NUREG-1437
Supplement 21

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 21

**Regarding
Browns Ferry Nuclear Plant, Units 1, 2, and 3**

Draft Report for Comment

**U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, DC 20555-0001**

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Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
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Abstract

The U.S. Nuclear Regulatory Commission (NRC or Commission) considered the environmental impacts of renewing nuclear power plant operating licenses (OLs) for a 20-year period in its *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2, and codified the results in Title 10 of the Code of Federal Regulations (CFR) Part 51. In the GEIS (and its Addendum 1), the staff identifies 92 environmental issues and reaches generic conclusions related to environmental impacts for 69 of these issues that apply to all plants or to plants with specific design or site characteristics. Additional plant-specific review is required for the remaining 23 issues. These plant-specific reviews are to be included in a supplement to the GEIS.

This supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted to NRC by the Tennessee Valley Authority (TVA) to renew the OLs for Browns Ferry Nuclear Plant, Units 1, 2, and 3 (BFN) for an additional 20 years under 10 CFR Part 54. The SEIS includes the NRC staff's analysis that considers and weighs the environmental impacts of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the staff's recommendation regarding the proposed action.

Regarding the 69 issues for which the GEIS reached generic conclusions, neither TVA nor the staff has identified information that is both new and significant for any issue that applies to BFN. In addition, the staff determined that information provided during the scoping process did not call into question the conclusions in the GEIS. Therefore, the staff concludes that the impacts of renewing the BFN OLs will not be greater than impacts identified for these issues in the GEIS. For each of these issues, the staff's conclusion in the GEIS is that the impact is of SMALL[a] significance (except for collective offsite radiological impacts from the fuel cycle and high-level waste and spent fuel, which were not assigned a single significance level).

The remaining 23 issues that apply to BFN are addressed in this SEIS. For each applicable issue, the staff concludes that the significance of the potential environmental impacts of renewal of the OLs is SMALL. The staff also concludes that additional mitigation measures are not likely to be sufficiently beneficial as to be warranted. The staff determined that information provided during the scoping process did not identify any new issue that has a significant environmental impact.

The NRC staff recommends that the Commission determine that the adverse environmental impacts of license renewal for BFN are not so great that preserving the option of license

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

renewal for energy-planning decisionmakers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS; (2) the Environmental Report submitted by TVA; (3) consultation and discussions with Federal, State, and local agencies; (4) the staff's own independent review; and (5) the staff's consideration of public comments.

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Executive Summary

By letter dated December 31, 2003, the Tennessee Valley Authority (TVA) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating licenses (OLs) for Browns Ferry Nuclear Plant, Units 1, 2, and 3 (BFN) for additional 20-year periods. If the OLs are renewed, State regulatory agencies and TVA will ultimately decide whether the plant will continue to operate based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners. If the OLs are not renewed, then the plant must be shut down at or before the expiration dates of the current OLs, which are December 20, 2013, for Unit 1, June 28, 2014, for Unit 2, and July 2, 2016, for Unit 3.

The NRC has issued regulations implementing Section 102 of the National Environmental Policy Act of 1969 (NEPA) (42 USC 4321) in Title 10 of the Code of Federal Regulations (CFR) Part 51. Section 102 of NEPA directs that an environmental impact statement (EIS) is required for major Federal actions that significantly affect the quality of the human environment. In 10 CFR 51.20(b)(2), the Commission requires preparation of an EIS or a supplement to an EIS for renewal of a reactor OL. In addition, 10 CFR 51.95(c) states that the EIS prepared at the OL renewal stage will be a supplement to the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2.[(a)]

Upon acceptance of the TVA application, the NRC began the environmental review process described in 10 CFR Part 51 by publishing a Notice of Intent to prepare an EIS and conduct scoping. The staff visited the BFN site in March 2004 and held public scoping meetings on April 1, 2004, in Athens, Alabama. In the preparation of this supplemental environmental impact statement (SEIS) for BFN, the staff reviewed the TVA Environmental Report and compared it to the GEIS, consulted with other agencies, conducted an independent review of the issues following the guidance set forth in NUREG-1555, Supplement 1, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal,* and considered the public comments received during the scoping process. The public comments received during the scoping process that were considered to be within the scope of the environmental review are provided in Appendix A, Part 1, of this SEIS.

TVA, a federal corporation wholly owned by the U.S. Government, is subject to the requirements for Federal agencies in NEPA. In compliance with NEPA, TVA prepared an SEIS to provide the public and TVA decisionmakers with an assessment of the environmental impacts of extending the operating life of the BFN nuclear units. This NRC SEIS draws upon the content of the TVA SEIS, but was prepared by NRC staff independently.

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

The staff will hold two public meetings in Athens, Alabama, during January 2005 to describe the results of the NRC environmental review, answer questions, and provide members of the public with information to assist them in formulating comments on this SEIS. When the comment period ends, the staff will consider and address all of the comments received. These comments will be addressed in Appendix A, Part 2, of the final SEIS.

This SEIS includes the NRC staff's analysis that considers and weighs the environmental effects of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures for reducing or avoiding adverse effects. It also includes the staff's recommendations regarding the proposed action.

The Commission has adopted the following statement of purpose and need for license renewal from the GEIS:

> The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decisionmakers.

The goal of the staff's environmental review, as defined in 10 CFR 51.95(c)(4) and the GEIS, is to determine

> ... whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

Both the statement of purpose and need and the evaluation criterion implicitly acknowledge that there are factors, in addition to license renewal, that will ultimately determine whether an existing nuclear power plant continues to operate beyond the period of the current OL.

NRC regulations at 10 CFR 51.95(c)(2) contain the following statement regarding the content of SEISs prepared at the license renewal stage:

> The supplemental environmental impact statement for license renewal is not required to include discussion of need for power or the economic costs and economic benefits of the proposed action or of alternatives to the proposed action except insofar as such benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation. In addition, the supplemental environmental impact statement prepared at the license renewal stage need not discuss other issues not related to the environmental effects of the proposed action and the

alternatives, or any aspect of the storage of spent fuel for the facility within the scope of the generic determination in § 51.23(a) ["Temporary storage of spent fuel after cessation of reactor operation–generic determination of no significant environmental impact"] and in accordance with § 51.23(b).

The GEIS contains the results of a systematic evaluation of the consequences of renewing an OL and operating a nuclear power plant for an additional 20 years. It evaluates 92 environmental issues using the NRC's three-level standard of significance – SMALL, MODERATE, or LARGE – developed using the Council on Environmental Quality guidelines. The following definitions of the three significance levels are set forth in footnotes to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B:

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

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

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

For 69 of the 92 issues considered in the GEIS, the analysis in the GEIS reached the following conclusions:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

These 69 issues were identified in the GEIS as Category 1 issues. In the absence of new and significant information, the staff relied on conclusions as amplified by supporting information in the GEIS for issues designated as Category 1 in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B.

Of the 23 issues that do not meet the criteria set forth above, 21 are classified as Category 2 issues requiring analysis in a plant-specific supplement to the GEIS. The remaining two issues, environmental justice and chronic effects of electromagnetic fields, were not categorized. Environmental justice was not evaluated on a generic basis and must be addressed in a plant-specific supplement to the GEIS. Information on the chronic effects of electromagnetic fields was not conclusive at the time the GEIS was prepared.

This SEIS documents the staff's consideration of all 92 environmental issues identified in the GEIS. The staff considered the environmental impacts associated with alternatives to license renewal and compared the environmental impacts of license renewal and the alternatives. The alternatives to license renewal that were considered include the no-action alternative (not renewing the BFN OLs) and alternative methods of power generation. Based on projections made by the U.S. Department of Energy's Energy Information Administration, gas- and coal-fired generation appear to be the most likely power-generation alternatives if the power from BFN is replaced. These alternatives are evaluated assuming that the replacement power generation plant is located at either the BFN site or some other unspecified alternative location.

TVA and the staff established independent processes for identifying and evaluating the significance of any new information on the environmental impacts of license renewal. Neither TVA nor the staff identified information that is both new and significant related to Category 1 issues that would call the conclusions in the GEIS into question. Similarly, neither the scoping process nor the staff identified any new issue applicable to BFN that has a significant environmental impact.

In July 2004, TVA submitted extended power uprate (EPU) applications to increase the licensed power levels of each of the three units to 3952 MW(t), or 120 percent of the originally licensed power levels, for a total power level of 11,856 MW(t). If approved, the EPUs would take effect during the existing license term. NRC will evaluate the potential environmental impacts of an EPU in a separate Environmental Assessment. Therefore, the impacts associated with the increase in thermal power level from the currently licensed value to the EPU value is not evaluated in this SEIS. However, the staff performed its evaluation of impacts for the license renewal term in this SEIS assuming all three units are operating at 120 percent of the original licensed power level.

The staff determined that there is a potential, at the higher power levels, that BFN may no longer be within the envelope of impacts defined by the GEIS for some Category 1 issues. If the potential impacts are beyond the defined envelope, then the generic conclusions concerning these Category 1 issues may no longer be valid. The staff examined each of the 54 Category 1 issues applicable to BFN and determined that the level of impact for 34 of the Category 1 issues could be influenced by the thermal power level of the reactors. The staff then evaluated each of the 34 issues to determine if increasing the unit power level above the levels considered in the

GEIS would affect the generic conclusions. After evaluating all 34 issues the staff determined that the generic conclusions reached in the GEIS are still valid and none of the GEIS conclusions were changed based on the staff's analysis. Therefore, the proposed EPU does not constitute new and significant information and the staff could continue to rely upon the conclusions of the GEIS for all Category 1 issues applicable to BFN.

TVA's license renewal application presents an analysis of the Category 2 issues plus environmental justice and chronic effects from electromagnetic fields. The staff reviewed the TVA analysis for each issue and conducted an independent review of each issue. Three Category 2 issues are not applicable because they are related to plant design features or site characteristics not found at BFN. Four Category 2 issues are not discussed in this SEIS because they are specifically related to refurbishment. TVA has stated that its evaluation of structures and components, as required by 10 CFR 54.21, did not identify any major plant refurbishment activities or modifications as necessary to support the continued operation of BFN for the license renewal term. In addition, any replacement of components or additional inspection activities are within the bounds of normal plant operation, and are not expected to affect the environment beyond the bounds of the plant operations evaluated in TVA's 1972 Final Environmental Statement Related to Operation of BFN.

Fourteen Category 2 issues related to operational impacts and postulated accidents during the license renewal term, as well as environmental justice and chronic effects of electromagnetic fields, are discussed in detail in this SEIS. Five of the Category 2 issues and environmental justice apply to both refurbishment and operation during the license renewal term and are only discussed in this SEIS in relation to operation during the license renewal term. For all 14 Category 2 issues and environmental justice, the staff concludes that the potential environmental effects are of SMALL significance in the context of the standards set forth in the GEIS. In addition, the staff determined that appropriate Federal health agencies have not reached a consensus on the existence of chronic adverse effects from electromagnetic fields. Therefore, no further evaluation of this issue is required. For severe accident mitigation alternatives (SAMAs), the staff concludes that a reasonable, comprehensive effort was made to identify and evaluate SAMAs. Based on its review of the SAMAs for BFN, and the plant improvements already made, the staff concludes that none of the candidate SAMAs are cost-beneficial.

Mitigation measures were considered for each Category 2 issue. Current measures to mitigate the environmental impacts of plant operation were found to be adequate, and no additional mitigation measures were deemed sufficiently beneficial to be warranted.

If the BFN OLs are not renewed and Units 1, 2, and 3 cease operation on or before the expiration of their current licenses, then the adverse impacts of likely alternatives will not be smaller than those associated with continued operation of BFN. The impacts may, in fact, be greater in some areas.

Unit 1 has not operated since 1985, and the applicant is currently engaged in activities necessary to return it to service. Almost all of the activities associated with this effort are confined to existing onsite structures, and little new construction is necessary. Impacts arising from these activities are outside the scope of the license renewal review. Any impacts associated with this effort would be bounded by the EIS prepared by TVA when the plant was originally licensed.

The NRC staff recommends that the Commission determine that the adverse environmental impacts of license renewal for BFN are not so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS; (2) the Environmental Report submitted by TVA; (3) consultation and discussions with other Federal, State, and local agencies; (4) the staff's own independent review; and (5) the staff's consideration of public comments.

Abbreviations/Acronyms

°	degree
µCi	microcurie(s)
µCi/ml	microcuries per milliliter
µGy	microgray(s)
µm	micrometer(s)
µSv	microsieverts

ac	acre(s)
ABWR	Advanced Boiling Water Reactor
ACC	averted cleanup and decontamination costs
ADCNR	Alabama Department of Conservation and Natural Resources
ADEM	Alabama Department of Environmental Management
ADPH	Alabama Department of Public Health
ADWFF	Alabama Division of Wildlife and Freshwater Fisheries
AEA	Atomic Energy Act of 1954
ALARA	As Low As Reasonably Achievable
ANHP	Alabama Natural Heritage Program
AOC	present value of averted offsite property damage costs
AOE	present value of averted occupational exposure
AOSC	present value of averted onsite costs
APE	present value of averted public exposure
ATWS	anticipated transient without scram

BA	Biological Assessment
BFN	Brown's Ferry Nuclear Power Plant, Units 1, 2, and 3
Bq	becquerel(s)
BMT	basemat melt-through
Btu	British thermal unit(s)
BWR	boiling water reactor
BWROG	Boiling Water Reactor Owners Group

C	Celsius
CCDP	conditional core damage probability
CCW	condenser circulating water
CDF	core damage frequency
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CHRS	containment heat removal system
Ci	curie(s)
cm	centimeter(s)

COE	cost of enhancement
COPC	chemicals of potential concern
CS	core spray
CVCS	chemical and volume control system
dba	decibel(s)
DBA	design-basis accident
DC	direct current
DCH	direct containment heating
DMR	Discharge Monitoring Report
DOE	U.S. Department of Energy
DPR	demonstration project reactor
DSM	demand-side management
EECU	emergency equipment cooling water
EIA	Energy Information Administration (of DOE)
EIS	environmental impact statement
ELF-EMF	extremely low frequency-electromagnetic field
EOP	Emergency Operating Procedure
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
EPU	extended power uprate
EQ	equipment qualification
ER	Environmental Report
ESRP	Environmental Standard Review Plan, NUREG-1555, Supplement 1, Operating License Renewal
F	Fahrenheit
FAA	Federal Aviation Administration
FIVE	fire induced vulnerability evaluation
FR	Federal Register
FPS	feet per second
FSAR	Final Safety Analysis Report
ft	foot/feet
FWPCA	Federal Water Pollution Control Act of 1972
FWS	U.S. Fish and Wildlife Service
gal	gallon
GDC	general design criteria
GEIS	Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437

gpm	gallons per minute
ha	hectare(s)
HCLPE	high confidence low probability of failure
HHSI	high head safety injection
HLW	high-level radioactive waste
HPCI	high pressure coolant injection
hr	hour(s)
Hz	Hertz
in.	inch(es)
IPE	Individual plant examination
IPEEE	individual plant examination of external events
ISFSI	independent spent fuel storage installation
ISLOCA	interfacing systems loss-of-coolant accident
kg	kilogram(s)
km	kilometer(s)
KPDS	key plant damage states
kV	kilovolt(s)
kV/m	kilovolt per meter
kWh	kilowatt hour(s)
L	liter(s)
lb	pound
LERF	large early release frequency
LLW	low level waste
LNG	liquefied natural gas
LOCA	loss-of-coolant accident
LOOP	loss of offsite power
LWR	light-water reactor
m	meter(s)
m/s	meter(s) per second
m^3/d	cubic meters per day
m^3/s	cubic meter(s) per second
mA	milliampere(s)
MAAP	Modular Accident Analysis Program
MACCS2	MELCOR Accident Consequence Code System 2
mi	mile(s)
min	minutes

MGD	millions of gallons per day
mGy	milligray(s)
mL	milliliter(s)
MMNS	Mississippi Museum of Natural Science
MNHP	Mississippi Natural Heritage Program
mph	miles per hour
mrad	millirad(s)
mrem	millirem(s)
mSv	millisievert(s)
MT	metric ton(s) (or tonne[s])
MTU	metric ton(s)-uranium
MW	megawatt(s)
MWd/MTU	megawatt-days per metric ton of uranium
MWh	megawatt hours
MW(e)	megawatt(s) electric
MW(t)	megawatt(s) thermal
MWh	megawatt hour(s)
NA	not applicable
NAS	National Academy of Sciences
NCI	National Cancer Institute
NCWRC	North Carolina Wildlife Resources Commission
NEPA	National Environmental Policy Act of 1969
NESC	National Electric Safety Code
ng/J	nanogram per joule
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NO_x	nitrogen oxide(s)
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NWPPC	Northwest Power Planning Council
ODCM	Offsite Dose Calculation Manual
OL	operating license
OLTP	original licensed thermal power
PAR	passive autocatalytic recombiners
PDS	plant damage state
PM_{10}	particulate matter, 10 microns or less in diameter
ppt	parts per thousand
PRA	Probabilistic Risk Assessment

PSA	Probabilistic Safety Assessment
PSD	prevention of significant deterioration
PSW	plant service water
PWR	pressurized water reactor
RAB	reactor auxiliary building
RAI	request for additional information
RCIC	reactor core isolation cooling
RCP	reactor coolant pump
RCRA	Resource Conservation and Recovery Act
RCS	Reactor Coolant System
REM	radiological environmental monitoring
REMP	radiological environmental monitoring program
RHR	residual heat removal
RHRSW	residual heat removal service water (system)
rms	root mean square
RWST	Refueling Water Storage Tank
ry	reactor year
s	second(s)
SAG	Severe Accident Guideline
SAMA	Severe Accident Mitigation Alternative
SAMG	Severe Accident Management Guideline
SAR	Safety Analysis Report
SBO	station blackout
SCR	selective catalytic reduction
SEIS	Supplemental Environmental Impact Statement
SER	Safety Evaluation Report
SGTR	steam generator tube rupture
SHPO	State Historic Preservation Office
SO_2	sulfur dioxide
SO_x	sulfur oxide(s)
Sv	sievert(s)
SW	service water
TBq	terrabecquerel
TRM	Tennessee River Mile
TVA	Tennessee Valley Authority
UDB	urban development boundary
UFSAR	Updated Final Safety Analysis Report

U.S.	United States
USC	United States Code
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USFWS	United States Fish and Wildlife Service
yd	yard
yr	year

1.0 Introduction

Under the Nuclear Regulatory Commission's (NRC's) environmental protection regulations in Title 10 of the Code of Federal Regulations (CFR) Part 51, which implement the National Environmental Policy Act of 1969 (NEPA), renewal of a nuclear power plant operating license (OL) requires the preparation of an environmental impact statement (EIS). In preparing the EIS, the NRC staff is required first to issue the statement in draft form for public comment, and then issue a final statement after considering public comments on the draft. To support the preparation of the EIS, the staff has prepared a *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999)[a]. The GEIS is intended to (1) provide an understanding of the types and severity of environmental impacts that may occur as a result of license renewal of nuclear power plants under 10 CFR Part 54, (2) identify and assess the impacts that are expected to be generic to license renewal, and (3) support 10 CFR Part 51 to define the number and scope of issues that need to be addressed by the applicants in plant-by-plant license renewal proceedings. Use of the GEIS guides the preparation of complete plant-specific information in support of the OL renewal process.

The Tennessee Valley Authority (TVA) operates Browns Ferry Nuclear Plant, Units 1, 2, and 3 (BFN) in northern Alabama under OLs 50-259, 50-260, and 50-296, respectively, which were issued by the NRC. These OLs will expire in December 2013 for Unit 1, June 2014 for Unit 2, and July 2016 for Unit 3. On December 31, 2003, TVA submitted an application to NRC to renew the OLs for BFN for an additional 20 years under 10 CFR Part 54 (TVA 2003a). TVA is a *licensee* for the purposes of its current OLs and an *applicant* for the renewal of the OLs. Pursuant to 10 CFR 54.23 and 51.53(c), TVA submitted an Environmental Report (ER) (TVA 2003b) in which it analyzed the environmental impacts associated with the proposed license renewal action, considered alternatives to the proposed action, and evaluated mitigation measures for reducing adverse environmental effects.

TVA, a federal corporation wholly owned by the U.S. Government, is subject to the requirements for Federal agencies in NEPA. In compliance with NEPA, TVA prepared a supplemental EIS (SEIS) to provide the public and TVA decisionmakers with an assessment of the environmental impacts of extending the operating life of the BFN nuclear units (TVA 2002). This NRC SEIS draws upon the content of the TVA SEIS, but was prepared by NRC staff independently.

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

This report is the plant-specific supplement to the GEIS (the supplemental EIS [SEIS]) for the TVA license renewal application. This SEIS is a supplement to the GEIS because it relies, in part, on the findings of the GEIS. The staff will also prepare a separate safety evaluation report in accordance with 10 CFR Part 54.

1.1 Report Contents

The following sections of this introduction (1) describe the background for the preparation of this SEIS, including the development of the GEIS and the process used by the staff to assess the environmental impacts associated with license renewal; (2) describe the proposed Federal action to renew the BFN OLs; (3) discuss the purpose and need for the proposed action; and (4) present the status of TVA's compliance with environmental quality standards and requirements that have been imposed by Federal, State, regional, and local agencies that are responsible for environmental protection.

The ensuing chapters of this SEIS closely parallel the contents and organization of the GEIS. Chapter 2 describes the site, power plant, and interactions of the plant with the environment. Chapters 3 and 4, respectively, discuss the potential environmental impacts of plant refurbishment and plant operation during the license renewal term. Chapter 5 contains an evaluation of potential environmental impacts of plant accidents and includes consideration of severe accident mitigation alternatives. Chapter 6 discusses the uranium fuel cycle and solid waste management. Chapter 7 discusses decommissioning, and Chapter 8 discusses alternatives to license renewal. Finally, Chapter 9 summarizes the findings of the preceding chapters and draws conclusions about the adverse impacts that cannot be avoided, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and the irreversible or irretrievable commitment of resources. Chapter 9 also presents the staff's recommendation with respect to the proposed license renewal action.

Additional information is included in the appendixes. Appendix A contains public comments related to the environmental review for license renewal and staff responses to those comments. Appendixes B through G, respectively, list the following:

- the preparers of the supplement
- the chronology of NRC staff's environmental review correspondence related to this SEIS
- the organizations contacted during the development of this SEIS
- TVA's compliance status in Table E-1 (this appendix also contains copies of consultation correspondence prepared and sent during the evaluation process)

- GEIS environmental issues that are not applicable to BFN

- severe accident mitigation alternatives.

1.2 Background

Use of the GEIS, which examines the possible environmental impacts that could occur as a result of renewing individual nuclear power plant OLs under 10 CFR Part 54 and the established license renewal evaluation process, supports the thorough evaluation of the impacts of renewal of OLs.

1.2.1 Generic Environmental Impact Statement

NRC initiated a generic assessment of the environmental impacts associated with the license renewal term to improve the efficiency of the license renewal process by documenting the assessment results and codifying the results in the Commission's regulations. This assessment is provided in the GEIS, which serves as the principal reference for all nuclear power plant license renewal EISs.

The GEIS documents the results of the systematic approach that was taken to evaluate the environmental consequences of renewing the licenses of individual nuclear power plants and operating them for an additional 20 years. For each potential environmental issue, the GEIS (1) describes the activity that affects the environment, (2) identifies the population or resource that is affected, (3) assesses the nature and magnitude of the impact on the affected population or resource, (4) characterizes the significance of the effect for both beneficial and adverse effects, (5) determines whether the results of the analysis apply to all plants, and (6) considers whether additional mitigation measures would be warranted for impacts that would have the same significance level for all plants.

NRC's standard of significance for impacts was established using the Council on Environmental Quality (CEQ) terminology for "significantly" (40 CFR 1508.27, which requires consideration of both "context" and "intensity"). Using the CEQ terminology, NRC established three significance levels – SMALL, MODERATE, or LARGE. The definitions of the three significance levels are set forth in the footnotes to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, as follows:

> SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
>
> MODERATE – Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

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

The GEIS assigns a significance level to each environmental issue, assuming that ongoing mitigation measures would continue.

The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

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

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

In the GEIS, the staff assessed 92 environmental issues and determined that 69 qualified as Category 1 issues, 21 qualified as Category 2 issues, and 2 issues, environmental justice and chronic effects of electromagnetic fields, were not categorized. Environmental justice was not evaluated on a generic basis and must be addressed in a plant-specific supplement to the GEIS. Information on the chronic effects of electromagnetic fields was not conclusive at the time the GEIS was prepared.

Of the 92 issues, 11 are related only to refurbishment, 6 are related only to decommissioning, 67 apply only to operation during the license renewal term, and 8 apply to both refurbishment and operation during the renewal term. A summary of the findings for all 92 issues in the GEIS is codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B.

1.2.2 License Renewal Evaluation Process

An applicant seeking to renew its OLs is required to submit an ER as part of its application. The license renewal evaluation process involves careful review of the applicant's ER and assurance that all new and potentially significant information not already addressed in or available during the GEIS evaluation is identified, reviewed, and assessed to verify the environmental impacts of the proposed license renewal.

In accordance with 10 CFR 51.53(c)(2) and (3), the ER submitted by the applicant must

- provide an analysis of the Category 2 issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B in accordance with 10 CFR 51.53(c)(3)(ii)

- 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)(2), the ER does not need to

- consider the economic benefits and costs of the proposed action and alternatives to the proposed action except insofar as such benefits and costs are either (1) essential for making a determination regarding the inclusion of an alternative in the range of alternatives considered, or (2) relevant to mitigation

- consider the need for power and other issues not related to the environmental effects of the proposed action and the alternatives

- discuss any aspect of the storage of spent fuel within the scope of the generic determination in 10 CFR 51.23(a) in accordance with 10 CFR 51.23(b)

- contain an analysis of any Category 1 issue unless there is significant new information on a specific issue – this is pursuant to 10 CFR 51.53(c)(3)(i) and (iv).

New and significant information is (1) information that identifies a significant environmental issue not covered in the GEIS and codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, or (2) information that was not considered in the analyses summarized in the GEIS and that leads to an impact finding that is different from the finding presented in the GEIS and codified in 10 CFR Part 51.

In preparing to submit its application to renew the BFN OLs, TVA developed a process to ensure that information not addressed in or available during the GEIS evaluation regarding the environmental impacts of license renewal for BFN would be properly reviewed before submitting the ER, and to ensure that such new and potentially significant information related to renewal of the licenses for Units 1, 2, and 3 would be identified, reviewed, and assessed during the period of the NRC review. TVA reviewed the Category 1 issues that appear in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, to verify that the conclusions of the GEIS remained valid with respect to BFN. This review was performed by personnel from TVA and its support organization who were familiar with NEPA issues and the scientific disciplines involved in the preparation of a license renewal ER.

The NRC staff also has a process for identifying new and significant information. That process is described in detail in NUREG-1555, Supplement 1, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal*, (NRC 2000). The search for new information includes (1) review of an applicant's ER and the process for discovering and evaluating the significance of new information; (2) review of records of public comments; (3) review of environmental quality standards and regulations; (4) coordination with Federal, State, and local environmental protection and resource agencies; and (5) review of the technical literature. New information discovered by the staff is evaluated for significance using the criteria set forth in the GEIS. For Category 1 issues where new and significant information is identified, reconsideration of the conclusions for those issues is limited in scope to the assessment of the relevant new and significant information; the scope of the assessment does not include other facets of the issue that are not affected by the new information.

Chapters 3 through 7 discuss the environmental issues considered in the GEIS that are applicable to BFN. At the beginning of the discussion of each set of issues, there is a table that identifies the issues to be addressed and lists the sections in the GEIS where the issue is discussed. Category 1 and Category 2 issues are listed in separate tables. For Category 1 issues for which there is no new and significant information, the table is followed by a set of short paragraphs that state the GEIS conclusion codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, followed by the staff's analysis and conclusion. For Category 2 issues, in addition to the list of GEIS sections where the issue is discussed, the tables list the subparagraph of 10 CFR 51.53(c)(3)(ii) that describes the analysis required and the SEIS sections where the analysis is presented. The SEIS sections that discuss the Category 2 issues are presented immediately following the table.

Section 4.7 addresses potential new and significant information. In July 2004, TVA submitted extended power uprate (EPU) applications (TVA 2004a, b) to increase the licensed power levels of each of the three units to 3952 megawatts-thermal (MW[t]), or 120 percent of the originally licensed power levels, for a total power level of 11,856 MW(t). The staff determined that there is a potential, at the uprated power level, that BFN may no longer be within the envelope of impacts defined by the GEIS, as amended, for some Category 1 issues.

To address this concern, the staff examined each of the 54 Category 1 issues applicable to BFN and determined that 34 of the Category 1 issues could be influenced by the thermal power level of the reactors. The staff then evaluated each of the 34 issues to determine if increasing the unit power level above the levels considered during the development of the GEIS would affect the specific generic conclusions. After evaluating all 34 issues the staff determined that the generic conclusions reached in the GEIS are still valid and none of the GEIS conclusions were changed based on the staff's analysis. Therefore, the proposed EPU does not constitute new and significant information and the staff could continue to rely upon the conclusions of the GEIS for all Category 1 issues applicable to BFN.

NRC prepares an independent analysis of the environmental impacts of license renewal and compares these impacts to the environmental impacts of alternatives. Evaluation of the TVA license renewal application began with publication of a notice of acceptance for docketing and opportunity for a hearing in the *Federal Register* (69 FR 11460) on March 10, 2004. The staff published a notice of intent to prepare an EIS and conduct scoping (69 FR 11462) on March 10, 2004. Two public scoping meetings were held on April 1, 2004, in Athens, Alabama. Comments received during the scoping period were summarized in the Environmental Impact Statement Scoping Process: *Environmental Scoping Summary Report – Browns Ferry Nuclear Plant, Units 1, 2, and 3, Limestone County, Alabama* (NRC 2004) dated July 2004. Comments applicable to this environmental review are presented in Part 1 of Appendix A.

The staff followed the review guidance contained in NUREG-1555, Supplement 1, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal* (NRC 2000). The staff and its contractors visited the BFN site on March 30 and 31, 2004, to gather information and to become familiar with the site and its environs. The staff also reviewed the comments received during scoping, and consulted with Federal, State, regional, and local agencies. A list of the organizations consulted is provided in Appendix D. Other documents related to BFN were reviewed and are referenced.

This SEIS presents the staff's analysis that considers and weighs the environmental effects of the proposed renewal of the OLs for BFN, the environmental impacts of alternatives to license renewal, and mitigation measures available for avoiding adverse environmental effects. Chapter 9, "Summary and Conclusions," provides the NRC staff's recommendation to the Commission on whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable.

A 75-day comment period begins on the date of publication of the U.S. Environmental Protection Agency Notice of Filing of the draft SEIS to allow members of the public to comment on the results of the NRC staff's review. During this comment period, two public meetings will be held in Athens, Alabama, in January 2005. During these meetings, the staff will describe the preliminary results of the NRC environmental review and answer questions to provide members of the public with information to assist them in formulating their comments.

1.3 The Proposed Federal Action

The proposed Federal action is renewal of the OLs for BFN. BFN is located in northern Alabama on the north shore of Wheeler Reservoir, an impoundment of the Tennessee River. The BFN site is approximately 16 km (10 mi) south of Athens, Alabama; 16 km (10 mi) northwest of Decatur, Alabama; and 48 km (30 mi) west of Huntsville, Alabama. The plant has three General Electric-designed boiling water reactors. Unit 1 is currently licensed at its original power level of 3293 MW(t) and a net power output of 1065 megawatts-electric (MW[e]). Units 2 and 3 were granted a license amendment during 1998 that raised their authorized thermal power levels by 5% to 3458 MW(t) and each unit currently has a net power output of 1118 MW(e). Plant cooling is normally provided by a once-through cooling system that draws water from the Tennessee River. The plant also has mechanical draft cooling towers that are used when needed to provide additional heat dissipation before the cooling water is returned to the river. With all three units operating, enough electricity would be produced to supply the needs of nearly two million homes. The current OL for Unit 1 expires on December 20, 2013; the license for Unit 2 expires on June 28, 2014; and the license for Unit 3 expires on July 2, 2016. By letter dated December 31, 2003, TVA submitted an application to the NRC (TVA 2003a) to renew these OLs for an additional 20 years of operation (i.e., until December 20, 2033, June 28, 2034, and July 2, 2036, for Units 1, 2, and 3, respectively).

All three of the BFN units were shut down in 1985 to review the TVA nuclear power program and to correct significant weaknesses (TVA 2003b). Unit 2 was returned to service in 1991, and Unit 3 was returned to service in 1995. In 2002, TVA began the process of returning Unit 1 to service, with operation expected to resume in 2007. Almost all the activities associated with this effort are confined to existing onsite structures and little new construction is necessary. No licensing action by NRC is required for the restart of Unit 1, and many of the activities that could have had some environmental impact have already been completed. TVA considered these impacts in a separate SEIS (TVA 2002). Therefore, the effects of Unit 1 restart are outside the scope of license renewal and are not considered in this SEIS, although the potential effects of continued operation of Unit 1 are considered in this analysis.

In July 2004, TVA submitted EPU applications (TVA 2004a, b) to increase the licensed power levels of each of the three units to 3952 MW(t), or 120 percent of the originally licensed power levels, for a total station power level of 11,856 MW(t). NRC will evaluate the potential environmental impacts of an EPU in a separate Environmental Assessment. Therefore, the impacts associated with the increase in thermal power level from the currently licensed value to the EPU value is not evaluated in this SEIS. However, the staff performed its evaluation of impacts for the license renewal term in this SEIS assuming all three units are operating at 120 percent of the original licensed power level.

This SEIS was prepared to evaluate the potential environmental impacts of operating the BFN units at 120 percent of their originally licensed power levels for an additional 20 years beyond the current license terms for each unit.

1.4 The Purpose and Need for the Proposed Action

Although a licensee must have a renewed license to operate a reactor beyond the term of the existing OL, the possession of that license is just one of a number of conditions that must be met for the licensee to continue plant operation during the term of the renewed license. Once an OL is renewed, State regulatory agencies and the owners of the plant will ultimately decide whether the plant will continue to operate based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners.

Thus, for license renewal reviews, the NRC has adopted the following definition of purpose and need (GEIS Section 1.3):

> The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and where authorized, Federal (other than NRC) decisionmakers.

This definition of purpose and need reflects the Commission's recognition that, unless there are findings in the safety review required by the Atomic Energy Act of 1954 or findings in the NEPA environmental analysis that would lead the NRC to reject a license renewal application, the NRC does not have a role in the energy-planning decisions of State regulators and utility officials as to whether a particular nuclear power plant should continue to operate. From the perspective of the licensee and the State regulatory authority, the purpose of renewing an OL is to maintain the availability of the nuclear plant to meet system energy requirements beyond the current term of the plant's license.

1.5 Compliance and Consultations

TVA is required to hold certain Federal, State, and local environmental permits, as well as meet relevant Federal and State statutory requirements. In its ER, TVA provided a list of the authorizations from Federal, State, and local authorities for current operations as well as environmental approvals and consultations associated with BFN license renewal. Authorizations and consultations relevant to the proposed OL renewal action are included in Appendix E.

The staff has reviewed the list and consulted with the appropriate Federal, State, and local agencies to identify any compliance or permit issues or significant environmental issues of concern to the reviewing agencies. These agencies did not identify any new and significant environmental issues. The ER states that TVA is in compliance with applicable environmental standards and requirements for BFN. The staff has not identified any environmental issues that are both new and significant.

1.6 References

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

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

40 CFR Part 1508. Code of Federal Regulations, Title 40, *Protection of Environment,* Part 1508, "Terminology and Index."

69 FR 11460. March 10, 2004. "Notice of Acceptance for Docketing of the Application and Notice of Opportunity for a Hearing Regarding Renewal of License Nos. DPR-33, DPR-52 and DPR-68 for an Additional Twenty-Year Period." *Federal Register,* U.S. Nuclear Regulatory Commission.

69 FR 11462. March 10, 2004. "Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process." *Federal Register,* U.S. Nuclear Regulatory Commission.

Atomic Energy Act of 1954. 42 USC 2011, et seq.

National Environmental Policy Act of 1969 (NEPA). 42 USC 4321, et seq.

Tennessee Valley Authority (TVA). 2002. *Final Supplemental Environmental Impact Statement for Operating License Renewal of the Browns Ferry Nuclear Plant in Athens, Alabama.* Knoxville, Tennessee.

Tennessee Valley Authority (TVA). 2003a. *Application for Renewed Operating Licenses, Browns Ferry Units 1, 2, and 3.* Knoxville, Tennessee.

Tennessee Valley Authority (TVA). 2003b. *Applicant's Environmental Report – Operating License Renewal Stage, Browns Ferry Units 1, 2, and 3.* Knoxville, Tennessee.

Tennessee Valley Authority (TVA). 2004a. *Tennessee Valley Authority Browns Ferry Nuclear Plant (BFN), Unit 1, Proposed Technical Specifications (TS) Change TS-431 – Request for License Amendment for Extended Power Uprate Operation, Browns Ferry Unit 1 Extended Power Uprate Environmental Report.* Tennessee Valley Authority, Decatur, Alabama.

Tennessee Valley Authority (TVA). 2004b. *Tennessee Valley Authority Browns Ferry Nuclear Plant (BFN), Units 2 and 3, Proposed Technical Specifications (TS) Change TS-418 – Request for License Amendment for Extended Power Uprate Operation, Browns Ferry Units 2 and 3 Extended Power Uprate Environmental Report.* Tennessee Valley Authority, Decatur, Alabama.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants.* NUREG-1437, Volumes 1 and 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants Main Report*, "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2000. *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal.* NUREG-1555, Supplement 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2004. *Environmental Scoping Summary Report – Browns Ferry Nuclear Plant, Units 1, 2, and 3, Limestone County, Alabama.* Washington, D.C.

2.0 Description of Nuclear Power Plant and Site and Plant Interaction with the Environment

The Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 (BFN) site is located on the north shore of Wheeler Reservoir in Limestone County, Alabama, at Tennessee River Mile (TRM) 294. The plant consists of three boiling water reactors (BWRs) that produce steam, which passes through a turbine to generate electricity. In addition to the nuclear units, the major features of the site are intake and discharge canals, switchyards, a training center, an employee physical fitness center, a materials storage and procurement complex, and structures from a former aquatic research laboratory. The plant and its environment are described in Section 2.1, and the interaction of the plant with the environment is presented in Section 2.2.

2.1 Plant and Site Description and Proposed Plant Operation During the License Renewal Term

BFN is located on approximately 340 ha (840 ac) of Federally owned land that is under the custody of the Tennessee Valley Authority (TVA). TVA is a corporate agency and instrumentality of the United States, as described in the TVA Environmental Report (ER) (TVA 2003a). The site is approximately 48 km (30 mi) west of Huntsville, Alabama; 16 km (10 mi) northwest of Decatur, Alabama; and 16 km (10 mi) southwest of Athens, Alabama. Figures 2-1 and 2-2 show the location of BFN and features within an 80-km and 10-km (50-mi and 6-mi) radius of the site.

Land in the vicinity of BFN is used primarily for agriculture. Population densities are low, with no population centers of significance within 16 km (10 mi) of the plant. The site is surrounded to the north and east by rural countryside. It includes open pasture lands, scattered farmsteads, few residents, and little industry within several miles. The terrain is gently rolling with open views to higher elevations to the north. The south and west side of the plant site abuts Wheeler Reservoir, which is a wide expanse of open river used for a variety of recreational purposes. The reservoir in the vicinity of the plant site is moderately used by recreational boaters and fishermen. There are no homes within the foreground viewing distance to the north and east. However, adjacent to the plant site several developments have partial views of the site – a small residential development is sited to the northwest and another across Wheeler Reservoir to the southwest, and the Mallard Creek public use area is directly across the reservoir. A berm, graded during the initial construction of the plant site and containing approximately 2.5 million m^3 (3.3 million yd^3) of earth excavated to make cooling water channels, lies adjacent to the cooling tower complex and blocks views of the northern and eastern plant areas. Two wildlife management areas – Swan Creek State Wildlife Management

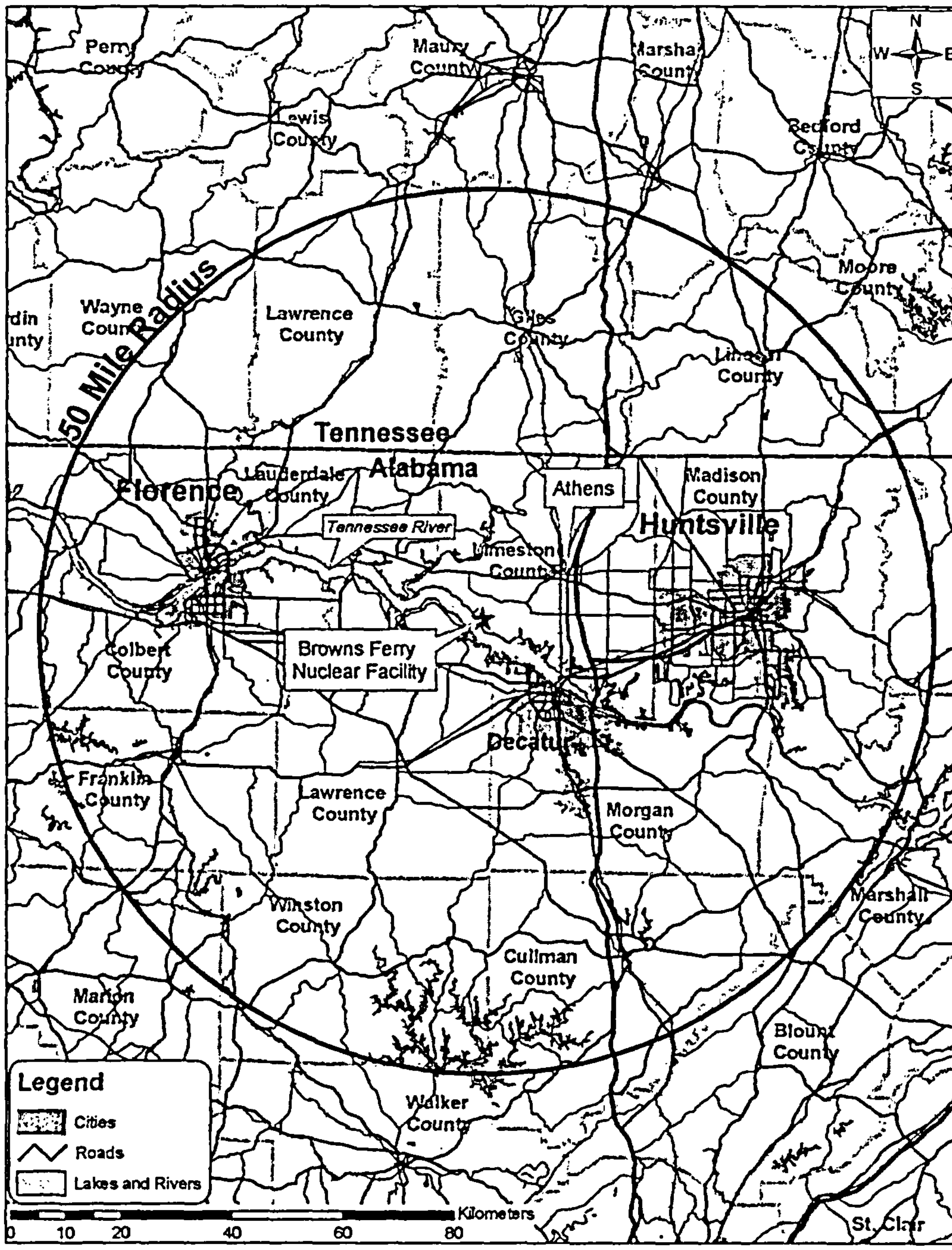
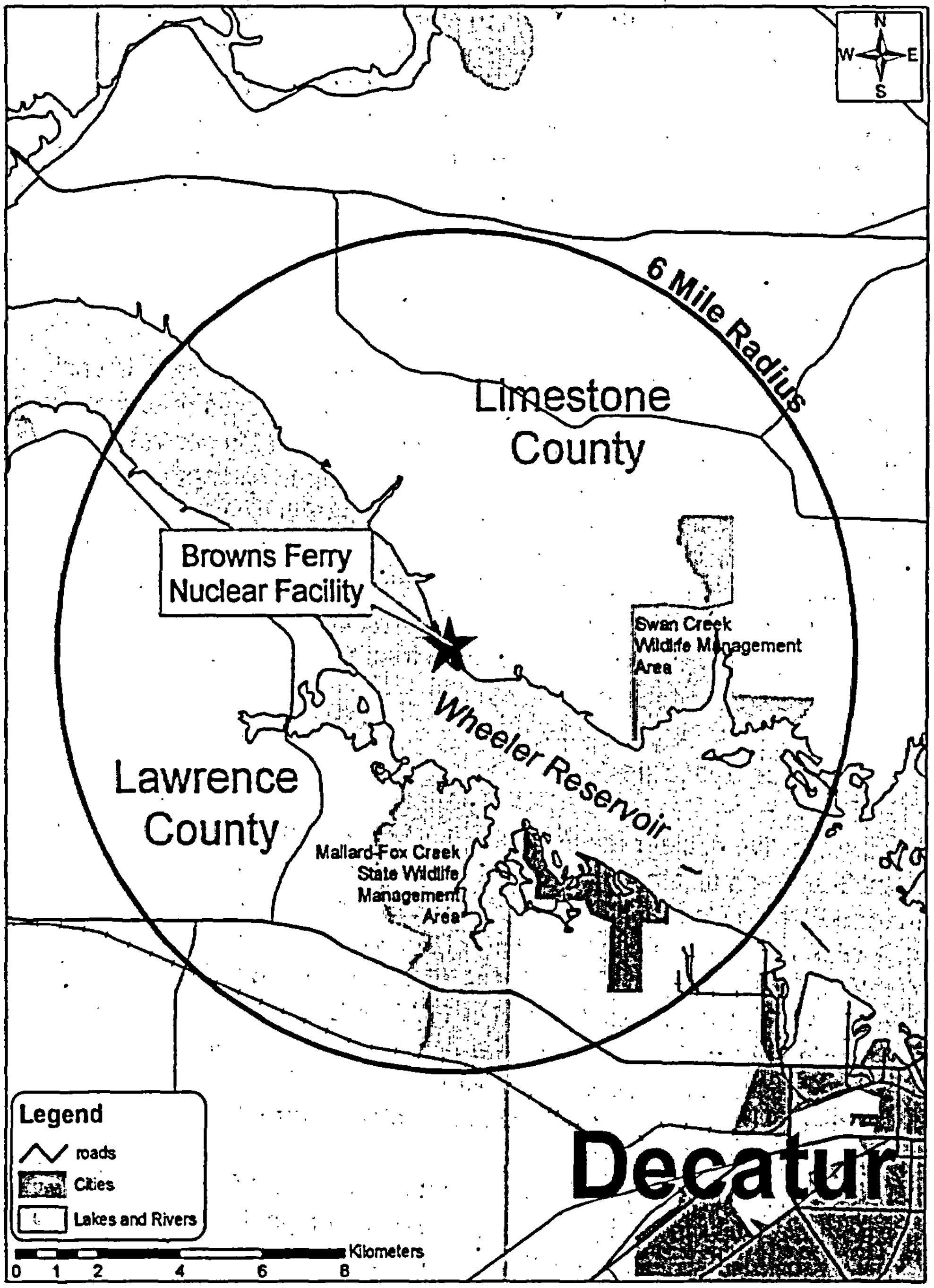


Figure 2-1. Location of Browns Ferry Nuclear Power Plant, Units 1, 2, and 3, 80-km (50-mi) Region



1 **Figure 2-2.** Location of Browns Ferry Nuclear Power Plant, Units 1, 2, and 3,
2 10-km (6-mi) Region

Area and Mallard-Fox Creek State Wildlife Management Area – are within 5 km (3 mi) of the BFN site (TVA 2003a). The Swan Creek Wildlife Management Area includes more than 1200 ha (3000 ac) of land and more than 2000 ha (5000 ac) of water surrounded by numerous industrial facilities. The Mallard-Fox Creek State Wildlife Management Area encompasses approximately 280 ha (700 ac) of land and 690 ha (1700 ac) of water and is primarily used for small game hunting. The Round Island Recreation Area is located approximately 5.6 km (3.5 mi) upstream of BFN.

2.1.1 External Appearance and Setting

The three-unit BFN plant, including the intake and discharge canals, is enclosed by a security fence. Primary access to the plant area is by way of an access road through a security gate. The plant has the following principal physical structures in the central site area: reactor containment building, turbine building, radioactive waste building, service building, intake pumping station, transformer yard, 161-kV and 500-kV switchyards, off-gas stack, sewage treatment facilities, and administration and maintenance buildings. The hot and cold water discharge channels and mechanical draft cooling towers are located northwest of the central site area, while the training center, employee physical fitness center, materials storage and procurement complex, and structures from a former aquatic research laboratory are located to the east of the central site area.

2.1.2 Reactor Systems

BFN has two active nuclear reactor units (Units 2 and 3) and one inactive unit (Unit 1) as shown in Figure 2-3. Each unit includes a BWR and a steam-driven turbine generator manufactured by General Electric Company. Each unit was licensed for an output of 3293 megawatts-thermal (MW[t]), with a design net electric rating of 1065 megawatts-electric (MW[e]). Major construction on BFN, TVA's first nuclear power plant, began in 1967. Commercial operation began in 1974 for Unit 1, in 1975 for Unit 2, and in 1977 for Unit 3. All three units were shut down in 1985 during a review of the TVA nuclear power program. Unit 2 returned to service in May 1991, and Unit 3 resumed operation in November 1995. Work began in 2002 to bring Unit 1 up to current standards, and operation of the reactor is currently scheduled to resume in 2007.

In 1998, BFN completed an Integrated Plant Improvement Project for Units 2 and 3. Among the improvements made was a 5 percent uprate of the original licensed thermal power (OLTP) for both units from 3293 to 3458 MW(t). The impacts of this action were evaluated in an Environmental Assessment. The U.S. Nuclear Regulatory Commission (NRC) issued the Environmental Assessment and Finding of No Significant Impact related to the October 1, 1997, application for a five-percent power uprate on August 26, 1998 (NRC 1998). An amendment to the BFN OL was approved by NRC for the five percent uprate on September 8, 1998. During

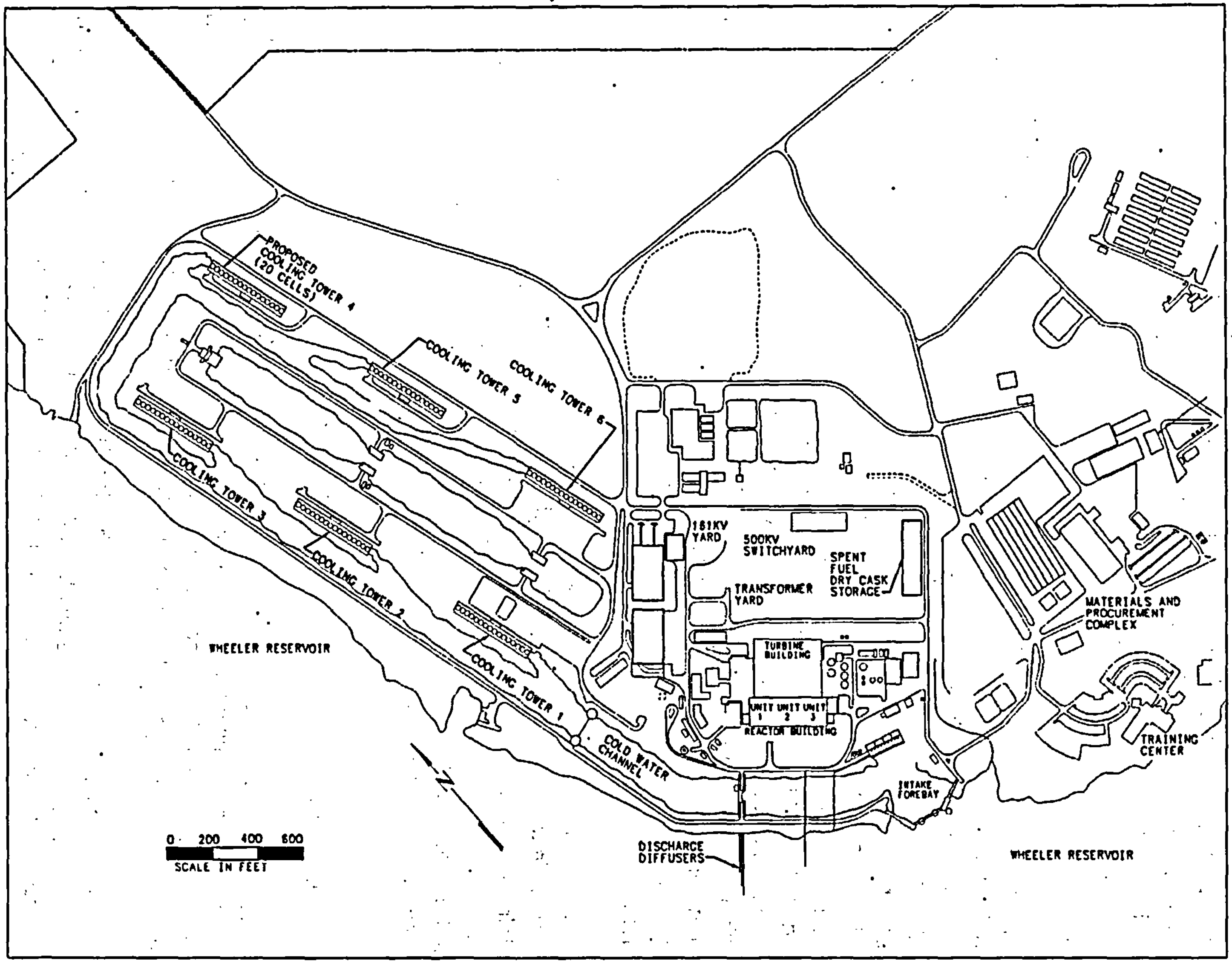


Figure 2-3. Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Site Features

June 2004, TVA submitted applications for extended power uprates (EPUs) to 120 percent of OLTP at each of the three BFN units (TVA 2004a, b). These applications, if approved by the staff, will take effect during the existing license term. The impacts evaluated in this SEIS include those from operation of all three of the BFN reactor units, each at 120 percent of the OLTP.

The nuclear steam supply system at BFN is typical of General Electric BWRs. Each nuclear system includes a single-cycle, forced-circulation, General Electric BWR that produces steam for direct use in a steam turbine. The design employs a pressure suppression primary containment that houses the reactor vessel, the reactor coolant recirculating loops, and other branch connections of the reactor primary system. The pressure suppression system consists of a drywell, a pressure suppression chamber that stores a large volume of water, connecting vents between the drywell and the pressure suppression chamber, isolation valves, containment cooling systems, and other service equipment. Cooling systems are provided to remove heat from the reactor core, the drywell, and the water in the pressure suppression chamber, thus providing continuous cooling of the primary containment under accident conditions. Appropriate isolation valves are actuated during this period to ensure confinement of radioactive material, which might otherwise be released from the reactor containment during the course of an accident.

The secondary containment substructure consists of poured-in-place, reinforced concrete exterior walls that extend up to the refueling floor. The refueling room floor is also constructed of reinforced, poured-in-place concrete. The secondary containment structure completely encloses the primary containment dry wells, fuel storage and handling facilities, and essentially all of the core standby cooling systems for the three units. During normal operation and when isolated, the secondary containment is maintained at a negative pressure relative to the building exterior.

2.1.3 Cooling and Auxiliary Water Systems

Wheeler Reservoir on the Tennessee River is the source for cooling water and most of the auxiliary water systems for BFN (see Figure 2-3). Potable water is supplied by the City of Athens Utilities Water Department in Athens, Alabama. Groundwater is not used at the site. Figure 2-3 shows the general layout of the buildings and structures at the site.

The intake forebay is separated from Wheeler Reservoir by a gate structure with three bays that are each 12 m (40 ft) wide by about 7.3 m (24 ft) high (TVA 1972). Each bay includes a 6-m (20-ft)-high gate that can be raised or lowered depending on the operational requirements of the plant. The flow velocity through the openings varies depending on the gate position. When the gates are in their full open position and the plant is operated in either the open or helper modes, the average flow velocity through the openings is about 0.2 m/s (0.6 fps) for the operation of one unit, 0.34 m/s (1.1 fps) for the operation of two units, and 0.52 m/s (1.7 fps) for the operation of all three units (TVA 2003a). These flow velocities are based on an intake flow per unit of about 46,300 L/s (734,000 gpm), which is 46.3 m^3/s (1635 cfs).

The intake pumping station includes 18 bays (i.e., six bays per reactor unit), each with a traveling screen. Each bay has a net opening size of about 2.6 m by 6 m (8.75 ft by 20 ft). The maximum average flow velocity through each bay is about 0.49 m/s (1.6 fps) and is independent of the reservoir surface elevation. The maximum average velocity through a clean screen with net openings of 0.95 cm by 0.95 cm (3/8 in. by 3/8 in.) is about 0.64 m/s (2.1 fps) (TVA 2003a). Flow velocities through the intake pump station bays and traveling screens are independent of the number of units in operation and the reservoir elevation.

The BFN units are normally cooled by pumping water from Wheeler Reservoir into the turbine generator condensers and discharging it back to the reservoir via three large submerged diffuser pipes that are perforated to maximize uniform mixing into the flow stream. These pipes range in diameter from 5.2 m to 6.2 m (17 ft to 20.5 ft). The flow exits each discharge pipe through 7800 5-cm (2-in.) ports (TVA 2003a). This straight-through flow path is known as "open cycle" or "open mode" operation. As originally designed, the maximum thermal discharge from the once-through cooling water system is directed into the Wheeler Reservoir, with a temperature increase across the intake and discharge of 13.9°C (25°F) (TVA 1972). The flow exits the diffusers and mixes with the reservoir flow. At the edge of the discharge mixing zone, the water temperature is required to be less than 5.6°C (10°F) above ambient (ADEM 2003).

Through various gates, some of this cooling water can also be directed through cooling towers to reduce its temperature as necessary to comply with environmental regulations. This flow path is known as the "helper mode."

The capacity also exists to recycle cooling water from the cooling towers directly back to the intake structure without being discharged to the reservoir. This flow path, known as the "closed mode" of operation, has not been used since the restart of Units 2 and 3 because of difficulties in achieving temperature limits in summer months and problems with equipment reliability. TVA does not anticipate using this mode in the future, and no procedures for operating in this mode currently exist.

In recent years, only Units 2 and 3 have been operated, but because of a combination of system upgrades and improved flow calibrations, the measured total per-unit condenser circulating water (CCW) flow rate in open mode (with three CCW water pumps per unit) has increased. The condenser tubes were replaced with stainless steel tubing that have a larger internal diameter and lower flow resistance. This modification increased flow through the condenser by approximately 6 percent. TVA estimates total intake for three-unit operation in open mode to be 139 m^3/s (4907 cfs) or 12,000 m^3/d (3171 MGD) (TVA 2003a).

Because of various system limitations, BFN cannot pass all the CCW through the cooling towers when operating in the helper mode. The fraction of cooling water that cannot be passed through the cooling towers is routed directly to the river. Almost all of the cooling water that passes through the cooling towers is returned to the river, but a small amount is lost to the atmosphere during operation. If cooling tower capacity is increased during the license renewal term, this consumptive use could increase proportionately. The cooling towers are only operated when necessary to meet thermal discharge temperature limits specified in the National Pollutant Discharge Elimination System (NPDES) permit, typically a few weeks during the hottest part of the summer (typically July and August).

For the last 6 years, during which Units 2 and 3 have both been in service, the greatest amount of time cooling tower operation has been required has been about 8 percent of a year (TVA 2003a). Increased thermal power proposed for Units 2 and 3 will result in an additional increase of approximately 2.2°C (4°F) in the circulating water temperature leaving the main condenser (for each operating unit) (Hopping 2004). This increase in water discharge temperature would result in increased use of the cooling tower during summer periods to maintain compliance with discharge limitations. No changes to the plant intake system or to the individual unit intake flow rates are expected to be required as a result of the Unit 2 and 3 EPU project, and operations will continue to meet regulatory limits established in the existing NPDES permit.

Simulations with the near-field hydrothermal model were conducted for the period 1985 through 2002, excluding 2 years (1989 and 1990) for which no river ambient temperature data are available (TVA 2003a). Model results showed that, with Units 2 and 3 operating at 120 percent power, on average the cooling towers will be used approximately 5.3 percent of the time, and derating will be required approximately 0.10 percent of the time (i.e., 6.2 days over the 16-year simulation period). On average, with all three units at 120 percent power, use of the cooling towers will increase to approximately 7.2 percent of the time and derating will increase to approximately 0.29 percent of the time (i.e., 17 days over the 16-year simulation).

The residual heat removal service water (RHRSW) system consists of four pairs of pumps located on the intake structure for pumping raw river water to the heat exchangers in the RHRSW system and four additional pumps for supplying water to the emergency equipment cooling water (EECU) system. The EECU system distributes cooling water supplied by the RHRSW system to essential equipment during normal and accident conditions.

In June 2004, TVA submitted applications for EPUs for the three BFN units (TVA 2004a, b). TVA has stated (TVA 2002a) that "no changes are expected to be required to the plant intake system or to the individual unit intake flow rates as a result of the EPU project." TVA also indicated that existing thermal discharge limits would be met by increased use of the helper towers, and if necessary, derating one or more units. The EPU environmental report for BFN, Unit 1stated that an additional sixth cooling tower, consisting of 20 cells would be built. This sixth cooling tower would be associated only with returning Unit 1 to service (TVA 2004a).

2.1.4 Radioactive Waste Management Systems and Effluent Control Systems

BFN uses various radioactive waste management systems to collect and process the liquid, gaseous, and solid wastes produced during reactor operations. These systems reduce the quantities of radioactive liquid, gaseous, and solid effluents released to the environment. The waste disposal systems meet the design objectives of Title 10 of the Code of Federal Regulations (CFR) Part 50, Appendix I (*Numerical Guide 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*), and controls the release of radioactive material to within the limits specified in the Offsite Dose Calculation Manual (ODCM) and NPDES permits. The methods employed for the controlled release of those contaminants depend primarily on the physical state of material (i.e., solid, liquid, or gaseous) (TVA 2004c).

The liquid and solid wastes from BFN are routed to a common radioactive waste building for collection, treatment, sampling, and disposal. Packaged solid wastes and reusable radioactive material may be temporarily stored in the onsite radioactive waste storage facility or in approved outside storage locations. Gaseous wastes are processed and routed to a common tall stack for release to the atmosphere. The liquid and gaseous radioactive waste systems are designed to reduce the activity in the liquid and gaseous wastes such that the concentrations in routine discharges are below the applicable regulatory limits. The liquid and gaseous effluents are continuously monitored, and the discharge is stopped if the effluent concentrations exceed predetermined levels.

Radioactive fission products build up within the fuel as a consequence of the fission process. These fission products are contained in the sealed fuel rods, but small quantities may escape from the fuel rods into the reactor coolant. Neutron activation of components in the primary coolant system also results in release of radioactive material into the coolant. Non-fuel solid wastes result from treating and separating radionuclides from gaseous and liquid effluents and from removing contaminated material from various reactor areas. Solid wastes also consist of reactor components, equipment, and tools removed from service, as well as contaminated protective clothing, paper, rags, and other trash generated from plant operations, design modifications, and routine maintenance activities. Solid wastes may be shipped to a waste processor for volume reduction before disposal, or they may be sent directly to a licensed burial site. Spent resins and filters are stored or packaged for shipment to an offsite processing or disposal facility.

Spent fuel consists of fuel rods that have exhausted a certain percentage of their fissile fuel material; they are periodically removed from the reactor core for disposal. Units 2 and 3 currently operate on a 24-month refueling cycle per unit, with one unit refueling every year. Spent fuel is stored onsite in the spent fuel pool. TVA is constructing an independent spent fuel storage installation (ISFSI) for storage of spent fuel in dry storage casks.

The ODCM for BFN (TVA 2004c) is subject to NRC inspection and describes the methods and parameters used for calculating offsite doses resulting from radioactive gaseous and liquid effluents. It is also used for calculating gaseous and liquid effluent monitoring alarm/trip setpoints for release of effluents from BFN. Operational limits for releasing liquid and gaseous effluents are specified to ensure compliance with NRC regulations.

In June 2004, TVA submitted a request for a license amendment for a power uprate at BFN Units 2 and 3 from 3458 MW(t) to 3952 MW(t) (TVA 2004b). Also, TVA plans to return Unit 1 to commercial operation and increase the power level from 3293 MW(t) to 3952 MW(t) (TVA 2004a). The net result of these plans is that TVA intends to operate all three units at the combined total power level of 11,856 MW(t) during the license renewal term. TVA has estimated that operation at the combined total power level of 11,856 MW(t) could increase the amount of radioactive material released in liquid and gaseous effluents and solid radioactive wastes by as much as a factor of 1.8 over the current operation.

2.1.4.1 Liquid Waste Processing Systems and Effluent Controls

The function of the liquid radioactive waste control system is to collect, treat, store, and dispose of all radioactive liquid wastes. Liquid waste is collected in sumps and drain tanks at various locations throughout the plant and are then transferred to the appropriate collection tanks in the Radwaste Building for treatment, storage, and disposal. Waste to be discharged from the system is processed on a batch basis, with each batch being processed by such method or methods appropriate for the quality and quantity of materials determined to be present. Processed liquid waste may be returned to the condensate system for reuse within the plant, or it may be discharged to the environment through the circulating water discharge canal. The liquid waste in the discharge canal is diluted with condenser effluent circulating water to achieve permissible radionuclide concentrations at the site boundary.

Batches of low-conductivity liquid waste are processed through a filter and a waste demineralizer. Demineralizer effluent is sent to a waste sample tank. Depending on the conductivity and level of radioactivity, the liquid may then be discharged to the circulating water discharge canal or the cooling tower blowdown line, transferred to condensate storage tanks, or returned for further processing through the demineralizer.

High-conductivity liquids are processed through a filter and are collected in a floor drain sample tank. If the concentration after dilution is within the applicable limits, the filtered liquid may be discharged.

An alternate method of processing low- and high-conductivity liquid is the use of vendor-supplied, portable equipment that can be interconnected to the permanent radioactive waste system. Depending on effluent quality and plant needs, the liquid can either be transferred to the waste sample tank or the floor drain sample tank. Processing from the waste sample tank or floor drain sample tank is identical to that described above.

All systems are protected against overflow and other unplanned releases by appropriate alarms and shutdown devices. The ODCM prescribes the alarm/trip setpoints for the liquid effluent radiation monitors (TVA 2004c).

During the years 1999 through 2003, the volume of liquid effluents from Units 2 and 3 ranged from 0 to 4.9 million L (0 to 1.3 million gal) per year, including a total of 79 batch releases (TVA 2000, 2001, 2002b, 2003b, 2004c). During 3 of those 5 years, there were no batch releases because liquids were processed and returned to the condensate system for reuse within the plant. The total radioactivity released in liquid effluents during that time was 6.3×10^{11} Bq (17 Ci). The largest annual release during this period was 4.1×10^{11} Bq (11 Ci), which occurred in 1999. Section 2.2.7 describes the hypothetical doses to a maximally exposed individual as a result of those releases.

These liquid radiological effluent releases are typical of the annual releases for operation of BFN, Units 2 and 3 without the power uprates. As discussed earlier, operation at the combined total power level of 11,856 MW(t) during the license renewal term could increase liquid effluent releases by as much as a factor of 1.8 over these typical values.

2.1.4.2 Gaseous Waste Processing Systems and Effluent Controls

Radioactive gaseous effluents include low concentrations of fission-product noble gases (such as krypton and xenon), halogens (mainly iodines), tritium in the form of water vapor, and particulate material containing both fission products and activated corrosion products. The gaseous radioactive waste system is designed to collect and process potentially radioactive effluents prior to discharge through the elevated main plant stack. The system receives gaseous discharges from each main condenser air ejector, startup vacuum pump, condensate drain tank vent, and steam packing exhauster. Gases from each main condenser air ejector are passed through a preheater, catalytic recombiner, condenser, moisture separator, and dehumidification coil. The gases then enter a decay pipe that provides a retention time of approximately 6 hours, during which nitrogen-16 and oxygen-19 decay to negligible levels. The gases are then passed through a cooler condenser, moisture separator, reheater, prefilter, six charcoal beds, and an afterfilter before they are mixed with dilution air and exhausted to the main stack. The charcoal beds provide about 9.7 hours of retention time for krypton isotopes and 7.3 days of retention time for xenon isotopes. Gases from the gland seals and startup vacuum pumps are held for approximately 1.75 minutes, to allow for decay of nitrogen-16 and oxygen-19, and then are passed directly to the stack for release.

The ODCM prescribes alarm/trip setpoints for the gaseous effluent radiation monitors (TVA 2004c). The actual gaseous effluents for the period from 1999 to 2003 averaged about 6.7×10^{13} Bq (1800 Ci) per year, with a maximum of 1.8×10^{14} Bq (4900 Ci) in 2003 (TVA 2000, 2001, 2002b, 2003b, 2004c). Section 2.2.7 describes hypothetical doses to a maximally exposed individual as a result of these releases.

These gaseous radiological effluent releases are typical of the annual releases for operation of Units 2 and 3 without the power uprates. As discussed earlier, operation at the combined total power level of 11,856 MW(t) during the license renewal term could increase gaseous effluent releases by as much as a factor of 1.8 over these typical values.

2.1.4.3 Solid Waste Processing

Solid waste from routine operations at Units 2 and 3 consists of spent (dewatered) resin, solidified resin, filters, sludge, evaporator bottoms, dry compressible waste, irradiated components (control rods, etc.), and other non-compressible waste. The solid radioactive waste system consists of systems and components that are used to process and package wet and dry solid wastes so that the waste is suitable for transport and disposal. The system is not used for spent fuel storage and shipment.

Solid waste is typically stored onsite for a period of time to allow for decay of short-lived radionuclides. Solid wastes from equipment originating in the nuclear system is stored in the fuel storage pool to allow for radioactive decay before they are prepared for reprocessing or offsite storage. Examples of the waste include components such as activated control rods and in-core instrumentation.

Methods used for processing and packaging solid radioactive waste depend primarily on the waste characteristics. Process solid waste such as spent demineralizer resins and filter materials is collected and dewatered to meet burial site and 10 CFR 61.56 requirements. It is either temporarily stored onsite in concrete storage modules or shipped directly for burial offsite in a licensed disposal facility. High-integrity containers are used to package waste when the waste classification requires that it meet stability requirements. High-integrity containers used for disposal of this waste are certified for acceptance at the disposal facility to which the waste is shipped.

Dry active waste from operation and maintenance activities is collected throughout the radiologically controlled areas of the facility. Dry active waste such as paper, rags, or used clothing is either placed into containers for storage or shipped directly to a waste processor for volume reduction and subsequent transport to an offsite licensed disposal facility. Most dry active waste has relatively low radionuclide content and may be handled manually. Dry active waste that does not meet the criteria for processing by the offsite processor may be packaged for direct shipment to a disposal facility. Where practical, selected items may be decontaminated onsite for reuse or release. Dry active waste is monitored during packaging to ensure applicable controls are maintained.

Disposal and transportation of solid radioactive waste are performed in accordance with the applicable requirements of 10 CFR Parts 61 and 71, respectively. During the period from 1999 to 2002, generation rates for radioactive solid wastes from routine operation and maintenance activities at Units 2 and 3 ranged from 514 to 654 m^3 (18,200 to 23,100 ft^3) per year (Pierce 2004). During the period from 1999 to 2002, Units 2 and 3 made 133 shipments of solid radioactive waste with a total activity of 3.0×10^{13} Bq (820 Ci) (TVA 2000, 2001, 2002b, 2003b).

These quantities of solid radioactive waste are typical for operation of BFN, Units 2 and 3 without the power uprates. As discussed earlier, operation at the combined total power level of 11,856 MW(t) during the license renewal term could increase the quantities of solid radioactive waste by as much as a factor of 1.8 over these typical values.

2.1.5 Nonradioactive Waste Systems

The principal nonradioactive effluents from BFN consist of hazardous (chemical), lubrication oil, construction, and sanitary wastes. As is the case with any large industrial facility, BFN generates a variety of wastes that are classified as hazardous under the Resource Conservation and Recovery Act (RCRA). Such wastes include paint-related materials, spent solvents used for cleaning and degreasing, and universal wastes such as batteries, fluorescent light tubes, etc. TVA operates a Hazardous Waste Storage Facility in Muscle Shoals, Alabama, that holds a RCRA Part B permit for temporary storage of hazardous waste. The Hazardous Waste Storage Facility serves as a central collection point for TVA-generated hazardous wastes, and maintains contracts with facilities used to process and dispose of the waste. All hazardous waste generated at BFN is shipped to the Hazardous Waste Storage Facility for consolidation, storage, and transfer to licensed facilities for treatment and disposal. BFN recycles paint solvents (primarily methyl ethyl ketone) using an onsite still. Universal wastes are collected and shipped to recycling firms. Hazardous waste generation rates for BFN average approximately 1540 kg (3400 lbs) per calendar year. Although it is not a hazardous waste as defined in the RCRA regulations, used oil also is generated at BFN as a result of maintenance activities on plant equipment. All used oil is collected, stored onsite, and shipped to an approved recycling center for energy recovery.

Following restart of Unit 1, hazardous waste generation rates during routine operation of all three units are expected to fall within the normal year-to-year variation currently experienced with two unit operation. Existing waste management systems are capable of handling the hazardous wastes anticipated from operation of all three units at the uprated power level throughout the license renewal period.

General plant trash such as paper, metals, garbage, and other items collected as part of routine plant operation activities is managed through a TVA system-wide contract with a licensed waste disposal company. This waste material is collected and transported to a State-licensed regional landfill. Generation rates for this type of material are currently approximately 45 MT (50 tons) per month. BFN has an active recycling program to segregate and recycle scrap metal, cardboard, paper, batteries, and aluminum cans at approved State and local recycling facilities (TVA 2003a)

Once Unit 1 is operational, the amount of trash generated would be similar to that of the other operating units, and the overall amount generated would increase slightly (approximately 12.5 percent) from the current level because of the incremental increase in permanent plant staff necessary to operate three units. The existing contractor is capable of handling the increased waste volumes anticipated. Landfill capacity and projections for availability of landfill space in Alabama indicate that sufficient space to accommodate this material from BFN should be available for the duration of the license renewal term (TVA 2003a).

For construction and demolition debris associated with ongoing site activities, such as modifications and additions to facilities, BFN operates a State-permitted construction/demolition landfill within the confines of the BFN site. This landfill is permitted to accept non-hazardous, non-radioactive solid wastes at an average volume of 4.5 MT (5 tons) per day from the BFN site. Materials permitted for disposal include scrap lumber, bricks, sandblast grit, crushed metal drums, glass, wiring, non-asbestos insulation, roofing materials, building siding, scrap metal, concrete with reinforcing steel, and similar construction and demolition wastes. The landfill occupies approximately 3.1 ha (7.7 ac). The generation rate for this type of material over the past 2 years is approximately 0.036 MT (0.04 tons) per day (TVA 2003a).

Once Unit 1 resumes operation, the amount of construction/demolition waste generated as a result of the three-unit operation would not be expected to increase substantially over the rates experienced for two-unit operations.

2.1.6 Plant Operation and Maintenance

The BFN maintenance and modification program supports operation of the nuclear power plant and ensures that equipment, systems, and structures are maintained and modified in accordance with applicable requirements and at a quality level required for them to perform their intended functions as specified in the original design, material specifications, and inspection requirements. Additionally, the following guidance from the Institute of Nuclear Power Operations has been incorporated into the maintenance and modification program as appropriate:

- Inspections are performed by qualified individuals in nuclear assurance or other TVA nuclear organizations where necessary to ensure quality.

- Inspections are performed by individuals other than those who performed or directly supervised the activity being inspected. Inspection results are documented and maintained as records.

- The inspection program provides assurance that plant quality-related items and activities within the scope of the Nuclear Quality Assurance Plan conform to predetermined quality requirements called for in specifications, procedures, and drawings.

- The inspection program includes quality control inspections, nondestructive examinations, line verifications, and special inspections.

TVA Nuclear Standard Programs and Processes address procedural requirements for material receipt and inspection, the American Society of Mechanical Engineers Section XI in-service inspection program, special nuclear material control, and nuclear fuel management (TVA 2003a).

2.1.7 Power Transmission System

BFN is connected into the TVA system network by seven 500-kilovolt (kV) lines via the 500-kV switchyard (Figure 2-4). One line is to the Madison substation, two lines are to the Trinity substation, one line each are to the West Point, Maury, and Union substations, and one line is to the Limestone 500-kV substation (TVA 2003a). In addition, there are two 161-kV lines, one to the Athens substation and one to the Trinity substation. All lines occupy portions of four

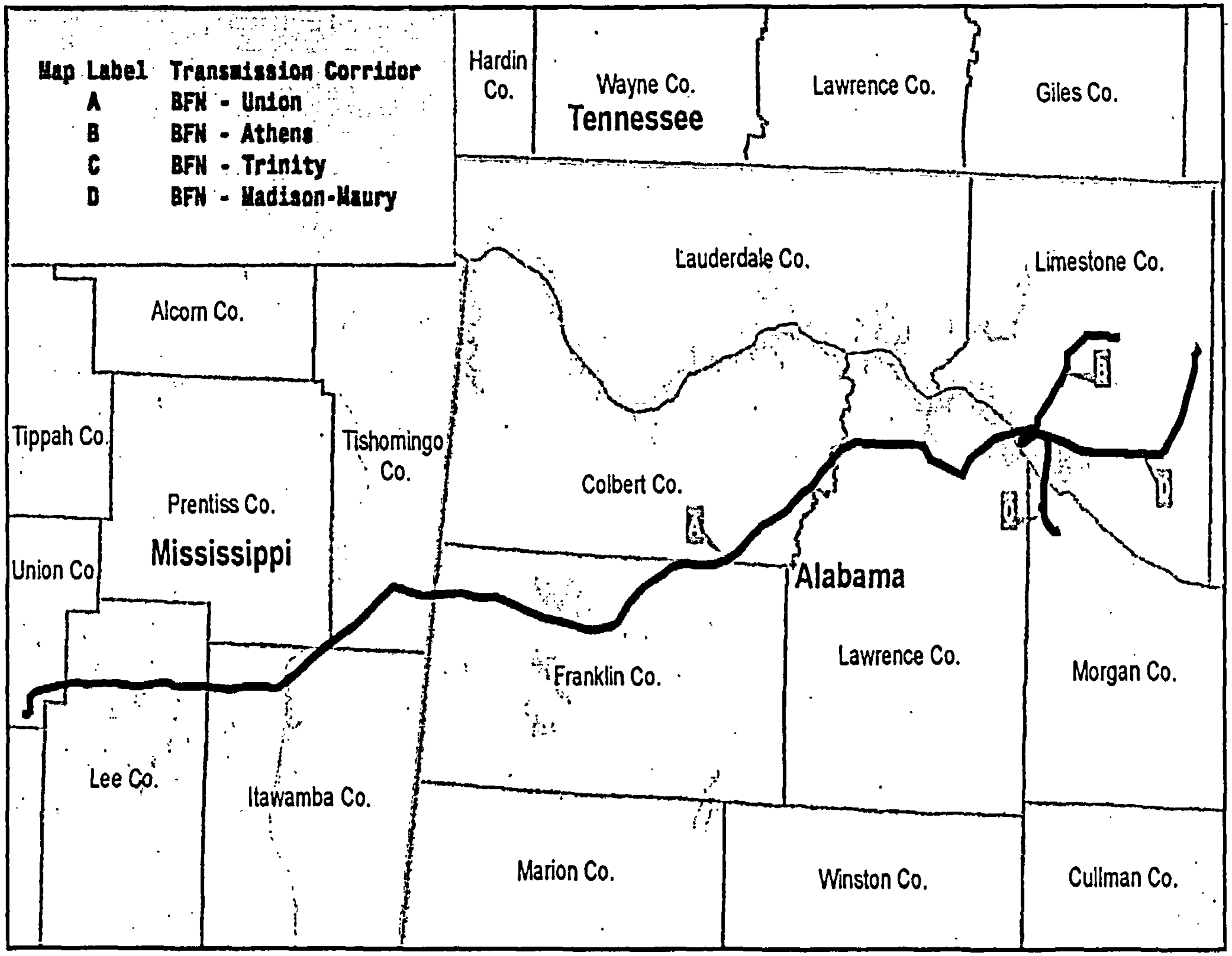


Figure 2-4. Map of Transmission Line Rights-of-Way for Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

Table 2-1. Browns Ferry Nuclear Power Power Plant, Units 1, 2, and 3 Transmission Line Rights-of-Way

Right-of Way	Line	kV	Year Completed	Length km	Length mi
BFN to Trinity	BFN-Trinity	500	1968	17.8	11.1
	BFN-Trico	500	1996		
	Trinity-BFN	161	1968		
BFN-Maury	BFN-Madison	500	1968	37.2	23.1
	BFN-West Point	500	1968		
	BFN-Maury	500	1968		
	BFN-Limestone	500	1995		
BFN-Athens	BFN-Athens	161	1968	23.1	14.3
BFN to Union	BFN-Union	500	1980	176.8	109.9

transmission line rights-of-way, one to the Maury substation, one to the Trinity substation, one to the Athens substation, and one to the Union, Mississippi, substation (Figure 2-4, Table 2-1). There are portions of other transmission lines within these rights-of-way that were not constructed specifically to connect BFN to the TVA power system. However, for the sake of simplicity and a comprehensive analysis, all the rights-of-way are included in the assessment.

