendix I during any of the ARERR years reviewed by the NRC staff.

In addition to the REMP, TVA has an onsite groundwater protection initiative program in accordance with NEI 07-07, “Industry Groundwater Protection Initiative” (NEI 2007-TN1913). This program monitors the onsite nuclear power plant environment to detect leaks from nuclear power plant systems and pipes containing radioactive liquid. Section 3.5.2.3 contains information on Browns Ferry’s groundwater protection initiative program.

Based on its review of the REMP data, the NRC staff finds no apparent high tritium or other radionuclide concentration releases that might indicate an ongoing inadvertent release that could affect public health from Browns Ferry. The groundwater monitoring program data at Browns Ferry show that TVA monitors, characterizes, and actively remediates spills, and that there were no significant radiological impacts to the offsite environment from operations at Browns Ferry.

3.13.2 Nonradioactive Waste

Browns Ferry generates nonradioactive waste as a result of nuclear power plant maintenance, cleaning, and operational processes. Browns Ferry manages nonradioactive wastes in accordance with applicable Federal and State regulations, as implemented through its corporate procedures. Browns Ferry generates and manages hazardous wastes, nonhazardous wastes, and universal wastes. TVA maintains a list of waste vendors that it has approved for use across the entire company to remove and dispose of the nonradioactive wastes offsite (TVA 2025-TN11355).

Waste minimization and pollution prevention are important elements of operations at all nuclear power plants. Licensees are required to consider pollution prevention measures as dictated by the Pollution Prevention Act Public Law 101 5084 (TN6607) and the Resource Conservation and 6 Recovery Act of 1976, as amended Public Law 94 580 (TN1281).

The Resource Conservation and Recovery Act governs the disposal of solid waste. The Land Division of the Alabama Department of Environmental Management is authorized by the EPA to implement the Resource Conservation and Recovery Act and regulate solid and hazardous waste in Alabama (TVA 2025-TN11355). Browns Ferry has a nonradioactive waste management program to handle nonradioactive waste in accordance with Federal, State, and corporate regulations and procedures. Browns Ferry maintains a waste minimization program that uses material control, process control, waste management, recycling, and feedback to reduce waste.

3.13.3 Proposed Action

As described in the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-1 for generic issues related to waste management, the impacts of nuclear power plant SLR and continued operations would be SMALL during the SLR term. The NRC staff's review of waste management for Browns Ferry for a subsequent period of operations did not identify any new and significant information that would change the conclusion in the LR GEIS. Thus, as concluded in the LR GEIS, for these Category 1 (generic) issues, the impacts of continued operation of Browns Ferry on all forms of waste management during the SLR term would be SMALL.

The ultimate disposal of spent fuel in a potential future geologic repository is a separate and independent licensing action that is outside the regulatory scope of this review. Per 10 CFR Part 51 (TN10253) Subpart A, Appendix B, the Commission concludes that the impacts presented in NUREG-2157 (NRC 2014-TN4117) would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 (TN4878) should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent nuclear fuel and high-level waste disposal, this issue is considered generic to all nuclear power plants. There are no plant-specific (Category 2) waste management issues applicable to Browns Ferry.

3.14 Evaluation of New and Significant Information

As stated in Section 3.1 of this SEIS, for Category 1 (generic) issues, the NRC staff can rely on the analysis in the LR GEIS (NRC 2013-TN2654) unless otherwise noted. Table 3-1 lists the Category 1 issues that apply to Browns Ferry during the proposed LR period. For these issues, the NRC staff did not identify any new and significant information based on its review of the Browns Ferry ER (TVA 2024-TN11042, TVA 2025-TN11355), the environmental site audits, review of available information as cited in this SEIS, or the environmental scoping process that would change the conclusions presented in the LR GEIS.

New and significant information must be new based on a review of the LR GEIS (NRC 2013-TN2654) as codified in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 (TN10253). Such information must also bear on the proposed action or its impacts, presenting a picture of the impacts that are seriously different from those envisioned in the LR GEIS (i.e., impacts of greater severity than impacts considered in the LR GEIS, considering their intensity and context).

The NRC defines new and significant information in Regulatory Guide 4.2, Supplement 1, Revision 2 "*Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications*" (NRC 2024-TN10280) as (1) information that identifies a significant environmental impact issue that was not considered or addressed in the LR GEIS and, consequently, not codified in Table B-1, in Appendix B to Subpart A of 10 CFR Part 51 (TN10253); or (2) information not considered in the assessment of impacts evaluated in the LR GEIS leading to a picture of the environmental consequences of the action that is significantly different than previously considered, such as an environmental impact finding different from that codified in Table B-1. Further, a significant environmental issue includes, but is not limited to, any new activity or aspect associated with the nuclear power plant that can act upon the environment in a manner or with an intensity and/or scope (context) not previously recognized.

In accordance with 10 CFR 51.53(c) (TN10253), the applicant's ER must analyze the Category 2 (site-specific) issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B. Additionally, the applicant's ER must discuss actions to mitigate any adverse impacts associated with the proposed action and environmental impacts of alternatives to the proposed action. In accordance with 10 CFR 51.53(c)(3), the applicant's ER does not need to analyze any Category 1 issue unless there is new and significant information about a specific issue.

NUREG-1555, Supplement 1, Revision 2, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants for Operating License Renewal*, describes the NRC process for identifying new and significant information (NRC 2024-TN10251). The search for new information includes the following:

- review of the Browns Ferry ER and the process for discovering and evaluating the significance of new information
- review of TVA's EIS
- review of public comments
- review of environmental quality standards and regulations
- coordination with Federal, State, and local environmental protection and resource agencies
- review of technical literature as documented through this SEIS

New information that the NRC staff discovers is evaluated for significance using the criteria set forth in the LR GEIS. For Category 1 issues in which new and significant information is identified, reconsideration of the conclusions for those issues is limited in scope to assessment of the relevant new and significant information; the scope of the assessment does not include other facets of an issue that the new information does not affect.

The NRC staff reviewed the discussion of environmental impacts associated with operation during the LR term in the LR GEIS and has conducted its own independent review, including a public involvement process (e.g., public meetings and comments) to identify new and significant issues for the Browns Ferry LRA environmental review. The assessment of new and significant information for each resource is addressed in each resource area discussion.

3.15 Impacts Common to All Alternatives

This section describes the impacts that the NRC staff considers common to the proposed action and replacement power alternatives. In addition, the following sections discuss the termination of operations, the decommissioning of a power plant and potential replacement power facilities, and greenhouse gas (GHG) emissions.

3.15.1 Uranium Fuel Cycle

The uranium fuel cycle includes uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials, and management of low-level wastes and high-level wastes related to uranium fuel cycle activities. Section 4.14.1 of the LR GEIS describes in detail the generic potential impacts of the radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes (NRC 2024-TN10161). The NRC staff incorporates the information in the LR GEIS, Section 4.14.1 (NRC 2024-TN10161: pp. 4-150 through 4-164), here by reference. The LR GEIS does not identify any plant-specific (Category 2) uranium fuel cycle issues.

As stated in the LR GEIS (NRC 2024-TN10161), the generic issues related to the uranium fuel cycle as identified in Table 3-1 of this SEIS would not be affected by continued operations associated with SLR. The NRC staff identified no new and significant information for these issues. Thus, as concluded in the LR GEIS, the impacts of generic issues related to the uranium fuel cycle would be SMALL.

3.15.2 Terminating Nuclear Power Plant Operations and Decommissioning

This section addresses the environmental impacts of Browns Ferry SLR associated with the termination of operations and the decommissioning of a nuclear power plant. All operating nuclear power plants will terminate operations and be decommissioned at some point after the end of their operating life or after a decision is made to cease operations. For the proposed action at Browns Ferry, SLR could delay this eventuality for an additional 20 years beyond the current license period. The Subsequent Renewed Facility Operating Licenses for Browns Ferry Unit 1 would expire on December 20, 2053, on June 28, 2054 for Unit 2, and on July 2, 2056 for Unit 3.

The decommissioning process begins when a licensee informs the NRC that it has permanently ceased reactor operations, defueled, and intends to decommission the nuclear plant. The licensee may also notify the NRC of the permanent cessation of reactor operations prior to the

end of the license term. Consequently, most nuclear plant activities and systems dedicated to reactor operations would cease after reactor shutdown. The environmental impacts of decommissioning a nuclear power plant are evaluated NUREG-0586, *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors* (NRC 2002-TN665). Additionally, Section 4.14.2 of the LR GEIS (NRC 2024-TN10161) summarizes the incremental environmental impacts associated with nuclear power plant decommissioning activities. As noted in Table 3-1, there is one Category 1 issue, "Termination of Nuclear Power Plant Operations and Decommissioning," applicable to Browns Ferry decommissioning following the SLR term. The LR GEIS did not identify any site-specific (Category 2) decommissioning issues.

The NRC staff determined that SLR would have a negligible effect on the impacts of terminating operations and decommissioning on all resources. The NRC staff identified no information or situations that would result in different environmental impacts for this issue for the SLR term at Browns Ferry. Therefore, the NRC staff concludes that the incremental environmental impacts of the termination of plant operations and decommissioning due to continued nuclear power plant operations at Browns Ferry during the SLR term would be SMALL.

3.16 Greenhouse Gas Emissions and Climate Change

The following sections discuss GHG emissions and climate change impacts. Section 3.16.1 evaluates GHG emissions associated with the operation of Browns Ferry. Section 3.16.2 discusses the observed changes in climate and potential future climate change during the SLR term, based on climate model simulations under future global GHG emissions scenarios. Section 3.16.3 discusses the impacts of the changes in climate on environmental resources.

3.16.1 Greenhouse Gases

Gases found in the Earth's atmosphere that trap heat and play a role in the Earth's climate are collectively termed GHGs. These GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), water vapor (H_2O), and fluorinated gases, such as hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride (SF_6). The Earth's climate responds to changes in concentrations of GHGs in the atmosphere because these gases affect the amount of energy absorbed and heat trapped by the atmosphere. Increasing concentrations of GHGs in the atmosphere generally increase the Earth's surface temperature. Since 1850, CO_2 concentrations have increase by 50 percent (USGCRP 2023-TN9762).

The sixth assessment synthesis report from the Intergovernmental Panel on Climate Change (IPCC) states that "[i]t is unequivocal that human influence has warmed the atmosphere, ocean, and land" (IPCC 2023-TN8557). Long-lived GHGs—CO_2, CH_4, N_2O, and fluorinated gases—are well mixed throughout the Earth's atmosphere, and their impact on climate is long-lasting and cumulative in nature as a result of their long atmospheric lifetimes (EPA 2016-TN7561). Therefore, the extent and nature of climate change is not specific to where GHGs are emitted. Carbon dioxide is of primary concern for global climate change because it is the primary gas emitted as a result of human activities. In 2019, global net GHG emissions were estimated to be 59 ± 6.6 gigatons of CO_2 equivalents (CO_2eq), with the largest share in gross GHG emissions being CO_2 from fossil fuel combustion and industrial processes (IPCC 2023-TN8557). In 2019, atmospheric concentrations of CO_2 (measured at 410 parts per million) were higher than any time in at least 2 million years (IPCC 2023-TN8557). In 2021, the State of Alabama emitted a total of 149.1 million tons (135.3 million MT) of CO_2eq (ADEM 2024-TN11534).

The electric power industry and the transportation sectors contributed approximately 35.4 and 28.3 percent, respectively, of total emissions.

The 2013 LR GEIS (NRC 2013-TN2654) presents life-cycle GHG emissions associated with nuclear power generation. The nuclear life-cycle GHG emissions consists of the uranium fuel cycle phases, and nuclear power plant construction, operation, and decommissioning. As presented in Table 4.12-4 through Table 4.12-6 of the 2013 LR GEIS, life-cycle GHG emissions from nuclear power can range from 1 to 228 grams carbon equivalent per kilowatt-hour. GHG emissions from operation of nuclear power plants are typically minor. The operation of Browns Ferry results in both direct and indirect GHG emissions. Direct emission sources include onsite combustion equipment (e.g., boilers and diesel generators) included in Browns synthetic minor source air permit. Browns Ferry tracks monthly operating hours for each piece of equipment on a 12-month rolling basis. TVA has calculated GHG emissions from stationary combustion sources, which are provided in Table 3-20. Indirect (i.e., workforce commuting) emissions estimates are also included in Table 3-20. Fluorinated gas emissions from refrigerant sources and from electrical transmission and distribution systems can result from leakage, service, repair, or disposal of sources. In addition to being GHGs, chlorofluorocarbons and hydrochlorofluorocarbons are ozone-depleting substances that are regulated by the Clean Air Act under Title VI, “Stratospheric Ozone Protection (TN1141). TVA uses fluorinated gases at Browns Ferry in refrigerants and electrical breakers (TVA 2025-TN11355). TVA maintains an environmental compliance program for the use, storage, and handling of refrigerants and SF_6. This program is used to document refrigerant losses, as well as SF_6 emissions. When leaks are identified, a condition report is generated and entered into the Browns Fery corrective action program database, and a work order is developed to repair the leak (TVA 2025-TN11355). Refrigerant use, storage, and handling on site is governed by TVA and Browns Ferry environmental procedures, which are compliant with CAA requirements (TVA 2025-TN11355).

Table 3-20 Annual Greenhouse Gas Emissions from Operation at Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

Year	Direct Emissions[(a)]	Indirect Emissions[(b)]	Total
2020	5,755	9,915	15,670
2021	3,385	9,915	13,300
2022	10,365	9,915	20,280
2023	3,305	9,915	13,220

Note: All reported values are in tons and rounded. To convert to metric tons per year, multiply by 0.90718. Expressed in carbon dioxide equivalents (CO_2eq), a metric used to compare the emissions of GHG based on their global warming potential (GWP). The GWP is a measure used to compare how much heat a GHG traps in the atmosphere. The GWP is the total energy that a gas absorbs during a period of time compared to carbon dioxide. CO_2eq is obtained by multiplying the amount of the GHG by the associated GWP. For example, the GWP of methane is 21; therefore, 1 ton of methane emission is equivalent to 21 tons of carbon dioxide emissions.

(a) Direct emissions include onsite combustion sources (boiler and generators), refrigerants, and electrical breakers. Emissions calculated using fuel usage for combustion sources and leaks of fluorinated gases (TVA 2025-TN11647).

(b) Indirect emissions consist of worker vehicles. Workforce commuting calculations are based on 2,098 passenger vehicles per day, based on total number of Browns Ferry employees in 2023 (2,147), a 4.5 percent carpool rate (USCB 2020-TN11535), and EPA’s Greenhouse Gas Equivalencies Calculator (EPA 2024-TN10062).

3.16.2 Climate Change

Climate change is the decades or longer change in climate measurements (e.g., temperature and precipitation) that has been observed on a global, national, and regional level (IPCC 2007-

TN7421; EPA 2016-TN7561; USGCRP 2014-TN3472). Globally, the year 2024 was the warmest year on record and the 10 warmest years since 1850 have occurred in the past decade (NOAA 2025-TN11287).

Global surface temperature has increased faster since 1970 than in any other 50-year period over at least the last 2,000 years (IPCC 2023-TN8557). From 2011 through 2020, the global surface temperature was 2°F (1.1°C) warmer than that in the preindustrial period (1850–1900) (IPCC 2023-TN8557). From 1901 to 2023, global precipitation has increased at an average rate of 0.03 in. (0.08 cm) per decade (EPA 2024-TN10205). From 1901 to 2023, average surface temperature across the contiguous United States has increased by 0.17 °F (0.09 °C) per decade (EPA 2024-TN10205). From 1901 to 2023, total annual precipitation in the contiguous United States has increased at a rate of 0.18 in. (0.4 cm) per decade (EPA 2024-TN10205). Furthermore, the United States Global Change Research Program (USGCRP) reports that, since 1970, the contiguous United States is warming faster than the global average. Since 1970, the global average surface temperature has increased by 1.7°F (0.9°C), while the average surface temperature in the contiguous United States has increased by 2.5°F (1.4°C) (USGCRP 2023-TN9762). The observed climate change indicators across the United States include increases in the frequency and intensity of heavy precipitation, earlier onset of spring snowmelt and runoff, rise of the sea level and increased tidal flooding in coastal areas, an increased occurrence of heat waves, and a decrease in the occurrence of cold waves.

Observed climate changes and impacts have not been uniform across the United States. Temperature data from 1900 to 2012 indicate that the Southeast region (where Browns Ferry is located) did not experience significant warming up until the 1960s. Since the early 1960s, the Southeast has been warming at a similar rate as the rest of the United States (NOAA 2013-TN7424; USGCRP 2009-TN18, USGCRP 2014-TN3472, USGCRP 2018-TN5847). Between 2002 and 2021 (relative to 1901 to 1960), annual average temperature data in the Southeast varied with some areas experiencing increases in temperature and others a decrease. Annual average temperature in the northern regions of Alabama experienced an increase of 0–1.5°F (0–0.83°C) between 2002 and 2021 (USGCRP 2023-TN9762). The number of hot days (days at or above 95°F [35°C]) has decreased by 9.7 days, the number of cold days (days at or below 32°F [0°C]) has increased by 3.0 days, and the number of warm nights (nights at or above 70°F [21°C]) have increased by 7.9 nights in the Southeast from 2002–2021 relative to 1901–1960 (USGCRP 2023-TN9762).

Precipitation in the Southeast region varies considerably. Average annual precipitation data for the Southeast from 2002–2021 (relative to the 1901–1960 average) exhibits increases and decreases, with the northern portion of Alabama exhibiting primarily a 0–15 percent increase (USGCRP 2023-TN9762). The Southeast has experienced a 37 percent increase in the number of extreme precipitation days (defined as the top 1 percent of heaviest precipitation events) during the period 1958–2021 (USGCRP 2023-TN9762).

The NRC staff used the NOAA “Climate at a Glance” tool to analyze temperature and precipitation trends for the 1895–2021 period in Alabama’s Northern Valley Climate Division (Climate Division No. 1). A trend analysis shows that the average annual temperature has increased at a rate of 0.2°F (0.11°C) per decade, while annual precipitation has decreased at a rate of 0.08 in. (0.2 cm) per decade (NOAA NCEI 2021-TN6902, NOAA NCEI 2021-TN6903). In its ER, TVA provided average summer (June, July, and August) air temperature for Huntsville, Alabama from 1958 through 2021 and provided a trendline showing an increment of approximately 0.065°F (0.036°C) per year (TVA 2025-TN11355).

3.16.3 Proposed Action

3.16.3.1 Greenhouse Gas Emissions

As described in the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-1 of this SEIS, the GHG Impacts of climate change from continued operations would be SMALL. The NRC staff did not identify any new and significant information that would change the conclusion in the LR GEIS. GHG emissions from routine operations at Browns Ferry include combustion sources and workforce commuting. TVA does not anticipate future upgrades or replacement activities of emission sources during the SLR term to support plant operation that could result in a significant increase in GHG emissions. Thus, as concluded in the LR GEIS, for the "Greenhouse gas impact on climate change," generic issue, the impact of continued operation of Browns Ferry on climate change would be SMALL.

3.16.3.2 Climate Change Impacts on Environmental Resources

As documented in the LR GEIS (NRC 2024-TN10161) and cited in Table 3-1, there is a Category 2 issue "Climate Change Impacts on Environmental Resources" applicable to Browns Ferry. According to the LR GEIS, the impacts of climate change on environmental resources during the LR term are location-specific and cannot be generally evaluated. Changes in climate can have broad implications for certain resource areas. Climate change may impact the affected environment in a way that alters the environmental resources that are impacted by the proposed action (SLR). For there to be a climate change impact on an environmental resource, the proposed action (SLR) must have an incremental new, additive, or increased physical effect or impact on the resource or environmental condition. Below, the NRC discusses climate change projections and the effects of climate change on environmental resource areas that may also be directly affected by continued operations during the SLR term.