Maintenance of the transmission line rights-of-way is the responsibility of the TVA Transmission and Power Supply – Transmission Operations and Maintenance organization (TVA 2003a). Maintenance activities include vegetation management, pole replacement, installation of lightning arresters and counterpoise, and equipment upgrades. Regular maintenance activities are conducted on a 3- to 5-year cycle. Detailed discussion on transmission line maintenance activities is found in Section 4.2. All activities are reviewed by specialists in the TVA Regional Natural Heritage and Cultural Resources Program. The TVA program maintains a detailed Geographic Information System database of natural and cultural resources along the entire TVA distribution system. The database includes daily updates of Federally and State-listed species habitat and occurrence records (TVA 2003a). Maintenance activities that have the potential to impact sensitive resources are carefully planned and implemented to minimize disturbance.

2.2 Plant Interaction with the Environment

Sections 2.2.1 through 2.2.8 provide general descriptions of the environment near BFN as background information. They also provide detailed descriptions where needed to support the analysis of potential environmental impacts of refurbishment and operation during the license renewal term, as discussed in Chapters 3 and 4. Section 2.2.9 describes the historic and archaeological resources in the area, and Section 2.2.10 describes possible impacts associated with other Federal project activities.

2.2.1 Land Use

BFN is located on the north shore of Wheeler Reservoir in an unincorporated portion of Limestone County, Alabama. Limestone County does not have land-use zoning applicable to unincorporated portions of the county. Wheeler Reservoir is formed by Wheeler Dam, which is owned and operated by TVA and is approximately 32 km (20 mi) downriver from BFN. The reservoir is 119 km (74 mi) long (TVA 2003a).

BFN is approximately 48 km (30 mi) west of Huntsville, Alabama; 16 km (10 mi) northwest of Decatur, Alabama; and 16 km (10 mi) southwest of Athens, Alabama. The site is a 340 ha (840 ac) tract just south of U.S. Highway 72 and is directly accessible from County Road 25 (Nuclear Plant Road). County Road 25 intersects U.S. Highway 72 approximately 10 km (6 mi) north of the site; it also intersects U.S. Highway 31 approximately 14 km (9 mi) east of the site.

The Swan Creek State Wildlife and Mallard-Fox Creek State Wildlife Management Areas are within 5 km (3 mi) of the plant site. The Swan Creek Wildlife Management Area includes more than 1200 ha (3000 ac) of land and more than 2000 ha (5000 ac) of water surrounded by numerous industrial facilities. The Mallard-Fox Creek State Wildlife Management Area includes approximately 280 ha (700 ac) of land and 690 ha (1700 ac) of water, and is primarily used for small game hunting (TVA 2003a).

2.2.2 Water Use

At the BFN site, the Tennessee River flows from southeast to northwest; and the average width in Wheeler Reservoir ranges from 1.6 to 2.4 km (1 to 1.5 mi). Wheeler Reservoir extends from Guntersville Dam at TRM 349 downstream to Wheeler Dam at TRM 274.9. The drainage area upstream of Wheeler Dam is 76,640 km^2 (29,590 mi^2). The reservoir was created in 1936 as one of the first major dam projects on the Tennessee River for flood control, power generation, and navigation. Wheeler Reservoir has a normal summer pool elevation of 169.5 m (556 ft) above mean sea level and a minimum water elevation of 168 m (550 ft). The lake usually reaches its summer pool elevation by mid-April. Fall drawdown, in anticipation of winter rains, usually begins around August 1. At summer pool elevation, the reservoir has an area of 27,140 ha (67,070 ac), a volume of 1290 million m^3 (1.05 million ac-ft), a mean depth of 4.8 m (15.7 ft), and a hydraulic residence time of 10.7 days (TVA 2002a).

The most recent total BFN intake flow reported to the Alabama Department of Environmental Management (ADEM) in the monthly Discharge Monitoring Report (December 2003) and to the Alabama Department of Economic and Community Affairs in the Annual Certificate of Use Report is 8 million m^3/d (2114 MGD), which is approximately 46.3 m^3/s (734,000 gpm) per unit. With the return of Unit 1, the total intake flow would then become approximately 12 million m^3/d (3171 MGD) or 139 m^3/s (4907 cfs), which represents an increase over the previous high reported number (10.8 million m^3/d or 2855 million gpm) of 11 percent.

TVA is pursuing EPUs, which would increase the total combined power level to 11,856 MW(t) with no further increase in intake flows. The additional heat would be routed through the diffusers for discharge. TVA has modeled the mixing zone and believes BFN can continue to meet current ADEM regulatory limits of the NPDES permit by employing various mitigating measures such as derating and use of the cooling tower helper mode of operation.

BFN cannot put all the CCW through the cooling towers when operating in the helper mode because of various system limitations. TVA reports the maximum practical throughput for the six cooling towers as 105.5 m^3/s (3725 cfs) (TVA 2004a). Remaining CCW flow bypasses the cooling towers and is routed directly to the river. Almost all the cooling tower flow is also returned to the river, but there is a small amount lost into the air during operation. When evaporation and "drift" are considered, these losses can approach 2 percent of the total cooling tower flow. TVA estimates 1.53 m^3/s (54 cfs) at 105 percent and 1.76 m^3/s (62 cfs) at 120 percent EPU for Units 2 and 3 (Hopping 2004). TVA has committed to rebuild the sixth cooling tower; therefore, the consumptive use of cooling water would increase. TVA estimates 2.01 m^3/s (71 cfs) at 105 percent and 2.32 m^3/s (82 cfs) at 120 percent EPU for all three units (Hopping 2004). The cooling towers are only operated when necessary to meet thermal discharge temperature limits specified in the NPDES permit, typically a few weeks during the hottest part of the summer (usually during July and August).

Although most of the intake water is used for condenser cooling, a small amount (approximately 3 percent) of it is used for other plant uses such as emergency equipment cooling water, residual heat removal, raw cooling water, fire protection, and raw service water systems (TVA 2003a). Almost all of this water is ultimately returned to the river, either directly or indirectly through leakage drains. The only consumption of this water at the site would be from a negligible and unquantifiable amount of evaporation when the water is exposed to air.

BFN also consumes a relatively small amount of river water for use in making highly purified or "demineralized" water for various uses in the plant that require high-grade water. On average, this consumptive rate is approximately 5.7 million L/month (1.5 million gal/month) in the summer, which is somewhat higher than the winter consumption because of running the turbine building air wash system to keep equipment operating temperatures down. This consumptive rate is equivalent to 2.2 L/s (0.077 cfs) (TVA 2003a).

Using an unsteady flow model of Wheeler Reservoir, the measured releases from Guntersville Dam and Wheeler Dam were used to compute the hourly flow in Wheeler Reservoir at BFN (TVA 1977a). TVA analyzed these data to obtain a time series of the daily average flow for the period 1976 to 2002. For this period, the following statistical properties are identified for the flow at BFN: the average daily flow was 1320 m^3/s (46,606 cfs), ranging from 10,700 m^3/s (378,742 cfs) to 75 m^3/s (2638 cfs) (TVA 2003a). The total intake water flow of 139 m^3/s (4907 cfs) can encompass a significant fraction of the daily average river flow past the plant.

Target minimum flows currently used for TVA river operations were established by an environmental impact statement in 1990 (TVA 1990). The minimum daily average flows in the Tennessee River at BFN are 280 m^3/s (10,000 cfs) for July through September, 230 m^3/s (8000 cfs) for December through February, and 140 m^3/s (5000 cfs) otherwise.

Based on the information given above, the Tennessee River average annual flow at BFN for the period 1976 to 2002 equates to 4.16×10^{10} m^3/yr (1.47×10^{12} ft^3/yr). This is less than the 9×10^{10} m^3/yr (3.15×10^{12} ft^3/yr) criterion stated by NRC in 10 CFR 51.53(c)(3)(ii)(A) as the value beneath which "an assessment of the impact of the proposed action on the flow of the river and related impacts on in-stream and riparian ecological communities must be provided."

The critical time for approaching the maximum river water temperature limits specified in the BFN NPDES permit, and therefore requiring the use of cooling towers or plant derates, is July and August. Based on the time series data from 1976 to 2002, the average flow in Wheeler Reservoir at BFN was 963.57 m^3/s (34,028 cfs) during July and August (TVA 2003a). During these same months and same period, the minimum daily average flow observed at BFN was 79.71 m^3/s (2815 cfs), occurring on July 1, 1987. For comparison, the "7Q10" low flow value (i.e., the lowest average flow for 7 consecutive days that has an average recurrence interval of 10 years) given in the rationale for the BFN NPDES permit is 246 m^3/s (8700 cfs) (ADEM 2003). The daily average flow exceeded the 7Q10 low flow value 98.6 percent of the time in July and 98.8 percent of the time in August.

The Athens Utilities Water Department supplies potable water to BFN. Potable water consumption at the site is partly a function of the number of people working at the site. Besides drinking fountains and bathrooms, potable water is also used for fire protection, supplied to a 1.9-million-L (500,000-gal) fire protection water bladder tank, and for various clean water uses, such as window and building wash water and pressurized spray water for equipment cleaning. Some flow is lost to occasional leaks. BFN typically uses 15,000 to more than 30,000 m^3 per month (4 to 8 million gal per month) of potable water (TVA 2003a).

There is no groundwater use at BFN.

2.2.3 Water Quality

Pursuant to the Federal Water Pollution Control Act Amendments of 1972 (FWPCA), the water quality of the plant effluents is regulated through the NPDES, and ADEM is delegated to issue NPDES permits In Alabama. The current permit (AL0022080) was issued December 29, 2000, and is due to expire January 31, 2006. The NPDES permit specifies the discharge standards and monitoring requirements for each discharge. This permit specifies effluent limits for pH, total residual chlorine, oil, grease, biological oxygen demand, fecal coliform, total suspended solids, temperature, naphthalene, and BETX (i.e., benzene, ethyl benzene, toluene, and xylene isomers). Any new regulations promulgated by the U.S. Environmental Protection Agency (EPA) or the State of Alabama would be reflected in future permits.

Compliance with the NPDES process, other provisions of the FWPCA (e.g., Sections 316 (a), 316 (b), 401, 404), and other regulatory requirements are expected to adequately control potential chemical effluent effects. In general, under these regulatory programs, TVA treats waste water effluents, collects and properly disposes of potential contaminants, and undertakes pollution prevention activities that comply with regulatory requirements and minimize the risk of adverse environmental impacts. The NPDES permit contains temperature limits based on a 316(a) demonstration that EPA approved in June 1977. The NPDES permit can be re-opened and modified in the event ADEM determines, through biological and/or water quality monitoring, that more stringent limitations and/or monitoring requirements are necessary to ensure the protection and propagation of aquatic life in the Tennessee River.

Effluent discharges from plant systems such as yard drains, station sumps, and sanitary waste water would not be expected to change significantly through the license renewal term. Considering that the plant waste water lagoons and sedimentation ponds possess clay and Hypalon liners, respectively, no impacts to groundwater resources are anticipated. The changes in pond/lagoon discharges to the river would remain within the bounding conditions established in the NPDES.

2.2.4 Air Quality

The climate at the BFN site varies between continental in the fall to maritime in the summer. During the winter and spring seasons, the climate is variable between the two classifications. The climate at Huntsville, Alabama, which is well documented, is generally considered representative of the BFN site[a]. Climatological records for Huntsville indicate that precipitation is fairly evenly distributed among all months, but the winter and spring seasons are wetter than the fall and summer. Normal monthly precipitation ranges from 17 cm (6.7 in.) in March to

(a) Climatological data for Huntsville is available at http://www.ncdc.noaa.gov/ol/climate/climatedata.html

8.4 cm (3.3 in.) in August. Normal daily maximum temperatures for Huntsville range from 9.4°C (48.9°F) in January to a high of slightly more than 32°C (89°F) in July. Normal minimum temperatures range from almost -0.6°C (31°F) in January to almost 21°C (70°F) in July. During the period from 1968 to 2002, the highest recorded temperature at Huntsville was 40°C (104°F), which occurred in July, while the lowest temperature recorded temperature is -24°C (-11°F), which occurred in January. The temperatures generally drop below 0°C (32°F) about 63 days annually.

Thunderstorms are reported about 57 days annually in the Huntsville area. Although thunderstorms occur in all months of the year, most occur during the months of May, June, July, and August. Thunderstorms can have windstorms and sometimes hail associated with them, and in some cases produce tornadoes. The highest reported wind speed at Huntsville during the period from 1968 to 2002 was 28.2 m/s (63 mph) from the north-northeast direction. During the period from January 1, 1950, to December 31, 2003, 50 days of hail events were reported in Limestone County. The largest reported hailstones were 9.5 cm (3.75 in.), which fell on the City of Athens, Alabama, on May 18, 1995 (NOAA 2004). During the same time period, 24 tornados were reported in Limestone County. The most violent storm occurred on April 3, 1974, when 11 deaths were reported and 80 people were injured. The most property damage occurred during a tornado on May 18, 1995, when property damage amounting to $5 million was reported along with one death and 55 injuries (NOAA 2004).

The National Severe Storms Laboratory in Kansas City, Missouri, calculated the tornado return probability for the BFN site based on tornado occurrences within a 55.6-km (30-nautical-mi) radius during the period from 1950 to 1986. Based on 48 tornado occurrences having path size estimates during that 37-year period, the return probability for the site is 6.979×10^{-4} with a mean return interval of 1433 years.

The wind energy resource in northern Alabama is limited. The annual average wind power density in Alabama is almost exclusively Class 1 on a scale of 1 through 7 (Elliott et al. 1987). Areas suitable for wind turbine applications have a rating of 3 or higher. The only areas that meet this criterion are ridge tops in northeastern Alabama where the Appalachian foothills begin, along the exposed Gulf Coast shoreline of Alabama, and in the Mobile Bay area during the winter and spring seasons.

The BFN site is located within the Tennessee River Valley-Cumberland Mountains Interstate Air Quality Control Region (40 CFR 81.72). Presently, this region is considered in attainment for all criteria pollutants (40 CFR 81.301). The EPA is in the process of promulgating new, more restrictive standards for ozone and particulate matter. For ozone, the current 1-hour ozone standard will be replaced by an 8-hour standard. Once these new standards are implemented, several counties that are part of the control region may not be in compliance.

The Sipsey Wilderness area is the only area in Alabama designated in 40 CFR 81.401 as a mandatory Class 1 Federal area in which visibility is an important value. The Wilderness area is located about 45 km (28 mi) southwest of the BFN site. All other Class 1 areas located in Tennessee or Mississippi are greater than 80 km (50 mi) from BFN.

Diesel-power auxiliary (emergency) generators, auxiliary boilers, and other small sources such as fuel storage facilities emit various non-radiological pollutants. Emissions from these sources are regulated by ADEM under a Synthetic Minor Operating Permit (ADEM Administrative Code 335-3-15-02-10). This permit remains in effect until the existing administrative code is amended. The terms of that permit require the site to track actual emissions. The most recent report (for 2003) indicated that a total of 35.3 MT (38.9 tons) of pollutants were discharged to the atmosphere from these sources (TVA 2004d). For the period from 1998 to 2003, annual emissions have varied between 27.2 and 40.8 MT (30 and 45 tons).

2.2.5 Aquatic Resources

The aquatic resources in the vicinity of the BFN site are associated primarily with the Wheeler Reservoir portion of the Tennessee River. Wheeler Reservoir is the source and receiving body for the BFN cooling system. The BFN site has about 3772 m (12,375 ft) of Wheeler Reservoir frontage (TVA 2003a). Other nearby aquatic habitats include the following tributaries to Wheeler Reservoir: Paint Rock and Flint Rivers in the upper reach; Indian, Cotaco, and Flint Creeks in the middle reach; and Limestone, Piney, Swan, Fox, Mallard, Spring, First, and Second Creeks and the Elk River in the lower section. Elk River is the largest of these tributaries, and flows into Wheeler Reservoir about 16 km (10 mi) downstream of BFN. Guntersville Reservoir is located upstream of Wheeler Reservoir, while Wilson Reservoir is located downstream from Wheeler Reservoir.

The seven transmission lines associated with BFN cross a number of streams ranging in size from small intermittent streams to the Tennessee River. Rivers and larger streams crossed by or near the transmission lines include Limestone, Piney, Round Island, Swan, Big Nance, Town, Spring, Cedar, Little Bear, and Bear Creeks in Alabama, and Bear, Little Brown, Donivan, Twentymile, Mantachie, Mud, and Bridge Creeks and the Tennessee-Tombigbee Waterway in Mississippi.

TVA began its Vital Signs Monitoring Program in 1990 to systematically monitor key physical, chemical, and biological indicators (i.e., dissolved oxygen, chlorophyll, sediments, benthic macroinvertebrates, and fish) to evaluate the ecological conditions of its reservoirs and to target detailed assessment studies if significant problems are found (Dycus 1998). Monitoring is done in the inflow area (generally riverine in nature), transition zone (mid-reservoir area), and forebay area (generally lacustrine or lake-like in nature). The Vital Signs Monitoring Program transition zone sampling station for Wheeler Reservoir is located at TRM 295.9, a short distance upstream of BFN (TVA 2003a). The ecological health rating for a sample site can range from a minimum of 4.5 (all indicators poor) to 22.5 (all indicators excellent). The overall health evaluation for a reservoir is determined by summing the ratings from all sites and dividing by the maximum possible rating for the sites, expressed as a percentage. This approach provides a potential range of scores from 20 to 100 percent and applies to all reservoirs regardless of the number of indicators or sample sites. The percent scoring range is then divided into categories representing good (greater than 72 percent), fair (52 to 72 percent), and poor (less than 52 percent) ecological health conditions for run-of-the-river reservoirs (the cut off between a poor and fair rating for tributary and storage reservoirs is 57 percent rather than 52 percent) (Dycus 1998). Between 1991 and 2003, the ecological health scores for Wheeler Reservoir ranged from a low of 61 (fair) in 1999 to a high of 76 (good) in 1997, with a 1993 to 1997 average of 73 (good) (Dycus 1998). Ecological health scores in 2001 and 2003 were 65 and 72, respectively, indicating a continuing fair rating in recent years (TVA 2004e).

A total of 63 fish species plus hybrid sunfish, hybrid striped bass x white bass (*Morone saxatilis* x *M. chrysops*), and hybrid walleye x sauger (*Stizostedion vitreum* x *S. canadense*) were collected from 1995 through 2002 in the vicinity of BFN (TVA 2002a, 2003a). A total of 72 fish species were collected in impingement samples between 1974 and 1977 (TVA 1978). Important commercial fish species that occur in Wheeler Reservoir include blue catfish (*Ictalurus furcatus*), channel catfish (*I. punctatus*), flathead catfish (*Pylodictis olivaris*), bigmouth buffalo (*Ictiobus cyprinellus*), smallmouth buffalo (*I. bubalus*), and common carp (*Cyprinus carpio*). Gizzard shad (*Dorosoma cepedianum*) and threadfin shad (*D. petenense*) are the dominant forage species in Wheeler Reservoir (TVA 2003a). Threadfin shad has been the dominant species numerically in Wheeler Reservoir since 1990 (Baxter and Buchanan 1998).

Game fish species include largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieu*), spotted bass (*M. punctulatus*), black crappie (*Pomoxis nigromaculatus*), white crappie (*P. annularis*), bluegill (*Lepomis macrochirus*), longear sunfish (*L. megalotis*), redear sunfish (*L. microlophus*), sauger, striped bass, hybrid striped bass, yellow bass (*Morone mississippiensis*), and yellow perch (*Perca flavescens*). Largemouth bass is the species most often sought by sport fishermen, followed by crappie. Bluegill are the most numerous game fish in Wheeler Reservoir (Baxter and Buchanan 1998). The sport fishery is supplemented by stockings of striped bass, hybrid striped bass, largemouth bass, and channel catfish.

The Vital Signs Monitoring Reservoir Fish Assemblage Index metric scores are based primarily on fish community structure and function; but also consider percentage of sample represented by omnivores and insectivores, overall number of fish collected, and the occurrence of fish with anomalies (e.g., diseases, lesions, parasites, and deformities). The Reservoir Fish Assemblage Index scores from 1993 to 2002 have equated to a rating of fair upstream of BFN (TRM 295.9) and good downstream of BFN at TRM 277. Monitoring done at TRM 292.5 just downstream of BFN from 2000 through 2002 have equated to a rating of good (Baxter and Gardner 2003). There are no health advisories against the consumption of fish from Wheeler Reservoir. However, there are advisories against consuming bigmouth and smallmouth buffalo from two tributaries of upper Wheeler Reservoir (Indian Creek and Huntsville Spring Branch from Redstone Arsenal to the Tennessee River) because of DDT contamination (ADPH 2002, 2003).

The Sport Fishing Index was developed to quantify sport fishing quality for individual sport fish species. The Sport Fishing Index uses information from population sampling (e.g., catch per unit effort from electrofishing and gill netting) and creel results (e.g., angler success) to describe the quality of the resident fishery. Parameters measured include the length and weight of fish in various categories (e.g., preferred-size fish, memorable-size fish, and trophy-size fish). The Sport Fishing Index can range from 20 (very poor) to 60 (excellent) (Hickman 2000). The 2002 scores for Wheeler Reservoir and the TVA system-wide average (given in parentheses) were Florida largemouth bass, *Micropterus salmoides floridanus*, 38 (37); bluegill, 26 (29); channel catfish, 28 (26); hybrid striped bass, 44 (40); northern largemouth bass (*M. s. salmoides*), 34 (33); sauger, 42 (30); smallmouth bass, 36 (35); and spotted bass, 42 (35) (TVA 2002c). While the sport fishery in Wheeler Reservoir cannot be considered excellent, these scores do indicate that, except for bluegill, the quality of the sport fishery in the reservoir is slightly above average for the TVA system.

Currently, seven invasive aquatic animal species pose a threat to aquatic communities in the TVA reservoir system: common carp, grass carp (*Ctenopharyngodon idella*), alewife (*Alosa pseudoharengus*), blueback herring (*A. aestivalis*), rusty crayfish (*Orconectes rusticus*), Asiatic clam (*Corbicula fluminea*), and zebra mussel (*Dreissena polymorpha*). The Asiatic clam and zebra mussel are the most problematic of these species due to their impacts on power plants and city water supplies, as well as to their potential ecological impacts (TVA 2004f). The grass carp has been introduced into TVA reservoirs to control heavy infestations of aquatic vegetation. The introduced grass carp are sterile, and the population can be maintained at desired levels by adjusting stocking rates. Grass carp have been collected infrequently in gill net and electroshock samples at TRM 295.9 (TVA 2002a). Other non-native species such as the striped bass, hybrid striped bass, and yellow perch have become popular game species in the Wheeler Reservoir (Baxter and Buchanan 1998).

The phytoplankton of Wheeler Reservoir is diverse. As many as 27 Chrysophyta (yellow-green or yellow-brown algae), 52 Chlorophyta (green algae), and 17 Cyanophyta (blue-green algae) taxa have been documented (TVA 1977b). The zooplankton assemblage is also diverse, with 32 cladoceran, 24 copepod, and 47 rotifer taxa having been reported (TVA 1977b). The non-native cladoceran *Daphnia lumholtzi* has been documented throughout the Tennessee River system (Baker 2001), and is therefore expected to occur in Wheeler Reservoir (TVA 2003a). It may eventually become a dominant zooplankton species in the southern United States (CARS 2004).

In 2002, there were an estimated 1820 ha (4500 ac) of aquatic plant coverage in Wheeler Reservoir. Between 1976 and 2002, this has varied from a low of 8 ha (20 ac) (1976 to 1978) representing a trace percentage of the reservoir to a high of 3983 ha (9843 ac) (in 1988) or about 14 percent of the reservoir (TVA 2004f). The aquatic plants that commonly occur in Wheeler Reservoir include the invasive exotic Eurasian watermilfoil (*Myriophyllum spicatum*), hydrilla (*Hydrilla verticillata*), spinyleaf naiad (*Najas minor*), the invasive native coontail (*Ceratophyllum demersum*), and southern naiad (*N. guadalupensis*). Most of these plants occur in the broad, shallow overbank habitat upstream of BFN between TRM 296 and 305 (TVA 2002a). Eurasian watermilfoil, hydrilla, and spinyleaf naiad are submersed aquatic plants that can be severely problematic to reservoir use, while the submersed aquatic southern naiad and the free-floating coontail are generally considered beneficial species, they can occasionally reach nuisance levels (TVA 2004f).

The overbank areas support communities of Asiatic clams, fingernail clams, burrowing mayflies, aquatic worms, and chironomids, while cobble and bedrock areas (found mainly in the old channel) support Asiatic clams, bryozoans, sponges, caddisflies, snails, and some leeches (TVA 2002a). The Vital Signs Monitoring Program transition station at TRM 295.5 had benthic community scores of excellent in 1994, good in 1995, and excellent in both 1997 and 1999 (Dycus and Baker 2000). Benthic macroinvertebrate monitoring was initiated in 2000 in support of the BFN thermal variance monitoring. The benthic community was rated excellent at TRM 295.9 (upstream of the BFN diffusers) in 2000 and in good condition in 2001 and 2002. At TRM 291.7 (downstream of the BFN diffusers) the rating was excellent in 2001 and good in 2002 (Baxter and Gardner 2003). The average mean density of benthic macroinvertebrates collected upstream (TRM 295.9) and downstream (TRM 291.7) of BFN in November 2002 were 473 and 445/m^2 (5091 and 4790/ft^2), respectively (Baxter and Gardner 2003). In comparison, downstream reaches of Wheeler Reservoir at TRM 277 and Elk River had average ratings of poor between 1994 and 2002, while the upstream reach of Wheeler Reservoir at TRM 347 had an average rating of good over this time period (Baxter and Gardner 2003).

Historically, 39 mussel species occurred in Wheeler Reservoir. Thirty-one of these species were considered riverine (i.e., those that evolved in free-flowing reaches), with 19 of these species now considered non-reproducing riverine species within Wheeler Reservoir (Ahlstedt and McDonough 1992). In 1982, 12 mussel species were collected during a survey for the proposed barge facility at BFN (Pryor 1982), and 11 species were collected across the river during a survey for a proposed barge terminal for the Mallard-Fox Creek Development Project (Carroll 1982). The washboard (*Megalonaias nervosa*) was the most common species collected during both surveys. It is currently the predominant species that is commercially harvested (TVA 2003a). The Ohio pigtoe (*Pleurobema cordatum*) was previously the most valuable commercial species, but its numbers have decreased because of habitat alterations due to impoundment (Ahlstedt and McDonough 1992). None of the species collected were Federally or State protected.

In 1991, 24 species of mussels were collected from Wheeler Reservoir, with six species represented by weathered, empty shells (Ahlstedt and McDonough 1992). The 24 species included all species previously collected near BFN in the two 1982 collections by Pryor and Carroll. It was estimated that 460 million mussels or 2.33 mussels/m^2 (0.22 mussels/ft^2) occurred in the reservoir in 1991 (Ahlstedt and McDonough 1992). The most common species (and estimated number within Wheeler Reservoir) collected in 1991 were the elephant-ear (*Elliptio crassidens,* 116 million), washboard (88 million), pink heelsplitter (*Potamilus alatus,* 56 million), and threehorn wartyback (*Obliquaria reflexa,* 44 million) (Ahlstedt and McDonough 1992). In addition to the habitat alteration resulting from reservoir creation, over-harvesting and periods of drought (e.g., from 1983 to 1988) may have affected reproduction and/or survival of most thick-shelled mussel species in Wheeler Reservoir (Ahlstedt and McDonough 1992). Water-quality impairments and loss of necessary fish hosts have also contributed to the decline of mussel populations. The biodiversity of mussel communities in the mainstem Tennessee River reservoirs is anticipated to continue the long-term downward trend in terms of abundance and diversity (TVA 2004f).

In 1998, 17 mussel species were collected on the east channel of Wheeler Reservoir near Hobbs Island, over 64 river kilometers (40 river miles) upstream of BFN, between TRMs 336.4 and 335.5. The two most common mussel species were the elephant-ear and the Ohio pigtoe. Two Federally endangered species were also collected: one specimen of the rough pigtoe (*Pleurobema plenum*) and 16 specimens of the pink mucket (*Lampsilis abrupta*) (Yokely 1998). In 1999, 16 native mussel species were collected in the vicinity of BFN: 14 species at (TRM) 298 upstream of BFN and 12 species at TRM 292 downstream of BFN. None of these were Federally listed species (TVA 2003a). Eleven commercial mussel species have been reported near BFN from TRM 305 to TRM 275 (Ahlstedt and McDonough 1992).

Two areas of Wheeler Reservoir are designated as State-protected mussel sanctuaries where 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) (TVA 2003). In the reservoir overbanks, mussels are generally spread over large areas and are not concentrated in mussel beds (TVA 2003a).

The Asiatic clam was first reported in Alabama in 1962, and is now widespread throughout the state (Foster et al. 2000). It inhabits lakes and streams of all sizes and occurs in silt, mud, sand, or gravel substrates (Cummings and Mayer 1992). The major impact caused by the Asiatic clam is biofouling, particularly of power plant and industrial water systems. It also modifies benthic substrates and competes with native species (Foster et al. 2000). The Asiatic clam is consumed by a number of fish, birds, and mammals. Its population density and distribution can be affected by excessively high or low temperatures, salinity, drying, low pH, silt, low dissolved oxygen, and diseases and parasites. The Asiatic clam can often dominate the benthic community, occurring at densities of thousands per square meter (Foster et al. 2000).

Between 1969 and 1976, densities of the Asiatic clam between TRM 307.5 and TRM 278 ranged from 103 to 167 clams/m^2 (9.6 to 15.5 clams/ft^2) (TVA 1977b). The Asiatic clam competes with native mussels for food, nutrients, and space. Dense populations of the Asiatic clam may ingest large numbers of unionid sperm, glochidia, and newly metamorphosed juveniles. They may also actively disturb sediments; therefore, dense populations may reduce suitable habitat space for juvenile native mussels. Periodic die-offs may produce enough ammonia and consume enough oxygen to kill native mussels (Butler 2002).

The zebra mussel had established populations in the Tennessee River by 1992 and had been reported in Alabama by 1994 (Benson 2004). It has continued to spread throughout the river system. Zebra mussel densities in the Tennessee River have remained low, but are now abundant enough below Wilson Dam that they can be measured quantitatively (Butler 2002). The zebra mussel inhabits lakes and streams of all sizes, attaching to rocks, freshwater mussels, or almost any other hard surface (Cummings and Mayer 1992). Their increase causes a decline among many native mussels, as it can out-compete native species for oxygen and food and is so prolific that it can smother native mussel beds (GSMFC 2003).

The raw water intake for BFN is treated biannually with a molluscide to control biofouling by zebra mussels and Asiatic clams. Also, biweekly raw water samples are analyzed from April through October for zebra mussel veligers as an early warning for potential biofouling (TVA 2002a). Data from these samples indicate that zebra mussel reproduction near BFN remains at a low level and that the zebra mussel should not pose a threat to plant operations in the immediate future (TVA 2003a). However, the primary means of keeping the condenser tubes clear of Asiatic clams is the use of a system that uses small sponge rubber balls that are continuously recirculated through the condenser tubes (TVA 1972).

There are 38 Federally listed aquatic species (including three candidate species) whose distribution includes, or has historically included, the Wheeler Reservoir portion of the Tennessee River or its tributaries, or other streams, rivers, or caves within the counties of Alabama and Mississippi through which the BFN transmission line rights-of-way pass (Table 2-2). One of the BFN transmission lines crosses designated critical habitat for one federally protected species of freshwater mussel. All but nine of the Federally protected 38 species would not currently be expected to occur within Wheeler Reservoir or the streams crossed by the transmission line rights-of-way associated with BFN for the following reasons: (1) the species are presumed to

Table 2-2. Federally and State-Listed Aquatic Species Potentially Occurring in Colbert, Franklin, Lawrence, Limestone, or Morgan Counties, Alabama and/or Itawamba, Lee, Tishomingo, or Union Counties, Mississippi

Scientific Name	Common Name	Status[a] Federal	AL	MS	Habitat
		Aquatic Snails			
Athearnia anthonyi	Anthony's riversnail	E	P	--	Large rivers and lower reaches of large creeks on cobble/boulder substrates near riffles
Campeloma decampi	slender campeloma	E	P	--	Large creeks in soft sediments (sand or mud) or detritus
Lithasia lima	warty rocksnail	–	NOST	–	Rocky riffles of low gradient large-sized rivers or moderate gradient medium-sized rivers
Lithasia verrucosa	varicose rocksnail	--	NOST	--	Rocky shoals and riffles in moderate currents of medium to large rivers at depths up to 1 m (3 ft)
Pyrgulopsis pachyta	armored snail (armored marstonia)	E	P	--	Shallow, still water along the edge of pools on tree roots and detritus of creeks
		Mussels			
Cumberlandia monodonta	spectaclecase	C	P	--	Large rivers with swiftly flowing water, among boulders in patches of sand, cobble, or gravel in areas where current is reduced
Cyclonaias tuberculata	purple wartyback	--	--	S1	Medium or large rivers in gravel or mixed sand and gravel
Cyprogenia stegaria	fanshell	E	P	--	Medium to large rivers
Dromus dromas	dromedary pearlymussel	E	P	--	Sand and gravel substrates in ruffles and shoals of medium to large rivers
Ellipsaria lineolata	butterfly	--	NOST	S3	Large rivers in sand or gravel
Elliptio arca	Alabama spike	--	--	S3	Shoreline of rivers in sand, sand and gravel, or rock substrates

Table 2-2. (contd)

Scientific Name	Common Name	Status[a] Federal	AL	MS	Habitat
Epioblasma brevidens	Cumberlandian combshell	E	P	S1	Coarse sand to mixtures of gravel, cobble and boulder-sized rocks in medium to large rivers; tends to occur at depths <1m (3 ft)
Epioblasma capsaeformis	oyster mussel	E	P	–	Usually in small- to medium-sized rivers in the substrates of coarse sand to boulder substrates and moderate to swift currents
Epioblasma florentina florentina	yellow-blossom pearlymussel	E	P	–	Riffle and shoal areas of small- to medium-sized streams
Epioblasma florentina walkeri	tan riffleshell	E	X	–	Headwaters, riffles, and shoals in sand and gravel substrates
Epioblasma penita	southern combshell	E	--	S1	Riffles or shoals of medium-sized rivers with sandy gravel to gravel-cobble substrates in moderate to swift current
Epioblasma torulosa torulosa	tubercled blossom	E	P	--	Sandy gravel substrates in riffles and shoals in rapid currents of medium to large rivers
Epioblasma triquetra	snuffbox	--	--	S1	Medium to large rivers in clear, gravel riffles
Epioblasma turgidula	turgid blossom pearlymussel	E	P	–	Sand and gravel substrates of shallow, fast-flowing streams
Fusconaia barnesiana	Tennessee pigtoe	--	NOST	S1	Cracks in bedrock to mixtures of coarse sand, gravel, cobble and boulders in riffle and shoal areas with moderate to swift currents of medium to large rivers; seldom in depths >1m (3 ft)
Fusconaia cor	shiny pigtoe	E	P	–	Shoals and riffles in clear streams with moderate to fast current
Fusconaia cuneolus	fine-rayed pigtoe	E	P	--	Firm cobble and gravel substrates of clear, high gradient streams

Table 2-2. (contd)

	Scientific Name	Common Name	Status[a] Federal	AL	MS	Habitat
1	*Hemistena lata*	cracking pearlymussel	E	P	--	Sand, gravel and cobble substrates in swift currents or mud and sand in slower currents of medium to large rivers
2	*Lampsilis abrupta*	pink mucket	E	P	--	Larger rivers in gravel or sand
3	*Lampsilis cardium*	plain pocketbook	--	--	S3S4	Small creeks to large rivers in mud, sand or gravel
4	*Lampsilis ovata*	pocketbook	--	NOST	--	Large rivers in coarse sand or gravel
5 6	*Lampsilis perovalis*	orangenacre mucket	T	--	S1	Medium and large rivers in gravel/cobble or gravel/coarse sand substrates
7 8	*Lampsilis virescens*	Alabama lampmussel	E	P	--	Sand and gravel substrates in shoal areas of medium to large rivers
9	*Lemiox rimosus*	birdwing pearlymussel	E	NOST	--	Riffle areas with sand and gravel substrates in moderate to fast currents of creeks to medium-sized rivers
10 11	*Lexingtonia dolabelloides*	slabside pearlymussel	C	P	S1	Moderate to high gradient riffles in medium to large rivers
12	*Ligumia recta*	black sandshell	--	--	S2	Gravel-cobble and possibly coarse sand substrates in shoals in medium to large rivers
13 14	*Medionidus conradicus*	Cumberland moccasinshell	–	NOST	--	Sand and gravel substrates or in cracks or under rocks in creeks to medium-sized rivers
15 16	*Obovaria jacksoniana*	southern hickorynut	--	--	S2	Medium-sized gravel substrates in river areas of low to moderate currents
17	*Obovaria retusa*	ring pink	E	P	--	Gravel and sand bars of large rivers
18	*Obovaria unicolor*	Alabama hickorynut	--	--	S3	Sand/gravel substrates in river areas of moderate current
19 20	*Plethobasus cicatricosus*	white wartyback pearlymussel	E	P	--	Gravel substrates of large rivers

Table 2-2. (contd)

Scientific Name	Common Name	Status[a] Federal	AL	MS	Habitat
Plethobasus cooperianus	orangefoot pimpleback	E	P	--	Sand, gravel and cobble substrates in riffles and shoals in deep water and steady current of large rivers
Pleurobema clava	clubshell	E	P	--	Medium to large rivers in gravel or mixed gravel and sand
Pleurobema curtum	black clubshell	E	--	SH	Sandy gravel to gravel-cobble substrates in riffles and shoals with moderate to fast currents in medium to large rivers
Pleurobema decisum	southern clubshell	E	--	S1S2	Sand and gravel substrates of medium to large rivers
Pleurobema oviforme	Tennessee clubshell	--	NOST	--	Sand and gravel substrates (occasionally mud or cracks between bedrock slabs) in vicinity of riffles and shoals of medium to large rivers
Pleurobema perovatum	ovate clubshell	E	--	S1	Moderate gradient pools and riffles of medium to large rivers
Pleurobema plenum	rough pigtoe	E	P	--	Medium to large rivers in sand or gravel
Pleurobema taitianum	heavy pigtoe	E	--	SH	Riffles and shoals on sandy gravel to gravel-cobble substrates in areas of moderate to fast currents of medium to large rivers
Potamilus alatus	pink heelsplitter	--	--	S2	Medium to large rivers in mud or mixed mud, sand and gravel
Potamilus ohiensis	pink papershell	--	NOST	--	Medium to large rivers in silt, mud or sand
Ptychobranchus fasciolaris	kidneyshell	--	NOST	S1	Rivers with coarse sand and gravel substrates
Ptychobranchus subtentum	fluted kidneyshell	C	NOST	–	Small to medium rivers in areas with swift current or riffles; larger rivers in shoal areas
Quadrula intermedia	Cumberland monkeyface	E	P	--	Sand and gravel substrates in shallow riffle and shoal areas of headwater streams to bigger rivers at depths to 0.6 m (2 ft)

Table 2-2. (contd)

Scientific Name	Common Name	Status[a] Federal	AL	MS	Habitat
Quadrula metanevra	monkeyface	–	NOST	SH	Gravel or mixed sand and gravel substrates in medium to large rivers
Quadrula rumphiana	ridged mapleleaf	–	–	S2	Medium-sized rivers in sand/gravel substrates in moderately silty waters of moderate gradient
Strophitus subvexus	southern creekmussel	–	–	S2	Small to large creeks in sand or sandy mud substrates in areas of low to no current
Toxolasma cylindrellus	pale lilliput	E	P	--	Firm rubble, gravel, and sand substrates in shallow riffles and shoals of clean, fast-flowing streams
Toxolasma lividus	purple lilliput	–	NOST	–	Small to medium-sized rivers in mud, sand and gravel substrates
Truncilla truncata	deertoe	–	–	S3	Medium to large rivers in mud, sand or gravel substrates
Villosa taeniata	painted creekshell	–	NOST	–	Smaller streams in sand/gravel substrates
Villosa trabalis	Cumberland bean	E	NOST	–	Sand, gravel, and cobble substrates in waters of moderate to swift currents and depths <1m (3 ft) in medium to large rivers
Villosa vanuxemensis	mountain creeksheel	–	NOST	–	Smaller streams in sand/gravel substrates
		Crayfish and Shrimp			
Palaemonias alabamae	Alabama cave shrimp	E	S1	--	Silt-bottom pools in caves
Cambarus jonesi	Alabama cave crayfish	--	NOST	–	Subterranean pools
Cambarus veitchorum	White Spring Cave crayfish	--	NOST	–	Subterranean pools
Hobbseus petilus	Tombigbee riverlet crayfish	--	--	S2	Slow to moderately flowing small, shallow streams in sand/gravel substrates

Table 2-2. (contd)

Scientific Name	Common Name	Status[a]			Habitat
		Federal	AL	MS	
Procambarus ablusus	crayfish	--	--	S3	Streams
Procambarus pecki	phantom cave crayfish	--	NOST	--	Subterranean pools with silty bottoms
		Fishes			
Clinostomus funduloides	rosyside dace	--	--	S2	Rocky flowing pools of headwaters, creeks and small rivers
Cottus carolinae	banded sculpin	--	--	S1	Gravel and rubble riffles of headwaters, creeks and small rivers; springs and their effluents
Crystallaria asprella	crystal darter	--	--	S1	Clean sand and gravel runs of small to medium rivers
Cyprinella callistia	Alabama shiner	--	--	S2	Gravel- and rubble-bottomed pools and runs of creeks and small to medium rivers
Cyprinella monacha	spotfin chub	E	P	--	Rocky riffles and runs of clean small to medium riffles
Cyprinella spiloptera	spotfin shiner	--	--	S2	Sand and gravel runs and pools of creeks and small, medium and sometimes large rivers
Cyprinella whipplei	steelcolor shiner	--	--	S3	Rocky and sandy runs and, less often, pools of creeks and small to medium rivers
Elassoma alabamae	spring pygmy sunfish	--	P	--	Spring systems
Etheostoma blennioides	greenside darter	--	--	SH	Rocky riffles of creeks and small to medium rivers; shores of large lakes
Etheostoma boschungi	slackwater darter	T	P	--	Gravel-bottomed pools and runs of creeks and small rivers
Etheostoma douglasi	Tuskaloosa darter	--	NOST	--	Fast rocky riffles of creeks and small to medium rivers
Etheostoma flabellare	fantail darter	--	--	S2	Rocky riffles of creeks and small to medium rivers
Etheostoma kennicotti	stripetail darter	--	--	S2	Rocky pools of headwaters, creeks and small rivers

Table 2-2. (contd)

Scientific Name	Common Name	Status[a]			Habitat
		Federal	AL	MS	
Etheostoma nigripinne	blackfin darter	--	--	S2	Rocky pools and adjacent riffles of headwaters, creeks and small rivers
Etheostoma rufilineatum	redline darter	--	--	S2	Clear, fast rocky riffles of creeks and small to medium rivers
Etheostoma tuscumbia	Tuscumbia darter	--	P	--	Springs and spring runs
Etheostoma wapiti	boulder darter	E	P	--	Fast, rocky riffles of small to medium rivers
Etheostoma zonistium	bandfin darter	--	--	S2	Sand- and gravel-bottomed pools of headwaters, creeks and small rivers
Ichthyomyzon castaneus	chestnut lamprey	--	--	S3	Lakes and streams
Ictiobus niger	black buffalo	--	--	S3	Pools and backwaters of small to large rivers, impoundments and lakes
Lythrurus ardens	rosefin shiner	--	--	S2	Rocky pools and runs of clear, fairly fast headwaters, creeks and small rivers
Moxostoma duquesnei	black redhorse	--	--	S1	Sand- to rock-bottomed pools and runs of creeks and small to medium rivers; impoundments
Moxostoma macrolepidotum	shorthead redhorse	--	--	S1	Rocky pools, runs and riffles in small to large rivers; lakes
Notropis boops	bigeye shiner	--	--	S1	Flowing, usually clear and rocky, pools of creeks and small to medium rivers
Notropis rubellus	rosyface shiner	--	--	S1	Rocky runs and flowing pools of small to medium rivers
Noturus exilis	slender madtom	--	--	S1	Rocky riffles, runs and flowing pools of clear creeks and small rivers; rarely along wave-swept margins of large impoundments
Noturus munitus	frecklebelly madtom	--	--	S2	Rocky riffles and runs of medium to large rivers, often near vegetation

Table 2-2. (contd)

Scientific Name	Common Name	Status(a) Federal	AL	MS	Habitat
Percina evides	gilt darter	--	--	S1	Rocky riffles of small to medium riffles
Percina lenticula	freckled darter	--	--	S2	Fast, deep rocky riffles of small to medium rivers
Percina phoxocephala	slenderhead darter	--	--	S1	Gravel runs and riffles of creeks and small to medium rivers
Phenacobius mirabilis	suckermouth minnow	--	--	S1	Gravel and rubble riffles and runs of creeks and small to medium, sometimes large, rivers.
Phoxinus erythrogaster	southern redbelly dace	--	--	S2	Rocky, usually spring-fed pools of headwaters and creeks
Polyodon spathula	paddlefish	--	NOST	S3	Slow-moving water of large rivers
Rhinichthys atratulus	blacknose dace	–	–	S1	Rocky pools of headwaters and creeks
Typhlichthys subterraneus	southern cavefish	--	P	--	Subterranean waters
Amphibians					
Cryptobranchus alleganiensis alleganiensis	eastern hellbender	--	P	S1	Rocky, clear creeks and rivers with large shelter rocks
Gyrinophilus palleucus	Tennessee cave salamander	--	P	--	Clean, permanent streams and pools of limestone caves

(a) candidate; E = endangered; NOST (State ranking developed by Alabama National Heritage Program) = considered rare or sensitive, but has no official status; P = protected; S1 = critically imperiled; S2 = imperiled; S3 = rare or uncommon; S4 = widespread, abundant and apparently secure; SH = of historical occurrence; T = threatened, X = extirpated; -- = not listed.
Sources: ADCNR 2003; Cummings and Mayer 1992; FWS 1990a, 2000a, b, 2004a,b; Johnson and Wehrle 2004; MMNS 2002; MNHP 2002; NatureServe 2004; NCWRC 2004; Page and Burr 1991; TVA 2003a.

be extinct, (2) the species are presumed to be extirpated in the region, (3) there are no recent records for the species in the region, (4) there are no collection records for the species from pertinent locations, and/or (5) project areas of concern do not have appropriate habitat for the species (e.g., county records are for streams or caves that are not crossed by the BFN transmission lines). Additional information on these 29 Federally listed species are provided in the Biological Assessment in Appendix E.

The following discussion first addresses the nine Federally listed species that are known to presently occur in Wheeler Reservoir or one or more of the streams crossed by the transmission line rights-of-way associated with BFN. However, no Federally protected aquatic species have been collected, or are currently known to occur, in the immediate vicinity of the BFN site based on TVA's Vital Signs Monitoring Program data and Regional Natural Heritage Programs database (Baxter and Gardner 2003). Following the discussion of the Federally listed aquatic species is a discussion of the aquatic species that are only State-listed for Alabama or Mississippi.

- **Federally Listed Species**

Anthony's riversnail (*Athearnia anthonyi*) is Federally listed as endangered (FWS 1994). It was known to occur in Alabama, Georgia, and Tennessee (FWS 2004c). It has been extirpated from most of its historic range because of pollution, siltation, and habitat modification or destruction. Many populations were lost when the Tennessee River and the lower reaches of its tributaries were impounded (FWS 1994). Only two populations of Anthony's riversnail are known to survive. The largest of these occurs in the Tennessee River in Jackson County, Alabama, and Marion County, Tennessee, a short distance downstream of Nickajack Dam. This population also extends a short distance into the lower sections of the Sequatchie River, Marion County, Tennessee. The other surviving population is restricted to a relatively short reach of lower Limestone Creek, Limestone County, Alabama (FWS 1997a). Limestone Creek is crossed three times by a BFN transmission line and is closely paralleled by the transmission line along two stream segments. However, the BFN transmission line does not cross or parallel the lower section of Limestone Creek where the snail is known to occur. Anthony's riversnail inhabits large rivers and the lower reaches of larger creeks, and occurs on cobble/boulder substrates in the vicinity of riffles. However, it does not always occur in strongly flowing sections (NatureServe 2004). At the two sites in Limestone Creek where Anthony's riversnail occurs, its density ranges up to several hundred individuals per square meter. However, Limestone Creek has been severely impacted in the past by heavy siltation and probably other sources of pollution (e.g., pesticide spraying and mining effluents). A single catastrophic pollution event could potentially destroy all populations of the snail in the creek (FWS 1994; NatureServe 2004). A recovery plan for the Anthony's riversnail has been prepared (FWS 1997a).

The slender campeloma (*Campeloma decampi*) is Federally listed as endangered (FWS 2000b). It is known to exist in only several isolated populations along Limestone, Piney, and Round Island Creeks in northern Alabama (NatureServe 2004). All three creeks are crossed by BFN transmission lines. The slender campeloma typically burrows in soft sediments or detritus. Impacts to the slender campeloma include siltation and other pollutants from poor land-use practices and waste discharges (FWS 2000b).

The armored snail (or armored marstonia) (*Pyrgulopsis pachyta*) is Federally listed as endangered (FWS 2000b). It is known to occur in Alabama from several isolated sites in Limestone and Piney Creeks near Mooresville, Alabama (NatureServe 2004). Piney Creek was formerly a tributary of Limestone Creek before the construction of Wheeler Reservoir (NatureServe 2004). Both creeks are crossed by a BFN transmission line; however, these crossings occur several miles upstream from Mooresville. The armored snail is found in shallow, still water along the edge of pools on tree roots and detritus. It probably also occurs on mud substrates (NatureServe 2004). Impacts to the armored snail include siltation and other pollutants from poor land-use practices and waste discharges (FWS 2000b).

The spectaclecase (*Cumberlandia monodonta*) is a candidate for Federal listing. Its historic range includes Alabama, Arkansas, Iowa, Indiana, Illinois, Kentucky, Missouri, Nebraska, Ohio, Tennessee, Virginia, and Wisconsin (FWS 2004a). It has been largely reduced to a relatively few disjunct sites. The spectaclecase at some of the sites may no longer be capable of reproduction due to loss of fish hosts or due to adverse environmental conditions (e.g., hypolimnetic releases from reservoirs) (NatureServe 2004). In Alabama, the spectaclecase is known in Limestone and Morgan Counties. The spectaclecase is usually found in areas with a strong current. In medium-size rivers, it prefers coarse substrates such as cobble, gravel, or cracks in bedrock. In large rivers, substrates used are typically finer and include sand or mud. It may be associated with shoals, bars, and islands (NatureServe 2004). The spectaclecase is often found in small clusters of the same-aged individuals. Other than burrowing deeper into the substrate, adults are essentially sessile (NatureServe 2004). Fish hosts for the spectaclecase are unknown (Schulz and Marbain 1998). Live specimens of the spectaclecase have been collected in the main stem of the Tennessee River in Colbert, Lauderdale, Limestone, and Morgan Counties as recently as 2000. Recent collections in the mainstream of the Tennessee River have been made in the tailwaters downstream of dams. Relic specimens (i.e., present only as weathered shells) were collected in the Elk River, Limestone County, Alabama in 1998 and 1974 (Butler 2002).

The Cumberlandian combshell (*Epioblasma brevidens*) is Federally listed as endangered, within its entire range (FWS 1997b), except where proposed for establishment as a nonessential experimental population in the free-flowing reach of the Tennessee River from the base of Wilson Dam downstream to the backwaters of Pickwick Reservoir (about 19 km [12 mi]) and the lower 8 km (5 mi) of all tributaries to this reach in Colbert and Lauderdale counties, Alabama (FWS 2001). A draft recovery plan has been prepared for the species (FWS 2003). It is known to occur in Alabama, Kentucky, Tennessee and Virginia (FWS 2004d). The Cumberlandian combshell is now restricted to populations in limited areas of five drainages, and some of these may no longer be reproducing. The species was eliminated from much of its historic range by impoundments. Existing populations are in decline due to pollution (especially from mining activities), impoundments, and siltation (FWS 1997b). It was last collected from Muscle Shoals (the area now incorporated within the upper reaches of Pickwick Reservoir through Wilson Reservoir and into Wheeler Reservoir) in 1925 (Garner 1997). The Cumberlandian combshell is typically associated with riffle and shoal areas in medium and large rivers in substrates of coarse sand to cobble. It has been apparently eliminated from the mainstems of the Tennessee and Cumberland Rivers (FWS 2004e). In Alabama, moribund specimens were found in the late 1990s in Bear Creek, a tributary of the Tennessee River (NatureServe 2004). Fish hosts for the Cumberlandian combshell include darters and sculpins (Schulz and Marbain 1998). Critical habitat has been designated for the species within the Tennessee and Cumberland River Basins, including a portion of Bear Creek that flows through Colbert County, Alabama, and Tishomingo County, Mississippi (FWS 2004e). One of the BFN transmission lines crosses Bear Creek in Tishomingo County, Mississippi, within the reach of designated critical habitat.

The pink mucket (*Lampsilis abrupta*) is Federally listed as endangered (FWS 1976). It is known to occur in Alabama, Arkansas, Illinois, Indiana, Kentucky, Louisiana, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia (FWS 2004f). It seems to be surviving and reproducing in sections of river that have been altered by impoundments. However, its range has diminished (e.g., extirpated from Ohio, Pennsylvania, and Illinois) (NatureServe 2004). Within Alabama, the pink mucket occurs in Colbert, Lauderdale, Limestone, Madison, Marshall, and Morgan Counties (NatureServe 2004). Suitable hosts for the glochidia of the pink mucket include freshwater drum (*Aplodinotus grunniens*), largemouth bass, smallmouth bass, spotted bass, sauger, and walleye (Fuller 1974; Barnhart et al. 1997). The pink mucket inhabits areas of large rivers with swift currents, at depths ranging from 0.5 to 8.0 m (1.6 to 26.2 ft) and a mixed sand/gravel/cobble substrate (Barclay 2004). Therefore, it is unlikely that the pink mucket exists in Wheeler Reservoir in the areas near or downstream from BFN. They are generally collected in the tailwater areas downstream from the Tennessee River drainage dams (Barclay 2004). Sixteen individual pink muckets were collected near Hobbs Island (more than 64 km [40 mi] upstream of BFN) in 1998 (Yokely 1998). Past and ongoing threats to the pink mucket include habitat loss and modification from dams and dredging, water-quality degradation, and commercial overharvesting (NatureServe 2004). The zebra mussel would also pose a threat to the pink mucket in areas where they co-exist.

The slabside pearlymussel (*Lexingtonia dolabelloides*) is a candidate for Federal listing. Its historic range includes Alabama, Kentucky, Tennessee, and Virginia (FWS 2004b). Most surviving individuals are restricted to two or three populations, and the long-term viability of all extant occurrences is questionable (NatureServe 2004). It historically occurred in the Cumberland River, although it is now extirpated from the entire Cumberland River system. The slabside pearlymussel was more prevalent in the Tennessee River system. Historically, it was fairly common from Muscle Shoals (the area now incorporated within the upper reaches of Pockwick Reservoir through Wilson Reservoir and into Wheeler Reservoir) to the Tennessee River headwater tributaries in Virginia and the Duck River drainage. It was last collected from Muscle Shoals in 1963 (Garner 1997). Remaining populations occur in a number of tributary streams of the Tennessee River system, but not in the main stem of the river (NatureServe 2004). Bear Creek is the only one of these streams that is crossed by a BFN transmission line. Fish hosts for the slabside pearlymussel include the smallmouth bass and, possibly, various minnow species (Schulz and Marbain 1998). Threats to the species include channel alterations, impoundments, siltation, pollution, commercial clamming, and gravel and coal mining (NatureServe 2004). It is generally found in areas of moderate to swift current velocities with substrates ranging from coarse sand to heterogeneous assemblages for larger-sized particles (NatureServe 2004).

The rough pigtoe (*Pleurobema plenum*) is Federally listed as endangered (FWS 1976). It is known to occur in Alabama, Indiana, Kentucky, Pennsylvania, Tennessee, and Virginia (FWS 2004g), and it has a wide, but very fragmented, distribution that includes Colbert, Lauderdale, Limestone, and Morgan Counties in Alabama. Within the Tennessee River, the rough pigtoe is currently present in an undetermined number of miles downstream of Pickwick, Wilson, and Guntersville Dams (NatureServe 2004). The rough pigtoe occurs in medium to large rivers in sand, gravel, and cobble substrates in shoals, although it is occasionally found on flats and muddy sand (NatureServe 2004). It does not occur in the impounded sections of rivers (FWIE 1996). Therefore, it is unlikely that the rough pigtoe exists in Wheeler Reservoir in the areas near or downstream from BFN. One individual was collected near Hobbs Island (more than 64 km [40 mi] upstream of BFN) in 1998 (Yokely 1998). Possible host fish for the rough pigtoe are bluegill and rosefin shiner (*Lythrurus ardens*) (Schulz and Marbain 1998). The long-term viability of most populations is in jeopardy, particularly for those in large rivers where zebra mussels are established (NatureServe 2004). Threats to the rough pigtoe include impoundments, channelization, dredging, industrial and residential discharges, siltation, herbicide and fertilizer run-off, zebra mussels, loss of glochidial hosts, and natural predators (NatureServe 2004).

The slackwater darter (*Etheostoma boschungi*) is Federally listed as threatened (FWS 1977a). Critical habitat was also designated for the species (FWS 1977a, b). It is known to occur in Alabama and Tennessee (FWS 2004h). The slackwater darter occupies the following five tributaries of the Tennessee River: Buffalo River and upper Shoal Creek in Lawrence County, Tennessee; the Flint River in Madison County, Alabama; Swan Creek in Limestone County, Alabama; and Cypress Creek in Lauderdale County, Alabama (NatureServe 2004). Swan Creek is crossed by one of the BFN transmission lines. Critical habitat for the slackwater darter includes many of the permanent and intermittent streams that are tributaries to Cypress Creek in Lauderdale County, Alabama, and Wayne County, Tennessee (FWS 1977b). None of these streams are located near BFN transmission lines. The slackwater darter typically occurs in gravel-bottomed pools and sluggish areas of creeks and small rivers that are not more than 12 m (39 ft) wide and 2 m (6.6 ft) deep. They often inhabit slow waters beneath undercut banks or accumulations of leaf litter or detritus. Spawning occurs in very shallow (5 to 10 cm [2 to 4 in.]) clear, flowing seepage water characterized by the presence of rushes and sedges in fields and open woods. Threats to the species include habitat loss and degradation. The heavy use of groundwater dries seepage areas used for spawning (NatureServe 2004).

- **State-Listed Species**

In addition to the 31 Federally listed mussel species, an additional 22 mussel species are State-listed within one or more of the counties of concern in Alabama and Mississippi (Table 2-2). As for the Federally listed mussel species, the State-listed species have been primarily impacted by impoundments. Some of the species listed for Mississippi have also been affected by habitat modifications created by the Tennessee-Tombigbee Waterway. The mussel species have also been variously impacted by water-quality degradation (e.g., siltation and chemical contamination). Continued declines in some of these species could be expected in the future, which may lead to their becoming Federally listed species. Several of the species may be listed in one state or the other due to natural constraints in distribution (e.g., a mussel species may be primarily associated with either the Mobile River or the Tennessee River system). For example, the pink heelsplitter is considered imperiled in Mississippi, but is considered a commercial species in Alabama (Ahlstedt and McDonough 1992).

The Alabama cave shrimp (*Palaemonias alabamae*) is Federally listed as endangered (FWS 1988). It is known only from two caves in Madison County, Alabama (NatureServe 2004). Habitat for the cave shrimp is silt-bottom pools in caves (FWS 1990b). Degradation of habitat and groundwater contamination are the major threats to this species (FWS 1990b).

Three Alabama-listed troglobitic crayfish (Alabama cave crayfish [*Cambarus jonesi*], White Spring Cave crayfish [*C. veitchorum*], and phantom cave crayfish [*Procambarus pecki*]) occur in the project area. The Alabama cave crayfish is endemic to Alabama. It is known to occur in caves between Florence and Guntersville, Alabama (NatureServe 2004). The White Spring Cave crayfish is endemic to White Spring Cave in Limestone County, Alabama. It has a very small population size and a low reproductive potential (NatureServe 2004). The phantom cave crayfish is known from only three cave locations in Colbert, Lauderdale, and Morgan Counties, Alabama (NatureServe 2004). Degradation of habitat and groundwater contamination are the major threats to these species (NatureServe 2004).

Two Mississippi-listed crayfish species occur within several of the counties of concern. The Tombigbee riverlet crayfish (*Hobbseus petilus*) is considered imperiled in Itawamba and Lee Counties, while the crayfish *Procambarus ablusus* is considered rare or uncommon in Tishomingo County (MMNS 2002). The imperiled status of the Tombigbee riverlet crayfish results from its restricted range and potential habitat impacts related to the Tennessee-Tombigbee Waterway. There are no existing threats to *P. ablusus* (NatureServe 2004). Its status in Mississippi is based more on Tishomingo County being at the edge of the species range. The species is considered to be apparently secure within Tennessee (NatureServe 2004).

The spring pygmy sunfish (*Elassoma alabamae*) is known in several spring systems in Alabama. Its status has improved as a result of introductions and discoveries of additional populations (NatureServe 2004). It is currently known to occur in Limestone County, Alabama, in the Beaverdam Moss Spring complex (most of Moss Spring and its spring run to Beaverdam Creek, the areas within Beaverdam Swamp, and Lowe's Ditch) and in the Pryor Springs system. It was extirpated from Cave Spring in Lauderdale County, Alabama, because of habitat inundation by Pickwick Reservoir (NatureServe 2004). In Beaverdam Creek, the range of the spring pygmy sunfish extends downstream to the impounded section of Wheeler Reservoir (Floyd 1999). The species has been negatively impacted by impoundments and water-quality degradation from poor land-use practices (e.g., crop-dusting, vegetation control, and agricultural practices). They are also vulnerable to wetland alterations and chemical spills (NatureServe 2004). The spring pygmy sunfish occurs in areas of clear water with fine sand or mud substrates and abundant and thickly matted vegetation along the shoreline. It apparently uses different spring and swamp microhabitats at different times of the year (NatureServe 2004). Spawning occurs in March and April. Adults spawn at one year of age and die within a few days to months after spawning. The eggs are attached to aquatic vegetation above the substrate (NatureServe 2004).

The Tuskaloosa darter (*Etheostoma douglasi*) has a small range, but occurs in a number of areas in the upper Black Warrior system (Locust Fork and Sipsey Fork systems) in Alabama. It is moderately threatened by timber practices and coal mining, siltation, and proposed reservoirs on Locust Fork (NatureServe 2004). A portion of the Sipsey Fork system occurs in the southern portion of Lawrence County that is not crossed by the BFN transmission lines.

Fewer than 15 populations of the Tuscumbia darter (*Etheostoma tuscumbia*) are known to occur in springs and spring runs along the Tennessee River in Alabama. It is extirpated from Tennessee (NatureServe 2004). Threats to the Tuscumbia darter include changes in the water table, siltation, predation, and loss of aquatic vegetation (NatureServe 2004). Structures such as low dams that are larger than 1.2- to 1.5-m (4- to 5-ft) high pose a barrier to dispersal. Warm summer temperatures in waters surrounding springs are also believed to preclude dispersal (NatureServe 2004). It feeds on invertebrates such as amphipods, snails, and midge larvae, with reduced feeding in winter (NatureServe 2004).

The paddlefish (*Polyodon spathula*) is widespread in rivers in the eastern and central United States. While populations are faring well in some areas, they are declining or of unknown trend over much of the range. Threats to the species include habitat alteration (e.g., dams and impoundments), pollution, siltation, and overharvesting. States stock paddlefish to compensate for destruction or unavailability of spawning habitat (NatureServe 2004). While notable increases in paddlefish have been documented in portions of the Tennessee, Cumberland, and Arkansas rivers, they have all but disappeared from the Tennessee River in Alabama (NatureServe 2004).

The southern cavefish (*Typhlichthys subterraneus*) has a discontinuous range in subterranean waters of Alabama, Arkansas, Georgia, Indiana, Kentucky, Missouri, and Tennessee. The species is apparently stable, but individual populations are vulnerable to habitat alteration and pollution of groundwater (NatureServe 2004).

In addition to the fish species already discussed, 27 other fish species (10 minnows, 10 darters, three suckers, two madtoms, one sculpin, and one lamprey) are listed as species of special concern within one or more of the Mississippi counties within which BFN transmission line rights-of-way occur (Table 2-2). However, no fish species are listed for Lee County, and only the spotfin shiner (*Cyprinella spiloptera*) and steelcolor shiner (*C. whipplei*) are listed for Union County. Both species, plus the other 25 fish species, occur in Itawamba and/or Tishomingo Counties where they occur in the Tennessee and/or the Tennessee-Tombigbee Waterway systems. The frecklebelly madtom (*Noturus munitus*) has a discontinuous distribution (Page and Burr 1991), and within the Tennessee drainage is only known from an upper tributary above Wheeler Reservoir. Twenty-five of the fish species are at the edge of their natural distribution and are more common elsewhere. Water pollution, sedimentation, or habitat loss, modification, or fragmentation could have a localized impact on some of these species. Similarly, siltation pollution or habitat fragmentation (e.g., between adult habitat and spawning streams) account for the rare or uncommon status of the chestnut lamprey (*Ichthyomyzon castaneus*) within Itawamba County, Mississippi.

The eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*) ranges widely within the central interior portion of the eastern United States (NatureServe 2004). Northern Alabama and extreme northeastern Mississippi are at the southeastern edge of the eastern hellbender's range (NYSDEC 2003). Within Alabama, the eastern hellbender occurs in Colbert, Franklin, Lauderdale, Limestone, Madison, Marshall, and Morgan Counties (NatureServe 2004). It has been collected in Bear Creek in Tishomingo County in Mississippi and the Tennessee River, and may also occur in Cedar Creek in Mississippi (Mayasich et al. 2003). While the species is apparently secure, populations have declined or been eliminated in many areas due to impoundments, sedimentation, water pollution, overharvesting, and heavy recreational use of habitat (NatureServe 2004). Degradation of habitat is the principal threat to the eastern hellbender. As it primarily "breathes" through its skin, the eastern hellbender requires cool, well-oxygenated, flowing water (NatureServe 2004). The hellbender inhabits rocky, clear creeks and rivers that usually have large rock shelters. They tend to avoid temperatures greater than 20°C (68°F). Males prepare nests beneath large flat rocks or submerged logs, and attend to the eggs. Crayfish are the primary prey, but they also eat other invertebrates and fishes (often scavenged) (NatureServe 2004).

The Tennessee cave salamander (*Gyrinophilus palleucus*) has a small range in Alabama, Tennessee, and Georgia. Threats to the species include flooding of caves because of dams, pollution, siltation, mining, and dumping (NatureServe 2004).

2.2.6 Terrestrial Resources

BFN is located within the Highland Rim section of the Interior Low Plateau Physiographic Province on the north shore of Wheeler Reservoir in Limestone County, Alabama. Botanically, the project site occurs within the Mississippian Plateau section of the Western Mesophytic Forest Region (EPA 2004). In this region of northern Alabama, native forest communities generally consist of mixed oak forests of varying composition in relation to topography and soils. Historically, upland forests in the project area were characterized by mixtures of southern red oak (*Quercus falcata*), black oak (*Q. velutina*), post oak (*Q. stellata*), and white oak (*Q. alba*) with dogwood (*Cornus* spp.) commonly present in the understory. The clearing of forested lands for agriculture has converted many of these forest communities to early successional habitats, allowing representative native plant communities to become replaced by introduced plant species.

The site is a 340-ha (840-ac) tract situated in an area where the land is used primarily for agriculture. The countryside includes open pasture lands, scattered farmsteads, few residents, and little industry within several miles. The south and west side of the plant site abuts Wheeler Reservoir. The shoreline is approximately 3772 m (12,375 ft) with 58 percent stabilized with riprap; the remaining 42 percent of the shoreline of the site is partially eroded and is composed of mixed upland forest vegetation. The stabilized shoreline is adjacent to BFN and is primarily vegetated by young (approximately 4- to 5-year-old) black willow (*Salix nigra*), common hackberry (*Celtis occidentalis*), sumac (*Rhus* spp.), and exotic species such as Chinese privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*), and trumpet creeper (*Campsis radicans*). The remainder of the shoreline is just west of the facility and is a young mixed upland forest scattered with a few large specimens (approximately more than 80 years old) of oak and loblolly pine (*Pinus taeda*). Young plants associated with the upland forest include black locust (*Robinia pseudoacacia*), sweetgum (*Liquidambar styraciflua*), sassafras (*Sassafras albidum*), cottonwood (*Populus* spp.), elm (*Ulmus* spp.), common hackberry, and black cherry (*Prunus serotina*). Common understory vegetation in the forested area includes Chinese privet, spleenwort (*Asplenium* spp.), Virginia creeper (*Parthenocissus quinquefolia*), and poison ivy (*Toxicodendron radicans*).

Invasive exotic plant species are an issue in the area. There are approximately 19 invasive plant species in the area (TVA 2003a) with a special emphasis on Chinese privet, Japanese honeysuckle, Japanese knotweed (*Polygonum cuspidatum*), and Nepal grass (*Microstegium vimineum*). There are approximately 10 ha (25 ac) and 5 ha (12 ac) of National Wetlands

Inventory and U.S. Army Corps of Engineers-classified wetlands, respectively, occurring within the BFN site. This includes forested wetlands, emergent (marsh) wetlands, and scrub-shrub/emergent wetlands (based on 1980s aerial photography). The wetland ecological communities identified on the BFN site are dominated by plant species that are common in the region. These include black willow, buttonbush *(Cephalanthus occidentalis)*, sedges *(Carex lupulina, C. vulpinoidea, Rhyncospora corniculata)*, rushes (*Juncus* spp.), water hemlock *(Conium maculatum)*, and smartweeds *(Polygonum* spp.). These wetlands occur in areas that have been previously disturbed by clearing and agriculture, and parts that are currently maintained by periodic mowing. These types of wetlands are on land that was previously used or is currently being used for agriculture. The dominant vegetation species occurring within them are common in the region.

The vegetation communities described above are not unusual for the area and provide no uncommon forms of wildlife habitat. Animal species commonly associated with upland communities include white-tailed deer (*Odocoileus virginianus*), cottontail rabbit (*Syvilagus floridanus*), Virginia opossum (*Didelphis virginiana*), hispid cotton rat (*Sigmodon hispidus*), song sparrow (*Melospiza melodia*), eastern bluebird (*Sialia sialis*), northern mockingbird (*Mimus polyglottus*), turkey vulture (*Cathartes aura*), tufted titmouse (*Baeolophus bicolor*), American toad (*Bufo americanus*), spring peeper (*Pseudacis crucifer*), black racer (*Coluber constrictor constrictor*), and eastern box turtle (*Terrapene carolina*) (TVA 2003a). Riparian communities can support a unique assemblage of wildlife including muskrat (*Ondatra zibethicus*), beaver (*Castor canadensis*), raccoon *(Procyon lotor)*, wood duck (*Aix sponsa*), belted kingfisher (*Ceryle alcyon*), barred owl (*Strix varia*), American woodcock (*Scolopax minor*), Carolina wren (*Thryothorus ludovicianus*), prothonotary warbler (*Protonotaria citrea*), eastern phoebe (*Sayornis phoebe*), bullfrog (*Rana catesbeiana*), green frog (*Rana clamitans*), eastern newt (*Notophthalmus viridescens*), southern two-lined salamander (*Eurycea cirrigera*), common snapping turtle (*Chelydra serpentina serpentina*), and northern water snake (*Nerodia sipedon*) (TVA 2003a). Some waterholes along Wheeler Reservoir are used by American alligators (*Alligator mississippiensis*) in the winter. Invasive terrestrial animals that are expected to occur in the project vicinity include European starling (*Sturnus vulgaris*), house sparrow (*Passer domesticus*), and rock dove (*Columba livia*).

Two wildlife management areas – Swan Creek State Wildlife Management Area and Mallard-Fox Creek State Wildlife Management Area – are within 5 km (3 mi) of the BFN site (TVA 2003a). The Swan Creek Wildlife Management Area includes more than 1200 ha (3000 ac) of land and more than 2000 ha (5000 ac) of water surrounded by numerous industrial facilities. The Mallard-Fox Creek State Wildlife Management Area encompasses approximately 280 ha (700 ac) of land and 690 ha (1700 ac) of water and is primarily used for small game hunting. The Round Island Recreation Area is located approximately 5.6 km (3.5 mi) upstream of BFN. The BFN-to-Maury, Alabama, transmission line right-of-way crosses the Duck River State Wildlife Management Area, the Duck River Unit 1 Proposed Designated Critical Habitat, and Elk

River and Richland Creek, both of which are listed on the Nationwide Rivers Inventory. The BFN-to-Union, Mississippi, transmission line right-of-way crosses the John Bell Williams State Wildlife Management Area, the Natchez Trace National Parkway, the Tennessee-Tombigbee Waterway, and the Foxtrap Creek Ravine Potential National Natural Landmark.

Terrestrial species listed by the FWS that have the potential to occur in the vicinity of the BFN site or along the transmission line rights-of-way are presented in Table 2-3. State-listed species (excluding Federally listed species) that have the potential to occur in the vicinity of the BFN

Table 2-3. Federally Listed Terrestrial Species Reported at the Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Site and Counties Associated with Transmission Line Rights-of-Way

Scientific Name	Common Name	Federal Status[(a)]
Birds		
Haliaeetus leucocephalus	bald eagle	T
Picoides borealis	red-cockaded woodpecker	E
Mammals		
Myotis grisescens	gray bat	E
Myotis sodalis	Indiana bat	E
Plants		
Apios priceana	Price's potato bean	T
Asplenium scolopendrium var. *americanum*	American hart's-tongue fern	T
Dalea foliosa	leafy prairie clover	E
Helianthus eggertii	Eggert's sunflower	T
Leavenworthia crassa	fleshy-fruited gladecress	C
Lesquerella lyrata	lyrate bladder-pod	T
Xyris tennesseensis	Tennessee yellow-eyed grass	E

(a) E = endangered, T = Threatened, C = Candidate, (FWS 2004a).

site or along the transmission line rights-of-way are presented in Table 2-4 for Alabama (ANHP 2003) and Table 2-5 for Mississippi (MMNS 2002). A review of the TVA Regional Natural Heritage database indicates that no Federally or State-listed species of animals or plants have been reported from areas within 5 km (3 mi) of the BFN (TVA 2003a). BFN transmission line rights-of-way pass through Limestone, Morgan, Lawrence, Colbert, and Franklin Counties in Alabama and Tishomingo, Itawamba, Lee, and Union Counties in

Mississippi.[a] Eleven Federally listed terrestrial species have been reported from these counties. There are 89 species listed for the State of Alabama and 116 species listed for Mississippi.[a]

Table 2-4. Alabama State-Listed Terrestrial Species Reported from the Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 and Associated Transmission Line Rights-of-Way

Scientific Name	Common Name	State Status[a]
Insects		
Batrisodes jonesi	beetle	NOST
Batrisodes specus	beetle	NOST
Batrisodes tumoris	beetle	NOST
Batrisodes valentinei	beetle	NOST
Pseudanophthalmus distinguens	ground beetle	NOST
Pseudanophthalmus fluviatilis	cave beetle	NOST
Pseudanophthalmus lodingi	ground beetle	NOST
Pseudosinella hirsuta	springtail	NOST
Pseudosinella spinosa	cave springtail	NOST
Rhadine caudata	ground beetle	NOST
Arachnids		
Nesticus jonesi	cave spring cave spider	P
Amphibians		
Aneides aeneus	green salamander	P
Reptiles		
Eumeces authracinus pluvialis	southern coal skink	NOST
Lampropeltis triangulum syspila	red milk snake	NOST
Birds		
Accipiter cooperii	Cooper's hawk	P
Thryomanes bewickii bewickii	Bewick's wren	P
Mammals		
Corynorhinus rafinesquii	eastern big-eared bat	P
Myotis austroriparium	southeastern bat	P

(a) Prentiss County, Mississippi is not included. Species are accounted for in adjacent counties.

Table 2-4. (contd)

Scientific Name	Common Name	State Status[a]
Myotis septentrionalis	northern long-eared bat	NOST
Plants		
Acorus calamus	sweetflag	NOST
Aplectrum hyemale	puttyroot	NOST
Asplenium ruta-muraria	wall-rue spleenwort	NOST
Astragalus tennesseensis	Tennessee milk-vetch	NOST
Boykinia aconitifolia	brook saxifrage	NOST
Bryoxiphium norvegicum	sword moss	NOST
Cotinus obovatus	American smoke-tree	NOST
Cuscuta harperi	Harper's dodder	NOST
Cypripedium candidum	white lady-slipper	NOST
Cystopteris tennesseensis	Tennessee bladderfern	NOST
Dalea gattingeri	Gattinger prairie-clover	NOST
Delphinium alabamicum	Alabama larkspur	NOST
Delphinium exaltatum	tall larkspur	NOST
Dicentra cucullaria	Dutchman's breeches	NOST
Dodecatheon frenchii	French's shootingstar	NOST
Elodea canadensis	waterweed	NOST
Enemion biternatum	false rue-anemone	NOST
Equisetum arevense	common horsetail	NOST
Eriogonum longifolium var. *harperi*	Harper's umbrella-plant	NOST
Erythronium albidum	white trout-lily	NOST
Frasera caroliniensis	American columbo	NOST
Huperzia lucidula	shining clubmoss	NOST
Huperzia porophila	rock clubmoss	NOST
Hydrastis canadensis	goldenseal	NOST
Hymenophyllum tayloriae	gorge filmy fern	NOST
Isoetes butleri	Butler's quillwort	NOST
Jamesianthus alabamensis	Alabama warbonnet	NOST
Leavenworthia alabamica	Alabama glade-cress	NOST

Table 2-4. (contd)

Scientific Name	Common Name	State Status[a]
Leavenworthia uniflora	Michaux leavenworthia	NOST
Lesquerella densipila	Duck River bladderpod	NOST
Linum sulcatum var. *harperi*	Harper's grooved-yellow flax	NOST
Listera australis	southern twayblade	NOST
Mirabilis albida	pale umbrella-wort	NOST
Monotropsis odorata var. *odorata*	sweet pinesap	NOST
Neobeckia aquatica	lake-cress	NOST
Neviusia alabamensis	Alabama snow-wreath	NOST
Onosmodium molle ssp. *molle*	soft false gromwell	NOST
Ophioglossum engelmannii	limestone adder's tongue	NOST
Oxalis grandis	great yellow wood-sorrel	NOST
Pachysandra procumbens	Allegheny-spurge	NOST
Pediomelum subacaule	tuberous scurfpea	NOST
Phlox pulchra	Wherry's phlox	NOST
Plantago cordata	heartleaved plantain	NOST
Platanthera lacera	ragged fringed orchid	NOST
Schoenolirion croceum	sunnybell	NOST
Selaginella arenicola ssp. *riddellii*	spikemoss	NOST
Selaginella rupestris	spikemoss	NOST
Sida elliottii	Elliot sida	NOST
Silene rotundifolia	roundleaf catchfly	NOST
Silphium brachiatum	Cumberland rosinweed	NOST
Spiranthes magnicamporum	Great Plains ladies'-tresses	NOST
Stewartia ovata	mountain camellia	NOST
Talinum calcaricum	limestone flame-flower	NOST
Talinum mengesii	flame-flower	NOST
Thalictrum debile	southern meadow-rue	NOST
Thalictrum mirabile	little mountain meadow-rue	NOST
Trichomanes petersonii	dwarf filmy-fern	NOST
Trichostomum crispulum	moss	NOST

Table 2-4. (contd)

Scientific Name	**Common Name**	**State Status[a]**
Trillium flexipes	nodding trillium	NOST
Trillium pusillum var. 1	interior least trillium	NOST
Trillium recuvatum	prairie trillium	NOST
Trillium sessile	sessile trillium	NOST
Triosteum angustifolium	horse-gentian	NOST
Viola egglestonii	Eggleston's violet	NOST

(a) Status rankings developed by Alabama Natural Heritage Program. P = protected, NOST = no official status, but species are tracked by the Alabama Natural Heritage Program due to rarity in the state (ADCNR 2003).

Table 2-5. Mississippi State-Listed Terrestrial Species Reported from the Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Associated Transmission Line Rights-of-Way

Scientific Name	**Common Name**	**State Status[a]**
Amphibians		
Aneides aeneus	green salamander	S1
Eurycea lucifuga	cave salamander	S1
Gyrinophilus porphyriticus	spring salamander	S1
Hemidactylium scutatum	four-toed salamander	S1
Pseudacris brachyphona	mountain chorus frog	S3
Pseudotriton ruber	red salamander	S3
Reptiles		
Lampropeltis calligaster rhombomaculata	mole kingsnake	S2
Lampropeltis getula nigra	black kingsnake	S3
Regina septemvittata	queen snake	S3
Insects		
Ellipsaria lineaolata	butterfly	S3
Birds		
Accipiter striatus	sharp-shinned hawk	S1
Aimophila aestivalis	Bachman's sparrow	S3
Petrochelidon pyrrhonota	cliff swallow	S3

Table 2-5. (contd)

Scientific Name	Common Name	State Status[a]
Mammals		
Myotis septendrionalis	northern myotis	S3
Peromyscus ploionotus	oldfield mouse	S2S3
Plants		
Anemone quinquefolia	wood anemone	S1S2
Antennaria solitaria	single-headed pussytoes	S3
Aplectrum hyemale	puttyroot	S1
Aquilegia canadensis	wild columbine	S1S2
Arabis canadensis	sicklepod	S2S3
Asarum canadense	Canada wild-ginger	S2S3
Asplenium pinnatifidum	lobed spleenwort	S1
Asplenium resiliens	black-stem spleenwort	S1
Asplenium rhizophyllum	walking-fern spleenwort	S1S2
Asplenium trichomanes	maidenhair spleenwort	S1
Astragalus canadensis	rattle-vetch	S2
Aster ericoides	white heath aster	S2
Athyrium thelypterioides	silvery spleenwort	S2S3
Cacalia muehlenbergii	great Indian-plantain	S1
Callirhoe triangulata	clustered poppy-mallow	S1S2
Camassia scilloides	wild hyacinth	S2S3
Carex jamesii	Nebraska sedge	S1S2
Carex oligocarpa	eastern few-fruit sedge	S1
Carex picta	painted sedge	S2S3
Carex prasina	drooping sedge	S1
Carex seorsa	separated sedge	S1S2
Carex stricta	uptight sedge	S2
Carex virescens	ribbed sedge	S1
Carya laciniosa	big shellbark hickory	S2S3
Carya leiodermis	swamp hickory	S2S3
Cheilanthes lanosa	hairy lipfern	S2

Table 2-5. (contd)

Scientific Name	Common Name	State Status[a]
Chelone glabra	white turtlehead	S3
Chelone lyonii	pink turtlehead	S1
Chelone obliqua	red turtlehead	SH
Chimaphila maculata	spotted wintergreen	S2
Cimifuga racemosa	black bugbane	S1S2
Cladrastis kentukea	yellowwood	S2
Clematis beadlei	vase-vine leather-flower	S1
Coreopsis auriculata	lobed tickseed	S2S3
Cypripedium pubescens	yellow lady's-slipper	SU
Decodon verticillatus	hairy swamp loosestrife	S2S3
Delphinium tricorne	dwarf larkspur	S2
Dentaria diphylla	pepper-root	S1S2
Dentaria heterophylla	slender toothwort	S2S3
Dicentra cucullaria	Dutchman's breeches	S1
Dirca palustris	eastern leatherwood	S2
Dodecatheon meadia	shooting star	S2
Erythronium albidum	white dog's tooth violet	S2
Erythronium americanum	yellow dog's tooth violet	S1S2
Erythronium rostratum	beaked dog's tooth violet	S1S2
Euonymus atropurpureus	burning bush	S2S3
Fraxinus quadrangulata	blue ash	S2
Gynmocladus dioicus	Kentucky coffee-tree	S2
Heuchera villosa var. *macrorhiza*	giant alumroot	S1
Hexalectris spicata	crested coralroot	S2
Hexastylis shuttleworthii	large-flowered heartleaf	S1
Hybanthus concolor	green violet	S2
Hydrophyllum appendiculatum	appendaged waterleaf	S1
Hydrophyllum macrophyllum	large-leaf waterleaf	S1
Ilex montana	mountain holly	S3
Isoetes engelmannii	Appalachian quillwort	S1S2

Table 2-5. (contd)

Scientific Name	Common Name	State Status[a]
Juglans cineria	white walnut	S2
Lesquerella gracilis	spreading bladder-pod	S2
Ligusticum canadense	nondo lovage	S1S2
Luzula acuminata	hairy woodrush	S3
Melanthium virginicum	Virginia bunchflower	S2S3
Mertensia virginica	Virginia bluebells	S1S2
Muhlenbergia tenuiflora	slender muhly	S1S2
Nemastylis geminiflora	prairie-iris	S2
Neviusia alabamensis	Alabama snow-wreath	S1
Osmorhiza longistylis	smoother sweet-cicely	S3
Pachysandra procumbens	Allegheny-spurge	S3
Panax quinquefolius	American ginseng	S3
Pellaea atropurpurea	purple-stem cliff-brake	S1S2
Penstemon tenuiflorus	narrow flowered beard tongue	S2S3
Perideridia americana	eastern eulophus	S1S2
Phacelia bipinnatifida	fernleaf phacelia	S1
Philadelphus hirsutus	hairy mock-orange	S1
Pinus virginiana	Virginia pine	S2
Platanthera cristata	crested fringed orchid	S3
Platanthera integrilabia	white fringeless orchid	S1
Platanthera lacera	green fringed-orchid	S1S2
Platanthera peramoena	purple fringeless orchid	S2S3
Polemonium reptans	Jacob's ladder	S2S3
Rhamnus lanceolata	lance-leaved buckthorn	S2
Rhododendron arborescens	smooth azalea	S1
Sabatia campestris	prairie pink	S2S3
Salvia urticifolia	nettle-leaf sage	S2S3
Sedum ternatum	wood stonecrop	S2
Solidago flaccidifolia	Appalachian goldenrod	S1S2
Solidago sphacelata	false goldenrod	S1S2

Table 2-5. (contd)

Scientific Name	Common Name	State Status[a]
Spiraea tomentosa	hardhack spiraea	SH
Spiranthes ovalis	lesser ladies-tresses	S2S3
Staphylea trifolia	American bladdernut	S3
Stellaria pubera	giant chickweed	S2S3
Stewartia ovata	mountain camellia	S1
Swertia caroliniensis	American colombo	S2S3
Tiarella cordifolia	heart-leaved foam-flower	S2
Tomanthera auriculata	earleaf false-foxglove	S1
Tradescantia ernestiana	Palmer's spiderwort	S1
Trautvetteria caroliniensis	Carolina tassel-rue	S1
Trichomanes boschianum	bristle-fern	S1
Trillium flexipes	drooping trillium	S1
Triosteum angustifolium	narrow-leaf fever root	S3
Triphora trianthophora	three birds orchid	S2S3
Viola pubescens var. *eriocarpon*	smooth yellow violet	S1S2

(a) Status rankings developed by the Natural Heritage Inventory; S1 = critically imperiled because of extreme rarity; S2 = Imperiled because of rarity; S3 = rare or uncommon; SH = historically extant; SU = status uncertain (MMNS 2002; MNHP 2002).

The bald eagle (*Haliaeetus leucocephalus*) is listed as threatened by the FWS for Franklin County, Alabama, and Itawamba and Tishomingo Counties, Mississippi. Bald eagles prefer habitat along coastlines, lakes, rivers, and other water bodies that provide their primary food source (i.e., fish and waterfowl) (NatureServe 2004). Eagles generally nest in tall trees or cliff faces near water and away from human disturbance. Bald eagles are known in the area around BFN, but there is no known nesting habitat within 5 km (3 mi) of the site. BFN transmission line rights-of-way are likely to be within foraging areas for this species.

The red-cockaded woodpecker (*Picoides borealis*) is listed as endangered by the FWS for Lawrence County, Alabama. Red-cockaded woodpeckers inhabit older open pine forests, (generally at least 80 to 120 years old) (FWS 2004d). Hardwood forests or pine forests with a hardwood understory are usually avoided. There is no woodpecker habitat within 5 km (3 mi) of the BFN site, and it is unlikely that there is any suitable habitat along the BFN transmission line rights-of-way.

Gray bats (*Myotis grisescens*) are listed by the FWS as endangered in Colbert, Franklin, Lawrence, Limestone, and Morgan Counties, Alabama, and Tishomingo County, Mississippi. Gray bats are colonial and are restricted to cave or cave-like habitats (FWS 2004d). Gray bats roost and females form maternity colonies in caves located along rivers and reservoirs over which they feed. In the winter, gray bats congregate and hibernate in a limited number of caves across the southeast (FWS 2004d, i). Roosting and foraging habitat for gray bats is very limited on the BFN site. Water sources for the bats include lagoons, sedimentation ponds, drainage canals, and forested habitats are primarily small woodlots of poor quality. Although no suitable habitats for these species occur on the BFN site, gray bats likely forage along the Tennessee River, adjacent to the site. BFN transmission line rights-of-way are also likely to be within foraging areas for this species.

Indiana bats (*Myotis sodalis*) are listed by the FWS as endangered in Colbert, Lawrence, Limestone, and Morgan Counties, Alabama and Tishomingo County, Mississippi. Indiana bats are highly colonial and hibernate in caves during winter months but can be found in hollow trees and under loose tree bark during the summer, where they form small maternity colonies (FWS 2004d). Indiana bats forage for insects primarily in riparian and upland forests. Roosting and foraging habitat for Indiana bats is very limited on the BFN site. Water sources for the bats include lagoons, sedimentation ponds, drainage canals, and forested habitats are primarily small woodlots of poor quality. BFN transmission line rights-of-way are also likely to be within foraging areas for this species.

Price's potato bean (*Apios priceana*) is listed as threatened by the FWS in Lee County, Mississippi. This species is found in open mixed hardwood forests often on floodplains in or near riparian areas (NatureServe 2004). Although thought to be somewhat dependent on disturbances that maintain an early succession environment, it is also reported to be sensitive to some management activities such as logging, cattle grazing, and highway right-of-way maintenance. No populations of Price's potato bean are known within 5 km (3 mi) of the BFN site, but suitable habitat could be found along the BFN transmission line rights-of-way.

American hart's-tongue fern (*Asplenium scolopendrium* var. *americanum*) is listed as threatened by the FWS in Morgan County, Alabama (FWS 2004d). In the southern portions of its range (Alabama), this fern is found only around the openings to limestone caves and sinkholes. No populations have been recorded within 5 km (3 mi) of the BFN site; no suitable habitat could be found along the BFN transmission line rights-of-way.

Leafy prairie clover (*Dalea foliosa*) is listed as endangered by the FWS in Franklin, Lawrence, and Morgan Counties, Alabama (FWS 2004d). This species is found in association with cedar glades in northern Alabama and central Tennessee. No populations of leafy prairie clover are known to occur from within 5 km (3 mi) of the BFN site, and no suitable habitat could be found along the BFN transmission line rights-of-way.

Eggert's sunflower (*Helianthus eggertii*) is listed as threatened by the FWS in Colbert, Franklin, Lawrence, Limestone, and Morgan Counties, Alabama. This species is found in barren habitats within the Interior Plateau Ecoregion of Kentucky, Tennessee, and Alabama (NatureServe 2004). No populations are recorded within 5 km (3 mi) of the BFN site. Populations may occur along the BFN transmission line rights-of-way because the species is reported to respond favorably to management activities such as burning and mowing (NatureServe 2004).

Fleshy-fruited gladecress (*Leavenworthia crassa*) is listed as a candidate species by the FWS for Lawrence and Morgan Counties, Alabama. Reportedly endemic to Lawrence and Morgan Counties, this species inhabits limestone glades and has been identified in only six sites (NatureServe 2004). No populations have been recorded within 5 km (3 mi) of the BFN site, but suitable habitat could be found along the BFN transmission line rights-of-way.

The lyrate bladder-pod (*Lesquerella lyrata*) is listed as threatened by the FWS in Colbert, Franklin, and Lawrence Counties, Alabama. The species in known in only two populations in Franklin and Colbert Counties (FWS 2004d). The plant is an annual in the mustard family and is found in disturbed glade habitats. No populations exist within 5 km (3 mi) of the BFN site, but suitable habitat could be found along the BFN transmission line rights-of-way.

Tennessee yellow-eyed grass (*Xyris tennesseensis*) is listed as endangered by the FWS in Franklin County, Alabama. This species is found in moist-to-wet, limestone-derived soils in open or lightly wooded sites (FWS 2004d). No populations are known to exist within 5 km (3 mi) of the BFN site, but suitable habitat could be found along the BFN transmission line rights-of-way.

2.2.7 Radiological Impacts

TVA has conducted a radiological environmental monitoring program (REMP) around the BFN site since 1968. Through this program, radiological impacts to workers, the public, and the environment are monitored, documented, and compared to the appropriate standards. The objectives of the REMP are described below:

- Provide representative measurements of radiation and radioactive materials in the exposure pathways and of the radionuclides that have the highest potential for radiation exposures to members of the public.

- Supplement the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways.

Results of measurements of radiological releases and environmental monitoring are summarized in annual reports (TVA 2004c, g). The limits for all radiological releases are specified in the Browns Ferry ODCM, and these limits are designed to meet Federal standards and requirements (TVA 2004c). The REMP includes monitoring of the aquatic environment (fish, invertebrates, and shoreline sediment), the atmospheric environment (airborne radioiodine, gross beta, and gamma), the terrestrial environment (vegetation), and direct radiation (TVA 2004g).

Review of historical data on releases and the resultant dose calculations indicated that the doses to maximally exposed individuals in the vicinity of the BFN site were a small fraction of the limits specified in EPA's environmental radiation standards 40 CFR Part 190 as required by 10 CFR 20.1301(d). Dose estimates are calculated for a hypothetical maximally exposed individual, based on monitored liquid and gaseous effluent release data, onsite meteorological data, local river flow data, and appropriate pathways identified in the ODCM (TVA 2004c).

The dose from all pathways during the period from 1999 to 2003 to a maximally exposed individual was less than 0.0035 mSv (0.35 mrem) per year to the body or organ other than the thyroid. To calculate the dose to the maximally exposed individual, the calculated doses from the liquid and gaseous effluent exposure pathways are summed. For the liquid effluent pathway the whole body dose was calculated to be 0.0013 mSv (0.13 mrem) per year. The liquid exposure pathways included drinking water, fish ingestion, and direct radiation from shoreline sediment during recreation such as boating. For the gaseous effluent pathways, the whole body dose was calculated to be 0.0022 mSv (0.22 mrem) per year; the gaseous exposure pathways included inhalation, ingestion of milk and crops, and direct radiation from the airborne radioactive material. The thyroid dose from all pathways was less than 0.0096 mSv (0.96 mrem) per year (TVA 2000, 2001, 2002b, 2003b, 2004c).

These doses are typical of the annual dose for operation of BFN, Units 2 and 3 without the power uprates. As discussed earlier, operation at the combined total power level of 11,856 MW(t) during the license renewal term could increase doses by as much as a factor of 1.8 over these typical values. Historically doses to the population from BFN are well below NRC and EPA limits and would continue to be well below NRC and EPA limits during operation at the combined total power level of 11,856 MW(t) during the license renewal term.

2.2.8 Socioeconomic Factors

The staff reviewed the TVA ER and information obtained from several county, city, and economic development staff during a site visit to Limestone and Morgan counties in the spring 2004. The following information describes the economy, population, and communities near BFN.

2.2.8.1 Housing

BFN employs approximately 1000 people on a full-time basis, with an additional 2475 contract employees who are primarily working on the restart of Unit 1 (TVA 2004h). About 300 contract employees who are not affiliated with the restart of Unit 1 support the non-outage operations at Units 2 and 3. Approximately 26 percent of these employees (both plant and contract) live in Lauderdale County, while an additional 21 percent live in Limestone County, 16 percent live in Madison County, and 14 percent live in Morgan County, with the remainder living in other locations (see Table 2-6). Although the employee residences are widely dispersed, the socioeconomic analysis primarily focuses on Lauderdale, Limestone, Madison, and Morgan counties, because more than 75 percent of the BFN employees live in these counties, and Limestone County is where BFN is located (TVA 2004h).

Table 2-6. Residence by County for Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Tennessee Valley Authority and Contract Employees

County	Tennessee Valley Authority Employees		Contract Employees		Total (Employees and Contractors)	
Colbert	71	6.9%	261	10.5%	332	9.5%
Cullman	4	0.4%	13	0.5%	17	0.5%
Franklin	13	1.3%	68	2.7%	81	2.3%
Giles, TN	5	0.5%	4	0.2%	9	0.3%
Jackson	11	1.1%	32	1.3%	43	1.2%
Lauderdale	306	29.6%	617	24.9%	923	26.3%
Lawrence, AL	18	1.8%	94	3.8%	112	3.2%
Lawrence, TN	21	2.0%	60	2.4%	81	2.3%
Limestone	251	24.3%	496	20.0%	747	21.3%
Madison	137	13.2%	419	16.9%	556	15.8%
Marshall, AL	8	0.8%	13	0.5%	21	0.6%
Morgan	172	16.6%	312	12.6%	484	13.8%
Wayne	0	0.0%	23	0.9%	23	0.7%
Other	18	1.7%	63	2.5%	81	2.3%
Total	1035		2475		3510	

Source: TVA 2004h.

BFN is currently in the process of restarting Unit 1. There are presently more than 2000 temporary workers onsite who are working on the restart of Unit 1. In addition, the units are on a schedule to refuel in alternate years. During refueling, the number of employees increases by as many as 900 temporary workers for a period of 30 to 40 days. Most of the temporary employees appear to primarily reside in surrounding counties and commute to the plant rather than make use of temporary rental housing available in Limestone County (TVA 2003a). Local real estate agents in Athens also confirmed this trend despite the recent increase in employment at the plant, resulting from Unit 1 restart activities. The local real estate market has remained relatively unaffected and rental rates have not significantly increased.[(a)]

Table 2-7 provides the number of housing units and housing unit vacancies for Lauderdale, Limestone, Madison, and Morgan counties for 1990 and 2000. Limestone County, where BFN is located, had 26,897 housing units in 2000, with a vacancy rate around 8 percent. Lauderdale County, in which the greatest number of TVA plant and contract employees reside, had

Table 2-7. Total Occupied and Vacant (Available) Housing Units by County, 1990 and 2000

	1990	2000	Approximate Percentage Change
		LAUDERDALE COUNTY	
Housing Units	33,522	40,424	21%
Occupied Units	30,905	36,088	17%
Vacant Units	2,617	4,336	66%
		LIMESTONE COUNTY	
Housing Units	21,455	26,897	25%
Occupied Units	19,685	24,688	25%
Vacant Units	1,770	2,209	25%
		MADISON COUNTY	
Housing Units	97,855	120,288	23%
Occupied Units	91,208	109,955	21%
Vacant Units	6,647	10,333	55%
		MORGAN COUNTY	
Housing Units	40,419	47,388	17%
Occupied Units	37,799	43,602	15%
Vacant Units	2,620	3,786	45%
Sources: U.S. Census Bureau (USCB) 2000, 1990.			

(a) Personal communication (discussion) with L. McBay and L. Smith, Century 21 Realtors, Athens, Alabama (March 31, 2004).

40,424 housing units and a vacancy rate of just over 10 percent. Madison and Morgan counties, both of which have a larger population base and a relatively more diverse employment market, had vacancy rates in 2000 of nine and eight percent, respectively (USCB 2000). These counties are not subject to restrictive growth control measures that limit housing development (TVA 2003a).

Table 2-8 contains data on population, estimated population, and annual population growth rates for Lauderdale, Limestone, Madison, and Morgan counties. All counties experienced positive population growth in the 1990s, with Limestone's rate of increase exceeding 20 percent (TVA 2003a).

Table 2-8. Population Growth in Lauderdale, Limestone, Madison and Morgan Counties, Alabama – 1980 to 2020

	Lauderdale County		Limestone County		Madison County		Morgan County	
	Population	**% Change (each decade)**	**Population**	**% Change (each decade**	**Population**	**% Change (each decade)**	**Population**	**% Change (each decade)**
1980	80,546	--	46,005	--	196,966	--	90,231	--
1990	79,661	(-1.1)	54,135	17.7	238,912	21.3	100,043	10.9
2000	87,966	10.4	65,676	21.3	276,700	15.8	111,064	11.0
2015	98,015*	11.4	81,747*	24.5	324,153*	17.1	124,358*	12.0
2025	103,176*	5.3	90,865*	11.2	349,713*	7.9	131,112*	5.4

-- = No data available.
* *population estimated*
Sources: TVA 2003a.

2.2.8.2 Public Services

Public services include water supply, education, and transportation.

- **Water Supply**

The City of Athens Water Services and the Limestone County Water Authority are the primary sources of potable water in Limestone County. The City of Athens Water Services draws water from the Elk River and currently has a Safe Yield from the River of 21.3 x 10^4 m^3/day (56 MGD) (TVA 2004i). Limestone County Water Authority draws water from the Elk River and four wells. Both of these water systems operate with excess capacity, and currently meet water demands for Unit 1 restart activities, and normal BFN operations. As shown in Table 2-9, the average total daily water demand on the City of Athens system is about 2.5 x 10^4 m^3/day (6.5 MGD), which is less than half the permitted capacity of 5.1×10^4 m^3/day (13.5 MGD). Athens City Water Services has plans to upgrade its intake structure to accommodate an increased intake rate of 6.8×10^4 m^3/day (18 MGD) to ensure supply reliability. This system upgrade is scheduled for implementation during 2004. BFN typically uses 500 to 1000 m^3/day (0.13 to 0.26 MGD).

Table 2-9. Public Water Supply Systems in Limestone County, Alabama

Water System	Source	Permitted Capacity m^3/d (MGD)	Average Daily Demand m^3/d (MGD)	Peak Demand Per Day m^3/d (MGD)	Area Served
City of Athens Water Services	Elk River and wells	5.1×10^4 (13.5)	2.5×10^4 (6.5)	4.1×10^4 (10.7)	City of Athens/ Limestone County
Limestone County Water Authority	Elk River and wells	3.0×10^4 (8)	2.4×10^5 (6.25)	2.6×10^4 (6.75)	Limestone County

Source: TVA 2003a, 2004i

- **Transportation**

The BFN site is located approximately 16 km (10 mi) southwest of Athens in northern Alabama in Limestone County and is located just south of U.S. Highway 72, which runs from South Pittsburg, Tennessee, west to Memphis, Tennessee. The site is directly accessible from County Road 25 (Shaw Road), which intersects U.S. Highway 72 approximately 10 km (6 mi) north of the site. County Road 25 (Nuclear Plant Road) also intersects U.S. Highway 31 approximately 14 km (9 mi) east of the site. U.S. Highway 31 intersects U.S. Highway 72 northeast of the site. Browns Ferry Road to County Road 25 just east of the site provides a more direct route to the site from Athens. U.S. Highways 72 and 31 are both high-quality, four-lane roads with adequate lane widths, alignments, turning lanes, and speed limits of 80 km/hr (50 mph) through Athens and increasing away from the city.

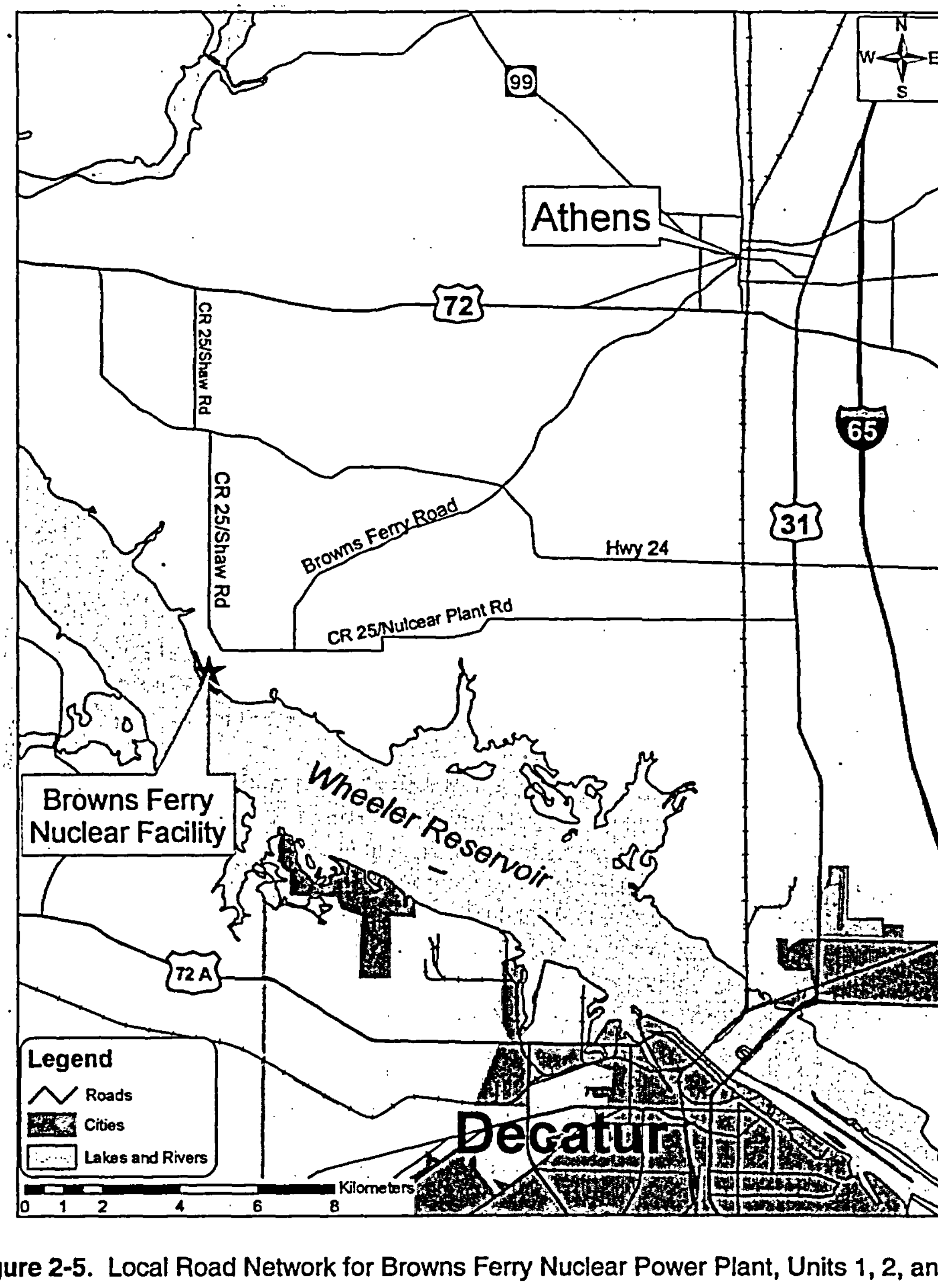
County Road 25 and Browns Ferry Road are medium-quality, two-lane roads with level alignment, some passing zones, and speed limits of 72 km/hr (45 mph). There is direct accessibility to BFN off County Road 25. The large diamond intersection at one entrance allows for smooth turning movements into and out of the BFN site. Another access road into the plant commonly used by contractors uses a traffic light at the intersection with Nuclear Plant Road. BFN, which is the primary traffic generator in the vicinity of the site, currently averages a daily site population of approximately 1200 persons. The population currently peaks at approximately 2000 people during outages, which occur every 24 months (per unit) for approximately 2 months. Current truck deliveries are minimal (less than 10 per week) and include hydrogen trucks, Calgon™ water chemistry trucks, and occasional diesel fuel deliveries during peak months. Rural residences located along the county roads that provide access to the site are also sources of traffic in the area (TVA 2003).

Figure 2-5 shows a map of the local road network for the area. The latest available (1998) average daily traffic counts in proximity to the site indicate approximately 13,440 vehicles per day on U.S. Highway 72 north of the site and 16,260 vehicles per day on U.S. Highway 31 south of U.S. Highway 72. There are no available traffic counts on the county roads; however, TVA estimates approximately 1600 vehicles per day on Shaw Road, Browns Ferry Road, and Nuclear Plant Road.

BFN does not have direct rail service; however, a railway spur track with an unloading area is located off the CSX (Louisville and Nashville Railroad) mainline that runs north and south in Tanner, Alabama, approximately 13 km (8 mi) east of BFN. TVA leased this small parcel of land from CSX and used it for offloading during construction of BFN; however, TVA has not used the spur and unloading area for offloading and transporting materials to the plant since then. After offloading, heavy items were transported on heavy trucks via a "hardened" pathway to the site. This pathway included shallow fords through creek beds along the way. At the site, a short railroad spur runs into the turbine building for transport into the plant (TVA 2003a).

TVA plans to use the railroad spur track and unloading area for future removal of dry cask spent fuel storage canisters from the site. There are no plans to use it for Unit 1 restart activities or regular plant operations. Traffic on the Tennessee River near BFN includes both commercial and recreational vessels. The river channels and the locks at Guntersville Lock and Dam and at Wheeler Dam are more than adequate for handling river traffic. Both Guntersville Lock and Wheeler Lock are operating below their utilization capacity (TVA 2003a).

BFN has a qualified barge facility near the northwest corner of the site. Currently it consists of barge tie points and a wide ramp going down into the water. The ramp was used during initial plant construction to transport very heavy loads such as reactor vessels. The barge facility is currently used several times per year, but a temporary crane has to be brought in to unload the barge each time. The roadbed from the plant to the barge facility is "hardened" for heavy loads. Future work is contemplated to upgrade the barge facility by stabilizing the riverbank and installing anchoring cells and a permanent dock (so that the facility will no longer require use of a temporary crane). An upgraded barge facility could eventually be used to facilitate transport of spent fuel canisters offsite for disposal in a national repository. The barge facility would likely be used for some heavy items during Unit 1 restart; however, its use for this purpose and the proposed facility upgrade is independent of the decision to restart Unit 1. Appropriate environmental analyses would be done if TVA decides to propose upgrading the barge facility.



1 **Figure 2-5.** Local Road Network for Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

Three pipelines pass within 8 km (5 mi) of the center of the BFN plant site. One pipeline that carries xylene runs north and south about 3.9 km (2.4 mi) east of the plant. The other two pipelines carry natural gas in a common right-of-way about 6.1 km (3.8 mi) south-southwest of the plant. The natural gas pipelines generally run east-west. The only pipeline crossing the BFN site boundary is a potable water line from the Athens Water District. There are no plans to install or connect to any pipelines in the foreseeable future. BFN is connected to the TVA system network by seven 500-kV lines: one line to Madison substation; two lines to Trinity substation; one line each to the West Point, Maury, and Union substations; and one line to Limestone substation.

Normal station power is from the unit station service transformers connected between the generator breaker and main transformer of each unit. Startup power is from the TVA 500-kV system network through the 500-kV to 20.7-kV main and 20.7 kV to 4.16-kV unit station service transformers. Auxiliary power is available through the two common station service transformers that are fed from two 161-kV lines supplying the 161-kV switchyard, one line each from the Athens and Trinity substations.

2.2.8.3 Offsite Land Use

BFN is located in northern Alabama on the north shore of Wheeler Reservoir in an unincorporated portion of Limestone County. Madison, Morgan, Lawrence, and Lauderdale Counties also are in the vicinity of BFN. The largest city in Limestone County is Athens, and the population in the county is approximately 67,000, with approximately 19,000 residing in Athens.

BFN is located in an agricultural area, surrounded by cropland principally planted with cotton. Limestone County is ranked first in Alabama for the most cotton grown. About 89,000 ha (220,000 ac) or 66.8 percent of the total acreage in Limestone County is used for agriculture (TVA 2003a). In addition, there are approximately 31,930 ha (78,900 ac) of forested land in the county, constituting approximately 23.9 percent of total county acreage. The majority of the forested land is located in the northern two-thirds of the county. Trends show that the amount of forested land has been declining since the early 1960s (TVA 2003a). The amount of land devoted to agriculture has been gradually increasing.

Only about two percent of Limestone County is urban development; however, the current trend in population growth will likely result in more land becoming urbanized (TVA 2003a). Population in Limestone County has been gradually increasing because of increased employment opportunities in the county as well as in nearby Huntsville and Decatur. It is expected that the majority of residential growth will occur around Athens and in the Elkmont Village area

(TVA 2003a). Development of commercial property is rapidly occurring in the area of the intersection of U.S. Highway 72 and Interstate 65 and along the U.S. Highway 72 corridor to Huntsville.

2.2.8.4 Visual Aesthetics and Noise

- **Visual Aesthetics**

BFN is situated in an area where the land is used primarily for agriculture. Population densities are low, with no population centers of significance within 16 km (10 mi) of the plant. The site is surrounded to the north and east by rural countryside. It includes open pasture lands, scattered farmsteads, few residents, and little industry within several miles. The terrain is gently rolling with open views to higher elevations to the north. The south and west sides of the plant abut Wheeler Reservoir, which is a wide expanse of open river used for an array of recreational purposes. The reservoir in the vicinity of BFN is moderately used by recreational boaters and fishermen (TVA 2003a).

There are no homes within foreground viewing distance to the north and east. Adjacent to the site however, is a small residential development located to the northwest. Another residential development is located across Wheeler Reservoir to the southwest, and the Mallard Creek public use area is directly across the reservoir. These developments have at least partial views of the plant site. A berm, graded during the initial construction of the plant and containing approximately 2.5 million m^3 (3.3 million yd^3) of earth excavated to make cooling water channels, lies adjacent to the cooling tower complex and blocks views of the northern and eastern plant area (TVA 2003a).

Two wildlife management areas – Swan Creek State Wildlife Management Area and Mallard-Fox Creek State Wildlife Management Area – are within 5 km (3 mi) of the BFN site (TVA 2003a). The Swan Creek Wildlife Management Area includes more than 1200 ha (3000 ac) of land and more than 2000 ha (5000 ac) of water surrounded by numerous industrial facilities. The Mallard-Fox Creek State Wildlife Management Area encompasses approximately 280 ha (700 ac) of land and 690 ha (1700 ac) of water and is primarily used for small game hunting. The Round Island Recreation Area is located approximately 5.6 km (3.5 mi) upstream of BFN (TVA 2003a).

- **Noise**

Several communities near BFN are exposed to noise from plant operations. The two areas considered to be most susceptible are the Paradise Shores and the Lakeview communities. Paradise Shores is located downstream and adjacent to the BFN site, while Lakeview is located across the river and about 2591 m (8500 ft) from the center of the cooling tower area

(TVA 2002a). Upstream and adjacent to the site are two new subdivisions of waterfront homes – Pointe Westmoreland and Lookingbill. Given the distance and buildings and terrain features between BFN and its cooling tower area, Pointe Westmoreland and Lookingbill are not considered to be sensitive to the current noise environment. Given the growth that has occurred around BFN since it first became operational, the initial background noise estimates for both the Paradise Shores and Lakeview communities were not considered representative of present-day conditions.

In June 2001, TVA conducted a new background noise survey (TVA 2002a). For the Paradise Shores community, the 15-hour daytime (7:00 a.m. to 10:00 p.m.) average noise value was 45.7 decibels, while the nighttime (10:00 p.m. to 7:00 a.m.) average was 43.1 decibels. Similar data for the Lakeview community for the same time periods was 44.1 and 38.7 decibels. The predominant noise sources were traffic, lawn mowers, home air-conditioners, and children's activities. At night, insects, frogs, air-conditioners, and traffic were the dominating noises (TVA 2002a). Lakeview has posted traffic restrictions that reduced traffic, thus reducing the recorded background noise values.

In July 2001, a daytime noise survey was conducted while the three cooling towers closest to Paradise Shores were operating. Measurements taken at the same locations used for the background noise survey indicated a total noise level of 45.8 decibels, while the calculated total noise level value for this location was 46.4 decibels, based on noise measurements taken from another location closer to the cooling towers. If the other two operating cooling towers were used, the estimated background noise level would increase by less than 1 decibel. For six cooling towers (assumes the replacement and operation of the sixth cooling tower), the additional total noise level would be 1 to 2 decibels greater than the levels measured during the July 2001 survey. On the day of the testing, noise from the existing five operating cooling towers was not detected in the Lakeview community.

Currently, there are no Federal, State, or local municipal noise standards, or regulations (TVA 2002a). The utility uses the EPA-recommended level of 55 decibels for the annual equivalent sound level day/night as the basis for acceptable noise level for residential areas before noise reduction measures would be considered (TVA 2002a). While the measured noise levels obtained both for the background and during cooling tower operation were discrete measurements, that information can be used to calculate the average annual day/night level. TVA estimated these values to be 50 decibels for Paradise Shores and 46 decibels for Lakeview (TVA 2002a). Therefore, the current estimated noise levels for both communities is below the recommended EPA level. However, this does not preclude the potential for annoyance and complaints from some members of either the Paradise Shores or Lakeview communities because of disturbances of communication, relaxation, and concentration.

2.2.8.5 Demography

- **Resident Population Within 80 km (50 mi)**

Population within 80 km (50 mi) (in 16-km [10-mi] annular rings) of BFN was estimated (TVA 2003). An estimated 164,936 people live within 32 km (20 mi) of BFN, and 872,478 live within 80 km (50 mi) (TVA 2003a). The largest population centers within a portion of the 16-km (10-mi) area are Athens (located in Limestone County with a population 18,967) and Decatur (located in Morgan County with a population of 53,929) (USCB 2000).

Between 1990 and 2000, the population of Lauderdale County grew by 10 percent, Limestone County population grew by 21 percent, Madison County grew by 16 percent, and Morgan County grew by 11 percent. All the population growth of these counties, which surround the plant, were equal to or greater than the growth of the State of Alabama between these same years (10 percent). As a group, these four counties have been growing faster than the State of Alabama, and projections indicate that this trend is expected to continue for the next several years. The faster growth however, is limited to Limestone and Madison counties, which constitute the Huntsville metropolitan area (TVA 2003a).

- **Workforce**

The economy of Limestone County is more closely linked to BFN activities then are the economies of Lauderdale, Madison, and Morgan counties, because TVA is one of the largest sources of employment for Limestone County residents and contributes a greater share to the county's revenue relative to the share contributed by other neighboring counties.

The largest single employer in Limestone County is Delphi Saginaw Steering Systems, which has approximately 2600 employees. The next largest employers include the TVA BFN site and the County Board of Education, each of which employs approximately 1200 people throughout the year. Other major employers in the county include Target Distribution (retail distribution), Federal Mogul Sealing Systems (production of automotive gaskets), Steelcase, Inc., (production of office furniture), and ConAgra Poultry (poultry processing) (Athens-Limestone Chamber of Commerce 2004).

The number of jobs in Limestone County has more than doubled since 1970, reaching a total of 32,068 jobs in 2001 (Table 2-10). The 2001 level is 17.9 percent higher than the 1990 level. During this same time period, the population grew by 24.5 percent, suggesting that Limestone County has become more of a bedroom community to Huntsville as its growth has continued to spread toward the west. With the exception of Colbert and Lawrence Counties, the employment market for the surrounding counties listed in Table 2-10 has been strong during the past three decades relative to State and U.S. growth rates. Based on TVA forecasts of employment for the TVA Power Service Area, employment in Limestone County is expected to be around 41,000 in 2015 and about 53,000 in 2035, which is approximately 2 percent growth per year for the next 30 years (TVA 2003a). Limestone County is more dependent on manufacturing, government, and farm employment than other neighboring counties, as is presented in Table 2-11. The region around BFN has an industrial distribution similar to that of the state as a whole, although it is slightly more dependent on manufacturing. The state, as well as the region surrounding BFN, is more dependent on manufacturing and less on trade and service employment than is the nation as a whole.

Table 2-10. Number of Jobs by County in the Vicinity of Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

County	1970	1980	1990	2001	Average Annual Percent Change 1970-2001	Percent Change, 1990-2001
Colbert	25,045	29,775	28,594	28,292	0.4%	(-1.1%)
Lauderdale	20,518	29,126	36,579	43,171	3.6%	18.0%
Lawrence	7,289	8,905	11,445	11,766	2.0%	2.8
Limestone	14,056	18,300	27,188	32,068	4.1%	17.9%
Madison	93,110	108,507	165,710	194,841	3.5%	17.6%
Morgan	34,144	42,699	54,151	64,473	2.9%	19.1%
Alabama (x 1000)	1,413	1,736	2,062	2,410	2.3%	16.9%
United States (x 1000)	91,282	114,231	139,427	167,536	2.7%	20.2%

Source: TVA 2003a

Table 2-11. Major Employment Sectors in Counties Surrounding Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 and in Alabama – 2001

Employment Sector	Colbert	Lauderdale	Lawrence	Limestone	Madison	Morgan	Alabama
Trade and Services	12,391	21,197	4,165	13,180	103,266	28,626	1,151,833
Manufacturing	4,272	6,087	1,883	6,381	27,278	13,797	334,947
Agriculture	849	2,159	1,953	2,149	3,117	1,612	84,339
Government	5,885	7,382	1,753	5,836	37,604	7,930	383,141
Other	4,895	6,346	2,012	4,522	23,576	12,508	455,433
Total Jobs	**28,292**	**43,171**	**11,766**	**32,068**	**194,841**	**64,473**	**2,409,693**
Unemployment (Rate)	2,082 (8.2%)	3,260 (8.0%)	1,115 (6.6%)	1,299 (4.1%)	4,880 (3.4%)	3,083 (5.4%)	112,004 (5.3%)

Source: TVA 2003a; U.S. Bureau of Labor Statistics (BLS 2004)

- **Transient Populations**

There appears to be very little seasonal fluctuation in local populations around BFN caused by transient populations moving through the area. Because migratory workers travel and can spend a significant amount of time in an area without being actual residents, they may be unavailable for census takers to count. If this occurs, these workers would be "under-represented" in U.S. Census Bureau (USCB) population counts. Although migrant workers are commonly found in rural agriculturally productive areas and a significant portion of Limestone County is made up of agricultural land, the farming in this area is less labor-intensive than other regions because of the types of crops that are raised (primarily cotton and soy beans) and the lack of irrigation requirements. There appear to be no significant concentrations of migrant workers in areas surrounding BFN (TVA 2003a).[a]

- **Taxes**

Property taxes are used to fund schools, police and fire protection, road maintenance, and other municipal services. Property taxes may be levied by counties, cities, towns, villages, school districts, and special districts. BFN is located in Limestone County, which generates most of its tax revenues through *ad valorem* taxes, which are taxes levied on the value of real estate. The commercial and industrial sectors generate relatively more of the tax revenues in Limestone County than the residential sector.[b]

Although TVA is a nonprofit entity, which is not subject to conventional state and local taxation, it makes in-lieu-of-taxation payments to states in which its power operations are carried on and in which it has acquired properties previously subject to State and local taxation in accordance with federal law, Section 13 of the TVA Act, 16 U.S.C. §831l. Under Section 13, TVA pays five percent of its gross power revenues to such states and counties (TVA 2004h).

TVA makes tax-equivalent payments to eight states, including Alabama. The State of Alabama then allocates its tax-equivalent payments from TVA in accordance with Title 40 "Revenue and Taxation," Chapter 28 "Distribution of Payments Made In Lieu of Taxes," Sections 40-28-1 through 40-28-4. Alabama distributes 75 percent of the TVA tax-equivalent payments to the 16 TVA-served counties based on a formula from TVA's book value of power property and sales in each of these counties. These counties then share a portion of their payment with cities, the school systems, hospitals, etc., within their boundaries. The remainder of the tax-

(a) Personal Communication (discussion) with M. Jordan and A. Stover, community Development Department, Decatur, Alabama (March 31, 2004).

(b) Personal Communication (discussion) with M. Cole, D. Seibert, T. Hill, P.Ball, E. Ezzell, Limestone County Commission (March 31, 2004).

equivalent payments are either retained for the State's general fund or are distributed to counties not served by TVA. During FY 2003, the State of Alabama allocated $15 million to the general fund, $58 million to TVA-served counties, and nearly $4 million to counties not served by TVA (TVA 2004h).

TVA tax-equivalent payments that are distributed to Limestone County, the City of Athens, and school districts within Limestone County are included in Table 2-12. Because of the series of tax payment formulas and distribution policies, the total amount of the TVA tax-equivalent payment listed in the third column of Table 2-12 is not solely attributable to the existence and operation of BFN. The TVA allocation paid to Limestone County is however, largely attributed to TVA's fixed assets. An estimated portion of the tax-equivalent payment to the local jurisdictions that could reasonably be attributed to the existence and operation of BFN in Limestone County is provided in Table 2-12, Column 5.

In fiscal year 2003, Limestone County received just over $4.5 million from the State as redistribution of TVA's tax-equivalent payment. Approximately $2 million of this payment to Limestone County could be attributed to the presence of BFN in the county. Tax-equivalent payments for BFN that were retained by Limestone County average about eight percent of the total revenue taken in by the county. The distribution of these payments to various county funds (e.g., general fund, building fund, hospital), school districts, and local municipalities is included in Table 2-12. BFN accounted for a smaller proportion of the City of Athens' total revenue (only 2.0 percent) and even less for the local school districts (one percent) during this same period. Although Morgan County also relies on the significant tax-equivalent payments from TVA (approximately $10 million, $2 million of which is retained by the county) (MCC 2004), the amount directly attributable to BFN operations and asset value is far less than the share contributed to Limestone County revenues (TVA 2004h).

Table 2-12. Limestone County Distribution of Tax-Equivalent Payments Made by Tennessee Valley Authority in Fiscal Year 2003

Fund	Total Fund Revenue ($)	Tax Equivalent Payment by TVA ($)	Percent of Total Revenues	Estimated TVA Payment Attributable to BFN[(a)] ($)	Percent of Total Revenue
Limestone County General Fund	6,372,000	1,110,276	17%	488,521	8%
Limestone Hospital Fund	1,471,000	221,955	15%	97,660	7%
Limestone Public Buildings, Roads and Bridges	1,850,000	443,536	24%	195,156	11%
City of Athens (less utilities)	17,073,000	884,817	5%	389,320	2%
Athens City School District	23,946,000	545,406	2%	239,979	1%
Limestone County School District	49,547,000	1,157,867	2%	509,462	1%
Other (e.g., libraries and other towns)	NA	166,361	NA	73,199	NA

(a) It is estimated that 44 percent of the TVA tax-equivalent payment is attributable to BFN; thus, all distributions were adjusted proportionately to estimate the BFN portion.
NA = Not Available
Source: City of Athens 2004; LCC 2004; NCES 2004; and TVA 2004h, I.

2.2.9 Historic and Archaeological Resources

The area around BFN is rich in prehistoric and historic resources. Recent literature provided adequate background information for the area. Consequently, only a brief summary is provided here. Prehistoric and historic period overviews for Alabama are provided by U.S. National Park Service (2004), Hudson (1999), and Walthall (1980).

2.2.9.1 Prehistoric Period

Archaeological research has indicated that prehistoric Native American occupation of the region around BFN occurred from the Paleo-Indian period (about 10,000 to 8000 B.C.) to the Mississippian period (about A.D. 900 to 1500). Archaeological periods are based on changing settlement and land-use patterns and artifact styles. In Alabama, prehistoric chronology is divided into five broad time periods: Paleo-Indian, Archaic, Gulf Formational, Woodland, and Mississippian.

The prehistoric periods were marked by initial reliance on big game hunting for subsistence, followed by increased use of smaller game animals and plant foods in the Archaic period, more sedentary villages, and an increased reliance on cultivated crops. Through the Mississippian period, the Native American population occupied larger base camps in the river valleys, with subsistence based on agriculture, hunting and gathering, and intergroup trade. The late prehistoric period is primarily identified by the introduction of European trade goods.

2.2.9.2 Native American Historic Period

Prior to the early 18th Century, most of Alabama was home to Native Americans belonging to a southeastern alliance known as the Creek Confederacy. Today's Creek Nation, also known as the Muskogee, were the major tribe in that alliance. The Confederacy consisted of separate and independent tribes that gradually became, over a long period of time, a single political organization. Throughout most of its history however, the Confederacy was a dynamic institution, constantly changing in size as tribes, for whatever reason, entered or left the alliance.

At the time of historic European contact, the ancestors of the modern Creek Indians lived in a number of small distinct Mississippian-related societies in Alabama and Georgia. The dominant group, sharing a common language or dialects, was the Muskogee. The Muskogee consisted of 12 bands including the Kasihta, Coweta, Coossa, Abihka, Wakokai, Eufaula, Hilibi, Atasi, Kolomi, Tukabahchee, Pakana, and the Okchai. The bands situated to the north along the Coosa, Tallapoosa, and Alabama Rivers became known as the Upper Creek, while those along the Chattahoochee and Flint Rivers collectively became known as the Lower Creek.

In the early 1800s, a population of Creek Indians and other groups (such as the Yamassee) were still present in Alabama. However, in 1830 the American Congress passed the Indian Removal Act. Within a couple of years from this date, virtually the entire expanse of Alabama was devoid of Indian settlements.

2.2.9.3 Euro-American Historic Period

The Alabama territory was first explored by the Spanish in 1540. Their immediate objective was to create settlements along the Gulf of Mexico. Entering Pensacola Bay, they failed to establish a permanent settlement, but explored parts of Alabama. The first settlement was built in 1720 in the Mobile area by the French under the command of Baptiste le Moyne Bienville, who was a colonizer and the governor of Louisiana for France. The Alabama territory was later ceded to Great Britain in 1763 after the French and Indian Wars.

After the American Revolution in 1783, the Alabama territory came under the possession of the United States. The defeat of the Creek Indians by Andrew Jackson in 1814 spurred settlement and Alabama became a territory in 1817. Alabama was admitted to the Union in 1819. Late in 1819, the Missouri Territory embraced all of the Louisiana Purchase and the question was raised as to the legal status of slavery in Missouri and the rest of the territory west of the Mississippi. This debate led to the beginning of the Civil War. Alabama was one of several southern states that ceded from the union on January 11, 1861. The Confederate government was organized at Montgomery on February 4, 1861. After the Civil War in 1868, Alabama was readmitted to the Union. Both world wars stimulated industrialization and crop diversification in the State of Alabama.

TVA began major construction on BFN in 1967. Unit 1 began commercial operation in August 1974, Unit 2 in 1975, and Unit 3 in 1977. BFN was TVA's first nuclear power plant.

2.2.9.4 Historic and Archaeological Resources at BFN

Much of the BFN site has been disturbed by construction of the nuclear power plant facilities and related infrastructure, including roads, parking lots, and the cooling towers. Some previous disturbance has also occurred along the transmission line rights-of-way. However, there are a few small areas on the site that remain undeveloped. Intact archaeological sites may be present within these undeveloped areas.

The final environmental impact statement for the construction of BFN (TVA 1972) listed one site on the National Register of Historic Places, which is the TVA Wilson Dam located 31 km (19 mi) downstream from BFN. Prior to construction, TVA relocated the Cox Cemetery that involved moving more than 50 graves. Complete records of the grave relocation activities were filed with the Alabama Historical Commission.

TVA has an extensive cultural resource program that works to protect historic resources, as required by Federal law. Staff are responsible for the identification, evaluation, and protection of cultural resources on TVA lands and land affected by TVA actions (TVA 2004j). The majority of undisturbed land at BFN was surveyed in 2001 as part of the review for license renewal. The survey identified two historic properties. The first property identified was a prehistoric archaeological site (1Li535) with an Early-to-Middle Woodland period occupation. The site is considered potentially eligible for listing in the National Register of Historic Places (TVA 2002a). The second historic property identified was the Cox Cemetery. This cemetery was relocated during the initial construction of BFN. No historic structures were identified during the historic structures survey.

Cultural resources location information is protected by the Archaeological Resources Protection Act of 1979 and by 36 CFR Part 800. Therefore, no maps, photos, or figures of historic properties are provided in this draft SEIS.

2.2.10 Related Federal Project Activities and Consultations

The staff reviewed the possibility that activities of other Federal agencies might impact the renewal of the OLs for BFN. Any such activities could result in cumulative environmental impacts and the possible need for a Federal agency to become a cooperating agency for preparation of this SEIS (10 CFR 51.10(b)(2)).

TVA, a federal corporation wholly owned by the U.S. Government, is subject to the requirements for Federal agencies in the National Environmental Police Act of 1969 (NEPA). In compliance with NEPA, TVA prepared a SEIS to provide the public and TVA decisionmakers with an assessment of the environmental impacts of extending the operating life of the BFN nuclear units (TVA 2002a). This NRC draft SEIS draws upon the content of the TVA SEIS, but was prepared by NRC staff independently.

BFN is located on the north bank of Wheeler Reservoir on the Tennessee River. The reservoir is created by Wheeler Dam, which is approximately 32 km (20 mi) downriver from the plant. Wheeler Dam was constructed and is operated by TVA for flood control, power generation, and navigation.

The Mallard Creek Recreation Area is located directly across the Tennessee River from BFN. This is a TVA developed and operated area. It includes developed areas for camping, picnicking, swimming, and boat launching. Approximately 5.6 km (3.5 mi) upstream of the plant is Round Island Recreation Area, also developed and operated by TVA. It also features facilities for camping, swimming, picnicking, and boat launching. The reservoir in the vicinity of the plant site is moderately used by recreational boaters and fishermen. Wheeler National Wildlife Refuge, operated by FWS, is located upstream from BFN. It is one of the southern-most wintering areas for ducks and geese in the southeastern United States.

After reviewing the Federal activities in the vicinity of the BFN site, the staff determined that there were no Federal project activities that would make it desirable for another Federal agency to become a cooperating agency for preparation of the SEIS.

NRC is required under Section 102(C) of NEPA to consult with and obtain the comments of any Federal agency that has jurisdiction by law or special expertise with respect to any environmental impact involved in the subject matter of the SEIS. During the course of preparing this draft SEIS, NRC consulted with TVA, FWS, and the National Marine Fisheries Service (NOAA Fisheries). Consultation correspondence with these agencies is included in Appendix E.

2.3 References

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10 CFR Part 71. Code of Federal Regulations, Title 10, *Energy*, Part 71, "Packaging and Transportation of Radioactive Material."

36 CFR Part 800. Code of Federal Regulations, Title 36, *Parks, Forest, and Public Property*, Part 800, "Protection of Historic Properties."

40 CFR Part 81. Code of Federal Regulations, Title 40, *Protection of the Environment*, Part 81, "Designations of Areas for Air Quality Planning Purposes."

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3.0 Environmental Impacts of Refurbishment

Environmental issues associated with refurbishment activities are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999).[(a)] The GEIS includes a determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

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

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

License renewal actions may require refurbishment activities for the extended plant life. These actions may have an impact on the environment that requires evaluation, depending on the type of action and the plant-specific design. Environmental issues associated with refurbishment that were determined to be Category 1 issues are listed in Table 3-1.

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

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

Table 3-1. Category 1 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
SURFACE-WATER QUALITY, HYDROLOGY, AND USE (FOR ALL PLANTS)	
Impacts of refurbishment on surface-water quality	3.4.1
Impacts of refurbishment on surface-water use	3.4.1
AQUATIC ECOLOGY (FOR ALL PLANTS)	
Refurbishment	3.5
GROUNDWATER USE AND QUALITY	
Impacts of refurbishment on groundwater use and quality	3.4.2
LAND USE	
Onsite land use	3.2
HUMAN HEALTH	
Radiation exposures to the public during refurbishment	3.8.1
Occupational radiation exposures during refurbishment	3.8.2
SOCIOECONOMICS	
Public services: public safety, social services, and tourism and recreation	3.7.4; 3.7.4.3; 3.7.4.4; 3.7.4.6
Aesthetic impacts (refurbishment)	3.7.8

The potential environmental effects of refurbishment actions would be identified, and the analysis would be summarized within this section, if such actions were planned. The Tennessee Valley Authority (TVA) indicated that it has performed an evaluation of structures and components pursuant to Title 10 of the Code of Federal Regulations (CFR) 54.21 to identify activities that are necessary to continue operation of Browns Ferry Nuclear Plant, Units 1, 2, and 3 during the requested 20-year period of extended operation. These activities include replacement of certain components as well as new inspection activities and are described in the Environmental Report (TVA 2003).

However, TVA stated that the replacement of these components and the additional inspection activities are within the bounds of normal plant component replacement and inspections (TVA 2003). Therefore, they are not expected to affect the environment outside the bounds of plant operations as evaluated in TVA's final environmental statement (TVA 1972). In addition, TVA's evaluation of structures and components as required by 10 CFR 54.21 did not identify any major plant refurbishment activities or modifications necessary to support the continued

Table 3-2. Category 2 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53 (c)(3)(ii) Subparagraph
TERRESTRIAL RESOURCES		
Refurbishment impacts	3.6	E
THREATENED OR ENDANGERED SPECIES (FOR ALL PLANTS)		
Threatened or endangered species	3.9	E
AIR QUALITY		
Air quality during refurbishment (nonattainment and maintenance areas)	3.3	F
SOCIOECONOMICS		
Housing impacts	3.7.2	I
Public services: public utilities	3.7.4.5	I
Public services: education (refurbishment)	3.7.4.1	I
Offsite land use (refurbishment)	3.7.5	I
Public services, transportation	3.7.4.2	J
Historic and archaeological resources	3.7.7	K
ENVIRONMENTAL JUSTICE		
Environmental justice	Not addressed[(a)]	Not addressed[(a)]

(a) Guidance related to environmental justice was not in place at the time the GEIS and the associated revision to 10 CFR Part 51 were prepared. If an applicant plans to undertake refurbishment activities for license renewal, environmental justice must be addressed in the applicant's Environmental Report and the staff's environmental impact statement.

operation of Browns Ferry Nuclear Plant, Units 1, 2, and 3 beyond the end of the existing operating licenses. Therefore, refurbishment is not considered in this supplemental environmental impact statement.

The applicant is in the process of restarting Browns Ferry Nuclear Plant, Unit 1, and used the term "refurbishment" within the Environmental Report (TVA 2003) when discussing some of the impacts of restart. The staff determined that all of the activities associated with the restart of Unit 1 can, and are, being conducted within the scope of the existing operating license as reviewed previously (TVA 1972, 2002). Therefore, these activities are not considered refurbishment for the purposes of license renewal, and are not being evaluated within the scope of the license renewal application.

3.1 References

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

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

Tennessee Valley Authority (TVA). 1972. *Final Environmental Statement, Browns Ferry Nuclear Plant, Units 1, 2, and 3.* Knoxville, Tennessee.

Tennessee Valley Authority (TVA). 2002. *Final Supplemental Environmental Impact Statement (SEIS) for Operating License Renewal of the Browns Ferry Nuclear Plant in Athens, Alabama.* Knoxville, Tennessee.

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4.0 Environmental Impacts of Operation

Environmental issues associated with operation of a nuclear power plant during the license renewal term are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999)[a]. The GEIS includes a determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, OR LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

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

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

This chapter addresses the issues related to operation during the license renewal term that are listed in Table B-1 of Title 10 of the Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B, and are applicable to the Browns Ferry Nuclear Plant, Units 1, 2, and 3 (BFN). Section 4.1 addresses issues applicable to the BFN cooling system. Section 4.2 addresses issues related to transmission lines and onsite land use. Section 4.3 addresses the radiological impacts of normal operation, and Section 4.4 addresses issues related to the socioeconomic impacts of normal operation during the license renewal term. Section 4.5 addresses issues related to groundwater use and quality, while Section 4.6 discusses the impacts of license renewal-term operations on threatened and endangered species. Section 4.7 addresses potential new information that was raised during the scoping period, and Section 4.8 discusses

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

cumulative impacts. The results of the evaluation of environmental issues related to operation during the license renewal term are summarized in Section 4.9. Finally, Section 4.10 lists the references for Chapter 4. Category 1 and Category 2 issues that are not applicable because they are related to plant design features or site characteristics not found at BFN are listed in Appendix F.

4.1 Cooling System

Resumption of three-unit operation after restart of Unit 1 will require upgrading the cooling tower system by constructing a 20-cell cooling tower on the foundation of the original cooling tower number four, and increasing the water intake flow rates by approximately 11 percent above those of past three-unit operation (TVA 2003b). The facility would be operated to ensure that the maximum discharge water temperature and the temperature increase between the intake and discharge points remain within approved regulatory limits. Use of cooling towers would increase, and on rare occasions when the cooling towers are unable to meet thermal limits, the facility would be derated to remain in compliance. Although significant impacts are not anticipated, Tennessee Valley Authority (TVA) will also confirm expected levels of impingement and entrainment resulting from increased intake water flow rates by monitoring during current two-unit operation and following resumption of three-unit operations (TVA 2003b).

Category 1 issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, which are applicable to cooling system operation for BFN during the license renewal term, are listed in Table 4-1 (NRC 1996). TVA stated in its environmental report (ER) that no new information existed for the issues that would invalidate the GEIS conclusions (TVA 2003b). Additionally, the staff has not identified any new and significant information during its independent review of the ER (TVA 2003b), the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 megawatts-thermal (MW[t[). Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of the issues, the staff concluded in the GEIS that the impacts are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-1. Category 1 Issues Applicable to the Operation of the Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Cooling System During the License Renewal Term

ISSUE 10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
SURFACE WATER QUALITY, HYDROLOGY, AND USE (FOR ALL PLANTS)	
Altered current patterns at intake and discharge structures	4.2.1.2.1; 4.3.2.2; 4.4.2
Altered thermal stratification of lakes	4.2.1.2.3; 4.4.4.2
Temperature effects on sediment transport capacity	4.2.1.2.3; 4.4.2.2
Scouring caused by discharged cooling water	4.2.1.2.3; 4.4.2.2
Eutrophication	4.2.1.2.3; 4.4.2.2
Discharge of chlorine or other biocides	4.2.1.2.4; 4.4.2.2
Discharge of sanitary wastes and minor chemical spills	4.2.1.2.4; 4.4.2.2
Discharge of other metals in wastewater	4.2.1.2.4; 4.3.2.2; 4.4.2.2
Water use conflicts (plants with once-through cooling systems)	4.2.1.3
AQUATIC ECOLOGY (FOR ALL PLANTS)	
Accumulation of contaminants in sediments or biota	4.2.1.2.4; 4.3.3; 4.4.3; 4.4.2.2
Entrainment of phytoplankton and zooplankton	4.2.2.1.1; 4.3.3; 4.4.3
Cold shock	4.2.2.1.5; 4.3.3; 4.4.3
Thermal plume barrier to migrating fish	4.2.2.1.6; 4.4.3
Distribution of aquatic organisms	4.2.2.1.6; 4.4.3
Premature emergence of aquatic insects	4.2.2.1.7; 4.4.3
Gas supersaturation (gas bubble disease)	4.2.2.1.8; 4.4.3
Low dissolved oxygen in the discharge	4.2.2.1.9; 4.3.3; 4.4.3
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	4.2.2.1.10; 4.4.3
Stimulation of nuisance organisms	4.2.2.1.11;4.4.3

Table 4-1.(contd)

ISSUE 10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
Terrestrial Resources	
Cooling tower impacts on crops and ornamental vegetation	4.3.4
Cooling tower impacts on native plants	4.3.5.1
Bird collisions with cooling towers	4.3.5.2
Human Health	
Microbiological organisms (occupational health)	4.3.6
Noise	4.3.7

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

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

  > Altered current patterns have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of altered current patterns during the license renewal term beyond those discussed in the GEIS.

- Altered thermal stratification of lakes. Based on information in the GEIS, the Commission found that

  > These effects have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of altered thermal stratification of lakes beyond those discussed in the GEIS.

- <u>Temperature effects on sediment transport capacity</u>. Based on information in the GEIS, the Commission found that

  > These effects have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of temperature on sediment transport capacity during the license renewal term beyond those discussed in the GEIS.

- <u>Scouring caused by discharged cooling water</u>. Based on information in the GEIS, the Commission found that

  > Scouring has not been found to be a problem at most operating nuclear power plants and has caused only localized effects at a few plants. It is not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of scouring during the license renewal term beyond those discussed in the GEIS.

- <u>Eutrophication</u>. Based on information in the GEIS, the Commission found that

  > Eutrophication has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of eutrophication during the license renewal term beyond those discussed in the GEIS.

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

> Effects are not a concern among regulatory and resource agencies and are not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, its evaluation of other available information, such as the National Pollutant Discharge Elimination System (NPDES) permit for BFN, Discharge Monitoring Reports (DMRs), discussion with the NPDES compliance office, and operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of discharge of chlorine or other biocides during the license renewal term beyond those discussed in the GEIS.

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

> Effects are readily controlled through NPDES permit and periodic modifications, and are not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, its evaluation of other available information, including the NPDES permit for BFN, DMRs, discussion with the NPDES compliance office, and operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of discharges of sanitary wastes and minor chemical spills during the license renewal term beyond those discussed in the GEIS.

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

> These discharges have not been found to be a problem at operating nuclear power plants with cooling-tower-based heat dissipation systems and have been satisfactorily mitigated at other plants. They are not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, its evaluation of other available information, such as the NPDES permit for BFN, DMRs, discussion with the NPDES compliance office, and operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of discharges of other metals in waste water during the license renewal term beyond those discussed in the GEIS.

- Water-use conflicts (plants with once-through cooling systems). Based on information in the GEIS, the Commission found that

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

The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no water-use conflicts during the license renewal term beyond those discussed in the GEIS.

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

  > Accumulation of contaminants has been a concern at a few nuclear power plants but has been satisfactorily mitigated by replacing copper alloy condenser tubes with those of another metal. It is not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of accumulation of contaminants in sediments or biota during the license renewal term beyond those discussed in the GEIS.

- Entrainment of phytoplankton and zooplankton. Based on information in the GEIS, the Commission found that

  > Entrainment of phytoplankton and zooplankton has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, its review of monitoring programs, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of entrainment of phytoplankton and zooplankton during the license renewal term beyond those discussed in the GEIS.

- Cold shock. Based on information in the GEIS, the Commission found that

    > Cold shock has been satisfactorily mitigated at operating nuclear plants with once-through cooling systems, has not endangered fish populations or been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds, and is not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of cold shock during the license renewal term beyond those discussed in the GEIS.

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

    > Thermal plumes have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of thermal plumes to migrating fish during the license renewal term beyond those discussed in the GEIS.

- Distribution of aquatic organisms. Based on information in the GEIS, the Commission found that

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

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, its review of monitoring programs, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts on the distribution of aquatic organisms during the license renewal term beyond those discussed in the GEIS.

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

  > Premature emergence has been found to be a localized effect at some operating nuclear power plants but has not been a problem and is not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of premature emergence during the license renewal term beyond those discussed in the GEIS.

- Gas supersaturation (gas bubble disease). Based on information in the GEIS, the Commission found that

  > Gas supersaturation was a concern at a small number of operating nuclear power plants with once-through cooling systems but has been satisfactorily mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of gas supersaturation during the license renewal term beyond those discussed in the GEIS.

- Low dissolved oxygen in the discharge. Based on information in the GEIS, the Commission found that

  > Low dissolved oxygen has been a concern at one nuclear power plant with a once-through cooling system but has been effectively mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, its review of monitoring programs, or its evaluation of other available information, such as operation at a combined total power level of

11,856 MW(t). Therefore, the staff concludes that there are no impacts of low dissolved oxygen during the license renewal term beyond those discussed in the GEIS.

- <u>Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses</u>. Based on information in the GEIS, the Commission found that

  > These types of losses have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of losses from predation, parasitism, and disease among organisms exposed to sublethal stresses during the license renewal term beyond those discussed in the GEIS.

- <u>Stimulation of nuisance organisms</u>. Based on information in the GEIS, the Commission found that

  > Stimulation of nuisance organisms has been satisfactorily mitigated at the single nuclear power plant with a once-through cooling system where previously it was a problem. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of stimulation of nuisance organisms during the license renewal term beyond those discussed in the GEIS.

- <u>Cooling tower impacts on crops and ornamental vegetation</u>. Based on information in the GEIS, the Commission found that

  > Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no cooling tower impacts on crops and ornamental vegetation during the license renewal term beyond those discussed in the GEIS.

- Cooling tower impacts on native plants. Based on information in the GEIS, the Commission found that

> Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no cooling tower impacts on native plants during the license renewal term beyond those discussed in the GEIS.

- Bird collisions with cooling towers. Based on information in the GEIS, the Commission found that

> These collisions have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of bird collisions with cooling towers during the license renewal term beyond those discussed in the GEIS.

- Microbiological organisms (occupational health). Based on information in the GEIS, the Commission found that

> Occupational health impacts are expected to be controlled by continued application of accepted industrial hygiene practices to minimize worker exposures.

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of microbiological organisms on occupational health during the license renewal term beyond those discussed in the GEIS.

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

> Noise has not been found to be a problem at operating plants and is not expected to be a problem at any plant during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of noise during the license renewal term beyond those discussed in the GEIS.

The Category 2 issues related to cooling system operation during the license renewal term that are applicable to BFN are listed in Table 4-2 and discussed in Sections 4.1.1, through 4.1.5.

Table 4-2. Category 2 Issues Applicable to the Operation of the Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Cooling System During the License Renewal Term

ISSUE 10 CFR Part 51, Subpart A, Appendix B, Table B	GEIS Sections	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
WATER USE (FOR PLANTS WITH ONCE-THROUGH AND COOLING POND HEAT-DISSIPATION SYSTEMS)			
Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow)	4.3.2.1; 4.4.2.1	B	4.1.1
AQUATIC ECOLOGY			
Entrainment of fish and shellfish in early life stages	4.2.2.1.2; 4.4.3	B	4.1.2
Impingement of fish and shellfish	4.2.2.1.3; 4.3.3; 4.4.3	B	4.1.3
Heat shock	4.2.2.1.4; 4.4.3	B	4.1.4
HUMAN HEALTH			
Microbiological organisms (public health)(plants using lakes or canals, or cooling towers or cooling ponds that discharge into a small river)	4.3.6	G	4.1.5

4.1.1 Water-Use Conflicts (Make-up Water from a Small River)

The Tennessee River average annual flow at BFN for 1976 through 2002 was 4.16×10^{10} m^3/yr (1.47×10^{12} ft^3/yr). This annual flow is less than the 9×10^{10} m^3/yr (3.15×10^{12} ft^3/yr) criterion stated by the Nuclear Regulatory Commission (NRC) in 10 CFR 51.53(c)(3)(ii)(A) as the value below which "an assessment of the impact of the proposed action on the flow of the river and related impacts on instream and riparian ecological communities must be provided" (NRC 1996).

NRC made water use and water availability issues a Category 2 issue because two factors may cause them to become important for some nuclear power plants that use cooling towers (NRC 1996). First, the relatively small rates of cooling water withdrawal and discharge allows some power plants with cooling towers to be located on small bodies of water that are susceptible to droughts or competing water uses. Second, closed-cycle cooling systems evaporate cooling water, and this consumptive water loss may represent a substantial proportion of the flow in small rivers. Loss of a substantial portion of flow from a small stream as a result of evaporative losses from a cooling tower will reduce the amount of habitat for fish and aquatic invertebrates. Off-stream water uses, such as power plant consumption, must be regulated to ensure that important in-stream uses, such as habitat for aquatic organisms, boating, sport fishing, and waste assimilation, are not compromised.

BFN normally operates in open mode using once-through cooling. Modeling (TVA 2003b) predicts that, on average, BFN will operate in the open mode 93 percent of the time. Cooling towers are not used during open mode operations and consumptive water use is reduced.

For three units operating at a combined total power level of 11,856 MW(t), modeling shows the cooling towers would only be used on average 7 percent of the time in what is called "helper mode" (TVA 2003b). During these times, the total BFN intake water flow for three-unit operation of 12 million m^3/d (3171 MGD) or 139 m^3/s (4907 cfs) can be a significant fraction of the river flow past the plant (7Q10 of 250 m^3/s or 8700 cfs in NPDES permit rationale). However, even when operating in helper mode, consumptive water use is negligible and is expected to remain so throughout the license renewal term.

Cooling tower consumptive water use is not expected to exceed 2.3 m^3/s (82 cfs) (Hopping 2004), which is less than one percent of the 7Q10. For a two-unit operation cooling tower use is even less frequent with modeling predicting tower use, on average, only 5 percent of the time (TVA 2003b).

Consumptive and off-stream water use has not resulted in significant use conflicts due to the large volume of reservoir water available, the high river flow rate, and the return of most of the water withdrawn (TVA 2003b). Regulatory control of withdrawal rates and NPDES permit limits for return water quality also mitigate potential conflicts. Potential trade-offs can occur with instream water uses (e.g., in-stream use conflicts among aquatic life, waste assimilation, navigation, power generation, flood control, and lake levels). These potential conflicts are addressed by historic operating procedures, legal requirements, and regulatory procedures.

The staff independently reviewed the TVA ER and visited the site. The staff determined that water-use conflicts would be SMALL and could be mitigated by derating the plant.

4.1.2 Entrainment of Fish and Shellfish in Early Life Stages

For power plants with once-through cooling systems, entrainment of fish and shellfish in early life stages into cooling water systems is considered a Category 2 issue, requiring a site-specific assessment before license renewal. To perform this evaluation, the staff reviewed the TVA ER and other TVA environmentally related documents, visited the BFN site, and reviewed the applicant's State of Alabama NPDES Permit AL0022080, which was issued on December 29, 2000, became effective on February 1, 2001, and will remain in force until January 31, 2006 (ADEM 2000).

Section 316(b) of the Federal Water Pollution Control Act of 1972 (FWPCA) (also referred to as the Clean Water Act) requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts. Entrainment of fish and shellfish into the cooling water system is a potential adverse environmental impact that can be minimized by use of the best available technology.

On July 9, 2004, the U.S. Environmental Protection Agency (EPA) published a final rule in the *Federal Register* (69 FR 41575) (EPA 2004) addressing cooling water intake structures at existing power plants where flow levels exceed a minimum threshold value of 190,000 m^3/d (50 MGD). The rule is Phase II in EPA's development of 316(b) regulations that establish national requirements applicable to the location, design, construction, and capacity of cooling water intake structures at existing facilities that exceed the threshold value for water withdrawals. The national requirements, which are implemented through NPDES permits, minimize the adverse environmental impacts associated with the continued use of the intake systems. Licensees are required to demonstrate compliance with the Phase II performance standards at the time of renewal of their NPDES permit. Licensees may be required as part of the NPDES renewal to alter the intake structure, redesign the cooling system, modify station operation, or take other mitigative measures as a result of this regulation. The new performance standards are designed to significantly reduce entrainment losses due to plant operation. Any required site-specific mitigation would result in less impact from entrainment during the license renewal period.

For all three units operating at a combined total power level of 11,856 MW(t), the total BFN intake water flow would be139 m^3/s (2.2 million gpm), which can be a significant fraction of the river flow past the plant, especially during the lowest average flow for 7 consecutive days that can have a recurrence of 10 years (7Q10 low-flow value), of 246 m^3/s (3.9 million gpm) (Section 2.2.2). This intake flow represents an 11 percent increase over the original 100 percent power load of 124.9 m^3/s (1.98 million gpm) (Buchanan 1980).

The critical time of year for approaching the maximum river water temperature limits specified in the BFN NPDES Permit (ADEM 2000), and therefore requiring the use of cooling towers or plant de-rates, is July and August. The average flow in Wheeler Reservoir at BFN during these months is 965 m^3/s (15.3 million gpm) during July and August (TVA 2003b). During these same months the daily average flow exceeds the 7Q10 low-flow value 98.6 percent of the time in July and 98.8 percent of the time in August.

Characterization of the ichthyoplankton of Wheeler Reservoir was initiated prior to startup of BFN, and continued during the initial years of operations (1974 through 1979). From 80 to 98 percent of the larval fish populations were composed of clupeids (e.g., threadfin shad [*Dorosoma petenense*] and gizzard shad [*D. cepedianum*]). Fish larvae entrainment during the initial 6 years of operation ranged from 1.0 to 9.0 percent of the total number of larval fish in the reservoir passing by the plant (Table 4-3). During this same period, the mean hydraulic entrainment (portion of the river flow passing through the plant) varied from 3.0 to 13.3 percent (TVA 1978a; Buchanan 1980). During all years, percent entrainment of larval fish was less than hydraulic entrainment (Table 4-3). In addition to shad, other fish comprising greater than

Table 4-3. Calculated Entrainment of Fish Eggs and Larvae at Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 – 1974 to 1979

Year	Fish Egg Entrainment Percent (Number)	Larval Fish Entrainment Percent (Number)	Percent Mean Hydraulic Entrainment
1974	13.3 (459 million)	1.0 (125 million)	3.0
1975	1.3 (50 million)	3.3 (770 million)	4.4
1976	3.8 (143 million)	6.3 (1.3 billion)	8.4
1977	2.7 (149 million)	9.0 (3.7 billion)	12.0
1978	3.6 (50 million)	5.4 (2.92 billion)	13.3
1979	8.1 (188 million)	4.5 (1.34 billion)	9.0

Sources: Buchanan 1980; TVA 1978a.

1 percent of the total number of entrained larvae included suckers, minnows, freshwater drum (*Aplodinotus grunniens*), and white and yellow basses (*Morone chrysops* and *M. mississippiensis*) (TVA 1978a). The three fish families with the highest estimated entrainment (i.e., percent loss of larvae passing BFN) during three-unit operation at BFN in 1977 were Clupeidae (12.1 percent), Catostomidae (4.5 percent), and Sciaenidae (6.1 percent) (TVA 2002).

Taxa that exhibited increases in larval entrainment percentage over the period of study (1974 through 1977, which coincided with an increase from one- to three-unit operation) included those known to be widely distributed in the water column and essentially planktonic (e.g., Clupeidae, Moronidae, Cyprinidae, and Percidae). Those not exhibiting this trend included fishes that have nest-inhabiting or parental-care characteristics in early life (e.g., Ictaluridae and Centrarchidae) and are thus unlikely to be as planktonic or uniformly distributed in the water column (TVA 1978a). Fish entrainment was generally lower than hydraulic entrainment (the amount of river flow that passes through the plant) because fish larvae are not truly planktonic except at very early stages (TVA 1978a).

Fish egg entrainment during the initial six years of operation ranged from 1.3 to 13.3 percent of the total number of eggs in the reservoir passing by the plant. During 1974, the percent egg entrainment was much higher than hydraulic entrainment. During 1979, the percent egg entrainment was similar to hydraulic entrainment, and from 1975 through 1978, percent egg entrainment was much lower than hydraulic entrainment (Table 4-3). The only two commonly occurring species in Wheeler Reservoir that have buoyant or semibuoyant eggs are freshwater drum and mooneye (*Hiodon tergisus*), although the skipjack herring (*Alosa chrysochloris*) may also have buoyant eggs (TVA 1972). It was speculated that conditions were favorable in 1974 for spawning freshwater drum to be attracted to or near the plant intake resulting in the release of large numbers of eggs into the cooling water source (TVA 1978a). A similar speculation accounts for the large percentage of catfish larvae that were entrained in 1975 (TVA 1978a).

Under the original operating mode of 100 percent power load, entrained organisms were subject to a 13.9°C (25°F) temperature rise (TVA 2003b). Under 120 percent power load this increase in temperature could be as high as 15.9°C (28.7°F) (Hopping 2004). Total duration of cooling system passage is estimated at 7 to 11 minutes, with 5 to 9 minutes spent in heated waters (TVA 2003b). When discharge temperatures do not exceed 37.8°C (100°F), some entrainment survival would be expected (LaJeone and Monzingo 2000). Under a very conservative scenario, total mortality of all entrained ichthyoplankton occurs. Three-unit operation at 120 percent power load would increase intake flow rates by approximately 11 percent (TVA 2003b). Therefore, the amount of entrainment would be expected to increase, but the percent increase would be expected to be lower than the hydraulic entrainment increase.

Flow studies conducted at BFN have indicated that the majority of the water hydraulically entrained by the plant comes from the right side of the main river channel. This pelagic area contains significantly lower densities of drifting fish larvae than found in the overbank areas. Higher densities of fish eggs (mostly freshwater drum) are transported in the channel portion of the river, but entrainment of freshwater drum eggs and larvae have not resulted in noticeable decreases in abundance of this species, nor is it expected under return to three-unit operation at increased operational rates (TVA 2003b). There are no specific or unique spawning or nursery areas or migration routes for any fish species located upstream of BFN that would make eggs or larvae of these species unusually susceptible to entrainment (TVA 2003b). No obvious declines in these fish species have been noticed based on collection of adults in Wheeler Reservoir (TVA 2003b). Because ichthyoplankton in Wheeler Reservoir are produced upstream and downstream of BFN, it was concluded that entrainment would not add significantly to expected natural mortality of fish eggs and larvae in the reservoir (Buchanan 1980).

The staff reviewed the available information in the TVA ER (TVA 2003b) and in other BFN documents related to the FWPCA 316(b) permitting process. Based on the results of past entrainment studies and the operating history of BFN intake structure, the staff concludes that the potential impacts of entrainment of fish and shellfish in the early life stages into the cooling water intake system are SMALL, and further mitigation measures should not be warranted. Nevertheless, TVA will evaluate levels of entrainment by monitoring under current two-unit operation and following the return of three-unit operation. Analysis of current and future entrainment data collected at BFN will use modeling techniques designed to extrapolate from the lost production of eggs and larvae of forage species (e.g., clupeids) to more effectively assess overall potential entrainment impacts (TVA 2003b). TVA's Vital Signs Monitoring Program would also continue to assess aquatic communities in Wheeler Reservoir. If it is determined that increased entrainment is resulting in unacceptable environmental impacts, TVA would assess technologies, operational measures, and restoration measures that could be undertaken to remedy the impacts, and institute appropriate mitigation measures in consultation with appropriate Federal and State of Alabama agencies (TVA 2003b).

4.1.3 Impingement of Fish and Shellfish

For plants with once-through cooling systems, impingement of fish and shellfish on debris screens of cooling water system intakes is considered a Category 2 issue, which requires a site-specific assessment before license renewal. To perform this evaluation, the staff reviewed the TVA ER and other TVA environmentally related documents, visited the BFN site, and reviewed the applicant's State of Alabama NPDES Permit AL0022080, issued on December 29, 2000, which became effective on February 1, 2001, and will remain in force until January 31, 2006 (ADEM 2000).

Section 316(b) of the FWPCA requires the location, design, construction, and capacity of cooling-water intake structures reflect the best technology available for minimizing adverse environmental impacts. Impingement of fish and shellfish on the debris screens of the cooling water intake system is a potential adverse environmental impact that can be minimized by use of the best available technology.

On July 9, 2004, EPA published a final rule in the *Federal Register* (69 FR 41575) (EPA 2004) addressing cooling water intake structures at existing power plants whose flow levels exceed a minimum threshold value of 190,000 m^3/d (50 MGD). The rule is Phase II in EPA's development of 316(b) regulations that establish national requirements applicable to the location, design, construction, and capacity of cooling water intake structures at existing facilities that exceed the threshold value for water withdrawals. The national requirements, which are implemented through NPDES permits, minimize the adverse environmental impacts associated with the continued use of the intake systems. Licensees are required to demonstrate compliance with the Phase II performance standards at the time of renewal of their NPDES permit. Licensees may be required as part of the NPDES renewal to alter the intake structure, redesign the cooling system, modify station operation, or take other mitigative measures as a result of this regulation. The new performance standards are designed to significantly reduce impingement losses due to plant operation. Any required site-specific mitigation would result in less impact from impingement during the license renewal period.