The effects of climate change on Browns Ferry structures, systems, and components are outside the scope of this Category 2 issue. Site-specific environmental conditions are considered when siting nuclear power plants. This includes the consideration of meteorological and hydrologic siting criteria as set forth in 10 CFR Part 100, "Reactor Site Criteria" (TN282). The NRC regulations require that nuclear power plant SSCs important to safety be designed to withstand the effects of natural phenomena, such as flooding, without loss of capability to perform safety functions. Further, nuclear power plants are required to operate within technical safety specifications in accordance with the NRC operating license, including coping with natural phenomena hazards. The NRC conducts safety reviews before allowing licensees to make operational changes caused by changing environmental conditions. Additionally, the NRC evaluates nuclear power plant operating conditions and physical infrastructures to ensure ongoing safe operations under the nuclear power plant's initial and renewed operating licenses through the NRC's Reactor Oversight Program. If new information about changing environmental conditions becomes available, the NRC will evaluate the new information to determine whether any safety-related changes are needed at licensed nuclear power plants. This is a separate and distinct process from the NRC staff's LR environmental review that it conducts in accordance with NEPA.

Future global GHG emission concentrations (emission scenarios) and climate models are commonly used to project possible climate change. Climate model simulations often use GHG emission scenarios to represent possible future social, economic, technological, and demographic development that, in turn, drive future emissions. Climate models indicate that over the next decade, warming is very similar across all emission scenarios (USGCRP 2023-

TN9762). However, by mid-century (2040–2070), the differences between the projected temperatures under higher and lower emission scenarios become observable. The impacts of climate change increase with warming, and warming is certain to continue if emissions of CO_2 do not reach net zero (USGCRP 2023-TN9762).

The IPCC has generated various representative concentration pathway (RCP) scenarios commonly used by climate modeling groups to project future climate conditions (IPCC 2000-TN7652, IPCC 2013-TN7434; USGCRP 2017-TN5848, USGCRP 2018-TN5847). In the IPCC Fifth Assessment Report, four RCPs were developed and are based on predicted changes in radiative forcing (a measure of the influence that a factor, such as GHG emissions, has in changing the global balance of incoming and outgoing energy) in the year 2100, relative to preindustrial conditions. The four RCPs are numbered in accordance with the change in radiative forcing measured in watts per square meter (W/m^2) (i.e., +2.6 [very low], +4.5 [lower], +6.0 [mid-high], and +8.5 [higher]) (USGCRP 2018-TN5847). For example, RCP 2.6 is representative of a mitigation scenario aimed at limiting the increase in the global mean temperature to 3.6°F (2°C) (IPCC 2014-TN7651). The RCP 8.5 reflects a continued increase in global emissions resulting in increased warming by 2100. In the IPCC Working Group contribution to the Sixth Assessment Report, five shared socioeconomic pathways were used and associated modeling results were the basis for their climate change assessments (IPCC 2021-TN7435). These five socioeconomic pathway scenarios (SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5) cover a range of GHG pathways and climate change mitigation. The Fifth National Climate Assessment (USGCRP 2023-TN9762) uses share socioeconomic pathways, RCPs, and global warming levels when presenting projected climate change. Global warming levels are used to describe the level of global temperature increase (e.g., 2.7°F or 1.5°C) relative to preindustrial temperature conditions (USGCRP 2023-TN9762). Global warming levels depend on future emissions.

Because the effects of climate change can vary regionally, climate change information at the regional and local scale is necessary to assess the impacts on the human environment for a specific location. Therefore, the NRC staff considered the best available climate change studies performed by the USGCRP and partner agencies as part of the staff's assessment of potential changes in climate indicators during the Browns Ferry SLR terms (2033–2053 for Unit 1, 2034–2054 for Unit 2, and 2036–2056 for Unit 3). Reports from the USGCRP and partner agencies provide projected changes in temperature precipitation patterns, and other climate outcomes on a regional level. The results of these studies are summarized below.

Regional projections for annual mean temperature are available from the Fourth National Climate Assessment based on the RCP 4.5 and RCP 8.5 scenarios for the mid-century (2036–2065) as compared to the average for 1976–2005. The modeling predicts increases of 3.4–4.3°F (1.9–2.4°C) across the Southeast region by mid-century (USGCRP 2017-TN5848). Under the RCP 8.5 scenario, the coldest and warmest daily temperatures of the year are expected to increase by 4.97°F and 5.69°F (2.76°C and 3.16°C), respectively, in the Southeast by midcentury (USGCRP 2017-TN5848). For the portion encompassing northern Alabama, the Fifth National Climate Assessment projects annual temperature increases from 3.0–4.0°F (1.7–2.2°C) under the 2.7°F (1.5°C) global warming level and 7.9–9.0°F (4.4-5.0°C) under the 7.2°F (4.0°C) global warming level scenario (USGCRP 2023-TN9762), compared with the period 1851–1900.

Climate model simulations suggest spatial differences in annual mean precipitation change across the Southeast with some areas experiencing an increase and others a decrease in precipitation. Based on the intermediate (RCP 4.5) emission scenarios for the mid-century (2036–2065) across northern Alabama annual mean precipitation is projected to increase by

0.5–2 in. (1.3–5.1 cm) relative to 1991–2020 (USGCRP 2023-TN9762). For the 1.5°C (2.7°F) and 4.0°C (7.2°F) global warming levels, average annual precipitation in northern Alabama is predicted to increase by 0–5 percent and 5–10 percent, respectively compared with the period 1851–1900 (USGCRP 2023-TN9762). The Fifth National Climate Assessment projects continued increases in the frequency and intensity of heavy or extreme precipitation events across the United States, including across the Southeast region (USGCRP 2023-TN9762).

Changes in climate could have broad implications for certain resource areas. As discussed below, the NRC staff considers the impacts of climate change on environmental resources that are incrementally affected by the proposed action.

Air Quality

Climate change can impact air quality as a result of changes in meteorological conditions. Air pollutant concentrations are sensitive to winds, temperature, humidity, and precipitation. Ozone levels and PM have been found to be particularly sensitive to climate change influences. Ozone is formed by the chemical reaction of NO_x and volatile organic compounds in the presence of heat and sunlight. The emission of ozone precursors also depends on the temperature, wind, and solar radiation (IPCC 2007-TN7421). Warmer temperatures, air stagnation, droughts, and wildfires are favorable conditions for higher levels of ozone and $PM_{2.5}$ (USGCRP 2023-TN9762). In the Southeast, recent studies indicate that the position of the Bermuda High in the summer influences surface ozone in the eastern part of the United States (Zhang and Wang 2016-TN10554). USGCRP reports that there is medium confidence that climate change is projected to worsen air quality in many regions in the United States (2023-TN9762). This is due to the uncertainty in how meteorology will respond to climate change and how these meteorological conditions will in turn change air pollutant concentrations. For instance, while warmer average temperatures are projected to increase seasonal mean daily maximum 8-hour average ozone and $PM_{2.5}$ concentrations, increases in annual average precipitation will decrease $PM_{2.5}$ concentrations (USGCRP 2023-TN9762).

Nolte et al. examined the impact of climate change on ozone and $PM_{2.5}$ under RCP 4.5, RCP 6.0, and RCP 8.5 scenarios for 2025–2035 relative to 1995–2005 (Nolte et al. 2018-TN8571). For the Southeast region, Nolte et al. found no changes in annual mean concentrations of total $PM_{2.5}$ under the RCP 4.5 scenario but increases in annual mean concentrations of total $PM_{2.5}$ under the RCP 6.0 and 8.5 scenarios (Nolte et al. 2018-TN8571). However, changes in the annual mean concentrations of total $PM_{2.5}$ for Alabama were not statistically significant. Under the RCP 4.5 emission scenario, East et al. 2024 (TN10550) found that by mid-century the average 1 year ozone concentrations may increase by 2 parts per billion (ppb) across most of the United States, including the Southeast, and the number of days per year with daily maximum 8-hour average ozone concentrations that exceed 70 ppb will increase. East et al. 2024 findings suggest that increasing the frequency of high ozone concentrations can increase the risk of not meeting NAAQS by mid-century in areas currently attaining them. As discussed in Section 3.3.2, Limestone County is designated in attainment for all NAAQS Emissions from operation of Browns Ferry are minor and represent less than 1 percent of Limestone County's total emissions. Therefore, the NRC staff concludes that any climate change-related deterioration in air quality in Limestone County would not exacerbate the minor air quality impacts associated with Browns Ferry SLR.

Surface Water Resources

Climatic changes, such as changes in air temperature and precipitation patterns, can affect the availability of water resources. Climate change projections suggest a variety of impacts to water resources in the region where Browns Ferry is located may occur over the SLR period. The region has experienced a rise in extreme precipitation events, with a projected continuation of this trend. Extreme precipitation events can increase runoff and the potential for riverine flooding, which can degrade water quality by transporting higher sediment loads and contaminants. Projected changes in annual runoff by 2050, under an intermediate scenario, suggest an increase of up to 0.5 in. (1.27 cm) in Alabama (USGCRP 2023-TN9762: Figure 4.7).

Rising ambient temperatures contribute to greater evapotranspiration, which could affect seasonal water availability and hydrological balance, and increases in surface water temperatures (USGCRP 2023-TN9762: Figure 4.4). As discussed above, annual average temperature in the northern regions of Alabama have experienced an increase of 0 –1.5°F (0–0.83°C) between 2002–2021 (USGCRP 2023-TN9762: Figure 2.4) and modeling predicts increases of 3.4–4.3°F (1.9–2.4°C) across the Southeast region by mid-century (USGCRP 2017-TN5848: Table 6.4). An increase in the number of hot days and the number of warm nights could increase surface water temperature and evaporation. Historically, monthly and seasonal average water temperatures of Wheeler Reservoir from 2005 through 2024 do not indicate an observable trend in water temperature (TVA 2025-TN11355: Figure 3.5-9, Figure 3.5-10, and Figure 4.13-4). Warmer water and higher air temperatures can reduce the efficiency of thermal power plant cooling technologies. Increased water temperatures could lead to an increase in annual average water withdrawal and other operational changes and/or an increase in the volume and temperature of the circulating cooling water discharged back to the reservoir. Browns Ferry operates under an NPDES permit that limits thermal discharges to a maximum 1-hour average of 93°F (34°C), a maximum 24 hour average of 90°F (32°C), and a maximum increase of 10°F (5.6°C) over ambient temperatures at the edge of the discharge mixing zone (TVA 2025-TN11355). The helper cooling towers assist in meeting discharge water temperature limits specified in the NDPES permit.

Nuclear power plant operators, including those at Browns Ferry, can account for changes in water temperature and availability in operational procedures. These measures will ensure that operation does not further exacerbate climate change-related impacts on surface water resources. For instance, TVA has developed a hydrothermal modeling tool that can account for changes in meteorological conditions (ambient air temperature, humidity, water temperatures) to predict needed derating that would be required to maintain compliance with NDPES temperature limits (TVA 2025-TN11355). Furthermore, TVA manages and controls Wheeler Reservoir level and flow. Increases in air and water temperatures can be accommodated by these operational changes to minimize impacts. Additionally, Browns Ferry consumes only 0.1 percent of the total water it withdrawals from the Wheeler Reservoir (TVA 2025-TN11355). Therefore, the NRC staff concludes that any climate change-related change in surface water resources in the region would not exacerbate the minor surface water and hydrological impacts associated with Browns Ferry.

Aquatic Resources

Changes in water temperature can alter the balance of aquatic ecosystems. Water temperature is an essential physical property of all lakes to which aquatic resources rely on. An increase in annual mean air temperature of 3.4–4.3°F (1.9–2.4°C) across the majority of the Southeast by midcentury and an increase in the number of hot days (≥95°F or 35°C) and the number of warm

nights (≥70°F or 21.1°C) is projected for Limestone County, Alabama (USGCRP 2017-TN5848, USGCRP 2024-TN9798, USGCRP 2023-TN9762). Higher ambient air temperatures can increase surface water temperatures (USGCRP 2023-TN9762). Wheeler Reservoir temperatures are highly dependent on river flow, which in turn is controlled by TVA (TVA 2025-TN11355). In its ER, TVA provided monthly and seasonal average water temperatures of Wheeler Reservoir (upstream and downstream of Browns Ferry) from 2005 through 2024 and no observable trend in water temperature was apparent (TVA 2025-TN11355: Figure 3.5-9, Figure 3.5-10, and Figure 4.13-3). Temperature directly affects water quality and increasing water temperatures extends the duration of thermal stratification in lakes, separating them into density layers each year (USGCRP 2014-TN3472). Extending thermal stratification in lakes can eliminate or reduce lake circulation and mixing patterns, resulting in reduced dissolved oxygen which leads to nutrient, heavy metals, and toxin enrichment of the aquatic environment (USGCRP 2014-TN3472). In turn, this creates impacts to biodiversity and changes in biological productivity. Nutrient enrichment and warming water temperatures can lead to harmful algal blooms which further reduce dissolved oxygen levels within lakes (EPA 2025-TN11131, EPA 2025-TN11132). Warming water temperatures may also influence the abundance and distribution of both native and invasive species, as well as result in earlier spawning times (Phillips et al. 2018-TN10290). Habitat for cold-water species in the Tennessee River may be reduced up to 100 percent (EPRI 2009-TN5223). Recreationally popular cool-water fish like walleye and striped bass could also see population declines (EPRI 2009-TN5223). In contrast, several State or federally listed warm-water species including the slackwater darter (LT, SP), snail darter (SP), spring pygmy sunfish (LT,SP), and Tuscumbia darter (SP) may benefit from expanding warm-water habitats (EPRI 2009-TN5223). Additionally, several introduced species and one invasive species, the grass carp, could thrive in warming waters, potentially to the detriment of native species.

TVA's compliance with the NPDES permit thermal discharge limits, along with Browns Ferry's ability to switch operations from open mode to helper mode to meet the maximum 24-hour average of 90°F (32°C), and a maximum increase of 10°F (5.6°C) above ambient temperatures, minimizes the impacts of Browns Ferry's continued operation (TVA 2024-TN11042). Even at the maximum thermal discharge the thermal discharge plume would extend over only approximately 117 ac (47 ha) of the 67,070 ac (27,140 ha) lake (Benton 2001-TN11450). These measures ensure that operation does not further exacerbate climate change-related impacts on the aquatic environment. Therefore, the NRC staff concludes that any climate change-related increases in water temperature in Wheeler Reservoir would not exacerbate the minor discharge temperature impacts associated with Browns Ferry SLR.

3.17 Cumulative Effects

Actions considered in the cumulative effects (impacts) analysis include the proposed LR action when added to the environmental effects from past, present, and reasonably foreseeable future actions. The analysis considers all actions including minor ones, because the effects of individually minor actions may be collectively significant over a period of time. The goal of the cumulative effects analysis is to identify potentially significant effects. The environmental effects of the proposed SLR action when combined with the effects of other actions could result in a cumulative impact.

The cumulative effects or impacts analysis only considers resources and environmental conditions that could be affected by the proposed license renewal action, including the effects of continued reactor operations during the SLR term and any refurbishment activities at a nuclear power plant. In order for there to be a cumulative effect, the proposed action must have an

incremental new, additive, or increased physical effect or impact on the resource or environmental condition beyond that already occurring.

For the purposes of analysis, past and present actions include all actions that have occurred since the commencement of reactor operations up to the submittal of the SLR request. Older actions are accounted for in baseline assessments presented in the affected environment discussions in Sections 3.2 through 3.13. The time frame for the consideration of reasonably foreseeable future actions is the 20 year SLR term. Reasonably foreseeable future actions include current and ongoing planned activities through the end of the period of extended operation.

The incremental effects of the proposed action when added to the effects from past, present, and reasonably foreseeable future actions and other actions result in the overall cumulative effect. A qualitative cumulative effects analysis is conducted in instances where the incremental effects of the proposed action and past, present, and reasonably foreseeable future actions are uncertain or not well known.

Information from TVA's ER (TVA 2024-TN11042, TVA 2025-TN11355); responses to requests for additional information; information from other Federal, State, and local agencies; scoping comments; and information gathered during the environmental site audit at Browns Ferry were used to identify past, present, and reasonably foreseeable future actions in the cumulative effects analysis.

No major changes to Browns Ferry operations are anticipated during the proposed SLR term. TVA has undertaken the replacement of the existing cooling towers serving Browns Ferry in order to address issues associated with their reliable operation. Five of the six existing cooling towers have been replaced, while Cooling Tower 2 is scheduled for replacement. In addition, TVA constructed a new Cooling Tower 7 in 2012 (TVA 2025-TN11355). Table 3-21 lists the cooling towers at Browns Ferry and their status.

Table 3-21 Browns Ferry Nuclear Plant Cooling Tower Status

Cooling Tower	Constructed or Replaced	Year
1	Replaced	2022
2	Replaced	2027 (scheduled)
3	Replaced	2013
4	Replaced	2007
5	Replaced	2013
6	Replaced	2014
7	Constructed	2012

An addition of a third ISFSI pad is under consideration, but details of construction and schedule are unknown (TVA 2024-TN11042).

Other projects in the vicinity of the Browns Ferry site include (LC 2022-TN11538):

- Development and expansion at the Redstone Arsenal 30 mi (48 km) east of Browns Ferry.
- Expected residential, business, and commercial development in surrounding cities and on Cummings Research Park property.

- Construction to replace water mains and install new customer service lines in Courtland, Alabama has begun 11 mi (18 km) west of Browns Ferry.
- Twelve transportation projects under construction or anticipated in the nearby counties; all projects are over 10 mi (16 km) from Browns Ferry.
- Continued urban population growth in Limestone County, Alabama.

3.17.1 Air Quality

The region of influence that the NRC staff considered in the cumulative air quality analysis consists of the Limestone County because air quality designations in Alabama are made at the county level. TVA has not proposed any refurbishment activities during the SLR term. As a result, the NRC staff expect that air emissions and sources from the nuclear power plant during the SLR term would be similar to those presented in Section 3.3. Cumulative impacts to air quality in Limestone County would be the result of future projects and actions that change present-day emissions within the county, as well as from environmental trends as discussed in Section 3.16. Increases in air emissions result from construction activities, continued urban population growth, and development. Emissions from construction activities would be temporary, however, those from population growth and development would be longer-term.

3.17.2 Water Resources

3.17.2.1 Surface Water Resources

The description of the affected environment in Section 3.5.1, serves as the baseline for the cumulative impacts assessment for surface water resources. Wheeler Reservoir serves both as the source of cooling water for Browns Ferry operations as well as the receiving water for Browns Ferry return flows and comingled effluents. TVA operates a system of dams and reservoirs within the Tennessee River Valley with associated facilities, including controlling the releases from Guntersville and Wheeler Dams. This operational control enables TVA to effectively monitor and manage any surface water issues near Browns Ferry (TVA 2004-TN11594). The nearest upstream and downstream intakes from Browns Ferry are 12 mi (19 km) and 7.5 mi (12 km), respectively.

Between 2016 and 2023, Browns Ferry withdrew an average of about 2,875 MGD and consumed approximately 0.1 percent of the total withdrawal annually (TVA 2025-TN11355). Since 1995, surface water withdrawals and net usage of Wheeler Reservoir have declined significantly, primarily due to reductions in thermoelectric use (TVA 2025-TN11355). This trend is expected to continue, with overall water withdrawals in the Tennessee River Watershed projected to decrease by 11 percent by 2045 (Sharkey and Springston 2022-TN11361). No current or planned projects near Browns Ferry are expected to impact water use beyond TVA's regulatory capacity (TVA 2025-TN11355). TVA has not identified any SLR-related refurbishment activities and has not proposed to increase surface water withdrawals or consumptive use during the SLR term.