During the initial years of plant operation (1974 through 1977), 72 species of fish were collected in impingement samples (TVA 1978a). Four species comprised 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 1.0 percent of the total fish impinged; many less than 0.01 percent. Forty-two of the species were impinged at rates estimated to be one fish or less per day (TVA 1978a). Juvenile fish occurred more often than adults in impingement samples. This is attributed to (1) the greater relative abundance of these age classes, (2) juvenile fish of some species may concentrate in the shoreline areas, and (3) juveniles are weaker swimmers than adults (TVA 1978a).

Table 4-4 provides the impingement information for the most prevalent species during initial years of BFN operation (1974 to 1977). Overall, there was a positive relationship between the level of plant operation and impingement. However, for several species (e.g., spotted sucker [*Minytrema melanops*], silver chub [*Macrhybopsis storeriana*], white crappie [*Pomoxis annularis*], and sauger [*Stizostedion canadense*]) impingement levels may have reflected year class variation of the species within the reservoir rather than the level of plant operation (TVA 1978a). Nuclear generating stations are typically operated as baseload facilities and daily changes in the operational mode are minimal. Also, there is usually only a minor variation in cooling water use between years as long as all units are operating at normal levels. Therefore, when there are dramatic fluctuations in impingement collections from week to week or from year to year, they generally reflect prevailing conditions in the river and changes in the fish community (Bowzer and Lippincott 2000).

Table 4-4. Calculated Total Number and Percent of Total Impingement for the Most Prevalent Fish Species Impinged at Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 – 1974 to 1977

Common Name (Scientific Name)	March 1974 - March 1975	March 1975 - March 1976	Sept 1976 - Aug 1977
skipjack herring (*Alosa chrysochloris*)	220,964 (4.2 %)	98,751 (3.7 %)	110,487 (1.7 %)
gizzard shad (*Dorosoma cepedianum*)	188,300[(a)] (3.5 %)	343,312 (12.8 %)	1,353,913 (20.3 %)
threadfin shad (*Dorosoma petenense*)	4,552,208[(a)] (86.5 %)	1,909,492 (71.0 %)	4,635,290 (69.5 %)
channel catfish (*Ictalurus punctatus*)	21,716 (0.4 %)	11,435 (0.4 %)	24,719 (0.4 %)
white bass (*Morone chrysops*)	14,126 (0.3 %)	13,408 (0.5 %)	50,681 (0.8 %)
yellow bass (*Morone mississippiensis*)	14,453 (0.3 %)	29,936 (1.1 %)	67,005 (1.0 %)
green sunfish (*Lepomis cyanellus*)	10,154 (0.2 %)	3115 (0.1 %)	39,210 (0.6 %)
bluegill (*Lepomis macrochirus*)	17,556 (0.3 %)	9423 (0.4 %)	84,977 (1.3 %)
redear sunfish (*Lepomis microlophus*)	7910 (0.2 %)	2561 (0.1 %)	27,625 (0.4 %)
freshwater drum (*Aplodinotus grunniens*)	179,501 3.4 %)	233,902 (8.7 %)	215,783 (3.2 %)
Total number impinged (Number of species impinged)	5,263,546 (51 species)	2,688,498 (52 species)	6,673,488 (61 species)

(a) The 48,937 individuals identified as only *Dorosoma* spp. were proportionally split between gizzard and threadfin shad.
Source: TVA 1978a.

The number of fish impinged between 1974 and 1977 were compared to the estimated standing stock of fish within Wheeler Reservoir (TVA 1978a). For the species listed in Table 4-4, the percent standing stock impinged between September 1976 and August 1977 were skipjack herring, 5.39 percent; gizzard shad, 0.40 percent; threadfin shad, 0.66 percent; channel catfish (*Ictalurus punctatus*), 1.35 percent; white bass, 5.56 percent; yellow bass, 11.72 percent; green sunfish (*Lepomis cyanellus*), 3.49 percent; bluegill (*L. macrochirus*), 0.04 percent; redear sunfish (*Lepomis microlophus*) 0.21 percent; and freshwater drum, 3.32 percent (TVA 1978a). The estimated number of fish that occur in Wheeler Reservoir was based on densities of fish collected in three coves. The coves are located in Second Creek near the Wheeler Dam (1.1 ha [2.7 ac] in area and 1.8 m [5.9 ft] deep), a cove at Lawrence County Park (1.4 ha [3.5 ac] in area and 1.3 m [4.3 ft] deep), and a cove on Elk River (0.6 ha [1.5 ac] in area and 1.4 m deep [4.6 ft]) (TVA 1978b).

No major or significant spawning areas, nursery grounds, feeding areas, wintering areas, or migration routes are located near BFN that would result in an increased potential for impingement (Baxter and Buchanan 1998; TVA 2003b). The intake channel at BFN is 150 m (492 ft), long from the skimmer wall to the pumping station. At normal maximum pool, the water depth along a 6.1-m (20.0-ft)-wide area in the middle of the intake channel is 10.1 m (33.1 ft). From there the sides of the channel slope at a 3-to-1 ratio. Directly in front of the pumping station the bottom slopes down an additional 1.5 m (4.9 ft) to the bottom of the intake opening, resulting in a maximum depth of 11.6 m (38.1 ft) at the intake screen at normal maximum pool (TVA 1978a). Fish have free access to the intake channel and can reside within this area without necessarily succumbing to impingement.

During original operations, the intake screens were cleaned either on a regular basis (e.g., at shift changes or daily) or when a pressure differential value is exceeded across the screens due to fouling. The often long impingement time, in addition to exposure to high-pressure spray system during the cleaning process, essentially resulted in a 100 percent mortality of impinged fish (TVA 1978a). The intake screens are now continuously backwashed as they are rotated, so impingement loss is not 100 percent. However, the survival rate has not been determined.

The paddlefish (*Polyodon spathula*) is the only State-listed fish species that has been collected in impingement samples (TVA 1978a). An estimated 168 specimens were collected between March 1974 and March 1975; 15 between March 1975 and March 1976; and 14 specimens between September 1976 and August 1977. They comprised less than 0.01 percent of the number of fish impinged in those years (TVA 1978a).

During the course of preparing this draft Supplemental Environmental Impact Statement (SEIS), the staff considered mitigation measures for the continued operation of BFN. Based on the assessment to date, the staff expects that the measures in place at BFN (e.g., shoreline intake, escape passages, and a fish return system), provide mitigation for impacts related to impingement, and no new mitigation measures are warranted. There have been no measurable changes to the fish community of Wheeler Reservoir related to the BFN, and no indications that impingement has had a destabilizing impact on fish populations (TVA 2003b). The direct and indirect effects associated with the modification of the Tennessee River through creation of reservoirs has had the greatest influence on fish populations (see Section 2.2.5 of this draft SEIS).

The staff reviewed the available information in the TVA ER, other BFN documents related to the FWPCA 316(b) permitting process, and TVA's Vital Signs Monitoring Program evaluations and other documents related to the fish community of Wheeler Reservoir. Based on the results of past impingement studies and the operating history of BFN intake structure, the staff concludes that the potential impacts of impingement of fish and shellfish are SMALL, and further mitigation measures should not be warranted. Nevertheless, the TVA will evaluate the levels of impingement by monitoring under current two-unit operation and following the return of three-unit operation at 120 percent power load, which will increase intake flow rates by approximately 11 percent over those of past three-unit operation (TVA 2003b). Modeling techniques are currently being refined, which will allow more realistic analysis of the effects of impingement and allow extrapolation of impingement losses to production foregone for forage fish. These or similar modeling techniques will be employed to analyze future impingement data from BFN to better quantify long-term, far-field effects of impingement to the reservoir fish community (TVA 2003b). TVA's Vital Signs Monitoring Program would also continue to assess aquatic communities in Wheeler Reservoir. If it is determined that increased impingement is resulting in unacceptable environmental impacts, TVA would assess technologies, operational measures, and restoration measures that could be undertaken to remedy the impacts, and institute appropriate mitigation measures in consultation with appropriate Federal and State of Alabama agencies (TVA 2003b).

4.1.4 Heat Shock

For plants with once-through cooling systems, the effects of heat shock are listed as a Category 2 issue and require plant-specific evaluation before license renewal. The staff made impacts on fish and shellfish resources resulting from heat shock a Category 2 issue because of continuing concerns about thermal-discharge effects and the possible need to modify thermal discharges in the future in response to changing environmental conditions (NRC 1996). Information to be considered includes (1) the type of cooling system (whether once-through or cooling pond) and (2) evidence of a FWPCA Section 316(a) variance or equivalent state documentation. To perform this evaluation, the staff reviewed the TVA ER and other TVA environmentally related documents, visited the BFN site, reviewed the facilities thermal variance monitoring and 316(a) studies, and reviewed the applicant's State of Alabama NPDES Permit No. AL0022080, which was issued on December 29, 2000, became effective on February 1, 2001, and will remain in force until January 31, 2006 (ADEM 2000).

BFN has a once-through heat dissipation system. Water is discharged back to the river through submerged diffusers located on the river bottom and oriented perpendicular to the river flow. The diffusers for each unit have 7800 5-cm (2-in.)-diameter ports located on the downstream-facing portion of the diffuser pipe and angled to force the heated effluent up into the water column (TVA 2003a). BFN also currently has five mechanical draft cooling towers, with a sixth to be added, which can be operated to assist in heat dissipation (helper mode) primarily during summer (July and August) hot-weather periods (TVA 2003b). BFN has been able to operate at full power in the open-cycle mode, while still meeting state water temperature standards under most river flow and temperature conditions. Under the original three-unit operation at 100 percent power levels, BFN used river water at the rate of 124.9 m^3/s (1.98 million gpm) and condenser cooling water was warmed a maximum of 13.9°C (25°F) above ambient temperature before being discharged to the river (Buchanan 1990). Under three-unit operation at a combined total power level of 11,856 MW(t), BFN would use river water at the rate of 139 m^3/s (2.20 million gpm) (an 11 percent increase). The maximum temperature increases above ambient temperature would be 15.9°C (28.7°F) under open mode for each unit's diffuser. Under helper mode, the diffuser discharge temperature would be 10.7°C (19.3°F) above ambient temperature for Unit 1 and 3.8°C (6.8°F) above ambient temperature for both Units 2 and 3 (Hopping 2004).

Based on results of a supplemental 316(a) demonstration for alternative thermal discharge limits for BFN (TVA 1983), the thermal limitations that have been in place for BFN since 1984 are a maximum 1-hour average of 33.9°C (93°F), a maximum 24-hour average of 32.2°C (90°F), and a maximum 24-hour average temperature increase of 5.6°C (10°F) over ambient conditions. This varies from the more stringent thermal criteria established in 1972 of a maximum temperature at the edge of the mixing zone of 30°C (86°F) and a maximum temperature increase of 2.8°C (5°F) (TVA 1983). These limitations are applied at the edges of a mixing zone with the following dimensions: (1) a maximum length of 730 m (2400 ft) downstream of the diffusers, (2) a maximum width of 600 m (2000 ft), and (3) a maximum length of 46 m (150 ft) upstream of the diffusers to the top of the diffuser pipes and extends to the bottom downstream of the diffusers (TVA 2003b). Annual ambient maximum temperatures in Wheeler Reservoir rarely exceed 31.7°C (89°F) in the main channel, but often exceed this temperature in the shallow areas of embayments and coves (TVA 2002). If the upstream 24-hour temperature exceeds 32.2°C (90°F), the 24-hour downstream temperature may equal, but not exceed, the upstream value. This type of operation is acceptable until the 1-hour average limit of 33.9°C (93°F) is obtained (TVA 2003b).

The BFN discharge diffusers are located such that fish would not become entrapped in areas of elevated temperatures. Acute thermal impacts to aquatic organisms (e.g., immediate death or disability) are unlikely (TVA 2003b). However, larval fish that pass through the mixing zone may be stunned by exposure to elevated temperatures, making them more susceptible to predation (TVA 1972). No heat-related fish kills have been reported for BFN. Thermal discharges related to the operation of BFN affect a relatively small area of Wheeler Reservoir. The required thermal mixing zone does not exceed a surface area of 47.3 ha (117 ac). This is less than 0.2 percent of the surface area of Wheeler Reservoir.

Maximum temperatures at the edge of the thermal mixing zone do not exceed the upper thermal limits for species such as bluegill; black and white crappie (*Pomoxis annularis* and *P. nigromaculatus* respectively); largemouth (*Micropterus salmoides*), smallmouth (*M. dolomieu*), and Florida largemouth bass (*M. s. floridanus*); channel catfish (*Ictalurus punctatus*), and golden shiner (*Notemigonus crysoleucas*) (TVA 2002). For example, the upper temperature avoided by fish acclimated to 30°C (86°F) were 35°C (95°F) for spotfin shiner (*Cyprinella spiloptera*), 35°C (95°F) for bluegill, 33°C (91.4°F) for green sunfish, 33°C (91.4°F) for smallmouth bass, 34.0°C (93.2°F) for spotted bass (*Micropterus punctulatus*), and 35°C (93.2°F) for channel catfish (Cherry et al. 1975). However, the thermal tolerance of some species such as yellow perch (*Perca flavescens*), white sucker (*Catostomus commersoni*), walleye (*Stizostedion vitreum*), sauger, and emerald shiner (*Notropis atherinoides*) could be exceeded during annual extreme water temperatures (TVA 2002). Nevertheless, species such as sauger are reported to disperse throughout the reservoir and are not found in the vicinity of the BFN during extreme ambient water temperatures (Baxter and Buchanan 1998).

Although individual fish may occasionally be found in thermal effluents at lethal temperatures, populations as a whole avoid such conditions (Talmage and Opresko 1981). The thermal preference for relatively large numbers of species common to Wheeler Reservoir (e.g., shad, bass, crappie, sunfish, freshwater drum, and some minnows) have been found to be in the range of 28 to 32°C (82.4 to 89.6°F); while some fish such as gar, carp, catfish, and minnows have been observed in thermal effluents in summer that range from 32 to 36°C (89.6 to 96.8°F) (Talmage and Opresko 1981). Young fish generally have a higher thermal preference and greater tolerance to elevated temperatures than older fish (Talmage and Opresko 1981). Therefore, although younger fish may not be as capable of avoiding the thermal plume as older fish, they may not experience thermal shock during passage through the plume.

Thermal releases from BFN have not had a significant impact on the aquatic community of Wheeler Reservoir (TVA 1983; Baxter and Buchanan 1998; Buchanan 1990; Lowery and Poppe 1992). From 1985 through 1992, a biological monitoring program was conducted to evaluate the effects of thermal discharges from BFN on phytoplankton and on total standing stocks and selected fish species in Wheeler Reservoir. Algal surveys were conducted in 1989 (during plant shutdown) and in 1991 (during plant operation). The only consistent observation was that the planktonic community varied on a daily basis regardless of location and habitat type. There was no indication that operation of BFN, even with the revised thermal limits, had influenced the phytoplankton community in Wheeler Reservoir (Lowery and Poppe 1992). Special attention was focused on sauger and yellow perch for BFN thermal variance studies because these cool water species would be more susceptible to elevated water temperatures than would most of the warmwater fish species that occur in the reservoir. Survey results indicated that BFN had no adverse impact on the reproductive success of either species nor on the movement of sauger past BFN (Baxter and Buchanan 1998). The tailwater of Guntersville Dam are the primary spawning location for sauger in Wheeler Reservoir (Buchanan 1990) and therefore, are not influenced by thermal discharges from BFN. Overfishing for sauger in Wheeler Reservoir and drought conditions (e.g., low flows and decreased turbidity) in the Tennessee Valley from 1985 through 1988 had adverse impacts on sauger spawning success (Maceina et al. 1998; Baxter and Buchanan 1998).

Currently, TVA operates cooling towers at BFN only when the water temperature of discharges approaches and presents the potential for exceeding the NPDES thermal limit. When this situation occurs, not all cooling towers are necessarily placed in service. To maximize the net generation of the plant, only those towers necessary to keep the water temperature below the thermal limits are operated. Thus, as long as derating is part of the operational strategy for maintaining the NPDES limits, there is no significant difference in the hottest average thermal discharge for any of the cooling tower options. Additionally, TVA is working towards improving its methods of predicting water temperatures in Wheeler Reservoir and optimizing the operation of the cooling system provided at BFN. Computer simulations indicate that the combination of using existing cooling towers, the addition of a new cooling tower, and derating the plant, when necessary, would allow compliance with the current NPDES permit when all three units are operating at 120 percent of original licensed thermal power (TVA 2003b). In-stream temperatures at the end of the mixing zone would remain within NPDES-permitted limits; thus, heat shock impacts would not be expected (TVA 2003b). To maintain temperatures within thermal limitation requirements, BFN would utilize its cooling towers, on average, about 5.3 percent of the time, and derating will be required approximately 0.1 percent of the time when Units 2 and 3 are operating at 120 percent power levels. When all three units are operating at 120 percent power levels, on average the cooling towers would be required about 7.2 percent of the time, and derating would occur approximately 0.29 percent of the time (TVA 2003b).

The staff reviewed the available information, including that provided by the applicant, the staff's site visit, the State of Alabama NPDES permit, the thermal variance monitoring and 316(a) studies, and other public sources. The staff evaluated the potential impacts to aquatic resources caused by heat shock during continued operation. Discharge temperatures would remain within the NPDES limits; thus, heat shock impacts are not anticipated (TVA 2003b). It is the staff's conclusion that the potential impacts to fish and shellfish due to heat shock during the license renewal term are SMALL and further mitigation measures are not warranted.

4.1.5 Microbiological Organisms (Public Health)

The effects of microbiological organisms on human health are listed as a Category 2 issue and require plant-specific evaluation before license renewal. The average annual flow of Wheeler Reservoir near the BFN site is 4.16×10^{10} m^3/yr (1.47×10^{12} ft^3/yr), which is less than the 9×10^{10} m^3/yr (3.15×10^{12} ft^3/yr) threshold value in 10 CFR 51.53(c)(3)(ii)(G) for thermal discharge to a small river. Thus, the effects of its discharge on microbiological organisms must be addressed for BFN.

The Category 2 designation is based on the magnitude of the potential public-health impacts associated with thermal enhancement of the enteric pathogens *Salmonella* spp. and *Shigella* spp., the bacterium *Pseudomonas aeruginos*, thermophilic fungi, a number of species from the Genus *Legionella* and pathogenic strains of the free-living amoebae *Naegleria* spp. and *Acanthamoeba* spp. (NRC 1999). The BFN diffuser discharge temperatures would not exceed 44.4°C (112°F) under three-unit operation at 120 percent power level. The maximum diffuser discharge temperature would be 44.61°C (112.3°F) with just Units 2 and 3 in operation at 120 percent power level (Hopping 2004). Except under rare, extreme ambient water temperatures, the discharge temperatures at the edge of the thermal discharge plume would not exceed the maximum 1-hour average of 33.9°C (93°F) or the maximum 24-hour average of 32.2°C (90°F). The annual ambient maximum temperature in Wheeler Reservoir seldom exceeds 31.7°C (89°F).

Thermophilic microorganisms can have optimum growth temperatures of 50°C (122°F) or more, a maximum temperature tolerance of up to 70°C (158°F), and a minimum tolerance of about 20°C (68°F) (Deacon 2004). However, thermal preferences and tolerances vary among the various microorganisms and environmental conditions. *Pseudomonas aeruginosa* has an optimum temperature for growth of 37°C (98.6°F) and can tolerate a temperature as high as 42°C (107.6°F) (Todar 2002). A water temperature range of 32.2 to 40.6°C (90 to 105°F) provide ideal conditions for *Legionella* spp. bacterial growth (CDC 2004). *Salmonella* spp. can thrive at temperatures between 4.4 to 60°C (40 to 140°F) (Kendall 2003), whereas *Acanthamoeba* spp. and *Naegleria* spp. were not found to colonize hot water systems of 40°C (104°F) or higher (Rohr et al. 1998).

Based on maximum temperatures at the diffusers and the edge of the permitted thermal plume, coupled with the dilution provided by Wheeler Reservoir and the short period of time for water to pass through the cooling system (i.e., 7 to 11 minutes, with 5 to 9 minutes of this spent in heated water), the thermophilic microorganisms are not expected to cause any appreciable public health risk (TVA 2003b). The Alabama Department of Public Health (Lofgren 2003) agreed that there is no significant threat to the public from thermophilic microorganisms attributable to operation of BFN (see Appendix E). Disinfection of the BFN sewage treatment plant effluent and NPDES permit requirements to monitor fecal coliforms in this effluent (ADEM 2000) further reduces the potential for the heated discharge to be a seed source or inoculant for pathogenic micro-organisms.

The staff independently reviewed the TVA ER, visited the BFN site, and reviewed the applicant's State of Alabama NPDES Permit AL0022080 (ADEM 2000). Based on its review of this information, coupled with the fact that BFN operations and cooling systems are not expected to change significantly over the license renewal term, the staff concludes that the potential impacts to public health from microbiological organisms resulting from the BFN cooling-water discharges are SMALL. Therefore, additional mitigation is not warranted.

4.2 Transmission Lines

BFN is connected into the TVA system network by seven 500-kV lines via the 500-kV switchyard. One line is to the Madison substation; two lines are to the Trinity substation; one line each is to the West Point, Maury, and Union, Mississippi substations, and one line is to the Limestone 500-kV substation (TVA 2003b). In addition, there are two 161-kV lines, one to the Athens substation and one to the Trinity substation. All lines occupy portions of four rights-of-way: one to Maury substation, one to the Trinity substation, one to the Athens substation, and one to the Union, Mississippi, substation. There are portions of transmission lines within these rights-of-way that were not constructed specifically to connect BFN to the TVA power system. However, for the sake of simplicity and a comprehensive analysis, the entire right-of-way is included in this assessment. The 260 km (160 mi) of transmission line rights-of-way cross 10 counties in Alabama and Mississippi.

Continued maintenance activities on the transmission line rights-of-way that are used to connect BFN to the electric power grid will be required if the proposed action is adopted. The TVA Transmission and Power Supply-Transmission Operations and Maintenance organization conducts maintenance activities on transmission lines and rights-of-way in the TVA system. These activities include, but are not restricted to, maintenance of vegetation in each right-of-way, replacement of poles or towers, installation of lightning arresters and counterpoise, and upgrading of existing equipment. Regular maintenance activities are conducted on a 3-to-5 year cycle (Muncy et al. 1999).

Transmission line maintenance activities are reviewed for potential resource issues by technical specialists in the TVA Regional Natural Heritage and Cultural Resources programs (Muncy et al. 1999). A 1.6-km (1.0-mi) buffer area is reviewed for the presence of terrestrial species, while a 16.1-km (10-mi) buffer area is used for aquatic species (TVA 2003b). The TVA Regional Natural Heritage program maintains a database of some 27,000-plus occurrence records for protected plants, animals, caves, National Wetland Inventory wetlands, cultural resources, and areas of management concern for the entire TVA Power Service Area. TVA also conducts fieldwork to inventory and protect threatened and endangered species and environmentally sensitive areas on public lands that it administers. Activities carried out by project staff members include monitoring species populations, educating the public, and managing and maintaining habitats (including caves) at TVA-managed sites.

Transmission line rights-of-way are regularly surveyed and video taped from helicopter. Video tapes can be used to search for sensitive habitat types before field crews are dispatched. Access routes and restrictions for maintenance activities are determined based on knowledge of the species or resources to be protected. Vehicles and equipment are restricted from the site when habitat/sensitive resources are present (Class 2 restrictions). Within Class 2 restricted areas, all vegetation clearing and herbicide applications are done by hand. Class 1 restrictions allow hand or mechanical clearing and herbicides use for vegetation control on transmission line rights-of-way. There is no broadcast application of herbicides. Herbicide application is carefully controlled, personnel are trained, licensed, and follow manufacturer's guidelines, EPA guidance, and State regulations.

The streamside management zone is maintained to slow and spread surface water flow, to trap and filter suspended particulates before they reach the stream channel, protect stream bank integrity, and protect stream water temperature.

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to transmission lines from BFN are listed in Table 4-5. The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, consultation with the U.S. Fish and Wildlife Service (FWS) and the Alabama Division of Wildlife and Freshwater Fisheries (ADWFF), and the staff's evaluation of other information, such as operation at a combined total of 11,856 MW(t). Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of those issues, the staff concluded in the GEIS that the impacts are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-5. Category 1 Issues Applicable to the Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Transmission Lines During the License Renewal Term

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

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

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

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

  The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, consultation with the FWS and ADWFF, and the staff's evaluation of other information, such as operation at a combined total of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of transmission line rights-of-way maintenance during the license renewal term beyond those discussed in the GEIS.

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

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

  The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, consultation with the FWS and ADWFF, and the staff's evaluation of other information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of bird collisions with power lines during the license renewal term beyond those discussed in the GEIS.

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

  No significant impacts of electromagnetic fields on terrestrial flora and fauna have been identified. Such effects are not expected to be a problem during the license renewal term.

  The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, consultation with the FWS and ADWFF, and the staff's evaluation of other information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of electromagnetic fields on flora and fauna during the license renewal term beyond those discussed in the GEIS.

- Flood plains and wetlands on power line right-of-way. Based on information in the GEIS, the Commission found that

  Periodic vegetation control is necessary in forested wetlands underneath power lines and can be achieved with minimal damage to the wetland. No significant impact is expected at any nuclear power plant during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, consultation with the FWS and ADWFF, and the staff's evaluation of other information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of transmission line rights-of-way on flood plains and wetlands during the license renewal term beyond those discussed in the GEIS.

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

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

The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no air-quality impacts of transmission lines during the renewal term beyond those discussed in the GEIS.

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

  Projected onsite land use changes required during ... the renewal period would be a small fraction of any nuclear power plant site and would involve land that is controlled by the applicant.

The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no onsite land-use impacts during the license renewal term beyond those discussed in the GEIS.

- Power line right-of-way. Based on information in the GEIS, the Commission found that

  Ongoing use of power line right of ways would continue with no change in restrictions. The effects of these restrictions are of small significance.

  The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of power line rights-of-way on land use during the license renewal term beyond those discussed in the GEIS.

Category 2 and uncategorized issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to transmission lines from BFN are listed in Table 4-6, and are discussed in Sections 4.2.1 and 4.2.2.

Table 4-6. Category 2 and Uncategorized Issues Applicable to the Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Transmission Lines During the Renewal Term

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

4.2.1 Electromagnetic Fields – Acute Effects

In the GEIS (NRC 1996), the staff found that without a review of the conformance of each nuclear plant transmission line with National Electrical Safety Code (NESC) (IEEE1997) criteria it was not possible to determine the significance of the electric shock potential. Evaluation of individual plant transmission lines is necessary because the issue of electric shock safety was not addressed in the licensing process for some plants. For other plants, land use in the vicinity of transmission lines may have changed, or power distribution companies may have chosen to upgrade line voltage. To comply with 10 CFR 51.53(c)(3)(ii)(H), the applicant must provide an assessment of the potential shock hazard if the transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the NESC standard of 5 mA for preventing electric shock from induced currents.

The BFN site is connected to the TVA power system via seven 500-kV lines and two 161-kV lines. A study was completed by the applicant to evaluate the transmission system against current NESC requirements (IEEE 2002). That study included evaluation of both the vertical clearance requirements and potential for shock from steady-state current due to electrostatic effects for the largest equipment under the lines that could be short-circuited to ground. Drawings for each transmission line were reviewed and wire elevations were noted for road crossings under each line. Two types of roadways that passed under the lines were evaluated. These were unpaved roadways where harvesting equipment might travel and paved roadways (city, county, State, and Federal). The reference vehicles evaluated for electric field effects included a standard trailer, a cotton harvester, and an automobile. The electric field calculations were made using Version 3.1 of ENVIRO, which is a module of the Electric Power Research Institute (EPRI) electromagnetic field workstation. Steady-state current calculations were then made using procedures outlined in the EPRI Transmission Line Reference Book. Upon review of this study completed by the utility, the staff concluded that the maximum steady-state current was less than the 2002 NESC standard of 5 mA; therefore, the assessment was adequate to meet the requirements of 10 CFR 51.53. The staff concludes that the impact of the potential shock is SMALL, and additional mitigation measures are not warranted.

4.2.2 Electromagnetic Fields – Chronic Effects

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

The potential for chronic effects from these fields continues to be studied and is not known at this time. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the U.S. Department of Energy (DOE). A NIES report (NIEHS 1999) contains the following conclusion:

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

This statement is not sufficient to cause the staff to change its position with respect to the chronic effects of electromagnetic fields. The staff considers the GEIS finding of "not applicable" still appropriate and will continue to follow developments on this issue.

4.3 Radiological Impacts of Normal Operations

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to BFN in regard to radiological impacts are listed in Table 4-7. TVA stated in its ER (TVA 2003b) that it is not aware of any new and significant information associated with renewal of the BFN operating licenses (OLs).

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

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

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the staff concluded in the GEIS that the impacts are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

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

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

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

  The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Any increases in radioactive effluents associated with plant operation at a combined total power level of 11,856 MW(t) for an additional 20 years would result in radiation doses to the public that would remain well within regulatory limits. These doses are not expected to result in health impacts to individuals or populations near the plant. Therefore, the staff concludes that there are no impacts of radiation exposures to the public during the license renewal term beyond those discussed in the GEIS.

- Occupational radiation exposures (license renewal term). Based on information in the GEIS, the Commission found that

  > Projected maximum occupational doses during the license renewal term are within the range of doses experienced during normal operations and normal maintenance outages, and would be well below regulatory limits.

  The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Additional staff will be required to operate BFN at a combined total power level of 11,856 MW(t); however, the doses to individual plant workers would remain within regulatory limits. Therefore, the staff concludes that there are no impacts of occupational radiation exposures during the license renewal term beyond those discussed in the GEIS.

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

4.4 Socioeconomic Impacts of Plant Operations During the License Renewal Term

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to socioeconomic impacts during the license renewal term are listed in Table 4-8. In its ER (TVA 2003b), TVA stated that it is not aware of any new and significant information associated with the license renewal of the BFN OLs. The staff has not identified any new and significant information during its independent review of the ER, the staff's site visit, the scoping process, or its evaluation of other information, such as operation at a combined total of 11,856 MW(t).

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

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

Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS (NRC 1996). For these issues, the staff concluded in the GEIS that the impacts are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

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

- <u>Public services – public safety, social services, and tourism and recreation</u>. Based on information in the GEIS, the Commission found that

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

  The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts on public safety, social services, and tourism and recreation during the license renewal term beyond those discussed in the GEIS.

- <u>Public services – education (license renewal term)</u>. Based on information in the GEIS, the Commission found that

  Only impacts of small significance are expected.

  The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts on education during the license renewal term beyond those discussed in the GEIS.

- <u>Aesthetic impacts (license renewal term)</u>. Based on information in the GEIS, the Commission found that

  No significant impacts are expected during the license renewal term.

  The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no aesthetic impacts during the license renewal term beyond those discussed in the GEIS.

- <u>Aesthetic impacts of transmission lines (license renewal term)</u>. Based on information in the GEIS, the Commission found that

  No significant impacts are expected during the license renewal term.

The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no aesthetic impacts of transmission lines during the license renewal term beyond those discussed in the GEIS.

Table 4-9 lists the Category 2 socioeconomic issues that require plant-specific analysis and environmental justice, which was not addressed in the GEIS. These issues are discussed in Sections 4.4.1 through 4.4.6.

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

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

(a) Guidance related to environmental justice was not in place at the time the GEIS and the associated revision to 10 CFR Part 51 were prepared. Therefore, environmental justice must be addressed in the licensee's ER and the staff's environmental impact statement.

4.4.1 Housing Impacts

Impacts on housing are considered SMALL when a small or not easily discernible change in housing availability occurs. Impacts are considered MODERATE when there is discernible but short-lived reduction in available housing units because of project-induced migration. Impacts are considered LARGE when project-related housing demands result in very limited housing availability and would increase rental rates and housing values well above normal inflation (NRC 1996).

In determining housing impacts, the applicant chose to follow Appendix C of the GEIS (NRC 1996), which presents a population characterization method that is based on two factors, "sparseness" and "proximity." Sparseness measures population density within 32 km (20 mi) of the site, and proximity measures population density and city size within 80 km (50 mi). Each factor has categories of density and size (NRC 1996, Table C.1), and a matrix is used to rank the population category as low, medium, or high (NRC 1996, Figure C.1).

In 2000, the population living within 32 km (20 mi) of BFN was estimated to be approximately 164,936 (TVA 2003b). This total converts to a population density of about 52 persons/km^2 (136 persons/mi^2) living within a 32-km (20-mi) radius of BFN. This concentration falls into the GEIS sparseness Category 4 (i.e., having greater than or equal to 46 persons/km^2 [120 persons/mi^2]).

An estimated 872,478 people live within 80 km (50 mi) of the BFN site (TVA 2003b), equating to a population density of around 43 persons/km^2 (112 persons/mi^2). In addition, the City of Huntsville, which has a population of 158,216, is located about 48 km (30 miles) to the east of the site (TVA 2003b). Applying the GEIS proximity measures (NRC 1996), BFN is classified as Category 3 (i.e., having one or more cities with 100,000 or more persons and less than 73 persons/km^2 [190 persons/mi^2] within 80 km [50 mi] of the site). According to the GEIS, these sparseness and proximity scores identify the BFN nuclear units as being located in a high-population area.

10 CFR Part 51, Subpart A, Appendix B, Table B-1, states that impacts on housing availability are expected to be of SMALL significance at plants located in a high-population area where growth-control measures are not in effect. The BFN site is located in a high-population area. There are no restrictive growth-control measures that would limit housing development in Limestone County or any of its neighboring counties (Lawrence, Lauderdale, Madison, or Morgan Counties) (TVA 2003b).

SMALL impacts result when no discernible change in housing availability occurs, changes in rental rates and housing values are similar to those occurring statewide, and no housing construction or conversion is required to meet new demand (NRC 1996). The GEIS assumes that an additional staff of 60 permanent per-unit workers might be needed during the license renewal term to perform routine maintenance and other activities.

TVA plans no refurbishment activities as part of the license renewal process; therefore, employment will not change significantly in the area as a result of the license renewal of the plant. Activities related to the replacement of a cooling tower are outside the scope of license renewal because they are related to current operations and the restart of Unit 1.

The staff reviewed the available information relative to housing impacts and TVA's conclusions. Based on this review, including interviews with local real estate agents, the staff concludes that the impact on housing during the license renewal term would be SMALL, and additional mitigation is not warranted.

4.4.2 Public Services: Public Utilities

Impacts on public utility services are considered SMALL if there is little or no change in the ability of the system to respond to the level of demand, and thus there is no need to add capita l facilities. Impacts are considered MODERATE if overtaxing of service capabilities occurs during periods of peak demand. Impacts are considered LARGE if existing levels of service (e.g., water or sewer services) are substantially degraded and additional capacity is needed to meet ongoing demands for services. The GEIS indicates that, in the absence of new and significant information to the contrary, the only impacts on public utilities that could be significant are impacts on public water supplies (NRC 1996).

Analysis of impacts on the public water supply system considered both plant demand and plant-related population growth. Section 2.2.2 describes the BFN-permitted withdrawal rate and actual use of water. TVA plans no refurbishment activities at BFN, and none of the refurbishment activities would require staffing that would exceed BFN's current level of staffing, so plant demand would not change beyond current demands (TVA 2004a).

For the sake of evaluation, the staff assumed a possible increase of 100 new jobs (including 60 employees), and an overall population increase of approximately 249 as a result of those jobs.[(a)] The plant-related population increase would require an additional 49 to 68 m^3/d (0.013 to 0.018 MGD) of water. This amount is within the total residual capacity of the water treatment plants serving BFN (Table 2-9). Thus, the staff concludes that the impact of increased water use resulting from the potential increase in employment is SMALL, and mitigation is not warranted.

4.4.3 Offsite Land Use

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

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

SMALL – Little new development and minimal changes to an area's land-use pattern

MODERATE – Considerable new development and some changes to the land-use pattern

LARGE – Large-scale new development and major changes in the land-use pattern.

The current OLs for Units 1, 2, and 3 expire in 2013, 2014, and 2016, respectively. Unit 1 is currently not operating; however, TVA projects that operation will resume in 2007 (TVA 2003b).

(a) Calculated by assuming that the average number of persons per household is 2.49 in the state of Alabama (100 jobs x 2.49 = 249) (USCB 2000).

When Unit 1 resumes operation, the total permanent employment at the BFN site is expected to increase by 150 workers (TVA 2003b). TVA determined that no additional plant workers will be required during the license renewal term (TVA 2003b). Section 3.7.5 of the GEIS states that if plant-related population growth is less than 5 percent of the study area's total population, offsite land use changes would be small, especially if the study area has established patterns of residential and commercial development, a population density of at least 23 persons/km^2 (60 persons/mi^2), and at least one urban area with a population of 100,000 or more within 80 km (50 mi). For BFN, there is no expected population growth as a result of renewal of the three OLs. Consequently, the staff concludes that population changes resulting from license renewal are likely to result in minimal change to the land-use pattern in the area.

Tax revenue can affect land use because it enables local jurisdictions to be able to provide the public services (e.g., transportation and utilities) necessary to support development. Section 4.7.4.1 of the GEIS states that the assessment of tax-driven, land-use impacts during the license renewal term should consider (1) the size of the plant's payments relative to the community's total revenues, (2) the nature of the community's existing land-use pattern, and (3) the extent to which the community already has public services in place to support and guide development. If the plant's tax payments are projected to be small relative to the community's total revenue, tax-driven land-use changes during the plant's license renewal term would be small, especially where the community has pre-established patterns of development and has provided adequate public services to support and guide development. Section 4.7.2.1 of the GEIS states that if tax payments by the plant owner are less than 10 percent of the taxing jurisdiction's revenue, the significance level would be small. If the plant's tax payments are projected to be medium to large (10 to 20 percent) relative to the community's total revenue, new tax-driven, land-use changes would be moderate. This is most likely to be true where the community has no pre-established patterns of development (i.e., land-use plans or controls) or has not provided adequate public services to support and guide development in the past, especially infrastructure that would allow industrial development. If the plant's tax payments are projected to be a dominant source of the community's total revenue, new tax-driven, land-use changes would be large. This would be especially true where the community has no pre-established pattern of development or has not provided adequate public services to support and guide development in the past.

TVA makes tax-equivalent payments to the State of Alabama and local governments in eight states. These payments are redistributed to the counties that are served by TVA power. See Section 2.2.8 for a discussion on the distribution of tax-equivalent payments to affected counties. A certain amount of this revenue is used for development and infrastructure within the community. It is not expected that this percentage will vary significantly in the future (TVA 2003b). Consequently, the staff concludes that tax-driven land-use impacts resulting from license renewal are likely to be minimal. Overall, changes in land use associated with population and tax revenue changes resulting from license renewal are likely to be SMALL.

4.4.4 Public Services: Transportation

On October 4, 1999, 10 CFR 51.53(c)(3)(ii)(J) and 10 CFR Part 51, Subpart A, Appendix B, Table B-1, were revised to state that "Public Services: Transportation Impacts During Operations" is a Category 2 issue (see NRC 1999 for more discussion of this clarification). The issue is treated as such in this SEIS.

As noted in Section 2.2.8.2., BFN is located approximately 16 km (10 mi) southwest of Athens in Limestone County and is located just south of U.S. Highway 72. The site is directly accessible from County Road 25. One portion of County Road 25 (Shaw Road) serves as a primary north-south corridor in the vicinity of the plant and intersects U.S. Highway 31 approximately 14.4 km (9 mi) east of the site. Browns Ferry Road, which intersects County Road 25 just east of the site, runs northeast from BFN and provides a direct route to BFN from Athens. The latest available 1998 average daily traffic counts in proximity to BFN indicate approximately 13,440 vehicles per day on U.S. Highway 72 north of the site and 16,260 vehicles per day on U.S. Highway 31 south of U.S. Highway 72. There are no available traffic counts on the county roads; however, TVA estimates approximately 1600 vehicles per day on Shaw Road, Browns Ferry Road, and Nuclear Plant Road. BFN is currently a primary source of traffic on these county roads (TVA 2003b).

The bounding scenario of 60 additional license renewal staff plus an additional 150 staff for expanded ongoing operation of the plant represents approximately one to two percent of the traffic volume on U.S. Highways 72 and 31. If it is assumed that traffic is split equally in three directions on Shaw Road, Nuclear Plant Road, and Browns Ferry Road, the average daily traffic on these county roads would increase to approximately 1810 (assuming no carpooling), which represents a 13 percent increase in average daily traffic.

To alleviate peak congestion and degradation of county roads in the vicinity of BFN, TVA identified specific site mitigation measures to improve the local roadway during peak periods. These mitigation measures include flexible working hours to reduce peak hours, delayed shift changes, restrictions for trucks traveling during peak hours, roadway improvements, which would include lane widening, realignment and lane addition, and repaving (TVA 2003b).

The staff reviewed the available information, including that provided by TVA, the staff's site visit, the scoping process, discussions with other agencies, and other public sources. Using this information, the staff evaluated the potential impacts to transportation service resulting from operation of BFN. It is the staff's conclusion that the potential impacts to transportation service degradation during the license renewal term are SMALL, considering that no additional staff are expected for renewal refurbishment activities. During the course of preparing this draft SEIS, the staff considered mitigation measures for the continued operation of BFN. When continued operation for an additional 20 years is considered as a whole, all the specific effects on the environment (whether or not "significant") were considered. Based on this assessment, the staff expects that the measures identified by BFN provide mitigation for all impacts related to transportation, and no new mitigation measures are warranted.

4.4.5 Historic and Archaeological Resources

The National Historic Preservation Act of 1966 (NHPA), as amended, requires Federal agencies to take into account the effects of their undertakings on historic properties. The historic preservation review process mandated by Section 106 of NHPA is outlined in regulations issued by the Advisory Council on Historic Preservation at 36 CFR Part 800. License renewal of an OL could potentially affect historic properties that may be located at the site. Therefore, in accordance with NHPA, NRC must make a reasonable effort to identify historic properties in the areas of potential effects. If no historic properties are present or affected, NRC is required to notify the State Historic Preservation Officer (SHPO) before proceeding. If it is determined that historic properties are present, NRC is required to assess and resolve possible adverse effects of the undertaking.

In 1972, TVA consulted with the Alabama Historical Commission for the construction of BFN as required by NHPA. In a letter dated March 16, 1972, the Alabama Historical Commission concluded that in the area of BFN nothing was found that would be adversely affected by the addition of the plant (AHC 1972). The original construction of the plant required the relocation of the Cox Cemetery. It was the opinion of the SHPO that the relocation of the cemetery occurred with considerable care.

In 2002, TVA prepared an SEIS for renewal of the BFN OLs (TVA 2002). In addition to the EIS, TVA consulted with the Alabama SHPO regarding renewal of the BFN OLs. On April 24, 2002, the Alabama SHPO concurred with TVA that the project activities associated with license renewal at BFN will have no effect on significant cultural resources provided that site 1Li535 and the Cox Cemetery are avoided (SHPO 2002).

The NRC sent a letter to the Alabama SHPO, dated March 8, 2004 (NRC 2004b), and stated that in accordance with 36 CFR 800.8, the SEIS will include analyses of potential impacts to historic and archaeological resources. In the context of the NHPA, the NRC staff determined that the area of potential effect for license renewal action is the area at the power plant site and its immediate environs, which may be impacted by post-license renewal land-disturbing operation or by projected refurbishment activities associated with the proposed action.

Seventeen Native American Tribes were sent letters on March 23, 2004, providing them with an opportunity to provide input regarding cultural resource issues in the vicinity of BFN and inviting them to participate in the National Environmental Policy Act (NEPA) process. Several Federal and State agencies were contacted to identify tribes that may have a potential interest in the lands at BFN including the Alabama SHPO, the Advisory Council on Historic Preservation, the Bureau of Indian Affairs, the Alabama Department of Transportation, and the U.S. Forest

Service. The Tribes contacted were the Poarch Creek Indians, Miccosukee Indian Tribe, Seminole Indian Tribe, Coushatta Indian Tribe, Jena Band of Choctaw Indians, Mississippi Band of Choctaw Indians, Eastern Band of Cherokee Indians, Alabama-Coushatta Tribe of Texas, Alabama-Quassarte Tribal Town, Cherokee Nation of Oklahoma, Chickasaw Nation, Choctaw Nation of Oklahoma, Kialegee Tribal Town, Muscogee (Creek) Nation, Seminole Nation of Oklahoma, Thlopthlocco Tribal Town, and United Keetoowah Band of Cherokee Indians. An example of one of the letters sent to the Tribes is included in Appendix E.

Operation of BFN, as planned under the application for license renewal, would protect undiscovered historic or archaeological resources on the site because the undeveloped natural landscape and vegetation would remain undisturbed, and access to the site would remain restricted.

TVA operating procedures take into account the inadvertent discovery of historic and archaeological remains at BFN. However, care should be taken during normal operational and maintenance conditions to ensure that historic resources are not inadvertently impacted. These activities may include not only operation of BFN itself but also land management-related actions such as recreation, wildlife habitat enhancement, and maintaining/upgrading BFN access roads through the site and on transmission line rights-of-way.

TVA recently conducted a study to determine if changes in the operating policies for TVA's reservoirs would produce greater overall public value. TVA prepared a programmatic EIS for the Reservoirs Operation Study (TVA 2004b). Consultations with seven SHPOs, including the Alabama Historical Commission, and other consulting parties under the requirements of Section 106 of NHPA, have resulted in agreement(s) stipulating the actions TVA will take to avoid or reduce the adverse effects of the selected alternative on historic properties. The factors that were analyzed by TVA include shoreline erosion, exposure by elevation fluctuations, land development, and visual impacts. The agreement(s) developed can be found in the programmatic EIS for the Reservoirs Operation Study (TVA 2004b).

Based on the staff's archaeological and historic resources analysis and the consultation that has occurred, on TVA commitment that 1Li535 and the Cox Cemetery will be avoided, and the fact that operation will continue within the bounds of station operations as evaluated in the final EIS (TVA 1972), the staff concludes that the potential impacts on historic and archaeological resources are expected to be SMALL, and mitigation is not warranted.

4.4.6 Environmental Justice

Environmental justice refers to a Federal policy that requires Federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its actions on minority[(a)] or low-income populations. The memorandum accompanying Executive Order 12898 (59 FR 7629) directs Federal executive branch agencies to consider environmental justice under NEPA. The Commission's "Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions" contains guidance and information for addressing environmental justice (69 FR 52040). Although the Executive Order is not mandatory for independent agencies, NRC has voluntarily committed to undertake environmental justice reviews. Specific guidance is provided in NRC Office of Nuclear Reactor Regulation Office Instruction LIC-203, Rev. 1 "Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues" (NRC 2004a).

The staff examined the geographic distribution of minority and low-income populations within 80 km (50 mi) of the BFN site, employing the 2000 census (USCB 2000) for low-income populations and minority populations. The populations within an 80-km (50-mi) radius of BFN encompassed all or parts of 19 counties. The staff supplemented its analysis through the scoping process and by field inquiries to county planning departments, social service agencies, and local real estate agents.

For purposes of the staff's review, a minority population is defined to exist if the percentage of each minority, or aggregated minority category within the census tract or block group[(b)] potentially affected by the license renewal of BFN, exceeds the corresponding percentage of minorities in the entire state by 20 percent, or if the corresponding percentage of minorities within the census tract or block group is at least 50 percent. A low-income population is defined to exist if the percentage of low-income population within a census tract or block group exceeds the corresponding percentage of low-income population in the entire state by 20 percent, or if the corresponding percentage of low-income population within a census tract or block group is at least 50 percent. The minority population in the State of Alabama makes up 30 percent of the population and the low-income population makes up 16 percent of the total population in the state. The minority population in the State of Tennessee makes up 20 percent of the population and the low-income population makes up 14 percent of the total population in the state.

TVA used 2000 census data for identifying minority and low-income populations within 80 km (50 mi) of the BFN site. TVA also followed the convention of employing census tracts within the

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(a) The NRC Guidance for performing environmental justice reviews defines "minority" as American Indian or Alaskan Native, Asian or Pacific Islander, Black not of Hispanic Origin, or Hispanic (NRC 2004a).

(b) A census block group is a combination of census blocks, which are statistical subdivisions of a census tract. A census block is the smallest geographic entity for which the U.S. Census Bureau (USCB) collects and tabulates decennial census information. A census tract is a small, relatively permanent statistical subdivision of counties delineated by local committees of census data users in accordance with USCB guidelines for the purpose of collecting and presenting decennial census data. Census block groups are subsets of census tracts (USCB 2001).

80-km (50-mi) radius of BFN (TVA 2003b), and staff confirmed these results by examining the minority and low-income populations by census block group within the 80-km (50-mi) radius of the site. If the census tract or block group minority or low-income percentage exceeded the state by 20 percent then the census tract or block group was counted (TVA 2003b). Using this convention, the 80-km (50-mi) radius includes 74 census block groups for minority populations and 27 census block groups for low-income populations. Figure 4-1 shows the distribution of minority populations within the 80-km (50-mi) radius. The shaded areas in Figure 4-1 indicate census block groups where the aggregate percentage of minorities is at least 20 percentage points above the percentage of minorities in the States of Alabama and Tennessee or greater than 50 percent.

Minority population concentrations are present in eight counties within the 80-km (50-mi) radius of the BFN site. Minority populations are primarily concentrated in the urban center of Huntsville. Madison County contains 43 of the 74 block groups containing significant minority populations. The next greatest concentration of minority populations lives in Colbert and Morgan counties, which each have six block groups with significant minority populations. Lauderdale and Lawrence, Alabama each have five minority block groups. Limestone County, where BFN is located, has four minority block groups. The minority block groups in Morgan County are predominantly composed of black/African-American concentrations and are within the 16-km (10-mi) radius evacuation zone of BFN (USCB 2000; CDD 2004).

Data from the 2000 census characterize low-income populations within the 80-km (50-mi) radius of the BFN site (USCB 2000). Applying the NRC criterion of "more than 20 percent greater" than the state average or "greater than 50 percent," the census block groups containing low-income populations were identified. Figure 4-2 shows the locations of the low-income populations within 80 km (50 mi) of the BFN site. The lower income populations are concentrated around the urban center of Huntsville, where 11 of the 27 low-income block groups are found. Lauderdale County has seven additional low-income block groups, while Colbert County has four block groups. Franklin, Morgan, and Winston counties in Alabama, and Lawrence and Lincoln counties in Tennessee only have 1 low-income block group each.

With the locations of minority and low-income populations identified, the staff proceeded to evaluate whether any of the environmental impacts of the proposed action could affect these populations in a disproportionately high and adverse manner. Based on staff guidance (NRC 2004a), air, land, and water resources within about 80 km (50 mi) of the BFN site were examined. Within that area, a few potential environmental impacts could affect human populations; all of these impacts were considered minimal for the general population.

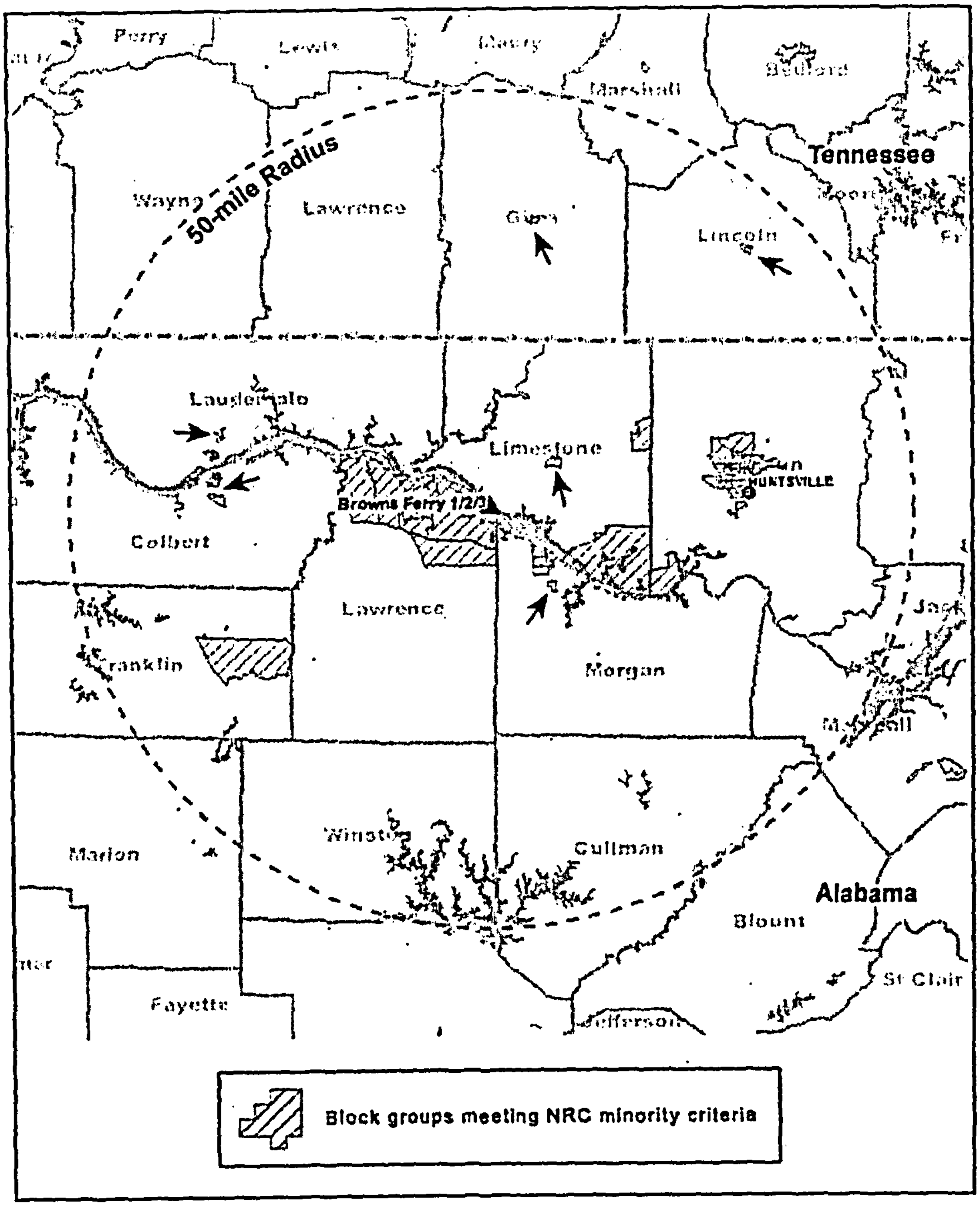

Figure 4-1. Geographic Distribution of Minority Populations (shaded areas) Within 80 km (50 mi) of Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Based on 2000 Census Block Group Data

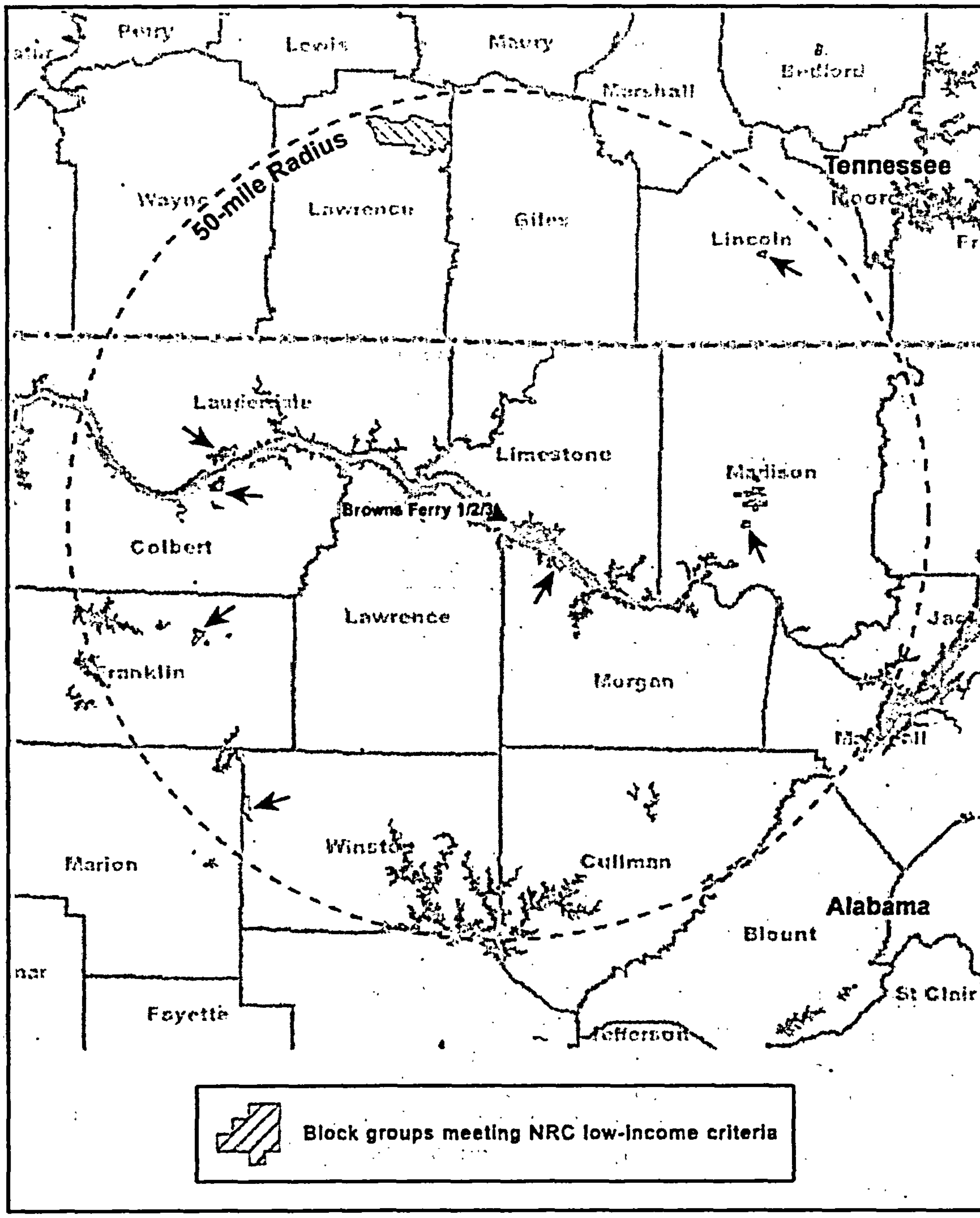

Figure 4-2. Geographic Distribution of Low-Income Populations (shaded areas) Within 80 km (50 mi) of Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Based on 2000 Census Block Group Data

The environmental impacts associated with BFN license renewal that could affect human populations are discussed in each associated section. The staff found no unusual resource dependencies or practices such as subsistence agriculture, hunting, or fishing through which minority and/or low-income populations could be disproportionately highly and adversely affected. In addition, the staff did not identify any location-dependent disproportionately high and adverse impacts affecting these minority and low-income populations. The staff concludes that offsite impacts from BFN to minority and low-income populations are SMALL, and no special mitigation actions are warranted.

4.5 Groundwater Use and Quality

The Category 1 issues related to groundwater use conflicts during the license renewal term that are applicable to BFN are discussed in the section that follows, and are listed in Table 4-10.

Table 4-10. Category 1 Issues Applicable to Groundwater Use Conflicts of Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 During the License Renewal Term

ISSUE 10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
(FOR POTABLE AND SERVICE WATER PLANTS USING < 100 GPM)	
Groundwater use conflicts (potable and service water plants that use <100 gpm)	4.8.1.1

- Groundwater use conflicts (potable and service water plants using < 100 gpm). Based on information in the GEIS, the Commission found that

> Groundwater use conflicts related to potable and service water plants using <100 gpm have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

BFN does not withdraw groundwater for potable or service water use. The staff has not identified any new and significant information during its independent review of the TVA ER, the scoping process, the staff's site visit, and the staff's evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of groundwater use conflicts related to potable and service water plants using less than 100 gpm during the license renewal term beyond those discussed in the GEIS.

The Category 2 issues related to groundwater-use conflicts during the license renewal term that are applicable to BFN are listed in Table 4-11 and are discussed in Section 4.5.1.

Table 4-11. Category 2 Issue Applicable to Groundwater Use Conflicts of Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 During the License Renewal Term

ISSUE 10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
AQUATIC ECOLOGY			
(FOR PLANTS WITH COOLING TOWERS WITHDRAWING MAKEUP WATER FROM A SMALL RIVER)			
Groundwater use conflicts (plants using cooling towers and withdrawing makeup water from a small river)	4.8.1.3	B	4.5.1

4.5.1 Groundwater Use Conflicts (plants using cooling towers and withdrawing make-up water from a small river)

For plants using make-up water from a small river, potential use conflicts is a Category 2 issue, which requires a site-specific assessment prior to license renewal. The Tennessee River average annual flow at BFN for the period from 1976 through 2002 was 1320 m^3/s (46,606 ft^3/s) or 4.16×10^{10} m^3/yr (1.47×10^{12} ft^3/yr). This is less than the 9×10^{10} m^3/yr (3.15×10^{12} ft^3/yr) criterion stated by NRC in 10 CFR 51.53(c)(3)(ii)(A) as the value beneath which an assessment of the impact of the proposed action must be provided.

NRC has determined that indirect groundwater-use conflict can result from surface water withdrawal from a small river (NRC 1996). It is a potentially important concern that has been designated a Category 2 issue. Rivers often supply alluvial aquifers, and large-scale withdrawals of make-up water for evaporative loss could impact an alluvial aquifer during periods of low flow.

BFN uses cooling towers and withdraws make-up water from the Tennessee River; however, there are no existing or proposed offsite or onsite groundwater supply wells. Rights to "use" of groundwater at BFN were acquired by ownership of property overlying aquifers. There are no future water rights to groundwater underlying BFN (including Native American tribal rights).

Although shallow groundwater at BFN can occur within unconsolidated terrace deposits of alluvial origin, the terrace deposits are not recognized as an aquifer at the site. This is primarily due to the limited permeability and spatial extent of the terrace deposits. Therefore, groundwater-use conflicts associated with surface water withdrawals are small and may only occur during low flow conditions, which may affect aquifer recharge.

A total of 18 environmental monitoring wells have been installed at the BFN site since 1980, and groundwater level measurements were monitored on a monthly basis through 1989. The water levels in those wells have fluctuated throughout the year; however, there is no decreasing trend (Julian 2004). This indicates that site surface water consumption had not indirectly lowered groundwater levels or created conflicts through 1989.

The water levels in Wheeler Reservoir throughout 2003, and for the period from 1991 to 1997, were both consistent with the period from 1972 to 1990 (Julian 2004). This indicates that reservoir levels have had consistent annual profiles since routine site groundwater monitoring ceased in 1989. Furthermore, because the lake levels have not dropped since 1991, site surface water consumption has not indirectly lowered groundwater levels or created groundwater conflicts since site monitoring ceased in 1989.

An offsite well survey was conducted in May 1995 to identify groundwater supplies within a 3.2-km (2-mi) radius of the BFN site (TVA 1999). The closest known public groundwater supply (Limestone County Water System, Well G-1) resides approximately 3.2 km (2 mi) north of BFN (Bohac 2004). There is no groundwater use by BFN, and site dewatering wells have been inactive since the 1980s. All wells at the site are used for environmental monitoring purposes only.

The staff independently reviewed the TVA ER (TVA 2003b) and visited the site. Also, the potential for water-use conflicts was reviewed directly with respect to surface water withdrawals in Section 4.1.1 and was found to be SMALL. Because no groundwater is used at the plant, and the terrace deposits are characterized by limited permeability, the indirect use of groundwater by surface water withdrawal is even more remote. Surface water withdrawals for cooling system make-up water is not expected to affect groundwater levels. Therefore, the staff concludes that groundwater use conflicts would be SMALL.

4.6 Threatened or Endangered Species

Threatened or endangered species are listed as a Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue is listed in Table 4-12.

Table 4-12. Category 2 Issue Applicable to Threatened or Endangered Species in the Vicinity of Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 During the License Renewal Term

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

This issue requires consultation with appropriate agencies to determine whether threatened or endangered species are present and whether they would be adversely affected by continued operation of the nuclear plant during the license renewal term. The presence of threatened or endangered species in the vicinity of the BFN site is discussed in Sections 2.2.5 and 2.2.6. On March 4, 2004, the staff contacted the FWS to request information on threatened and endangered species and the impacts of license renewal (NRC 2004c). In response, on May 19, 2004, the FWS provided additional information regarding Federally listed species that have been observed or may occur in the vicinity of the BFN site and its associated transmission lines, as well as the concerns that the FWS have regarding those species (Goldman 2004). On October 25, 2004 the staff sent (NRC 2004d) a biological assessment (BA) (see Appendix E) to the FWS for concurrence.

4.6.1 Aquatic Species

As described in Section 2.2.5, there are 38 Federally listed aquatic species (including three candidate species) that occur in either Wheeler Reservoir or its tributaries or in other streams, rivers, or caves within the counties of Alabama and Mississippi through which the BFN transmission lines pass. The species that occur in Wheeler Reservoir and its tributaries are not impacted by plant operations. During BFN's thermal variance monitoring (1985 to 1998) and current Vital Signs Monitoring Programs, no threatened or endangered aquatic species were found within the area that would be affected by operational changes at BFN (TVA 2003b). Additionally, cooling water intake and discharge are closely monitored under the NPDES program, and permit limits are reviewed on a regular basis by State regulatory agencies to ensure the protection of aquatic biota.

A number of listed species occur in the counties crossed by the BFN transmission lines; however, this does not imply that they occur under or near the transmission lines. The TVA Regional Natural Heritage Program keeps track of Federally and State-protected species. Aquatic animal occurrence records are maintained and updated by TVA staff on a regular basis. Each sensitive area review project is reviewed for the known or likely occurrence of protected aquatic species in streams in or adjacent to the transmission line rights-of-way. A 16-km (10-mi) buffer area around the transmission line being reviewed is examined to determine the likely occurrence of protected aquatic animals. Once an occurrence is located, appropriate class restrictions are applied. Furthermore, best management practices, outlined by Muncy et al. (1999), are employed to protect listed species and their habitats while carrying out vegetation management activities along the transmission lines (TVA 2003b).

The staff concluded in its BA (NRC 2004d) that continued operation of BFN, including return to three-unit operation at a total combined power level of 11,856 MW(t) and the associated transmission line rights-of-way maintenance activities during the license renewal term, will have no effect, or is not likely to adversely affect any Federally listed aquatic species, nor will it adversely impact any designated critical habitat. Thus, the staff concludes that the impact on threatened or endangered aquatic species from an additional 20 years of operation would be SMALL, and additional mitigation is not warranted.

4.6.2 Terrestrial Species

No Federally listed species are known to occur within 5 km (3 mi) of the BFN site (TVA 2003b). Although no Federally or State-listed species have been reported from areas within 5 km (3 mi) of BFN, a total of 11 Federally listed species have been identified from counties traversed by transmission line rights-of-way along with over 200 State-listed species. Federally listed species reported to occur from Limestone, Morgan, Lawrence, Colbert, and Franklin counties in Alabama and Tishomingo, Itawamba, Lee, and Union Counties in Mississippi are the bald eagle, red-cockaded woodpecker, gray bat, Indiana bat, Price's potato-bean, American hart's tongue fern, leafy prairie clover, Eggert's sunflower, fleshy-fruited gladecress, lyrate bladder-pod, and the Tennessee yellow-eyed grass.

Habitat for some of the Federally listed species and some of the State-listed species could potentially be found within or traversed by BFN transmission line rights-of-way. Two wildlife management areas occur within 5 km (3 mi) of the BFN site – Swan Creek State Wildlife Management Area and Mallard-Fox Creek State Wildlife Management Area (TVA 2003b). Approximately 5.6 km (3.5 mi) upstream of BFN is the Round Island Recreation Area. The BFN-to-Maury, Alabama, transmission line right-of-way cross the Duck River State Wildlife Management Area, the Duck River Unit 1 Proposed Designated Critical Habitat, and Elk River and Richland Creek, both of which are listed on the Nationwide Rivers Inventory. The BFN-to-Union, Mississippi, transmission line right-of-way cross the John Bell Williams State Wildlife Management Area, the Natchez Trace National Parkway, the Tennessee-Tombigbee Waterway, and the Foxtrap Creek Ravine Potential National Natural Landmark.

TVA monitors and tracks populations of Federally and State-sensitive terrestrial species on the BFN site and within transmission line rights-of-way. In addition, TVA works with their contract personnel and appropriate Federal and State agencies to develop and implement restrictions and safeguards to protect threatened and endangered species and their habitats during maintenance of transmission line rights-of-way (Muncy et al. 1999).

The staff concluded in its BA (NRC 2004d) that continued operation of BFN, including return to three-unit operation at a total combined power level of 11,856 MW(t) and the associated transmission line rights-of-way maintenance activities during the license renewal term, will have no effect, or is not likely to adversely affect any Federally listed terrestrial species, nor will it adversely impact any designated critical habitat. Thus, the staff concludes that the impact on threatened or endangered terrestrial species from an additional 20 years of operation would be SMALL, and additional mitigation is not warranted.

4.7 Evaluation of Potential New and Significant Information on Impacts of Operations During the License Renewal Term

The GEIS assesses 92 environmental issues. Sixty-nine of these issues were found to be Category 1 issues, and are identified in 10 CFR Part 51 as not requiring additional plant-specific analysis in the absence of new and significant information. The staff reviewed the list and consulted with the appropriate Federal, State, and local agencies to identify any compliance or permit issues or significant environmental issues of concern to the reviewing agencies. These agencies did not identify any new and significant environmental issues. The ER states that TVA is in compliance with applicable environmental standards and requirements for BFN. The staff has not identified any environmental issues that are both new and significant.

The staff identified one potential issue that required further analysis. Category 1 issues were established by the GEIS after a review of data from existing operating nuclear plants. The analysis established an envelope of impact for each of the Category 1 issues that were based on the impacts that were identified at nuclear power plants throughout the United States at the time the GEIS was prepared. TVA has applied for extended power uprate (EPU) for the three BFN units. These EPUs would eventually increase thermal power levels from the initially licensed levels of 3293 MW(t)/unit to 3952 MW(t)/unit. This represents a total power increase of 20 percent. Once the uprate has been achieved, BFN will have a combined total power level of 11,856 MW(t), and will become the largest nuclear power plant in the United States.

For this reason, the staff determined that there is a potential that, at the uprated power level, BFN may no longer be within the envelope of impacts defined by the GEIS, as amended, for some Category 1 issues. If the potential impacts are beyond the defined envelope, the generic conclusions concerning these Category 1 issues may no longer be valid, and the power uprate could therefore represent new and significant information regarding some of the Category 1 issues. Category 2 issues are not a concern in this regard because all applicable Category 2 issues are evaluated on a site-specific basis for each facility undergoing license renewal.

To address this concern, the staff examined each of the 54 Category 1 issues applicable to BFN and determined that 34 of the Category 1 issues could be influenced by the station thermal power level. The staff then evaluated each of the 34 issues to determine if increasing the unit power level above the levels considered during the development of the GEIS would affect the specific generic conclusions. After evaluating all 34 issues the staff determined that the generic conclusions reached in the GEIS are still valid and that no additional analysis or evaluation of these issues is necessary. The 34 issues evaluated are listed in Tables 4-13 through 4-17. An explanation of why the GEIS conclusion is still valid for the uprated BFN site is provided following each table.

Table 4-13. Cooling System-Related Category 1 Issues that are Potentially Affected by Proposed Extended Power Uprates at Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

ISSUE 10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
SURFACE WATER QUALITY, HYDROLOGY, AND USE (for all plants)	
Altered current patterns at intake and discharge structures	4.2.1.2.1; 4.3.2.2; 4.4.2
Altered thermal stratification of lakes	4.2.1.2.3; 4.4.4.2

Table 4-13. (contd)

ISSUE 10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
Temperature effects on sediment transport capacity	4.2.1.2.3; 4.4.2.2
Scouring caused by discharged cooling water	4.2.1.2.3; 4.4.2.2
Eutrophication	4.2.1.2.3; 4.4.2.2
Discharge of chlorine or other biocides	4.2.1.2.4; 4.4.2.2
Discharge of other metals in wastewater	4.2.1.2.4; 4.3.2.2; 4.4.2.2
Water use conflicts (plants with once-through cooling systems)	4.2.1.3
AQUATIC ECOLOGY (for all plants)	
Accumulation of contaminants in sediments or biota	4.2.1.2.4; 4.3.3; 4.4.3; 4.4.2.2
Entrainment of phytoplankton and zooplankton	4.2.2.1.1; 4.3.3; 4.4.3
Cold shock	4.2.2.1.5; 4.3.3; 4.4.3
Thermal plume barrier to migrating fish	4.2.2.1.6; 4.4.3
Distribution of aquatic organisms	4.2.2.1.6; 4.4.3
Low dissolved oxygen in the discharge	4.2.2.1.9; 4.3.3; 4.4.3

Table 4-13. (contd)

Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	4.2.2.1.10; 4.4.3
Stimulation of nuisance organisms	4.2.2.1.11;4.4.3
Premature emergence of aquatic insects	4.2.2.1.7; 4.4.3
TERRESTRIAL RESOURCES	
Cooling tower impacts on crops and ornamental vegetation	4.3.4
Cooling tower impacts on native plants	4.3.5.1

Table 4-13. (Contd)

SURFACE WATER QUALITY, HYDROLOGY, AND USE (FOR ALL PLANTS)	
HUMAN HEALTH	
Microbiological organisms (occupational health)	4.3.6
Noise	4.3.7

Altered current patterns at intake and discharge structures

Any localized effects on current patterns would have been manifest during the initial stages of three-unit operation and would have been mitigated, if necessary, at that time. Three-unit operation at BFN, at the combined total power level of 11,856 WM (t) expected during the license renewal term, uses existing intake and discharge structures and "no changes are expected to the individual unit flow rates as a result of EPU" (TVA 2002). Total intake flow is expected to be a maximum of 139 m^3/s (4907 cfs) or 12 million m^3/d (3171 MGD) (TVA 2003b). The staff concludes that the cooling system operation on current patterns is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Altered thermal stratification of lakes

TVA has modeled temperature stratification in Wheeler Reservoir with near- and far-field modeling. Three-unit operation at BFN, at the combined total power level of 11,856 MW (t) expected during the license renewal term, will increase the water discharge temperature and resulting thermal stratification; however, it will not exceed temperature limits set by the NPDES permit (Hopping 2004). The licensee will be required to operate within the limits of the NPDES permit during the license renewal term. The limits impose the most severe restrictions in the late summer when thermal stratification is most pronounced at the reservoir. The staff concludes that the effect of the cooling system operation on altered thermal stratification is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Temperature effects on sediment transport capacity

Three-unit operation at BFN, at the combined total power level of 11,856 MW(t) expected during the license renewal term, will increase the water discharge temperature and theoretically could decrease viscosity and change the sediment transport capacity within the Tennessee River. The difference in the discharge temperature is not significant relative to changing the viscosity of the water, and the area of the reservoir affected by elevated temperature is small. This would not result in a detectable change in sediment transport capacity. The staff concludes that the effect of the cooling system operation on temperature effects on sediment transport capacity is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Scouring caused by discharged cooling water

Three-unit operation at BFN, even at the combined total power level of 11,856 MW(t) expected during the license renewal term, uses existing intake and discharge structures and "no changes are expected to the individual unit flow rates as a result of EPU" (TVA 2002). Total intake flow is expected to be a maximum of 139 m^3/s (4907 cfs) or 12 million m^3/d (3171 MGD) (TVA 2003b). The staff concludes that the effect of the cooling system operation on scouring is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Eutrophication

Three-unit operation at BFN, at the combined total power level of 11,856 MW(t) expected during the license renewal term, will increase water discharge temperature, but all discharges will continue to be within the thermal limits established in the NPDES permit. The licensee will be required to operate within the limits of the NPDES permit during the license renewal term. The limits impose the most severe restrictions in the late summer when thermal stratification is most pronounced in the reservoir. The staff concludes that the effect of the cooling system operation on eutrophication is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Discharge of chlorine or other biocides

BFN uses some biocides in parts of the service water system, but currently does not use chlorine or other biocides in the cooling water system. Therefore, resumption of three-unit operation at BFN, even at the 120 percent EPU expected during the license renewal term, is not likely to alter the quantity of biocides released from the station. Based on the need to stay within NPDES limits, no additional mitigation measures to reduce the discharge of biocides are necessary during the license renewal term. The effect of the cooling system operation on discharge of biocides is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Discharge of other metals in waste water

Three-unit operation at BFN at the combined total power level of 11,856 MW(t) expected during the license renewal uses existing intake and discharge structures and "no changes are expected to the individual unit flow rates as a result of EPU" (TVA 2002). Total intake flow is expected to be a maximum of 139 m^3/s (4907 cfs) or 12 million m^3/d (3171 MGD) (TVA 2003b). Discharges of heavy metals are controlled under the NPDES permitting system administered by the State of Alabama. The current NPDES permit restricts the discharge of heavy metals. Furthermore, the main condensers of all three units will be re-tubed with stainless steel prior to the license renewal term. The staff concludes that the effect of the cooling system operation on discharge of metals in waste water is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Water-use conflicts (plants with once-through cooling systems)

Three-unit operation at BFN, at the combined total power level of 11,856 MW(t) expected during the license renewal term, uses existing intake and discharge structures and "no changes are expected to the individual unit flow rates as a result of EPU" (TVA 2002). Consumptive and off-stream water uses have not resulted in significant water-use conflicts because of the large volume of the Wheeler Reservoir water available, the high river flow rate, and the return of most of the water withdrawn (TVA 2003b). Regulatory control of withdrawal rates and NPDES permit limits for return water quality also mitigate potential conflicts. The staff concludes that the effect of water-use conflicts is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Accumulation of contaminants in sediments or biota

The three-unit operation at BFN, at the combined total power level of 11,856 WM(t) expected during the license renewal term, uses existing intake and discharge structures and "no changes are expected to the individual unit flow rates as a result of EPU" (TVA 2002). The condensers at BFN are being re-tubed with stainless steel tubing (TVA 2003b). Therefore, accumulation of contaminants associated with the condenser tubes in sediment or biota would not be expected to be a concern during the license renewal term. Furthermore, compliance with the NPDES permit, other provisions of the FWPCA (e.g., Sections 316(a) and 316(b), 401, and 404), and other regulatory requirements are expected to adequately control potential chemical effluent effects (TVA 2003b). The staff concludes that the effect of the accumulation of contaminants in sediments or biota is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Entrainment of phytoplankton and zooplankton

Because of the large numbers and short generation times of phytoplankton and zooplankton, impacts of entrainment on these organisms have rarely been documented outside the immediate vicinity of the plant and are considered to be of little consequence (NRC 1996). Algal surveys conducted in 1989 (during plant shutdown) and again in 1991 (during plant operation) did not indicate that operation of BFN under current thermal plume criteria had any impact on the phytoplankton community of Wheeler Reservoir (Lowery and Poppe 1992). Results from a two-dimensional, far-field model that included an assessment of the effects on reservoir algal biomass were essentially unchanged with all three units operating at a combined total power level of 11,856 MW(t) (TVA 2003b). The staff concludes that the effect on entrainment of phytoplankton or zooplankton is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Cold shock

It would not be expected that all three units would go off-line at the same time. Cold-shock mortalities, even at one-unit plants, are relatively rare and usually involve small numbers of fish. No population-level impacts have been observed (NRC 1996). Therefore, any fish that do occupy the thermal plume during winter conditions would still have areas of above-ambient temperatures to occupy during one- or two-unit operation. Furthermore, the high-velocity diffusers provide for rapid mixing of the heated discharge waters with ambient-temperature river water and discourage fish from residing in the warmest portion of the plume. The staff concludes that the effect of cold shock from operation is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Thermal plume barrier to migrating fish

The impact of the thermal plume is constrained by the NPDES permit. The NPDES permit limits are designed to protect aquatic species, in particular, to prevent the establishment of a thermal plume barrier to fish migration. The licensee will be required to operate within the limits of the NPDES permit during the license renewal term. Furthermore, fish species typical of those that predominate Wheeler Reservoir have a range difference of at least 5°C (9°F) to over 10°C (18°F) between their acclimation temperature and upper avoidance temperature (Cherry et al. 1975). The staff concludes the effect of the thermal plume as a barrier to migrating fish is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Distribution of aquatic organisms

Past operations of BFN have not been shown to affect the distribution of aquatic organisms in Wheeler Reservoir (TVA 2003b). As discussed in Section 2.2.5, the aquatic biota are primarily affected by physical and chemical changes to the Tennessee River that have occurred from its modification from a free-flowing river to a series of run-of-the-river reservoirs. Within the reservoir, there are three somewhat distinct zones: the tailwaters of the upstream dam, the transition area (within which BFN is located), and the more lacustrine (lake-like) conditions in the area upstream of the reservoir dam. The distribution of aquatic biota in Wheeler Reservoir is primarily influenced by the habitats and physicochemical conditions within each zone. The staff concludes the effect of the distribution of aquatic organisms is within the envelope of impacts considered in the GEIS as a Category 1 issue.

* Premature emergence of aquatic insects

The discharge diffusers will ensure adequate mixing of the discharge flow and the receiving waters. Typically, the warmer water is buoyant and does not impinge directly on the reservoir substrate. The licensee has a considerable amount of benthic data from Wheeler Reservoir that show no impact related to premature emergence of insects. The additional heat associated with the combined total power level of 11,856 MW(t) is not expected to significantly increase the amount of benthic invertebrate habitat that is subject to elevated temperatures. The staff concludes the effect of thermal discharge on premature emergence of aquatic insects is within the envelope of impacts considered in the GEIS as a Category 1 issue.

* Low dissolved oxygen in the discharge

Current dissolved oxygen levels near the BFN site is rated "good" by TVA (TVA 2004b). Results from simulations using a two-dimensional, far-field model that included an assessment of the effects on reservoir dissolved oxygen concentrations were essentially unchanged under all three units operating at a combined total power level of 11,856 MW(t) (TVA 2003b). Thus, as long as the licensee maintains compliance with the NPDES regulatory requirements, operation of all three units at a combined total power level of 11,856 MW(t) of original power is expected to have insignificant effects on dissolved oxygen concentrations. The staff concludes the effect of low dissolved oxygen discharges is within the envelope of impacts considered in the GEIS as a Category 1 issue.

* Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses

Although it is likely that operation of a once-through cooling system will cause some changes in predator-prey relationships, the fact that no long-term changes in population- or community-level effects from operation of BFN have been observed (TVA 2003b) is evidence that losses from predation, parasitism, and disease are not occurring from sublethal stresses (NRC 1996). The Vital Signs Monitoring Program and other assessments of aquatic biota in Wheeler Reservoir have not demonstrated any changes to aquatic organisms related to predation, parasitism, or disease that could be attributable to sublethal stresses (thermal, physical, or chemical) caused by operations of BFN. The Vital Signs Monitoring Reservoir Fish Assemblage Index has been determined for fish in Wheeler Reservoir since the early 1990s. This index considers fish disease, lesions, parasites, and abnormalities as factors in determining the index. The index value downstream of BFN has been as good as or better than other portions of the reservoir (Section 2.2.5). No fish consumption advisories exist for the mainstream of Wheeler Reservoir (Section 2.2.5). Thermal and chemical discharges from BFN are governed by the NPDES permit. Thermal and chemical discharges can stress aquatic organisms leading to increased parasitism and disease. Discharge limits are established at levels that are protective of aquatic biota. As permit conditions would not change, the effects of BFN operation at a combined total power level of 11,856 MW(t) on predation, parasitism, and disease on organisms exposed to sublethal stresses would likely remain the same. The staff concludes that the effect of predation, parasitism, and disease among organisms exposed to sublethal stresses is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Stimulation of nuisance organisms

Past operations of BFN have not been shown to stimulate nuisance organisms. Water levels in Wheeler Reservoir are actively managed during the summer to limit mosquito breeding habitat (Section 2.2.5). Physical and chemical treatment of the cooling system has had a controlling influence on the Asiatic clam (*Corbicula fluminea*) in the immediate plant area. Thermal discharges in the immediate area of the diffusers are at a level that can adversely impact Asiatic clams. When ambient reservoir temperatures are 22.4°C (72.4°F) or more, the maximum 24-hour average temperature rise of 5.6°C (10°F) would be above the optimum summer temperatures for the zebra mussel (*Dreissena polymorpha*). Therefore, increased thermal loading associated with operation of the plant at 120 percent power levels would have a further localized controlling influence over these nuisance species. The staff concludes that the effect on the stimulation of nuisance organisms is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Cooling tower impacts on crops and ornamental vegetation

Although the cooling towers are likely to be operated more frequently with three units operating at a combined total power level of 11,856 MW(t) (TVA 2003b), because they are helper towers, they will be operated less frequently than those located at plants with closed-cycle cooling systems. The staff determined in the GEIS that cooling tower impacts on crops and ornamental vegetation at plants where the cooling towers are operated continuously was not significant. The staff concludes that the effect of cooling towers impacts on crops and ornamental vegetation is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Cooling tower impacts on native vegetation

Although the cooling towers are likely to be operated more frequently with three units operating at a combined total power level of 11,856 MW(t) (TVA 2003b), because they are helper towers, they will be operated less frequently than those located at plants with a closed-cycle cooling system. The staff determined in the GEIS that cooling tower impacts on native vegetation at plants where the cooling towers are operated continuously was not significant. The staff concludes that the effect of cooling towers on native vegetation is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Microbial organisms (occupational health)

As discussed in Section 4.1.5, some thermophilic microbiological organisms have a range of optimum conditions within the range of temperatures that would occur at either 100 percent or 120 percent power levels. BFN was one of nine power plants that participated in a study in the early 1980s on the presence of *Legionella* spp. in power plant cooling systems. As with most locations studied, *Legionella* spp. bacteria were found in ambient-temperature (intake), pre-condenser, post-condenser, and outfall (discharge) waters, though not in concentrations sufficiently high to be a health concern. Subsequent studies determined that concentrated *Legionella* spp. aerosols could present a health concern for workers cleaning condenser tubes and cooling towers. As a precaution, BFN has adopted the practice of having workers engaged in these activities wear appropriate respiratory protection (TVA 2003b). Therefore, even though condenser tube and cooling tower cleaning requirements for a three-unit operation may increase, the potential for occupational health risks would still be negligible, because health risks would not increase due to of the use of appropriate respiratory protection. The staff concludes the effect of microbial organisms on occupational health is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Noise

The cooling towers are likely to be operated more often when there are three units operating at a combined total power level of 11,856 MW(t) (TVA 2003b), and thus there would be more days per year when noise from tower operations could affect onsite personnel or be detected offsite. However, because these are helper towers, they will be operated intermittently, and not continuously as they are at plants with closed-cycle cooling systems. The staff determined in the GEIS that the impacts of cooling tower noise at plants with continuously operated towers are not significant. The staff concludes the effect of noise from the cooling towers is within the envelope of impacts considered in the GEIS as a Category 1 issue.

Table 4-14. Radiological Impacts of Normal Operations-Related Category 1 Issues that are Potentially Affected by Proposed Extended Power Uprates at Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

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

- Radiation exposures to public (license renewal term)

Some increase in radionuclide emissions might occur as a result of the combined total power level of 11,856 MW(t) (TVA 2003b); the increase would be up to a factor of 1.8 over current two unit operations if the increase is proportional to the power level. Recent routine emissions at the site have been well below regulatory limits. Furthermore, BFN, regardless of the thermal power level, will be required to operate during the license renewal term within the regulatory limits. The staff concludes that the effects of radiation exposure to the public is within the envelope of impacts considered in the GEIS as a Category 1 issue provided that releases are maintained within the regulatory limits.

- Occupational radiation exposures (license renewal term)

Some increase in worker dose rates might occur as a result of the combined total power level of 11,856 MW(t) (TVA 2003b); the increase would be up to a factor of 1.8 over current two unit operations if the increase is proportional to the power level. However, application of as low as reasonably achievable (ALARA) principles has reduced worker exposures relative to historic levels, and doses to individual workers at the site would be controlled to remain below regulatory limits. The staff determined in the GEIS that the dose-related impacts to workers are of small significance if doses and releases do not exceed permissible levels in the Commission's Regulations. BFN, regardless of the thermal power level, will be required to operate within the regulatory limits. The staff concludes the effect of occupational radiation exposure is within the envelope of impacts considered in the GEIS as a Category 1 issue provided that the exposure to workers is maintained within the regulatory limits.

Table 4-15. Socioeconomic-Related Category 1 Issue Potentially Affected by Proposed Extended Power Uprates at Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
SOCIOECONOMIC	
Aesthetic impacts (license renewal term)	4.7.6

- Aesthetic impacts (license renewal term)

The cooling towers are likely to be operated more often when there are three units operating at a combined total power level of 11,856 MW(t) (TVA 2003b); thus, there would be more days per year when there is a visible steam plume, and when noise from tower operations could be detected offsite. However, because these are helper towers, they will be operated intermittently, and not continuously as they are located at plants with closed-cycle cooling systems. The staff determined in the GEIS that the aesthetic impacts of cooling tower plumes at plants with continuously operated towers are not significant. The staff concludes the effects of aesthetic impacts of cooling tower plumes is within the envelope of impacts considered in the GEIS as a Category 1 issue.

Table 4-16. Postulated Accident-Related Category 1 Issue Potentially Affected by Proposed Extended Power Uprates at Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

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

- Design-basis accidents

TVA is required to submit an updated Final Safety Analysis Report as part of the EPU license amendment application. NRC staff evaluates this Final Safety Analysis Report, the application, and the design of the facility prior to granting or denying the EPU application. If the EPU is granted, the staff will have evaluated design-basis accidents (DBAs) in light of the new power level, and will have determined that postulated DBA doses continue to meet NRC regulations. Therefore, the environmental impacts of DBAs will continue to be small. The staff concludes that the effect of the cooling system operation on DBAs is within the envelope of impacts considered in the GEIS as a Category 1 issue.

Table 4-17. Uranium Fuel Cycle and Waste Management-Related Category 1 Issues Potentially Affected by Proposed Extended Power Uprates at Browns Ferry Nuclear Plant, Units 1, 2, and 3

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste)	6.1; 6.2.1; 6.2.2.1; 6.2.2.3; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (collective effects)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (spent fuel and high-level waste)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6
Nonradiological impacts of the uranium fuel cycle	6.1; 6.2.2.6; 6.2.2.7; 6.2.2.8; 6.2.2.9; 6.2.3; 6.2.4; 6.6
Low-level waste storage and disposal	6.1; 6.2.2.2;6.4.2; 6.4.3; 6.4.3.1; 6.4.3.2; 6.4.3.3; 6.4.4; 6.4.4.1; 6.4.4.2; 6.4.4.3; 6.4.4.4; 6.4.4.5; 6.4.4.5.1; 6.4.4.5.2; 6.4.4.5.3; 6.4.4.5.4; 6.4.4.6;6.6
Mixed waste storage and disposal	6.4.5.1; 6.4.5.2; 6.4.5.3; 6.4.5.4; 6.4.5.5; 6.4.5.6; 6.4.5.6.1; 6.4.5.6.2; 6.4.5.6.3; 6.4.5.6.4; 6.6

Table 4-17. (Contd)

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
Onsite spent fuel	6.1; 6.4.6; 6.4.6.1; 6.4.6.2; 6.4.6.3; 6.4.6.4; 6.4.6.5; 6.4.6.6; 6.4.6.7; 6.6
Nonradiological waste	6.1; 6.5; 6.5.1; 6.5.2; 6.5.3; 6.6
Transportation	6.1; 6.3.1; 6.3.2.3; 6.3.3; 6.3.4; 6.6, Addendum 1

- Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste)

Offsite impacts of the uranium fuel cycle have been considered by the Commission in Table S-3 in 10 CFR 51.51(b). Based on information in the GEIS, impacts on individuals from radioactive gaseous and liquid releases including radon-222 and technetium-99 are small. There may be some local increase in radiological emissions in the immediate vicinity of the facility; however, the impact on the entire uranium fuel cycle would be negligible. Regardless of the combined total power level at BFN, the plant and fuel cycle facilities will continue to be required to operate within applicable regulatory limits. The staff concludes the effect of offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste) is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Offsite radiological impacts (collective effects)

Some increase in radionuclide emissions might occur at BFN as a result of increased fuel requirements for the combined total power level of 11,856 MW(t); the increase would be up to a factor of 1.8 over current two unit operations if the increase is proportional to the power level. Nevertheless, releases would continue to be required to be within regulatory limits. Collective doses to the population in the vicinity of BFN have been well below levels that would result in estimated health effects; therefore, collective dose to the BFN surrounding population would remain small. Nationwide, a potential increase in annual radiation exposures to the public from BFN would be inconsequential and not substantially change the GEIS conclusions. The staff concludes that the effect of offsite radiological impacts (collective effects) is within the envelope of impacts considered in the GEIS as a Category 1 issue provided that the releases are maintained to within the regulatory limits.

- Offsite radiological impacts (spent fuel and high-level waste)

Some increase in radiation dose to members of the public might result from increased spent fuel generation during reactor operations at a combined total power level of 11,856 MW(t); the increase would be up to a factor of 1.8 over current two unit operations if the increase is proportional to the power level. During the uprated operational period, public exposures from spent fuel disposal would be maintained within regulatory limits and are expected to remain small. The staff concludes that the effect of offsite impacts (spent fuel and high-level waste) is within the envelope of impacts considered in the GEIS as a Category 1 issue provided that exposure to the public is maintained to within the regulatory limits.

- Nonradiological impacts of the uranium fuel cycle

Uprate of the power level at BFN would result in needs for somewhat larger quantities of fuel, as well as increased need for spent fuel and waste storage and disposal. The nonradiological impacts of these activities would be reflected in needs for additional workforce to carry out fuel manufacturing and waste and spent fuel management activities. Those activities could also result in an additional potential for industrial accidents and illnesses. However, they would not necessarily entail a higher risk than alternative occupations in which the workforce might be engaged. Other nonradiological impacts, such as land use, fugitive dust generation, air-quality impacts, erosion, sedimentation, and disturbance of ecosystems, are unlikely to increase substantially. The effect on the entire United States uranium fuel cycle from the additional fuel utilization at BFN would be negligible. The staff concludes that the effect of nonradiological impacts of the uranium fuel cycle is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Low-level waste storage and disposal

Some increase in radiation dose to members of the public might result from increased LLW storage and disposal during reactor operations at a combined total power level of 11,856 MW(t); the increase would be up to a factor of 1.8 over current two unit operations if the increase is proportional to the power level. During the uprated operational period, public exposures from LLW disposal would be maintained within regulatory limits and are expected to remain small. The staff concludes the effect of public exposure from LLW storage and disposal is within the envelope of impacts considered in the GEIS as a Category 1 issue provided that exposure to the public is maintained to within the regulatory limits.

- Mixed waste storage and disposal

Some increase in radiation dose to members of the public and exposure to toxic materials might result from increased mixed waste generation during reactor operations at a combined total power level of 11,856 MW(t); the increase would be up to a factor of 1.8 over current two unit operations if the increase is proportional to the power level. During the uprated operational period, public exposures from mixed waste disposal would be maintained within regulatory limits and are expected to remain small. Any increase in mixed waste storage would be within the current BFN storage capacity, and additional impact on licensed mixed waste disposal facilities would be minimal. The staff concludes the effect of mixed waste storage and disposal is within the envelope of impacts considered in the GEIS as a Category 1 issue provided that the radiation dose to the public is maintained to within the regulatory limits.

- Onsite spent fuel

Some marginal increase in onsite storage of spent fuel is expected as a result of a combined total power level of 11,856 MW(t), The commission has made a generic determination that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the license life for generation including any license renewal term. During the uprated operational period, occupational exposures from spent fuel management would be maintained within regulatory limits and with continuing application of ALARA principles, are expected to remain small. The staff concludes that the effect on occupational exposure from onsite spent fuel is within the envelope of impacts considered in the GEIS as a Category 1 issue provided that the occupational exposure is maintained to within the regulatory limits during the storage period.

- Nonradiological waste

Operation of BFN at uprated power levels is not expected to substantially change the quantities of nonradiological waste generated at the facility. Any small marginal increases in routine nonradiological waste generated at the plant would be well within quantities that could be accommodated by onsite or community waste management facilities, and ongoing waste minimization and recycling programs are expected to continue to reduce the quantities of these wastes. The staff concludes the effect from nonradiological waste is within the envelope of impacts considered in the GEIS as a Category 1 issue.

- Transportation

Some increase in radiation dose to members of the public and transportation workers might result from increased transport of unirradiated fuel, spent fuel, and radiological wastes during reactor operations at a combined total power level of 11,856 MW(t); the increase would be up to 20 percent during operation, if the increase is in proportion to the power level. Because of the regulatory requirements related to fuel shipments, the staff believes that any increase in BFN impact due to the combined total power level will be consistent with the impact values contained in 10 CFR 51.52(c), Summary Table S-4 - Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor. The staff concludes that the effect of transportation of the unirradiated fuel, spent fuel, and radiological wastes is within the envelope of impacts considered in the GEIS as a Category 1 issue provided that the dose to the public and transportation workers is maintained to within the regulatory limits during the renewal period.

4.8 Cumulative Impacts of Operations During the License Renewal Term

The staff considered the potential cumulative impacts during the evaluation of information applicable to each of the potential impacts of operations during the license renewal term identified within the GEIS. For purposes of this analysis, past actions were those related to the resources at the time of plant licensing and construction, present actions are those related to the resources at the time of current operation of the power plant, and future actions are considered to be those that are reasonably foreseeable through the end of the current license term, as well as the 20-year license renewal term. The geographical area over which past, present, and future actions could contribute to cumulative impacts is dependent on the type of action considered, and is described below for each impact area.

The impacts of the proposed action are combined with other past, present, and reasonably foreseeable future actions at BFN, regardless of what agency (Federal or non-Federal) or person undertakes such other actions. These combined impacts are defined as "cumulative" in 40 CFR 1508.7 and include individually minor, but collectively significant, actions taking place over time. It is possible that an impact that may be SMALL by itself could result in a MODERATE or LARGE impact when considered in combination with the impacts of other actions on the affected resource. Likewise, if a resource is regionally declining or imperiled, even a SMALL individual impact could be important if it contributes to or accelerates the overall resource decline.

4.8.1 Cumulative Impacts Resulting from Operation of the Plant Cooling System

For the purposes of this analysis, the geographic area considered for cumulative impacts resulting from operation of the BFN cooling system is primarily the Wheeler Reservoir portion of the Tennessee River. Wheeler Reservoir is located within the Lower Tennessee River Basin which extends from Chattanooga, Tennessee, to near Paducah, Kentucky. The main stem of the Tennessee River in this area is highly regulated with few free-flowing reaches. Six major reservoirs are located within the Lower Tennessee River, and three additional reservoirs are located on its major tributaries (USGS 1998). The reservoirs were created for the purpose of power generation, navigation, and flood control. They are also used extensively as sources of drinking water and for recreational activities (USGS 1998.) Interbasin transfers of water occur downstream of BFN (i.e., with the Mobile River Basin via the Tennessee-Tombigbee Waterway near the Pickwick Reservoir and with the Cumberland River Basin through the Barkley-Kentucky Canal at the Kentucky Reservoir) (Kingsbury et al. 1999).

The mean annual streamflow in the Lower Tennessee River Basin ranges from about 1017 m^3/s (35,900 cfs) at Chattanooga, Tennessee, to 1858 m^3/s (65,600 cfs) at Paducah, Kentucky. Elk and Duck Rivers are the two largest tributaries within the lower Tennessee River Basin and contribute about 26 percent of the streamflow gained between Chattanooga and Paducah (Kingsbury et al. 1999). Within the Tennessee River watershed, an average of 46.2 million m^3/d (12.2 billion gpd) were used in 2000 for public supply, industrial water supply, irrigation, and thermoelectric power generation; however, only about 5 percent (2.5 million m^3/d [649 MGD]) was used consumptively. By 2030, water withdrawals are projected to increase to nearly 53 million m^3/d (14 billion gpd) (Hutson et al. 2003). Most of the consumptive use (2.0 million m^3/d [530 MGD]) has occurred upstream of Wheeler Dam, and this is expected to increase to 2.9 million m^3/d (760 MGD) by 2030 (TVA 2003b). Within Wheeler Reservoir there are eight potable water intakes that withdraw about 0.47 million m^3/d (124 MGD) for municipal and industrial use, while there are 11 municipal plant discharges totaling over 0.11 million m^3/d (30 MGD) and 18 municipal plants discharging more than 9.5 million m^3/d (2513 MGD) (TVA 2003b).

The main land cover in the Lower Tennessee River Basin is forest (55 percent) and row crops and pastureland (41 percent). There are numerous industries along the mainstem of the Tennessee River in northern Alabama. They manufacture and produce a variety of products (e.g., missiles and rockets, electronics, pulp and paper, synthetic fibers, chemicals, aluminum, and nickel-plated foam) (USGS 1998).

Section 2.2.5 discusses the major changes and modifications within the Tennessee River, particularly the Wheeler Reservoir area, that have had the greatest effects on aquatic resources. These include physical and chemical stresses, developments, overfishing (including commercial clam harvests), and introduction of non-native species. Physical and chemical stresses that have impacted the Tennessee River include urban, industrial, and agricultural contaminants (e.g., nutrients, toxic chemicals, sediments); stream modifications (e.g., dams and reservoirs); land use changes (e.g., residential, recreational, agricultural, and industrial development); dredging (e.g., to maintain navigation channels); shoreline modifications; wetland elimination and modification; water diversions (e.g., Tennessee-Tombigbee Waterway); and commercial and recreational boating (TVA 2003b, 2004b).

Construction of the TVA reservoir system significantly altered both the water quality and physical environment of the Tennessee River, with little regard for the subsequent effects on aquatic resources (TVA 2004b). Overall, completion of the water control system on the Tennessee River resulted in the following impacts (Barclay 2004):

- conversion of riverine habitat to reservoir pool habitat
- loss of riverine habitat and associated biota
- conversion of floodplain to reservoir pool
- loss of seasonal floodplain habitat and associated biota
- fragmentation of riverine sections
- disruption of fish migrations

- seasonal fluctuations of pool levels
- thermal stratification
- stress or mortality of organisms or sensitive life stages
- seasonal dissolved oxygen depletion in temperature stratified waters
- ammonia released by the presence of oxygen-depleted water
- disruption of sediment transport
- trapping of sediment, capture of toxic substances associated with substrates,
- toxic substance releases
- nutrient enrichment with consequent changes in habitat quality and associated species.

Within the Lower Tennessee River Basin, nutrient enrichment and pathogens have been identified as water-quality issues affecting both surface water and groundwater.. Nonpoint sources for nutrients (nitrogen and phosphorous) include urban runoff, fertilizer application, failing septic tanks, livestock waste, nitrogen fixation, sediment and rock dissolution, and atmospheric deposition (Kingsbury et al.1999).

Because of the altered habitat conditions created by reservoir pools and dam tailwater, State agencies introduced numerous sport and some prey species into the Tennessee River watershed including several trout species, striped bass (*Morone saxatilus*), northern pike (*Esox lucius*), yellow perch (*Perca flavescens*), walleye (*Stizostedion vitreum*), rainbow smelt (*Osmerus mordax*), and alewife (*Alosa pseudoharengus*). Some of the game species are not self-sustaining and, thus, continue to be stocked (TVA 2004b). Non-native species (e.g., common carp [*Cyprinus carpio*], grass carp [*Ctenopharyngodon idella*], Eurasian watermilfoil [*Myriophyllum spicatum*], and Asian clam) have impacted native aquatic species. Further spread or establishment of species such as the alewife, bighead carp (*Hypophthalmichthys nobilis*), silver carp (*H. molitrix*), zebra and quagga mussels (*Dreissena bugensis*), rusty crayfish (*Orconectes rusticus*), and the cladoceran *Daphnia lumholtzi* may also have major impacts on the aquatic community dynamics in Wheeler Reservoir.

TVA's reservoir operations policy guides the day-to-day operation of the Tennessee River system, and sets the balance of trade-offs for the sometimes competing uses of water in the system. TVA undertook a study to determine if changes in its reservoir system operating policies could produce a greater overall public value. A no-action alternative and eight alternative operating policies were evaluated. The evaluations included the assumption that the consumptive use of water above Wheeler Dam would increase by 0.87 million m^3/d (230 MGD). Reservoir operations over the 100 year hydrologic record were simulated. It was determined that for all hydrologic conditions and for all alternatives the existing minimum flow past BFN could be maintained (TVA 2004b). Therefore, the growth in consumptive water use would not affect minimum flow past BFN regardless of the reservoir operating policy adopted.

Under the preferred TVA reservoir system operating policy alternative, drawdown of Wheeler Reservoir would begin on Labor Day rather than on August 1 to increase recreational opportunities. Fluctuations in reservoir levels to strand mosquito eggs and larvae would continue until Labor Day. Also, minimum winter elevations would be raised 15 cm (6 in.) to ensure that the 3.4-m (11-ft) navigation channel is maintained throughout the reservoir (TVA 2004b).

Under its regulatory programs, TVA treats wastewater effluents, collects and properly disposes of potential contaminants, and undertakes pollution prevention activities that comply with regulatory requirements and minimize the risk of adverse environmental impacts (TVA 2003b). The BFN NPDES permit is renewed every 5 years; this helps to ensure that no changes have been made to the facility that would alter aquatic impacts and that no significant adverse impacts have occurred. Compliance with the NPDES process, other provisions of the FWPCA (e.g., Sections 316[a], 316[b], 401, and 404), and other regulatory requirements are expected to adequately control potential chemical effluent effects. In general, under these regulatory programs, TVA treats wastewater effluents, collects and properly disposes of potential contaminants, and undertakes pollution prevention activities that comply with regulatory requirements and minimize the risk of adverse environmental impacts.

Future contributions to cumulative impacts to aquatic resources within Wheeler Reservoir would generally occur from those actions that currently cause impacts (e.g., reservoir operations, human habitation, urban and industrial development, agriculture, and commercial and recreational fisheries). There is a potential for severe impacts to aquatic resources from large oil or chemical spills within Wheeler Reservoir or its tributaries, but the risk of such spills is relatively small. The probability of smaller spills is higher, but the impacts from such spills would probably be small, temporary, and additive, and unlikely to severely affect aquatic resources, especially if spill response activities are undertaken when such events occur. The potential exists for the expansion of exotic species that have already begun to occur in the Tennessee River, and for additional exotic species to become established in Wheeler Reservoir.

The reservoir water supply is adequate to meet the needs of BFN for cooling purposes under all conditions. The total BFN intake water flow of 139 m^3/s (4907 cfs) can encompass a significant fraction of the daily average river flow past the plant; however, consumptive water uses are negligible and are expected to remain so throughout the license renewal term (TVA 2003b). There are no significant cumulative impacts on water supply. The staff, while preparing this assessment, assumed that other industrial, commercial, or public installations could be located in the general vicinity of the BFN site prior to the end of BFN operations. The discharge of water to Wheeler Reservoir from these facilities would be regulated by the ADEM. The discharge limits are set considering the overall or cumulative impact of all of the other regulated activities in the area. Compliance with the FWPCA and its NPDES permits minimizes cumulative effects on aquatic resources.

There are also other power plants within the Tennessee River system that impact aquatic biota. Entrainment, impingement, and, for non-hydroelectric plants, thermal discharges occur at other power plants within the Tennessee River system. These include 11 coal-fired plants, 30 hydroelectric facilities, and three nuclear plants (including BFN) operated by the TVA (ScanChattanooga.Com 2001) and non-TVA plants such as the two Calpine combined-cycle plants near Decatur (TVA 2003b). Fish egg entrainment is not likely to be a serious problem at most dams because the freshwater drum, mooneye and, possibly, skipjack herring are the only species with buoyant or semibuoyant eggs. Larvae and juveniles of non-migratory species may only be incidentally susceptible to turbine entrainment, and the resultant effects are not significant to the dynamics of the reservoir's resident fish community (Cada 1990).

The staff has determined that the cumulative impacts of BFN cooling system operations (including entrainment and impingement of fish and shellfish, heat shock, or any of the cooling system-related Category 1 issues) are not contributing to an overall decline in water quality or the status of the fishery or other aquatic resources, and no additional mitigation measures are warranted.

Continued operation of BFN will require renewed discharge permits from the ADEM, which will address changing requirements so that cumulative water-quality objectives are served. Therefore, the staff concludes that the potential cumulative impacts of cooling system operation contributed by the continued operation of BFN will be SMALL, and that no further mitigation measures are warranted.

4.8.2 Cumulative Impacts Resulting from Continued Operation of the Transmission Lines

The continued operation of the BFN electrical transmission facilities was evaluated to determine if there is a potential for interactions with other past, present, and future actions that could result in adverse cumulative impacts to terrestrial resources such as wildlife populations, the size and distribution of habitat areas, aquatic resources such as wetlands and floodplains, and both the acute and chronic effects of electromagnetic fields. For purposes of this analysis, the geographic area that encompasses the past, present, and foreseeable future actions that could contribute to adverse cumulative effects is the area serviced by the transmission lines associated with the BFN (Figure 2.4).

TVA follows right-of-way management procedures that were found to be protective of sensitive ecological resources, including wildlife habitat, wetlands, and floodplains (TVA 2003b). TVA maintains maps of known sensitive resources such as wetlands, and maintains the transmission line rights-of-way to minimize impacts, with the result that no net loss of resources occurs. The maintenance procedures minimize disturbance to wildlife and, in many ways, provide greater protection relative to many of the surrounding areas with other land uses.

The staff determined that the electrical current induced by the electromagnetic fields from the BFN transmission lines is well below the National Electric Safety Code recommendations for preventing electrical shock from induced currents. Therefore, continued operation of the BFN transmission lines will not detectably change the overall potential for electrical shock in the future within the analysis area. With respect to chronic effects of electromagnetic fields, although the staff considers the GEIS conclusion of "not applicable" to be appropriate in regard to BFN, the BFN transmission lines are not likely to detectably contribute to the regional exposure to extremely low frequency electromagnetic fields (ELF-EMF). This conclusion is based on the fact that BFN transmission lines primarily pass through sparsely populated, rural areas, with few residences or businesses close enough to have detectable ELF-EMF.

Therefore, since the impacts from maintaining and operating the transmission system are so minor that they will neither destabilize or noticeably alter the existing aquatic or terrestrial environment, the staff determined that the cumulative impacts of continued operation of BFN transmission lines will be SMALL, and that no additional mitigation is warranted.

4.8.3 Cumulative Radiological Impacts

EPA and NRC established radiological dose limits for protection of the public and workers from both instanteneous and cumulative impacts of exposure to radiation and radioactive materials. These dose limits are codified in 40 CFR Part 190 and 10 CFR Part 20. For the purpose of this analysis, the area within an 80-km (50-mi) radius of the BFN site was included. As stated in Section 2.2.7, TVA has conducted a radiological environmental monitoring program (REMP) around the BFN site since 1968. The REMP measures radiation and radioactive materials from all sources, including BFN. Additionally, in Sections 2.2.7 and 4.3, the staff concluded that impacts of radiation exposure to the public and workers (occupational) from operation of BFN during the license renewal term are small. Therefore, the monitoring program and staff's conclusion considered cumulative impacts. The NRC and the State of Alabama would regulate any reasonably foreseeable future actions in the vicinity of the BFN site that could contribute to cumulative radiological impacts.

Therefore, the staff concludes that cumulative radiological impacts of continued operations of BFN would be SMALL, and that no further mitigation measures are warranted.

4.8.4 Cumulative Socioeconomic Impacts

Much of the analysis of socioeconomic impacts presented in Section 4.4 of this draft SEIS already incorporate cumulative impact analysis, because the metrics used for quantification only make sense when placed in the total or cumulative context. For instance, the impact of the total number of additional housing units that may be needed can only be evaluated with respect to the total number of units in the impacted area. Therefore, the geographic area of the cumulative analysis varies depending on the particular impact considered, and may depend on specific boundaries, such as taxation jurisdictions, or may be distance related, as for environmental justice.

The continued operation of BFN is not likely to add to any cumulative socioeconomic impacts beyond those already evaluated in Section 4.4. In other words, the impacts of issues such as transportation or offsite land use are likely to be nondetectable beyond the regions previously evaluated and will quickly decrease with increasing distance from the site. The staff determined that the impacts on housing, public utilities, public services, offsite land use, and environmental justice would all be negligible. There are no reasonable foreseeable scenarios that would alter these conclusions in regard to cumulative impacts.

Related to historic and archeological resources, two sites at BFN have been identified that require protection. TVA has procedures in place to protect these sites, and to take into account the inadvertent discovery of historic and archaeological remains at BFN. There are no plans to construct new facilities in areas that have not been heavily disturbed in the past, or to construct new transmission lines. Therefore, continued operation and maintenance of the BFN site and transmission line rights-of-way would not impact historic or archeological properties beyond the site or rights-of-way boundaries and, therefore, the contribution to cumulative adverse impacts would be negligible.

Based on these considerations, the staff concludes that continued operation of BFN is not likely to make a detectable contribution to the cumulative effects associated with any of the socio-economic issues discussed in Section 4.4; therefore, the cumulative impacts will be SMALL, and no additional mitigation measures are warranted.

4.8.5 Cumulative Impacts on Groundwater Use and Quality

There are no groundwater withdrawals at BFN, and TVA imports potable water from local utilities, most of which withdraw water from surface sources, primarily the Tennessee River. As described in Section 4.5.1, operation of BFN has not had a detectable impact on groundwater levels in the vicinity of the site. BFN does not discharge any waste to the groundwater. Because there are no groundwater withdrawals or discharges at BFN and none are anticipated in the future, BFN is not causing a detectable change in the regional groundwater usage or quality. Therefore, the contributions to cumulative impacts are SMALL, and no mitigation measures are warranted.

4.8.6 Cumulative Impacts on Threatened or Endangered Species

The geographic area considered in the analysis of potential cumulative impacts to threatened or endangered species includes those Alabama and Mississippi counties that contain the BFN site and its associated transmission line rights-of-way (Colbert, Franklin, Lawrence, Limestone, and Morgan Counties in Alabama, and Itawamba, Lee, Tishomingo, and Union Counties in Mississippi) and the waters of the Tennessee River, particularly Wheeler Reservoir, in the vicinity of the BFN site[(a)]. As discussed in Sections 2.2.5 and 2.2.6, there are a number of threatened or endangered species that could occur within this area. The staff's findings, presented in the October 25, 2004 (NRC 2004d) BA and in Section 4.6, are that continued operation of BFN, including return to three-unit operation at a total combined power level of 11,856 MW(t) and associated transmission line rights-of-way maintenance during the license renewal term, will have no effect, or is not likely to adversely affect any Federally listed species, nor will it adversely impact any designated critical habitat. Therefore, the BFN contribution to cumulative impacts to Federally protected species or designated critical habitat is SMALL and no mitigation is warranted.

- **Aquatic Species**

Thirty-eight Federally listed aquatic species (including three candidate species) occur (or historically occurred) in either Wheeler Reservoir or its tributaries or in other streams, rivers, or caves within the counties of Alabama and Mississippi within which the BFN transmission lines pass. As mentioned in Section 2.2.5, past actions that have adversely affected these species have included siltation, impoundments, in-stream-habitat disturbance, contaminants, pearl button and cultured pearl industries (for mussel species), and introduced species. As discussed in Section 4.6.1, best management practices are used for transmission line maintenance, which reduces the likelihood of adverse impacts to aquatic habitats and any protected species that may be present within them.

The combination of nonpoint-source pollution (primarily from siltation) and alteration of flow regimes (primarily from impoundments) are anthropogenic factors responsible for about 72 percent of fish imperilment problems in the Southeast (Etnier 2002). These factors are also the major contributor to the endangerment of most of the listed mussel species, while habitat loss, modification, and fragmentation caused by impoundments have impacted the aquatic snail species (Neves et al. 2002). Because some mussels can live to be more than 100 years old, population declines due to poor reproductive success may continue for decades. Therefore, extirpation of some species may be a prolonged event, lagging behind the factors directly responsible for attrition of the fauna (Neves et al. 2002). An oil or chemical spill, especially in a tributary stream, could be significant for a listed species that has a limited distribution (e.g.,

(a) Prentiss County, Mississippi not included. Species accounted for in adjacent counties.

Anthony's riversnail [*Athearnia anthonyi*], slender campeloma [*Campeloma decampi*], and boulder darter [*Etheostoma boschungi*]).

The Asiatic clam competitively interacts with native mussels for food and space. Invasion of the Tennessee River basin by the zebra mussel and the quagga mussel could also be detrimental to native mussels (Neves et al. 2002). The zebra mussel may ultimately cause extinction to several Federally protected mussels or cause other mussel species to become endangered or threatened (Neves et al. 2002). If the black carp (*Mylopharyngodon piceus*) becomes established in the Tennessee River, it could pose a serious threat to the listed mussel and snail species because it feeds almost exclusively upon molluscs (Chick 2002; Jernigan 2003).

The staff determined that the contribution to cumulative impacts to aquatic threatened or endangered species due to continued operation of BFN and its transmission lines would be inconsequential, and that no further mitigation measures are warranted.

- **Terrestrial Species**

There are no Federally listed threatened or endangered species known to occur within at least 5 km (3 mi) of the BFN site. Operation of BFN is not likely to have a detectable effect on terrestrial species located 5 km (3 mi) away from the site. Therefore, operations at the plant site will not have a detectable contribution to the cumulative, regional impacts on threatened or endangered species.

Habitat for some of the Federally listed species could potentially be found within the rights-of-way of BFN transmission lines. However, TVA monitors and tracks populations of Federal listed species on the BFN site and within transmission line rights-of-way. In addition, TVA works with its contract personnel and appropriate Federal and State agencies to develop and implement restrictions and safeguards to protect threatened or endangered species and their habitats during maintenance of transmission line rights-of-way (Muncy et al. 1999). In some cases, the rights-of-way and the maintenance practices may provide for habitat that is not found in surrounding areas with other land uses.

Therefore, the staff determined that the contributions to cumulative impacts to threatened or endangered terrestrial species due to the continued operation of the BFN and associated transmission lines will be inconsequential, and that additional mitigation measures would not be warranted.

4.9 Summary of Impacts of Operations During the License Renewal Term

TVA and the staff discovered no new and significant information related to any of the applicable Category 1 issues associated with BFN operation during the license renewal term. Therefore, the staff concludes that the environmental impacts associated with the Category 1 issues are bounded by the impacts described in the GEIS. For each of the issues, the GEIS concluded that the impacts would be SMALL and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

Plant-specific environmental evaluations were conducted for 14 Category 2 issues applicable to BFN operation during the license renewal term and for environmental justice and chronic effects of electromagnetic fields. For all 14 issues and environmental justice, the staff's conclusion is that the potential environmental impact of license renewal-term operations of BFN would be of SMALL significance in the context of the standards set forth in the GEIS and that further mitigation is not warranted. In addition, the staff determined that a consensus has not been reached by appropriate Federal health agencies regarding chronic adverse effects from electromagnetic fields. Therefore, no evaluation of this issue is required.

Cumulative impacts of past, present, and reasonably foreseeable future actions were considered, regardless of what agency (Federal or non-Federal) or person undertakes such other actions. For purposes of analysis, where BFN license renewal impacts are deemed to be SMALL, the staff concluded that these impacts would not result in significant cumulative impacts on potentially affected resources.

4.10 References

10 CFR Part 20. Code of Federal Regulations, Title 10, *Energy*, Part 20, "Standards for Protection Against Radiation."

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

36 CFR Part 800. Code of Federal Regulations, Title 36, *Parks, Forests, and Public Property*, Part 800, "Protection of Historic Properties."

40 CFR Part 190. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 190, "Environmental Protection Standards for Nuclear Power Operations."

40 CFR Part 1508. Code of Federal Regulation, Title 40, *Protection of Environment*, Part 1508, "Terminology and Index."

59 FR 7629. Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority and Low-Income Populations." *Federal Register.* Vol. 59, No. 32. February 16, 1994.

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5.0 Environmental Impacts of Postulated Accidents

Environmental issues associated with postulated accidents are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).[a] The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic.

(2) Single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

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

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

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

5.1 Postulated Plant Accidents

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

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

5.1.1 Design-Basis Accidents

In order to receive NRC approval to operate a nuclear power facility, an applicant must submit a safety analysis report (SAR) as part of the application. The SAR presents the design criteria and design information for the proposed reactor and comprehensive data on the proposed site. The SAR also discusses various hypothetical accident situations and the safety features that are provided to prevent and mitigate accidents. The NRC staff reviews the application to determine whether the plant design meets the Commission's regulations and requirements and includes, in part, the nuclear plant design and its anticipated response to an accident.

DBAs are those accidents that both the licensee and the NRC staff evaluate to ensure that the plant can withstand normal and abnormal transients, and a broad spectrum of postulated accidents without undue hazard to the health and safety of the public. A number of these postulated accidents are not expected to occur during the life of the plant but are evaluated to establish the design basis for the preventive and mitigative safety systems of the facility. The acceptance criteria for DBAs are described in 10 CFR Part 50 and 10 CFR Part 100.

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

The Commission has determined that the environmental impacts of DBAs are of SMALL significance for all plants because the plants were designed to successfully withstand these accidents. Therefore, for the purposes of license renewal, design-basis accidents are designated as a Category 1 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. The early resolution of the DBAs make them a part of the current licensing basis of the plant; the current licensing basis of the plant is to be maintained by the licensee under its current license and, therefore, under the provisions of 10 CFR 54.30, is not subject to review under license renewal. This issue, applicable to BFN, is listed in Table 5-1.

Table 5-1. Category 1 Issue Applicable to Postulated Accidents During the License Renewal Term

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

Based on information in the GEIS, the Commission found that

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

Tennessee Valley Authority (TVA) stated in its Environmental Report (ER) (TVA 2003) that it is not aware of any new and significant information associated with the renewal of the Browns Ferry Nuclear Plant, Units 1, 2, and 3 (BFN) OLs. The staff has not identified any new and significant information during the staff's independent review of the BFN ER (TVA 2003), the scoping process, the staff's site visit, the staff's evaluation of other available information, and public comments. Therefore, the staff concludes that there are no impacts of design-basis accidents during the renewal term beyond those discussed in the GEIS.

5.1.2 Severe Accidents

Severe nuclear accidents are those that are more severe than DBAs because they could result in substantial damage to the reactor core, whether or not there are serious offsite consequences. The GEIS assessed the impacts of severe accidents during the license renewal period, using the results of existing analyses and site-specific information to conservatively predict the environmental impacts of severe accidents for each plant during the renewal period.

Based on information in the GEIS, the Commission found that

> The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives.

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

Table 5-2. Category 2 Issue Applicable to Postulated Accidents During the License Renewal Term

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

The staff has not identified any new and significant information during the staff's independent review of the BFN ER (TVA 2003), the scoping process, the staff's site visit, the staff's evaluation of other available information, and public comments. Therefore, the staff concludes that there are no impacts of severe accidents beyond those discussed in the GEIS. However, in accordance with 10 CFR 51.53(c)(3)(ii)(L), the staff has reviewed severe accident mitigation alternatives (SAMAs) for BFN. The results of the staff's review are discussed in Section 5.2.

5.2 Severe Accident Mitigation Alternatives (SAMAs)

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

5.2.1 Introduction

This section presents a summary of the SAMA evaluation for BFN conducted by TVA and described in the ER (TVA 2003) and of the NRC's review of that evaluation. The details of the review are described in the NRC staff evaluation that was prepared by the staff with contract assistance from Information Systems Laboratories, Inc. The entire evaluation is presented in Appendix G.

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

In the second step, TVA examined the major risk contributors and identified possible ways (SAMAs) of reducing that risk. Common ways of reducing risk are changes to components, systems, procedures, and training. TVA initially identified 135 potential SAMAs. TVA screened out SAMAs that were not applicable to BFN due to design differences, had already been implemented, were similar in nature and could be combined with another SAMA, or cost more than $6M to implement. This screening reduced the list of potential SAMAs to 43.

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

Finally in the fourth step, the costs and benefits of each of the remaining SAMAs were compared to determine whether the SAMA was cost-beneficial, meaning the benefits of the SAMA were greater than the costs (a positive cost-benefit). In the final analysis, TVA concluded that none of these 43 SAMAs were cost-beneficial for BFN.

Each of these four steps is discussed in more detail in the sections that follow.

5.2.2 Estimate of Risk

TVA submitted an assessment of SAMAs for BFN as part of the ER (TVA 2003). This assessment considers all three Browns Ferry units, each operating at 120 percent of their original licensed power level. Ideally, this assessment would take advantage of a plant-specific Probabilistic Safety Assessment (PSA) that reflects operation of all three units at 120 percent of their original licensed power. However, such a PSA is not currently available. Because of the progressive screening nature of the SAMA evaluation, TVA relied on the available PSA information, along with engineering knowledge of the plant, to form a basis for the three-unit SAMA assessment. This assessment was based on the most recent PSA for Unit 2 and Unit 3 available at that time. A PSA for Unit 1 was not available at the time of the SAMA analysis. The assessment was also based on insights from a Multiple-Unit PSA performed in 1995 to bound the effects of three-unit operation, a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer program, and insights from the Browns Ferry Individual Plant Examination (TVA 1992) and the Individual Plant Examination of External Events (IPEEE) (TVA 1995, 1996, 1997).

Two distinct analyses are combined to form the basis for the risk estimates used in the SAMA analysis: (1) the BFN PSA Unit 2 and Unit 3 models, and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PSA model) developed specifically for the SAMA analysis. The SAMA analysis is based on the most recent PSA models available at the time of the ER, referred to as the Extended Power Uprate (EPU) PSA for Unit 2, and the EPU PSA for Unit 3. The PSAs include a Level 1 analysis to determine the CDF from internally-initiated events and a Level 2 analysis to assess containment performance during severe accidents. The scope of the BFN PSAs does not include external events.

The baseline CDFs for the purpose of the SAMA evaluation are approximately 2.6×10^{-6} per year for Unit 2 and 3.6×10^{-6} per year for Unit 3. The CDFs are based on the risk assessment for internally-initiated events at EPU conditions, i.e., 120 percent of their original licensed power level. TVA did not include the contribution to risk from external events within the BFN risk estimates. This is discussed further in Sections G.2.2 and G.6.2.

The breakdown of CDF by initiating event is provided in Table 5-3. As shown in this table, transients and loss of offsite power initiated events are dominant contributors to the CDF.

Table 5-3. BFN Core Damage Frequency

	Unit 2		Unit 3	
Initiating Event or Accident Class	**CDF (Per Year)**	**% Contribution to CDF**	**CDF (Per Year)**	**% Contribution to CDF**
Transients	1.6×10^{-6}	63	1.8×10^{-6}	52
Loss of offsite power (LOOP)	4.8×10^{-7}	19	1.1×10^{-6}	32
Support system failures	2.2×10^{-7}	8	2.3×10^{-7}	7
Internal Flooding	1.0×10^{-7}	4	1.6×10^{-7}	5
Loss of coolant accidents (LOCAs)	5.3×10^{-8}	2	5.4×10^{-8}	2
Stuck open relief valves	4.7×10^{-8}	2	5.8×10^{-8}	2
Interfacing system LOCA (ISLOCA)	4.6×10^{-8}	2	4.6×10^{-8}	1
Total CDF (from internal events)	**2.6×10^{-6}**	**100**	**3.4×10^{-6}**	**100**

Bypass events (i.e., interfacing systems loss of coolant accident) contribute two percent or less to the total internal events CDF. Anticipated transients without scram (ATWS) events and station blackout (SBO) events are not specifically identified in the internal events CDF breakdown. In response to an RAI, TVA stated that the ATWS CDF is estimated to be 2.3×10^{-7} per year for each unit, and the SBO CDF is 3.7×10^{-8} per year for Unit 2 and 3.9×10^{-8} per year for Unit 3 (TVA 2004a). SAMAs to address ATWS and SBO events were considered in the SAMA evaluation. TVA estimated the dose from all postulated accidents to the population within 80 km (50 mi) of the BFN site to be approximately 0.0164 person-Sv (1.64 person-rem) per year for Unit 2, and approximately 0.0195 person-Sv (1.95 person-rem) per year for Unit 3. The breakdown of the population dose by containment release mode is summarized in Table 5-4. No containment failures and early containment failures dominate the population dose. The apparent conclusion that population dose is dominated by events involving no containment failure is due to the conservative assignment of key plant damage states to release categories in which containment is assumed to fail.

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

	Unit 2		Unit 3	
Containment Release Mode	**Population Dose (Person-Rem[1] Per Year)**	**% Contribution**	**Population Dose (Person-Rem[1] Per Year)**	**% Contribution**
Early containment failure or Containment isolation failure	0.64	39	0.71	36
Bypass	0.01	<1	0.01	<1
Late containment failure	0.11	7	0.16	8
No containment failure[2]	0.88	54	1.07	55
Total Population Dose	**1.64**	**100**	**1.95**	**100**

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

5.2.3 Potential Plant Improvements

Once the dominant contributors to plant risk were identified, TVA searched for ways to reduce that risk. In identifying and evaluating potential SAMAs, TVA considered SAMA analyses performed for other operating plants that have submitted license renewal applications, as well as industry and NRC documents that discuss potential plant improvements, such as NUREG-1560 (NRC 1997b). TVA identified 135 potential risk-reducing improvements (SAMAs) to plant components, systems, procedures and training.

All but 43 of the these SAMAs were removed from further consideration because: (1) the SAMA was not applicable at BFN due to design differences, (2) the SAMA had already been addressed in the existing BFN design, (3) the SAMA was similar to and could be combined with another SAMA, or (4) the SAMA cost more than $6M to implement, considering the effects of multiple-unit operation and uncertainties.

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

5.2.4 Evaluation of Risk Reduction and Costs of Improvements

TVA evaluated the risk-reduction potential of the remaining 43 SAMAs that were applicable to BFN. A majority of the SAMA evaluations were performed in a bounding fashion in that the SAMA was assumed to completely eliminate the risk associated with the proposed enhancement. Such bounding calculations overestimate the benefit of the risk reduction and are conservative.

TVA estimated the costs of implementing the 43 candidate SAMAs through the application of engineering judgment and review of prior BFN completed capital projects for similar improvements. The cost estimates provided in the ER accounted for inflation (three percent per year) to arrive at year 2016 estimated costs. Cost estimates typically included changes to and implementation of procedures, training, and documentation, in addition to any hardware costs (TVA 2003).

The staff reviewed TVA's bases for calculating the risk reduction for the various plant improvements and concluded that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative. Therefore, the staff based its estimates of averted risk for the various SAMAs on TVA's risk reduction estimates. However, the staff concluded that the benefit estimates should be increased by a factor of two to account for the potential impacts of external events.

The staff reviewed the bases for the applicant's cost estimates. For certain improvements, the staff also compared the cost estimates to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensees' analyses of SAMAs for operating reactors and advanced light-water reactors.

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

5.2.5 Cost/Benefit Comparison

The cost-benefit analysis performed by TVA was based primarily on NUREG/BR-0184 (NRC 1997a) and was executed consistent with this guidance. The total benefit associated with each of the 43 SAMAs was evaluated by TVA. These values were determined for the various averted costs based on the estimated annual reductions in CDF and person-rem dose.

For the TVA SAMA evaluation, it is assumed that with all 3 units operational, the baseline CDFs and risks for Units 1 and 2 are equal and will be four times greater than the CDF from the Unit 2 EPU PSA. Because Unit 1 is more closely tied to Unit 2 than to Unit 3, it is expected that the impact of Unit 1 operation on the Unit 3 CDF and risk would be smaller than the above impact on Unit 2. Based on this reasoning, the operation of Unit 1 is assumed to result in a factor of two increase in Unit 3 CDF and risk from that indicated by the Unit 3 EPU PSA. Therefore, TVA applied a multiplier of four to the Unit 2 averted cost estimates (benefits), assumed these same benefits for Unit 1, and applied a multiplier of two to the Unit 3 averted cost estimates. Additionally, TVA accounted for analysis uncertainties by comparing the implementation costs with three times the averted cost estimates. As a result, all SAMAs that were evaluated were eliminated because the cost was expected to exceed the estimated benefit, as adjusted to account for multiple-unit operation and uncertainties.

The staff based its evaluation on TVA's estimated benefits for a seven-percent discount rate, applied the same multipliers as TVA to account for multiple-unit operation, and applied an additional multiplier of two to the averted cost estimates for each SAMA to account for the potential impact of external events. As a result, none of the SAMAs appeared to be potentially cost-beneficial. However, four SAMAs appeared to be within a factor of three of being cost-beneficial. These involve: improving/enhancing procedures for load shedding, which would improve DC reliability (SAMA B11); improving procedures and hardware changes for use of cross-tied component cooling or service water (SW) pumps (SAMA G04); adding redundant DC control power for the SW pumps (SAMA G12c); and, developing procedure(s) to instruct operators to trip unneeded residual heat removal/core spray pumps on loss of room ventilation (SAMA G17). TVA performed a more detailed assessment of each of these SAMAs to more realistically estimate the risk reduction and/or implementation costs for each SAMA. Based on the re-assessment, none of the SAMAs are within a factor of three of being cost-beneficial.

5.2.6 Conclusions

The staff reviewed the TVA SAMA analysis and concluded that the methods used and the implementation of those methods were sound. The treatment of SAMA benefits and costs, the generally large negative net benefits, and the inherently small baseline risks support the general conclusion that the SAMA evaluations performed by TVA are reasonable and sufficient for the license renewal submittal.

The staff considered the impact if the cost and benefits were increased by a factor of three to account for uncertainties and determined that four SAMAs could be potentially cost-beneficial. TVA re-examined each of these SAMAs and provided a more realistic estimate of their benefits and/or implementation costs. As a result of this reassessment, the cost-benefit analyses showed that none of the candidate SAMAs were cost-beneficial.

The staff concludes that none of the candidate SAMAs are cost beneficial. This conclusion is consistent with the low residual level of risk indicated in the BFN PSA and the fact that BFN has already implemented many plant improvements identified from the IPE and IPEEE process, with the exception of the removal of the transformers, which is scheduled to occur in the future.

5.3 References

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

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

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

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

Tennessee Valley Authority (TVA). 1992. Letter from Mark O. Medford, TVA, to U. S. NRC Document Control Desk. Subject: Browns Ferry Nuclear Plant (BFN) – Response to Generic Letter (GL) 88-20 – "Individual Plant Examination for Severe Accident Vulnerabilities – 10 CFR 50.54(f)," September 1, 1992.

Tennessee Valley Authority (TVA). 1995. Letter from Pedro Salas, TVA, to U. S. NRC Document Control Desk. Subject: Browns Ferry Nuclear Plant (BFN) – Generic Letter (GL) 88-20, Supplement 4, Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities – Partial Submittal of Report, July 24, 1995.

Tennessee Valley Authority (TVA). 1996. Letter from Pedro Salas, TVA, to U. S. NRC Document Control Desk. Subject: Browns Ferry Nuclear Plant (BFN) – Units 2 and 3 – Generic Letter (GL) 87-02, Supplement 1, Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46 and GL 88-20, Supplement 4, Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities – Submittal of Seismic Evaluation Reports (TAC Nos. M69431, M69432, M83596 and M83597), June 28, 1996.

Tennessee Valley Authority (TVA). 1997. Letter from T. E. Abney, TVA, to U. S. NRC Document Control Desk. Subject: Browns Ferry Nuclear Plant (BFN) – Unit 3 – Generic Letter (GL) 88-20, Supplement 4, Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities – Submittal of Report Internal Fires Analysis (TAC No. M83597), July 11, 1997.

Tennessee Valley Authority (TVA). 2003. *Applicant's Environmental Report–Operating License Renewal Stage, Browns Ferry Nuclear Power Plant Units 1, 2, and 3.* Tennessee Valley Authority, Knoxville, Tennessee. December 2003.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. NUREG-1437, Volumes 1 and 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1997a. *Regulatory Analysis Technical Evaluation Handbook.* NUREG/BR-0184, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1997b. *Individual Plant Examination Program: Perspectives on Reactor Safety and Plant Performance.* NUREG-1560, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2004a. Letter from Michael T. Masnik, U.S. NRC to J. A. Scalice, Tennessee Valley Authority. Subject: Request for Additional Information (RAI) Regarding Severe Accident Mitigation Alternatives for the Browns Ferry Nuclear Plant, Units 1, 2, and 3 (TAC Nos. MC1768, MC1769, and MC1770), April 28, 2004.

6.0 Environmental Impacts of the Uranium Fuel Cycle and Solid Waste Management

Environmental issues associated with the uranium fuel cycle and solid waste management are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999).[a] The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste [HLW] and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

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

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

This chapter addresses the issues that are related to the uranium fuel cycle and solid waste management during the license renewal term that are listed in Table B-1 of Title 10 of the Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B, and are applicable to Browns Ferry Nuclear Plant, Units 1, 2, and 3 (BFN). The generic potential radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes are described in detail in the GEIS based, in part, on the generic impacts provided in 10 CFR 51.51(b), Table S-3, "Table of Uranium Fuel Cycle Environmental Data," and in 10 CFR 51.52(c), Table S-4, "Environmental Impact of Transportation of Fuel and Waste to and

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

from One Light-Water-Cooled Nuclear Power Reactor." The GEIS also addresses the impacts from radon-222 and technetium-99. There are no Category 2 issues for the uranium fuel cycle and solid waste management.

6.1 The Uranium Fuel Cycle

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

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

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
URANIUM FUEL CYCLE AND WASTE MANAGEMENT	
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste)	6.1; 6.2.1; 6.2.2.1; 6.2.2.3; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (collective effects)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (spent fuel and high-level waste)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6
Nonradiological impacts of the uranium fuel cycle	6.1; 6.2.2.6; 6.2.2.7; 6.2.2.8; 6.2.2.9; 6.2.3; 6.2.4; 6.6
Low-level waste storage and disposal	6.1; 6.2.2.2;6.4.2; 6.4.3; 6.4.3.1; 6.4.3.2; 6.4.3.3; 6.4.4; 6.4.4.1; 6.4.4.2; 6.4.4.3; 6.4.4.4; 6.4.4.5; 6.4.4.5.1; 6.4.4.5.2; 6.4.4.5.3; 6.4.4.5.4; 6.4.4.6;6.6
Mixed waste storage and disposal	6.4.5.1; 6.4.5.2; 6.4.5.3; 6.4.5.4; 6.4.5.5; 6.4.5.6; 6.4.5.6.1; 6.4.5.6.2; 6.4.5.6.3; 6.4.5.6.4; 6.6
Onsite spent fuel	6.1; 6.4.6; 6.4.6.1; 6.4.6.2; 6.4.6.3; 6.4.6.4; 6.4.6.5; 6.4.6.6; 6.4.6.7; 6.6
Nonradiological waste	6.1; 6.5; 6.5.1; 6.5.2; 6.5.3; 6.6
Transportation	6.1; 6.3.1; 6.3.2.3; 6.3.3; 6.3.4; 6.6, Addendum 1

The Tennessee Valley Authority (TVA) stated in its Environmental Report (ER) (TVA 2003) that it is not aware of any new and significant information associated with renewal of the BFN operating licenses. The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the staff concluded in the GEIS that the impacts are SMALL except for collective offsite radiological impacts from the fuel cycle and from HLW and spent fuel disposal, as discussed below, and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

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

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

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

  The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no offsite radiological impacts of the uranium fuel cycle during the license renewal term beyond those discussed in the GEIS.

- Offsite radiological impacts (collective effects). Based on information in the GEIS, the Commission found that

  > The 100 year environmental dose commitment to the U.S. population from the fuel cycle, high level waste and spent fuel disposal excepted, is calculated to be about 14,800 person rem [148 person Sv], or 12 cancer fatalities, for each additional 20-year power reactor operating term. Much of this, especially the contribution of radon releases from mines and tailing piles, consists of tiny doses summed over large populations. This same dose calculation can theoretically be extended to include many tiny doses over additional thousands of years as well as doses outside the U.S. The result of such a calculation would be thousands of cancer fatalities from the fuel cycle, but this result assumes that even tiny doses have some statistical adverse health effect which will not ever be

> mitigated (for example no cancer cure in the next thousand years), and that these doses projected over thousands of years are meaningful. However, these assumptions are questionable. In particular, science cannot rule out the possibility that there will be no cancer fatalities from these tiny doses. For perspective, the doses are very small fractions of regulatory limits and even smaller fractions of natural background exposure to the same populations.
>
> Nevertheless, despite all the uncertainty, some judgement as to the regulatory NEPA [National Environmental Policy Act] implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective effects of the fuel cycle, this issue is considered Category 1.

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no offsite radiological impacts (collective effects) from the uranium fuel cycle during the license renewal term beyond those discussed in the GEIS.

- <u>Offsite radiological impacts (spent fuel and high level waste disposal)</u>. Based on information in the GEIS, the Commission found that

> For the high level waste and spent fuel disposal component of the fuel cycle, there are no current regulatory limits for offsite releases of radionuclides for the current candidate repository site. However, if we assume that limits are developed along the lines of the 1995 National Academy of Sciences (NAS) report [NAS 1995], "Technical Bases for Yucca Mountain Standards," and that in accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository can and likely will be developed at some site which will comply with such limits, peak doses to virtually all individuals will be 100 millirem [1 mSv] per year or less. However, while the Commission has reasonable confidence that these assumptions will prove correct, there is considerable uncertainty since the limits are yet to be developed, no repository application has been completed or reviewed, and uncertainty is inherent in the models used to evaluate possible pathways to the human environment. The NAS report indicated that 100 millirem [1 mSv] per year should be considered as a starting point for limits for individual

doses, but notes that some measure of consensus exists among national and international bodies that the limits should be a fraction of the 100 millirem [1 mSv] per year. The lifetime individual risk from 100 millirem [1 mSv] annual dose limit is about is about 3×10^{-3}.

Estimating cumulative doses to populations over thousands of years is more problematic. The likelihood and consequences of events that could seriously compromise the integrity of a deep geologic repository were evaluated by the Department of Energy in the "Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste," October 1980 [DOE 1980]. The evaluation estimated the 70-year whole-body dose commitment to the maximum individual and to the regional population resulting from several modes of breaching a reference repository in the year of closure, after 1,000 years, after 100,000 years, and after 100,000,000 years. Subsequently, the NRC and other federal agencies have expended considerable effort to develop models for the design and for the licensing of a high level waste repository, especially for the candidate repository at Yucca Mountain. More meaningful estimates of doses to population may be possible in the future as more is understood about the performance of the proposed Yucca Mountain repository. Such estimates would involve very great uncertainty, especially with respect to cumulative population doses over thousands of years. The standard proposed by the NAS is a limit on maximum individual dose. The relationship of potential new regulatory requirements, based on the NAS report, and cumulative population impacts has not been determined, although the report articulates the view that protection of individuals will adequately protect the population for a repository at Yucca Mountain. However, EPA's generic repository standards in 40 CFR part 191 generally provide an indication of the order of magnitude of cumulative risk to population that could result from the licensing of a Yucca Mountain repository, assuming the ultimate standards will be within the range of standards now under consideration. The standards in 40 CFR part 191 protect the population by imposing "containment requirements" that limit the cumulative amount of radioactive material released over 10,000 years. Reporting performance standards that will be required by EPA are expected to result in releases and associated health consequences in the range between 10 and 100 premature cancer deaths with an upper limit of 1,000 premature cancer deaths world-wide for a 100,000 metric tonne (MT) repository.

Nevertheless, despite all the uncertainty, some judgement as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent fuel and high level waste disposal, this issue is considered Category 1.

On February 15, 2002, subsequent to the preparation of an environmental impact statement (DOE 2002) and receipt of a recommendation by the Secretary, U.S. Department of Energy, the President recommended the Yucca Mountain site for the development of a repository for the geologic disposal of spent nuclear fuel and high-level nuclear waste. The U.S. Congress approved this recommendation on July 9, 2002. On July 23, 2002, the President signed into law House Joint Resolution 87 designating Yucca Mountain as the repository for spent nuclear fuel and HLW. This development does not represent new and significant information with respect to the offsite radiological impacts related to spent fuel and HLW disposal related to license renewal.

On June 13, 2001, acting pursuant to the Energy Policy Act, the U.S. Environmental Protection Agency (EPA) published its final rule, "Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada," at 40 CFR Part 197 (66 FR 32074). Shortly thereafter, NRC issued its conforming licensing standards in 10 CFR Part 63, "Disposal of High-level Radioactive Wastes in a Proposed Geological Repository at Yucca Mountain, Nevada" (66 FR 55732). On July 9, 2004, in *Nuclear Energy Institute, Inc. v. EPA*, No. 01-1258, the U.S. Court of Appeals for the District of Columbia Circuit vacated the EPA's 40 CFR Part 197 standard and, insofar as the NRC incorporated the EPA compliance period (i.e., 10,000 years for Yucca Mountain) in its rule, 10 CFR Part 63 was also vacated (D.C. Cir. July 9, 2004). The promulgation of the EPA and NRC rules subsequent to the issuance of the GEIS and the invalidation of the 40 CFR 197 standard does not change the Commission's conclusions that the offsite radiological impacts are not sufficiently large that the option of extended operation under 10 CFR Part 54 should be eliminated.

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, including operation at a combined total of 11,856 MW(t). Therefore, the staff concludes that there are no offsite radiological impacts related to spent fuel and HLW disposal during the license renewal term beyond those discussed in the GEIS.

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

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

  The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no nonradiological impacts of the uranium fuel cycle during the license renewal term beyond those discussed in the GEIS.

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

  The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts to the environment will remain small during the term of a renewed license. The maximum additional on-site land that may be required for low-level waste storage during the term of a renewed license and associated impacts will be small. Nonradiological impacts on air and water will be negligible. The radiological and nonradiological environmental impacts of long-term disposal of low-level waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient low-level waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

  The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of low-level waste storage and disposal associated with the license renewal term beyond those discussed in the GEIS.

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

  The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal will not increase the small, continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and

> nonradiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient mixed waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of mixed waste storage and disposal associated with the license renewal term beyond those discussed in the GEIS.

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

> The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated on site with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage is not available.

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of onsite spent fuel associated with the license renewal term beyond those discussed in the GEIS.

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

> No changes to generating systems are anticipated for license renewal. Facilities and procedures are in place to ensure continued proper handling and disposal at all plants.

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no nonradiological waste impacts during the license renewal term beyond those discussed in the GEIS.

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

> The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with average burnup for the peak rod to current levels approved by NRC up to 62,000 MWd/MTU and the cumulative impacts of transporting high-level waste to a single repository, such as Yucca Mountain, Nevada are found to be consistent with the impact values contained in 10 CFR 51.52(c), *Summary Table S-4—Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor*. If fuel enrichment or burnup conditions are not met, the applicant must submit an assessment of the implications for the environmental impact values reported in § 51.52.

BFN meets the fuel-enrichment and burnup conditions set forth in Addendum 1 to the GEIS. The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts of transportation associated with the license renewal term beyond those discussed in the GEIS.

6.2 References

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

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

10 CFR Part 63. Code of Federal Regulations, Title 10, *Energy,* Part 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada."
40 CFR Part 191. Code of Federal Regulations, Title 40, *Protection of Environment,* Part 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste."

40 CFR Part 197. Code of Federal Regulations, Title 40, *Protection of Environment,* Part 197, "Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada."

National Academy of Sciences (NAS). 1995. *Technical Bases for Yucca Mountain Standards.* Washington, D.C.

National Environmental Policy Act (NEPA) of 1969, as amended, 42 USC 4321, et. seq.

Tennessee Valley Authority (TVA). 2003. *Applicant's Environmental Report – Operating License Renewal Stage, Browns Ferry Units 1, 2, and 3.* Knoxville, Tennessee.

U.S. Department of Energy (DOE). 1980. *Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste.* DOE/EIS-0046F, Washington, D.C.

U.S. Department of Energy (DOE). 2002. *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada.* DOE/EIS-0250F, Office of Civilian Radioactive Waste Management, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants.* NUREG-1437, Volumes 1 and 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report,* "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

7.0 Environmental Impacts of Decommissioning

Environmental impacts from the activities associated with the decommissioning of any reactor before or at the end of an initial or renewed license are evaluated in the *Generic Environmental Impact Statement for Decommissioning of Nuclear Facilities Regarding the Decommissioning of Nuclear Power Reactors*, NUREG-0586, Supplement 1 (NRC 2002). The staff's evaluation of the environmental impacts of decommissioning presented in Supplement 1 resulted in a range of impacts for each environmental issue. These results may be used by licensees as a starting point for a plant-specific evaluation of the decommissioning impacts at their facilities.

The incremental environmental impacts associated with decommissioning activities resulting from continued plant operation during the renewal term are evaluated in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999).[a] The evaluation in NUREG-1437 includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

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

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

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

7.1 Decommissioning

Category 1 issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B that are applicable to Browns Ferry Nuclear Plant, Units 1, 2, and 3 decommissioning following the renewal term are listed in Table 7-1. Tennessee Valley Authority (TVA) stated in its Environmental Report (ER) (TVA 2003) that it is aware of no new and significant information regarding the environmental impacts of Browns Ferry Nuclear Plant, Units 1, 2, and 3 license renewal. The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of these issues, the staff concluded in the GEIS that the impacts are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 7-1. Category 1 Issues Applicable to the Decommissioning of Browns Ferry Nuclear Power Plant, Units 1, 2,and 3 Following the License Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
DECOMMISSIONING	
Radiation Doses	7.3.1; 7.4
Waste Management	7.3.2; 7.4
Air Quality	7.3.3; 7.4
Water Quality	7.3.4; 7.4
Ecological Resources	7.3.5; 7.4
Socioeconomic Impacts	7.3.7; 7.4

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

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

  > Doses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem [0.01 person-Sv] caused by buildup of long-lived radionuclides during the license renewal term.

  The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no radiation dose impacts associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

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

  > Decommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected.

  The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts from solid waste associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

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

  > Air quality impacts of decommissioning are expected to be negligible either at the end of the current operating term or at the end of the license renewal term.

  The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts on air quality associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

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

  > The potential for significant water quality impacts from erosion or spills is no greater whether decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts.

  The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts on water quality associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

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

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

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no impacts on ecological resources associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

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

> Decommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year relicense period, but they might be decreased by population and economic growth.

The staff has not identified any new and significant information during its independent review of the TVA ER, the staff's site visit, the scoping process, or its evaluation of other available information, such as operation at a combined total power level of 11,856 MW(t). Therefore, the staff concludes that there are no socioeconomic impacts associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

7.2 References

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

Tennessee Valley Authority (TVA). 2003. *Applicant's Environmental Report – Operating License Renewal Stage, Browns Ferry Units 1, 2, and 3.* Knoxville, Tennessee.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants.* NUREG-1437, Volumes 1 and 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2002. *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities. Supplement 1 Regarding the Decommissioning of Nuclear Power Reactors. Final Report.* NUREG–0586, Supplement 1, Volumes 1 and 2. Office of Nuclear Reactor Regulation, Washington, D.C.

8.0 Environmental Impacts of Alternatives to Operating License Renewal

This chapter examines the potential environmental impacts associated with denying the renewal of the operating licenses (OLs) (i.e., the no-action alternative) for Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 (BFN); the potential environmental impacts from electric generating sources other than BFN; the possibility of purchasing electric power from other sources to replace power generated by BFN and the associated environmental impacts; the potential environmental impacts from a combination of generating and conservation measures; and other generation alternatives that were deemed unsuitable for replacement of power generated by BFN. The environmental impacts are evaluated using the U.S. Nuclear Regulatory Commission's (NRC's) three-level standard of significance – SMALL, MODERATE, or LARGE – developed using the Council on Environmental Quality guidelines and set forth in the footnotes to Table B-1 of Title 10 of the Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B:

> SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
>
> MODERATE – Environmental effects are sufficient to alter noticeably, but not to destabilize important attributes of the resource.
>
> LARGE – Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The impact categories evaluated in this chapter are the same as those used in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999)[(a)] with the additional impact categories of environmental justice and transportation.

8.1 No-Action Alternative

NRC's regulations implementing the National Environmental Policy Act of 1969 (NEPA) specify that the no-action alternative be discussed in an NRC environmental impact statement (EIS) (10 CFR Part 51, Subpart A, Appendix A(4)). For license renewal, the no-action alternative refers to a scenario in which NRC would not renew the OLs for the three BFN units. The Tennessee Valley Authority (TVA) would then decommission the three BFN units after plant operations cease.

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

TVA states in its Environmental Report (ER) (TVA 2003) that if renewal of the Unit 1 OL is denied, further work on Unit 1 recovery and restart would terminate because restart would be economically infeasible. Operation of Units 2 and 3 would cease upon expiration of their OLs in 2014 and 2016, respectively. TVA would likely jointly and concurrently decommission all three units after the expiration of the Unit 3 OL (TVA 2003).

Under the no-action alternative, replacement of BFN electricity generation capacity would be met by (1) demand-side management (DSM) and energy conservation, (2) power purchased from other electricity providers, (3) TVA generating alternatives other than BFN, or (4) some combination of these options. The environmental impacts associated with alternative generation technologies are discussed in Section 8.2.

TVA will be required to comply with NRC decommissioning requirements at 10 CFR 50.82 whether or not the BFN OLs are renewed. If the OLs are renewed, decommissioning activities may be postponed for up to an additional 20 years.

The environmental impacts associated with decommissioning under both license renewal and the no-action alternative would be bounded by the discussion of impacts in Chapter 7 of the GEIS, Chapter 7 of this draft supplemental environmental impact statement (SEIS), and Supplement 1 to the *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities Regarding the Decommissioning of Nuclear Power Reactors* (NRC 2002). The impacts of decommissioning after 60 years of operation are not expected to be significantly different from those occurring after 40 years of operation.

The environmental impacts resulting from the no-action alternative are summarized in Table 8-1 and are discussed in the following paragraphs. Implementation of the no-action alternative would also have certain positive impacts in that adverse environmental impacts associated with the current operation of BFN would be eliminated.

Table 8-1. Summary of Environmental Impacts of the No-Action Alternative at the Browns Ferry Nuclear Power Plant, Units 1,2,and 3

Impact Category	Impact	Comment
Land Use	SMALL	Onsite impacts expected to be temporary. No offsite impacts expected.
Ecology	SMALL	Impacts to ecology are expected to be temporary and can be mitigated using best management practices.
Water Use and Quality	SMALL	Water use would decrease. Water quality unlikely to be adversely affected.
Air Quality	SMALL	Greatest impact is likely to be from fugitive dust; impact can be mitigated using best management practices.

Table 8-1. (contd)

Impact Category	Impact	Comment
Waste	SMALL	Low-Level radioactive waste (LLW) would be disposed of in licensed facilities. High-level radioactive waste (HLW) can be safely stored until a permanent HLW repository is available.
Human Health	SMALL	Radiological doses to workers and members of the public are expected to be within regulatory limits and comparable to, or lower than, doses from operating plants. Occupational injuries are possible, but injury rates at nuclear power plants are below the U.S. average industrial rate.
Socioeconomics	MODERATE	Decrease in employment in Limestone County and surrounding counties and tax revenues in Limestone County.
Aesthetics	SMALL	Positive impact from eventual removal of buildings and structures. Some noise impact during decommissioning operations.
Historic and Archaeological Resources	SMALL	Minimal impact on land utilized during plant operations. Land occupied by BFN would likely be retained by TVA for other purposes.
Environmental Justice	SMALL	Some loss of employment opportunities and social programs is expected.

8.1.1 Land Use

Temporary changes in onsite land use could occur during decommissioning. Temporary changes may include addition or expansion of staging and laydown areas or construction of temporary buildings and parking areas. Offsite land-use impacts associated with uranium mining would no longer occur. In the GEIS, the staff estimated that approximately 400 ha (1000 ac) would be affected for mining the uranium and processing it during the operating life of a 1000-MW(e) nuclear power plant (NRC 1996). Following decommissioning, the land occupied by BFN would likely be retained by TVA for other purposes. It is expected that the existing transmission system, including rights-of-way, would be retained. Eventual sale or transfer of the land occupied by the plant, however, could result in changes to land use. Notwithstanding this possibility, the impacts of the no-action alternative on land use are considered SMALL.

8.1.2 Ecology

Impacts on aquatic ecology could result from removal of in-water pipes and structures. Any impacts to aquatic ecology would likely be short term and could be mitigated. The aquatic environment is expected to recover naturally. Impacts on the terrestrial ecology could occur as a result of land disturbance for additional laydown yards, stockpiles, and support facilities. Land disturbance is expected to be minimal and result in relatively short-term impacts that can be mitigated using best management practices. The land is expected to recover naturally. Overall, the ecological impacts associated with decommissioning are considered SMALL.

8.1.3 Water Use and Quality

Cessation of plant operations would result in a significant reduction in water use because reactor cooling would no longer be required. As plant staff size decreases, the demand for potable water is expected to also decrease. Onsite disposal of demolition debris could result in minimal impacts to water quality. Overall, water use and quality impacts of decommissioning are considered SMALL.

8.1.4 Air Quality

Decommissioning activities that can adversely affect air quality include dismantlement of systems and equipment, demolition of buildings and structures, and the operation of internal combustion engines. The most likely adverse impact would be the generation of fugitive dust. Best management practices, such as seeding and wetting, can be used to minimize the generation of fugitive dust. Overall, air-quality impacts associated with decommissioning activities are considered SMALL.

8.1.5 Waste

Decommissioning activities would result in the generation of radioactive and nonradioactive waste. The volume of low-level radioactive waste (LLW) is related to the type and size of the plant, the decommissioning option chosen, and the waste treatment and volume reduction procedures used. LLW must be disposed of in a facility licensed by NRC or a State with authority delegated by NRC. Recent advances in volume reduction and waste processing have significantly reduced waste volumes. A permanent repository for high-level radioactive waste (HLW) is not currently available. The NRC has made a generic determination that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of that reactor at its spent fuel storage basin or at either onsite or offsite independent spent fuel storage installations (10 CFR 51.23(a)). Disposal of nonradioactive waste would be at onsite and offsite licensed disposal facilities. Overall, waste impacts associated with decommissioning activities are considered SMALL.

8.1.6 Human Health

Radiological doses to occupational workers during decommissioning activities are estimated to average approximately 5 percent of the dose limits in 10 CFR Part 20, and to be similar to, or lower than, the doses experienced by workers in operating nuclear power plants. Collective doses to members of the public and to the maximally exposed individual as a result of decommissioning activities are estimated to be well below the limits in 10 CFR Part 20, and to be similar to, or lower than, the doses received from operating nuclear power plants. Occupational injuries to workers engaged in decommissioning activities are possible. However, historical injury and fatality rates at nuclear power plants have been lower than the average U.S. industrial rates. Overall, the human health impacts associated with decommissioning activities are considered SMALL.

8.1.7 Socioeconomics

If BFN ceased operation, there would be a decrease in employment and tax revenues associated with the closure. Impacts on employment (primary and secondary) and population would occur over a wide area. BFN employees reside in a number of counties; however, approximately 75 percent of employees live in Lauderdale, Limestone, Madison, and Morgan Counties (TVA 2003).

Tax-related impacts would occur in Limestone County and surrounding counties. TVA makes tax-equivalent payments to states served by TVA who in turn redistribute some of the tax payments to the counties that are served by TVA power. In fiscal year 2001 to 2002, Limestone County received more than $4.5 million from the State of Alabama as redistribution of these payments from TVA (TVA 2003). Other counties in the primary labor market area received substantial amounts as well. For example, Madison County received more than $13 million and Morgan County more than $10 million. In 2002, revenues from TVA represented 5.88 percent of the total budget of Limestone County (TVA 2003). The no-action alternative would result in the loss of the taxes attributable to BFN as well as the loss of plant payrolls 20 years earlier than if the OLs were renewed. There would also be an adverse impact on housing values and the local nearby economy if BFN were to cease operations.

Both Chapter 7 of the GEIS and Supplement 1 to NUREG-0586 (NRC 2002) note that socioeconomic impacts would be expected as a result of the decision to close a nuclear power plant, and that the direction and extent of the overall impacts would depend on the state of the economy, the net change in workforce at the plant, and the changes in local government tax receipts. The socioeconomic impact of decommissioning activities themselves is expected to be minimal. Appendix J of Supplement 1 to NUREG-0586 (NRC 2002) shows that the overall socioeconomic impact of plant closure plus decommissioning could be greater than small.

The staff concluded that when the property tax revenue from a nuclear power plant comprises less than 10 percent of the tax revenue of a local jurisdiction, the socioeconomic impacts associated with the loss of the plant's tax revenue as a result of plant closure would likely be minor. Because the tax payments received by Limestone County from TVA are less than 10 percent of total tax revenue, socioeconomic impacts to Limestone County resulting from loss of this revenue would be minimal.

TVA employees working at BFN contribute time and money toward community involvement, including school, churches, charities, and other civic activities. It is likely that with a reduced presence in the community following decommissioning, community involvement efforts by TVA and its employees in the region would be less.

Overall, the socioeconomic impacts associated with non-renewal and decommissioning of the BFN OLs are considered MODERATE.

8.1.8 Aesthetics

Decommissioning would result in the eventual dismantlement of buildings and structures at the BFN site resulting in a positive aesthetic impact. Noise would be generated during decommissioning operations that may be detectable offsite; however, the impact is unlikely to be of large significance. Overall, the aesthetic impacts associated with decommissioning are considered SMALL.

8.1.9 Historic and Archaeological Resources

The amount of undisturbed land needed to support the decommissioning process would be relatively small. Activities conducted within operational areas are not expected to have a detectable effect on important cultural resources because these areas have likely been impacted during the operating life of BFN. Minimal disturbance of land outside TVA's operational area for decommissioning activities is expected. Historic and archaeological resources on undisturbed portions of the plant site are not expected to be adversely affected. The site would likely be retained by TVA following decommissioning. Eventual sale or transfer of the site, however, could result in adverse impacts to cultural resources if the land-use pattern changes dramatically. Notwithstanding this possibility, the impacts of the no-action alternative on historic and archaeological resources are considered SMALL.

8.1.10 Environmental Justice

Current operations at BFN have no disproportionate adverse impacts on the minority and low-income populations of Limestone County and surrounding counties, and no environmental pathways have been identified that would cause disproportionate impacts. Closure of the plant would result in decreased employment opportunities and tax revenues in Limestone County and surrounding counties as a result of reduced in-lieu-of-tax payments from TVA. Together, these impacts could have negative and disproportionate impacts on minority or low-income populations. Overall, however, the environmental justice impacts under the no-action alternative are considered SMALL.

8.2 Alternative Energy Sources

This section discusses the environmental impacts associated with alternative sources of electric power to replace the baseload[a] electric power generating capacity of BFN assuming that the OLs are not renewed.