As described in Section 3.13, normal and abnormal radioactive liquid effluent releases were within 10 CFR Part 20, Appendix B and 10 CFR Part 50, Appendix I limits over the reporting years of 2019 through 2023. Additionally, the NRC staff review of the radiological environmental monitoring results for the last 5 years did not identify any adverse trends in radioactivity levels in surface water (TVA 2020-TN11373, TVA 2021-TN11374, TVA 2022-TN11375, TVA 2023-TN11376, TVA 2024-TN11377). Under the CWA, the NRC cannot issue a Federal permit or

license unless the CWA Section 401 water quality certification has been issued or the water quality certification requirement has been waived by a State or another authorized agency. The ADEM approved a Section 401 waiver request for Browns Ferry on July 3, 2024 (TVA 2024-TN11362). Wastewater and stormwater discharges from Browns Ferry are regulated under ADEM NPDES Permit No. AL0022080. ADEM would be expected to alter NPDES discharge conditions, as necessary, to protect the water quality of the Wheeler Reservoir. Moreover, any offsite projects would similarly have to comply with ADEM regulations such that cumulative water-quality objectives are served. Compliance with the NPDES permit and other regulatory requirements including SWPPP, BMPs, and industrial pollution prevention program (IPPP) will minimize the impact on surface water quality during the SLR term.

In summary, a substantial regulatory framework exists to address current and future water quality and water use considerations. Based on the review of relevant information, the NRC staff conclude that the proposed action would have no cumulative effect beyond that already being experienced.

3.17.2.2 Groundwater Resources

The description of the affected environment in Section 3.5.2 is used as the basis for the cumulative impacts assessment for groundwater resources. No groundwater is currently used at Browns Ferry and no groundwater withdrawals are planned for operations during the LR term. Groundwater flow paths in the power block area are toward Wheeler Reservoir with groundwater discharge occurring into the reservoir, the intake channel, or the cold water channel where significant dilution would occur. In addition, Browns Ferry groundwater affected by inadvertent radionuclide releases is isolated from nearby domestic groundwater users. TVA will continue to implement its groundwater protection program and spill prevention control plans to reduce groundwater quality impacts. Based on this information, the proposed action would have no cumulative impacts beyond those identified in Section 3.5.3.2.

3.17.3 Socioeconomics

As discussed in Section 3.10, continued operation of Browns Ferry during the SLR term would have no impact on socioeconomic conditions in the region beyond what is already being experienced. TVA has no planned activities at Browns Ferry beyond continued reactor operations and maintenance.

Because TVA has no plans to hire additional workers during the SLR term, overall expenditures and employment levels at Browns Ferry would remain unchanged and there would be no new or increased demand for housing and public services. Therefore, the only contributory effects would come from reasonably foreseeable future planned operational activities at Browns Ferry and other planned offsite activities, unrelated to the proposed action (SLR). When combined with past, present, and reasonably foreseeable future activities, the proposed action would have no new or increased effect beyond what is currently being experienced.

3.17.4 Human Health

The NRC and EPA have established radiological dose limits to protect the public and workers from both acute and long-term exposure to radiation and radioactive materials. These dose limits are specified in 10 CFR Part 20 (TN283) and 40 CFR Part 190 (TN739), “Environmental Radiation Protection Standards for Nuclear Power Operations” . As discussed in Section 3.11, the impacts on human health from continued nuclear power plant operations during the SLR term would be SMALL.

For the purposes of this cumulative impact analysis, the geographical area considered is the area within a 50 mi (80 km) radius of Browns Ferry. There are no other operational nuclear power plants within this 50 mi (80 km) radius. As discussed in Section 3.13.1, TVA stores spent nuclear fuel from Browns Ferry in a storage pool and in an onsite ISFSI. Per the Browns Ferry ER (TVA 2024-TN11042) Section 2.2.4.4, the current ISFSI pads will be filled on or before year 2036 and will need to be expanded prior to the SLR period of extended operation. The needed dry storage capacity would involve construction of a third ISFSI storage pad. The addition of a third ISFSI storage pad is under consideration, but no installation schedule has been established. The site has adequate space onsite to accommodate the construction of an additional ISFSI pad if necessary (TVA 2025-TN11355).

The EPA regulations at 40 CFR Part 190 (TN739) limit the dose to members of the public from all sources in the nuclear fuel cycle, including nuclear power plants, fuel fabrication facilities, waste disposal facilities, and transportation of fuel and waste. As discussed in Section 3.13, TVA has a radiological environmental monitoring program that measures radiation and radioactive materials in the environment from Browns Ferry, its ISFSI, and all other sources. The NRC staff reviewed the radiological effluent and environmental monitoring reports for the 5-year period from 2019 through 2023 as part of this cumulative impacts assessment (TVA 2020-TN11371, TVA 2021-TN11372, TVA 2022-TN11369, TVA 2023-TN11370, TVA 2024-TN11368, TVA 2020-TN11373, TVA 2021-TN11374, TVA 2022-TN11375, TVA 2023-TN11376, TVA 2024-TN11377). The NRC staff's review of TVA's data showed no indication of an adverse trend in radioactivity levels in the environment from either Browns Ferry or the ISFSI. The data showed that there was no measurable impact on the environment from operations at Browns Ferry.

Based on this information, there would be no significant cumulative radiological effect on human health resulting from the proposed action (SLR), in combination with the cumulative effects from other sources. This conclusion is based on the NRC staff's review of radiological environmental monitoring program data, radioactive effluent release data, and worker dose data; the expectation that Browns Ferry would continue to comply with Federal radiation protection standards during the period of extended operation; continued NRC oversight of plant emissions and activities, and the continued regulation of any future development or actions in the vicinity of Browns Ferry by the State of Alabama.

3.17.5 Waste Management and Pollution Prevention

This section of the SEIS considers the incremental waste management impacts of the proposed Browns Ferry SLR term when added to the contributory effects of other past, present, and reasonably foreseeable future actions. In Section 3.13.3, the potential waste management impacts from continued operations at Browns Ferry during the LR term were determined to be SMALL.

As discussed in Sections 3.13.1 and 3.13.2 of this SEIS, TVA maintains waste management programs for radioactive and nonradioactive waste generated at Browns Ferry and is required to comply with Federal and State permits and other regulatory waste management requirements. There are no other operational nuclear power plants within this 50 mi (80 km) radius. All industrial facilities within a 50 mi (80 km) radius of Browns Ferry are also required to comply with appropriate NRC (if licensed for possessing radioactive material), EPA, and State requirements for the management of radioactive and nonradioactive waste. Current waste management activities at Browns Ferry would likely remain unchanged during the SLR term.

Furthermore, the NRC staff expects that TVA would continue to ensure Browns Ferry complies with Federal and State requirements for radioactive and nonradioactive waste.

Therefore, the proposed action, including continued radioactive and nonradioactive waste generation during the SLR term, would have no cumulative effect beyond what is already being experienced. This is based on the expected continued compliance by TVA with Federal and State of Alabama requirements for radioactive and nonradioactive waste management, as applicable, at Browns Ferry and the expected regulatory compliance of other waste producers in the area.

3.18 Resource Commitments Associated with the Proposed Action

This section describes the NRC's consideration of potentially unavoidable adverse environmental impacts that could result from implementation of the proposed action and alternatives; the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity; and the irreversible and irretrievable commitments of resources.

3.18.1 Unavoidable Adverse Environmental Impacts

Unavoidable adverse environmental impacts are impacts that would occur after implementation of all workable mitigation measures. Carrying out any of the replacement energy alternatives considered in this SEIS, including the proposed action, would result in some unavoidable adverse environmental impacts.

Minor unavoidable adverse impacts on air quality would occur due to emission and release of various chemical and radiological constituents from power plant operations. Nonradiological emissions resulting from power plant operations are expected to comply with Federal EPA and State emissions standards. Chemical and radiological emissions would not exceed the national emission standards for hazardous air pollutants.

During nuclear power plant operations, workers and members of the public would face unavoidable exposure to low levels of radiation as well as hazardous and toxic chemicals. Workers would be exposed to radiation and chemicals associated with routine plant operations and the handling of nuclear fuel and waste material. Workers would have higher levels of exposure than members of the public, but doses would be administratively controlled and would not exceed regulatory standards or administrative control limits. In comparison, the alternatives involving the construction and operation of a non-nuclear power-generating facility would also result in unavoidable exposure to hazardous and toxic chemicals, for workers and the public.

The generation of spent nuclear fuel and waste material, including low-level radioactive waste, hazardous waste, and nonhazardous waste, would be unavoidable. Hazardous and nonhazardous wastes would be generated at some non-nuclear power-generating facilities. Wastes generated during plant operations would be collected, stored, and shipped for suitable treatment, recycling, or disposal in accordance with applicable Federal and State regulations. Due to the costs of handling these materials, the NRC staff expects that power plant operators would optimize all waste management activities and operations in a way that generates the smallest possible amount of waste.

3.18.2 Relationship between Short-Term Use of the Environment and Long-Term Productivity

The operation of power-generating facilities would result in short-term uses of the environment, as described in Sections 3.2 through 3.13 (see sections titled, “Proposed Action”). Short term is the period of time when continued power-generating activities take place.

Power plant operations require short-term use of the environment and commitment of resources (e.g., land and energy), indefinitely or permanently. Certain short-term resource commitments are substantially greater under most energy alternatives, including LR, than under the no-action alternative because of the continued generation of electrical power and the continued use of generating sites and associated infrastructure. During operations, all energy alternatives entail similar relationships between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

Air emissions from nuclear power plant operations introduce small amounts of radiological and nonradiological emissions to the region around the nuclear power plant site. Over time, these emissions would result in increased concentrations and exposure, but the NRC staff does not expect that these emissions would affect air quality or radiation exposure to the extent that they would impair public health and long-term productivity of the environment.

Continued employment, expenditures, and tax revenues generated during power plant operations directly benefit local, regional, and State economies over the short term. Local governments investing project-generated tax revenues into infrastructure and other required services could enhance economic productivity over the long term.

The management and disposal of spent nuclear fuel, low-level radioactive waste, hazardous waste, and nonhazardous waste require an increase in energy and consume space at treatment, storage, or disposal facilities. Regardless of the location, the use of land to meet waste disposal needs would reduce the long-term productivity of the land.

Power plant facilities are committed to electricity production over the short term. After decommissioning these facilities and restoring the area, the land could be available for other future productive uses.

3.18.3 Irreversible and Irretrievable Commitment of Resources

Resource commitments are irreversible when primary or secondary impacts limit the future options for use of a resource. For example, the consumption or loss of nonrenewable resources is irreversible. An irretrievable commitment refers to the use or consumption of resources for a period of time (e.g., for the duration of the action under consideration) that are neither renewable nor recoverable for future use. Irreversible and irretrievable commitments of resources for electrical power generation include the commitment of land, water, energy, raw materials, and other natural and human-made resources required for power plant operations. In general, the commitments of capital, energy, labor, and material resources are also irreversible.

The implementation of any of the replacement energy alternatives considered in this SEIS would entail the irreversible and irretrievable commitments of energy, water, chemicals, and—in some cases—fossil fuels. These resources would be committed during the LR term and over the entire life cycle of the power plant, and they would be unrecoverable.

Energy expended would be in the form of fuel for equipment, vehicles, power plant operations, and electricity for equipment and facility operations. Electricity and fuel would be purchased from offsite commercial sources. Water would be obtained from existing water supply systems or withdrawn from surface water or groundwater. These resources are readily available, and the NRC staff does not expect that the amounts required would deplete available supplies or exceed available system capacities.

4 CONCLUSION

4.1 Environmental Impacts of License Renewal

This draft SEIS contains the environmental review of the application for renewed operating licenses for Browns Ferry. After reviewing the site-specific (Category 2) environmental issues in this draft SEIS, the NRC staff concluded that issuing renewed licenses for Browns Ferry would have SMALL impacts for the Category 2 issues applicable to the SLR at Browns Ferry. The NRC staff considered mitigation measures for each Category 2 issue, as applicable. The NRC staff concluded that no additional mitigation measure is warranted.

4.2 Comparison of Alternatives

In Chapter 2, the NRC staff considered alternatives to issuing renewed operating licenses for Browns Ferry. Based on the review presented in this draft SEIS, the NRC staff concludes that the environmentally preferred alternative is the proposed action. The NRC staff recommends that renewed Browns Ferry operating licenses be issued. As shown in Table 2-1, all replacement power alternatives have impacts in more than one resource area that are greater than SLR, in addition to the environmental impacts inherent to new construction projects. To make up the lost power generation if the NRC does not issue renewed licenses for Browns Ferry (i.e., the no-action alternative), energy decision-makers may implement one of the replacement power alternatives discussed in Chapter 2, or a comparable alternative capable of replacing the power generated by Browns Ferry.

4.3 Recommendation

The NRC staff's preliminary recommendation is that the adverse environmental impacts of SLR for Browns Ferry are not so great that preserving the option of SLR for energy-planning decision-makers would be unreasonable. This preliminary recommendation is based on the following:

- the analysis and findings in the LR GEIS
- the ER submitted by the applicant
- the EIS prepared by the applicant
- the NRC staff's consultation with Federal, State, Tribal, and local agencies
- the NRC staff's independent environmental review
- the NRC staff's consideration of public comments received during the scoping process

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6 LIST OF PREPARERS

Table 6-1 List of Preparers

Name	Education and Experience
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Lloyd Desotell, NRC	MS Civil Engineering MS Water Resources Management BA Environmental Studies Over 20 years of experience conducting surface and subsurface hydrologic analyses.
Peyton Doub, NRC	MS Plant Physiology BS Plant Sciences (Botany) Professional Wetland Scientist Certified Environmental Professional Duke NEPA Certificate 37 years of relevant experience.
Brian Glowacki, NRC	BS Environmental Engineering +5 years of experience.
Caroline Hsu, NRC	BS Molecular Biology BA English Literature 13 years of government experience.
Steve Koenick, NRC	MS Environmental Engineering BS Mechanical Engineering Over 30 years of government experience.
Sarah Lopas, NRC	MPA Environmental Policy BA Molecular Biology and Environmental Science 23 years of combined industry and government experience in environmental reviews, and licensing and rulemaking project management.
Nancy Martinez, NRC	BS Earth and Environmental Science AM Earth and Planetary Science 13 years of experience in environmental impact analysis.
Donald Palmrose, NRC	PhD Nuclear Engineering MS Nuclear Engineering BS Nuclear Engineering 39 years of experience including operations on U.S. Navy nuclear powered surface ships, NEPA analyses, nuclear safety and material reviews, U.S. Department of Energy nuclear authorization basis support, and NRC project management.

Table 6-1 List of Preparers (Continued)

Name	Education and Experience
Leah Parks, NRC	PhD Environmental Management MS Environmental Engineering BS Systems and Information Engineering 17 years of academic and government experience including nuclear power plant operations, health physics, decommissioning, waste management, environmental impact analysis, and performance assessment.
Jeffrey Rikhoff	MRP Regional Environmental Planning MS Development Economics BA English 44 years of combined industry and government experience in NEPA compliance for DOE Defense Programs/NNSA and Nuclear Energy, DoD, and DOI; project management; land use, socioeconomics, historic and cultural resource impact assessments, consultation with American Indian Tribes, and comprehensive land use and industrial development planning studies.
Angela Sabet, NRC	MS Civil Engineering BS Geology 19+ years of project management in Construction, environmental compliance, and power projects, certified hazardous materials manager, design-build professional, leadership in energy and environmental design advanced professional building design and construction, envision sustainability professional.
Jay Robinson, NRC	BS Fire Safety AAS Fire Science Technology 30+ years' experience in fire protection, risk assessment, nuclear power plant operations, government, and project management.
Gerry Stirewalt, NRC	PhD Structural Geology 2 post-doctoral appointments BA Geology/Mathematics Registered PG and CEG 50+ years relevant experience in Environmental and Engineering Geology, including 3-D geospatial modeling of subsurface stratigraphy, tectonic faults, and groundwater contaminant plumes.
Jessica Umaña, NRC	BS Geography and Environmental Systems 25+ years project management experience
Teresa Carlon, PNNL	BS Information Technology 30+ years of experience as SharePoint administrator, project coordinator, and databases.
Kirsten Chojnicki, PNNL	PhD Geological Sciences; MS Geological Sciences; BS Earth and Space Science; 8 years management experience, 10+ years of experience in geology, 4 years of experience in environmental impact analysis.
Caitlin Condon, PNNL	PhD Radiation Health Physics; BS Environmental Health; 7 years of experience including health physics, project management, NEPA environmental impact assessments, waste management, radionuclide dispersion and dosimetry modeling.

Table 6-1 List of Preparers (Continued)

Name	Education and Experience
Stephen Ferencz, PNNL	PhD Geosciences (Hydrogeology/Hydrology) MA Earth Sciences BA Geology 8 years of experience in hydrologic, groundwater, and water systems modeling; 3 years of experience in environmental remediation and site characterization.
Julia Flaherty, PNNL	MS Environmental Engineering BS Civil Engineering 20+ years of experience in boundary layer meteorology and dispersion modeling. 15+ years of experience in NEPA environmental impact assessments.
Tracy Fuentes, PNNL	PhD Urban Design and Planning MS Plant Biology BS Botany Over 15 years of experience, including NEPA planning; environmental impact analysis, environmental resource monitoring, data analysis, and research.
Lexie Goldberger, PNNL	MS Atmospheric Sciences BS Geophysical Sciences 10+ years of experience including NEPA environmental impact assessments, field deployments, data analysis, and research.
Dave Goodman, PNNL	JD Law BS Economics 15 years of experience including NEPA environmental impact assessments, ecological restoration, Endangered Species Act, land use and visual resources, and environmental law and policy.
Leah Hare, PNNL	MS Geographic Information Science BS Environmental Studies 10+ years of experience in environmental monitoring, regulatory compliance, project management, and environmental assessment.
Philip Meyer, PNNL	PhD Civil Engineering MS Civil Engineering BA Physics 30+ years relevant experience in subsurface hydrology and contaminant transport, including 15+ years of experience in groundwater resource assessment and environmental impacts analysis.
Dan Nally, PNNL	MA Urban and Environmental Policy and Planning BS Biology 12 years of experience in preparation and review of NEPA documents, related regulatory compliance, and conducting public outreach and engagement.
Michelle Niemeyer, PNNL	MS Agricultural Economics BS Agricultural Economics 15+ years of experience including NEPA environmental impact assessments, project management, economics, and stakeholder engagement.
Mike Parker, PNNL	BA English Literature 25 years of experience copyediting, document design, and formatting and 20 years of experience in technical editing.

Table 6-1 List of Preparers (Continued)

Name	Education and Experience
Rajiv Prasad, PNNL	PhD Civil and Environmental Engineering MTech Civil Engineering BE Civil Engineering 25+ years of experience in applying hydrologic principles to water resources engineering, hydrologic design, flooding assessments, environmental engineering, and impacts assessment including 15+ years of experience in NEPA environmental assessments of surface water resources.
Adrienne Rackley, PNNL	MS Economics BA Business Administration AA General Studies
Lindsey Renaud, PNNL	MA Anthropology BA Anthropology 10+ years in cultural resource management, NEPA environmental impact assessments and Section 106 and 110 compliance. Secretary of the Interior-qualified registered professional archaeologist. Experience in Tribal engagement and Native American Graves Protection and Repatriation Act compliance.
Kacoli Sen, PNNL	PhD Cancer Biology MS Zoology (specialization Ecology) BS Zoology Diploma in Environmental Law Over 7 years of technical and scientific editing and production experience.
Kazi Tamaddun, PNNL	PhD Civil and Environmental Engineering MS Civil and Environmental Engineering BS Civil Engineering (Structure and Geotech) 11 years of experience in hydro-climatology, hydraulics, and water systems modeling, including 4 years of experience in NEPA environmental assessment of surface water resources
Caitlin Wessel, PNNL	PhD Marine Science MS Coastal, Marine, and Wetland Science BS Biology 11 years of relevant experience in environmental impact assessment and aquatic ecology.
Dana Vesty, PNNL	BS Environmental Science PWS (Professional Wetland Scientist) 9 years of experience in environmental assessments, permitting, environmental resource monitoring, and data analysis.

AA = associate degree; AM = Master of Arts; BA = Bachelor of Arts; BE = Bachelor of Engineering; BS = Bachelor of Science; DoD = U.S. Department of Defense; DOE = U.S. Department of Energy; DOI = U.S. Department of Interior; EFH = essential fish habitat; MBA Master of Business Administration; MHP = Master of Public Health; MPM = Master of Project Management; MRP = Master of Regional Planning; MS = Master of Science; MTech = Masters of Technology; NEPA = National Environmental Policy Act of 1969; NNSA = National Nuclear Security Administration; NRC = U.S. Nuclear Regulatory Commission; PhD = Doctor of Philosophy; PMP = Project Management Professional; PNNL = Pacific Northwest National Laboratory.

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7 LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS TO WHOM THE NRC SENDS COPIES OF THIS EIS

Name and Title	Affiliation and Address
Kajumba, Ntale	U.S. Environmental Protection Agency
Hallman, Michael	Alabama Department of Public Health
Gordon, Alison	U.S. Geological Survey
Mangum, Rachael	Advisory Council on Historic Preservation
Denham Downen, Karen	Choctaw Nation of Oklahoma
John, Lisa	The Chickasaw Nation

The NRC staff has listed the names of these commenters in the scoping summary report (Agencywide Documents Access and Management System Accession No. ML24155A084). The commenters were offered an opportunity to receive this SEIS. However, the NRC staff could not send a copy of this SEIS to the commenters who did not provide contact information, and those persons are not listed here. Appendix C lists correspondence with agencies and Tribes, including distribution of the SEIS.

APPENDIX A

COMMENTS RECEIVED ON THE BROWNS FERRY UNIT 1, 2, AND 3 ENVIRONMENTAL REVIEW

A.1 Comments Received During the Scoping Period

The U.S. Nuclear Regulatory Commission (NRC) staff conducted a scoping process for the environmental review of the Browns Ferry Nuclear Plant (Browns Ferry) Unit 1, 2 and 3, licenses renewal application in accordance with the National Environmental Policy Act of 1969 (TN661) (NEPA). The scoping process began on April 3, 2024, with publication of the NRC's notice of intent in the *Federal Register* (89 FR 23056-TN11357). In its notice of intent, the NRC requested that members of the public and stakeholders submit comments on the scope of the environmental review for the proposed Browns Ferry Unit 1, 2 and 3, licenses renewal.

The scoping process included two virtual public scoping meetings on April 11, 2024 and on April 18, 2024. Attendees made oral statements that were recorded and transcribed by a certified court reporter. A summary and transcripts of the public scoping meetings are available in the NRC's Agencywide Documents Access and Management System (ADAMS) under ADAMS Package No. ML24155A042 (NRC 2024-TN11381). The ADAMS Public Electronic Reading Room is accessible at http://www.nrc.gov/reading-rm/adams.html. In addition to the comments received during the public meetings, comments were also received electronically via Regulations.gov and email.

At the conclusion of the scoping process, the NRC staff issued a scoping summary report ML24155A084 (NRC 2024-TN11556). The report contains comments received during the public meetings and electronically during the scoping period as well as the NRC staff's consideration of these comments.

A.2 References

89 FR 23056. April 3, 2024. "Notice of Intent To Conduct Scoping Process and Prepare Environmental Impact Statement; Tennessee Valley Authority; Browns Ferry Nuclear Plant, Units 1, 2, and 3." *Federal Register*, Nuclear Regulatory Commission. TN11357.

National Environmental Policy Act of 1969 (NEPA), as amended. 42 U.S.C. § 4321 et seq. TN661.

NRC (U.S. Nuclear Regulatory Commission). 2024. Environmental Impact Statement Scoping Process Summary Report Browns Ferry, Units 1, 2 and 3 Limestone County, Alabama. Rockville, Maryland. ADAMS Accession No. ML24155A084. TN11556.

NRC (U.S. Nuclear Regulatory Commission). 2024. Memorandum from J.M. Umana, Project Manager, Environmental Project Management Branch 1, Division of Rulemaking, Environmental, and Financial Support, Office of Nuclear Material Safety and Safeguards, to S.S. Koenick, Chief, Environmental Project Management Branch 1, Division of Rulemaking, Environmental, and Financial Support, Office of Nuclear Material Safety and Safeguards, dated June 13, 2024, regarding "Meeting Summary: Public Scoping Webinars for the Environmental Review of the Subsequent License Renewal Application for Browns Ferry Nuclear Plant, Units

1 1, 2, and 3 (EPID Number: L-2024-SLE-0000) (Docket Numbers: 50-259, 50-260, and 50-296)."
2 Washington, D.C. ADAMS Accession Package No. ML24155A038. TN11381.

APPENDIX B

APPLICABLE LAWS, REGULATIONS, AND OTHER REQUIREMENTS

B.1 Federal and State Requirements

There are several Federal laws and regulations that affect environmental protection, health, safety, compliance, and consultation at every U.S. Nuclear Regulatory Commission (NRC)-licensed nuclear power plant. Some of these laws and regulations require permits by or consultations with other Federal agencies or State, Tribal, or local governments. Certain Federal environmental requirements have been delegated to State authorities for enforcement and implementation. Furthermore, States have also enacted laws to protect public health and safety and the environment. It is the NRC's policy to make sure nuclear power plants are operated in a manner that provides adequate protection of public health and safety and protection of the environment through compliance with applicable Federal and State laws, regulations, and other requirements, as appropriate.

The Atomic Energy Act of 1954, as amended (AEA) (TN663) and the Energy Reorganization Act of 1974, as amended (TN4466), give the NRC the licensing and regulatory authority for commercial nuclear energy use. They allow the NRC to establish dose and concentration limits for protection of workers and the public for activities under NRC jurisdiction. The NRC implements its responsibilities under the AEA through regulations set forth in Title 10, "Energy," of the *Code of Federal Regulations* (CFR). The AEA also authorizes the NRC to enter into an agreement with any State that allows the State to assume regulatory authority for certain activities (TN10029). A State that enters into such an agreement with the NRC is called an Agreement State, which assumes regulatory responsibility over certain byproducts, sources, and quantities of special nuclear materials not sufficient to form a critical mass. The Alabama Office of Radiation Control Alabama Emergency Management Agency administers the Alabama State Program.

In addition to carrying out some Federal programs, State legislatures develop their own laws. State statutes can supplement, as well as implement, Federal laws for protection of air, surface water, and groundwater. State legislation may address solid waste management programs, locally rare or endangered species, and historic and cultural resources.

The U.S. Environmental Protection Agency (EPA) has the primary responsibility to administer the Clean Water Act, as amended (TN662). The National Pollutant Discharge Elimination System (NPDES) program addresses water pollution by regulating the discharge of potential pollutants to waters of the United States. The Clean Water Act (CWA) allows for primary enforcement and administration through State or Tribal agencies, as long as the State program is at least as stringent as the Federal program. EPA has delegated the authority to issue NPDES permits to the Alabama Department of Environmental Management.

1 **Table B-1 Federal and State Requirements**

Category Law or Regulation	Requirements
Current Operating License and License Renewal Atomic Energy Act, 42 U.S.C. 2011 et seq.	The AEA of 1954, as amended, and the Energy Reorganization Act of 1974 (42 U.S.C. 5801 et seq.) give the NRC the licensing and regulatory authority for nuclear energy uses within the commercial sector. They give the NRC responsibility for licensing and regulating commercial uses of atomic energy and allows the NRC to establish dose and concentration limits for protection of workers and the public for activities under NRC jurisdiction. The NRC implements its responsibilities under the AEA through regulations set forth in Title 10 of the CFR.
Current Operating License and License Renewal National Environmental Policy Act of 1969, 42 U.S.C. 4321 et seq.	NEPA, as amended, requires Federal agencies to integrate environmental values into their decision-making process by considering the environmental impacts of proposed Federal actions and reasonable alternatives to those actions. NEPA establishes policy, sets goals (in Section 101), and provides means (in Section 102) for carrying out the policy. NEPA Section 102(2) contains action-forcing provisions to ensure that Federal agencies follow the letter and spirit of the Act. For major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of NEPA requires Federal agencies to prepare a detailed statement that includes the environmental impacts of the proposed action and other specified information.
Current Operating License and License Renewal 10 CFR Part 20	Regulations in 10 CFR Part 20, "Standards for Protection Against Radiation," establish standards for protection against ionizing radiation resulting from activities conducted under licenses issued by the NRC. These regulations are issued under the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, as amended. The purpose of these regulations is to control the receipt, possession, use, transfer, and disposal of licensed material by any licensee in such a manner that the total dose to an individual (including doses resulting from licensed and unlicensed radioactive material and from radiation sources other than background radiation) does not exceed the standards for protection against radiation prescribed in the regulations in this part.
Current Operating License and License Renewal 10 CFR Part 50	Regulations in 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," are NRC regulations issued under the Atomic Energy Act, as amended, and Title II of the Energy Reorganization Act of 1974, to provide for the licensing of production and utilization facilities, including power reactors.
Current Operating License and License Renewal 10 CFR Part 51	Regulations in 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," contain the NRC's regulations that implement NEPA.
Current Operating License and License Renewal 10 CFR Part 54	NRC regulations in 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," govern the issuance of renewed operating licenses and renewed combined licenses for nuclear power plants licensed under Sections 103 or 104b of the AEA, as amended, and Title II of the Energy Reorganization Act of 1974. The regulations focus on managing adverse effects of aging. The rule is intended to ensure that important systems, structures, and components will continue to perform their intended functions during the period of extended operation.

Table B-1 Federal and State Requirements (Continued)

Category Law or Regulation	Requirements
Air Quality Protection Clean Air Act, 42 U.S.C. 7401 et seq.	The CAA is intended to "protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population." The CAA establishes regulations to ensure maintenance of air quality standards and authorizes individual States to manage permits. Section 118 of the CAA requires each Federal agency, with jurisdiction over properties or facilities engaged in any activity that might result in the discharge of air pollutants, to comply with all Federal, State, interstate, and local requirements with regard to the control and abatement of air pollution. Section 109 of the CAA directs the EPA to set NAAQS for criteria pollutants. The EPA has identified and set NAAQS for the following criteria pollutants: particulate matter, sulfur dioxide, carbon monoxide, ozone, nitrogen dioxide, and lead. Section 111 of the CAA requires the establishment of national performance standards for new or modified stationary sources of atmospheric pollutants. Section 160 of the CAA requires that specific emission increases must be evaluated before permit approval to prevent significant deterioration of air quality. Section 112 requires specific standards for release of hazardous air pollutants (including radionuclides). These standards are implemented through plans developed by each State and approved by the EPA. The CAA requires sources to meet standards and obtain permits to satisfy those standards. Nuclear power plants may be required to comply with the CAA Title V, Sections 501–507, for sources subject to new source performance standards or sources subject to National Emission Standards for Hazardous Air Pollutants. EPA regulates the emissions of air pollutants using 40 CFR Parts 50 to 99.
Water Resources Protection Clean Water Act, 33 U.S.C. 1251 et seq., and the NPDES (40 CFR Part 122)	The CWA was enacted to "restore and maintain the chemical, physical, and biological integrity of the Nation's water." The Act requires all branches of the Federal Government with jurisdiction over properties or facilities engaged in any activity that might result in a discharge or runoff of pollutants to surface waters, to comply with Federal, State, interstate, and local requirements. As authorized by the CWA, the NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. The NPDES program requires all facilities that discharge pollutants from any point source into waters of the United States to obtain an NPDES permit. A nuclear power plant may also participate in the NPDES General Permit for Industrial Stormwater due to stormwater runoff from industrial or commercial facilities to waters of the United States. EPA is authorized under the CWA to directly implement the NPDES program; however, EPA has authorized many States to implement all or parts of the national program. Section 401 of the CWA requires States to certify that the permitted discharge would comply with all limitations necessary to meet established State water quality standards, treatment standards, or schedules of compliance. The USACE is the lead agency for enforcement of CWA wetland requirements (33 CFR Part 320, "General Regulatory Policies"). Under Section 401 of the CWA, EPA or a delegated State agency has the authority to review and approve, condition, or deny all permits or licenses that might result in a discharge to waters of the State, including wetlands.
Water Resources Protection	Congress enacted the CZMA in 1972 to address the increasing pressures of over-development upon the Nation's coastal resources. The National

Table B-1 Federal and State Requirements (Continued)

Category Law or Regulation	Requirements
Coastal Zone Management Act of 1972, as amended (16 U.S.C. 1451 et seq.)	Oceanic and Atmospheric Administration administers the Act. The CZMA encourages States to preserve, protect, develop, and, where possible, restore or enhance valuable natural coastal resources such as wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as the fish and wildlife using those habitats. Participation by States is voluntary. To encourage States to participate, the CZMA makes Federal financial assistance available to any coastal State or territory, including those on the Great Lakes, as long as the State or territory is willing to develop and implement a comprehensive coastal management program.
Water Resources Protection Wild and Scenic Rivers Act, 16 U.S.C. 1271 et seq.	The Wild and Scenic Rivers Act created the National Wild and Scenic Rivers System, which was established to protect the environmental values of free-flowing streams from degradation by impacting activities, including water resources projects.
Waste Management and Pollution Prevention Resource Conservation and Recovery Act, 42 U.S.C. 6901 et seq.	The RCRA requires EPA to define and identify hazardous waste; establish standards for its transportation, treatment, storage, and disposal; and require permits for persons engaged in hazardous waste activities. Section 3006, “Authorized State Hazardous Waste Programs” (42 U.S.C. 6926), allows States to establish and administer these permit programs with EPA approval. EPA regulations implementing RCRA are found in 40 CFR Parts 260 through 283. Regulations imposed on a generator or on a treatment, storage, and/or disposal facility vary according to the type and quantity of material or waste generated, treated, stored, and/or disposed. The method of treatment, storage, and/or disposal also impacts the extent and complexity of the requirements.
Waste Management and Pollution Prevention Pollution Prevention Act, 42 U.S.C. 13101 et seq.	The Pollution Prevention Act establishes a national policy for waste management and pollution control that focuses first on source reduction, then on environmental issues, safe recycling, treatment, and disposal.
Protected Species Endangered Species Act, 16 U.S.C. 1531 et seq.	The ESA was enacted to prevent the further decline of endangered and threatened species and to restore those species and their critical habitats. Section 7, “Interagency Cooperation,” of the Act requires Federal agencies to consult with the FWS or the NMFS on Federal actions that may affect listed species or designated critical habitats.
Protected Species Magnuson–Stevens Fishery Conservation and Management Act, 16 U.S.C. 1801 et seq.	The Magnuson–Stevens Fishery Conservation and Management Act, as amended, governs marine fisheries management in U.S. Federal waters. The Act created eight regional fishery management councils and includes measures to rebuild overfished fisheries, protect essential fish habitat, and reduce bycatch. Under Section 305 of the Act, Federal agencies are required to consult with the National Marine Fisheries Service for any Federal actions that may adversely affect essential fish habitat.

Table B-1 Federal and State Requirements (Continued)

Category Law or Regulation	Requirements
Historic and Cultural Resources National Historic Preservation Act, 54 U.S.C. 100101 et seq. (formerly 16 U.S.C. 470 et seq.)	The National Historic Preservation Act was enacted to create a national historic preservation program, including the National Register of Historic Places and the ACHP. Section 106 of the Act requires Federal agencies to take into account the effects of their undertakings on historic properties. The Advisory Council on Historic Preservation regulations implementing Section 106 of the Act are found in 36 CFR Part 800, "Protection of Historic Properties." The regulations call for public involvement in the Section 106 consultation process, including involvement from Indian Tribes and other interested members of the public, as applicable.

ACHP = Advisory Council on Historic Preservation; AEA = Atomic Energy Act; BFN = Browns Ferry Nuclear Plant ; CAA = Clean Air Act; CFR = *Code of Federal Regulation*; CWA = Clean Water Act; CZMA = Coastal Zone Management Act of 1972; EPA = U.S. Environmental Protection Agency; FWS = U.S. Fish and Wildlife Service; NAAQS = National Ambient Air Quality Standards; NEPA = National Environmental Policy Act; NMFS = National Marine Fisheries Service; NRC = U.S. Nuclear Regulatory Commission; RCRA = Resource Conservation and Recovery Act; U.S.C. = *U.S. Code*; USACE = U.S. Army Corps of Engineers.

B.2 Operating Permits and Other Requirements

Table B-2 Operating Permits and Other Requirements for Browns Ferry Nuclear Plant

Permit	Responsible Agency	Number	Expiration Date	Authorized Activity
Operating license	NRC	Renewed DPR-33 (Unit 1)	Expires on December 20, 2033	Operation of BFN Unit 1
Operating license	NRC	Renewed DPR-52 (Unit 2)	Expires on June 28, 2034	Operation of BFN Unit 2
Operating license	NRC	Renewed DPR-68 (Unit 3)	Expires on July 2, 2036	Operation of BFN Unit 3
CWA (33 U.S.C. Section 1251 et seq.); 40 CFR 122.26; Alabama, NPDES Permit	ADEM	AL0022080	Issued on: June 7, 2018 Effective Date July 1, 2018 Expires on August 31, 2023, Permit renewal application submitted; renewal anticipated in 2023[(a)]	CWA (33 U.S.C. Section 1251 et seq.); 40 CFR 122.26; Alabama, Discharges to river including cooling waters, fire protection, and storm waters
RCRA, Regulated Waste Permit	ADEM	AL8640015410	Not Applicable	Regulated Waste Permit (hazardous waste, used oil, universal waste permit)
40 CFR 49.158 335-14-01, Minor Source Permit	USEPA; ADEM	708-0003-X003	Issued on: March 2014 Indefinite (valid until system is modified)	Fuel Facility

Table B-2 Operating Permits and Other Requirements for Browns Ferry Nuclear Plant (Continued)

Permit	Responsible Agency	Number	Expiration Date	Authorized Activity
AL Codes 22-22A-1 through 22-22a-17, Synthetic Minor Permit	ADEM	708-0003-X005	Issued on: November 2020 Indefinite (valid until system is modified)	Synthetic minor permit (i.e., emergency diesel generators, auxiliary boilers)
State of Tennessee Department of Environment & Conservation	TDEC	T-AL002-L22	Renewed Annually	Radioactive material shipments
Health/Safety Code 401.52 and Admin Code 289.257	Texas DSHS	W0019	Issued on: July 2022 Expires: June 2032	Radioactive material shipments
UT Administrative Codes R313-26 and R313-19	UDEC	1505009347	Renewed annually	Radioactive material shipments
TVA Act of 1933, Tennessee River Management	TVA	NA	NA	Use of Wheeler Reservoir water
42 U.S.C. 7401 et seq., CAA	EPA	Certificate	NA	Federal law that regulates air emissions from stationary and mobile sources.
Section 10	Rivers and Harbors Act of 1899	Authorization	NA	Federal agency issuing a license must consider cultural impacts and consult with SHPO.
CWA Section 401 (33 U.S.C. 1341) (33 U.S.C. 1344) (Section 404)	ADEM	Certification	NA	Applicant seeking Federal license for a project with discharge to State waters must obtain either State certification that proposed action would comply with applicable State water quality standards, or a waiver. Actions involving wetlands and/or stream crossings would be subject to Federal Clean Water Act Section 404 permit requirements

Table B-2 Operating Permits and Other Requirements for Browns Ferry Nuclear Plant (Continued)

Permit	Responsible Agency	Number	Expiration Date	Authorized Activity

NRC = U.S. Nuclear Regulatory Commission ; CAA = Clean Air Act; BFN = Browns Ferry Nuclear Plant; CWA = Clean Water Act; ADEM = Alabama Department of Environmental Management; USEPA = United States Environmental Protection Agency; TDEC = State of Tennessee Department of Environment & Conservation; Texas DSHS = Texas Department of State Health Services; UDEC = Universal Distinct Element Code; N/A = not available; NPDES = National Pollutant Discharge Elimination System; RCRA = Resource Conservation and Recovery Act; TVA = Tennessee Valley Authority; U.S.C. = United States Code; UDEQ = Utah Department of Environmental Quality, RCRA = Resource Conservation and Recovery Act.
(a) TVA currently working on addendum, for permit.
Source: TVA 2025-TN11355.