The TVA ER states that the combined generating capacity of BFN Units 1, 2, and 3 at full uprated power will be 3840 megawatts-electric (MW[e])[b] (TVA 2003). This level of power production will make BFN among the largest, if not the largest, thermal generating station in the United States (DOE/EIA 2002). If the BFN OLs are not renewed, it is unlikely that this level of power (3840 MW[e]) would be produced from alternative generating sources at the BFN site or any other single alternative site. For purposes of the Section 8.2 analysis, it is assumed that replacement power production for the 3840 MW(e) will occur at more than one site and that the BFN site could be one site for siting new alternative power generating sources. Siting of additional energy sources at the BFN site would likely require TVA to acquire additional land beyond the current site boundary. Such acquisition would be complicated by the fact that there are nearby residential areas both upriver and downriver from the BFN site; however, the site could potentially be expanded to the northeast.

The order of presentation of alternative energy sources in Section 8.2 does not imply which alternative would be most likely to occur or to have the least environmental impacts. The following generation alternatives are considered in detail:

- pulverized coal (Section 8.2.1)

- coal gasification (Section 8.2.2)

- natural gas combined-cycle (Section 8.2.3)

- new nuclear (Section 8.2.4).

Consistent with the TVA ER, the principal cooling alternative considered for each alternative energy plant is closed-cycle wet cooling using mechanical draft cooling towers. For completeness, the alternative of once-through cooling is considered, although the use of once-through cooling for newly constructed power plants is limited by the Environmental Protection Agency

(a) A baseload plant normally operates to supply all or part of the minimum continuous load of a system and consequently produces electricity at an essentially constant rate. Nuclear power plants are commonly used for baseload generation; that is, these units generally run near full load continuously.
(b) One megawatt electric (MW[e]) represents one million watts of electric capacity.

(EPA) requirements specified in 40 CFR Part 125, Subpart I, for cooling water intake structures for new facilities under Section 316(b) of the Clean Water Act.

The alternative of purchasing power from other sources to replace power generated at BFN is discussed in Section 8.2.5. Other power generation alternatives and conservation alternatives considered by the staff and found not to be reasonable replacements for the BFN generation capacity are discussed in Section 8.2.6. Section 8.2.7 discusses the environmental impacts of a combination of generation and conservation alternatives.

Each year, the Energy Information Administration (EIA), a component of the U.S. Department of Energy (DOE), issues an Annual Energy Outlook. The 2004 report projects that combined-cycle,[a] combustion turbine, or distributed generation technology fueled by natural gas is likely to account for approximately 62 percent of new electricity generating capacity added between 2002 and 2025 (DOE/EIA 2004). Combined-cycle technology can be used to meet baseload requirements. Coal-fired plants are projected by EIA to account for approximately 33 percent of new capacity during this period. Coal-fired plants are generally used to meet baseload requirements. Renewable energy sources, primarily wind and biomass units, are projected by EIA to account for the remaining 5 percent of capacity additions. EIA's projections are based on the assumption that providers of new generating capacity will seek to minimize cost while meeting applicable environmental requirements. Combined-cycle plants are projected by EIA to have the lowest adjusted generation cost for new plants in 2010 (DOE/EIA 2004). Coal-fired plants are projected to have the lowest adjusted generation cost for new plants in 2025 (DOE/EIA 2004).

EIA projects that oil-fired plants will account for no new generation capacity in the United States through the year 2025, except for limited industrial combined heat and power applications, because of higher fuel costs and lower efficiencies (DOE/EIA 2004).

EIA's reference case also projects that new nuclear power plants will not account for any new generation capacity in the United States through the year 2025 because of the relative economics of competing technologies (DOE/EIA 2004). In spite of this projection, a new nuclear plant alternative for replacing power generated by BFN was considered in the TVA ER and is discussed in Section 8.2.4.

If an alternative generating technology were selected to replace power generated by BFN, Units 1, 2, and 3 would be decommissioned. Environmental impacts associated with decommissioning are discussed in Section 8.1 and are not otherwise addressed in Section 8.2.

(a) In the combined-cycle unit, hot combustion gases in a combustion turbine rotate the turbine to generate electricity. Waste combustion heat from the combustion turbine is routed through a heat-recovery boiler to make steam to generate additional electricity.

8.2.1 Pulverized Coal-Fired Generation

In a pulverized coal-fired generation system, pieces of coal are crushed between balls or cylindrical rollers. The raw coal is then fed into the pulverizer along with air heated to about (343°C) 650°F from the boiler. As the coal is crushed by the rolling action, the hot air both dries it and moves the usable fine coal powder to a burner in the boiler where it is combusted.

In its ER, TVA considered the construction of 1200-MW(e) pulverized coal power stations, composed of two 600-MW(e) subcritical units (TVA 2003). At least three of these stations would be needed to replace the generating capacity of BFN. Each unit would have its own subcritical steam generator and condensing steam turbine generator. The subcritical steam generators would be balanced draft pulverized coal furnaces with drum type, single reheat boilers. Each unit would be an eight-heater cycle design with four low-pressure feedwater heaters, three high-pressure feedwater heaters, and a de-aerator. Ignition fuel would be No. 2 fuel oil.

Major structures for the pulverized coal-fired facility would include the boiler building, turbine and control building, and limestone preparation building. TVA assumed a single common concrete chimney for each station, with dual flues for wet stack gas (TVA 2003).

The pulverized coal-fired stations could be located near the coal supply (i.e., at the "mine mouth") or at a location with suitable cooling water that is closer to the loads to be served. For a mine-mouth plant, the impacts of coal transportation would be relatively small. However, lime or limestone, which is used in the scrubbing process for control of sulfur dioxide emissions,[a] would still need to be delivered to the plant site. Additionally, transmission line impacts would likely be greater for a mine-mouth plant than for a plant sited closer to the areas ultimately needing the power generated at the plant. For a plant not located at the mine mouth, coal would be delivered by railroad or barge.

Although the license renewal term is only 20 years, the impact of operating coal-fired stations for 40 years is considered (as a reasonable projection of the operating life of a coal-fired plant).

8.2.1.1 Closed-Cycle Cooling System

The overall impacts of constructing three 1200-MW(e) pulverized coal-fired power stations using closed-cycle cooling are discussed in the following sections and summarized in Table 8-2. The

(a) In a typical wet scrubber, lime (calcium hydroxide) or limestone (calcium carbonate) is injected as a slurry into the hot effluent combustion gases to remove entrained sulfur dioxide. The lime-based scrubbing solution reacts with sulfur dioxide to form calcium sulfite, which precipitates out and is removed in sludge form.

Table 8-2. Summary of Environmental Impacts of Pulverized Coal-Fired Generation Using Closed-Cycle Cooling

Impact Category	Impact	Comment
Land Use	MODERATE to LARGE	Approximately 1200 ha (3000 ac) for power block; coal handling, storage, and transportation facilities; infrastructure facilities; and waste disposal. Mining the coal and disposal of waste could impact more than 30,000 ha (120 mi^2). Additional land impacts for limestone mining, electric power transmission lines, rail spurs, and cooling water intake and discharge pipelines.
Ecology	MODERATE to LARGE	Impact depends on location and ecology of the site, surface water body used for intake and discharge, and electric power transmission line route; potential habitat loss and fragmentation; reduced productivity and biological diversity; impacts to terrestrial ecology from cooling tower drift.
Water Use and Quality	SMALL to MODERATE	Impact would depend on the volume of water withdrawn and discharged, the constituents in the discharge water, and the characteristics of the surface water body. Discharges would be regulated by the State or EPA.
Air Quality	MODERATE	Air emissions from three pulverized coal-fired plants sized to replace the uprated BFN capacity would be approximately: Sulfur oxides – 13,300 MT/yr (14,700 tons/yr) Nitrogen oxides – 15,900 MT/yr (17,500 tons/yr) PM_{10} – 3200 MT/yr (3500 tons/yr) Carbon monoxide – 4130 MT/yr (4550 tons/yr) Small amounts of mercury and other hazardous air pollutants and naturally occurring radioactive materials, mainly uranium and thorium. 40 million MT/yr (44 million tons/yr) of unregulated carbon dioxide.
Waste	MODERATE	For three 1200-MW(e) stations, potentially marketable material waste streams include 900,000 MT/yr (990,000 tons/yr) of fly ash, 224,400 MT/yr (247,500 tons/yr) of bottom ash, and 1,662,000 MT/yr (1,833,000 tons/yr) of flue gas desulfurization sludge (gypsum). Unusable waste streams would include 1695 MT/yr (1869 tons/yr) of raw water treatment sludges and 1062 MT/yr (1170 tons/yr) of general water treatment sludges.
Human Health	SMALL	Impacts are uncertain, but considered SMALL in the absence of more quantitative data.

Table 8-2. (contd)

Impact Category	Impact	Comment
Socioeconomics	MODERATE	Construction impacts depend on location and how many plants are constructed at the location. Limestone County could experience loss of BFN tax base and employment. Transportation impacts would result from commuting workers and delivery of coal and lime/limestone by rail or barge. Overall, impacts are considered MODERATE.
Aesthetics	MODERATE to LARGE	Impact would depend on the site selected and the surrounding land features. Power block, exhaust stacks, cooling towers, and cooling tower plumes would be visible from nearby areas. If needed, new electric power transmission lines could have a significant aesthetic impact. Noise impact from plant operations and intermittent sources such as rail transportation of coal would be noticeable. Overall, visual and noise impacts are considered MODERATE to LARGE.
Historic and Archeological Resources	SMALL	New plant locations would necessitate cultural resource studies. Any potential impacts can likely be effectively managed.
Environmental Justice	SMALL to MODERATE	Impacts would vary depending on population distribution at the site. Impacts in Limestone County would be the same as those under the no-action alternative.

use of three 1200-MW(e) units is intended to be an approximation of the uprated BFN capacity; actual capacity of BFN is slightly larger - 3840 MW(e). It is unlikely that the three 1200-MW(e) stations would be located at a single site.

- **Land Use**

Approximately 400 ha (1000 ac) would be required for construction and operation of each 1200-MW(e) station. This area includes land for a barge unloading facility, the coal pile, a limestone pile, ash and scrubber solids disposal area, and plant buildings and structures, but it does not include land for an associated coal mine, transmission lines, access road, and railroad spur (TVA 2003).

In the GEIS, the staff estimated that approximately 8800 ha (34 mi^2) would be affected for mining the coal and disposing of the waste to support a 1000-MW(e) coal plant during its operational life (NRC 1996). A replacement coal-fired plant to replace the 3840-MW(e) capacity of BFN would affect proportionately more land.

Construction of each station would permanently change the land use at the site, and would most likely involve an irretrievable but moderate loss of forest land and/or farmland. Because of the use of erosion control practices during and following construction, no significant impacts to plant site soils are anticipated.

The impacts of three 1200-MW(e) pulverized coal-fired generating stations on land use is best characterized as MODERATE to LARGE. The impact would definitely be greater than the alternative of renewing the BFN OLs.

- **Ecology**

The coal-fired generation alternative would introduce construction impacts and new incremental operational impacts. Even assuming siting at a previously disturbed area, the impacts would alter the ecology. Impacts could include wildlife habitat loss, reduced productivity, habitat fragmentation, and a local reduction in biological diversity. Use of cooling makeup water from a nearby surface water body could have adverse aquatic resource impacts. If needed, construction and maintenance of a transmission line and a rail spur would have ecological impacts. There could be impacts to terrestrial ecology from cooling tower drift. Overall, the ecological impacts would be MODERATE to LARGE.

- **Water Use and Quality**

Construction of each power station (including transmission lines and access roads) would affect surface water hydrology, but sites could be chosen to avoid extensive site excavation, filling, or grading. New construction would disturb the land surface, which may temporarily affect surface water quality. Potential water-quality impacts would consist of suspended solids from disturbed soils, biochemical oxygen demand, nutrient loading from disturbed vegetation, and oil and grease from construction equipment. New construction activities that disturb 2 ha (5 ac) or more would require a National Pollutant Discharge Elimination System (NPDES) permit for storm water discharges from the site to ensure the implementation of best management practices and to minimize impacts to surface waters during construction. To minimize the impacts of storm water flow erosion during construction, onsite retention areas (storm water detention pond) would be designed to detain storm water from the 25-year, 24-hour rainfall event. Runoff detention ponds would be designed to detain runoff within the containment areas to allow for settling and to reduce peak discharges. Best management practices would also be required during construction to minimize water-quality impacts. Construction would cause no significant consumption of surface water resources. Sanitary waste water would most likely be routed to a publicly owned treatment works, if available. If a sanitary waste treatment system was not available, one would be constructed (TVA 2003).

During operation, approximately 90.5 percent of the 908 L/s (14,400 gal/min) plant intake water requirement for each 1200-MW(e) station would be for cooling tower makeup water flow, or about 822.7 L/s (13,040 gal/min). This amount of water consumption is normally obtainable from river intake or wells with a negligible impact on water availability downstream or in the vicinity of the plant. Cooling water for the main condensers and miscellaneous components would be recirculated through the cooling towers, with the blowdown (i.e., the fraction of circulated water that is discharged to prevent the buildup of dissolved salts and minerals) and other plant operational waste water streams subsequently being discharged through diffusers. A biocide would be used to protect the cooling water system from biological growths. Cooling tower blowdown amounting to 164 L/s (2600 gal/min) is expected to be several times larger than any other waste water stream, but it would not contain any detectable amounts of priority pollutants. Plant process waste water streams would include demineralizer regeneration wastes (11.4 L/s [180 gal/min]), steam cycle blowdown (13 L/s [200 gal/min]), and service water/pre-treatment waste and chemical drains (5.80 L/s [92 gal/min]). Plant waste water outfalls would also require an NPDES permit, with established treatment standards and discharge limits. To prevent leachate in storm water runoff from entering the surficial aquifer, the coal storage area and the runoff basin would be lined with low-permeability materials. Runoff streams from the coal pile, fly ash and bottom ash piles, and gypsum storage area would be collected in the lined recycle basin for reuse (which would be sized to exceed capacity requirements for the 25-year, 24-hour storm event), with no direct discharge to the surface water (TVA 2003).

Overall, water use and quality impacts can be characterized as SMALL to MODERATE.

- **Air Quality**

The air-quality impacts of coal-fired generation vary considerably from those of nuclear generation due to emissions of sulfur oxides (SO_x), nitrogen oxides (NO_x), particulates, carbon monoxide, hazardous air pollutants such as mercury, and naturally occurring radioactive materials. Estimated emissions for SO_x, NO_x, PM_{10} (particulate matter with an aerodynamic diameter less than or equal to 10 μm), and carbon monoxide are shown in Table 8-2. The emissions are for new pulverized coal-fired plants meeting all applicable regulatory requirements with a capacity sufficient to replace the power generated at the BFN.

A new coal-fired generating plant would need to meet the new source review requirements in Title I of the Clean Air Act (42 USC 7491). The plant would need an operating permit issued under Title V of the Clean Air Act. The plant would also need to comply with the new source performance standards for new generating plants in 40 CFR Part 60 Subpart Da. The standards establish limits for particulate matter and opacity (40 CFR 60.42a), sulfur dioxide (SO_2) (40 CFR 60.43a), and NO_x (40 CFR 60.44a).

EPA has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P, including a specific requirement for review of any new major stationary source in an area designated as attainment or unclassified under the Clean Air Act.

Section 169A of the Clean Air Act establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment results from air pollution caused by human activities. In addition, EPA issued a new regional haze rule in 1999 (64 FR 35714). The rule specifies that State agencies must establish goals for reasonable progress towards achieving natural visibility conditions for each mandatory Class I Federal area located within a state. The reasonable progress goals must provide for an improvement in visibility for the most-impaired days over the period of the implementation plan and ensure no degradation in visibility for the least-impaired days over the same period (40 CFR 51.30(d)(1)). If a new coal-fired power plant were located close to a mandatory Class I area, additional air pollution control requirements could be imposed.

In 1998, EPA issued a rule requiring 22 eastern states to revise their State implementation plans to reduce NO_x emissions. Nitrogen oxide emissions contribute to violations of the national ambient air-quality standard for ozone (40 CFR 50.9). The total amount of NO_x that can be emitted by each of the 22 states in the year 2007 ozone season (May 1 through September 30, 2007) is specified in 40 CFR 51.121(e). For Alabama, the amount is 156,597 MT (172,619 tons). Any new coal-fired plant sited in Alabama would be subject to these limitations.

A new coal-fired power plant would be subject to the requirements in Title IV of the Clean Air Act. Title IV was enacted to reduce emissions of SO_2 and NO_x, the two principal precursors of acid rain, by restricting emissions of these pollutants from power plants. Title IV caps aggregate annual power plant SO_2 emissions and imposes control on SO_2 emissions through a system of marketable allowances. EPA issues one allowance for each ton of SO_2 that a unit is allowed to emit. New units do not receive allowances but are required to have allowances to cover their SO_2 emissions. Owners of new units must therefore acquire allowances from owners of other power plants by purchase or reduce SO_2 emissions at other power plants they own. Allowances can be banked for use in future years. Thus, a new coal-fired power plant would not add to net regional SO_2 emissions, although it might do so locally. Regardless, SO_2 emissions would be greater for the coal alternative than the OL renewal alternative because a nuclear power plant releases almost no SO_2 during normal operations.

Section 407 of the Clean Air Act establishes technology-based emission limitations for NO_x emissions. The market-based allowance system used for SO_2 emissions is not used for NO_x emissions. A new coal-fired power plant would be subject to the new source performance standards for such plants at 40 CFR 60.44a(d)(1). This regulation, issued on September 16, 1998 (63 FR 49453), limits the discharge of any gases that contain nitrogen oxides (expressed as NO_2) in excess of 200 ng/J of gross energy output (1.6 lb/MWh), based on a 30-day rolling average.

During the construction of a coal-fired plant, fugitive dust would be generated. Exhaust emissions would come from vehicles and motorized equipment used during the construction process. In addition, coal-handling equipment would introduce fugitive particulate emissions.

In December 2000, the EPA issued regulatory findings on emissions of hazardous air pollutants from electric utility steam-generating units (65 FR 79825). The EPA determined that coal- and oil-fired electric utility steam-generating units are significant emitters of hazardous air pollutants. Coal-fired power plants were found by EPA to emit arsenic, beryllium, cadmium, chromium, dioxins, hydrogen chloride, hydrogen fluoride, lead, manganese, and mercury. The EPA concluded that mercury is the hazardous air pollutant of greatest concern. The EPA found that (1) there is a link between coal utilization and mercury emissions; (2) electric utility steam-generating units are the largest domestic source of mercury emissions; and (3) certain segments of the U.S. population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health effects because of mercury exposures resulting from consumption of contaminated fish. Accordingly, EPA added coal- and oil-fired electric utility steam-generating units to the list of source categories under Section 112(c) of the Clean Air Act for which emission standards for hazardous air pollutants will be issued.

Coal contains uranium and thorium. Uranium concentrations are generally in the range of 1 to 10 parts per million. Thorium concentrations are generally about 2.5 times greater than uranium concentrations (Gabbard 1993). One estimate is that a 1000-MW(e) coal-fired plant had an annual release of approximately 4.7 MT (5.2 tons) of uranium and 11.6 MT (12.8 tons) of thorium in 1982 (Gabbard 1993). The population dose equivalent from the uranium and thorium releases and daughter products produced by the decay of these isotopes has been calculated to be significantly higher than that from nuclear power plants (Gabbard 1993).

A coal-fired plant would also have unregulated carbon dioxide emissions that could contribute to global warming. TVA estimates that pulverized coal-fired plants sufficient to replace the power generated at BFN would emit approximately 40 million MT/yr (44 million tons/yr) of carbon dioxide (TVA 2003).

The GEIS analysis did not quantify emissions from coal-fired power plants but implied that air-quality impacts would be substantial. The GEIS also mentioned global warming from unregulated carbon dioxide emissions and acid rain from SO_x and NO_x emissions as potential impacts (NRC 1996). Adverse human health effects from coal combustion, such as cancer and emphysema, have been associated with the products of coal combustion.

Overall, the air-quality impacts associated with three new 1200-MW(e) pulverized coal-fired stations to replace the power generated at BFN would be MODERATE. The impacts would be clearly noticeable, but would not destabilize air quality.

- **Waste**

Coal combustion generates waste in the form of ash, and equipment for controlling air pollution generates additional ash, spent selective catalytic reduction (SCR) catalyst, and scrubber sludge.

Pulverized coal-fired plants would produce solid material streams in significant quantities, including both potential by-products and unusable solid wastes. The potentially marketable material streams for three 1200-MW(e) units are shown in Table 8-2. All of these by-product and waste streams are classified as non-hazardous, as determined by the Resource Conservation and Recovery Act (RCRA) toxicity characteristic leaching procedure (TVA 2003). Provision would be made to store fly ash, bottom ash, and scrubber by-products onsite indefinitely. If permitted, it might be possible to inject ash into underground mine works in the future. TVA would explore the market potential and economic benefit of selling the ash and scrubber by-products to wallboard manufacturers. Water treatment sludges would be disposed of at a State-approved landfill, either onsite or offsite. Spent SCR catalyst would be regenerated or disposed of offsite. Waste impacts to groundwater and surface water could extend beyond the operating life of the plant if leachate and runoff from the waste storage area occurs. Disposal of the waste could noticeably affect land use and groundwater quality, but with appropriate management and monitoring, it would not destabilize any resources. After closure of the waste site and revegetation, the land could be available for other uses.

In May 2000, EPA issued a "Notice of Regulatory Determination on Wastes from the Combustion of Fossil Fuels" (65 FR 32214). EPA concluded that some form of national regulation is warranted to address coal combustion waste products because (1) the composition of these wastes could present danger to human health and the environment under certain conditions; (2) EPA has identified 11 documented cases of proven damages to human health and the environment by improper management of these wastes in landfills and surface impoundments; (3) present disposal practices are such that, in 1995, these wastes were being managed in 40 to 70 percent of landfills and surface impoundments without reasonable control in place, particularly in the area of groundwater monitoring; and (4) EPA identified gaps in State oversight of coal combustion wastes. Accordingly, EPA announced its intention to issue regulations for disposal of coal combustion waste under subtitle D of RCRA.

Debris would be generated during construction activities for the three 1200-MW(e) units. Such debris would be disposed of in landfills.

For all of the preceding reasons, the appropriate characterization of impacts from waste generated from burning pulverized coal is MODERATE; the impacts would be clearly noticeable but would not destabilize any important resource.

- **Human Health**

Coal-fired power generation introduces worker risks from coal and limestone mining, worker and public risks from coal and lime/limestone transportation, worker and public risks from disposal of coal combustion wastes, and public risks from inhalation of stack emissions. Emission impacts can be widespread and health risks are difficult to quantify. The coal alternative also introduces the risk of coal-pile fires and attendant inhalation risks.

The staff stated in the GEIS that there could be human health impacts (cancer and emphysema) from inhalation of toxins and particulates from a coal-fired plant, but did not identify the significance of these impacts (NRC 1996). In addition, the discharges of uranium and thorium from coal-fired plants can potentially produce radiological doses in excess of those arising from nuclear power plant operations (Gabbard 1993).

Regulatory agencies, including EPA and State agencies, set air emission standards and requirements based on human health impacts. These agencies also impose site-specific emission limits as needed to protect human health. As discussed previously, EPA has recently concluded that certain segments of the U.S. population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health effects because of mercury exposures from sources such as coal-fired power plants. However, in the absence of more quantitative data, human health impacts from radiological doses and inhaling toxins and particulates generated by burning coal at a newly constructed coal-fired plant are characterized as SMALL.

- **Socioeconomics**

The projected construction period for a 1200-MW(e) pulverized coal-fired power plant would be 54 months, with the first unit becoming operational at 48 months (TVA 2003). The total construction workforce would ramp up to the peak of 1100 workers over the first 18 months and then remain there until beginning to decline at 30 months to 500 workers at 42 months (TVA 2003). The total number of workers would exceed 500 for approximately 18 months. The peak number of workers would noticeably affect the local workforce for most sites, but the jobs would be temporary and many of the workers would commute from surrounding areas. The influx of workers could noticeably affect local school systems and other social services.

For a mine-mouth plant, the mining process preparation would increase the local construction employment to a base of 1500 workers for 4 years, peaking at 2500 workers (TVA 2003). A construction workforce of this size would have a noticeable impact for most prospective sites.

The permanent operating staff for a 1200-MW(e) pulverized coal-fired power plant would be approximately 120 workers. If the plant is sited at a mine mouth, the projected local employment for the mining operation would be approximately 320 workers (TVA 2003).

The coal-fired plants would provide a new tax base for the local communities in which they are sited through the in-lieu-of-tax payments made by TVA. In-lieu-of-tax payments in Limestone County would likely decrease if the BFN OLs are not renewed. For all of these reasons, the nontransportation socioeconomic impacts for new pulverized coal-fired plants would be noticeable, but would be unlikely to destabilize the area.

For transportation related to commuting of plant operating personnel for a 1200-MW(e) pulverized coal-fired power plant, the impacts are considered negligible. Transportation impacts would be temporary, noticeable, but not destabilizing during plant construction.

The GEIS states that socioeconomic impacts at a rural site would be larger than at an urban site, because more of the peak construction workforce would need to move to the area to work (NRC 1996).

Coal and lime/limestone would likely be delivered by rail to each power plant, although barge delivery is feasible for a site located on a navigable body of water. Socioeconomic impacts associated with rail transportation would likely have some impact to the community. Barge delivery of coal and lime/limestone would likely have minor socioeconomic impacts.

For power plants not located at the mine mouth, socioeconomic impacts would also occur at the site of coal mining.

Overall, the staff concludes that socioeconomic impacts associated with constructing and operating three 1200-MW(e) pulverized coal-fired plants would be MODERATE.

- **Aesthetics**

The coal-fired power block could be as much as 60 m (200 ft) tall and could be visible offsite during daylight hours. The exhaust stack could be as much as 200 m (650 ft) high. The stack would likely be highly visible in daylight hours for distances greater than 16 km (10 mi). The plant and associated stack would also be visible at night because of outside lighting. The Federal Aviation Administration generally requires that all structures exceeding an overall height of 60 m (200 ft) above ground level have markings and/or lighting so as not to impair aviation safety (FAA 2000). Visual impacts of a new coal-fired plant could be mitigated by landscaping and color selection for buildings that is consistent with the environment. Visual impact at night could be mitigated by reduced use of lighting, provided the lighting meets Federal Aviation Administration requirements, and appropriate use of shielding. Overall, the addition of the coal-fired unit and the associated exhaust stack would likely have some aesthetic impact. There could be a significant aesthetic impact if construction of a new transmission line and/or rail spur is needed.

Coal-fired generation would introduce mechanical sources of noise that would be audible offsite. Sources contributing to total noise produced by plant operation are classified as continuous or intermittent. Continuous sources include the mechanical equipment associated with normal plant operations. Intermittent sources include the equipment related to coal handling, solid-waste disposal, transportation related to coal and lime/limestone delivery, use of outside loudspeakers, and the commuting of plant employees. The noise impacts of a coal-fired plant would be slightly greater than those of current operations at BFN. Noise impacts associated with rail delivery of coal and lime/limestone would be most significant for residents living in the vicinity of the facility and along the rail route. Although noise from passing trains significantly raises noise levels near the rail line, the short duration of the noise reduces the impact. Nevertheless, given the frequency of train transport and the fact that many people are likely to be within hearing distance of the rail route, the impacts of noise on residents in the vicinity of the facility and the rail line would be noticeable. Noise associated with barge transportation of coal and lime/limestone would be minimal. Noise and light from the pulverized coal-fired power plants would be detectable offsite. Aesthetic impacts at the plant site would be mitigated if the plant were located in an industrial area adjacent to other power plants.

Overall, the aesthetic impacts associated with new pulverized coal-fired power plants can be categorized as MODERATE to LARGE.

- **Historic and Archaeological Resources**

At any prospective site for a pulverized coal-fired power plant, a cultural resources inventory would likely be needed for any onsite property that has not been previously surveyed. Other lands, if any, that are acquired to support the plant would also likely need an inventory of field cultural resources, identification and recording of existing historic and archaeological resources, and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site.

Before construction, studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on cultural resources. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission lines, rail lines, or other rights-of-way). Historic and archaeological resource impacts can generally be effectively managed and as such are considered SMALL.

- **Environmental Justice**

Environmental justice impacts would depend upon the sites chosen for the pulverized coal-fired power plants and the nearby population distribution. Construction activities would offer new employment possibilities, but could have negative impacts on the availability and cost of housing, which could disproportionately affect minority and low-income populations. Impacts in

Limestone County would be the same as those under the no-action alternative. Overall, environmental justice impacts are likely to be SMALL to MODERATE.

8.2.1.2 Once-Through Cooling System

The environmental impacts of constructing and operating a pulverized coal-fired power plant using closed-cycle cooling with wet cooling towers are essentially the same as the impacts for a coal-fired plant using a once-through system. However, there are some environmental differences between the closed-cycle and once-through cooling systems. Table 8-3 summarizes the incremental differences.

Table 8-3. Summary of Environmental Impacts of Pulverized Coal-Fired Generation with Once-Through Cooling

Impact Category	Change In Impacts from Closed-Cycle Cooling System
Land Use	10 to 12 ha (25 to 30 ac) less land required per 1200-MW(e) unit because cooling towers and associated infrastructure are not needed.
Ecology	Impact would depend on ecology at the site. No impact to terrestrial ecology from cooling tower drift. Increased water withdrawal with possible greater impact to aquatic ecology.
Surface Water Use and Quality	No discharge of cooling tower blowdown. Increased water withdrawal and more thermal load on receiving body of water.
Groundwater Use and Quality	No change
Air Quality	No change
Waste	No change
Human Health	No change
Socioeconomics	No change
Aesthetics	Less aesthetic impact because cooling towers would not be used.
Historic and Archaeological Resources	Less land impacted.
Environmental Justice	No change

8.2.2 Coal Gasification

Coal gasification is a method of producing relatively clean, burnable gas from almost any type of coal or from petroleum coke. The basic process involves crushing the coal and partially oxidizing the carbon in the coal. Partial oxidation converts the coal into a gaseous fuel composed primarily of combustible hydrogen and carbon monoxide. The gas can be piped directly into a gas turbine to generate electricity. The exhaust from the gas turbine is ducted into a heat recovery steam generator to produce steam for a conventional steam turbine generator. To make the overall process both environmentally safe and thermally efficient, a coal gasification plant must integrate a number of different technologies. Major systems include fuel preparation, an air separation unit, a gasifier, acid gas removal, sulfur recovery, a combustion turbine generator, a heat recovery steam generator, and a steam turbine generator (TVA 2003).

It its ER TVA evaluated the construction and operation of a 2720-MW(e) coal gasification plant sited at TVA's unfinished Bellefonte nuclear plant site. Additional capacity beyond the 2720-MW(e) plant, probably sited at another location, would be needed to fully replace the 3840-MW(e) uprated capacity of BFN. The Bellefonte site comprises approximately 610 ha (1500 ac) and is located adjacent to the Tennessee River (Guntersville Lake) in Jackson County, Alabama. Construction access routes are completed at the Bellefonte site, and basic support functions (i.e., electric power, potable water, sanitary waste disposal, office buildings, parking lots, railways, and barge unloading facility) are in place (TVA 2003). Almost all of the basic site preparation work such as grading has been completed.

The coal gasification plant would have eight 340-MW(e) modules, each consisting of one coal gasification plant, one combustion turbine, and one heat recovery steam generator. The steam recovered from each module would be collected and routed to the two existing low-pressure steam turbine generators, four modules per steam turbine. An air separation plant would be constructed for each gasifier to supply the pressurized 95 percent (by volume) oxygen required for the oxygen-blown gasifiers (TVA 2003).

Delivery of coal and/or petroleum coke to the Bellefonte site would be needed. Approximately 21,800 MT (24,000 tons) of fuel would be shipped in daily, probably via barge (TVA 2003). If coal is used as fuel, the origin would likely be southern Illinois. If petroleum coke is used as fuel, the origin would likely be Texas or Louisiana, states with extensive refining industries. Approximately 218 MT/day (240 tons/day) of limestone would likely be required for air pollution control. Trucking would be used for limestone delivery. Fuel oil would be required for startup activities, but would not be used as a backup fuel (TVA 2003).

8.2.2.1 Closed-Cycle Cooling System

The overall impacts of constructing a coal gasification plant at the Bellefonte site are discussed in the following sections and summarized in Table 8-4. Additional impacts would occur at another location as necessary to fully replace the 3840-MW(e) capacity of BFN. The impact categorizations in Table 8-4 are based on 3840 MW(e) of coal gasification generating capacity.

Table 8-4. Summary of Environmental Impacts of Coal Gasification Using Closed-Cycle Cooling

Impact Category	Impact	Comment
Land Use	MODERATE to LARGE	Impact at the Bellefonte site would be minor, but there would be offsite impacts for coal and limestone mining. At other sites, several hundred acres would be impacted for the power block; fuel handling, storage, and transportation facilities; infrastructure facilities; and for waste disposal. Additional land impacts for coal and limestone mining, electric power transmission lines, and cooling water intake and discharge pipelines.
Ecology	SMALL to LARGE	Impact at the Bellefonte site would be SMALL to MODERATE. Impacts at another site could be as much as LARGE and would depend on the location and the ecology of the site, the surface water body used for intake and discharge, and the electric power transmission line route; potential habitat loss and fragmentation; reduced productivity and biological diversity; impacts to terrestrial ecology from cooling tower drift.
Water Use and Quality	SMALL to MODERATE	Impact would depend on the volume of water withdrawn and discharged, the constituents in the discharge water, and the characteristics of the surface water body. Discharges at the Bellefonte site would be regulated by the Alabama Department of Environmental Management.
Air Quality	MODERATE	Air emissions from coal gasification plants sized to fully replace BFN capacity would be approximately: Sulfur oxides – 10,700 MT/yr (11,800 tons/yr) Nitrogen oxides – 4881 MT/yr (5380 tons/yr) PM_{10} – 1524 MT/yr (1680 tons/yr) Carbon monoxide – 5661 MT/yr (6240 tons/yr) Small amounts of mercury and other hazardous air pollutants and naturally occurring radioactive materials, mainly uranium and thorium, would be discharged along with approximately 28 million MT/yr (31 million tons/yr) of unregulated carbon dioxide.
Waste	MODERATE	Waste streams from the 2720-MW(e) plant would be 457,000 MT/yr (504,000 tons/yr) of slag, 36,000 MT/yr (40,000 tons/yr) of fly ash, 180,000 MT/yr (200,000 tons/yr) of sulfur, 1161 MT/yr (1280 tons/yr) of raw water treatment sludge, 730 MT/yr (800 tons/yr) of general waste water treatment sludge, and 36 MT/yr (40 tons/yr) of sludges from the biotreatment of gasification process waste water.

Table 8-4. (contd)

Impact Category	Impact	Comment
Human Health	SMALL	Impacts are uncertain, but considered to be SMALL in the absence of more quantitative data.
Socioeconomics	MODERATE	Peak construction employment at the Bellefonte site would be approximately 2200 workers. The operating workforce would be approximately 530. Limestone County could experience loss of BFN tax base and employment. Transportation impacts would result from commuting workers and delivery of coal and lime/limestone. Transportation of coal to the Bellefonte site would likely be by barge with negligible socioeconomic impacts. Overall, impacts are considered MODERATE.
Aesthetics	MODERATE	Introduction of 12 new emission stacks 99.1 m (325 ft) high and two flaring stacks 60 m (200 ft) high. No new transmission lines or cooling towers at the Bellefonte site.
Historic and Archeological Resources	SMALL	The Bellefonte site has had previous surveys for historic and archeological resources. Any potential impacts can likely be effectively managed.
Environmental Justice	SMALL to MODERATE	Impacts would vary depending on population distribution and makeup water at the site. Impacts in Limestone County would be the same as those under the no-action alternative.

- **Land Use**

TVA assumes siting of the coal gasification facility at the existing unfinished Bellefonte nuclear plant site (TVA 2003). The existing cooling towers and circulating water system at the Bellefonte site would be used. There is an existing 39.9-km (24.8-mi) 500-kV transmission line to the Bellefonte site that is not energized (TVA 2003). Approximately 77 ha (190 ac) to the southwest of the existing cooling towers would be used to construct new facilities. Construction in this location would require the demolition or relocation of several existing buildings and underground utilities. After completion of demolition, the area would be cleared of existing vegetation, then leveled to an elevation above the 500-year floodplain (TVA 2003). Construction would include the preparation of an area for disposal of unmarketable slag. There would be offsite land impacts to supply coal and limestone for the plant.

At another site, several hundred acres would be impacted for the power block; fuel handling, storage, and transportation facilities; infrastructure facilities; and waste disposal. There would be additional land impacts for coal and limestone mining, electric power transmission lines, and cooling water intake and discharge pipelines.

In the GEIS, the staff estimated that approximately 8800 ha (34 mi^2) would be affected for mining the coal and disposing of the waste to support a 1000-MW(e) coal plant during its operational life (NRC 1996). A replacement coal gasification plant to replace the 3840-MW(e) capacity of BFN would affect proportionately more land.

Overall, land-use impacts can be characterized as MODERATE to LARGE.

- **Ecology**

At the Bellefonte site, there are no Federally or State-listed threatened or endangered plant species (TVA 2003). Construction of barge facilities could result in some reduction in roosting and foraging sites for raptors, bats, waterfowl, and wading birds such as great egrets, green herons, and great blue herons. There are no caves at the Bellefonte site that support the Federally endangered Indiana and gray bats, but they are known to forage along the Guntersville Lake shoreline. However, areas close to the Bellefonte site have an extensive network of similar wooded shoreline and shallow lagoon habitats. Therefore, the impacts associated with new coal gasification facilities are expected to be minimal. Lowering the existing diffuser at the site and constructing the barge terminal and mooring cells would require in-stream dredging to remove approximately 115,000 m^3 (150,000 yd^3) of material, resulting in impacts on resident aquatic communities. However, surveys have found no toxic sediments and a low average density of mussels in the area, and it is expected that the dredge material would be disposed on land (TVA 2003). Because water intake demand is small compared to the total water mass flowing past the Bellefonte site, there is little potential for significant entrainment or impingement impacts (TVA 2003). The existing Bellefonte water intake structure would be used. The greatest impacts of entrainment and impingement would result from water withdrawn from the upstream productive overbank, although losses to the lake fish community should be minimal due to the large amounts of similar habitat near the plant and in other areas of the lake (TVA 2003). There could be impacts to terrestrial ecology from cooling tower drift.

At another site, the coal gasification alternative would introduce construction impacts and new incremental operational impacts.. Even assuming siting at a previously disturbed area, the impacts would alter the ecology. Impacts could include wildlife habitat loss, reduced productivity, habitat fragmentation, and a local reduction in biological diversity. Use of cooling makeup water from a nearby surface water body could have adverse aquatic resource impacts. If needed, construction and maintenance of a transmission line and a rail spur would have ecological impacts.

Overall, the ecological impacts at the Bellefonte site are considered SMALL to MODERATE and at another site SMALL to LARGE.

- **Water Use and Quality**

Raw water for construction and operation at the Bellefonte site would be obtained from the Tennessee River. The quantities needed would be unlikely to have a significant effect on the river. The highest sustained water needs during operation would be approximately 2315 L/s (36,700 gal/min), or about 0.21 percent of the average river flow. Of the 2315 L/s, 1142 L/s (18,100 gal/min) would be for cooling system makeup water. Both existing closed-cycle natural draft cooling towers on the Bellefonte site would be used (TVA 2003).

Potable water is supplied to the Bellefonte site by the City of Hollywood, which receives its water from the City of Scottsboro. The Bellefonte site is connected to the Hollywood municipal sewage system treatment plant located adjacent to the south side of the site. The sewage treatment plant serves the Bellefonte site and residential customers in the area, but currently it does not have sufficient capacity to handle the increased demand of a large construction workforce and would have to be enlarged (TVA 2003).

No significant construction-related impacts to surface water resources would be expected as a result of the project. The majority of the power plant and associated facilities would be constructed on land that has been previously disturbed due to construction activities related to the uncompleted Bellefonte nuclear plant. Construction of new facilities and overall site reclamation activities would affect surface hydrology, but extensive site excavation, filling, or grading would not be needed. The primary surface water impact during construction would be soil erosion, which could be kept low by the use of best management practices. To minimize the impacts of storm water flow during construction, a storm water retention pond would be designed to retain storm water from the 25-year, 24-hour rainfall event, in compliance with regulatory requirements (TVA 2003).

The surface water resources within the areas of the proposed development at the Bellefonte site are currently monitored under an NPDES permit issued by the Alabama Department of Environmental Management.

Any impacts to groundwater during operation would most likely be associated with storage and handling of feedstocks and the storage, handling, and disposal of wastes generated. Runoff from the coal and petroleum coke storage areas would be collected in a drainage basin and treated as needed (TVA 2003).

At another site, water use and quality impacts would depend on the volume of water withdrawn and discharged, the constituents in the discharge water, and the characteristics of the surface water body. Discharges would be regulated by the State or by EPA. Construction-related impacts at another site may be significantly greater than at the Bellefonte site; however, they would be mitigable and temporary.

Overall, water use and quality impacts at the Bellefonte site or another site can be characterized as SMALL to MODERATE.

- **Air Quality**

Estimated air emissions for a coal gasification plant meeting all applicable regulatory requirements and sized to fully replace the 3840-MW(e) uprated capacity of BFN are shown in Table 8-4 (TVA 2003). The estimated emissions are based on using petroleum coke as fuel. Emissions of SO_x are higher for petroleum coke than if coal is used as the fuel.

A new coal gasification generating plant would need to meet the new source review requirements in Title I of the Clean Air Act. The plant would need an operating permit issued under Title V of the Clean Air Act. The plant would also need to comply with the new source performance standards for new generating plants in 40 CFR Part 60, Subpart Da. The standards establish limits for particulate matter and opacity (40 CFR 60.42a), SO_2 (40 CFR 60.43a), and NO_x (40 CFR 60.44a).

EPA has various regulatory requirements for visibility protection in 40 CFR Part 51 Subpart P, including a specific requirement for review of any new major stationary source in an area designated as attainment or unclassified under the Clean Air Act. All of Jackson County, Alabama, the location of the Bellefonte site, is classified as attainment or unclassified for criteria pollutants under the Clean Air Act.[a]

Section 169A of the Clean Air Act establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment is from air pollution resulting from human activities. In addition, EPA issued a new regional haze rule in 1999 (64 FR 35714). The rule specifies that for each mandatory Class I Federal area located within a state, State agencies must establish goals that provide for reasonable progress towards achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for the most-impaired days over the period of the implementation plan and ensure no degradation in visibility for the least-impaired days over the same period (40 CFR 51.308(d)(1)). If a new coal gasification power plant were located close to a mandatory Class I area, additional air pollution control requirements could be imposed. The nearest Class I area to the Bellefonte site is the Cohutta Wilderness, which is approximately 120 km (75 mi) distant (TVA 2003).

In 1998, the EPA issued a rule requiring 22 eastern states to revise their state implementation plans to reduce NO_x emissions. Nitrogen oxide emissions contribute to violations of the national ambient air quality standard for ozone (40 CFR 50.9). The total amount of NO_x that

(a) Existing criteria pollutants under the Clean Air Act are ozone, carbon monoxide, particulates, sulfur dioxide, lead, and nitrogen oxide. Ambient air standards for criteria pollutants are set out at 40 CFR Part 50.

can be emitted by each of the 22 states in the year 2007 ozone season (May 1 through September 30) is set out at 40 CFR 51.121(e). For Alabama, the amount is 172,619 tons. Any new fossil-fired plant sited in Alabama would be subject to these limitations.

Overall, the air-quality impacts associated with new coal gasification plants to replace the power generated at BFN would be MODERATE. The impacts would be clearly noticeable, but would not destabilize air quality.

- **Waste**

The major solid waste and by-product streams would be generated by the gasifiers. Slag, fly ash, and sulfur account for more than 99 percent of the solids produced by coal gasification plants, with the remaining 1 percent consisting of spent catalysts and water treatment sludges. The generation rates in tons per year for a 2720-MW(e) plant are shown in Table 8-4 (TVA 2003). The slag produced is an inert, glass-like material that has been found in coal gasification demonstrations to be nonleachable (TVA 2003). Based on testing at gasification demonstration plants, the slag and fly ash from gasification of eastern bituminous coal is expected to be below the RCRA threshold limits for hazardous designation (TVA 2003). Most of the sulfur in the coal is converted to hydrogen sulfide in the synthetic gas. The hydrogen sulfide is removed by acid gas removal and then converted to elemental sulfur by-product in the sulfur recovery system. TVA anticipates that the slag, fly ash, and sulfur produced at a coal gasification plant would be of sufficient quality to be marketed (TVA 2003).

There would be three process solid waste streams composed of sludges from raw water or waste water treatment: raw water treatment sludge, general waste water treatment sludge, and sludge from the biotreatment of gasification process waste water. Generation amounts are shown in Table 8-4. These sludges are typically not hazardous and would be disposed of at nearby State-approved municipal disposal sites (TVA 2003).

Construction-related debris would be generated during construction activities for the coal gasification units and disposed of at a landfill.

For all the preceding reasons, the appropriate characterization of waste impacts from coal gasification is MODERATE; the impacts would be clearly noticeable but would not destabilize any important resource.

- **Human Health**

Power generation from coal introduces worker risks from coal and limestone mining, worker and public risks from coal and lime/limestone transportation, worker and public risks from disposal of coal combustion wastes, and public risks from inhalation of stack emissions. Emission impacts can be widespread and health risks difficult to quantify. The coal gasification alternative also introduces the risk of coal-pile fires and attendant inhalation risks.

The staff stated in the GEIS that there could be human health impacts (cancer and emphysema) from inhalation of toxins and particulates from a coal-fired plant, but did not identify the significance of these impacts (NRC 1996). In addition, the discharges of uranium and thorium from coal-fired plants can potentially produce radiological doses in excess of those arising from nuclear power plant operations (Gabbard 1993).

Regulatory agencies, including EPA and State agencies, set air emission standards and requirements based on human health impacts. These agencies also impose site-specific emission limits as needed to protect human health. As discussed previously, EPA has recently concluded that certain segments of the U.S. population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health effects due to mercury exposures from sources such as coal-fired power plants. However, in the absence of more quantitative data, human health impacts from radiological doses and inhaling toxins, and particulates generated by burning coal at a newly constructed coal gasification plant are characterized as SMALL.

- **Socioeconomics**

Peak employment during construction at the Bellefonte site would be approximately 2200 workers (TVA 2003). The peak number of workers would noticeably affect the local workforce near the Bellefonte site, but the jobs would be temporary and many of the workers would commute from surrounding areas. The influx of workers could noticeably affect local school systems and other social services. The permanent operating staff would be approximately 530 workers (TVA 2003).

The coal gasification plants would provide a new tax base for Jackson County and any other local communities in which they were sited through the in-lieu-of tax payments made by TVA. In-lieu-of-tax payments in Limestone County would likely decrease if the BFN OLs were not renewed. For all these reasons, the nontransportation socioeconomic impacts for new coal gasification plants would be noticeable, but would be unlikely to destabilize the area.

For transportation related to commuting of plant operating personnel, the impacts are considered negligible. Transportation impacts would be noticeable, temporary, but not destabilizing during plant construction.

The GEIS states that socioeconomic impacts at a rural site would be larger than at an urban site, because more of the peak construction workforce would need to move to the area to work (NRC 1996).

Coal and lime/limestone would likely be delivered by barge to the Bellefonte site (TVA 2003). Approximately 17 barges of coal per day would be delivered (TVA 2003). Some recreational impact would result from increased barge traffic. Nevertheless, barge delivery of coal and lime/limestone would likely have minor socioeconomic impacts.

For coal gasification power plants not located at the mine mouth, socioeconomic impacts would also occur at the site of the coal mine.

Overall, the staff concludes that socioeconomic impacts associated with constructing and operating new coal gasification plants would be MODERATE.

- **Aesthetics**

The 2720-MW(e) coal gasification plant would have 12 stacks for emissions that would be approximately 99.1 m (325 ft) high (TVA 2003). In addition, the completed plant would have two flaring stacks to burn waste gas approximately 60 m (200 ft) in height. Flaring operations would generally be visible within a 5-km (3-mi) radius, particularly at night. The stacks would not rise to the height of the existing cooling towers at the Bellefonte site, but would be visible up to 10 km (6 mi) away. Vapor fog from the cooling towers and stack emissions could be visible from distances of 16 km (10 mi) or more. There is an existing 40-km (24.8-mi) 500-kV transmission line to the Bellefonte site that is not energized (TVA 2003). Consequently, there would not be a new incremental aesthetic impact associated with transmission lines. Overall, construction and operation of a new coal gasification plant at the Bellefonte site would likely have a MODERATE aesthetic impact.

- **Historic and Archaeological Resources**

A 1972 archaeological survey of the Bellefonte site identified five historic sites, none of which are within proposed construction zones for a coal gasification plant (TVA 2003). The original town of Bellefonte was located just offsite and determined in 1974 to be eligible for placement on the National Register of Historic Places. Prior to the initiation of construction of the uncompleted Bellefonte nuclear plant, the Alabama State Historic Preservation Office determined that no mitigation would be required. Since that time all structures have been removed by landowners (TVA 2003).

At an alternative site, a cultural resources inventory would likely be needed for any onsite property that has not been previously surveyed. Other lands, if any, that are acquired to support the plant would also likely need an inventory of field cultural resources, identification and recording of existing historic and archaeological resources, and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site.

Before construction at an alternative site, studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on cultural resources. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission line, rail lines, or other rights-of-way). Historic and archaeological resource impacts can generally be effectively managed and would likely be SMALL.

- **Environmental Justice**

Environmental justice impacts would depend upon the population distribution around the Bellefonte site or other alternative sites. Construction activities would offer new employment possibilities, but could have negative impacts on the availability and cost of housing, which could disproportionately affect minority and low-income populations. Impacts in Limestone County would be the same as those under the no-action alternative assuming no construction of a coal gasification plant at the BFN site. Overall, environmental justice impacts are likely to be SMALL to MODERATE.

8.2.2.2 Once-Through Cooling System

The environmental impacts of constructing and operating a coal gasification plant using closed-cycle cooling with wet cooling towers are essentially the same impacts for a coal gasification plant using a once-through cooling system. However, there are some environmental differences between the closed-cycle and once-through cooling systems. Table 8-5 summarizes the incremental differences.

Table 8-5. Summary of Environmental Impacts of a Coal Gasification Plant with Once-Through Cooling

Impact Category	Change in Impacts from Closed-Cycle Cooling System
Land Use	Less land required because cooling towers and associated infrastructure are not needed.
Ecology	Impact would depend on ecology at the site. No impact to terrestrial ecology from cooling tower drift. Increased water withdrawal with possible greater impact to aquatic ecology.
Surface Water Use and Quality	No discharge of cooling tower blowdown. Increased water withdrawal and more thermal load on receiving body of water.
Groundwater Use and Quality	No change
Air Quality	No change
Waste	No change
Human Health	No Change
Socioeconomics	No change
Aesthetics	Less aesthetic impact because cooling towers would not be used.
Historic and Archaeological Resources	Less land impacted.
Environmental Justice	No change

8.2.3 Natural Gas Combined-Cycle Generation

The TVA ER considers the construction of 510-MW(e) natural gas combined-cycle power plants using mechanical draft cooling towers. Eight such plants would be needed to fully replace the 3840-MW(e) uprated capacity of BFN. It is likely that multiple locations would be needed for this number of plants. At each location it is likely that a new transmission line would need to be constructed to connect to existing lines. In addition, construction or upgrade of a natural gas pipeline from the plant location to a supply point where a firm supply of gas would be available would be needed.

Although the OL renewal term is only 20 years, the impact of operating the natural gas combined-cycle alternative for 40 years is considered (as a reasonable projection of the operating life of a natural gas combined-cycle plant).

8.2.3.1 Closed-Cycle Cooling System

The overall impacts associated with the construction and operation of natural gas combined-cycle plants of sufficient capacity to replace the uprated BFN are summarized in Table 8-6 and are discussed in the following sections.

Table 8-6. Summary of Environmental Impacts of Natural Gas Combined-Cycle Generation Using Closed-Cycle Cooling

Impact Category	Impact	Comment
Land Use	MODERATE to LARGE	Approximately 640 ha (1600 ac) would be needed to fully replace BFN capacity. Additional site-specific impacts for natural gas pipeline, electric power transmission lines, rail spurs, and cooling water intake and discharge pipelines.
Ecology	MODERATE	Impact depends on location and ecology of the site, surface water body used for intake and discharge, and electric power transmission line and natural gas pipeline routes; potential habitat loss and fragmentation; reduced productivity and biological diversity; impacts to terrestrial ecology from cooling tower drift.
Water Use and Quality	SMALL to MODERATE	Impact would depend on the volume of water withdrawn and discharged, the constituents in the discharge water, and the characteristics of the surface water body. Discharges would be regulated by the State or EPA.

Table 8-6. (contd)

Impact Category	Impact	Comment
Air Quality	MODERATE	Air emissions to fully replace BFN capacity would be approximately: Sulfur oxides – 67 MT/yr (74 tons/yr) Nitrogen oxides – 1295 MT/yr (1428 tons/yr) PM_{10} – 1188 MT/yr (1310 tons/yr) Carbon monoxide – 4941 MT/yr (5446 tons/yr) Small amounts of hazardous air pollutants would be discharged along with 17.1 million MT/yr (18.9 million tons/yr) of unregulated carbon dioxide.
Waste	SMALL	The only significant waste would be spent SCR catalyst used for control of nitrogen oxide emissions.
Human Health	SMALL	Impacts are uncertain, but considered SMALL in the absence of more quantitative data.
Socioeconomics	MODERATE	Construction impacts depend on location and how many plants are constructed at the location. Limestone County could experience loss of BFN tax base and employment. Impacts during operation of the natural gas plants would likely be SMALL. Transportation impacts would result from commuting workers.
Aesthetics	MODERATE to LARGE	Impact would depend on the site selected and the surrounding land features. Power block, exhaust stacks, cooling towers, and cooling tower plumes would be visible from nearby areas. If needed, new electric power transmission lines could have a significant aesthetic impact. Noise impact from plant operations and intermittent sources would be noticeable.
Historic and Archeological Resources	SMALL	New plant locations would necessitate cultural resource studies. Any potential impacts can likely be effectively managed.
Environmental Justice	SMALL to MODERATE	Impacts would vary depending on population distribution at the site. Impacts in Limestone County would be the same as those under the no-action alternative.

- **Land Use**

Each 510-MW(e) natural gas combined-cycle plant would require approximately 80 ha (200 ac) (TVA 2003). Additional land would be impacted for construction of a transmission line and natural gas pipeline to serve the plant. For any new natural gas combined-cycle plant, additional land would be required for natural gas wells and collection stations. In the GEIS, the staff estimated that approximately 1500 ha (3600 ac) would be needed for a 1000-MW(e) plant (NRC 1996). Proportionately more land would be needed for a natural gas combined-cycle plant replacing the 3840-MW(e) uprated generating capacity of BFN.

Overall, land-use impacts for construction of eight 510-MW(e) natural gas combined-cycle plants are considered MODERATE to LARGE.

- **Ecology**

Ecological impacts would depend on the nature of the land converted for the plant and any new transmission lines or gas pipelines. Construction of a transmission line and a gas pipeline to serve the plant would be expected to have temporary ecological impacts. Ecological impacts to a plant site and utility easements could include impacts on threatened or endangered species, wildlife habitat loss and reduced productivity, habitat fragmentation, and a local reduction in biological diversity. Intake and discharge of makeup water for the cooling system could adversely affect aquatic resources. There could be impacts to terrestrial ecology from cooling tower drift. Overall, ecological impacts are considered MODERATE.

- **Water Use and Quality**

Construction would be expected to increase erosion and storm water runoff of suspended solids above existing levels, but this would be temporary and mitigable by the use of best management practices. Completion of a retention pond for the treatment of storm water runoff early in the construction phase would significantly reduce potential increased solids loading to local surface drainage waterways. Application of best management practices to control erosion during construction should mitigate construction impacts of transmission lines and pipelines (natural gas supply, potable water supply, process water supply, and waste water discharge). Impacts of constructing new intake and discharge structures on nearby waterways and/or reservoirs would be minimized by construction techniques to minimize disturbance of sediments and by the use of mitigation measures such as coffer dams, turbidity curtains, and selection of a construction time window (TVA 2003).

Waste water discharges would be regulated by the State or by EPA. Approximately 90 percent of the waste water discharge flow would be cooling tower blowdown. Other sources of waste water include steam cycle blowdown, water from inlet fogging, demineralizer rinse water, and miscellaneous low-volume waste water. This water would be treated onsite as necessary to meet regulatory requirements before being discharged to local waters (TVA 2003).

Storm water runoff during plant operation would be drained to a retention pond to allow sediments to settle out prior to discharge to local waterways. Rainwater that falls in secondary containment around oil-containing equipment would drain to an oil/water separator where the oil would be removed for disposal and the water would subsequently drain to the process water pond. Excavation and grading associated with construction of the plant or any of the ancillary features, such as the transmission lines, backup power, process and potable water pipelines, waste water discharge pipelines, and natural gas pipelines, are not expected to cause adverse effects to groundwater. Excavations that penetrate the water table may require temporary construction dewatering. Any groundwater drawdown impacts associated with construction dewatering would be temporary. The long-term impact of these activities should be negligible because of the limited depth and relatively small area of disturbance. Structural damage to aquifer areas resulting from pipeline construction is not anticipated because aquifers are not generally located within excavation depth (TVA 2003).

The impact on the surface water would depend on the discharge volume and the characteristics of the receiving body of water. Intake from and discharge to any surface body of water would be regulated by the State.

Water-quality impacts from sedimentation during construction of a natural-gas-fired plant were characterized in the GEIS as small (NRC 1996). NRC staff also noted in the GEIS that operational water-quality impacts would be similar to, or less than, those from other generating technologies.

Overall, water use and quality impacts are considered SMALL to MODERATE.

- **Air Quality**

Natural gas is a relatively clean-burning fuel. The natural gas combined-cycle alternative would release similar types of emissions, but in lesser quantities than the coal-fired alternative.

A new natural gas combined-cycle generating plant would likely require a permit issued under the new source review procedures in Title I, Part C, of the Clean Air Act and an operating permit issued under Title V. A new natural gas combined-cycle power plant would also be subject to the new source performance standards for such units at 40 CFR Part 60, Subparts Da and GG. These regulations establish emission limits for particulates, opacity, SO_2, and NO_x.

The EPA has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P, including a specific requirement for review of any new major stationary source in an area designated as attainment or unclassified under the Clean Air Act.

Section 169A of the Clean Air Act establishes a national goal of preventing future impairment and remedying existing impairment of visibility in mandatory Class I Federal areas when the impairment results from air pollution caused by human activities. In addition, EPA issued a new regional haze rule in 1999 (64 FR 35714). The rule specifies that for each mandatory Class I Federal area located within a state, the State must establish goals that provide for reasonable progress towards achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for the most-impaired days over the period of the implementation plan and ensure no degradation in visibility for the least-impaired days over the same period (40 CFR 51.308(d)(1)). If a new natural gas combined-cycle power plant were located close to a mandatory Class I area, additional air pollution control requirements could be imposed.

In 1998, EPA issued a rule requiring 22 eastern states, including Alabama, to revise their State implementation plans to reduce nitrogen oxide emissions. NO_x emissions contribute to violations of the national ambient air-quality standard for ozone (40 CFR 50.9). The total amount of NO_x that can be emitted by each of the 22 states in the year 2007 ozone season (May 1 through September 30) is set out at 40 CFR 51.121(e). For Alabama, the amount is 156,597 MT (172,619 tons). Any new natural gas combined-cycle plant sited in Alabama would be subject to these limitations.

The estimated annual emissions for natural gas combined-cycle plants sized to replace the power generated by BFN are shown in Table 8-6 (TVA 2003).

The combustion turbine portion of the combined-cycle plant would be subject to EPA's National Emission Standards for Hazardous Air Pollutants for Stationary Combustion Turbines at 40 CFR Part 63, Subpart YYYY, if the site is a major source of hazardous air pollutants. Major sources have the potential to emit 9.1 MT (10 tons) per year or more of any single hazardous air pollutant or 22.7 MT (25 tons) or more per year of any combination of hazardous air pollutants (40 CFR 63.6085(b)).

Construction activities would result in temporary fugitive dust. Exhaust emissions would also come from vehicles and motorized equipment used during the construction process.

Overall, the air-quality impacts of new natural gas combined-cycle plants sized to replace the BFN capacity are estimated to be MODERATE.

- **Waste**

In the GEIS the staff concluded that waste generation from natural-gas-fired technology would be minimal (NRC 1996). *The only significant solid waste generated at a new natural gas* combined-cycle plant would be spent SCR catalyst. The SCR catalyst is used to control NO_x emissions. The spent catalyst would be regenerated or disposed of offsite. Other than spent SCR catalyst, waste generation at an operating natural gas combined-cycle plant would be largely limited to typical office wastes; impacts would be so minor that they would not noticeably *alter any important resource attribute. Construction-related debris would be generated during* construction activities.

Overall, the solid waste impacts associated with natural gas combined-cycle plants sized to replace the BFN capacity are expected to be SMALL.

- **Human Health**

Potential accidents related to plant operations include the possible rupture of natural gas pipelines both onsite and offsite, and the possible release of ammonia (TVA 2003). Ammonia is used in the SCR process for control of NO_x emissions. Both events are considered very low probability.

In the GEIS, the staff identified cancer and emphysema as potential health risks from gas-fired plants (NRC 1996). The risk may be attributable to NO_x emissions that contribute to ozone formation, which in turn contribute to health risks. NO_x emissions from any plant would be regulated by the State or EPA. For a plant sited in Alabama, NO_x emissions would be regulated by the Alabama Department of Environmental Management. Human health effects are not expected to be detectable or sufficiently minor that they would neither destabilize nor noticeably alter any important attribute of the resource. Overall, the impacts on human health of newly constructed natural gas combined-cycle plants are considered SMALL.

- **Socioeconomics**

Construction of a 510-MW(e) natural gas combined-cycle plant would take approximately 22 months (TVA 2003). Peak employment would be approximately 420 workers. Employment would exceed 200 workers for approximately 6 months (TVA 2003). During construction, the communities immediately surrounding each plant site would experience demands on housing and public services that could have noticeable impacts. These impacts would be tempered by construction workers commuting to the sites from more distant cities. After construction, the communities would be impacted by the loss of jobs. The operating workforce at each 510-MW(e) plant would be approximately 40 persons (TVA 2003). The BFN workforce would decline through a decommissioning period to a minimal maintenance size. The new natural gas combined-cycle plants would provide a new tax base through TVA's in-lieu-of-tax payments, at their respective locations.

Jobs related to pipeline construction and to transmission/distribution line upgrades would not be centralized at one location for any significant period of time and, therefore, would have no important impact on the local economy or on community and government services.

In the GEIS, the staff concluded that socioeconomic impacts from constructing a natural-gas-fired plant would not be very noticeable and that the small operational workforce would have the lowest socioeconomic impacts of any nonrenewable technology (NRC 1996). Compared to the coal-fired and nuclear alternatives, the smaller size of the construction workforce, the shorter construction time frame, and the smaller size of the operations workforce would mitigate socioeconomic impacts.

Transportation impacts related to commuting of plant operating personnel, the impacts would depend on the population density and transportation infrastructure in the vicinity of the site but are likely to be negligible. Impacts related to the commuting of plant construction personnel would be noticeable, temporary, but not destabilizing.

Overall, socioeconomic impacts resulting from construction and operation of natural gas combined-cycle plants can be characterized as MODERATE.

- **Aesthetics**

The natural gas combined-cycle plants would alter the visual landscape character at each location. The tallest structures would be the 46-m (150-ft)-high auxiliary boiler and two heat recovery steam generator stacks, as well as the 30-m (100-ft)-high steam turbine building (TVA 2003). Some portion of these structures would likely be visible for 2 km (1 mi) or more.

Cooling tower plumes would also be visible. There would be more lighting visible across the night landscape, and sky brightness would increase somewhat. Noise from the plant would be detectable offsite.

If a new electric power transmission line is needed, the aesthetic impact could be significant. The gas pipeline compressors also would be visible. Aesthetic impacts would be mitigated if the plant were located in an industrial area adjacent to other power plants. Overall, the aesthetic impacts associated with replacement natural gas combined-cycle plants are categorized as MODERATE to LARGE, with site-specific factors determining the final categorization.

- **Historic and Archaeological Resources**

A cultural resource inventory would likely be needed for any onsite property that has not been previously surveyed. Other lands, if any, that are acquired to support the plant would also likely need an inventory of field cultural resources, identification and recording of existing historic and archaeological resources, and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site.

Before construction, studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on cultural resources. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission lines, pipelines, or other rights-of-way). Impacts to cultural resources can be effectively managed under current laws and regulations and kept SMALL.

- **Environmental Justice**

Environmental justice impacts would depend upon the sites chosen for the natural gas combined-cycle power plants and the nearby population distribution. Construction activities would offer new employment possibilities, but could have negative impacts on the availability and cost of housing, which could disproportionately affect minority and low-income populations. Impacts in Limestone County would be the same as those under the no-action alternative assuming no construction of natural gas combined-cycle plants at the BFN site. Overall, environmental justice impacts are likely to be SMALL to MODERATE.

8.2.3.2 Once-Through Cooling System

The environmental impacts of constructing and operating a natural gas combined-cycle generating plant using once-through cooling are essentially the same as the impacts for a plant using closed-cycle cooling with wet cooling towers. However, there are some environmental differences between the closed-cycle and once-through cooling systems. Table 8-7 summarizes the incremental differences.

Table 8-7. Summary of Environmental Impacts of a Natural Gas Combined-Cycle Plant with Once-Through Cooling

Impact Category	Change in Impacts from Closed-Cycle Cooling System
Land Use	Less land required because cooling towers and associated infrastructure are not needed.
Ecology	Impact would depend on ecology at the site. No impact to terrestrial ecology from cooling tower drift. Increased water withdrawal with possible greater impact to aquatic ecology.
Surface Water Use and Quality	No discharge of cooling tower blowdown. Increased water withdrawal and more thermal load on receiving body of water.
Groundwater Use and Quality	No change
Air Quality	No change
Waste	No change
Human Health	No change
Socioeconomics	No change
Aesthetics	Less aesthetic impact because cooling towers would not be used.
Historic and Archaeological Resources	Less land impacted.
Environmental Justice	No change

8.2.4 Nuclear Power Generation

The TVA ER considers the feasibility of constructing and operating two Advanced Boiling Water Reactors (ABWR) at the unfinished Bellefonte nuclear plant site (TVA 2003). The ABWR design is a light-water reactor that has been certified by the NRC (10 CFR Part 52, Appendix A).

Although construction of the original Bellefonte nuclear units has been halted, TVA still retains construction permits issued by NRC. Construction access routes are completed at the site, and basic support functions (electric power, potable water, sanitary waste disposal, office buildings, parking lots, railways, and barge unloading facility) are in place to support resumption of construction. Almost all the basic site preparation work, such as grading, has been completed, including where the ABWR units would be constructed (TVA 2003). DOE is cooperating with an industry team led by TVA to conduct a detailed study of the potential construction of a two-unit ABWR nuclear plant at the Bellefonte site (DOE 2004a).

Construction of two ABWR units at the Bellefonte site would likely make use of the existing site intake water pumping station, natural draft cooling towers, discharge water diffusers, and electrical transmission lines and switchyards, each with varying degrees of modification

(TVA 2003). Some existing service facilities such as fire protection, temporary construction power, auxiliary boilers, office buildings and parking lots, environmental monitoring, outside lighting, diesel fuel storage tanks, telecommunications, and potable water and sanitary waste supply lines would be used wherever possible. Almost none of the existing unfinished nuclear units and their contiguous support systems would be used (TVA 2003). To supplement the existing natural draft cooling towers, two additional mechanical draft cooling towers may be built on land immediately adjacent to and just south of the existing cooling towers, between the existing cooling towers and the proposed ABWR plant (TVA 2003). A 3.6-ha (9-ac) cooling spray pond may also be constructed south of the ABWR plant to serve as the emergency core cooling ultimate heat sink for the two units. All this land has previously been cleared for other uses (TVA 2003).

The base or lowest expected power output is 1336 MW(e) per unit during summer, which would likely increase to 1380 MW(e) during winter months as the condenser inlet temperature (and consequently the condenser backpressure) is reduced (TVA 2003). Although some uprating of the ABWR units may be possible, an additional ABWR unit, probably constructed at another site, would likely be needed to fully replace the uprated 3840-MW(e) capacity of BFN.

NRC has summarized environmental data associated with the uranium fuel cycle in Table S-3 of 10 CFR 51.51. The impacts shown in Table S-3 are representative of the impacts that would be associated with a replacement nuclear power plant. The impacts shown in Table S-3 are for a 1000-MW(e) reactor and would need to be adjusted to reflect replacement of the uprated 3840-MW(e) capacity of BFN. The environmental impacts associated with transporting fuel and waste to and from a light-water cooled nuclear power reactor are summarized in Table S-4 of 10 CFR 51.52. The summary of NRC's findings on NEPA issues for license renewal of nuclear power plants in Table B-1 of 10 CFR Part 51 Subpart A, Appendix B, is also relevant, although not directly applicable, for consideration of environmental impacts associated with the operation of a replacement nuclear power plant. Additional environmental impact information for a replacement nuclear power plant using closed-cycle cooling is presented in Section 8.2.4.1 and using once-through cooling in Section 8.2.4.2.

8.2.4.1 Closed-Cycle Cooling System

The overall impacts associated with the construction and operation of two ABWR generating units at the Bellefonte site are discussed in the following sections. The impacts are summarized in Table 8-8. Additional impacts would occur, probably at another site, to fully replace the 3840-MW(e) capacity at BFN. The impact categorizations for Table 8-8 are based on 3840 MW(e) of new ABWR generating capacity.

Table 8-8. Summary of Environmental Impacts of New ABWR Units Using Closed-Cycle Cooling

Impact Category	Impact	Comment
Land Use	SMALL to LARGE	Most of the construction would take place on already disturbed areas of the Bellefonte site. Construction of an ABWR at another site would require approximately 200 ha (500 ac) for the plant and possibly additional land if a new transmission line and/or rail spur is needed. Additional land-use impacts would occur for uranium mining.
Ecology	SMALL to LARGE	Impact at the Bellefonte site would be SMALL to MODERATE. Impacts at another site could be LARGE and would depend on location and ecology of the site, surface water body used for intake and discharge, and electric power transmission line route; potential habitat loss and fragmentation; reduced productivity and biological diversity; and impacts to terrestrial ecology from cooling tower drift.
Water Use and Quality	SMALL to MODERATE	Impact would depend on the volume of water withdrawn and discharged, the constituents in the discharge water, and the characteristics of the surface water body. Discharges at the Bellefonte site would be regulated by the State of Alabama.
Air Quality	SMALL	Air emissions from ABWR plants sized to fully replace BFN capacity would be approximately: Sulfur oxides – 12.7 MT/yr (14 tons/yr) Nitrogen oxides – 12.7 MT/yr (14 tons/yr) PM_{10} – 0.62 MT/yr (0.68 tons/yr) Carbon monoxide – 3.4 MT/yr (3.7 tons/yr) Approximately 4350 MT/yr (4800 tons/yr) of unregulated carbon dioxide would be discharged.
Waste	SMALL	Radioactive waste generated at a ABWR would be less than a conventional boiling water reactor (BWR). Debris would be generated and removed during the construction process.
Human Health	SMALL	Impacts are uncertain, but considered SMALL in the absence of more quantitative data. ABWR units are expected to have a lower human health impact than existing BWR units.
Socioeconomics	MODERATE to LARGE	Peak construction employment at the Bellefonte site would be approximately 3100 workers. The operating workforce would be approximately 900. Limestone County could experience loss of BFN tax base and employment. Impacts at an alternate rural site could be LARGE.
Aesthetics	MODERATE to LARGE	At the Bellefonte site, a new off-gas stack would be needed. Cooling tower plumes would be visible for 16 km (10 mi) or more. At an alternative site, a new transmission line may be needed, which could have a LARGE impact.

Table 8-8. (contd)

Impact Category	Impact	Comment
Historic and Archeological Resources	SMALL	The Bellefonte site has had previous surveys for historic and archeological resources. Any potential impacts can likely be effectively managed.
Environmental Justice	SMALL to MODERATE	Impacts would vary depending on population distribution and makeup at the site. Impacts in Limestone County would be the same as those under the no-action alternative.

- **Land Use**

Twin ABWR units would be constructed adjacent to and directly south of the existing cooling towers (TVA 2003). A construction lay-down space is planned for the area bordered by the existing cooling towers, the existing 500-kV transmission line, and the ABWR plant. Almost all the ABWR construction activities would take place on land that has already been disturbed for the original Bellefonte construction. There are no buried structures that cannot be removed or transferred (TVA 2003).

Including wind effect, the maximum flood level of the Bellefonte site is 191.3 m (627.7 ft) above mean sea level, which is higher than the 189-m (620-ft) average grade for the planned construction area. Keeping the finished grade above the maximum flood level would require adding about 3 m (10 ft) of fill soil to the construction area, increasing its elevation to 192 m (630 ft) (TVA 2003). The grading soil would most likely be taken from hills to the east or southwest of the construction area.

Compared to a fossil-fueled power plant, which would involve either long fuel pipelines or large fuel and combustion product storage areas, the impacts on land use and soils are minimal for completing a relatively compact nuclear plant on the previously disturbed Bellefonte site. Land-use impacts are expected to be SMALL at the Bellefonte site, and MODERATE to LARGE if an additional site is needed to fully replace the power generated by BFN. At another site, approximately 200 ha (500 ac) would be needed for the plant and possibly additional land needed for construction of a transmission line and/or rail spur. Additional land-use impacts would occur for uranium mining.

- **Ecology**

At the Bellefonte site there are no Federally or State-listed threatened or endangered plant species (TVA 2003). There are no caves at the site that support the Federally endangered Indiana and gray bats, but they are known to forage along the Guntersville Lake shoreline. However, the immediate area near the site has an extensive network of similar wooded shoreline and shallow lagoon habitats.

The intake channel at the site has not been maintained and would require dredging, both initially and periodically throughout the life of the plant. Surveys have found no toxic sediments and a low average density of mussels in the area. It is expected that the dredge material would be disposed of on land (TVA 2003). Because water intake demand would be small compared to the total water mass flowing past the Bellefonte site, there is little potential for significant entrainment/impingement impacts. The existing water intake structure at the site would be used; this intake system entrains water through a 7.6-m (25-ft)-wide trench connected to the original river channel and is designed such that 85 percent of the intake demand would be withdrawn from the river channel and 15 percent from the more productive upstream overbank habitat. The greatest impacts of entrainment and impingement would result from water withdrawn from the upstream productive overbank, although losses to the lake fish community should be minimal due to the large amounts of similar habitat near the plant and in other areas of the lake (TVA 2003). There could be impacts to terrestrial ecology from cooling tower drift.

Overall, siting of two ABWR units at the Bellefonte site would have a SMALL to MODERATE ecological impact.

At an alternate site, there would be construction impacts and new incremental operational impacts. Even assuming siting at a previously disturbed area, the impacts would alter the ecology. Impacts could include wildlife habitat loss, reduced productivity, habitat fragmentation, and a local reduction in biological diversity. Use of cooling water from a nearby surface water body could have adverse aquatic resource impacts. If needed, construction and maintenance of the transmission line would have ecological impacts. Overall, the ecological impacts at an alternate site would be MODERATE to LARGE.

- **Water Use and Quality**

Raw water for construction and operation would be obtained from the Tennessee River. The quantities needed would be unlikely to have a significant effect on the river. Both existing closed-cycle natural draft cooling towers on the Bellefonte site would likely be used. The existing intake channel at the site has not been periodically maintained and may require some dredging (TVA 2003).

No significant construction-related impacts to surface water resources would be expected as a result of the project. The majority of the power plant and associated facilities would be constructed on land that has been previously altered because of construction activities related to the uncompleted Bellefonte nuclear plant. Construction of new facilities and overall site reclamation activities would affect surface hydrology, but extensive site excavation, filling, or grading would not be needed. The primary surface water impact during construction would be soil erosion, which could be kept low by the use of best management practices. To minimize the impacts of storm water flow during construction, a storm water retention pond would be designed to retain storm water from the 25-year, 24-hour rainfall event, in compliance with regulatory requirements (TVA 2003).

The surface water resources within the areas of the proposed development at the Bellefonte site are currently monitored under an NPDES permit issued by the Alabama Department of Environmental Management.

Potable water is supplied to the Bellefonte site by the City of Hollywood, which receives its water from the City of Scottsboro. The Bellefonte site is connected to the Hollywood municipal sewage system treatment plant located adjacent to the south side of the site. The sewage treatment plant serves the Bellefonte site and residential customers in the area, but currently it does not have sufficient capacity to handle the increased demand of a large construction force and would have to be enlarged (TVA 2003).

Surface water impacts at the Bellefonte site are expected to be sufficiently minor that they would not noticeably alter any important attribute of the resource.

For alternate sites, the impact on the surface water would depend on the discharge volume and the characteristics of the receiving body of water. Intake from and discharge to any surface body of water would be regulated by the State or by EPA.

A nuclear power plant sited at an alternate site may use groundwater. Groundwater withdrawal at an alternate site would likely require a permit.

Overall, water use and quality impacts are estimated to be SMALL to MODERATE.

- **Air Quality**

Annual emission rate estimates for operating ABWR units sized to fully replace the power generated by BFN are shown in Table 8-8 (TVA 2003). The only combustion sources to produce carbon dioxide are the small auxiliary heating boilers, emergency power generators (usually diesel-driven but sometimes combustion turbines), service vehicles, some portable self-powered devices such as pumps and generators, and some types of welding and heat treatment gear (TVA 2003).

There would be fugitive emissions during the construction process. Exhaust emissions would also come from vehicles and motorized equipment used during the construction process.

Overall, plant emissions and associated impacts are considered SMALL.

- **Waste**

The waste impacts associated with operation of pressurized-water reactor (PWR) and boiling water reactor (BWR) nuclear power plants are set out in Table B-1 of 10 CFR 51 Subpart A, Appendix B. Similar to conventional BWRs, during operation the ABWR produces spent resins from the condensate filters and demineralizers and dry active wastes from maintenance operations, typically gloves, plastic sheeting, mops, rags, wood, paper, metal, and plastic scraps. Based on experience with LLW generated at both conventional and advanced BWRs in Japan, TVA expects that the LLW generated at the ABWR units would be less than 15 percent of the LLW currently generated at BFN BWR units (TVA 2003). The reasons for the reduction in LLW for the ABWR include lower regeneration requirements for condensate demineralizer; non-precoat, hollow-fiber filters for the condensate filters; and less required maintenance and inspection overall. As an alternative means of disposal for solid and liquid LLW waste, TVA would explore the feasibility of shipping it to offsite contractors for processing (incineration, compaction, etc.) prior to permanent disposal at a licensed facility, similar to what is currently done for radioactive wastes generated at BFN (TVA 2003).

In addition to the impacts shown in Table B-1, construction-related debris would be generated during construction activities, which would be disposed of in landfills. During construction, some modifications to the existing cooling towers at the Bellefonte site might be necessary to increase their cooling capacity (TVA 2003). Modifications could potentially include replacing the present asbestos fill. In this case, proper disposal of the asbestos fill in an offsite permitted landfill would be required. Much of the waste generated during construction would be typical construction/ demolition waste (e.g., broken concrete, rock, asphalt, scrap lumber and metal, etc.) generated by the modification/removal of existing buildings such as old warehouses and the building of the new plant. There is enough space available on the Bellefonte site for a landfill to receive construction/demolition waste, but it may prove more economical to use any of several existing landfills within 80 km (50 mi) of Bellefonte that have adequate storage capacity and life expectancy (TVA 2003).

Waste impacts associated with construction of ABWR units at another site are unlikely to exceed those associated with construction at the Bellefonte site. Overall, waste impacts are considered SMALL.

- **Human Health**

Human health impacts for operating PWR and BWR nuclear power plants are set out in 10 CFR 51 Subpart A, Appendix B, Table B-1.

The total worker radiation exposure for an operating two-unit ABWR is projected to be about 0.62 man-Sieverts/yr, based on experience from the first 5 years of commercial operation for two comparable ABWR units in Japan and adjusted to projected steady-state conditions (TVA 2003). For three ABWR units to fully replace BFN capacity, total worker radiation exposure would be about 0.93 man-Sieverts/yr. For comparison, the median U.S. annual exposure for (two-unit) BWRs is 2.88 man-Sieverts/yr (TVA 2003). The reasons for the reduced occupational exposure include less piping, particularly in containment, and therefore less in-service inspection; larger maneuvering space for maintenance work inside containment; improved design requiring less maintenance of reactor components such as control rod drives; and shortened durations of refueling and maintenance outages due to expanded use of automated systems and design improvements such as split-type control rod drive housings. Approximately half of the radiation exposure is accumulated during outages. Experience with the prototype ABWR plants in Japan has shown that radiation exposure during outages has decreased steadily with time, reflecting lessons learned through operating experience (TVA 2003).

Overall, human health impacts for siting of new ABWR units at the Bellefonte site or at alternative sites are considered SMALL.

- **Socioeconomics**

Based on Japanese ABWR construction experience, TVA expects that the construction period for two new ABWR units at the Bellefonte site would be 34 months (TVA 2003). This abbreviated schedule reflects a high degree of modularization, requiring the use of large cranes; expansion of the work scope, which can proceed in parallel; and a number of improvements in field productivity through innovations such as increased use of automatic welding machines. Peak employment during construction of the two units is estimated to be approximately 3115 workers, of which 2885 workers would be craft workers and craft work supervisors (TVA 2003). Approximately 230 workers would be construction and pre-operational turnover engineers and technical advisors supplied by an architectural/engineering company with ABWR construction experience. TVA estimates that approximately one-third of the crafts workers would move into the local area, with the rest commuting from longer distances. TVA expects that less than half of those moving into the local area would buy or rent houses. Of those workers who do move to the area, TVA estimates that more than two-thirds would bring their families. TVA expects that few, if any, of the architectural/engineering personnel would buy houses in the local area (TVA 2003). TVA estimates that approximately 720 new students would attend the Scottsboro and Jackson county schools temporarily during the construction period (TVA 2003).

The total projected employment during operation for the two-unit ABWR plant is 906 workers (TVA 2003). For comparison, there are currently 1297 workers at BFN Units 2 and 3 (TVA 2003). TVA projects that the total population impact on Jackson County attributable to the new ABWR units would be approximately 1200 to 1400 workers. The total annual employment generated in Jackson County is estimated by TVA to be approximately 1600 workers, and the total annual income generated to be over $78 million (TVA 2003). The impacts from plant operation on housing, schools, and services such as fire protection would be less than those of peak construction and should, therefore, be accommodated without difficulty.

The new ABWR units would likely provide an increase in the in-lieu-of-tax payments received by Jackson County or any other county where new units are constructed by TVA. In-lieu-of-tax payments in Limestone County would likely decrease if the BFN OLs are not renewed. Employment in Limestone County would decrease if the BFN OLs are not renewed.

Construction of new ABWR units at a site other than Bellefonte would relocate some socioeconomic impacts, but would not eliminate them. Assuming the new units were not built at the BFN site, the communities around the BFN site would experience the impact of operational job loss and the loss of tax base. The communities around the new site would have to absorb the impacts of a large, temporary workforce and a permanent operating workforce. In the GEIS, the staff noted that socioeconomic impacts at a rural site would be larger than at an urban site because more of the peak construction workforce would need to move to the area to work (NRC 1996). Alternate sites would need to be analyzed on a case-by-case basis. Socioeconomic impacts at a rural site could be LARGE. Transportation-related impacts associated with commuting construction workers at an alternate site are site dependent. Transportation impacts related to commuting of plant operating personnel would also be site-dependent.

Overall, the socioeconomic impacts associated with constructing and operating new ABWR units sized to replace BFN capacity are considered MODERATE to LARGE.

- **Aesthetics**

The Bellefonte site is seen most frequently by passing motorists from various points along U.S. Highway 72. The on-ground plant facilities such as roads, parking lots, and office buildings are screened for the most part by low rolling terrain in the foreground. The Bellefonte site is buffered from the main Tennessee River channel by a wooded ridgeline, which rises approximately 60 m (200 ft) above the lake surface. Distant views of the 145-m (477-ft)-high cooling towers and the reactor domes can be seen in excess of 8 km (5 mi) away. The only new ABWR construction that would rise to a height comparable to the existing cooling towers would be an off-gas stack, which would have no associated visible plume (TVA 2003). Vapor fog from the cooling towers could be visible from distances of 16 km (10 mi) or more. There is an existing 39.9-km (24.8-mi) 500-kV transmission line to the Bellefonte site that is not energized (TVA 2003).

Noise from operation of a replacement nuclear power plant would potentially be audible offsite in calm wind conditions or when the wind was blowing in the direction of the listener. Mitigation measures, such as reduced or no use of outside loudspeakers, can be employed to reduce noise level.

At an alternate site, there would be an aesthetic impact from the buildings. There would also be a significant aesthetic impact if a new transmission line were needed. Noise and light from the plant would be detectable offsite. The impact of noise and light would be mitigated if the plant was located in an industrial area adjacent to other power plants. Overall, the aesthetic impacts associated with locating new ABWR units at Bellefonte or at an alternative site can be categorized as MODERATE to LARGE.

- **Historic and Archaeological Resources**

A 1972 archaeological survey of the Bellefonte site identified five historic sites, none of which are within proposed construction zones (TVA 2003). The original town of Bellefonte was located just offsite and determined in 1974 to be eligible for placement on the National Register of Historic Places. Prior to the initiation of construction of the uncompleted Bellefonte nuclear plant, the Alabama State Historic Preservation Office determined that no mitigation would be required. Since that time all structures have been removed by landowners (TVA 2003).

At an alternate site, a cultural resources inventory would likely be needed for any onsite property that has not been previously surveyed. Other lands, if any, that are acquired to support the plant would also likely need an inventory of field cultural resources, identification and recording of existing historic and archaeological resources, and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site.

Before construction at an alternate site, studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on cultural resources. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated rights-of-way where new construction would occur (e.g., roads, transmission lines, rail lines, or other rights-of-way). Historic and archaeological resource impacts can generally be effectively managed and would likely be SMALL at either the Bellefonte or an alternate site.

- **Environmental Justice**

Environmental justice impacts would depend upon the population distribution around the Bellefonte site or other alternate sites. Construction activities would offer new employment possibilities, but could have negative impacts on the availability and cost of housing, which could disproportionately affect minority and low-income populations. Impacts in Limestone County would be the same as those under the no-action alternative. Overall, environmental justice impacts are likely to be SMALL to MODERATE.

8.2.4.2 Once-Through Cooling System

The environmental impacts of constructing and operating new ABWR units using once-through cooling are essentially the same as the impacts for a plant using closed cycle-cooling with wet cooling towers. However, there are some environmental differences between the closed-cycle and once-through cooling systems. Table 8-9 summarizes the incremental differences.

Table 8-9. Summary of Environmental Impacts of a New Nuclear Plant with Once-Through Cooling

Impact Category	Change in Impacts from Closed-Cycle Cooling System
Land Use	Less land required because cooling towers and associated infrastructure are not needed.
Ecology	Impact would depend on ecology at the site. No impact to terrestrial ecology from cooling tower drift. Increased water withdrawal with possible greater impact to aquatic ecology.
Surface Water Use and Quality	No discharge of cooling tower blowdown. Increased water withdrawal and more thermal load on receiving body of water.
Groundwater Use and Quality	No change
Air Quality	No change
Waste	No change
Human Health	No change

Table 8-9. (contd)

Impact Category	Change in Impacts from Closed-Cycle Cooling System
Socioeconomics	No change
Aesthetics	Less aesthetic impact because cooling towers would not be used.
Historic and Archaeological Resources	Less land impacted.
Environmental Justice	No change

8.2.5 Purchased Electrical Power

If available, purchased power from other sources could potentially obviate the need to renew the BFN OLs. TVA currently purchases electric power from other generators (TVA 2003). However, some power purchase activities implemented by TVA have not performed as intended in delivering reliable power to TVA customers. TVA has issued several requests for proposals in recent years with the goal of obtaining additional peaking and baseload power (TVA 2003). Some of the responses have either not met stated conditions and requirements, or the entities submitting the proposals could not deliver power by the needed dates. Consequently, the projected power hoped for from the requests for proposals has not fully materialized (TVA 2003).

Current regional reserve margins[(a)] in the TVA service area are estimated to be approximately 30 percent; however, projections suggest that this surplus will be exhausted before the current BFN OLs expire (TVA 2003).

If power to replace the capacity of BFN were to be purchased from sources within the United States or from a foreign country, the generating technology likely would be one of those described in this SEIS and in the GEIS (probably coal, natural gas, or nuclear). The descriptions of the environmental impacts of other technologies in Chapter 8 of the GEIS and in Chapter 8 of this SEIS are representative of the environmental impacts associated with the purchased electrical power alternative to renewal of the BFN OLs. Under the purchased power alternative, the environmental impacts of imported power would still occur, but would be located elsewhere within the region, the United States, or another country.

8.2.6 Other Alternatives

Other generation technologies are discussed in the following subsections.

(a) Reserve margin is the amount of unused available capability of an electric power system (at peak load) as a percentage of total capability.

8.2.6.1 Oil-Fired Generation

EIA projects that oil-fired plants will account for no new generation capacity in the United States through the year 2025, except for limited industrial combined heat and power applications, because of higher fuel costs and lower efficiencies (DOE/EIA 2004). Oil-fired operation is more expensive than nuclear or coal-fired operation. In addition, future increases in oil prices are expected to make oil-fired generation increasingly more expensive than coal-fired generation. The high cost of oil has resulted in a decline in its use for electricity generation. In Section 8.3.11 of the GEIS, the staff estimated that construction of a 1000-MW(e) oil-fired plant would require about 49 ha (120 ac) (NRC 1996). Operation of oil-fired plants would have environmental impacts (including impacts on the aquatic environment and air) that would be similar to those from a coal-fired plant.

8.2.6.2 Wind Power

Most of Alabama, Mississippi, and western Tennessee are in a wind power Class 1 region (average wind speeds less than 5.6 m/s) (DOE 2004b). Class 1 has the lowest potential for wind energy generation (DOE 2004b). Alabama does not have sufficient wind resources to use large-scale wind turbines (DOE 2004c).

Aside from the coastal areas and exposed mountains and ridges of the Appalachian Mountains, there is little wind energy potential in the East Central region of the United States for current wind turbine applications (Elliott et al. 1987). Moreover, wind turbines typically operate at a 25 to 35 percent capacity factor compared to 90 to 95 percent for a baseload plant (NWPPC 2000).

Therefore, the staff concludes that locating a wind-energy facility on or near BFN or offshore as a replacement for BFN generating capacity would not be economically feasible given the current state of wind-energy generation technology.

8.2.6.3 Solar Power

Solar technologies use the sun's energy to provide heat and cooling, light, hot water, and electricity for homes, businesses, and industry. Solar power technologies (both photovoltaic and thermal) cannot currently compete with conventional nuclear and fossil-fueled technologies in grid-connected applications because of higher capital costs per kilowatt of capacity. Energy storage requirements also limit the use of solar-energy systems as baseload electricity supply. The average capacity factor of photovoltaic cells is about 25 percent (NRC 1996), and the capacity factor for solar thermal systems is about 25 to 40 percent (NRC 1996).

There are substantial impacts to natural resources (wildlife habitat, land use, and aesthetic impacts) from construction of solar-generating facilities. As stated in the GEIS, land requirements are high – 142 km^2 (55 mi^2) per 1000 MW(e) for photovoltaic (NRC 1996) and approximately 57 km^2 (22 mi^2) per 1000 MW(e) for solar thermal systems (NRC 1996). Neither type of solar electric system would fit at the BFN site, and both would have large environmental impacts at an alternate site.

The BFN site receives approximately 4500 to 5000 Wh/m^2 per day that can be used for flat-plate solar systems and 3500 to 4000 Wh/m^2 per day that can be used for solar concentrating systems. This is in comparison to areas in the southwestern United States that receive up to 7500 Wh/m^2 per day (DOE 2004d). For solar concentrating collectors, Alabama only has a useful resource in the southeastern portion of the state. The solar resource in Alabama can be used for water heating or photovoltaic systems, but not large concentrating solar thermal utility systems (DOE 2004d).

Because of the natural resource impacts (land and ecological), the area's relatively low rate of solar radiation, and high cost, solar power is not deemed a feasible baseload alternative to renewal of the BFN OLs. Some onsite generated solar power (e.g., from rooftop photovoltaic applications) may substitute for electric power from the grid. Implementation of solar generation on a scale large enough to replace BFN would likely result in LARGE environmental impacts.

8.2.6.4 Hydropower

Alabama has an estimated 363 MW[(a)] of developable hydroelectric resources (INEEL 1998). Tennessee has an estimated 138 MW of developable hydroelectric resources (INEEL 1997). This total amount is significantly less than needed to replace the 3840-MW(e) uprated capacity of BFN. As stated in Section 8.3.4 of the GEIS, hydropower's percentage of U.S. generating capacity is expected to decline because hydroelectric facilities have become difficult to site as a result of public concern about flooding, destruction of natural habitat, and alteration of natural river courses. In the GEIS, the staff estimated that land requirements for hydroelectric power are approximately 400,000 ha (1 million ac) per 1000 MW(e) (NRC 1996). Because of the relatively low amount of undeveloped hydropower resource in Alabama and Tennessee and the large land-use and related environmental and ecological resource impacts associated with siting hydroelectric facilities large enough to replace BFN, the staff concludes that local hydropower is not a feasible alternative to renewal of the BFN OLs. Any attempts to site hydroelectric facilities large enough to replace the BFN would result in LARGE environmental impacts.

8.2.6.5 Geothermal Energy

Geothermal energy technologies have an average capacity factor of 90 percent and can be used for baseload power where available. However, geothermal technology is not widely used for baseload generation due to the limited geographical availability of the resource and immature status of the technology (NRC 1996). As illustrated by Figure 8.4 in the GEIS, geothermal plants are most likely to be sited in the western continental United States, Alaska,

(a) One megawatt (MW) represents one million watts of electricity.

and Hawaii where hydrothermal reservoirs are prevalent. Alabama has low-to-moderate geothermal resources that can be tapped for direct heat or for geothermal heat pumps. However, electrical generation is not possible with these resources (DOE 2004e). There is no practical eastern location for geothermal capacity to serve as an alternative to BFN. The staff concludes that geothermal energy is not a feasible alternative to renewal of the BFN OLs.

8.2.6.6 Wood Waste

A wood-burning facility can provide baseload power and operate with an average annual capacity factor of around 70 to 80 percent and with 20 to 25 percent efficiency (NRC 1996). The fuels required are variable and site-specific. A significant barrier to the use of wood waste to generate electricity is the high delivered-fuel cost and high construction cost per MW of generating capacity. The larger wood-waste power plants are only 40 to 50 MW(e) in size. Estimates in the GEIS suggest that the overall level of construction impact per MW of installed capacity should be approximately the same as that for a coal-fired plant, although facilities using wood waste for fuel would be built at smaller scales (NRC 1996). Like coal-fired plants, wood-waste plants require large areas for fuel storage and processing and involve the same type of combustion equipment.

Because of uncertainties associated with obtaining sufficient wood and wood waste to fuel a baseload generating facility, ecological impacts of large-scale timber cutting (e.g., soil erosion and loss of wildlife habitat), and low efficiency, the staff determined that wood waste is not a feasible alternative to renewing the BFN OLs.

8.2.6.7 Municipal Solid Waste

Municipal waste combustors incinerate the waste and use the resultant heat to generate steam, hot water, or electricity. The combustion process can reduce the volume of waste by up to 90 percent and the weight of the waste by up to 75 percent (EPA 2004). Municipal waste combustors use three basic types of technologies: mass burn, modular, and refuse-derived fuel (DOE/EIA 2001). Mass burning technologies are most commonly used in the United States. This group of technologies process raw municipal solid waste "as is," with little or no sizing, shredding, or separation before combustion. The initial capital costs for municipal solid-waste plants are greater than for comparable steam-turbine technology at wood-waste facilities. This is caused by the need for specialized waste-separation/handling equipment for municipal solid waste (NRC 1996).

Growth in the municipal waste combustion industry slowed dramatically during the 1990s after rapid growth during the 1980s. The slower growth was due to three primary factors: (1) the Tax Reform Act of 1986, which made capital-intensive projects such as municipal waste combustion facilities more expensive relative to less capital-intensive waste disposal alternative such as landfills; (2) the 1994 Supreme Court decision (*C&A Carbone, Inc. v. Town of Clarkstown*), 511 U.S. 383(1994), which struck down local flow control ordinances that required waste to be delivered to specific municipal waste combustion facilities rather than landfills that may have had lower fees; and (3) increasingly stringent environmental regulations that increased the capital cost necessary to construct, operate, and maintain municipal waste combustion facilities (DOE/EIA 2001).

Municipal solid waste combustors generate an ash residue that is buried in landfills. The ash residue is composed of bottom ash and fly ash. Bottom ash refers to that portion of the unburned waste that falls to the bottom of the grate or furnace. Fly ash represents the small particles that rise from the furnace during the combustion process. Fly ash is generally removed from flue gases using fabric filters and/or scrubbers (DOE/EIA 2001).

Currently there are approximately 89 waste-to-energy plants operating in the United States. These plants generate approximately 2500 MW(e), or an average of approximately 28 MW(e) per plant (Integrated Waste Services Association 2004). The staff concludes that generating electricity from municipal solid waste would not be a feasible alternative to replace the uprated 3840-MW(e) baseload capacity of BFN and, consequently, would not be a feasible alternative to renewal of the BFN OLs.

8.2.6.8 Other Biomass-Derived Fuels

In addition to wood and municipal solid waste fuels, there are several other concepts for fueling electric generators, including burning crops, converting crops to a liquid fuel such as ethanol, and gasifying crops (including wood waste). In the GEIS, the staff stated that none of these technologies has progressed to the point of being competitive on a large scale or of being reliable enough to replace a large baseload plant such as BFN (NRC 1996). For these reasons, such fuels do not offer a feasible alternative to renewal of the BFN OLs.

8.2.6.9 Fuel Cells

Fuel cells work without combustion and its environmental side effects. Power is produced electrochemically by passing a hydrogen-rich fuel over an anode and air over a cathode. Activated by a catalyst, hydrogen atoms separate into protons and electrons, which take different paths to the cathode. The electrons go through an external circuit, creating a flow of electricity. The only by-products are heat, water, and carbon dioxide. Hydrogen fuel can come from a variety of hydrocarbon resources by subjecting them to steam under pressure. Natural gas is typically used as the source of hydrogen.

Phosphoric acid fuel cells are generally considered first-generation technology. Higher temperature second-generation fuel cells achieve higher fuel-to-electricity conversions and thermal efficiencies. The higher temperatures contribute to improved efficiencies and give the second-generation fuel cells the capability to generate steam for cogeneration and combined-cycle operations.

During the past three decades, significant efforts have been made to develop more practical and affordable fuel cell designs for stationary power applications, but progress has been slow (DOE 2004e). Today, the most widely marketed fuel cells cost about $4500 per kW of installed capacity; by contrast, a diesel generator costs $800 to $1500 per kilowatt, and a natural gas turbine can be even less (DOE 2004f).

DOE has launched an initiative – the Solid State Energy Conversion Alliance – to bring about dramatic reductions in fuel cell costs. DOE's goal is to cut costs to as low as $400 per kW of installed capacity by the end of this decade, which would make fuel cells competitive for virtually every type of power application (DOE 2004f).

The staff concludes that at the present time fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation. Future gains in cost competitiveness for fuels cells compared to other fuels are speculative. Fuel cells are, consequently, currently not a feasible alternative to renewal of the BFN OLs.

8.2.6.10 Delayed Retirement

It is conceptually possible that delayed retirement of other TVA generating units could replace the power generated by BFN. TVA has no plans for retiring any of its nuclear plants. Some fossil plants are slated for retirement, principally because of difficulty in meeting air emission requirements. Delayed retirement of these fossil units would involve major construction to upgrade or replace plant components (TVA 2003). The environmental impacts of such a scenario are bounded by the pulverized coal (Section 8.2.1) and natural gas combined-cycle (Section 8.2.3) generation alternatives.

8.2.6.11 Utility-Sponsored Conservation

The utility-sponsored conservation alternative refers to a situation with the following three conditions: (1) BFN ceases to operate, (2) no new generation is brought online to meet the lost generation, and (3) the lost generation is instead replaced by more efficient use of electricity brought about by DSM programs.

DSM programs consist of the planning, implementing, and monitoring activities of electric utilities that are designed to encourage consumers to modify their level and pattern of electricity usage. DSM programs have been part of TVA's energy portfolio since the 1970s. They were initiated in response to the rising cost of energy and the rising cost of building new electric generating units that began in the mid 1970s. By 1988, TVA DSM programs were credited with saving more than 2.3 billion kilowatt-hours per year and cutting system demand by 1200 MW (TVA 2003). Of these savings, 960 MW came from the residential sector after weatherization measures were installed in 631,000 homes in the Tennessee Valley. DSM initiatives (such as energy-right home electrical efficiency, direct load control, industrial customer products and services, and firm buy-back agreements) continue to be implemented through TVA power distributors with an estimated 154 MW of capacity added from 1995 through 1999, and an additional 264 MW from 2000 to 2002 (TVA 2003). TVA's energy savings attributable to DSM are part of its long-range plan for meeting projected demand, and thus are not available offsets for the generating capacity of BFN.

Current residential DSM programs offered by TVA include a new homes plan, a heat pump plan, a water heater plan, and a new manufactured home plan. Current commercial DSM programs offered by TVA include onsite operations support to aid the achievement of energy savings, support to industrial power users to improve energy efficiency, and an initiative to encourage use of groundwater heat pumps.

Although DSM programs are an important part of TVA's energy portfolio, the staff concludes that additional DSM, by itself, would not be sufficient to replace the uprated 3840-MW(e) capacity of BFN and that it is not a reasonable substitute for renewing the OLs.

8.2.7 Combination of Alternatives

Even though individual alternatives might not be sufficient on their own to replace the BFN generating capacity because of the small size of the resource or lack of cost-effective opportunities, it is conceivable that a combination of alternatives might be cost-effective.

BFN is projected to have an uprated capacity of 3840 MW(e). There are many possible combinations of alternatives to replace this capacity. Table 8-10 contains a summary of the environmental impacts of an assumed combination of alternatives consisting of 3060-MW(e) (six 510-MW[e]) plants of natural gas combined-cycle generation using mechanical draft cooling towers, 400 MW purchased from other generators, and 380 MW gained from additional DSM measures. The impacts associated with the natural gas combined-cycle units are based on the discussion in Section 8.2.3, adjusted for the reduced generating capacity. While the DSM measures would have few environmental impacts, operation of the new natural gas combined-cycle plants would result in increased emissions and other environmental impacts. The environmental impacts associated with power purchased from other generators would still occur, but would be located elsewhere within the region as discussed in Section 8.2.4. The environmental impacts associated with purchased power are not shown in Table 8-10. The staff concludes that it is very unlikely that the environmental impacts of any reasonable combination of generating and conservation options could be reduced to the level of impacts associated with renewal of the BFN OLs.

Table 8-10. Summary of Environmental Impacts of an Assumed Combination of Generation and Acquisition Alternatives

Impact Category	Impact	Comment
Land Use	MODERATE to LARGE	Approximately 80 ha (200 ac) for each of six 510-MW(e) plant. Additional site-specific impacts for natural gas pipeline, electric power transmission lines, rail spurs, and cooling water intake and discharge pipelines.
Ecology	MODERATE	Impact depends on location and ecology of the site, surface water body used for intake and discharge, and electric power transmission line and natural gas pipeline routes; potential habitat loss and fragmentation; reduced productivity and biological diversity; impacts to terrestrial ecology from cooling tower drift.

Table 8-10. (contd)

Impact Category	Impact	Comment
Water Use and Quality	SMALL to MODERATE	Impact would depend on the volume of water withdrawn and discharged, the constituents in the discharge water, and the characteristics of the surface water body. Discharges would be regulated by the State or EPA.
Air Quality	MODERATE	Air emissions would be approximately: Sulfur oxides – 53.6 MT/yr (59.1 tons/yr) Nitrogen oxides – 1032 MT/yr (1138 tons/yr) PM_{10} – 947 MT/yr 1044 (tons/yr) Carbon monoxide – 3940 MT/yr (4340 tons/yr) Small amounts of hazardous air pollutants would be emitted along with 13.7 million MT/yr (15.1 million tons/yr) of unregulated carbon dioxide.
Waste	SMALL	The only significant waste would be spent catalyst from the SCR process used to control NO_x emissions.
Human Health	SMALL	Impacts are uncertain, but considered SMALL in the absence of more quantitative data.
Socioeconomics	MODERATE	Construction impacts depend on location and how many plants are constructed at the location. Limestone County could experience loss of BFN tax base and employment. Impacts related to the operation of the gas plants would be minor. Transportation impacts would result from commuting workers.
Aesthetics	MODERATE to LARGE	Impact would depend on the site selected and the surrounding land features. Power block, exhaust stacks, cooling towers, and cooling tower plumes would be visible from nearby areas. If needed, new electric power transmission lines could have a LARGE aesthetic impact. Noise impact from plant operations and intermittent sources would be noticeable.
Historic and Archeological Resources	SMALL	New plant locations would necessitate cultural resource studies. Any potential impacts can likely be effectively managed.
Environmental Justice	SMALL to MODERATE	Impacts would vary depending on population distribution and makeup water at the site. Impacts in Limestone County would be the same as those under the no-action alternative.

8.3 Summary of Alternatives Considered

As discussed in Chapter 4, the environmental impacts of the proposed action, renewal of the BFN OLs, are SMALL for all impact categories, except for collective offsite radiological impacts from the fuel cycle and from HLW and spent fuel disposal. Collective offsite radiological impacts from the fuel cycle and from HLW and spent fuel disposal were not assigned a single significance level, but were determined by the Commission to be acceptable. The following alternative actions were considered: the no-action alternative (discussed in Section 8.1); new generation alternatives from pulverized coal, coal gasification, natural gas combined-cycle, and new nuclear (discussed in Sections 8.2.1 through 8.2.4, respectively); purchased electrical power (discussed in Section 8.2.5); alternative technologies (discussed in Section 8.2.6); and the combination of alternatives (discussed in Section 8.2.7).

The no-action alternative purchasing would require replacing electrical generating capacity by (1) DSM and energy conservation, (2) purchasing power from other electricity providers, (3) generating alternatives other than BFN, or (4) some combination of these options, and would result in decommissioning BFN. For each of the new generation alternatives (pulverized coal, coal gasification, natural gas combined-cycle, and new nuclear), the environmental impacts would not be less than the impacts of license renewal. For example, the land-disturbance impacts resulting from construction of any new facility would be greater than the impacts of continued operation of BFN. The impacts of purchased electrical power would still occur, but would occur elsewhere. Alternative technologies are not considered feasible at this time, and it is very unlikely that the environmental impacts of any reasonable combination of generation and conservation options could be reduced to the level of impacts associated with renewal of the BFN OL.

The staff concludes that the alternative actions, including the no-action alternative, may have environmental effects in at least some impact categories that reach MODERATE or LARGE significance.

8.4 References

10 CFR Part 20. Code of Federal Regulations, Title 10, *Energy*, Part 20, "Standards for Protection Against Radiation."

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

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

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy*, Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants."

40 CFR Part 50. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 50, "National Primary and Secondary Ambient Air Quality Standards."

40 CFR Part 51. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 51, "Requirements for Preparation, Adoption, and Submittal of Implementation Plans."

40 CFR Part 60. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 60, "Standards of Performance for New Stationary Sources."

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9.0 Summary and Conclusions

By letter dated December 31, 2003, the Tennessee Valley Authority (TVA) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating licenses (OLs) for Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 (BFN) for an additional 20-year period (TVA 2003a). If the OLs are renewed, State regulatory agencies and TVA will ultimately decide whether the plant will continue to operate based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners. If the OLs are not renewed, then the plants must be shut down at or before the expiration of the current OLs, which expire on December 20, 2013, for Unit 1, June 28, 2014, for Unit 2, and July 2, 2016, for Unit 3.

Section 102 of the National Environmental Policy Act of 1969 (NEPA) (42 USC 4321) directs that an environmental impact statement (EIS) is required for major Federal actions that significantly affect the quality of the human environment. The NRC has implemented Section 102 of NEPA in 10 CFR Part 51. Part 51 identifies licensing and regulatory actions that require an EIS. In 10 CFR 51.20(b)(2), the Commission requires preparation of an EIS or a supplement to an EIS for renewal of a reactor OL; 10 CFR 51.95(c) states that the EIS prepared at the OL renewal stage will be a supplement to the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999).[a]

Upon acceptance of the TVA application, NRC began the environmental review process described in 10 CFR Part 51 by publishing a notice of intent to prepare an EIS and conduct scoping (69 FR11462) on March 10, 2004 (NRC 2004a). The staff visited the BFN site in March 2004 and held public scoping meetings on April 1, 2004, in Athens, Alabama (NRC 2004b). The staff reviewed the TVA Environmental Report (ER) (TVA 2003b) and other TVA environmentally related documents and compared them to the GEIS, consulted and discussed the application with other agencies, and conducted an independent review of the issues following the guidance set forth in NUREG-1555, Supplement 1, the *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal* (NRC 2000). The staff also considered the public comments received during the scoping process for preparation of this supplemental environmental impact statement (SEIS) for BFN. The public comments received during the scoping process that were considered to be within the scope of the environmental review are provided in Appendix A, Part 1, of this draft SEIS.

The staff will hold two public meetings in Athens, Alabama, in January 2005, to describe the results of the NRC environmental review and to answer questions to provide members of the

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

public with information to assist them in formulating their comments on this SEIS. When the comment period ends, the staff will consider and address all of the comments received. These comments will be addressed in Appendix A, Part 2, of the final SEIS.

This draft SEIS includes the NRC staff's analysis that considers and weighs the environmental effects of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse effects. It also includes the staff's recommendation regarding the proposed action.

The NRC has adopted the following statement of purpose and need for license renewal from the GEIS:

> The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decisionmakers.

The goal of the staff's environmental review, as defined in 10 CFR 51.95(c)(4) and the GEIS, is to determine

> ... whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

Both the statement of purpose and need and the evaluation criterion implicitly acknowledge that there are factors, in addition to license renewal, that will ultimately determine whether an existing nuclear power plant continues to operate beyond the period of the current OL.

NRC regulations [10 CFR 51.95(c)(2)] contain the following statement regarding the content of SEISs prepared at the license renewal stage:

> The supplemental environmental impact statement for license renewal is not required to include discussion of need for power or the economic costs and economic benefits of the proposed action or of alternatives to the proposed action except insofar as such benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation. In addition, the supplemental environmental impact statement prepared at the license renewal stage need not discuss other issues not related to the environmental effects of the proposed

action and the alternatives, or any aspect of the storage of spent fuel for the facility within the scope of the generic determination in § 51.23(a) and in accordance with § 51.23(b).[(a)]

The GEIS contains the results of a systematic evaluation of the consequences of renewing an OL and operating a nuclear power plant for an additional 20 years. It evaluates 92 environmental issues using the NRC's three-level standard of significance – SMALL, MODERATE, or LARGE – developed using the Council on Environmental Quality guidelines. The following definitions of the three significance levels are set forth in the footnotes to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B:

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

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

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

For 69 of the 92 issues considered in the GEIS, the staff analysis in the GEIS shows the following:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective off-site radiological impacts from the fuel cycle and from high-level waste [HLW] and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

(a) The title of 10 CFR 51.23 is "Temporary storage of spent fuel after cessation of reactor operations-generic determination of no significant environmental impact."

These 69 issues were identified in the GEIS as Category 1 issues. In the absence of new and significant information, the staff relied on conclusions as amplified by supporting information in the GEIS for issues designated Category 1 in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B.

Of the 23 issues that do not meet the criteria set forth above, 21 are classified as Category 2 issues requiring analysis in a plant-specific supplement to the GEIS. The remaining two issues, environmental justice and chronic effects of electromagnetic fields, were not categorized. Environmental justice was not evaluated on a generic basis and must also be addressed in a plant-specific supplement to the GEIS. Information on the chronic effects of electromagnetic fields was not conclusive at the time the GEIS was prepared.

This SEIS documents the staff's consideration of all 92 environmental issues identified in the GEIS. The staff considered the environmental impacts associated with alternatives to license renewal and compared the environmental impacts of license renewal and the alternatives. The alternatives to license renewal that were considered include the no-action alternative (not renewing the OLs for BFN) and alternative methods of power generation. These alternatives were evaluated assuming that the replacement power generation plant is located at either the BFN site, at the unfinished Bellefonte nuclear plant site, or at other locations.

9.1 Environmental Impacts of the Proposed Action – License Renewal

TVA and the NRC staff have established independent processes for identifying and evaluating the significance of any new information on the environmental impacts of license renewal. Neither TVA nor the NRC staff has identified information that is both new and significant related to Category 1 issues that would call into question the conclusions in the GEIS. Similarly, neither the scoping process, TVA, nor the NRC staff has identified any new issue applicable to BFN that has a significant environmental impact. Therefore, the staff relies upon the conclusions of the GEIS for all Category 1 issues that are applicable to BFN.

TVA's license renewal application presents an analysis of the Category 2 issues that are applicable to BFN, plus environmental justice and chronic effects from electromagnetic fields. The staff has reviewed the TVA analysis for each issue and has conducted an independent review of each issue plus environmental justice and chronic effects from electromagnetic fields. Three Category 2 issues are not applicable because they are related to plant design features or site characteristics not found at BFN. Four Category 2 issues are not discussed in this SEIS because they are specifically related to refurbishment. TVA (TVA 2003b) has stated that its evaluation of structures and components, as required by 10 CFR 54.21, did not identify any major plant refurbishment activities or modifications as necessary to support the continued operation of BFN for the license renewal term. In addition, any replacement of components or additional inspection activities are within the bounds of normal plant component replacement and, therefore, are not expected to affect the environment outside the bounds of the plant operations evaluated in the TVA *Final Environmental Statement Related to the Operation of Browns Ferry Units 1, 2, and 3* (TVA 1972), which was adopted by the Atomic Energy Commission.

Fourteen Category 2 issues related to operational impacts and postulated accidents during the license renewal term, as well as environmental justice and chronic effects of electromagnetic fields, are discussed in detail in this SEIS. Four of the Category 2 issues and environmental justice apply to both refurbishment and to operation during the license renewal term and are only discussed in this SEIS in relation to operation during the license renewal term. For all 14 Category 2 issues and environmental justice, the staff concludes that the potential environmental effects are of SMALL significance in the context of the standards set forth in the GEIS. In addition, the staff determined that appropriate Federal health agencies have not reached a consensus on the existence of chronic adverse effects from electromagnetic fields. Therefore, no further evaluation of this issue is required. For severe accident mitigation alternatives (SAMAs), the staff concludes that a reasonable, comprehensive effort was made to identify and evaluate SAMAs. Based on its review of the SAMAs for BFN and the plant improvements already made, the staff concludes that none of the candidate SAMAs are cost-beneficial.

Mitigation measures were considered for each Category 2 issue. Current measures to mitigate the environmental impacts of plant operation were found to be adequate, and no additional mitigation measures were deemed sufficiently beneficial to be warranted. Cumulative impacts of past, present, and reasonably foreseeable future actions were considered, regardless of what agency (Federal or non-Federal) or person undertakes such other actions. For purposes of this analysis, where BFN license renewal impacts are deemed to be SMALL, the staff concluded that these impacts would not result in significant cumulative impacts on potentially affected resources.

The following sections discuss unavoidable adverse impacts, irreversible or irretrievable commitments of resources, and the relationship between local short-term use of the environment and long-term productivity.

9.1.1 Unavoidable Adverse Impacts

An environmental review conducted at the license renewal stage differs from the review conducted in support of a construction permit because the plant is in existence at the license renewal stage and has operated for a number of years. As a result, adverse impacts associated with the initial construction have been avoided, have been mitigated, or have already occurred. The environmental impacts to be evaluated for license renewal are those associated with refurbishment and continued operation during the license renewal term.

The adverse impacts of continued operation identified are considered to be of SMALL significance, and none warrants implementation of additional mitigation measures. The adverse impacts of likely alternatives if BFN ceases operation at or before the expiration of the current OLs will not be smaller than those associated with continued operation of these units, and they may be greater for some impact categories in some locations.

9.1.2 Irreversible or Irretrievable Resource Commitments

The commitment of resources related to construction and operation of BFN during the current license term was made when the plant was built. The resource commitments to be considered in this SEIS are associated with continued operation of the plant for an additional 20 years. These resources include materials and equipment required for plant maintenance and operation, the nuclear fuel used by the reactors and, ultimately, permanent offsite storage space for the spent fuel assemblies.

The most significant resource commitments related to operation during the license renewal term are the new fuel and the permanent storage space for the spent fuel. BFN currently replaces approximately 38 percent of the fuel assemblies in each unit during every refueling outage, which occurs on a 24-month cycle. With the planned extended power uprate, and a contemplated change to blended low-enriched uranium fuel assemblies, the proportion of the fuel assemblies replaced during each refueling cycle may increase to approximately 48 percent.

The likely power generation alternatives if BFN ceases operation on or before the expiration of the current OLs will require a commitment of resources for construction of the replacement plants as well as for fuel to operate the plants.

9.1.3 Short-Term Use Versus Long-Term Productivity

An initial balance between local short-term uses and the maintenance and enhancement of the long-term productivity of the environment at the BFN site was set when the plants were approved and construction began. That balance is now well established. Renewal of the OLs for BFN and continued operation of the plants will not alter the existing balance because the decision to use the BFN site to produce power has already been made, but may postpone the availability of the site for other uses. Denial of the application to renew the OLs will lead to shutdown of the plants and will alter the balance in a manner that depends on subsequent uses of the site. For example, the environmental consequences of turning the BFN site into a park or an industrial facility are quite different.

9.2 Relative Significance of the Environmental Impacts of License Renewal and Alternatives

The proposed action is renewal of the OLs for Units 1, 2, and 3 at BFN. Chapter 2 describes the site, the power plant, and interactions of the plant with the environment. As noted in Chapter 3, no refurbishment activities and therefore no refurbishment impacts are expected at BFN. Chapters 4 through 7 discuss environmental issues associated with renewal of the OLs. Environmental issues associated with the no-action alternative and alternatives involving power generation and use reduction are discussed in Chapter 8.

The significance of the environmental impacts from the proposed action (approval of the application for renewal of the OLs), the no-action alternative (denial of the application), alternatives involving nuclear or coal-fired, coal gasification, or natural-gas-fired generation of power at the BFN site, nuclear generation at the TVA-owned Bellefonte site, and a combination of alternatives are compared in Table 9-1. Continued use of a once-through cooling system with helper towers for BFN is assumed for Table 9-1.

Table 9-1 shows that the significance of the environmental effects of the proposed action are SMALL for all impact categories (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal, for which a single significance level was not assigned [Chapter 6]). The alternative actions, including the no-action alternative, may have environmental effects in at least some impact categories that reach MODERATE or LARGE significance.

9.3 Staff Conclusions and Recommendations

Based on (1) the analysis and findings in the GEIS (NRC 1996, 1999); (2) the TVA Environmental Report (TVA 2003b); (3) consultation with Federal, State, and local agencies; (4) the staff's own independent review; and (5) the staff's consideration of public comments, the recommendation of the staff is that the Commission determine that the adverse environmental impacts of license renewal for Units 1, 2, and 3 at BFN are not so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable.

Table 9-1. Summary of Environmental Significance of License Renewal, the No-Action Alternative, and Alternative Methods of Generation Using Closed-Cycle Cooling

Impact Category	Proposed Action (License Renewal)	No-Action Alternative (Denial of Renewal)	Pulverized Coal-Fired Generation	Coal Gasification[a]	Natural-Gas-Combined-Cycle Generation	New Nuclear Generation[a]	Combination of Energy Alternatives
Land Use	SMALL	SMALL	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE	SMALL to LARGE	MODERATE to LARGE
Ecology	SMALL	SMALL	MODERATE to LARGE	SMALL to LARGE	MODERATE	SMALL to LARGE	MODERATE
Water Use and Quality	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL tp MODERATE
Air Quality	SMALL	SMALL	MODERATE	MODERATE	MODERATE	SMALL	MODERATE
Waste	SMALL	SMALL	MODERATE	MODERATE	SMALL	SMALL	SMALL
Human Health	SMALL[b]	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Socio-economics	SMALL	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE to LARGE	MODERATE
Aesthetics	SMALL	SMALL	MODERATE to LARGE	MODERATE	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE
Historic and Archaeological Resources	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Environmental Justice	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE

(a) This alternative assumes building at TVA's unfinished Bellefonte nuclear plant site.
(b) Except for collective offsite radiological impacts from the fuel cycle and from HLW and spent-fuel disposal, for which a significance level was not assigned. See Chapter 6 for details.

9.4 References

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

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

National Environmental Policy Act of 1969 (NEPA). 42 USC 4321, et seq.

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U.S. Nuclear Regulatory Commission (NRC). 2004a. "Notice of Intent To Prepare an Environmental Impact Statement and Conduct Scoping Process." *Federal Register.* Vol. 69, No. 47, pp. 11462-11464. Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2004b. *Environmental Impact Statement Scoping Process: Summary Report – Brown Ferry Nuclear Plant, Units 1, 2, and 3.* Athens, Alabama.

Appendix A

Comments Received on the Environmental Review

Appendix A

Comments Received on the Environmental Review

Part I – Comments Received During Scoping

On March 10, 2004, the U.S. Nuclear Regulatory Commission (NRC) published a Notice of Intent in the Federal Register (69 FR 11462), to notify the public of the staff's intent to prepare a plant-specific supplement to the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2, to support the renewal application for the Browns Ferry operating licenses and to conduct scoping. The plant-specific supplement to the GEIS has been prepared in accordance with the National Environmental Policy Act (NEPA), Council on Environmental Quality (CEQ) guidance, and 10 CFR Part 51. As outlined by NEPA, the NRC initiated the scoping process with the issuance of the Federal Register Notice. The NRC invited the applicant; Federal, State, and local government agencies; Native American tribal organizations; local organizations; and individuals to participate in the scoping process by providing oral comments at the scheduled public meetings and/or submitting written suggestions and comments no later than May 9, 2004. The deadline for filing comments was subsequently extended to June 4, 2004 (69 FR 30338).

The scoping process included two public scoping meetings, which were held at Athens State University in Athens, Alabama on April 1, 2004. Approximately 40 members of the public attended each meeting. Both sessions began with NRC staff members providing a brief overview of the license renewal process and the NEPA process. After the NRC's prepared statements, the meetings were open for public comments. Seven attendees provided oral statements that were recorded and transcribed by a certified court reporter and written statements that were appended to the transcript. The meeting transcripts are an attachment to the April 1, 2004, Scoping Meeting Summary dated May 14, 2004. The meeting summary is available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records component of NRC's document system (ADAMS) under accession number ML041390581. In addition to the comments received during the public meetings, four comment letters and two e-mail messages were received by the NRC in response to the Notice of Intent.

The NRC received a letter dated May 19, from Mr. Larry Goldman of the U.S. Fish and Wildlife Service (FWS) providing comments on the environmental review. These comments were not included in the scoping summary report. However, the staff did consider the comments from FWS in the preparation of this supplemental environmental impact statement (SEIS).

At the conclusion of the scoping period, the NRC staff and its contractor(s) reviewed the transcripts and all written material to identify specific comments and issues. Each set of comments from a given commenter was given a unique identifier (Commenter ID), so that each set of comments from a commenter could be traced back to the transcript or letter by which the comments were submitted. Specific comments were numbered sequentially within each comment set. One commenter submitted comments through multiple sources (e.g., afternoon and evening scoping meetings). All of the comments received and the staff responses are included in the Environmental Scoping Summary Report dated July 2004.

Table A-1 identifies the individuals who provided comments applicable to the environmental review and the Commenter ID associated with each person's set(s) of comments. The individuals are listed in the order in which they spoke at the public meeting, and in alphabetical order for the comments received by letter or e-mail. To maintain consistency with the Scoping Summary Report, the unique identifier used in that report for each set of comments is retained in this appendix.

Specific comments were categorized and consolidated by topic. Comments with similar specific objectives were combined to capture the common essential issues raised by the commenters. The comments fall into one of the following general groups:

- Specific comments that address environmental issues within the purview of the NRC environmental regulations related to license renewal. These comments address Category 1 or Category 2 issues or issues that were not addressed in the GEIS. They also address alternatives and related Federal actions.

- General comments (1) in support of or opposed to nuclear power or license renewal or (2) on the renewal process, the NRC's regulations, and the regulatory process. These comments may or may not be specifically related to the Browns Ferry license renewal application.

- Questions that do not provide new information.

- Specific comments that address issues that do not fall within or are specifically excluded from the purview of NRC environmental regulations related to license renewal. These comments typically address issues such as the need for power, emergency preparedness, security, current operational safety issues, and safety issues related to operation during the renewal period.

Table A-1. Individuals Providing Comments During Scoping Comment Period

Commenter ID	Commenter	Affiliation (If Stated)	Comment Source and Accession Number:
BF-A	Stewart Horn		Afternoon Scoping Meeting ML041350407
BF-B	Dr. Lane Price		Afternoon Scoping Meeting
BF-C	Ann Harris	We the People, Inc.	Afternoon Scoping Meeting
BF-D	Stewart Ward		Afternoon Scoping Meeting
BF-E	Chuck Wilson	Tennessee Valley Authority	Afternoon Scoping Meeting
BF-F	Nancy Muse		Evening Scoping Meeting ML041350459
BF-G	Jeff North		Evening Scoping Meeting
BF-H	Chuck Wilson	Tennessee Valley Authority	Evening Scoping Meeting
BF-I	Zola		Email ML041250405
BF-J	Michael Bolt	Eastern Band of Cherokee Indians	Email ML0415540361
BF-K	Michelle Hamilton	Eastern Band of Cherokee Indians	Comment Letter ML041490083
BF-L	Sara Barczak and David Ritter	Southern Alliance for Clean Air and Public Citizen's Critical Mass Energy and Environmental Program	Comment Letter ML041340245
BF-M	Anoatubby	Chickasaw Nation	Comment Letter ML041410044
BF-N	Frances Lamberts	Tennessee League of Women Voters	Comment Letter ML041600095

Comments applicable to this environmental review and the staff's responses are summarized in this appendix. The parenthetical alpha-numeric identifier after each comment refers to the comment set (Commenter ID) and the comment number. This information, which was extracted from the Browns Ferry Scoping Summary Report, is provided for the convenience of those interested in the scoping comments applicable to this environmental review. The comments that are general or outside the scope of the environmental review for Browns Ferry are not included here. More detail regarding the disposition of general or inapplicable comments can be found in the summary report. The ADAMS accession number for the Scoping Summary Report is ML041970736.

This accession number is provided to facilitate access to the document through the Public Electronic Reading Room (ADAMS) http://www.nrc.gov/reading-rm.html.

Comments in this section are grouped in the following categories:

A.1.1 Aquatic Ecology Issues
A.1.2 Threatened and Endangered Species
A.1.3 Air Quality Issues
A.1.4 Human Health Issues
A.1.5 Cultural Resources Issues
A.1.6 Alternative Energy Sources
A.1.7 Surface Water Quality, Hydrology, and Use
A.1.8 Postulated Accidents
A.1.9 Uranium Fuel Cycle

Part I. Comments Received During Scoping

A.1 Comments and Responses

The comments and suggestions received as part of scoping are discussed below. Parenthetical numbers after each comment refer to the commenter's ID letter and the comment number. Comments can be tracked to the commenter and the source document through the ID letter and comment number listed in Table A-1.

A.1.1 Comments Concerning Aquatic Ecology Issues

Comment: I don't understand the terminology impingement and entrainment. I don't know how to comment on that without understanding what it is. (BF-F-6)

Comment: Through impingement and entrainment, and through thermal alteration of returned water they cause damage to aquatic life, including great fishery and related recreational losses along river systems on which they are located. (BF-N-15)

Response: *Impingement occurs when fish or shellfish are pulled onto the intake screens that are part of the cooling water systems associated with nuclear power plants. Entrainment occurs when fish, shellfish, or larvae that are too small to be impinged on the screen are entrained in the flow through the plant, traversing the plant cooling system. Impingement and entrainment, as well as other aquatic ecology issues, will be discussed in Chapter 2 and Chapter 4 of the SEIS.*

Comment: The EIS should include (3) analysis of aquatic wildlife and terrestrial species impacts, with extensive involvement of the Federal and State agencies charged with natural resource protection. (BF-N-23)

Response: *Impacts to aquatic and terrestrial species will be discussed in Chapter 4 of the SEIS.*

A.1.2 Comments Concerning Threatened and Endangered Species

Comment: New data on the status of Federally and State-listed endangered or threatened terrestrial animal, aquatic, and plant species should be required and studied as to the impacts of an additional 20 years of operations per reactor. (BF-L-13)

Comment: Proper notification to, along with creation of working relationships with, state agencies, Fish and Wildlife Service, and National Marine Fisheries Service should occur. (BF-L-14)

Response: *During the analysis and preparation of the draft SEIS for license renewal, the NRC staff consults with appropriate Federal agencies. The NRC usually contacts directly the U.S. Fish and Wildlife Service (Department of the Interior) and the National Marine Fisheries Service (Department of Commerce) for environmental issues related to the impact on any threatened or endangered species that may be in the vicinity of the plant or to any critical habitat. If other agencies have actions or jurisdiction over areas directly related to the review, they would also be contacted directly by the NRC.*

In addition to NRC coordinated consultation, after a draft SEIS is published, it is also reviewed by various Federal agencies at their discretion. For example, at the Federal level, the draft SEIS for license renewal are most commonly reviewed by the Environmental Protection Agency and the Department of the Interior. The comments from these agencies are considered and included in the final SEIS as appropriate.

Potential impacts of renewing the operating licenses for Browns Ferry Nuclear Plant, Units 1, 2, and 3 on threatened or endangered species will be evaluated in Chapter 2 and Chapter 4 of the SEIS.

A.1.3 Comments Concerning Air Quality Issues

Comment: We note that Limestone County is not evaluated as having bad air quality and that the annual quantity of emissions released into the atmosphere is normal for a nuclear plant. In an ideal situation it would not be necessary for us to make comment on air quality, however the air quality situation is far from ideal in the Great Smoky Mountains.. Because air flows from Alabama frequently move towards our mountains we would like to encourage the exploration of reducing emissions at Browns Ferry. (BF-J-1)

Response: *Air quality impacts from plant operations were evaluated in the GEIS and found to be minimal. Air emissions are regulated by the Environmental Protection Agency and the State of Alabama. Air quality will be discussed in Chapter 2 of the SEIS.*

A.1.4 Comments Concerning Human Health Issues

Comment: I'm also concerned about the level of radioactive substances that are effluent. If and what they are, and where can we get that information. Is that on the web site of the NRC? Radioactivity that is released into the environment in any way. (BF-F-7)

Comment: Could you specifically address the effluent from Browns Ferry. What do you all actually put into the river, itself? (BF-B-1)

Comment: I want to know whether the Millie is per what or per person. What it meant when you gave that answer, when you said equal to a dose of ... Is that what a person can get by being in the water at the point of the – at the pipes? (BF-D-1)

Response: *NRC is a regulatory agency charged with assuring public health and safety. NRC does this by providing the industry with regulations as well as conducting plant inspections. The licensee is allowed to release gaseous and liquid effluents to the environment, but the releases must be monitored and meet the requirements of 10 CFR Part 20, Appendix B, Table 2; therefore, contaminants may be present and detectable offsite. However, the release limits have been designed and proven to be protective of the health and safety of the public and environment. NRC sets limits on radiological effluents, requires monitoring of effluents and foodstuffs to ensure those limits are met, and has set dose limits to regulate the release of radioactive material from nuclear power facilities. The regulations are intentionally conservative and provide adequate protection for the public including the most radiosensitive members of the population. TVA monitors its effluent and calculates an offsite annual dose caused by radioactive liquid and gaseous effluents. These calculations are performed to demonstrate the licensee's compliance with its technical specifications and NRC regulations.*

NRC publishes two annual reports for Browns Ferry regarding environmental monitoring and environmental effluents. The "Annual Radiological Environmental Operating Report (AREOR)" and the "Annual Radiological Effluent Release (ARER) Report" are available to the public through NRC's Public Document Room in Rockville, Maryland, or from NRC's Electronic Reading Room available online at http://www.nrc.gov/reading-rm.html. The comments did not provide new and significant information; therefore, they will not be evaluated further.

A.1.5 Comments Concerning Cultural Resources

Comment: According to the information you provided, the EBCI's THPO has determined that the proposed activities will not have an effect on any known cultural resources significant to our Tribe. (BF-K-1)

Comment: We have also determined the undertaking will not have an affect on known cultural resources listed on or eligible for the National Register of Historic Places provided that archaeological site 1Li535 is avoided as stated in the BFN License Renewal Final Supplemental EIS. (BF-K-2)

Response: *The comments refer to historic and archaeological resources near Browns Ferry. These issues will be addressed in Chapter 2 and Chapter 4 of the SEIS.*

A.1.6 Comments Concerning Alternative Energy Sources

Comment: In our experience, the relicensing process has generally provided an inadequate analysis of energy alternatives. (BF-L-15)

Comment: In addition, other electricity generating technologies, such as solar, wind, and biomass should be investigated. (BF-L-17)

Comment: The League believes that an emphasis on conserving energy and using energy-efficient technologies is by far the wisest and safest course of action for our nation and state. (BF-N-3)

Comment: The League also believes that predominant reliance should be placed on production of energy from renewable sources. (BF-N-5)

Comment: We have applauded and strongly support the TVA's initiation of a Green Power Switch program whose wind, solar, and methane gas installations now produce electric power for more than seven thousand residential and business users. At this time, however, TVA's generational capacity under this program makes up less than one percent of its capacity from the two, now operating Browns Ferry units. For ecological and other reasons, the strongest market trends in the energy field, around the world favor energy production from renewable sources and weight of public opinion is on the side of expansion of these sources, at least within the Tennessee part of the Agency service area. (BF-N-6)

Response: *The GEIS included an extensive discussion of alternative energy sources. Environmental impacts associated with various reasonable alternatives to renewal of the* *operating licenses for Browns Ferry will be discussed in Chapter 8 of the SEIS. The comments did not provide new and significant information; therefore, they will not be evaluated further.*

Comment: It should thoroughly assess and clearly delineate (2) the alternative options and their economic, environmental and social benefits and costs. Delineation of alternatives should include optimization of energy efficiency technologies, energy conservation, and Green-Power-Switch program maximization. (BF-N-22)

Comment: It should also include comprehensive assessment and comparison of normal (4) safety-related costs for nuclear plants relative to alternative, renewable-source generation options. (BF-N-24)

Comment: The NRC must review in every respect these safety implications and costs of nuclear-power sources as against the societal and environmental advantages which renewable and substantially risk-free generation sources offer. (BF-N-27)

Response: *NRC determined that an applicant for license renewal need not provide an analysis of the economic costs or economic benefits of the proposed or alterative actions. The comments did not provide new and significant information; therefore, they will not be evaluated further.*

A.1.7 Comments Concerning Surface Water Quality, Hydrology and Use

Comment: I will only focus on the high discharge temperature that will occur when all three units are operating at 3952 Mega-watts Thermal. The existing five cooling towers are unable to cool the water at peak summer conditions without derating an operating unit. (BF-I-1)

Comment: There is no concerted effort to built back cooling tower #4 or build additional cooling towers to allow operation at 100% of Extended Power Uprate (EPU) without derating all three units or having to take one off-line. Studies have been conducted by TVA's Norris labs to validate this assertion. (BF-I-2)

Comment: I believe there is a planned effort to allow Unit 1 to continue in it's effort to restart with paying for the adequate cooling to meet the discharge limits. This is being driven by a fervent desire to hold the restart costs down and not impact schedule dates. (BF-I-3)

Response: *These comments refer to surface water quality issues. These issues will be addressed in Chapters 2 and 4 of the SEIS.*

Comment: NRC should evaluate the impacts of extended generation from a regional perspective and should investigate state-level political concerns that may affect that ability to dedicate large water resources for extremely long periods of time. (BF-L-9)

Comment: NRC should require updated water use information for the region on current water needs, as in what industries and municipalities are currently using and are projected to use in the future as population centers continue to grow. (BF-L-12)

Comment: Since construction of the Brown's Ferry plant some four decades ago, Tennessee and the region have experienced enormous growth in population, with corresponding demands on water--our most important and life-necessary natural resource. (BF-N-16)

Comment: Since Unit 1 has not operated since 1985, and all of the reactors came on-line for a time in the mid-to-late 1970s, thorough water withdrawal and water consumption analyses, along with fish and vegetation studies, must be done using updated data (not referring back to original operating license information). (BF-L-10)

Comment: Further, the impact of the water withdrawn and its effect on the flow of the Tennessee River should be evaluated not during just "normal" conditions but in times of drought, which have impacted the region when Browns Ferry Unit 1 was not even operating. (BF-L-11)

Comment: We have strong concerns regarding nuclear power plant impacts on the region's water resources. Reactors like those at Browns Ferry consume through evaporation about 20,000 gallons per minute; their flow-through rate exceeds 600,000 gallons per minute and their direct and indirect cost to the water resource exceeds 50 gallons per each kilowatt hour of electricity they generate. (BF-N-14)

Comment: Given their huge withdrawal demands, it is imperative that the NRC consider the water impacts from the Browns Ferry reactors in a comprehensive way and from the perspective of all human and wildlife needs and all competing uses over the longer-term future. (BF-N-17)

Comment: We believe, therefore, that committing to electricity generation such large water withdrawals as are needed for safe operation of the Browns Ferry reactors, for more than three decades hence, may not be wise when generation options which have no or minimal impacts, e.g. from renewable sources, are available. (BF-N-19)

Response: *These comments refer to water use and water use conflicts. These issues will be addressed in Chapter 4 of the SEIS.*

Comment: Possible threats to water security in the region under various climate-change scenarios must also be considered in this context. (BF-N-18)

Response: *While climate change is a legitimate concern, the specific impacts of climate change within a particular region or watershed are still highly speculative, and are therefore beyond the scope of a NEPA review for reactor license renewal. Furthermore, any changes in watershed characteristics would likely be gradual, allowing water use conflicts be resolved as needed. The comment did not provide new and significant information; therefore, will not be evaluated further.*

A.1.8 Comments Concerning Postulated Accidents

Comment: Directly relevant to Browns Ferry Unit 1 concerns about restart and the subsequent operating extension are the accident projections from the Brookhaven National Laboratory Study in 1997 for a closed BWR for an area within 50 miles of the plant: population dose of 38 million rem, 15, 300 latent fatalities, 140 square miles of condemned land, and a cost of $48 billion (NUREG/CR-6451, April 1997). (BF-L-4)

Comment: I believe that the people of the Tennessee Valley may be in real danger from a major nuclear accident if these concerns prove to be accurate. (BF-A-4)

Response: *The effects of accidents are considered in both environmental and safety reviews for license renewal. Postulated accidents, including design basis and severe accidents, will be addressed in Section 5.0 and Appendix G of the SEIS.*

A.1.9 Comments Concerning Uranium Fuel Cycle

Comment: Further, spent fuel casks, both for onsite storage and for transportation, have not undergone adequate testing to demonstrate thorough safety and containment of radiation, both during normal usage and during various accident scenarios. (BF-L-22)

Comment: Again, the industry's inclination to take every opportunity to cut costs (in attempting to make nuclear energy appear remotely viable, economically) creates a disturbing tension here, with nuclear utilities gravitating towards the casks that are cheapest and the least tested. (BF-L-23)

Response: *NRC is committed to preventing detrimental health impacts to the public. NRC has regulations covering the long-term storage of spent fuel onsite as well as packaging and transport of radioactive material. These regulations regarding packaging and transport of radioactive material are found at 10 CFR Part 71. NRC regulations related to exposure to the* *public are found at 10 CFR Part 20. In addition, the Department of Transportation and the Environmental Protection Agency have regulations to protect the public from health effects associated with radiation. Department of Transportation regulations related to transportation of radioactive material are found at 49 CFR Part 173, and Environmental Protection Agency regulations related to radiation are found at 40 CFR Parts 190 through 194.*

The safety and environmental effects of long-term storage of spent fuel onsite has been evaluated by NRC, and as set forth in the Waste Confidence Rule, the NRC has generically determined that such storage can be accomplished without significant environmental impact. In the Waste Confidence Rule, the Commission determined that spent fuel can be safely stored onsite for at least 30 years beyond the licensed operating life, which may include the term of a renewed license. NRC has a certification process for casks, regulated by 10 CFR Part 72. Such wastes are under continual licensing control. The comments did not provide new and significant information; therefore, they will not be evaluated further.

Part II. Comments Received on the Draft SEIS

Appendix B

Contributors to the Supplement

Appendix B

Contributors to the Supplement

The overall responsibility for the preparation of this supplement was assigned to the Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission (NRC). The statement was prepared by members of the Office of Nuclear Reactor Regulation with assistance from other NRC organizations, Pacific Northwest National Laboratory, Argonne National Laboratory, and Los Alamos National Laboratory.

Name	Affiliation	Function or Expertise
	NUCLEAR REGULATORY COMMISSION	
Michael T. Masnik	Nuclear Reactor Regulation	Sr. Project Manager, Ecology
Robert G. Schaaf	Nuclear Reactor Regulation	Project Manager
Tomeka Terry	Nuclear Reactor Regulation	Civil Engineer
Barry Zalcman	Nuclear Reactor Regulation	Technical Monitor
Jennifer A. Davis	Nuclear Reactor Regulation	Historic and Archaeological Resources
Robert Palla	Nuclear Reactor Regulation	Severe Accident Mitigation Alternatives
James Wilson	Nuclear Reactor Regulation	Ecology, Water Use
Andrew J. Kugler	Nuclear Reactor Regulation	Section Chief
Richard L. Emch	Nuclear Reactor Regulation	Radiation Protection
Alicia R. Williamson	Nuclear Reactor Regulation	Environmental Scientist
	PACIFIC NORTHWEST NATIONAL LABORATORY[(a)]	
Michael R. Sackschewsky		Task Leader
J. Amanda Stegen		Deputy Task Leader
William F. Sandusky		Air Quality, Noise, Electromagnetic Fields
Katherine A. Cort		Socioeconomics, Environmental Justice
Kathleen Rhoads		Decommissioning, Radiation Protection
Stuart B. Saslow		Water Use and Hydrology
Tara O. Eschbach		Historic and Archaeological Resources
Paul L. Hendrickson		Land Use, Alternatives
Cary A. Counts		Technical Editor
Debora A. Schulz		Document Design
Trina I. Russell		Document Design
Jean M. Cheyney		Document Design
Barbara Wilson		Publications Assistant
	ARGONNE NATIONAL LABORATORY[(b)]	
William Vinikour		Aquatic Ecology
	LOS ALAMOS NATIONAL LABORATORY[(c)]	
Sam Loftin		Terrestrial Ecology
	INFORMATION SYSTEMS LABORATORY	
Bob Schmidt		Severe Accident Mitigation Alternatives
Kimberly Green		Severe Accident Mitigation Alternatives

(a) Pacific Northwest National Laboratory is operated for the U.S. Department of Energy by Battelle Memorial Institute.
(b) Argonne National Laboratory is operated for the U.S. Department of Energy by the University of Chicago.
(c) Los Alamos National Laboratory is operated for the U.S. Department of Energy by the University of California.

Appendix C

Chronology of NRC Staff Environmental Review Correspondence Related to the Tennessee Valley Authority Application for License Renewal of Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

Appendix C

Chronology of NRC Staff Environmental Review Correspondence Related to the Tennessee Valley Authority Application for License Renewal of Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

This appendix contains a chronological listing of correspondence between the U.S. Nuclear Regulatory Commission (NRC) and the Tennessee Valley Authority (TVA) and other correspondence related to the NRC staff's environmental review, under 10 CFR Part 51, of TVA's application for renewal of the operating licenses for Browns Ferry Nuclear Power Plants, Units 1, 2, and 3 (BNF). All documents, with the exception of those containing proprietary information, have been placed in the Commission's Public Document Room, at One White Flint North, 11555 Rockville Pike (first floor), Rockville, Maryland, and are available electronically from the Public Electronic Reading Room found on the Internet at the following web address: http://www.nrc.gov/reading-rm.html. From this site, the public can gain access to the NRC's Agencywide Document Access and Management System (ADAMS), which provides text and image files of NRC's public documents in the Publicly Available Records (PARS) component of ADAMS. The ADAMS accession number for each document is included below.

December 31, 2003	Letter from TVA to NRC, BFN, Docket No. 50-259, 50-260, and 50-296, Application for Renewed Operating Licenses (Accession No. ML040060355).
January 7, 2004	Letter from NRC to Mr. J.A. Scalice, TVA, Receipt and Availability of the License Renewal Application for BFN (Accession No. ML040090370).
January 8, 2004	NRC press release announcing the availability of license renewal application for BFN (Accession No. ML040080693).
February 27, 2004	Letter from NRC to Mr. R. Crabtree, National Marine Fisheries Service (NOAA Fisheries), Request for List of Protected Species Within the Area Under Evaluation for the BFN License Renewal (Accession No. ML040610754).

March 4, 2004	Letter from NRC to Mr. J.A. Scalice, TVA, transmitting Determination of Acceptability and Sufficiency for Docketing, Proposed Review Schedule, and Opportunity for a Hearing Regarding the Application from Tennessee Valley Authority for Renewal of the Operating Licenses for BFN (Accession No. ML040650206).
March 4, 2004	Letter from NRC to Mr. J.A. Scalice, TVA, Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process for License Renewal for the BFN (Accession No. ML040640755).
March 5, 2004	Letter from NRC to Mr. L. Goldman, U.S. Fish and Wildlife Service (FWS), Request for List of Protected Species Within the Area Under Evaluation for the BFN License Renewal (Accession No. ML040680881).
March 8, 2004	Letter from NRC to Dr. L. Warner, State Historic Preservation Office, BFN Operating License Renewal (Accession No. ML040700557).
March 10, 2004	NRC press release announcing for hearing on application for license renewal of BFN (Accession No. ML040700395).
March 11, 2004	Letter from D. Bernhart, NOAA Fisheries, to NRC Protected Species List Request, Proposed Renewal of Operating Licenses for BFN, Limestone County, Alabama (Accession No. ML041330242).
March 17, 2004	Notice of Public Meeting to Discuss Environmental Scoping Process for the BFN License Renewal Application (Accession No. ML040770966).
March 23, 2004	Letter from NRC to the Honorable C. Smith, Principal Chief, Cherokee Nation of Oklahoma, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040890750).
March 23, 2004	Letter from NRC to the Honorable K. Chambers, Principal Chief, Seminole Nation of Oklahoma, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040890884).
March 23, 2004	Letter from NRC to the Honorable B. Anoatubby, Governor, Chickasaw Nation, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040890969).

March 23, 2004	Letter from NRC to the Honorable R.P. Beaver, Principal Chief, Muscogee (Creek) Nation, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040890973).
March 23, 2004	Letter from NRC to the Honorable M. Hicks, Principal Chief, Eastern Band of Cherokee Indians, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040890980).
March 23, 2004	Letter from NRC to the Honorable L. Poncho, Chairman, Coushatta Indians, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040860795).
March 23, 2004	Letter from NRC to the Honorable C. Enyart, Chief, Eastern Shawnee Tribe of Oklahoma, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040860780).
March 23, 2004	Letter from NRC to the Honorable C. Norris, Chief, Jena Band of Choctaw Indians, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040860586).
March 23, 2004	Letter from NRC to the Honorable P. Martin, Chief, Mississippi Band of Choctaw Indians, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040890862).
March 23, 2004	Letter from NRC to the Honorable B.K. McGertt, Town King, Thlopthlocco Tribal Town, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040860319).
March 23, 2004	Letter from NRC to the Honorable T. Yargee, Chief, Alabama-Quassarte Tribal Town, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040890959).
March 23, 2004	Letter from NRC to the Honorable L. Wesley, Towns King, Kialagee Tribal Towns, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040860311).
March 23, 2004	Letter from NRC to the Honorable G.E. Pyle, Chief, Choctow Nation of Oklahoma, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040860339).
March 23, 2004	Letter from NRC to the Honorable D. Proctor, Chief, United Keetoowah band of Cherokee Indians, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040890841).

March 23, 2004	Letter from NRC to the Honorable M. Cypress, Chairman, Seminole Indian Tribe, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040890689).
March 23, 2004	Letter from NRC to the Honorable K. Battiste, Chairman, Alabama-Coushatta Tribe of Texas, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040890931).
March 23, 2004	Letter from NRC to Mr. E. Barbry Jr., Director, Tunica-Biloxi Tribe, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040860762).
March 23, 2004	Letter from NRC to Ms. J. Makaseah, Cultural/Historic Preservation Department, Absentee-Shawnee Executive Committee, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040860705).
March 23, 2004	Letter from NRC to Mr. R. Thrower, Tribal Historic Preservation Office, Poarch Creek Indians, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040860251).
March 23, 2004	Letter from NRC to the Honorable B. Cypress, Chairman, Miccosukee Indians Tribe, Request for Comments Concerning BFN Operating License Renewal (Accession No. ML040860239).
March 31, 2004	Letter from NRC to Mr. J.A. Scalice, TVA, Review Schedule for Application for Renewal of the Operating Licenses for the Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 (TAC Nos. MC1704, MC1705, and MC1706). (Accession No. ML040910016).
April 28, 2004	Letter from NRC to Mr. J.A. Scalice, TVA, Request for Additional Information Regarding Severe Accident Mitigation Alternatives (SAMAs) for the BFN, License Renewal Application (Accession No. ML041200517).
May 14, 2004	Summary of Scoping Meetings to Support Review of the BFN, License Renewal Application (Accession No. ML041390581).

May 19, 2004	Letter from Mr. L. Goldman, FWS, Daphne, Alabama, to NRC, providing an updated list of protected species within the area under evaluation for the BFN License Renewal (Accession No. ML041550148).
May 20, 2004	Letter from NRC to Mr. J.A. Scalice, TVA, Notice of Extension of the Comment period on the Environmental Scope of the Plant-Specific Supplement to the Generic Environmental Impact Statement (GEIS) Regarding License Renewal for BFN (Accession No. ML041450255).
May 27, 2004	Letter from Mr. M.J. Burzynski, TVA to NRC, Browns Ferry Nuclear Plant (BFN) - Units 1,2, and 3 - March 30-31, 2004 Meeting Follow-Up - Additional Information for License Renewal Environmental Review (Accession No. ML041530161).
June 25, 2004	Letter from TVA to NRC, Browns Ferry Nuclear Plant (BFN), Units 2 and 3, Change Technical Specifications (TS) for TS-418, Request for License Amendment, Extended Power Uprate (EPU) Operation (Accession No. ML041840301).
June 28, 2004	Letter from TVA to NRC, Browns Ferry Nuclear Plant (BFN), Unit 1, Proposed Change for TS-431, Request for License Amendment, EPU Operation (Accession No. ML042800186).
July 7, 2004	Letter from TVA to NRC, Response to Request for Additional Information Regarding SAMAs to support the Review of the Browns Ferry Nuclear Power Plant, Units 1, 2, and 3, License Renewal Application (Accession No. ML041910423).
July 15, 2004	Letter from NRC to Karl W. Singer, TVA, Issuance of Environmental Scoping Summary Report Associated with the Staff's Review of the Application by Tennessee Valley Authority for Renewal of the Operating Licenses for Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 (TAC Nos. MC1768, MC1769, and MC1770) (Accession No. ML041970726).
August 20, 2004	Letter from NRC to TVA, Request for Additional Clarification Regarding Severe Accident Mitigation Alternatives for the Browns Ferry Nuclear Plant, Units 1, 2, and 3 (TAC Nos. MC1768, MC1769, and MC1770) (Accession No. ML042330233).

September 15, 2004	Letter from NRC to TVA, Summary of Telecommunication with TVA to discuss follow-on Severe Accident Mitigation Analysis (SAMA) Requests for Additional Information, (RAI) (Accession No. ML042590186).
September 30, 2004	Letter from TVA to NRC, Response to Request for Additional Information (RAI) Regarding Severe Accident Mitigation Alternatives for Browns Ferry Nuclear Plant (BFN) Units 1, 2, and 3 (Accession No. ML043860076)
October 20, 2004	E-mail from C. A. McCullough, TVA to R. Palla, NRC, Response to Request for Additional Information Concerning BFN, LR, SAMA, RAI-II, Number of Plant Damage States (Accession No.ML043010285)
October 25, 2004	Letter from NRC to L. Goldman, FWS, Biological Assessment for License Renewal of the Browns Ferry Nuclear Power Plant, and a Request for Informal Consultation (Accession No. ML042990342)

Appendix D

Organizations Contacted

Appendix D

Organizations Contacted

During the course of the staff's independent review of environmental impacts from operations during the renewal term, the following Federal, State, regional, local, and Native American tribal agencies were contacted:

Absentee-Shawnee Executive Committee, Shawnee, Oklahoma

Advisory Council on Historic Preservation, Washington D.C.

Alabama-Coushatta Tribe of Texas, Livingston, Texas

Alabama Department of Conservation, Montgomery, Alabama

Alabama Department of Environmental Quality, Decatur, Alabama

Alabama Department of Environmental Quality, Water Division, Montgomery, Alabama

Alabama Department of Transportation, Montgomery, Alabama

Alabama Economic and Community Development, Office of Water Resources, Montgomery, Alabama

Alabama Historical Commission, Montgomery, Alabama

Alabama-Quassarte Tribal Town, Wetumka, Oklahoma

Century 21 Realtors, Athens, Alabama

Cherokee Nation of Oklahoma, Tahlequah, Oklahoma

Chickasaw Nation, Ada, Oklahoma

Choctaw Nation of Oklahoma, Durant, Oklahoma

City of Athens Chamber of Commerce, Athens, Alabama

City Clerk, Athens, Alabama

Community Development Department, Decatur, Alabama

Coushatta Indian Tribe, Elton, Louisiana

Eastern Band of Cherokee Indians, Cherokee, North Carolina

Eastern Shawnee Tribe of Oklahoma, Seneca, Missouri

Jena Band of Choctaw Indians, Jena, Louisiana

Kialegee Tribal Town, Wetumka, Oklahoma

Limestone County Administrators, Athens, Alabama

Miccosukee Indian Tribe, Miami, Florida

Mississippi Band of Choctaw Indians, Philadelphia, Mississippi

Morgan County Commissioners Office, Decatur, Alabama

Muscogee (Creek) Nation, Okmulgee, Oklahoma

National Oceanic and Atmospheric Administration, St. Petersburg, Florida

Poarch Creek Indians, Atmore, Alabama

Seminole Indian Tribe, Hollywood, Florida

Seminole Nation of Oklahoma, Wewoka, Oklahoma

Thlopthlocco Tribal Town, Okemah, Oklahoma

Tribal Historic Preservation Office, Atmore, Alabama

Tunica-Biloxi Tribe, Office of Cultural and Historic Preservation Department, Marksville, Louisiana

USDA Forest Service, Bankhead National Forest, Double Springs, Alabama

USDA Forest Service, Southern Region, Pineville, Louisiana

U.S. Bureau of Indian Affairs, Washington, D.C.

U.S. Fish and Wildlife Service, Daphne, Alabama

United Keetoowah Band of Cherokee Indians, Tahlequah, Oklahoma

Appendix E

Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Compliance Status and Consultation Correspondence

Appendix E

Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Compliance Status and Consultation Correspondence

Licenses, permits, consultations, and other approvals obtained from Federal, State, regional, and local authorities for Browns Ferry Nuclear Plant, Units 1, 2, and 3 (BFN) are identified in this appendix.

Correspondence received during the evaluation process of the application for renewal of the operating license for BFN is identified in Table E-1. Copies of the correspondence are included at the end of this appendix.

The licenses, permits, consultations, and other approvals obtained from Federal, State, regional, and local authorities for BFN are listed in Table E-2.

Table E-1. Consultation Correspondence Regarding License Renewal for Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

Source	Recipient	Date of Letter
U.S. Nuclear Regulatory Commission (P.T. Kuo)	National Oceanic and Atmospheric Administration Fisheries (Dr. R. Crabtree)	February 27, 2004 (Accession No. ML04610754)
U.S. Nuclear Regulatory Commission (P.T. Kuo)	U.S. Fish and Wildlife Service (Mr. L. Goldman)	March 5, 2004 (Accession No. ML040680881)
U.S. Nuclear Regulatory Commission (P.T. Kuo)	Alabama Historical Commission (Dr. L. Warner)	March 8, 2004 (Accession No. ML0040700557)
National Oceanic Atmospheric Administration Fisheries (D. Bernhart)	U.S. Nuclear Regulatory Commission	March 11, 2004 (Accession No. ML0411330242)
U.S. Nuclear Regulatory Commission (P.T. Kuo)	Cherokee Nation of Oklahoma (The Honorable C. Smith)	March 23, 2004 (Accession No. ML040890750)
U.S. Fish and Wildlife Service (L. Goldman)	U.S. Nuclear Regulatory Commission (Dr. M. Masnik)	May 19, 2004 (Accession No. ML041550148)
U.S. Nuclear Regulatory Commission (P.T. Kuo)	U.S. Fish and Wildlife Service (Mr. L. Goldman)	October 25, 2004 (Accession No. ML042990342

Table E-2. Federal, State, and Local Licenses, Permits, Consultations, and Other Approvals for the Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

Agency	Authority	Description	Number	Issue Date	Expiration Date	Remarks
NRC	Atomic Energy Act, 10 CFR Part 50	Operating License for Unit 1	Docket Number: 05000259	12/20/1973	12/20/2013	License authorizes operation of Unit 1.
NRC	Atomic Energy Act, 10 CFR Part 50	Operating License for Unit 2	Docket Number: 05000260	08/02/1974	06/28/2014	License authorizes operation of Unit 2.
NRC	Atomic Energy Act, 10 CFR Part 50	Operating License for Unit 3	Docket Number: 05000296	08/18/1976	07/02/2016	License authorizes operation of Unit 3.
ADEM	Clean Water Act, Alabama Water Pollution Control Act	NPDES Permit	AL0022080	12/29/2000	01/31/2006	Permit authorizes effluent discharges to the Tennessee River.
ADEM	Clean Air Act, Alabama Air Pollution Control Act	Air emission permits	708-0003-Z002; 708-0003-Z003	10/5/1978; 08/28/1995	None	Permits cover operation of auxiliary boilers, emergency diesel generators, and gasoline dispensing facility.
ADEM	Alabama Solid Wastes Disposal Act	Construction/ Demolition landfill permit	42-02	05/17/2000	05/16/2005	Permit allows disposition of nonhazardous, nonradioactive wastes in the onsite landfill.
FWS	Section 7 of the Endangered Species Act (16 USC 1536)	Consultation	N/A			Section 7 of the Endangered Species Act requires that Federal agencies, in cooperation with the license applicant, consult with the FWS and/or the NOAA fisheries concerning the potential impacts of a proposed licensing action on threatened or endangered species. Correspondence with FWS related to Section 7 is included in Appendix E.

Table E-2. (contd)

Agency	Authority	Description	Number	Issue Date	Expiration Date	Remarks
Alabama Department of Economic and Community Affairs, Office of Water Resources		Water withdrawal permit	Certificate of Use No. OWR - 1058	01/1/2001	01/1/2006	Permit specifies the maximum capacity of water withdrawn, diverted, or consumed and average daily use.
Alabama Historical Commission	Section 106 of the National Historic Preservation Act (16 USC 470f)	Consultation	Letters from E.A. Brown, Deputy State Historic Preservation Officer, to TVA, dated 01/8/2001 and 05/24/2001			The National Historic Preservation Act requires Federal agencies to take into account the effect of any undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places. The Alabama Historical Commission determined that activities related to license renewal will have no effect on significant cultural resources provided that archaeological site 1Li535 and the Cox cemetery are avoided. Correspondence is included in Appendix E.

ADEM = Alabama Department of Environmental Management
CFR = Code of Federal Regulations
FWS = Fish and Wildlife Service
NOAA = National Oceanic and Atmospheric Administration
NPDES = National Pollutant Discharge Elimination System
NRC = Nuclear Regulatory Commission
USC = United States Code

1 February 27, 2004

Dr. Roy Crabtree
Regional Administrator
NOAA Fisheries
Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, FL 33702

SUBJECT: REQUEST FOR A LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE BROWNS FERRY NUCLEAR PLANT LICENSE RENEWAL

Dear Dr. Crabtree:

The U.S. Nuclear Regulatory Commission (NRC) is reviewing an application submitted by the Tennessee Valley Authority (TVA) for the renewal of the operating licenses for Browns Ferry Nuclear Plant Units 1, 2, and 3 (BFN). BFN is located in Limestone County, Alabama, 16 km (10 mi) southwest of Athens, Alabama. As part of the review of the license renewal application, the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provision of the National Environmental Policy Act (NEPA) of 1969, as amended, which includes an analysis of pertinent environmental issues, including endangered or threatened species and impacts to fish and wildlife. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended, and the Fish and Wildlife Coordination Act of 1934, as amended.

The proposed action would include the use and continued maintenance of existing plant facilities and transmission lines and would not result in significant new construction or disturbance. Any maintenance activities would be limited to previously disturbed areas. For the specific purpose of connecting BFN to the regional transmission system, there are seven 500-kilovolt (kV) lines and two 161-kV lines. These transmission line corridors are being evaluated as part of the SEIS process. The transmission line corridors traverse Limestone, Morgan, Lawrence, Franklin, and Colbert counties in Alabama; and Union, Lee, Tishomingo, and Itawamba counties in Mississippi. The site boundary and transmission lines are identified in Enclosures 1 and 2. The site boundary and transmission line corridors can also be viewed at http://www.nrc.gov/reactors/operating/licensing/renewal/applications/browns-ferry/env-bfn-2.pdf the NRC's web site on pages E-70 and E-388, respectively.

The plant uses an open-cycle cooling system to dissipate waste heat to the environment. Cooling water is drawn from Wheeler Reservoir on the Tennessee River into the turbine-generator condensers and discharging it back to the reservoir via large submerged diffuser pipes that are perforated to maximize uniform mixing into the flowstream. Mechanical draft helper cooling towers are also used in the summer to reduce the heat load to the reservoir.

To support the environmental impact statement preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests a list of species and information on protected, proposed, and candidate species and critical habitat that may be in

1 Dr. R. Crabtree -2-

the vicinity of BFN and its associated transmission lines. The NRC has requested the same information and list of species from the U.S. Fish and Wildlife Service.

On March 30-31, 2004, the NRC plans to conduct a site audit at the BFN site. In addition, we plan to hold two public NEPA scoping meetings on April 1, 2004, at the Athens State University Student Center Cafeteria Ballroom, 300 Beaty Street, Athens, Alabama 35611-1999. Your staff is invited to attend both the site audit and the public meetings. Additional information on these activities will be forwarded to Mr. David Bernhart of your staff. The NRC staff will also forward to your office a copy of the draft SEIS along with a request for comments.