B.3 References

42 U.S.C. § 2021 et seq. U.S. Code Title 42, Public Health and Welfare, Section 2021, "Cooperation with States." TN10029.

Atomic Energy Act of 1954. 42 U.S.C. § 2011 et seq. Public Law 112-239, as amended. TN663.

Energy Reorganization Act of 1974, as amended. 42 U.S.C. § 5801 et seq. TN4466.

Federal Water Pollution Control Act of 1972 (commonly referred to as the Clean Water Act). 33 U.S.C. § 1251 et seq. TN662.

APPENDIX C

CONSULTATION CORRESPONDENCE

C.1 Endangered Species Act Section 7 Consultation

As a Federal agency, the U.S. Nuclear Regulatory Commission (NRC) must comply with the Endangered Species Act of 1973 (ESA), as amended (TN1010), as part of any action authorized, funded, or carried out by the agency. In this case, the proposed agency action is whether to issue subsequent renewed facility operating licenses for the continued operation of Browns Ferry Nuclear Plant (Browns Ferry) Units 1,2, and 3. The proposed action would authorize Tennessee Valley Authority to operate Browns Ferry for an additional 20 years beyond the current renewed operating license term. Under Section 7 of the ESA, the NRC must consult with the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) ("the Services" [collectively] or "Service" [individually]), as appropriate, to ensure that the proposed action is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat.

C.2 Federal Agency Obligations under Section 7 of the Endangered Species Act

The ESA and the regulations that implement ESA Section 7 at Title 50 of the *Code of Federal Regulations* (CFR) Part 402 (TN4312) describe the consultation process that Federal agencies must follow in support of agency actions. As part of this process, the Federal agency shall either request that the Services (1) provide a list of any listed or proposed species or designated or proposed critical habitats that may be present in the action area, or (2) request that the Services concur with a list of species and critical habitats that the Federal agency has created (50 CFR 402.12(c)) (TN4312). If any such species or critical habitats may be present, the Federal agency prepares a biological assessment to evaluate the potential effects of the action and determine whether the species or critical habitats are likely to be adversely affected by the action (50 CFR 402.12(a)-TN4312; 16 *United States Code* [U.S.C.] 1536(c)-TN4459).

Biological assessments are required for any agency action that is a "major construction activity" (50 CFR 402.12(b)-TN4312). A major construction activity is a construction project or other undertaking having construction-type impacts that is a major Federal action significantly affecting the quality of the human environment under the National Environmental Policy Act of 1969, as amended (TN661) (NEPA) (51 FR 19926-TN7600). Federal agencies may fulfill their obligations to consult with the Services under ESA Section 7 and to prepare a biological assessment, if required, in conjunction with the interagency cooperation procedures required by other statutes, including NEPA (50 CFR 402.06(a)-TN4312). In such cases, the Federal agency should include the results of ESA Section 7 consultation(s) in the NEPA document (50 CFR 402.06(b)-TN4312).

C.2.1 Biological Evaluation

The proposed action of Browns Ferry subsequent license renewal (SLR) does not require the preparation of a biological assessment because it is not a major construction activity. Nonetheless, the NRC staff must consider the impacts of its actions on federally listed species and designated critical habitats. In cases where the staff finds that SLR "may affect" ESA-protected species or habitats, ESA Section 7 requires the NRC to consult with the relevant

Service(s). To support such consultations, the NRC staff has incorporated its analysis of the potential impacts of the proposed SLR into Section 3.8. The NRC staff refers to its ESA analysis as a "biological evaluation."

The NRC staff structured its biological evaluation in accordance with the Services' suggested biological assessment contents described at 50 CFR 402.12(f) (TN4312). Section 3.8.1.1 describes the action area as well as the ESA-protected species and critical habitats potentially present in the action area. No federally listed species or critical habitats under NMFS jurisdiction occur within the action area (Section 3.8.1.3).

Appendix C.2.3 assesses the potential effects of the proposed Browns Ferry SLR on the ESA-protected species and critical habitats under FWS jurisdiction that are potentially present in the action area and contains the NRC's effect determinations for each of those species and habitats. The results of the NRC staff's analysis for the proposed SLR for these species are summarized below in Table C-1.

As explained in Section 2.4 of this SEIS, NRC incorporates by reference the replacement energy alternatives evaluated in Tennessee Valley Authority's (TVA's) 2023 Browns Ferry SLR supplemental environmental impact statement (SEIS) (TVA 2023-TN11043), and also references the energy alternatives described in TVA's environmental report (ER) (TVA 2024-TN11042). TVA's SEIS eliminated stand-alone replacement energy alternatives from detailed study, and instead analyzed the environmental impacts of a combination of replacement energy generating capacity as part of the no-action alternative (should TVA not obtain SLRs for "all three Browns Ferry Nuclear Plant units"). Impacts of the no-action alternative would be as described in the TVA's 2023 Browns Ferry SLR SEIS, inclusive of additional ESA-protected species and critical habitats identified by NRC staff in this SEIS. Table 2-1 summarizes the effects of the no-action alternative on federally protected ecological resources, including ESA-protected species and critical habitats.

C.2.2 Chronology of Endangered Species Act Section 7 Consultation

C.2.2.1 Endangered Species Act Section 7 Consultation with the U.S. Fish and Wildlife Service

Following issuance of this SEIS, the NRC staff will seek the FWS's concurrence for the species for which the NRC determined that the proposed action of Browns Ferry SLR may affect but is not likely to adversely affect (see Table C-1) in accordance with 50 CFR 402.13(c) (TN4312). The final SEIS will list correspondence between the NRC and the FWS pursuant to ESA Section 7. Table C-2 lists the correspondence between the NRC and the FWS pursuant to ESA Section 7 that has transpired to date.

C.2.2.2 Endangered Species Act Section 7 Consultation with the National Marine Fisheries Service

As discussed in Section 3.8.1 and 3.8.4.2, no federally listed species or critical habitats under NMFS's jurisdiction occur within the action area. Therefore, the NRC staff did not engage the NMFS pursuant to ESA Section 7 for the proposed Browns Ferry SLR.

Table C-1 Effect Determinations for Federally Listed Species Under U.S. Fish and Wildlife Service Jurisdiction for Browns Ferry Nuclear Plant Subsequent License Renewal

Species or Critical Habitat	Federal Status[a]	Potentially Present in the Action Area?	Effect Determination[b]	FWS Concurrence Date[c]
gray bat	FE	Yes	NLAA	TBD
Indiana bat	FE	Yes	NLAA	TBD
northern long-eared bat	FE	No	NE	N/A
tricolored bat	FPE	No	NE	N/A
whooping crane	NEP	Yes	NLAA	TBD
eastern hellbender	FPE	No	NE	N/A
monarch butterfly	PFT	Yes	NLAA	N/A
spring pygmy sunfish	FT	No	NE	N/A
slackwater darter	FT	Yes	NLAA	TBD
birdwing pearlymussel	FE	No	NE	N/A
cracking pearlymussel	FE	No	NE	N/A
Cumberlandian combshell	FE	No	NE	N/A
dromedary pearlymussel	FE	No	NE	N/A
fluted kidneyshell	FE	No	NE	N/A
orangefoot pimpleback	FE	No	NE	N/A
pink mucket	FE	Yes	NLAA	TBD
ring pink	FE	No	NE	N/A
rough pigtoe	FE	No	NE	N/A
sheepnose mussel	FE	No	NE	N/A
spectaclecase	FE	Yes	NLAA	TBD
spectaclecase critical habitat	FPD	Yes	NLAA	N/A
Tennesse pigtoe	FPE	Yes	NLAA	N/A
Anthony's riversnail	FE	Yes	NLAA	TBD
armored snail	FE	Yes	NLAA	TBD
slender campeloma	FE	Yes	NLAA	TBD

N/A = not applicable, TBD = to be determined.

(a) Indicates protection status under the Endangered Species Act of 1973, as amended (ESA). FPT = federally proposed for listing as threatened; and FPE = proposed for Federal listing as endangered. EXPN = experimental, non-essential population. FPCH = Federally proposed critical habitat.

(b) The NRC staff makes its effect determinations for federally listed species in accordance with the language and definitions specified in the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) Endangered Species Consultation Handbook (FWS and NMFS 1998-TN1031). NE = not likely to adversely NLAA = may affect but is not likely to adversely affect. NLDAM = may affect but is not likely to destroy or adversely modify.

(c) The Endangered Species Act does not require Federal agencies to seek FWS concurrence for agency actions that are not likely to jeopardize the continued existence of any proposed species.

Table C-2 Endangered Species Act Section 7 Consultation Correspondence for Browns Ferry Nuclear Plant Subsequent License Renewal

Date	Description	ADAMS Accession No.[(a)]
2/27/2025	Alabama Ecological Services Field Office (FWS) to Peyton Doub (NRC), List of threatened and endangered species for proposed Browns Ferry SLR	ML25078A040

ADAMS = Agencywide Documents Access and Management System; ESA = Endangered Species Act; FWS = U.S. Fish and Wildlife Service; LR = license renewal; NRC = U.S. Nuclear Regulatory Commission.
(a) Access these documents through the NRC's ADAMS at http://adams.nrc.gov/wba/.

C.2.3 Effect Determinations for Federally Listed Species Under U.S. Fish and Wildlife Service Jurisdiction for Browns Ferry Subsequent License Renewal

C.2.3.1 Gray Bat (FE) and Indiana Bat (FE)

In Section 3.8.1.2, the NRC staff concludes that gray bat and Indiana bat may occur in the action area in spring, summer, and fall. If present, bat occurrence would be rare and in low abundance. Closest known records are from approximately 10 mi (16 km) from Browns Ferry (TVA 2024-TN11042: p. E3-49 to E3-50). Gray bats are known from two winter caves in Limestone County, the closest of which is approximately 8.7 mi (14 km) from Browns Ferry (TVA 2025-TN11355). Closest known Indiana bat record is a cave 10 mi (16 km) away from Browns Ferry, in Lauderdale County, Alabama (TVA 2025-TN11354: Attachment 2).

The gray bat is an insectivorous, migratory bat that roosts colonially in caves and mines year-round (FWS 2009-TN11465, MDC 2019-TN11493). They are also known to use quarries, bridges, and culverts as summer roosts. Hibernacula support typically support thousands of overwintering individuals, have multiple entrances, good air flow, and temperatures between 41°–48°F (5°–9°C). Females form summer maternity colonies consisting of a few hundred to thousands of individuals. Bachelor males segregate to separate summer roosts. Gray bat foraging typically occurs nocturnally along rivers, streams, lakes, and reservoirs. They specialize on aquatic insects (e.g., mayflies, caddisflies, and stoneflies), but opportunistically forage upon moths and beetles. Onsite wetlands, streams, and channels provide foraging habitat for gray bats, as does Wheeler Reservoir. No caves, mines, or other gray bat roosting habitat are known to occur on the Browns Ferry site (TVA 2024-TN11042: p. E3-49). Threats include adverse modification of caves, disturbance of individual bats within caves, contamination from pesticides, climate change, and the fungal disease white-nose syndrome (WNS) (*Pseudogymnoascus destructans*).

The Indiana bat is an insectivorous, migratory bat that overwinters colonially in caves and mines (FWS 2007-TN934). In spring, reproductive females migrate and form maternity colonies where they bear and raise their young in wooded areas. Average maternity colony size consists of about 80 adult females. Males and nonreproductive females typically do not roost in colonies and may stay close to their hibernaculum or migrate to summer habitat. Summer roosts are typically behind exfoliating bark of large, often dead, trees, but the species also roosts in bridges, caves, mines, and bat houses. Minimum roost tree diameter is 2.5 in. (6.4 cm) for males and 4.3 in. (11 cm) for females. Roost tree selection appears related to local availability of trees with suitable structure. Of the 33 tree species documented as maternity colony roost trees, most are deciduous. Indiana bat foraging typically occurs nocturnally, in semi-open to closed (open understory) forested habitats, forest edges, and riparian areas. They specialize on mostly flying insects from four orders: beetles, flies, moths, and caddisflies, but opportunistically

forage upon winged ants and spiders (presumably ballooning individuals) when present in large enough numbers. Onsite forests, wetlands, streams, and channels provide foraging habitat for gray bats, as does Wheeler Reservoir. No caves or mines or winter roost habitat are known to occur on the Browns Ferry site (TVA 2024-TN11042: p. E3-49). Threats include human disturbance of hibernating bats, commercialization of caves where the bats hibernate, loss and fragmentation of summer habitat, pesticides and other contaminants, climate change, and WNS.

TVA has a bat conservation strategy and completed programmatic consultation with FWS for routine operational actions that may affect endangered and threatened bats (TVA 2023-TN11477; FWS 2018-TN11478, FWS 2018-TN11479, FWS 2023-TN11480). TVA's programmatic assessment covers all four bat species listed in Table 3-11 and Virginia big-eared bat (*Corynorhinus townesendii virginianus*) (TVA 2023-TN11477, TVA 2024-TN11042: p. E2-6, Item #6 and FED 2 Attachment 3). FWS issued an incidental take statement (ITS) for Indiana Bat to TVA with the completion of the original consultation in 2018.

The potential stressors that protected bats could experience from the operation of a nuclear power plant (generically) are as follows:

- mortality or injury from collisions with nuclear power plant structures and vehicles
- habitat loss, degradation, disturbance, or fragmentation, and associated effects
- behavioral changes resulting from refurbishment or other site activities

This section addresses each of these stressors below.

Mortality or Injury from Collisions with Nuclear Power Plant Structures and Vehicles

Listed bats can be vulnerable to mortality or injury from collisions with buildings, structures and vehicles. Bat collisions with human-made structures at nuclear power plants are not well-documented but are likely rare based on available information in NUREG-1437, Revision 2, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Final Report* (LR GEIS), dated August 2024 (NRC 2024-TN10161: Section 3.6.3.1). The impacts associated with this SLR would be similar to those described in the LR GEIS (NRC 2024-TN10161), which is incorporated by reference.

Browns Ferry has five buildings or structures onsite that are at least 100 ft (31 m) above ground level (TVA 2024-TN11042: p. E2-3 to E2-4): the off gas stack (600 ft [182.9 m]), the guyed MET (meteorology) tower (298.6 ft [91 m]), free-standing cell phone communication tower (230 ft [70 m]), the reactor building (143 ft [44 m]), and the turbine building (104 ft [32 m]). To date, TVA has reported no incidents of injury or mortality of any species of bat on the Browns Ferry site associated with site buildings or structures. Accordingly, the NRC staff finds the likelihood of future gray bat or Indiana bat collisions with site buildings or structures to be extremely unlikely and, therefore, discountable.

Vehicle collision risk for bats varies depending on factors including time of year, location of roads and travel pathways in relation to roosting and foraging areas, the characteristics of individuals' flight, traffic volume, and whether young bats are dispersing. Although collision has been documented for several species of bats, neither gray nor Indiana bat seem particularly susceptible to vehicle collisions (MDC 2019-TN11493; FWS 2007-TN934). However, the FWS also finds it difficult to determine whether roads pose a greater risk for bats colliding with vehicles or a greater likelihood of decreasing risk of collision by deterring bat activity.

During the proposed Browns Ferry SLR term, vehicular traffic from truck deliveries, site maintenance activities, and personnel commuting to and from the site would continue throughout the SLR period as they have during the current licensing period. Vehicle use would occur primarily in areas that bats would be less likely to frequent, such as along established county and State roads or within industrial-use areas of the Browns Ferry site. Additionally, most vehicle activity would occur during daylight hours when bats are less active. There have been no documented bat incidents, including mortality or injury from collisions with plant structures and vehicles, at the Browns Ferry site (TVA 2024-TN11042: p. E2-5). If any were encountered, TVA would follow guidelines for reporting and handling dead or injured federally protected bats (TVA 2024-TN11042: p. E2-5). Accordingly, the NRC staff finds the likelihood of future bat collisions with vehicles to be extremely unlikely and, therefore, is not considered further.

Habitat Loss, Degradation, Disturbance, or Fragmentation, and Associated Effects

As previously discussed in this EIS, the Browns Ferry action area includes habitats that federally protected bats may rarely to occasionally inhabit in spring, summer, and fall. No caves, mines, or other hibernation or roosting habitat for gray bats occurs on the Browns Ferry site (TVA 2024-TN11042: p. E3-49), so proposed SLR activities would not impact any gray bat hibernation or roosting sites. Trees on the Browns Ferry site could serve as summer roosting habitat for Indiana bat, but none are currently known from the site.

The Browns Ferry site provides potential foraging habitat for both species. TVA does not propose any construction, land clearing, or other ground-disturbing activities that would affect forest, wetland, or riparian habitats. Other vegetation maintenance on the site over the course of the proposed SLR term would be of grassy, mowed areas between buildings and along walkways within the industrial portion of the site (TVA 2024-TN11042: Sections 2.2.2 and 4.6.1.1). Compliance with TVA's bat conservation strategy project review protocols and guidance, the NPDES permit, and other regulatory requirements including stormwater pollution prevention plan (SWPPP), best management practices (BMPs), and industrial pollution prevention program (IPPP) will minimize the impacts on and would maintain over foraging habitat during the SLR term.

Approximately 111.4 ac (45.1 ha) of forests scattered around the Browns Ferry site could provide potential summer roosting habitat for Indiana bat (TVA 2024-TN11042: p. E3-49). The proposed action does not involve forest removal or management and generally would not disturb the existing forested habitat on the site. Negative impacts on bats could result if roost trees are removed. Bats could also be directly injured during tree clearing. When tree removals are necessary, TVA preferentially removes them during the winter season (TVA 2024-TN11042: p. E2-5 to E2-6, Tables 1 and 2), when Indiana bats would not be present. Compliance with TVA's bat conservation strategy will minimize impacts on Indiana bats and summer roosting habitat. When necessary, TVA would continue to consult with FWS in separate ESA Section 7 for activities that are outside TVA's bat programmatic consultation, as occurred for tree removals around the meteorology (MET) tower (TVA 2024-TN11042: p. E2-5, Table 1).

The NRC staff finds that infrequent to rare tree removals in forested areas during the proposed LR term would not measurably affect any potential bat habitat in the action area. The continued preservation of the existing forested and natural areas on the site during the SLR term would benefit bats if present within or near the action area.

Behavioral Changes Resulting from Refurbishment or Other Site Activities

Construction or refurbishment and other site activities, including site maintenance and infrastructure repairs, could prompt behavioral changes in bats. Noise, vibration, and general human disturbance are stressors that may disrupt normal feeding, sheltering, and breeding activities (MDC 2022-TN11494). At low noise levels or farther distances, bats initially may be startled but would likely habituate to the low background noise levels. At closer range and louder noise levels, particularly if accompanied by physical vibrations from heavy machinery, many bats would likely be startled to the point of fleeing from their daytime roosts. Fleeing individuals could experience increased susceptibility to predation and would expend increased levels of energy, which could result in decreased reproductive fitness (MDC 2022-TN11494). Increased noise may affect foraging success. Schaub et al. (2008-TN8867) found that the foraging success of the greater mouse-eared bat (*Myotis myotis*) diminished in areas with noise mimicking the traffic sounds that would be experienced within 15 m (49 ft) of a highway.

Within the Browns Ferry action area, noise, vibration, and other human disturbances could dissuade bats from using the action area's habitats during migration, which could also reduce the fitness of gray and Indiana bats (MDC 2019-TN11493). However, bats that use the action area have likely become habituated to such disturbances because Browns Ferry has been consistently operating for several decades. Bats that are repeatedly exposed to predictable, loud noises may habituate to such stimuli over time (MDC 2019-TN11493). For instance, Indiana bats have been documented as roosting within approximately 1,000 ft (300 m) of a busy State route adjacent to Fort Drum Military Installation and immediately adjacent to housing areas and construction activities on the installation (U.S. Army 2014-TN8512). Both gray bats and Indiana bats would likely respond similarly at the Browns Ferry site. Compliance with TVA's bat conservation strategy project review protocols and guidance would minimize impacts that could lead to changes in behavior from site activities.

Continued operation of Browns Ferry during the SLR term would not include major construction or refurbishment and would involve no other maintenance or infrastructure repair activities besides routine activities already performed on the site. Levels and intensity of noise, lighting, and human activity associated with continued day-to-day activities and site maintenance during the SLR term would be similar to ongoing conditions since Browns Ferry began operating, and such activity would only occur on the developed, industrial-use portions of the site. While these disturbances could cause behavioral changes in migrating or summer roosting bats, such as the expenditure of additional energy to find alternative suitable roosts, the NRC staff assumes that gray and Indiana, if present in the action area, have already acclimated to regular site disturbances. Thus, continued disturbances during the SLR term would not cause behavioral changes in bats to a degree that would be able to be meaningfully measured, detected, or evaluated or that would reach the scale where a take might occur.

Summary of Effects

The potential stressors evaluated in this section are unlikely to result in effects on gray or Indiana bats that could be meaningfully measured, detected, or evaluated, and such stressors are otherwise unlikely to occur for the following reasons:

1. Bat collisions with nuclear power plant structures in the United States are rare, and none have been reported at Browns Ferry. Vehicle collisions attributable to the proposed action are also unlikely, and none have been reported at Browns Ferry.

2. The proposed action would not involve any construction, land clearing, or other ground-disturbing activities. Continued preservation of the existing forest habitats on the site would continue to provide terrestrial foraging habitat for both species and roosting habitat for any present Indiana bat individuals.
3. Compliance with the NPDES permit and other regulatory requirements including SWPPP, BMPs, and IPPP will minimize the impact on surface water quality and would maintain over water foraging habitat during the SLR term.
4. Bats, if present in the action area, have likely already acclimated to the noise, vibration, and general human disturbances associated with site maintenance, infrastructure repairs, and other site activities. During the SLR term, such disturbances and activities would continue at current rates and would be limited to the industrial-use portions of the site.

Conclusion for Gray Bat

All potential effects on the gray bat resulting from the proposed action would be insignificant or discountable. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the Indiana bat. Following the issuance of the draft SEIS, the NRC staff will seek the FWS's concurrence with this finding.

Conclusion for Indiana Bat

All potential effects on the Indiana bat resulting from the proposed action would be insignificant or discountable. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the Indiana bat. Following the issuance of the draft SEIS, the NRC staff will seek the FWS's concurrence with this finding.

C.2.3.2 Whooping Crane (EXPN)

In Section 3.8.1.2, the NRC staff concludes that whooping cranes may occur in the action area when moving between areas of more suitable habitat. If present, whooping cranes would occur occasionally and for short periods of time.

Information in this section is drawn from the FWS's species profile (FWS 2023-TN8854) unless otherwise cited. The whooping crane is North America's tallest bird. It is a large snowy white wading bird with black markings on the face. Whooping cranes currently exist in the wild at three locations and in captivity at 12 sites. There is only one self-sustaining wild population, the Aransas–Wood Buffalo National Park population, which nests in Wood Buffalo National Park and adjacent areas in Canada and winters in the coastal marshes of Aransas County, Texas. Whooping cranes overwinter and forage at Wheeler National Wildlife Refuge, Swan Wildlife Management Area, and other wetlands and agricultural fields around Wheeler Reservoir (Cantrell and Wang 2018-TN11482; eBird 2025-TN11481). TVA states no suitable foraging habitat for whooping cranes occurs on the Browns Ferry site and that no whooping cranes have been observed or documented on the Browns Ferry site (TVA 2024-TN11042: p. E2-6 to E2-7).

The primary human drivers affecting the whooping crane habitat include activities that cause a loss of wetlands or the degradation of wetland and riverine habitats (FWS 2023-TN8854). TVA proposes no construction or ground disturbance during the LR term that would impact wetland or riparian habitats. All plant operations would continue to occur within already developed land on the TVA site. TVA would continue to comply with its NPDES permit, and no activities during the SLR term would alter Wheeler Reservoir in a manner that could result in the degradation of

the riverine habitat for whooping cranes. TVA is currently drafting an memorandum of agreement with FWS that will include an Avian Protection Plan (TVA 2024-TN11042: p. E1-26) that would cover all TVA managed lands, not just Browns Ferry.

During the proposed SLR term, vehicular traffic from truck deliveries, site maintenance activities, and personnel commuting to and from the site would continue throughout the SLR term as they have during the current license term. Vehicle use would occur primarily in areas that whooping cranes would be less likely to frequent, such as along established county and State roads or within industrial-use areas of the Browns Ferry site. Accordingly, the NRC staff finds the likelihood of future whooping crane collisions with vehicles to be extremely unlikely and, therefore, is not considered further.

The risk of collisions with tall structures and in-scope transmission lines poses a threat to whooping cranes and other birds. TVA has no reports of whooping crane collisions anywhere within the TVA region (TVA 2024-TN11042: p. E2-6 to E2-7). Although there are many tall buildings and structures on the TVA site (TVA 2024-TN11042: p. E2-3), the NRC staff determined collision risk to be highly unlikely given absence of species, foraging habitat, and collisions on site, and therefore is not considered further.

Summary of Effects

The potential stressors evaluated in this section are unlikely to result in effects on whooping cranes that could be meaningfully measured, detected, or evaluated, and such stressors are otherwise unlikely to occur for the following reasons:

1. The proposed action would not involve any habitat loss, land-disturbing activities, or any activities that would degrade existing natural areas or potential wetland habitat for whooping cranes.
2. Continued preservation of the existing natural areas on the site would result in positive impacts on whooping cranes.
3. Collisions with tall structures or in-scope transmission lines are unlikely. Vehicle collisions attributable to the proposed action are also unlikely, and none have been reported at Browns Ferry.

Conclusion for Whooping Crane

All potential effects on the whooping crane resulting from the proposed action would be insignificant or discountable. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* whooping cranes.

The whooping crane is listed as a non-essential experimental population (EXPN) for the Browns Ferry action area. FWS has determined a non-essential population is not necessary for the continued existence of the species. For the purposes of consultation, EXPN are treated as a proposed species on private land with no section 7(a)(2) requirements, but Federal agencies must not jeopardize their existence (Section 7(a)(4)). Therefore, the NRC staff conclude that Section 7 ESA obligations are fulfilled for this proposed action.

C.2.3.3 Monarch Butterfly (FPT)

In Section 3.8.1.2, the NRC staff concludes that monarch butterflies may occur in the action area during spring, summer, and fall when individuals are moving between areas of suitable habitat. If present, monarchs would occur occasionally and for short periods of time.

The monarch is a large butterfly with bright orange wings and black veining and borders (FWS 2024-TN11177). During the breeding season, females lay eggs on milkweed (primarily *Asclepias* species [spp.]). Developing larvae feed on milkweed, which allows them to sequester toxic chemicals as a defense against predators, before pupating into a chrysalis to transform into the adult butterfly form. Monarchs produce multiple generations each breeding season, and most adult butterflies live 2–5 weeks. Migratory North American populations migrate long distances to overwinter in Mexico or California, enter reproductive diapause, and live 6–9 months. In early spring (February–March), surviving monarchs break diapause and mate at overwintering sites before dispersing. The same individuals that undertook the initial southward migration begin flying back through the breeding grounds, and their offspring restart the cycle of generational migration. No monarchs or milkweed are known from the Browns Ferry site (3.8.4.1), but both are known to occur within 6 mi (10 km) of the Browns Ferry site (iNaturalist 2024-TN11435).

The FWS (2024-TN11177) identifies the primary drivers affecting the health of the two North American migratory populations of monarch butterfly as (1) habitat loss and degradation, (2) insecticide exposure, and (3) climate change effects.

Monarch habitat loss and degradation has resulted from the conversion of grasslands to agriculture, widespread use of herbicides, logging/thinning at overwintering sites in Mexico, deterioration and incompatible management of overwintering sites in California, urban development, and drought. The proposed Browns Ferry SLR would not involve any habitat loss, land-disturbing activities, or any activities that would degrade existing natural areas or potential habitats for monarch butterflies. The continued preservation of existing natural areas on the site would result in positive impacts on monarch butterflies.

Most insecticides are nonspecific and broad-spectrum in nature. Furthermore, the larvae of many Lepidopterans are considered major pest species, and insecticides are specifically tested on this taxon to ensure that they will effectively kill individuals at the labeled application rates (FWS 2024-TN11177). Although insecticide use is most often associated with agricultural production, any habitat where monarchs are found may be subject to insecticide use. Studies looking specifically at the dose response of monarchs to neonicotinoids, organophosphates, and pyrethroids have demonstrated monarch toxicity (e.g., Krischik et al. 2015-TN8596; James 2019-TN8595; Krishnan et al. 2020-TN8597; Bagar et al. 2020-TN8594). Moreover, the magnitude of risk posed by insecticides may be underestimated, as research usually examines the effects of the active ingredient alone, while many of the formulated products contain more than one active insecticide.

During the proposed SLR term, TVA would continue applying herbicides as needed, according to labeled uses. Application would primarily be confined to industrial-use and other developed portions of the site (e.g., perimeters of parking lots, roads, and walkways). Continued herbicide application could directly affect monarchs in the action area by injuring or killing individuals exposed to these chemicals. Certain herbicides such as glyphosate (e.g., Round Up) can kill milkweed, which can affect the ability of female monarchs to lay eggs. Milkweeds exist in the vicinity (iNaturalist 2024-TN11435) and may exist in other undeveloped portions of the action

area. Given the conservation measures listed prior, there will be little to no impact to milkweed populations. Monarchs are only likely to occur in the action area seasonally during spring and fall migration when individuals are moving between areas of more suitable habitat. Because of the low likelihood of monarchs to be exposed to hazardous chemical levels, this potential impact is insignificant because it is unlikely to reach the scale where a take might occur.

Because the current and projected monarch population numbers are low, both the eastern and western populations are more vulnerable to catastrophic events, such as extreme storms at the overwintering habitat, and other climate change related phenomena. The FWS (FWS 2024-TN11177) anticipates that the eastern population will gain habitat in the northcentral region of North America as the species expands northward in response to increasing ambient temperatures. The degree and rate at which this expansion occurs will depend on the simultaneous northward expansion of milkweed. In the southern region of the continent, the population will either experience no gain or some loss of habitat.

Impacts on climate change during normal operations at nuclear power plants can result from the release of greenhouse gases (GHGs) from stationary combustion sources, refrigeration systems, electrical transmission and distribution systems, and mobile sources. However, such emissions are typically very minor because nuclear power plants do not normally combust fossil fuels to generate electricity. During the proposed SLR term, the contribution of TVA operations to climate-change-related effects on monarch butterflies would be too small to be meaningfully measured, detected, or evaluated.

Summary of Effects

The potential stressors evaluated in this section are unlikely to result in effects on monarch butterflies that could be meaningfully measured, detected, or evaluated, and such stressors are otherwise unlikely to occur for the following reasons:

1. The proposed action would not involve any habitat loss, land-disturbing activities, or any activities that would degrade existing natural areas or potential habitat for monarchs.
2. Continued preservation of the existing natural areas on the site would result in positive impacts on monarchs.
3. Herbicides would only be applied according to labeled uses in developed and manicured areas of the site. Herbicides would not be applied in natural areas. Monarchs would only have the potential to occur in the action area seasonally and infrequently, making the likelihood of herbicide exposure low. This represents an insignificant effect because it is unlikely to reach the scale where a take might occur.
4. The contribution of TVA operations to climate-change-related effects on monarchs would be too small to be meaningfully measured, detected, or evaluated.

Conclusion for Monarch Butterfly

All potential effects on the monarch butterfly resulting from the proposed action would be insignificant or discountable. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the monarch butterfly. Because the monarch butterfly is proposed for Federal listing as threatened, the ESA does not require the NRC to consult with or receive concurrence from the FWS regarding this species as long as the continued existence of the species is not jeopardized.

C.2.3.4 Slackwater Darter (FT)

In Section 3.8.1.2, the NRC staff concludes that the threatened slackwater darter has the potential to occur within the action area. Section 3.7.2 describes potential impacts to aquatic species generally in terms of impingent and mortality, thermal impacts, and water use conflicts.

The slackwater darter is a small (1.6 to 2.4 in. or 40 to 60 mm) freshwater fish that has dusky, irregularly spaced blotches on the underside of its head and body, gill membranes that are separate or nearly separate, and a forward opening mouth at the front of its head (ADCNR 2025-TN11495). Adults feed on small aquatic insects and crustaceans.

The slackwater darter only exists in tributary systems of the middle Tennessee River in Tennessee and Alabama (Roy et al. 2019-TN11496). The swan creek watershed in Limestone County, Alabama is upriver of the Browns Ferry site and one of the two confirmed spawning locations of the slackwater darter in Alabama (FWS 2024-TN11436). The darter has two required habitat types, nonbreeding and breeding. Most of the year they live in small to moderately large (12 m [39 ft] wide by 2 m [6 ft] deep) gravel-bottom pools, under leaves or debris, within creeks with slow current (FWS 2008-TN11500). In November, adult slackwater darters migrate to shallow (5 to 10 cm [2.5 to 5 in] deep) breeding habitats around groundwater seeps or natural springs found in flooded, slack water shorelines (FWS 2008-TN11500). Spawning occurs from late January to March and then in April or May the juveniles migrate back to the gravel-bottom pools (ADCNR 2025-TN11495).

The FWS Southeast Region identified 4 threats to the slackwater darter during their 5-year status review in 2024. The primary threats are habitat degradation, which results in declining water quality, and loss of connectivity between breeding and nonbreeding habitats. They also face a threat of loss of breeding habitat to farm ponds and from climate changes to temperature and precipitation.

TVAs fish entrainment sampling, conducted since 1993 in the vicinity of Browns Ferry, has not reported collecting any slackwater darters (TVA 2024-TN11042). Another study which sampled at various locations in 2001–2002, 2007–2008, and 2012–2013 found 2 slackwater darters at 1 location in Swan Creek in Limestone County and 3 locations in Madison County in 2008 (Johnston et al. 2013-TN11543). There is suitable habitat for the slackwater darter present in Shoal Creek, Limestone Creek, and Swan Creek which connect to Wheeler Reservoir upstream of Browns Ferry (Roy et al. 2019-TN11496).

Summary of Effects

The potential stressors evaluated in this section are unlikely to result in effects on slackwater darters that could be meaningfully measured, detected, or evaluated, and such stressors are otherwise unlikely to occur for the following reasons:

- The proposed action would not involve any habitat loss, land-disturbing activities, or any activities that would degrade existing natural areas or potential habitat for slackwater darters.
- The location of slackwater darters and their habitat in tributaries upstream of Browns Ferry means they will not be susceptible to habitat degradation or temperature increases attributable to the plant.

Conclusion for Slackwater Darter

All potential effects on the slackwater darter resulting from the proposed action would be discountable because the darter habitat does not overlap with any areas affected by the operation of Browns Ferry and has not been found in any surveys conducted in the vicinity of Browns Ferry. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the slackwater darter. Following the issuance of the draft SEIS, the NRC staff will seek the FWS's concurrence with this finding.

C.2.3.5 Pink Mucket (FE), Rough Pigtoe (FE), Tennessee Pigtoe (FPE), Sheepnose (FE), Spectaclecase (FE)

In Section 3.8.1.2, the NRC staff concludes that pink mucket, rough pigtoe, Tennessee pigtoe, sheepnose, and spectaclecase have the potential to occur within the action area. TVA conducted mussel surveys in 1991 and in 2021 immediately adjacent to the Browns Ferry. The 2021 survey sampled at 6 downstream and 5 upstream locations, 11 mussel species were found but none of the federally-listed mussel species were collected (TVA 2025-TN11355: Attachment 5). The 1991 survey sampled all of Wheeler Reservoir and none of the federally-listed mussel species were found in the lower section from Wheeler Dam to Decatur, that includes Browns Ferry (TVA 1992-TN11412). Section 3.7.2 describes potential impacts to aquatic species in terms of impingent and mortality, thermal impacts, and water use conflicts.

Freshwater mussels have a complex life cycle and reproductive process. Mussels release sperm into the water column where it is taken in by female mussels for fertilization and development of the larval form called glochidia (FWS 1997-TN11502). Once hatched the parasitic glochidia are released into the water column where they seek a host fish to attach to its gills or fins (Thorp and Rogers 2010-TN11506). If they fail to attach to the correct host fish the glochidia die. Once mature, with shells of their own, the juveniles drop off their host and if they settle into a suitable habitat they will mature into free-living mussels (FWS 1997-TN11502). Freshwater mussels are capable of moving a few feet but otherwise are fairly sedentary (Thorp and Rogers 2010-TN11506). Given this limited mobility the host fish is the primary means for dispersal and are essential for maintaining population connectivity.

The pink mucket inhabits muddy and sandy areas in shallow riffles and shoals in larger rivers and tributaries with free flowing, clean, well-oxygenated water (FWS 1997-TN11502; USDA Undated-TN11544). It buries itself in the bottom, leaving only the edge of its shell and its feeding siphons visible. Since the Tennessee River was impounded to form Wheeler Reservoir pink mucket have only been found in the more river-like upper reaches of the lake, no pink mucket have been found in surveys conducted in the vicinity of Browns Ferry (FWS 1985-TN11545; NRC 2005-TN5192). Primary threats to the pink mucket include habitat loss or fragmentation, pollution (especially chemical spills), invasive species (e.g., zebra mussel), and climate change (e.g., drought and rising temperatures) (FWS 2024-TN11469).

The rough pigtoe is found in sand, gravel, and cobble substrates in the shoals of medium to large rivers (66 ft [20 m] wide or larger) (FWS 1984-TN11457). It does not occur in the impounded sections of rivers (FWS 1984-TN11457). Therefore, like the pink mucket, it is unlikely that the rough pigtoe exists in Wheeler Reservoir in the areas near or downstream from Browns Ferry. One individual was collected near Hobbs Island in 1998, more than 40 mi (64 km) upstream of the plant (TVA 2004-TN11558). The rough pigtoe is considered extremely rare in the Tennessee River mainstem, and very few observations have been made below Guntersville Dam, Alabama since impoundment (FWS 2021-TN11546). The primary threats to rough pigtoe

are impoundments, siltation, pollution, invasive species (e.g., Asian clam, zebra mussel, and carp), and climate change (e.g., drought and rising temperatures) (FWS 1984-TN11457; FWS 2021-TN11546).

The Tennessee pigtoe only occurs within the Tennessee Basin and is found in riffles, shoals, and high gradient streams with stable substrates dominated by coarse sand, gravel, and cobble often in less than 2 ft (0.6 m) of water in small to medium sized rivers (FWS 2020-TN11470). It used to be found in the Tennessee River prior to impoundment but is now only found in Limestone, Swan, and Round Island Creeks (upstream of Browns Ferry) and Second Creek (downstream) (FWS 2020-TN11470; FWS 2023-TN11547). The primary threats to the Tennessee pigtoe have not been evaluated yet since the species is proposed and not listed, but the SSA does list hydrologic alteration and urban development as the primary drivers for the species current condition (FWS 2020-TN11470).

The sheepnose inhabits the shallow areas of larger rivers and streams with moderate to swift currents flowing over coarse sand and gravel but occasionally areas of mud, cobble, or boulders (FWS 2012-TN11461). In larger rivers they can be found in deep runs. Due to the impoundment of the Tennessee River only short, isolated patches of habitat are located below Guntersville Dam and the sheepnose has not been collected in any surveys adjacent to Browns Ferry (FWS 2012-TN11461). Primary threats to the sheepnose include habitat loss and fragmentation, pollution (especially chemical or sewage spills), and invasive species (e.g., zebra mussel) (FWS 2012-TN11461).

The spectaclecase is found in clusters on firm, smooth substrate in sheltered areas of large rivers (e.g., under rocks or tree roots, between boulders) (FWS 2025-TN11548). Other than relict spectaclecase mussel shells found (1991) in the lower portion of Wheeler Reservoir where Browns Ferry is located, live mussels have not been found in surveys adjacent to Browns Ferry, although they are reported to be present in the Wheeler National Wildlife Refuge, about 13 mi (21 km) upstream (FWS 2007-TN11407; TVA 2024-TN11042, TVA 1992-TN11412). Primary threats to the spectaclecase include habitat loss and fragmentation, pollution (especially chemical or sewage spills), and invasive species (e.g. zebra mussel) (FWS 2012-TN11550).

The potential stressors that these five mussel species could experience from the proposed SLR are as follows: (1) water quality impacts; (2) changes in hydrological regime; (3) lack of habitat connectivity; and (4) host species vulnerability.

Water Quality

While none of these mussel species have been reported in the vicinity of or downstream of Browns Ferry, they could be susceptible to indirect effects through impacts to host fish species due to increased temperature at the discharge and current alterations at the intake (e.g., impingement). The potential impacts to fish species are discussed in Section 3.7.2.1 and 3.7.2.2. The NRC staff determined that impingement is unlikely to cause noticeable or detectable impacts during the SLR term (Section 3.7.2.1). In addition, the NRC staff found that thermal impacts, as regulated by the NPDES permit, during the proposed SLR period would neither destabilize nor noticeably alter any important attribute of the aquatic environment (Section 3.7.2.2).

Hydrological Regime

Appropriate flow and temperature are critical to delivering oxygen and nutrients for respiration and filtration, allowing glochidia to move to their host and encyst for reproduction, and for removing silt and other fine sediments from within rock structures and crevices preventing mussel suffocation and degradation of mussel habitat. Normal fluctuation in velocity is expected, but extreme changes can be detrimental. Extreme high flow, associated with flood conditions, can potentially dislodge mussels and destroy habitat. Extreme low flows, associated with drought or water withdrawal, can impact reproduction, feeding, respiration, and, potentially, exposure and desiccation of the mussels.

The proposed SLR has the potential to impact the hydrological regime through continued withdrawal and discharge of water from and back into Wheeler Reservoir. The potential impacts to aquatic species are discussed in Section 3.7.2.3. From 2016 to 2022 Browns Ferry withdrew an average of 2,833 MGD from Wheeler Reservoir with an average water loss of 3.01 MGD, the rest of the water (2,830 MGD) was returned to Wheeler Reservoir through the discharge (TVA 2024-TN11042).

The NRC staff determined that water use conflicts with aquatic resources would either not occur from SLR or would be so minor that the effects on aquatic resources would be undetectable. In addition, TVA manages the Tennessee River system through a series of dams to provide flood control, ensure water supply, and maintain river navigability.

Habitat Connectivity

Artificial barriers affect freshwater mussels through direct effects (such as water temperature and flow changes and habitat alteration) and indirect effects (such as changes to food base and host availability). The proposed SLR will involve the continued discharge of thermal effluent into Wheeler Reservoir, as discussed in Section 3.7.2.2. The thermal plumes resulting from the release of thermal effluent could create barriers to fish passage for the host species. However, since the thermal plume only extends approximately halfway across the lake there is ample space for fish to move past without blocking passage. Therefore, the proposed SLR does not involve any activities that would result in barriers to connectivity for any of the host species.

Host Species Vulnerability

Mussel host species are susceptible to many of the same threats that affect mussels including contaminants, habitat degradation and fragmentation, lack of water quality and quantity, known disease issues or die-offs, and potential overharvest and collection. Impacts to host species have an indirect effect on mussels through the reduction in the abundance and distribution of its host species. Mussel glochidia or larvae are indirectly susceptible to the impingement and entrainment of their host fish. Impingement studies were conducted from 2007 to 2008 and entrainment studies were conducted from 2018 to 2020 at Browns Ferry, details of these studies can be found in Section 3.7.2.1.

Pink mucket relies on walleye, freshwater drum, sauger, and largemouth, smallmouth, and spotted bass as the host for the larval form (MDC Undated-TN11898). The largemouth, smallmouth, and spotted bass have been reported in impingement surveys conducted at Browns Ferry and freshwater drum and sauger have been reported in both the 2007 to 2008 impingement survey and in the 2018 to 2020 study of the entrainment of ichthyoplankton life stages. Tennessee pigtoe is assumed to rely on 10 host species, only 2 of which are reported

as present in Wheeler Reservoir, the striped shiner and the bluntnose minnow. Both were reported in the 2007 to 2008 impingement survey. Sheepnose larvae clump in jelly-like masses which are eaten by fish which are then use as a host, the only confirmed host fish is the sauger (FWS 2012-TN11461). It may also use the fathead minnow (*Pimephales promelas*), creek chub (*Semotilus atrromaculatus*), central stoneroller (*Campostoma anomalum*), and the brook stickleback (*Culaea inconstans*) which are not known to occur in Wheeler Reservoir (see Section 3.7.1.1). The sauger has been reported in both the 2007 to 2008 impingement survey and in the 2018 to 2020 study of the entrainment of ichthyoplankton life stages. Spectaclecase mussels use goldeneye (*Hiodon alosoides*) and mooneye (*Hiodon tergisus*) as hosts for reproduction, although the goldeneye has not been reported in Wheeler Reservoir (FWS 2022-TN11462). The mooneye was reported in the 2007 to 2008 impingement survey. Host fish for the rough pigtoe are unknown.

Of the host species which are found in Wheeler Reservoir both the freshwater drum and sauger have been found to be susceptible to entrainment and freshwater drum, largemouth bass, smallmouth bass, spotted bass, moon eye, and sauger have been found to be susceptible to impingement (TVA 2025-TN11354: Attachment 4). For entrainment, only 1 sauger larvae was collected over the 2-year study and only 429 freshwater drum larvae and 2,511 eggs, for context less than 1 percent of fish larvae and eggs survive to adulthood and for some fish species its less than 0.1 percent. TVA surveys confirmed there are no entrainable shellfish in the vicinity of the Browns Ferry Intake (TVA 2025-TN11354: Attachment 4). For impingement sampling, over the sampling period only 4 mooneye, 6 smallmouth bass, 7 striped shiner, 10 bluntnose minnow, 19 sauger, and 151 largemouth and spotted bass, each of which made up less than 0.1 percent of the total fish impinged. Freshwater drum was slightly higher at 20,909 over the sampling period but still only made-up 0.5 percent of the total. Browns Ferry has already installed modified traveling screens and plans to install a fish return system accompanied by an optimization study during the next NPDES permit cycle in order to meet BTA for impingement (TVA 2025-TN11354: Attachment 4). The fish return system would cut down on the numbers of fish being impinged.

Assuming the results of past impingement and entrainment surveys reflect future conditions, the indirect effect of impingement and entrainment on mussels over the course of the SLR period is likely to be insignificant. Future studies may identify additional natural host species for these mussels that might modify this conclusion.

Summary of Effects

The potential stressors evaluated in this section are unlikely to result in effects on pink mucket, rough pigtoe, Tennessee pigtoe, sheepnose, or spectaclecase that could be meaningfully measured, detected, or evaluated, and such stressors are otherwise unlikely to occur for the following reasons:

- The proposed action would not involve any habitat loss, or any in-water activities that would degrade existing potential habitat for mussels. Any activities that could impact mussels, such as dredging or activities that result in sedimentation, would require a permit and prior authorization.
- The continued discharge of thermal effluent into potential host fish habitat would be regulated by the ADEM to ensure protection of aquatic species. None of the mussels are present adjacent to or downstream of the plant.

- The continuation of operation of Browns Ferry would continue the risk of indirect impacts from the impingement and entrainment of mussel host species. Most of the host species have only been detected in very small numbers during impingement and entrainment sampling with the exception of freshwater drum which is one of six host fish for the pink mucket. While found in moderately low numbers during impingement and entrainment sampling the freshwater drum still only accounted for 0.5 percent of fish caught and Browns Ferry is in the process of installing a fish return system which would further lower this number.

Conclusion for Pink Mucket

The likelihood of the pink mucket occurring within the action area is extremely low, however, the presence and susceptibility of the species host to impingement could impact the species, should individuals be present. The NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the pink mucket. Following the issuance of the draft SEIS, the NRC staff will seek the FWS's concurrence with this finding.

Conclusion for Rough Pigtoe

All potential effects on the rough pigtoe resulting from the proposed action would be insignificant. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the rough pigtoe. Following the issuance of the draft SEIS, the NRC staff will seek the FWS's concurrence with this finding.

Conclusion for Tennessee Pigtoe

All potential effects on the Tennessee pigtoe resulting from the proposed action would be insignificant. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the Tennessee pigtoe. Because the Tennessee pigtoe is proposed for Federal listing as endangered, the ESA does not require the NRC to consult with or receive concurrence from the FWS regarding this species as long as the continued existence of the species is not jeopardized.

Conclusion for Sheepnose

All potential effects on the sheepnose mussel resulting from the proposed action would be insignificant. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the sheepnose mussel. Following the issuance of the draft SEIS, the NRC staff will seek the FWS's concurrence with this finding.

Conclusion for Spectaclecase

All potential effects on the spectaclecase resulting from the proposed action would be insignificant. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the spectaclecase. Following the issuance of the draft SEIS, the NRC staff will seek the FWS's concurrence with this finding.

C.2.3.6 Spectaclecase Proposed Critical Habitat

FWS has proposed 1,143 river mi (1,839 km) in 12 units as critical habitat for spectaclecase (89 FR 101100-TN11378). The action area lies within the proposed critical habitat unit SPCA 8:

Tennessee River, which consists of 142 river mi (228 km) in Alabama and Tennessee. The unit extends from the downstream side of Guntersville Dam (Marshall County, Alabama) downstream to Pickwick Landing Dam (Hardin County, Tennessee). Within these boundaries, the unit includes the river channel up to the ordinary high-water mark. SPCA 8 is occupied by spectaclecase and contains all the physical and biological features essential to the species conservation (Table C-4). Threats to the conservation of the spectaclecase within SPCA 8 include:

- changes to hydrology or water quality from anthropogenic sources, municipal or industrial pollutions, runoff, or sedimentation
- loss of riparian vegetation within the watershed and further development and conversion of bottomlands
- habitat loss from bank degradation or destruction, erosion, and in-water structures such as bridges and dams
- presence of invasive species, especially zebra mussel

The proposed action will not involve any activities that could result in the loss of riparian vegetation within the watershed and further development and conversion of bottomlands or in habitat loss from bank degradation or destruction, erosion, and in-water structures such as bridges and dams. The FWS identifies four physical and biological features of the critical habitat that apply for all proposed critical habitat units (89 FR 101100-TN11378). In Table C-4 the NRC presents the descriptions of each physical and biological feature (PBF) and analyzes the potential effects of the proposed Browns Ferry SLR on each of the four PBFs of the critical habitat.

Table C-3 Effect Determinations for the Physical and Biological Features of Spectaclecase Mussels Proposed Critical Habitat Unit SPCA 8: Tennessee River at Browns Ferry Nuclear Plant

PBF	Analysis	Determination[(a)]
PBF 1: Flow Regime	PBF 1 requires adequate flows or hydrological flow regime (magnitude, timing, frequency, duration, rate of change, and overall seasonality of discharge over time) necessary to maintain benthic habitats where species is found, to maintain stream connectivity, and to deliver oxygen and nutrients for respiration and filtration. Flood conditions may dislodge mussels or destroy their habitat or the habitat of their host fishes. Extreme low flows are also detrimental to the species. The proposed SLR will continue to withdraw water from Wheeler Reservoir through the intake forebay. As discussed in Section 3.5.3.1, the flow rate of water withdrawn from the river remains unchanged even when helper cooling towers are in operation. During such operations, Browns Ferry continues to function in an open-cycle, once-through mode, returning nearly all the withdrawn water to the Wheeler Reservoir. Since no water is taken from the river for makeup purposes, the volume returned to the reservoir is only slightly reduced due to evaporation and drift (~3 percent or 3.01 MGD when mechanical draft cooling towers are operational). The impacts to PBF 1 during the proposed SLR would be insignificant because the withdrawals and discharges of Browns Ferry will not be of a magnitude that would affect the flow of oxygen and nutrients necessary for the respiration and filtration of spectaclecase mussels.	NLAA

Table C-3 Effect Determinations for the Physical and Biological Features of Spectaclecase Mussels Proposed Critical Habitat Unit SPCA 8: Tennessee River at Browns Ferry Nuclear Plant (Continued)

PBF	Analysis	Determination[(a)]
PBF 2: Habitat Connectivity	PBF 2 requires suitable substrates and connected instream habitats to support the species and host fishes. Connectivity is characterized by suitable water quality, lack of barriers to dispersal (e.g., perched culverts, hydropower dams that lack passage for host fishes, water control structures), and presence of suitable shelter habitat and forage base for host fish. Long reaches of connected stream habitat support population resilience and dispersal. The proposed SLR will involve the continued operation of the NPDES permitted outfall DSN001 which returns cooling water to Wheeler Reservoir (see Section 3.7.2.2). The thermal plumes resulting from the discharged cooling water only extend approximately halfway across the lake and there is ample space for fish to move past without the thermal plume blocking passage. The proposed SLR would not involve any other activities that have the potential to impact habitat connectivity within SPCA 8. The activities associated with the proposed SLR would be insignificant and would not result in impacts to habitat connectivity that could be meaningfully measured or detected.	NLAA
PBF 3: Water and Sediment Quality	PBF 3 specifies the water and sediment quality parameters necessary to support normal behavior, growth, and viability of all life stages. These parameters include dissolved oxygen content above 2 to 3 ppm, salinity level below 2 to 4 ppm, temperature below 86°F (30°C), and contaminant concentrations below acute toxicity levels. Water quality parameters, including the potential for heat shock, may be impacted by the discharge of thermal effluent over the SLR period. Heat shock occurs when water temperature meets or exceeds the thermal tolerance of an aquatic species for some duration of the exposure (NRC 2024-TN10161). In most situations, host fish can avoid areas that exceed their thermal tolerance limits, although some aquatic species or life stages lack such mobility. Mussels downstream of the discharge may be impacted by an increase in temperature and contaminants; however, the discharged effluent is expected to rise to the surface of the water column and any mussels that may be present are expected to be aggregated under boulders, slabs, stumps where they are protected from the current, which would insulate them from the thermal impacts (FWS 2022-TN11462). The spectaclecase is also quite active and can relocate to more suitable habitat. Water quality is regulated by ADEM through its NPDES permitting program and ensures that authorized discharges do not harm aquatic species. The activities associated with the proposed SLR would be insignificant because the discharge of thermal effluent is regulated by the NPDES permit and would not result in impacts to water quality to a degree that the necessary water quality parameters would not be met.	NLAA
PBF 4: Presence of Host Fish Species	PBF 4 requires the presence and abundance of the mussel's respective host fishes necessary for recruitment of the species. For the spectaclecase these are the goldeneye (*Hiodon alosoides*) and mooneye (*Hiodon tergisus*). Section C.2.3.6 describes the presence, abundance, and the extremely low impingement rate of the only known host present in Wheeler Reservoir, the mooneye.	NLAA

Table C-3 Effect Determinations for the Physical and Biological Features of Spectaclecase Mussels Proposed Critical Habitat Unit SPCA 8: Tennessee River at Browns Ferry Nuclear Plant (Continued)

PBF	Analysis	Determination[(a)]
	The impacts to PBF 4 during the proposed SLR will be insignificant because the risk of direct or indirect impingement of host fish will not be of a magnitude to impact the presence and abundance of the host fish within the action area.	

ADEM = Alabama Department of Environmental Management; NPDES = National Pollutant Discharge Elimination System; PBF = physical and biological feature; SLR = subsequent license renewal; SPCA = Spectaclecase.

(a) The NRC staff makes its effect determinations for federally listed species in accordance with the language and definitions specified in the FWS and NMFS Endangered Species Consultation Handbook (FWS and NMFS 1998-TN1031).

Source: 89 FR 101100-TN11378.

Summary of Effects

The proposed Browns Ferry subsequent license renewal *may affect but is not likely to adversely affect* PBFs 1, 2, 3, and 4 of SPCA 8, the proposed critical habitat unit of spectaclecase mussels in the action area. The proposed action may cause habitat alterations from the continued withdrawal from the Wheeler Reservoir via the intake canal and alter water quality from the continued discharge of thermal effluent. However, any effects on the value of the habitat to the conservation of the species are either extremely unlikely to occur or would be so small that they could not be meaningfully measured or detected.

When discharging thermal effluent to Wheeler Reservoir, the licensee will abide by relevant Federal and State regulations, including conditions set forth in the NPDES permit (see Section 3.5.1.3 and 3.7.2.2).

Conclusion for Proposed Designated Critical Habitat of the Sheepnose Mussel

All potential effects on the spectaclecase critical habitat resulting from the proposed action would be insignificant or discountable. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the critical habitat of the spectaclecase mussel. Because the critical habitat is proposed for Federal designation, the ESA does not require the NRC to consult with or receive concurrence from the FWS as long as the action is not likely to adversely modify the proposed critical habitat.

C.2.3.7 Anthony's riversnail (FE), armored snail (FE), slender campeloma (FE)

In Section 3.8.1.2, the NRC staff concludes that Anthony's riversnail, armored snail, and slender campeloma have the potential to occur within the action area. Section 3.7.2 describes potential impacts to aquatic species in terms of impingent and mortality, thermal impacts, and water use conflicts.

Anthony's riversnails inhabits medium to large rivers and occurs on cobble/boulder substrates in the vicinity of riffles. However, it does not always occur in strongly flowing sections (59 FR 17994-TN11542). Currently, the riversnail only occupies four streams in Tennessee and Alabama. One surviving population is restricted to a relatively short reach of lower Limestone Creek, upstream of Browns Ferry and last observed in 2022. There are plans to re-establish populations in Piney Creek (upstream) and Elk River (downstream) all of which drain into

Wheeler Reservoir (59 FR 17994-TN11542). The primary threats to Anthony's riversnail include the loss of habitat due to the impoundment of the Tennessee River and more recently residential and industrial development, and water quality degradation from point and non-point pollution (FWS 2023-TN11551).

Armored snails are endemic only to watersheds in northern Alabama and are currently only found in Limestone and Piney Creeks, upstream of Browns Ferry, which drain into Wheeler Reservoir (FWS 2020-TN11471). They inhabit submerged root masses and bryophytes along creek edges but may also be found on rocks and vegetative debris. Armored snails were last surveyed in 2018 but at that time populations were stable (FWS 2020-TN11471). The primary threats to armored snails include the loss of habitat due to residential and industrial development, water quality degradation from agricultural runoff, and climate change (FWS 2020-TN11471).

Slender campeloma are only found in Limestone, Piney, and Round Island Creeks in northern Alabama, which drain into Wheeler Reservoir but are upstream of Browns Ferry (FWS 2020-TN11552). It is typically found burrowing in soft sediment (sand and/or mud) or detritus (65 FR 10033-TN11473). The most recent survey was in 2019 and suggested viable and self-sustaining populations (FWS 2020-TN11552). The primary threats to slender campeloma are include the loss of habitat due to residential and industrial development, water quality degradation from agricultural runoff, and climate change (FWS 2020-TN11552).

Summary of Effects

1. The proposed action would not involve any habitat loss, land-disturbing activities, or any activities that would degrade existing natural areas or potential habitat for any of the snails.
2. The location of all three snails and their habitat in tributaries upstream of Browns Ferry means they will not be susceptible to water quality degradation or temperature increases attributable to the plant.
3. Impacts on climate change during normal operations at nuclear power plants can result from the release of GHGs from stationary combustion sources, refrigeration systems, electrical transmission and distribution systems, and mobile sources. However, such emissions are typically very minor because nuclear power plants do not combust fossil fuels to generate electricity.

Conclusion for Anthony's riversnail

All potential effects on Anthony's riversnails resulting from the proposed action would be insignificant. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* Anthony's riversnail. Following the issuance of the draft SEIS, the NRC staff will seek the FWS's concurrence with this finding.

Conclusion for armored snail

All potential effects on armored snails resulting from the proposed action would be insignificant. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* armored snails. Following the issuance of the draft SEIS, the NRC staff will seek the FWS's concurrence with this finding.

Conclusion for slender campeloma

All potential effects on slender campeloma resulting from the proposed action would be insignificant. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* slender campeloma. Following the issuance of the draft SEIS, the NRC staff will seek the FWS's concurrence with this finding.

C.3 Magnuson–Stevens Act Essential Fish Habitat Consultation

The NRC must comply with the Magnuson–Stevens Fishery Conservation and Management Act of 1996 (MSA), as amended (TN7841), for any actions authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken that may adversely affect any essential fish habitat (EFH) identified under the MSA.

In Section 3.8, the NRC staff concludes that the NMFS has not designated any EFH under the MSA within the affected area. The NRC staff therefore conclude that the proposed Browns Ferry SLR would have no effect on EFH. Thus, the MSA does not require the NRC to consult with NMFS for the proposed action.

C.4 National Marine Sanctuaries Act Consultation

The National Marine Sanctuaries Act of 1966, as amended (TN7197), authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archaeological, educational, or aesthetic qualities as national marine sanctuaries. Under Section 304(d) of the act, Federal agencies must consult with the National Oceanic and Atmospheric Administration's Office of National Marine Sanctuaries if a Federal action is likely to destroy, cause the loss of, or injure any sanctuary resources.

In Section 3.8.3, the NRC staff concludes that no coastal or marine waters or Great Lakes occur near Browns Ferry. The NRC staff therefore conclude that the Browns Ferry SLR would have no effect on sanctuary resources. Thus, the National Marine Sanctuaries Act of 1966, as amended does not require the NRC to consult with the National Oceanic and Atmospheric Administration for the proposed action.

C.5 National Historic Preservation Act Section 106 Consultation

The National Historic Preservation Act of 1966, as amended (NHPA) (TN4839), requires Federal agencies to consider the effects of their undertakings on historic properties and consult with applicable State and Federal agencies, Tribal groups, individuals, and organizations with a demonstrated interest in the undertaking before taking action. Historic properties are defined as resources that are eligible for listing on the National Register of Historic Places. The NHPA Section 106 review process is outlined in regulations issued by the Advisory Council on Historic Preservation in 36 CFR Part 800, "Protection of Historic Properties" (TN513). In accordance with 36 CFR 800.8(c), "Use of the NEPA Process for Section 106 Purposes," the NRC has elected to use the NEPA process to comply with its obligations under Section 106 of the NHPA.

Table C-4 lists the chronology of consultation and consultation documents related to the NRC's NHPA Section 106 review of the Browns Ferry SLR.

Table C-4 National Historic Preservation Act Correspondence for Browns Ferry Nuclear Plant

Date	Sender and Recipient	Description	ADAMS Accession No.[(a)]
04/06/2024	C. Regan (NRC) to M. Hicks, Principal Chief, Eastern Band of Cherokee Indians	Letter Initiating Consultation and Request for Scoping Comments	ML24106A247
04/15/2024	C. Regan (NRC) to R. Nelson, Executive Director, Advisory Council on Historic Preservation	Request for Scoping Comments	ML24102A040
04/16/2024	C. Regan (NRC) to L.D. Jones, State Historic Preservation Officer, Alabama Historical Commission	Letter Initiating Consultation and Request for Scoping Comments	ML24102A041
04/15/2024	C. Regan (NRC) to S.A. Bryan, Tribal Chair, Poarch Band of Creek Indians	Letter Initiating Consultation and Request for Scoping Comments	ML24106A244
04/15/2024	C. Regan (NRC) to L.J. Johnson, Chief, Seminole Nation of Oklahoma	Letter Initiating Consultation and Request for Scoping Comments	ML24106A250
04/16/2024	C. Regan (NRC) to J. Cernek, Chairman, Coushatta Tribe of Louisiana	Letter Initiating Consultation and Request for Scoping Comments	ML24106A245
04/16/2024	C. Regan (NRC) to L.D. Jones, State Historic Preservation Officer, Alabama Historical Commission	Letter Initiating Consultation and Request for Scoping Comments	ML24102A041
04/16/2024	C. Regan (NRC) to J. Bunch, Chief, United Keetoowah Band of Cherokee Indians	Letter Initiating Consultation and Request for Scoping Comments	ML24107A002
04/16/2024	C. Regan (NRC) to J.R. Johnson Governor, Absentee Shawnee Tribe of Indians of Oklahoma	Letter Initiating Consultation and Request for Scoping Comments	ML24102A039
04/16/2024	C. Regan (NRC) to G.J. Wallace, Chief, Eastern Shawnee Tribe of Oklahoma	Letter Initiating Consultation and Request for Scoping Comments	ML24106A256
04/16/2024	C. Regan (NRC) to M.W. Osceola Jr., Chairman, Seminole Tribe of Florida	Letter Initiating Consultation and Request for Scoping Comments	ML24106A252
04/16/2024	C. Regan (NRC) to D. Hill, Principal Chief, Muscogee (Creek) Nation	Letter Initiating Consultation and Request for Scoping Comments	ML24106A248
04/16/2024	C. Regan (NRC) to B. Barnes, Chief, Shawnee Tribe	Letter Initiating Consultation and Request for Scoping Comments	ML24106A240
04/16/2024	C. Regan (NRC) to B. Anoatubby, Governor, Chickasaw Nation	Letter Initiating Consultation and Request for Scoping Comments	ML24106A238
04/16/2024	C. Regan (NRC) to R. Morrow, Town King, Thlopthlocco Tribal Town	Letter Initiating Consultation and Request for Scoping Comments	ML24106A251

Table C-4 National Historic Preservation Act Correspondence for Browns Ferry Nuclear Plant (Continued)

Date	Sender and Recipient	Description	ADAMS Accession No.[(a)]
04/16/2024	C. Regan (NRC) to M. Pierite, Chairman, Tunica-Biloxi Tribe of Louisiana	Letter Initiating Consultation and Request for Scoping Comments	ML24107A003
04/16/2024	C. Regan (NRC) to C. Hoskin Jr., Principal Chief, Cherokee Nation	Letter Initiating Consultation and Request for Scoping Comments	ML24106A249
04/16/2024	C. Regan (NRC) to S. Yahola, Town King, Kialegee Tribal Town	Letter Initiating Consultation and Request for Scoping Comments	ML24106A257
04/16/2024	C. Regan (NRC) to W. Yargee, Chief, Alabama-Quassarte Tribal Town	Letter Initiating Consultation and Request for Scoping Comments	ML24106A258
04/16/2024	C. Regan (NRC) to C. Ben, Chief, Mississippi Band of Choctaw Indians	Letter Initiating Consultation and Request for Scoping Comments	ML24106A243
04/16/2024	C. Regan (NRC) to D.B. Battise, Principal Chief, Alabama-Coushatta Tribe of Texas	Letter Initiating Consultation and Request for Scoping Comments	ML24106A241
04/16/2024	C. Regan (NRC) to E. Rogers, Tribal Chief, Jena Band of Choctaw Indians	Letter Initiating Consultation and Request for Scoping Comments	ML24106A254
04/16/2024	C. Regan (NRC) to G. Batton, Chief, Choctaw Nation of Oklahoma	Letter Initiating Consultation and Request for Scoping Comments	ML24106A242
04/16/2024	C. Regan (NRC) to T. Cypress, Chairman, Miccosukee Tribe	Letter Initiating Consultation and Request for Scoping Comments	ML24106A246
04/16/2024	C. Regan (NRC) to R. Russell, Principal Chief, Cherokee Tribe of Northeast Alabama	Letter Request for Scoping Comments	ML24102A042
04/16/2024	C. Regan (NRC) to J. Wright, Chief, Ma-Chis Lower Creek Indian Tribe of Alabama	Letter Request for Scoping Comments	ML24206A265
04/16/2024	C. Regan (NRC) to L. Bridges, Principal Chief, United Cherokee AniYunWiYa	Letter Request for Scoping Comments	ML24106A259
04/16/2024	C. Regan (NRC) to L. Byrd, Chief, MOWA Band of Choctaw Indians	Letter Request for Scoping Comments	ML24106A260
04/16/2024	C. Regan (NRC) to D. Everhart, Acting Chief, Piqua Shawnee Tribe	Letter Request for Scoping Comments	ML24106A261
04/16/2024	C. Regan (NRC) to M. Gilmore, Chief, Southeastern Mvskoke Nation	Letter Request for Scoping Comments	ML24106A262
04/16/2024	C. Regan (NRC) to V. Hamilton, Chief, Cher-O-Creek Intra Tribal Indians	Letter Request for Scoping Comments	ML24106A263

Table C-4 National Historic Preservation Act Correspondence for Browns Ferry Nuclear Plant (Continued)

Date	Sender and Recipient	Description	ADAMS Accession No.[(a)]
04/16/2024	C. Regan (NRC) to N. Massey, Principal Chief, Echota Cherokee Tribe of Alabama	Letter Request for Scoping Comments	ML24106A264
10/16/2024	L.A. Hewett, Deputy State Historic Preservation Officer, Alabama Historical Commission	Environmental Review of the Browns Ferry Nuclear Plant Subsequent License Renewal Application Limestone County	ML24308A004

NRC = U.S. Nuclear Regulatory Commission.
(a) Access these documents through the NRC's ADAMS at https://adams.nrc.gov/wba/.

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APPENDIX D

CHRONOLOGY OF ENVIRONMENTAL REVIEW CORRESPONDENCE

D.1 Environmental Review Correspondence

Table D-1 Environmental Review Correspondence

Date	Correspondence Description	ADAMS Accession No.[(a)] or Federal Register Citing
05/27/2021	Notice of Intent to Pursue SLR for BFNP, Units 1, 2, and 3	ML21147A359
05/10/2023	Public Meeting Announcement: Pre-Submittal Meeting for SLR Application for BFNP, Units 1, 2, and 3 - Environmental	ML23130A252
06/06/2023	Revision to Notice of Intent to Pursue SLR for BFNP, Units 1, 2, and 3 - Submittal Schedule	ML23157A126
06/13/2023	Letter to TVA: BFNP, Units 1, 2, and 3 SLR Application – Public Meeting Summary of Pre-Submittal Meeting	ML23156A489
06/13/2023	Memo: Browns Ferry - Meeting Summary for Environmental Pre-Submittal Meeting for SLR Application on May 11, 2023	ML23157A127
06/13/2023	NRC Presentation Browns Ferry SLR Pre-Application Meeting, Environmental Overview	ML23130A033
06/13/2023	TVA Presentation BFNP SLR License Application – ER	ML23130A030
01/19/2024	BFNP, Units 1, 2, and 3 Application for Subsequent Renewed Operating License	ML24019A009 (package)
01/19/2024	Cover Letter BFNP, Units 1, 2, and 3 Application for Subsequent Renewed Operating License	ML24019A010
01/19/2024	Enclosure 2: BFNP SLR License Application – ER	ML24023A476
02/03/2024	Browns Ferry, Units 1, 2, and 3 SLR Receipt and Availability	ML24022A173
02/08/2024	BFNP, Units 1, 2, and 3, SLR Application – Receipt and Availability - FRN	ML24022A174 89 FR 8725
03/15/2024	Browns Ferry SLR Application Acceptance Letter	ML24068A177
03/15/2024	BFNP Units 1, 2, and 3 – SLR Renewal Application Online Reference Portal	ML24073A355
03/21/2024	Browns Ferry SLR Application Acceptance and Opportunity for Hearing FRN	ML24068A176 89 FR 20254
04/03/2024	Notice of Intent to Conduct Scoping Process and Prepare Environmental Impact Statement; TVA; BFNP, Units 1, 2, and 3	ML24079A157 89 FR 23056
04/05/2024	Letter to TVA: BFNP, Units 1, 2, and 3 – Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process	ML24079A156
04/11/2024	Public Meeting Announcement: Environmental Scoping Meeting Related to the BFNP License Renewal Application	ML24102A044
04/11/2024	Transcript of April 11, 2024, Browns Ferry Public Scoping Meeting	ML24123A157
04/11/2024	NRC Presentation: Environmental Scoping Meeting Related to the BFNP, Units 1, 2, and 3 SLR Renewal Application	ML24078A272
04/18/2024	Public Meeting Announcement: Environmental Scoping Meeting Related to the BFNP SLR Renewal Application	ML24109A005

1

Table D-1 Environmental Review Correspondence (Continued)

Date	Correspondence Description	ADAMS Accession No.[(a)] or Federal Register Citing
04/18/2024	Transcript of April 18, 2024, Browns Ferry Public Scoping Meeting	ML24123A162
04/18/2024	NRC Presentation: Environmental Scoping Meeting Related to the BFNP, Units 1, 2, and 3 SLR Renewal Application	ML24078A272
04/18/2024	BFNP Meeting Summary, April 11th and 18th, 2024	ML24155A043
06/13/2024	Memo: Meeting Summary Public Scoping Webinars for the Environmental Review of the SLR Application for the BFNP, Units 1, 2, and 3	ML24155A042
07/10/2024	BFNP, Units 1, 2, and 3 – License Renewal Regulatory Limited Scope Audit Regarding the Environmental Review of the License Renewal Application	ML24183A414
09/03/2024	BFNP, Units 1, 2, and 3 – License Renewal Regulatory Scope Audit Regarding the Environmental Review of the License Renewal Application	ML24239A333
10/16/2024	TVA; BFNP, Units 1, 2, and 3; Notice of Intent to Prepare Environmental Impact Statement	ML24268A232 89 FR 84401
10/24/2024	Correspondence to TVA regarding Scoping Summary Report	ML24289A127 (package)
10/24/2024	Letter to TVA regarding Environmental Scoping Report Summary for Browns Ferry	ML24289A123
10/24/2024	Browns Ferry Scoping Summary Report	ML24155A084
01/15/2025	BFNP, Units 1, 2, and 3 – Summary of the 2024 Environmental Audit Related to the Review of the License Renewal Application ER	ML25007A078
01/30/2025	Summary: Clarification Call, January 30, 2025	ML25030A242
02/06/2025	Email to TVA: February 6, 2025, Clarification Call Summary re RAI HCR-14, and Revised RCI AQU-23	ML25038A095
02/18/2025	BFNP, Units 1, 2, and 3 Application for Subsequent Renewed Operating License, Responses to RCIs and RAIs, and ER	ML25050A455 (package)
02/18/2025	Cover Letter, Enclosure 1: RCI Responses, Enclosure 2: RAI Responses	ML25049A231
02/18/2025	Enclosure 3: ER, Revision 1	ML25049A231
03/04/2025	Follow-up Items re RCI and RAI responses submitted with ER Revision	ML25064A590
03/17/2025	Letter: Browns Ferry SLR Application Response to RCI AQU-23	ML25076A017
03/27/2025	BFNP, Units 1, 2, and 3 – Application for Subsequent Renewed Operating Licenses, ER RAI HCR-14 Response (non-proprietary)	ML25086A286
04/05/2025	BFNP, Units 1, 2, and 3 – Application for Subsequent Renewed Operating Licenses, ER Request for Additional Information GW-6, Request for Confirmatory Items: AQ-4-LSA, GC-1-LSA, AQU-13	ML25093A282

Table D-1 Environmental Review Correspondence (Continued)

Date	Correspondence Description	ADAMS Accession No.[(a)] or Federal Register Citing
05/23/2025	Federal Register Browns DEIS Notice of Availability	ML25114A152
05/23/2025	Letter to TVA Browns Ferry Units 1, 2, and 3 - Notice of Availability of DEIS	ML25114A114

ADAMS = Agencywide Documents Access and Management System; BFNP = Browns Ferry Nuclear Plant; ER = environmental report; FRN = *Federal Register Notice*; NRC = U.S. Nuclear Regulatory Commission; SLR = subsequent license renewal; TVA = Tennessee Valley Authority.
(a) Access these documents through the NRC's ADAMS at https://adams.nrc.gov/wba/.

NRC FORM 335 (12-2010) NRCMD 3.7

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

1. REPORT NUMBER
(Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.)

NUREG-1437
Supplement 21
Second Renewal

2. TITLE AND SUBTITLE

Generic Environmental Impact Statement for License Renewal of Nuclear Plants
Supplement 21, Second Renewal
Regarding Subsequent License Renewal of Browns Ferry Nuclear Power Plant, Units 1, 2, and 3
Draft Report for Comment

3. DATE REPORT PUBLISHED

MONTH	YEAR
May	2025

4. FIN OR GRANT NUMBER

5. AUTHOR(S)

See Chapter 6, “List of Preparers,” of the report.

6. TYPE OF REPORT

Technical

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8. PERFORMING ORGANIZATION - NAME AND ADDRESS (If NRC, provide Division, Office or Region, U. S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)

U.S. Nuclear Regulatory Commission (NRC)
Office of Nuclear Material Safety and Safeguards
Division of Rulemaking, Environmental, and Financial Support
Washington, D.C. 20555-0001

9. SPONSORING ORGANIZATION - NAME AND ADDRESS (If NRC, type "Same as above", if contractor, provide NRC Division, Office or Region, U. S. Nuclear Regulatory Commission, and mailing address.)

10. SUPPLEMENTARY NOTES

Docket Nos. 50-259, 50-260, 50-296

11. ABSTRACT (200 words or less)

The U.S. Nuclear Regulatory Commission (NRC or the Commission) prepared this supplemental environmental impact statement in response to an application submitted by Tennessee Valley Authority to renew the operating licenses for the Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 (Browns Ferry), for an additional 20 years. This supplemental environmental impact statement includes the preliminary analysis that evaluates the environmental impacts of the proposed action and environmental impacts of a combination of replacement energy generating capacity as part of the no-action alternative.

The NRC staff’s preliminary recommendation is that the adverse environmental impacts of subsequent license renewal for Browns Ferry are not so great that preserving the option of license renewal for energy-planning decision-makers would be unreasonable. This NRC preliminary recommendation is based on: (1) the analysis and findings in NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, (2) the Environmental Report submitted by Tennessee Valley Authority, as revised, (3) the Environmental Impact Statement prepared by Tennessee Valley Authority, (4) the NRC staff’s consultation with Federal, State, local, and Tribal, and local agencies, (5) the NRC staff’s independent environmental review, and the NRC staff’s consideration of public comments received during the scoping process.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)

Browns Ferry
Browns Ferry Nuclear Plant
License Renewal
Draft supplemental environmental impact statement
Draft SEIS
National Environmental Policy Act
NEPA
Environmental Impact

13. AVAILABILITY STATEMENT

unlimited

14. SECURITY CLASSIFICATION

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unclassified

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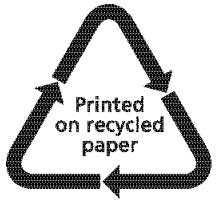
15. NUMBER OF PAGES

16. PRICE



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OFFICIAL BUSINESS

NUREG-1437
Supplement 21
Second Renewal, Draft

Generic Environmental Impact Statement for License Renewal of Nuclear Plants
Supplement 21, Second Renewal Regarding Subsequent License Renewal of
Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

May 2025