If you have any questions concerning BFN, the license renewal application, or other aspects of this project, please contact Dr. Michael Masnik, Senior Environmental Project Manager, at (301) 415-1191 or by e-mail at mtm2@nrc.gov.

Sincerely,

/RA/
Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-259, 50-260, and 50-296

March 5, 2004

Mr. Larry Goldman
Field Supervisor
U.S. Fish and Wildlife Service
Daphne Field Office
P.O. Drawer 1190
Daphne, AL 36526

SUBJECT: REQUESTS FOR A LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE BROWNS FERRY NUCLEAR PLANT LICENSE RENEWAL

Dear Mr. Goldman:

The U.S. Nuclear Regulatory Commission (NRC) is reviewing an application submitted by the Tennessee Valley Authority (TVA) for the renewal of the operating licenses for Browns Ferry Nuclear Plant Units 1, 2, and 3 (BFN). BFN is located in Limestone County, Alabama, 16 km (10 mi) southwest of Athens, Alabama. As part of the review of the license renewal application, the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provision of the National Environmental Policy Act (NEPA) of 1969, as amended, which includes an analysis of pertinent environmental issues, including endangered or threatened species and impacts to fish and wildlife. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended, and the Fish and Wildlife Coordination Act of 1934, as amended.

The proposed action would include the use and continued maintenance of existing plant facilities and transmission lines and would not result in significant new construction or disturbance. For the specific purpose of connecting BFN to the regional transmission system, there are seven 500-kilovolt (kV) lines and two 161-kV lines. These transmission line corridors are being evaluated as part of the SEIS process. The transmission line corridors traverse Limestone, Morgan, Lawrence, Franklin, and Colbert counties in Alabama; and Union, Lee, Tishomingo, and Itawamba counties in Mississippi. The site boundary and transmission lines are identified in Enclosures 1 and 2. The site boundary and transmission line corridors can also be viewed at http://www.nrc.gov/reactors/operating/licensing/renewal/applications/browns-ferry/env-bfn-2.pdf the NRC's website at on pages E-70 and E-388, respectively.

The plant uses an open-cycle cooling system to dissipate waste heat to the environment. Cooling water is drawn from Wheeler Reservoir on the Tennessee River into the turbine-generator condensers and discharging it back to the reservoir via large submerged diffuser pipes that are perforated to maximize uniform mixing into the flow-stream. Mechanical draft helper cooling towers are also used in the summer to reduce the heat load to the reservoir.

To support the environmental impact statement preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests a list of species and information on protected, proposed, and candidate species and critical habitat that may be in the vicinity of BFN and its associated transmission lines. The NRC has requested the same information and list of species from NOAA Fisheries. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act.

On March 30-31, 2004, we plan to conduct a site audit at the BFN site. We plan to hold two public NEPA scoping meetings on April 1, 2004, at the Athens State University Student Center Cafeteria Ballroom, 300 North Beaty Street, Athens, Alabama 35611-1999. You and your staff are invited to attend both the site audit and the public meetings. Your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is November 2004.

If you have any questions concerning BFN, the license renewal application, or other aspects of this project, please contact Dr. Michael Masnik, Senior Environmental Project Manager, at (301) 415-1191 or by e-mail at mtm2@nrc.gov.

Sincerely,
/RA/
Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-259, 50-260, and 50-296

March 8, 2004

Dr. Lee Warner
State Historic Preservation Officer
Alabama Historical Commission
468 South Perry Street
Montgomery, AL 36130-0900

SUBJECT: BROWNS FERRY NUCLEAR PLANT LICENSE RENEWAL REVIEW

Dear Dr. Warner:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application to renew the operating licenses for Browns Ferry Nuclear Plant, Units 1, 2, and 3 (BFN), which is located in Limestone County, Alabama, 16 km (10 mi) southwest of Athens, Alabama. BFN is operated by the Tennessee Valley Authority (TVA). The site boundary is shown on the NRC's web site at http://www.nrc.gov/reactors/operating/licensing/renewal/applications/browns-ferry/env-bfn-2.pdf on page E-70. The application for renewal was submitted by TVA on January 6, 2004, pursuant to NRC requirements at Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54). The NRC has established that, as part of the staff review of any nuclear power plant license renewal action, a site-specific Supplemental Environmental Impact Statement (SEIS) to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437, will be prepared under the provisions of 10 CFR Part 51, which implements the National Environmental Policy Act of 1969 (NEPA). In accordance with 36 CFR 800.8, the SEIS will include analyses of potential impacts to historic and cultural resources. A draft SEIS is scheduled for publication in November of 2004, and will be provided to you for review and comment.

In the context of the National Historic Preservation Act of 1966, as amended, the NRC staff has determined that the area of potential effect (APE) for a license renewal action is the area at the power plant site and its immediate environs which may be impacted by post-license renewal land disturbing operation or projected refurbishment activities associated with the proposed action. The APE may extend beyond the immediate environs in those instances where post-license renewal land disturbing operations or projected refurbishment activities, specifically related to license renewal, may potentially have an effect on known or proposed historic sites located beyond the immediate environs of the proposed site. This determination is made irrespective of ownership or control of the lands of interest.

We understand that in a letter dated January 8, 2001, after reviewing the TVA issued Draft Environmental Impact Statement for Operating License Renewal of the Browns Ferry Nuclear Plant, you concluded that license renewal activities will have no effect on significant cultural resources, provided that site 1Li535 and the Cox Cemetery are avoided. The Alabama Historical Commission tracking number for this action is 2001-1439.

On April 1, 2004, the NRC will conduct two public NEPA scoping meetings at the Athens State University Student Center Cafeteria Ballroom, 300 North Beaty Street, Athens, Alabama 35611-1999. You and your staff are invited to attend. Your office will receive a copy of the draft SEIS for review and comment. If you have any questions or require additional information, please contact the Senior Environmental Project Manager for the BFN project, Dr. Michael Masnik, at 301-415-1191 or mtm2@nrc.gov.

Sincerely,
/RA/
Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-259, 50-260, and 50-296

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, FL 33702
(727) 570-5312, FAX 570-5517
http://caldera.sero.nmfs.gov

MAR 11 2004

Dear Colleague:

The National Marine Fisheries Service (NOAA Fisheries) Protected Resources Division has reviewed your letter pursuant to section 7(a)(2) of the Endangered Species Act (ESA) concerning letter dated 2/27/04: The NRC is reviewing an application submitted by the Tennessee Valley Authority (TVA) for renewal of the operating licenses for Browns Ferry Nuclear Plants Units 1,2,3 (BFN)

____ We cannot determine impacts to threatened or endangered species, or designated critical habitat, under NOAA Fisheries' purview because the letter lacks sufficient information to evaluate the project. **Enclosed are guidelines to conduct a proper biological evaluation.**

✓ **As requested, enclosed is a list of federally-protected species under the jurisdiction of NOAA Fisheries for the state of** Alabama. Biological information on federally-protected sea turtles, shortnose and gulf sturgeon, smalltooth sawfish, and other listed species and candidate species can be found at the following website addresses: NOAA Fisheries Southeast Regional Office (http://caldera.sero.nmfs.gov/protect/protect.htm); NOAA Fisheries Office of Protected Resources (http://www.nmfs.noaa.gov/prot_res/prot_res.html); U.S. Fish and Wildlife Service (http://noflorida.fws.gov/SeaTurtles/seaturtle-info.htm), http://www.turtles.org; http://www/seaturtle.org; http://alabama.fws.gov/gs/; http://endangered.fws.gov/wildlife.html#Species; the Ocean Conservancy (http://www.cmc-ocean.org/main.php3); the Caribbean Conservation Corporation (http://www.cccturtle.org/); Florida Fish and Wildlife Conservation Commission (http://floridaconservation.org/psm/turtles/turtle.htm); http://obis.env.duke.edu/data/sp_profiles.php; www.mote.org/~colins/Sawfish/SawfishHomePage.html; www.floridasawfish.com; www.flmnh.ufl.edu/fish/sharks/InNews/sawprop.htm.

____ **It is NOAA Fisheries' opinion that the project will have no effect on listed species or critical habitat protected by the ESA under NOAA Fisheries' purview. No further consultation with NOAA Fisheries pursuant to section 7(a)(2) of the ESA is required.** Consultation with NOAA Fisheries, Habitat Conservation Division, pursuant to the Magnuson-Stevens Fishery Conservation and Management Act's requirements for essential fish habitat consultation (16 U.S.C. 1855 (b)(2) and 50 CFR 600.905-.930, subpart K), may be required. Please contact our Habitat Conservation Division at (727) 570-5317.

If you have any questions, please contact the ESA section 7 coordinator, Eric Hawk, at (727) 570-5312, or by e-mail at eric.hawk@noaa.gov.

Sincerely,

Katherine [signature] for
David Bernhart
Acting Assistant Regional Administrator for Protected Resources

✓ Enclosure
File: 1514-22.
O:\forms\no-effect letter.wpd
I/SER/2004/
AL Species List

Endangered and Threatened Species and Critical Habitats under the Jurisdiction of the National Marine Fisheries Service

Alabama

Listed Species	Scientific Name	Status	Date Listed
Marine Mammals			
blue whale	*Balaenoptera musculus*	Endangered	12/02/70
finback whale	*Balaenoptera physalus*	Endangered	12/02/70
humpback whale	*Megaptera novaeangliae*	Endangered	12/02/70
sei whale	*Balaenoptera borealis*	Endangered	12/02/70
sperm whale	*Physeter macrocephalus*	Endangered	12/02/70
Turtles			
green sea turtle	*Chelonia mydas*	Threatened[1]	07/28/78
hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	06/02/70
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	12/02/70
leatherback sea turtle	*Dermochelys coriacea*	Endangered	06/02/70
loggerhead sea turtle	*Caretta caretta*	Threatened	07/28/78
Fish			
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	Threatened	09/30/91

Species Proposed for Listing

None

Designated Critical Habitat

***Gulf Sturgeon: Gulf Sturgeon:* A final rule designating Gulf sturgeon critical habitat was published on March 19, 2003 (68 FR 13370) and 14 geographic areas (units) among the Gulf of Mexico rivers and tributaries were identified. Maps and details regarding the final rule can be found at alabama.fws.gov/gs**

Proposed Critical Habitat

None

3/10/04 11:20 AM

file:///O|/FORMS/Species Lists/AL_CAND.htm

Candidate Species[2]	Scientific Name
Fish	
Alabama shad	*Alosa alabamae*
dusky shark	*Carcharhinus obscurus*
Goliath grouper	*Epinephelus itajara*
night shark	*Carcharinus signatus*
saltmarsh topminnow	*Fundulus jenkinsi*
sand tiger shark	*Odontaspis taurus*
speckled hind	*Epinephelus drummondhayi*
Warsaw grouper	*Epinephelus nigritus*

1. Green turtles are listed as threatened, except for breeding populations of green turtles in Florida and on the Pacific Coast of Mexico, which are listed as endangered.

2. Candidate species are not protected under the Endangered Species Act, but concerns about their status indicate that they may warrant listing in the future. Federal agencies and the public are encouraged to consider these species during project planning so that future listings may be avoided.

2 of 2 3/10/04 11:20 AM

1 March 23, 2004

The Honorable Chadwick Smith, Principal Chief
Cherokee Nation of Oklahoma
PO Box 948
Tahlequah, OK 74465

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION REVIEW OF THE BROWNS FERRY NUCLEAR PLANT LICENSE RENEWAL APPLICATION

Dear Chief Smith:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of an application from Tennessee Valley Authority (TVA) to renew its operating licenses for the Browns Ferry Nuclear Plant, Units 1, 2, and 3 (BFN), located in Limestone County, Alabama, 16 km (10 mi) southwest of Athens, Alabama. BFN is in close proximity to lands that may be of interest to the Cherokee Nation Tribe. As described below, the NRC process includes an opportunity for public participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to 10 CFR 51.28(b), the NRC invites the Cherokee Nation Tribal Community to provide input to the scoping process relating to the NRC's environmental review of the application.

The NRC will hold public scoping meetings for the BFN license renewal supplement to the NRC's "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS) (NUREG-1437). These scoping meetings will be held at the Athens State University, Student Center Cafeteria Ballroom, 300 North Beaty Street, Athens, Alabama, on Thursday, April 1, 2004. There will be two sessions to accommodate interested parties. The first session will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second session will convene at 7:00 p.m., with a repeat of the overview portions of the meeting, and will continue until 10:00 p.m., as necessary. Additionally, the NRC staff will host informal discussions one hour before the start of each session. No formal comments on the proposed scope of the supplement to the GEIS will be accepted during the informal discussions. To be considered, comments must be provided either at the transcribed public meetings or in writing. The application and the environmental review process are described below.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating licenses for BFN will expire in 2013, 2014, and 2016 respectively. TVA submitted an environmental report as part of its application for renewal of the BFN operating license on January 6, 2004. The application is electronically available for inspection from the Publicly Available Records (PARs) component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible at http://www.nrc.gov/reading-rm/adams.html, which provides access through the NRC's Public Electronic Reading Room (PERR) link. If you do not have access to ADAMS or if there are problems in accessing the documents located in ADAMS, contact the NRC's Public Document Room (PDR) Reference staff at 1 (800) 397-4209, (301) 415-4737, or by e-mail to pdr@nrc.gov. In addition, the application can be viewed on the Internet at

1

Chief C. Smith 2

http://www.nrc.gov/reactors/operating/licensing/renewal/applications.html.

A paper copy of the document can be viewed at the NRC's PDR, located at One White Flint North, 11555 Rockville Pike (first floor), Rockville, Maryland, 20852-2738 and at the Athens-Limestone Public Library, 405 East South Street, Athens, Alabama, 35611-1999. Also, the GEIS assesses the scope and impact of environmental effects that would be associated with license renewal at any nuclear power plant site. A copy of this document can also be found on the NRC's website or at the NRC's PDR.

The NRC is gathering information for the document that will be a BFN-specific supplement to the GEIS. The supplement will contain the results of the review of the environmental impacts on the area surrounding the BFN site that are related to terrestrial ecology, aquatic ecology, hydrology, cultural resources, and socioeconomic issues (among others) and will contain a recommendation regarding the environmental acceptability of the license renewal action.

Please submit any written comments the Cherokee Nation Tribal Community may have to offer on the scope of the environmental review by April 26, 2004. Comments should be submitted either by mail to the Chief, Rules and Directives Branch, Division of Administrative Services, Mail Stop T-6D59, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555-0001, or by e-mail to BrownsFerryEIS@nrc.gov.

At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified, the conclusions reached, and will mail a copy to you.

The NRC will prepare a draft supplemental environmental impact statement (SEIS) for public comment, and will hold another set of public meetings in the site vicinity to solicit comments on the draft. A copy of the draft SEIS will be sent to you for your review and comment. After consideration of public comments received on the draft, the NRC will prepare a final SEIS. If you need additional information regarding the environmental review process, please contact Dr. Michael Masnik, Senior Environmental Project Manager, at (301) 415-1191.

Sincerely,

/RA/
Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-259, 50-260, and 50-296

United States Department of the Interior

FISH AND WILDLIFE SERVICE
P.O. Drawer 1190
Daphne, Alabama 36526

IN REPLY REFER TO:

04-0760

May 19, 2004

U.S. Nuclear Regulatory Commission
Division of Regulatory Improvement Programs
Attn: Dr. Michael Masnik
Washington, D.C. 20555-0001

Dear Dr. Masnik:

This letter is in response to your letter, dated March 4, 2004, notifying our agency of the Nuclear Regulatory Commission's (NRC) plan to prepare a Supplemental Environmental Impact Statement (SEIS) for the Browns Ferry Nuclear Plant Operations License Renewal, Limestone County, Alabama. The following comments are provided in accordance with the Fish and Wildlife Coordination Act, as amended (16 U.S.C. 661-667e), the Migratory Bird Treaty Act (16 U.S.C. 703, *et seq.*) and section 7 of the Endangered Species Act, as amended (16 U.S.C. 1531-1543).

According to your letter, the proposed action would include the use and continued maintenance of the existing plant facilities and transmission lines. However, you indicated that very little new construction or ground disturbance would occur as a result of the proposed action. The entire Tennessee River system and the 5-county area traversed by the transmission lines provides habitat to a number of terrestrial and aquatic federally listed species. A county list of these species may be found on our website at the following address, http://daphne.fws.gov/es/specieslst.htm. The SEIS should address the type of ground disturbance and maintenance needed for the transmission lines. If the maintenance involves the use of chemicals or mowing to maintain the rights-of-way in a herbaceous environment, further consultation with the Service will be required to determine the extent, if any, these applications will have on listed species.

The U.S. Fish and Wildlife Service, Daphne, Alabama Field Office has concerns with the thermal plume that will be created if the maximum operating power level is increased for the facility. Thermal plume could impact aquatic organisms, particularly the rough pigtoe (*Pleurobema plenum*), an endangered mussel found in the vicinity of the discharge. The Service requests that surveys for threatened and endangered mussels be conducted and thermal plume models be produced pursuant to the preparation of the SEIS, and provided to this office for review.

The Service appreciates the early coordination on this project and we look forward to working with you during the preparation of the SEIS. If you have questions or comments, please direct them to

PHONE: 251-441-5181 www.fws.gov FAX: 251-441-6222
SHIPPING ADDRESS: 1208-B Main Street, Daphne, AL 36526

Mr. Bruce Porter, at (251)441-5864 or via email bruce_porter@fws.gov.

Sincerely,

Larry E. Goldman
Field Supervisor

cc: Mr. Jon M. Loney,
Environmental Policy and Planning
Tennessee Valley Authority
400 West Summit Hill Drive
Knoxville, Tennessee 37902-1499

October 25, 2004

Mr. Larry Goldman
Field Supervisor
U.S. Fish and Wildlife Service
P.O. Drawer 1190
Daphne, AL 36526

SUBJECT: BIOLOGICAL ASSESSMENT FOR LICENSE RENEWAL OF THE BROWNS FERRY NUCLEAR POWER PLANT, AND A REQUEST FOR INFORMAL CONSULTATION

Dear Mr. Goldman:

The U.S. Nuclear Regulatory Commission (NRC) staff has prepared the enclosed biological assessment (Enclosure 1) to evaluate whether the proposed renewal of the Browns Ferry Nuclear Plant, Units 1, 2, and 3 (BFN) operating licenses for a period of an additional 20 years would have adverse effects on listed species. The proposed action (license renewal) is not a major construction activity. BFN is located on the north shore of Wheeler Reservoir in Limestone County, Alabama, at Tennessee River Mile (TRM) 294.

By letter dated March 5, 2004, the NRC requested a list of Federally threatened or endangered species that may be in the vicinity of BFN and its associated transmission lines. In a letter dated May 19, 2004, the U.S. Fish and Wildlife Service (FWS) directed the NRC to the following Website, http://daphne.fws.gov/es/specieslst.htm, for a list of Federally listed threatened or endangered species to evaluate in a biological assessment (BA). The FWS Website listed 11 terrestrial and 38 aquatic Federally protected species as potentially occurring in counties containing the BFN site, transmission line and rights-of-way, and Wheeler Reservoir. Your letter dated May 19, 2004, also expressed concerns related to the operation of BFN and the potential impact on the rough pigtoe; specifically, potential impacts resulting from the plant operating at maximum power levels.

For documentation purposes, the NRC has included all terrestrial and aquatic species found on the aforementioned FWS Website in the enclosed BA. This BA provides an evaluation of the potential impact of renewing the BFN operating licenses for an additional 20 years of operation on the forty-five listed species and four candidate species identified in Tables 1, 2, and 3 of the BA.

The NRC has determined that the proposed action has no effect on the red-cockaded woodpecker (*Picoides borealis*), the American hart's tongue fern (*Asplenium scolopendrium* var. *americanum*), and 29 of the aquatic species (Table 3). In addition, the staff has determined that the proposed action may affect, but is not likely to adversely affect, the bald eagle (*Haliaeetus leucocephalus*), gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), Price's potato bean (*Apios priceana*), leafy prairie clover (*Dalea foliosa*), Eggert's sunflower (*Helianthus eggertii*), fleshy-fruited gladecress (*Leavenworthia crassa*), lyrate bladder-pod (*Lesquerella lyrata*), Tennessee yellow-eyed grass (*Xyris tennesseensis*), Anthony's riversnail

L. Goldman

(*Athearnia anthonyi*), slender campeloma (*Campeloma decampi*), armored snail (*Pyrgulopsis pachyta*), spectaclecase (*Cumberlandia monodonta*), Cumberlandian combshell (*Epioblasma brevidens*), pink mucket (*Lampsilis abrupta*), slabside pearlymussel (*Lexingtonia dolabelloides*), rough pigtoe (*Pleurobema plenum*), and the slackerwater darter (*Etheostoma boschungi*). The site contains no critical habitat for any protected species. However, some areas within the transmission line rights-of-way have recently been designated critical habitat for the Cumberlandian combshell. TVA has designed and implemented maintenance procedures for its transmission line rights-of-way that protect all listed species and their habitats.

We are placing this BA in our project files and are requesting your concurrence with our determination. In reaching its conclusion, the NRC staff relied on information provided by the licensee, on research performed by NRC staff, and information from the FWS (i.e., including current listings of species provided by FWS, Daphne, Alabama Field Office).

If you have any questions regarding this BA or the staff's request, please contact Dr. Michael Masnik, Senior Project Manager, at 301-415-1191 or by email at mtm2@nrc.gov.

Sincerely,

/RA/

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-259, 50-260, and 50-296

Enclosure: As stated

cc w/encl.: See next page

Biological Assessment

Browns Ferry Nuclear Power Plant
License Renewal Review

Limestone County, Alabama

October 2004

Docket Numbers 50-259, 50-260, and 50-296

U.S. Nuclear Regulatory Commission
Rockville, Maryland

Biological Assessment of the Potential Effects on Endangered or Threatened Species from the Proposed License Renewal for the Browns Ferry Nuclear Plant

1.0 Introduction

The U.S. Nuclear Regulatory Commission (NRC) licenses the operation of domestic nuclear power plants in accordance with the Atomic Energy Act of 1954, as amended, and NRC implementing regulations. The Tennessee Valley Authority (TVA) operates Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 (BFN) pursuant to NRC operating license (OL) numbers DPR-33, DPR-52, DPR-68, which expire on December 20, 2013, June 28, 2014, and July 2, 2016, respectively.

TVA has prepared an Environmental Report (ER) (TVA 2003) in conjunction with its application for renewal of the BFN OLs, as provided for by the following NRC regulations:

- Title 10 of the Code of *Federal Regulations*, Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," Section 54.23, Contents of application - environmental information (10 CFR 54.23).

- Title 10 of the Code of Federal Regulations, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," Section 51.53, Postconstruction environmental reports, Subsection 51.53(c), Operating license renewal stage (10 CFR 51.53(c)).

The renewed OLs would allow up to 20 additional years of plant operation beyond the current licensed operating term.

No major refurbishment or replacement of important systems, structures, or components are expected during the 20-year BFN license renewal term. In addition, no construction activities are expected to be associated with license renewal.

In a letter dated March 5, 2004, the staff requested comments from the U.S. Fish and Wildlife Service (FWS) on the OL renewal application for BFN (NRC 2004). Specifically, the staff requested a list of species and information on protected, proposed, and candidate species and critical habitat that may be in the vicinity of BFN and its associated transmission line rights-of-way. In a letter from the FWS dated May 19, 2004 (FWS 2004e), the staff was directed to an FWS website (http://daphne.fws.gov/es/specieslst.htm) for a list of species to include in this biological assessment (BA). A total of 11 terrestrial and 38 aquatic species were listed for the counties within which the BFN site and its transmission line rights-of-way are located, and for Wheeler Reservoir, which serves as the source of cooling water for BFN. The FWS expressed specific concern (FWS 2004) over the potential impact of all three BFN units operating at maximum power levels on the rough pigtoe (*Pleurobema plenum*).

2.0 Proposed Action

The proposed Federal action is the renewal of the OLs for BFN. In response to the increasing demands for bulk power, TVA seeks to use existing facilities to the greatest extent possible to meet requirements for electric power. TVA is pursuing this approach because: (1) it ensures that future power needs can be met; (2) it avoids the large capital expenditures associated with construction of new generating facilities; and (3) it avoids the environmental impacts resulting from siting and constructing new power generating facilities. Consistent with this approach, TVA proposes to continue operation of BFN after expiration of the current OL for each unit. Implementing the proposed action is dependent on the staff determining that renewal of the OLs for BFN is the best course of action. Renewal of the current OLs would permit operation of the units for an additional 20 years beyond their current (original) 40-year operating license period.

In July 2004, the TVA submitted extended power uprate (EPU) applications to increase the licensed power levels of each of the three units to 3952 megawatts thermal (MW(t)) (i.e., to 120% of the originally licensed power levels), thereby bringing the combined total power level for the three units to 11,856 MW(t). In a separate environmental assessment, NRC is currently evaluating the potential environmental impacts of the proposed EPUs at BFN. If approved, the EPUs would take effect during the existing license term and would continue during the 20 year term of the renewed OLs. This BA was prepared to evaluate the potential environmental impacts of operating Units 1, 2, and 3 at 120% of their originally licensed power levels for an additional 20 years beyond the current license term for each unit.

Continued maintenance activities on the transmission line rights-of-way that are used to connect BFN to the electric power grid would be required if the proposed action is adopted. The TVA Transmission and Power Supply-Transmission Operations and Maintenance organization conducts maintenance activities on transmission lines and rights-of-way in the TVA system. These activities include, but are not restricted to, maintenance of vegetation in each right-of-way, replacement of poles or towers, installation of lightning arresters and counterpoise, and upgrading existing equipment. Regular maintenance activities are conducted on a 3-to-5-year cycle (Muncy et al. 1999).

3.0 The Plant

3.1 Plant Description

The three-unit BFN plant, including the intake and discharge canals, is enclosed by a security fence. Primary access to the plant area is by way of an access road through a security gate. The plant has the following principal physical structures in the central site area: reactor containment building, turbine building, radioactive waste building, service building, intake pumping station, transformer yard, 161-kV and 500-kV switchyards, off-gas stack, sewage treatment facilities, and administration and maintenance buildings. The hot and cold water discharge channels and mechanical draft cooling towers are located northwest of the central site area, while the training center, employee physical fitness center, materials storage and procurement complex, and structures from a former aquatic research laboratory are located to the east of the central site area (see Figure 1).

3.2 Reactor Systems

BFN has two active nuclear reactor units (Units 2 and 3) and one inactive unit (Unit 1). Each unit includes a boiling water reactor (BWR) and a steam-driven turbine generator manufactured by General Electric Company. Work began in 2002 to bring Unit 1 up to current standards, and operation of the reactor is currently scheduled to resume in 2007.

The nuclear steam supply system at BFN is typical of General Electric BWRs. Each nuclear system includes a single-cycle, forced-circulation, General Electric BWR that produces steam for direct use in a steam turbine. The design employs a pressure suppression primary containment that houses the reactor vessel, the reactor coolant recirculating loops, and other branch connections of the reactor primary system. The pressure suppression system consists of a dry well, a pressure suppression chamber that stores a large volume of water, connecting vents between the dry well and the pressure suppression chamber, isolation valves, containment cooling systems, and other service equipment. Cooling systems are provided to remove heat from the reactor core, the dry well, and the water in the pressure suppression chamber, thus providing continuous cooling of the primary containment under accident conditions. Appropriate isolation valves are actuated during this period to ensure confinement of radioactive material, which might otherwise be released from the reactor containment during the course of an accident.

The secondary containment substructure consists of poured-in-place, reinforced concrete exterior walls that extend up to the refueling floor. The refueling room floor is also constructed of reinforced, poured-in-place concrete. The secondary containment structure completely encloses the primary containment dry wells, fuel storage and handling facilities, and essentially all of the core standby cooling systems for the three units. During normal operation and when isolated, the secondary containment is maintained at a negative pressure relative to the building exterior.

3.3 Cooling and Auxiliary Water Systems

Wheeler Reservoir on the Tennessee River is the source for cooling water and most of the auxiliary water systems for BFN (see Figure 2). Potable water is supplied by the City of Athens Utilities Water Department in Athens, Alabama. Groundwater is not used at the site. Figure 1 shows the general layout of the buildings and structures at the site.

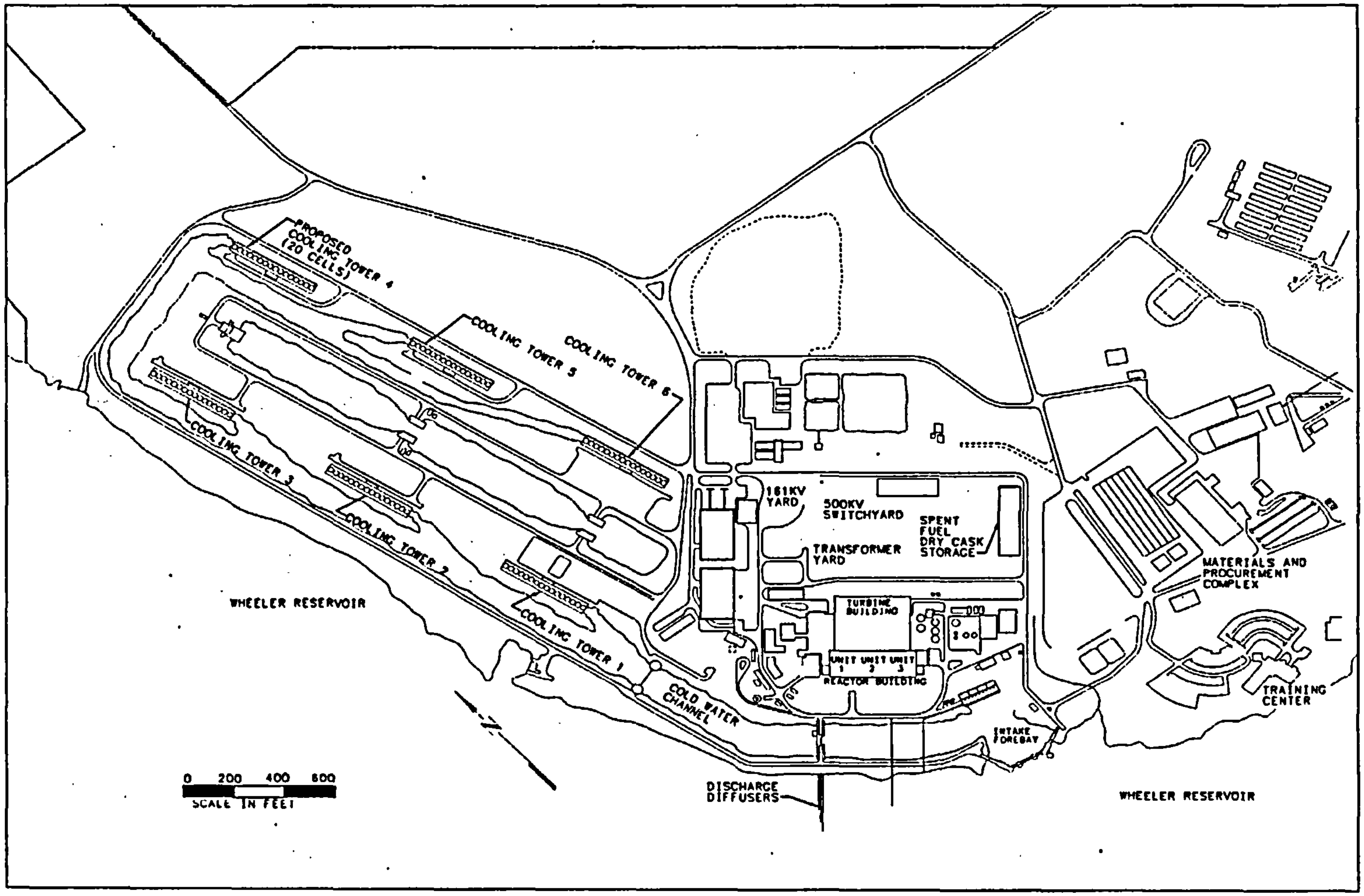

Figure 1. Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Site Features

The intake forebay is separated from Wheeler Reservoir by a gate structure with three bays that are each 12 m (40 ft) wide by about 7.3 m (24 ft) high (TVA 1972). Each bay includes a 6-m (20-ft)-high gate that can be raised or lowered depending on the operational requirements of the plant. The flow velocity through the openings varies depending on the gate position. When the gates are in their full-open position and the plant is operated in either the open mode (once-through) or cooling tower helper mode, the average flow velocity through the openings is about 0.2 m/s (0.6 fps) for the operation of one unit, 0.34 m/s (1.1 fps) for the operation of two units, and 0.52 m/s (1.7 fps) for the operation of all three units (TVA 2003). These flow velocities are based on an intake flow per unit of about 46,300 L/s (734,000 gpm), which is 46.3 m^3/s (1635 cfs).

The intake pumping station includes 18 bays (i.e., six bays per reactor unit), each with a traveling screen. Each bay has a net opening size of about 2.6 m by 6 m (8.75 ft by 20 ft). The maximum average flow velocity through each bay is about 0.49 m/s (1.6 fps) and is independent of the reservoir surface elevation. The maximum average velocity through a clean screen with net openings of 0.95 cm by 0.95 cm (3/8 in. by 3/8 in.) is about 0.64 m/s (2.1 fps) (TVA 2003). Flow velocities through the intake pump station bays and traveling screens are independent of the number of units in operation and the reservoir elevation.

The BFN units are normally cooled by pumping water from Wheeler Reservoir into the turbine generator condensers and discharging it back to the reservoir via three large submerged diffuser pipes that are perforated to maximize uniform mixing into the flow stream. These pipes range in diameter from 5.2 m to 6.2 m (17 ft to 20.5 ft). The flow exits each discharge pipe through 7800 5-cm (2-in.) ports (TVA 2003). This straight-through flow path is known as "open cycle" or "open mode" operation. As originally designed, the maximum thermal discharge from the once-through cooling water system is directed into the Wheeler Reservoir, with a temperature increase across the intake and discharge of 13.9°C (25°F) (TVA 1972). The flow exits the diffusers and mixes with the reservoir flow. At the edge of the discharge mixing zone, the water temperature is required to be less than 5.6°C (10°F) above ambient (ADEM 2003).

Through various gates, some of this cooling water can also be directed through mechanical draft cooling towers to reduce its temperature as necessary to comply with environmental regulations. This flow path is known as the "helper mode," and the cooling towers are referred to as "helper towers."

The capacity also exists to recycle cooling water from the cooling towers directly back to the intake structure without being discharged to the reservoir. This flow path, known as the "closed mode" of operation, has not been used since the restart of Units 2 and 3 because of difficulties in achieving temperature limits in summer months and problems with equipment reliability. TVA does not anticipate using this mode in the future, and no procedures for operating in this mode currently exist.

In recent years, only Units 2 and 3 have been in operation, but because of a combination of system upgrades and improved flow calibrations, the measured total per-unit condenser circulating water (CCW) flow rate in open mode (with three CCW water pumps per unit) has increased. The condenser tubes were replaced with stainless steel tubing that have a larger internal diameter and lower flow resistance. This modification increased flow through the condenser by approximately 6 percent. TVA estimates total intake for three-unit operation in open mode to be 139 m^3/s (4907 cfs) or 12,000 m^3/d (3171 MGD) (TVA 2003).

Because of various system limitations, BFN cannot pass all the CCW through the cooling towers when operating in the helper mode. The fraction of cooling water that cannot be passed through the cooling towers is routed directly to the river. Almost all of the cooling water that passes through the cooling towers is returned to the river, but a small amount is lost to the atmosphere during operation. If cooling tower capacity is increased during the license renewal term, this consumptive use could increase proportionately. The cooling towers are only operated when necessary to meet thermal discharge temperature limits specified in the National Pollutant Discharge Elimination System (NPDES) permit, typically a few weeks during the hottest part of the summer (typically July and August).

For the last 6 years, during which Units 2 and 3 have both been in service, the greatest amount of time cooling tower operation has been required has been about 8 percent of a year (TVA 2003). Increased thermal power limits proposed for Units 2 and 3 will result in an additional increase of approximately 2.2°C (4°F) in the circulating water temperature leaving the main condenser (for each operating unit) (Hopping 2004). This increase in water discharge temperature will result in increased use of the cooling tower during summer periods to maintain compliance with discharge limitations. No changes to the plant intake system or to the individual unit intake flow rates are expected to be required as a result of the Units 2 and 3 EPU project, and operations will continue to meet regulatory limits established in the existing NPDES permit.

Simulations with the near-field hydrothermal model were conduced for the period 1985 through 2002, excluding 2 years (1989 and 1990) for which no river ambient temperature data are available (TVA 2003). TVA varied both the use of the helper towers and unit power levels to maintain discharge temperatures to within NPDES permit limits. Model results showed that, with Units 2 and 3 operating at 120 percent power, the cooling towers will be used on average approximately 5.3 percent of the time, and derating will be required approximately 0.10 percent of the time (i.e., 6.2 days over the 16-year simulation period). On average, with all three units at 120 percent power, use of the cooling towers will increase to approximately 7.2 percent of the time and derating will increase to approximately 0.29 percent of the time (i.e., 17 days over the 16-year simulation). The simulation of three unit operation at 120 percent power assumed the construction and operation of an additional sixth 20 cell cooling tower. The licensee has committed placing the new tower in operation prior to the first summer following the return of Unit 1 to service(TVA 2004c).

The residual heat removal service water (RHRSW) system consists of four pairs of pumps located on the intake structure for pumping raw river water to the heat exchangers in the RHRSW system and four additional pumps for supplying water to the emergency equipment cooling water (EECU) system. The EECU system distributes cooling water supplied by the RHRSW system to essential equipment during normal and accident conditions.
The impacts evaluated in this BA include those from operation of all three of the BFN reactor

units, each at 120 percent of the original licensed thermal power level. TVA has stated (TVA 2002a) that "no changes are expected to be required to the plant intake system or to the individual unit intake flow rates as a result of the EPU project." TVA also indicated that existing thermal discharge limits would be met by increased use of the helper towers, and if necessary, derating one or more units

4.0 Environmental Setting

The proposed license renewal will apply to all three units BFN, which is located on the north shore of Wheeler Reservoir in Limestone County, Alabama, at Tennessee River Mile (TRM) 294. The BFN site is approximately 48 km (30 mi) west of Huntsville, Alabama; 16 km (10 mi) northwest of Decatur, Alabama; and 16 km (10 mi) southwest of Athens, Alabama (Figure 2). The power plant is located on a 340-ha (840-ac) tract owned by the Federal government and held in custody by TVA, a corporate agency and instrumentality of the United States.

4.1 Terrestrial Resources

BFN is located within the Highland Rim section of the Interior Low Plateau Physiographic Province. Botanically, the site is within the Mississippian Plateau section of the Western Mesophytic Forest Region (EPA 2004). In this region of northern Alabama, native forest communities generally consist of mixed oak forests that vary in composition in relation to topography and soils. Historically, upland forests in the vicinity of the site were characterized by mixtures of southern red oak (*Quercus falcata*), black oak (*Q. velutina*), post oak (*Q. stellata*), and white oak (*Q. alba*), with dogwood (*Cornus* spp.) commonly present in the understory. The clearing of forested lands for agriculture has converted many of these forest communities to early successional habitats, allowing introduced plant species to replace representative native plant communities.

The site is situated in an area where the land is used primarily for agriculture (TVA 2003). The countryside includes open pasture lands, scattered farmsteads, few residents, and little industry within several miles. The south and west side of the BFN site abuts Wheeler Reservoir, and has a shoreline of approximately 3772 m (12,375 ft), with 58 percent of the shoreline stabilized with riprap. The remaining 42 percent of the shoreline of the site is partially eroded and is composed of mixed upland forest vegetation. The stabilized shoreline adjacent to the BFN facilities is primarily vegetated by young (approximately 4-to-5-year-old) black willow (*Salix nigra*), common hackberry (*Celtis occidentalis*), sumac (*Rhus* spp.), and exotic species such as Chinese privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*), and trumpet creeper (*Campsis radicans*). The remainder of the shoreline just west of the facility is vegetated with a young mixed upland forest scattered with a few large, old specimens (approximately 80-plus years) of oaks and loblolly pine (*Pinus taeda*). Young plants associated with the upland forest include black locust (*Robinia pseudoacacia*), sweetgum (*Liquidambar styraciflua*), sassafras (*Sassafras albidum*), cottonwood (*Populus* spp.), elm (*Ulmus* spp.), common hackberry, and black cherry (*Prunus serotina*). Common understory vegetation in the forested area includes Chinese privet, spleenwort (*Asplenium* spp.), Virginia creeper (*Parthenocissus quinquefolia*), and poison ivy (*Toxicodendron radicans*).

Invasive exotic plant species are a concern in the area. TVA reports approximately 19 invasive species in the area with a special emphasis on Chinese privet, Japanese honeysuckle, Japanese knotweed (*Polygonum cuspidatum*), and Nepal grass (*Microstegium vimineum*) (TVA 2003).

There are approximately 10 ha (25 ac) and 5 ha (12 ac) of National Wetlands Inventory and U.S. Army Corps of Engineers-classified wetlands, respectively, occurring at the BFN site (TVA 2003). These areas include forested wetlands, emergent (marsh) wetlands, and scrub-shrub/emergent wetlands (based on 1980s aerial photography). The wetland ecological communities identified at the site are dominated by plant species that are common in the region, including black willow, buttonbush *(Cephalanthus occidentalis)*, sedges *(Carex lupulina, C. vulpinoidea, Rhyncospora corniculata)*, rushes *(Juncus* spp., *J. brachycarpus)*, water hemlock *(Conium maculatum)*, and smartweeds *(Polygonum* spp.). These wetlands occur in areas that have been previously disturbed by clearing and agriculture, and areas that are mowed periodically. These types of wetlands commonly occur on previously disturbed former or presently used agricultural land, and the dominant vegetation species occurring within them are common in the region.

The vegetation communities described above are not unusual for the area and provide no sensitive or rare forms of wildlife habitat. Wildlife habitat on the site can be broadly classified as upland and riparian/wetland. Animal species commonly associated with upland communities include white-tailed deer (*Odocoileus virginianus*), cottontail rabbit (*Sylvilagus floridanus*), Virginia opossum (*Didelphis virginiana*), hispid cotton rat (*Sigmodon hispidus*), song sparrow (*Melospiza melodia*), eastern bluebird (*Sialia sialis*), northern mockingbird (*Mimus polyglottus*), turkey vulture (*Cathartes aura*), tufted titmouse *(Baeolophus bicolor)*, American toad (*Bufo americanus*), spring peeper (*Pseudacris crucifer*), black racer (*Coluber constrictor constrictor*), and eastern box turtle (*Terrapene carolina*) (TVA 2003). Riparian communities can support a unique assemblage of wildlife including muskrat (*Ondatra zibethicus*), beaver (*Castor canadensis*), raccoon (*Procyon lotor*), wood duck (*Aix sponsa*), belted kingfisher (*Ceryle alcyon*), barred owl (*Strix varia*), American woodcock (*Scolopax minor*), Carolina wren (*Thryothorus ludovicianus*), prothonotary warbler (*Protonotaria citrea*), eastern phoebe (*Sayornis phoebe*), bullfrog (*Rana catesbeiana*), green frog (*Rana clamitans*), eastern newt *(Notophthalmus viridescens)*, southern two-lined salamander (*Eurycea cirrigera*), common snapping turtle (*Chelydra serpentina serpentina*), and northern water snake (*Nerodia sipedon*) (TVA 2003). Some water holes along Wheeler Reservoir are used by American alligators (*Alligator mississippiensis*) in the winter. Invasive terrestrial animals that are expected to occur in the project vicinity include European starling (*Sturnus vulgaris*), house sparrow (*Passer domesticus*), and rock dove (*Columba livia*).

BFN is connected to the TVA system network by seven 500-kilovolt (kV) transmission lines via the 500-kV switchyard (TVA 2003). One line is to the Madison substation; two are to the Trinity substation; one line each are to the West Point, Maury, and Union substations; and one line is to the Limestone 500-kV substation. There are two additional 161-kV lines, one to the Athens substation and one to the Trinity substation. All lines occupy portions of four rights-of-way; three that terminate at the Maury, Trinity, and Athens substations, Alabama, and one that

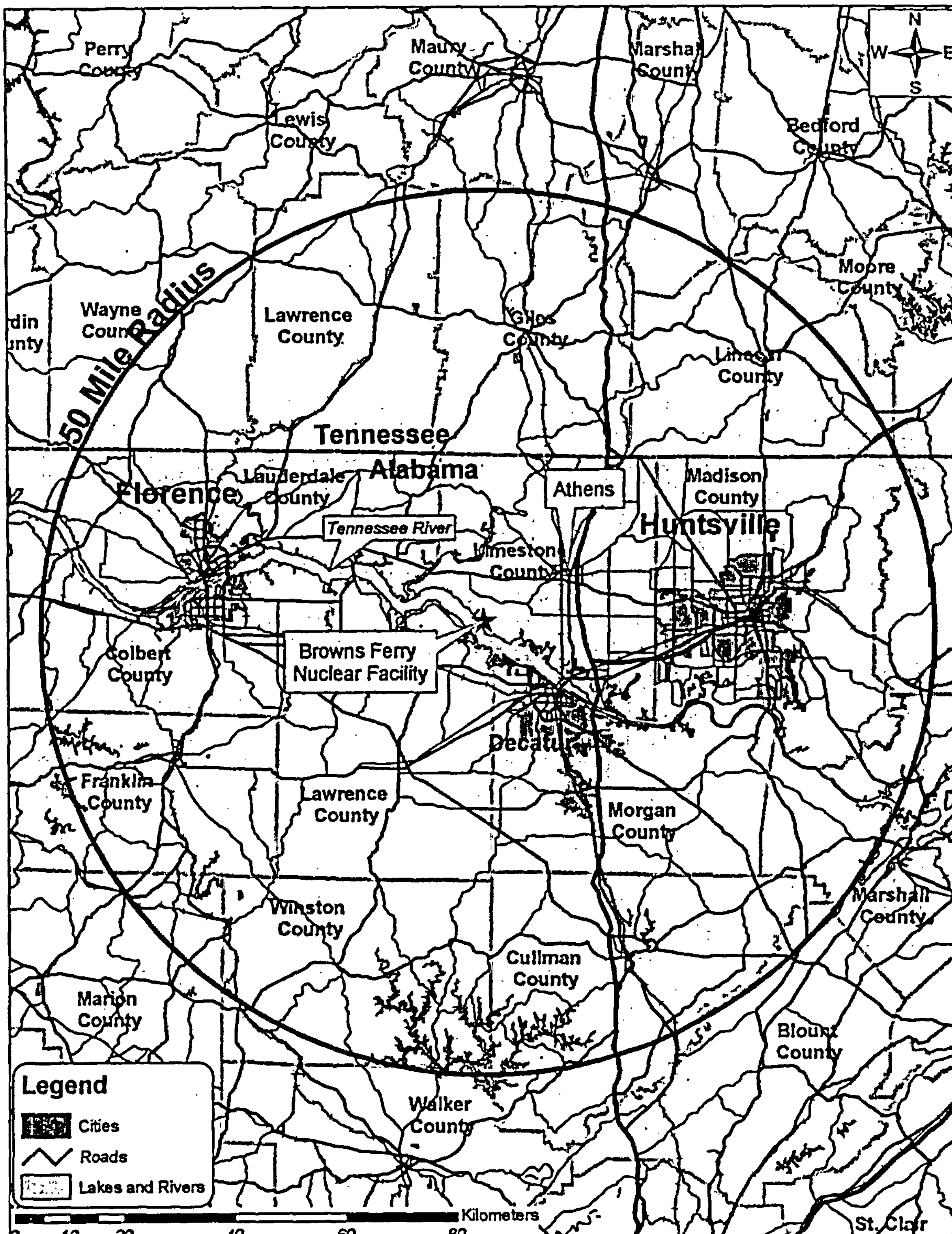

Figure 2. Brown's Ferry Nuclear Power Plant, Units 1, 2, and 3 Site and Surrounding Area

terminates at the Union substation in Union County, Mississippi (Figure 3). In all, there are approximately 257 km (160 mi) of transmission line rights-of-way associated with BFN. The rights-of-way pass through Colbert, Franklin, Lawrence, Limestone, and Morgan Counties, Alabama, and Itawamba, Lee, Tishomingo, and Union Counties, Mississippi.[a] The Maury, Trinity, and Athens transmission line rights-of-way are found in the Eastern Highland Plain ecoregion, while the 175-km (109-mi)-long Union right-of-way traverses the Eastern Highland Plain and Transition Hills, crosses into Mississippi and passes through the Fall Line Hills, Flatwoods/Blackland Prairie Margins, and Blackland Prairie ecoregions (EPA 2004).

Transmission line maintenance activities are reviewed for potential resource issues by technical specialists in the TVA Regional Natural Heritage and Cultural Resources programs (Muncy et al. 1999). A 1.6-km (1.0-mi) buffer area on either side of each transmission line right-of-way is reviewed for the presence of terrestrial species, while a 16.1-km (10-mi) buffer area is used for aquatic species (TVA 2003). The TVA Regional Natural Heritage program maintains a database of more than 27,000 occurrence records for protected plants, animals, caves, National Wetland Inventory wetlands, cultural resources, and areas of management concern for the entire TVA Power Service Area. TVA also conducts fieldwork to inventory and protect threatened and endangered species and environmentally sensitive areas on public lands it administers. Activities conducted by project staff members include monitoring species populations, educating the public, and managing and maintaining habitats (including caves) at TVA-managed sites.

Transmission line rights-of-way are regularly surveyed and video taped from a helicopter. Video tapes can then be used to search for sensitive habitat types before field crews are dispatched. Access routes and restrictions for maintenance activities are determined based on knowledge of the species or resources to be protected. Vehicles and equipment are restricted from a site when habitat-sensitive resources are present (Class 2 restrictions). Within Class 2 restricted areas, all vegetation clearing and herbicide applications are done by hand. Class 1 restrictions allow hand or mechanical clearing and herbicide use for vegetation control on transmission line rights-of-way. There is no broadcast application of herbicides. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, U.S. Environmental Protection Agency (EPA) guidelines, and State regulations. The streamside management zone is maintained to (1) slow and spread surface-water flow so particulate matter will be trapped and filtered before reaching the stream channel, (2) protect stream bank integrity, and (3) protect water temperature in the stream.

[a]Prentis County, Mississippi is not included. Species accounted for in adjacent counties.

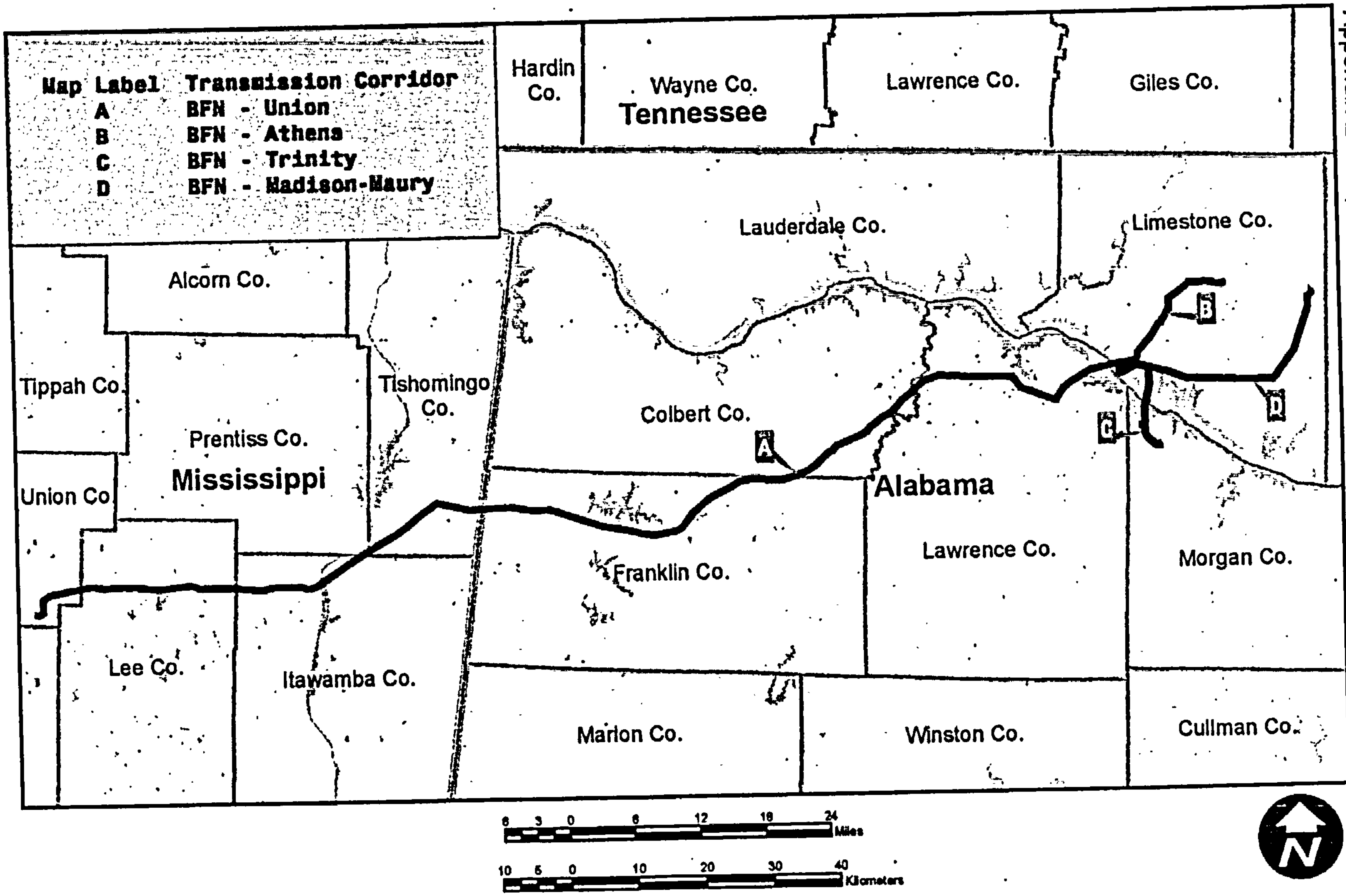

Figure 3. Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 and Its Associated Transmission Lines and Rights-of-Way

4.2 Aquatic Resources

The aquatic resources in the vicinity of BFN are primarily associated with the Wheeler Reservoir portion of the Tennessee River. Wheeler Reservoir is the source and receiving body for the BFN cooling system (TVA 2003). Other aquatic habitats include several tributaries to Wheeler Reservoir: Paint Rock and Flint Rivers in the upper reach; Indian, Cotaco, and Flint Creeks in the middle reach; and Limestone, Piney, Swan, Fox, Mallard, Spring, First, and Second Creeks and the Elk River in the lower section. Elk River, the largest of these tributaries, flows into Wheeler Reservoir about 16 km (10 mi) downstream of BFN. Guntersville Reservoir is upstream of Wheeler Reservoir, while Wilson Reservoir is downstream. All three reservoirs are run-of-the-river impoundments on the Tennessee River.

The seven transmission lines located in four rights-of-way associated with BFN cross a number of streams ranging in size from small intermittent streams to the Tennessee River. Rivers and larger streams crossed by or near the transmission lines include Limestone, Piney, Swan, Round Island, Big Nance, Town, Spring, Cedar, Little Bear, and Bear Creeks in Alabama; and Bear, Little Brown, Donivan, Twentymile, Mantachie, Mud, and Bridge Creeks and the Tennessee-Tombigbee Waterway in Mississippi. Transmission line right-of-way maintenance activities in the vicinity of stream and river crossings employ best management practices to minimize erosion and shoreline disturbance while encouraging vegetative cover (TVA 2003).

A total of 63 fish species plus hybrid sunfish, hybrid striped bass x white bass (*Morone saxatilis* x *M. chrysops*), and hybrid walleye x sauger (*Stizostedion vitreum* x *S. canadense*) were collected from 1995 through 2002 in the vicinity of BFN (TVA 2002b, 2003). A total of 72 fish species were identified in impingement samples collected between 1974 and 1977 (TVA 1978). Important commercial fish species that occur in Wheeler Reservoir include blue catfish (*Ictalurus furcatus*), channel catfish (*I. punctatus*), flathead catfish (*Pylodictis olivaris*), bigmouth buffalo (*Ictiobus cyprinellus*), smallmouth buffalo (*I. bubalus*), and common carp (*Cyprinus carpio*). Gizzard shad (*Dorosoma cepedianum*) and threadfin shad (*D. petenense*) are the dominant forage species in Wheeler Reservoir (TVA 2003). Threadfin shad has been the dominant species numerically in Wheeler Reservoir since 1990 (Baxter and Buchanan 1998). Game fish species include largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieui*), spotted bass (*M. punctulatus*), black crappie (*Pomoxis nigromaculatus*), white crappie (*P. annularis*), bluegill (*Lepomis macrochirus*), longear sunfish (*L. megalotis*), redear sunfish (*L. microlophus*), sauger, striped bass, hybrid striped bass, yellow bass (*Morone mississippiensis*), and yellow perch (*Perca flavescens*).

Historically, 39 mussel species occurred in Wheeler Reservoir. Thirty-one of these species were considered riverine (i.e., those that evolved in free-flowing reaches), with 19 of these species now considered non-reproducing riverine species within Wheeler Reservoir (Ahlstedt and McDonough 1992). In 1982, 12 mussel species were collected during a survey for the proposed barge facility at BFN (Pryor 1982), and 11 species were collected across the river during a survey for a proposed barge terminal for the Mallard-Fox Creek Development Project (Carroll 1982). The washboard (*Megalonaias nervosa*) was the most common species collected during both surveys. It is currently the predominant species that is commercially harvested (TVA 2003). The Ohio pigtoe (*Pleurobema cordatum*) was previously the most valuable commercial species, but its numbers have decreased because of habitat alterations due to impoundment (Ahlstedt and McDonough 1992). None of the species collected were Federally or State protected.

In 1991, 24 species of mussels were collected from Wheeler Reservoir, with six species represented by weathered, empty shells (Ahlstedt and McDonough 1992). The 24 species included all species previously collected near BFN in the two 1982 collections by Pryor and Carroll. It was estimated that 460 million mussels or 2.33 mussels/m^2 (0.22 mussels/ft^2) occurred in the reservoir in 1991 (Ahlstedt and McDonough 1992). The most common species (and estimated number within Wheeler Reservoir) collected in 1991 were the elephant-ear (*Elliptio crassidens,* 116 million), washboard (88 million), pink heelsplitter (*Potamilus alatus,* 56 million), and threehorn wartyback (*Obliquaria reflexa,* 44 million) (Ahlstedt and McDonough 1992). In addition to the habitat alteration resulting from reservoir creation, over-harvesting and periods of drought (e.g., from 1983 to 1988) may have affected reproduction and/or survival of most thick-shelled mussel species in Wheeler Reservoir (Ahlstedt and McDonough 1992). Water-quality impairments and loss of necessary fish hosts have also contributed to the decline of mussel populations. The biodiversity of mussel communities in the mainstem Tennessee River reservoirs is anticipated to continue the long-term downward trend in terms of abundance and diversity (TVA 2004a).

In 1998, 17 mussel species were collected on the east channel of Wheeler Reservoir near Hobbs Island, over 64 river kilometers (40 river miles) upstream of BFN, between TRMs 336.4 and 335.5. The two most common mussel species were the elephant-ear and the Ohio pigtoe. Two Federally endangered species were also collected: one specimen of the rough pigtoe (*Pleurobema plenum*) and 16 specimens of the pink mucket (*Lampsilis abrupta*) (Yokely 1998). In 1999, 16 native mussel species were collected in the vicinity of BFN: 14 species at (TRM) 298 upstream of BFN and 12 species at TRM 292 downstream of BFN. None of these were Federally listed species (TVA 2003). Eleven commercial mussel species have been reported near BFN from TRM 305 to TRM 275 (Ahlstedt and McDonough 1992).

Two areas of Wheeler Reservoir are designated as State-protected mussel sanctuaries where 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) (TVA 2003). In the reservoir overbanks, mussels are generally spread over large areas and are not concentrated in mussel beds (TVA 2003).

5.0 Evaluation of Threatened and Endangered Species

A review of the TVA Regional Natural Heritage database indicates that no Federally listed species of animals or plants have been reported from areas within 4.8 km (3.0 mi) of the BFN site (TVA 2003). However, there are 49 species (11 terrestrial and 38 aquatic species) that are listed as threatened, endangered, or candidate species by FWS that occur, at least historically, within the portion of the Tennessee River that encompasses Wheeler Reservoir or within one or more of the counties of Alabama and Mississippi within which the BFN transmission lines are located.

5.1 Terrestrial Species

There are 11 terrestrial species that are listed as threatened, endangered by the FWS and that potentially occur in the vicinity of BFN or along the transmission line rights-of-way (Table 1). All 11 Federally listed species have been reported from counties that contain BFN transmission line rights-of-way (Table 1).

Bald Eagle (*Haliaeetus leucocephalus*)

The bald eagle is reported to occur in Franklin County, Alabama, and Itawamba and Tishomingo Counties, Mississippi. Bald eagles prefer habitat along coastlines, lakes, rivers and other water bodies that provide their primary food source – fish and waterfowl (NatureServe 2004). Eagles generally nest in tall trees or on cliff faces near water and away from human disturbance. Bald eagles are known in the area around BFN, but there is no known nesting habitat within 4.8 km (3.0 mi) of the site. Nesting sites on other TVA property are managed using FWS guidelines (FWS 1987a). Transmission line rights-of-way are likely to be within foraging areas for this species, particularly those that cross Wheeler Reservoir and the Tennessee-Tombigbee Waterway. The TVA reports incidents of eagle mortality associated with transmission lines but no mortality has been observed on BFN-associated lines.

Construction and maintenance of transmission line rights-of-way are designed to minimize environmental impacts, and transmission line right-of-way maintenance activities are reviewed for potential resource issues by TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of the eagles in the area. Mechanical clearing and herbicide use may be used for vegetation control in transmission line rights-of-way. Access routes and activity restrictions are determined based on knowledge of the eagles in the area. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations. The staff reviewed TVA maintenance activities and determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, bald eagles.

Table 1. Federally Listed and Candidate Terrestrial Species for Colbert, Franklin, Lawrence, Limestone, and Morgan Counties, Alabama, and Itawamba, Lee, Tishomingo, and Union Counties, Mississippi, Occurring Near Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 and Along the Transmission Line Rights-of-Way.

Scientific Name	Common Name	Status[a]	County Listings AL[b]	County Listings MS[c]	Habitat
Birds					
Haliaeetus leucocephalus	bald eagle	T	Fr	It Ti	Coastlines, lakes, rivers and other water bodies
Picoides borealis	red-cockaded woodpecker	E	La	--	Open pine forests, generally at least 80 to 120 years old
Mammals					
Myotis grisescens	gray bat	E	Co Fr La Li Mo	Ti	Restricted to cave or cave-like habitats. Gray bats roost and form maternity colonies in caves located along rivers and reservoirs
Myotis sodalis	Indiana bat	E	Co La Li Mo	Ti	Hibernate in caves during winter months but can be found in hollow trees and under loose tree bark during the summer
Plants					
Apios priceana	Price's potato bean	T	--	Le	Open mixed hardwood forests often on floodplains, in or near riparian areas
Asplenium scolopendrium var. *americanum*	American hart's-tongue fern	T	Mo	--	Around the openings to limestone caves and sinkholes
Dalea foliosa	leafy prairie-clover	E	Fr La Mo	--	Cedar glades in northern Alabama and central Tennessee
Helianthus eggertii	Eggert's sunflower	T	Co Fr La Li Mo	--	Barrens habitats within the Interior Plateau Ecoregion of Kentucky, Tennessee, and Alabama

Table 1. (contd)

Scientific Name	Common Name	Status[(a)]	County Listings AL[(b)]	County Listings MS[(c)]	Habitat
Lesquerella lyrata	lyrate bladder-pod	T	Co Fr La	--	Disturbed glade habitats
Xyris tennesseensis	Tennessee yellow-eyed grass	E	Fr	--	Moist to wet, limestone-derived soils in open or lightly wooded sites
Leavenworthia crassa	Fleshy-fruited gladecress	C	La Mo	--	Endemic to limestone glades in Lawrence and Morgan Counties

(a) Status: C = candidate, E = endangered, T = threatened;.
(b) AL counties: Co = Colbert; Fr = Franklin; La = Lawrence; Li = Limestone; Mo = Morgan;.
(c) MS counties: It = Itawamba; Le = Lee; Ti = Tishomingo; – – = not listed.

Sources: FWS 2000b, 2004a; NatureServe 2004.

Red-Cockaded Woodpecker (*Picoides borealis*)

The red-cockaded woodpeckers is reported to occur in Lawrence County, Alabama, but not within at least 4.8 km (3.0 mi) of the transmission line rights-of-way. Red-cockaded woodpeckers inhabit open pine forests that are at least 80 to 120 years old (NatureServe 2004). Hardwood forests, or pine forests with a hardwood understory are usually avoided. There is no woodpecker habitat within 4.8 km (3.0 mi) of BFN, and it is unlikely that there is any suitable habitat along the BFN transmission line rights-of-way.

Because there is no habitat on the BFN site or transmission line rights-of-way, the staff determined that continued operation of BFN over the 20-year license renewal term will have no effect on the red-cockaded woodpecker.

Gray Bat (*Myotis grisescens*)

The gray bat is reported to occur in Colbert, Franklin, Lawrence, Limestone, and Morgan Counties, Alabama, and in Tishomingo County, Mississippi. Gray bats are colonial and are restricted to cave or cave-like habitats (NatureServe 2004). They roost, and the females form maternity colonies in caves located along rivers and reservoirs over which they feed. During the winter, gray bats congregate and hibernate in a limited number of caves across the southeast. Although no suitable habitat for this species occurs within 4.8 km (3.0 mi) of BFN, gray bats likely forage along the Tennessee River, adjacent to the plant site. Some of the BFN transmission line rights-of-way are likely to be within foraging areas for this species.

Construction and maintenance of transmission line rights-of-way are designed to minimize environmental impacts and transmission line right-of-way maintenance activities are reviewed for potential resource issues by the TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of gray bats in the area. Mechanical clearing and herbicides may be used for vegetation control in transmission line rights-of-way. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations.

The staff has reviewed TVA maintenance activities and has determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the gray bat.

Indiana Bat (*Myotis sodalis*)

The Indiana bat is reported to occur in Colbert, Lawrence, Limestone, and Morgan Counties, Alabama, and in Tishomingo County, Mississippi. Indiana bats are colonial and hibernate in caves during winter months, but they can be found in hollow trees and under loose tree bark during the summer, where they form small maternity colonies (NatureServe 2004). Indiana bats forage for insects primarily in riparian and upland forests. Roosting and foraging habitat for Indiana bats is very limited on the BFN site. Water sources are composed of water lagoons, sedimentation ponds, and drainage canals, and forested habitats are primarily small woodlots of poor quality. No suitable Indiana bat habitat is known to occur within 4.8 km (3.0 mi) of the BFN site. Some of the BFN transmission line rights-of-way are likely to be within foraging areas for this species.

Construction and maintenance of transmission line rights-of-way are designed to minimize environmental impacts, and may improve foraging habitat for Indiana bats. Transmission line right-of-way maintenance activities are reviewed for potential resource issues by the TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of Indiana bats in the area. Mechanical clearing and herbicides may be used for vegetation control in transmission line rights-of-way. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations.

Because there is no habitat for Indiana bats on the BFN site, and after reviewing the TVA maintenance activities, which may improve habitat along transmission line rights-of-way, the staff determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the Indiana bat.

Price's Potato Bean (*Apios priceana*)

Price's potato bean is reported to occur in Lee County, Mississippi. This species is found in open mixed hardwood forests, often on flood plains in or near riparian areas (NatureServe 2004). Although thought to be somewhat dependent on disturbances that maintain an early successional environment, it is also reported to be sensitive to some management activities such as logging, cattle grazing, and highway rights-of-way maintenance. No populations of Price's potato bean are known to exist within 4.8 km (3.0 mi) of BFN, but suitable habitat could be found along the BFN transmission line rights-of-way.

Construction and maintenance of transmission line rights-of-way are designed to minimize environmental impacts (Muncy et al. 1999), and may improve habitat for this species. Transmission line rights-of-way maintenance activities are reviewed for potential resource issues by the TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of Price's potato bean in the area. Mechanical clearing and herbicide use may be used for vegetation control on transmission line rights-of-way. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations.

Because there is no habitat for Price's potato bean on the BFN site, and after reviewing the TVA maintenance activities, which may improve habitat along transmission line rights-of-way, the staff determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, Price's potato bean.

American Hart's-Tongue Fern (*Asplenium scolopendrium* var. *americanum*)

American hart's-tongue fern is reported to occur in Morgan County, Alabama. In the southern portions of its range, this fern is found only around the openings to limestone caves and sinkholes (NatureServe 2004). No populations have been recorded within 4.8 km (3.0 mi) of BFN, and no suitable cave habitat has been identified along the BFN transmission line rights-of-way.

Because it does not occur at the BFN site or along BFN-associated transmission line rights-of-way, the staff has determined that continued operation of BFN over the 20-year license renewal term will have no effect on the American hart's tongue fern.

Leafy Prairie Clover (*Dalea foliosa*)

Leafy prairie clover is reported to occur in Franklin, Lawrence, and Morgan Counties, Alabama. This species is found in association with cedar glades in northern Alabama and central Tennessee. No populations of leafy prairie clover are known from within 4.8 km (3.0 mi) of BFN, but suitable habitat could be found along the transmission line rights-of-way. The leafy prairie clover has been found within 4.8 km (3.0 mi) of the Union transmission line in Colbert County, Alabama (TVA 2004b).

Construction and maintenance of the transmission line rights-of-way are designed to minimize environmental impacts, and transmission line rights-of-way maintenance activities are reviewed for potential resource issues by TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of leafy prairie clover in the area. Mechanical clearing and herbicides may be used for vegetation control on transmission line rights-of-way. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations.

There is no habitat on the BFN site but suitable habitat could exist along a portion of the Union transmission line in Colbert County, Alabama. After reviewing the TVA maintenance activities, the staff has determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the leafy prairie clover.

Eggert's Sunflower (*Helianthus eggertii*)

Eggert's sunflower is reported to occur in Colbert, Franklin, Lawrence, Limestone, and Morgan Counties, Alabama. This species is found in barrens habitat within the Interior Plateau Ecoregion of Kentucky, Tennessee, and Alabama (NatureServe 2004). No populations have been recorded within 4.8 km (3.0 mi) of BFN. Populations may occur along the BFN transmission rights-of-way because the species is reported to respond favorably to management activities such as burning and mowing (NatureServe 2004).

Construction and maintenance of transmission line.rights-of-way are designed to minimize environmental impacts (Muncy et al. 1999), and may improve habitat for this species. Transmission line right-of-way maintenance activities are reviewed for potential resource issues by the TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of the Eggert's sunflower in the area. Mechanical clearing and herbicides may be used for vegetation control on transmission line rights-of-way. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations.

Because there is no habitat on the BFN site and after reviewing the TVA maintenance activities, which may improve habitat along transmission line rights-of-way, the staff determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the Eggert's sunflower.

Fleshy-Fruited Gladecress (*Leavenworthia crassa*)

The fleshy-fruited gladecress is listed as a candidate species by FWS and is reported to occur in Lawrence and Morgan Counties, Alabama. Reportedly endemic to Lawrence and Morgan Counties, this species inhabits limestone glades and has been identified from only six sites (NatureServe 2004). No populations have been recorded within 4.8 km (3.0 mi) of BFN, but suitable habitat could be found along the BFN transmission line rights-of-way.

Construction and maintenance of transmission line rights-of-way are designed to minimize environmental impacts (Muncy et al. 1999), and may improve habitat for this species. Transmission line right-of-way maintenance activities are reviewed for potential resource issues by the TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of fleshy-fruited gladecress in the area. Mechanical clearing and herbicide use may be used for vegetation control on transmission line rights-of-way. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations.

Because there is no habitat on the BFN site and after reviewing the TVA maintenance activities, which may improve habitat along transmission line rights-of-way, the staff determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the fleshy-fruited gladecress.

Lyrate Bladder-Pod (*Lesquerella lyrata*)

Lyrate bladder-pod is reported to occur in Colbert, Franklin, and Lawrence Counties, Alabama. The species in known from only two populations in Franklin and Colbert Counties (FWS 2004b). The plant is an annual in the mustard family and is found in disturbed glade habitats. No populations have been recorded within 4.8 km (3.0 mi) of BFN, but suitable habitat could be found along the BFN transmission line rights-of-way.

Construction and maintenance of transmission line rights-of-way are designed to minimize environmental impacts (Muncy et al. 1999), and may improve habitat for this species. Transmission line right-of-way maintenance activities are reviewed for potential resource issues by the TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of lyrate bladder-pod in the area. Mechanical clearing and herbicide use may be used for vegetation control on transmission line rights-of-way. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations.

Because there is no habitat on the BFN site and after reviewing the TVA maintenance activities, which may improve habitat along transmission line rights-of-way, the staff determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the lyrate bladder-pod.

Tennessee Yellow-Eyed Grass (*Xyris tennesseensis*)

Tennessee yellow-eyed grass is reported to occur in Franklin County, Alabama. This species is found in moist-to-wet, limestone-derived soils in open or lightly wooded sites (NatureServe 2004). No populations are known to exist within 4.8 km (3.0 mi) of BFN, but suitable habitat could be found along the BFN transmission line rights-of-way. It has been found within 4.8 km (3.0 mi) of the Union transmission line in Franklin County, Alabama (TVA 2004b).

Construction and maintenance of transmission line rights-of-way are designed to minimize environmental impacts (Muncy et al. 1999), and may improve habitat for this species.

Transmission line right-of-way maintenance activities are reviewed for potential resource issues by the TVA (Muncy et al. 1999). Access routes and activity restrictions are determined based on knowledge of Tennessee yellow-eyed grass in the area. Mechanical clearing and herbicides may be used for vegetation control on transmission line rights-of-way. Herbicide application is carefully controlled and personnel who apply the herbicides are trained, licensed, and follow manufacturer's guidelines, EPA guidelines, and State regulations.

Because there is no habitat on the BFN site and after reviewing the TVA maintenance activities, which may improve habitat along transmission line rights-of-way, the staff determined that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the Tennessee yellow-eyed grass.

5.2 Aquatic Species

A total of 38 Federally listed aquatic species on the FWS websiteare identified as potentially occurring in the project area (i.e. Wheeler Reservoir or in streams crossed by transmission line rights-of-way associated with the BFN site). Nine of these species have a reasonable potential of occurring in the project area and are discussed in Section 5.2.1 below. The remaining 29 species are only briefly discussed in Section 5.2.2 because of presumed extinction or extripation from the project area, no recent records of collection, or because the habitat of the project area is clearly unsuitable for the species.

5.2.1 Species Potentially Occurring in the Project Area

Nine aquatic species are listed as threatened, endangered, or candidate species by FWS and have a reasonable potential to occur in the project area (i.e., Wheeler Reservoir or within streams crossed by the transmission lines associated with BFN) (Table 2).

Anthony's Riversnail (*Athearnia anthonyi*)

Anthony's riversnail is Federally listed as endangered throughout its entire range (FWS 1994), except where proposed for establishment as a nonessential experimental population in the free-flowing reach of the Tennessee River from the base of Wilson Dam downstream to the back-waters of Pickwick Reservoir (about 19 km [12 mi]) and the lower 8 km (5 mi) of all tributaries to this reach in Colbert and Lauderdale Counties, Alabama (FWS 2001). It was known to occur in Alabama, Georgia, and Tennessee. It has been extirpated from most of its historic range due to pollution, siltation, and habitat modification or destruction. Many populations were lost when the Tennessee River and the lower reaches of its tributaries were impounded (FWS 1994). Only two populations of Anthony's riversnail are known to survive. The largest of these occurs in the Tennessee River, Jackson County, Alabama, and Marion County, Tennessee, a short distance downstream of Nickajack Dam. This population also extends a short distance into the lower section Sequatchie River, Marion County, Tennessee (FWS 1997b). This population occurs well upstream from the BFN site. The other surviving population is restricted to a relatively short reach of lower Limestone Creek, Limestone County, Alabama (FWS 1997b). Limestone Creek is crossed at three locations by a BFN transmission line and is closely paralleled by the transmission line along two stream segments (TVA 2004b). However, the

BFN transmission line does not cross or parallel the lower section of Limestone Creek where the snail is known to occur. Anthony's riversnail inhabits large rivers and the lower reaches of larger creeks, occurring on cobble/boulder substrates in the vicinity of riffles. However, it does not always occur in strongly flowing sections (NatureServe 2004). At the two sites in Limestone

Table 2. Federally Listed and Candidate Aquatic Species Potentially Occurring in Wheeler Reservoir or Streams Crossed by the Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Transmission Line Rights-of-Way.

Scientific Name	Common Name	Status[a]	County Listings[b] AL	County Listings[b] MS	Habitat
			Snails		
Athearnia anthonyi	Anthony's riversnail	E	Co Li	--	Large rivers and lower reaches of large creeks on cobble/boulder substrates near riffles.
Campeloma decampi	slender campeloma	E	Li	--	Large creeks in soft sediments (sand or mud) or detritus.
Pyrgulopsis pachyta	armored snail	E	Li	--	Shallow, still water along the edge of pools on tree roots and detritus of creeks.
Scientific Name	**Common Name**	**Status[b]**	**County Listings[a] AL**	**County Listings[a] MS**	**Habitat**
			Mussels		
Cumberlandia monodonta	spectaclecase	C	Co La Li Mo	--	Large rivers with swiftly flowing water, among boulders in patches of sand, cobble, or gravel in areas where current is reduced.
Epioblasma brevidens	Cumberlandian combshell	E	Co Fr Li	Ti	Coarse sand to mixtures of gravel, cobble and boulder-sized rocks in medium to large rivers; tends to occur at depths less than 1m (3 ft).
Lampsilis abrupta	pink mucket	E	Co La Li Mo	--	Larger rivers in gravel or sand.

Lexingtonia dolabelloides	slabside pearlymussel	C	Co Fr Li	Ti	Moderate to high gradient riffles in medium to large rivers.
Pleurobema plenum	rough pigtoe	E	Co La Li Mo	--	Medium to large rivers in sand or gravel.
			Fish		
Etheostoma boschungi	slackwater darter	T	Li	--	Gravel-bottomed pools and runs of creeks and small rivers.

(a) Co = Colbert; Fr = Franklin; It = Itawamba; La = Lawrence; Li = Limestone; Mo = Morgan; Ti = Tishomingo; -- = not listed.
(b) Status: C = candidate, E = endangered, T = threatened.

Sources: ADCNR 2003; Cummings and Mayer 1992; FWS 1990b, 2000b, 2004c; Johnson and Wehrle 2004; MMNS 2002; MNHP 2002; NatureServe 2004; NCWRC 2004; Page and Burr 1991; TVA 2003, 2004a.

Creek where Anthony's riversnail is known to occur, its density reaches several hundred individuals per square meter. However, both Sequatchie and Limestone Creeks have been severely impacted in the past, and continue to be impacted, by siltation and other sources of pollution (e.g., pesticide spraying and mining effluents). A single catastrophic pollution event could potentially destroy all populations of the snail within a creek (FWS 1994, 1997b). A recovery plan for Anthony's riversnail has been prepared (FWS 1997b).

The staff visited the site and reviewed the life history information about Anthony's riversnail. Based on this information, and that previously described for the TVA transmission line rights-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, Anthony's riversnail.

Slender Campeloma (*Campeloma decampi*)

The slender campeloma is Federally listed as endangered throughout its entire range (FWS 2000a). It is known to occur in only several isolated populations along Limestone, Piney, and Round Island Creeks in northern Alabama (NatureServe 2004). All three creeks are crossed by BFN transmission lines. Piney Creek is crossed once, while Round Island and Limestone Creeks are each crossed three times. Segments of Round Island and Limestone Creeks are also closely paralleled by the transmission lines. The slender campeloma has been found within 4.8 km (3.0 mi) of the Trinity, Maury, and Athens transmission lines in Limestone County, Alabama (TVA 2004b). The slender campeloma typically burrows in soft sediment or detritus. Impacts to slender campeloma include siltation and other pollutants from poor land-use practices and waste discharges (FWS 2000a).

The staff visited the site and reviewed the life history information about the slender campeloma. On the basis of this information and information previously described for the TVA transmission line right-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the slender campeloma.

Armored Snail (*Pyrgulopsis pachyta*)

The armored snail (or armored marstonia) is Federally listed as endangered throughout its entire range (FWS 2000a). It is known to occur in Alabama from several isolated sites in Limestone and Piney Creeks near Mooresville, Alabama (NatureServe 2004). Piney Creek was formerly a tributary of Limestone Creek before the construction of Wheeler Reservoir (NatureServe 2004). The BFN transmission lines cross both of these streams. BFN transmission lines cross Limestone Creek at three locations and closely parallels along two segments of the creek. Both streams are crossed several miles upstream from Mooresville. The armored snail has been collected within 4.8 km (3.0 mi) of the Maury transmission line in Limestone County, Alabama (TVA 2004b). The armored snail is found in shallow, still water along the edge of pools on tree roots and detritus. It probably also occurs on mud (NatureServe 2004). Impacts to the armored snail include siltation and other pollutants from poor land-use practices and waste discharges (FWS 2000a).

The staff visited the site and reviewed the life history information about the armored snail. On the basis of this information and information previously described for the TVA transmission line right-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the armored snail.

Spectaclecase (*Cumberlandia monodonta*)

The spectaclecase is a candidate for Federal listing. Its historic range includes Alabama, Arkansas, Iowa, Indiana, Illinois, Kentucky, Missouri, Nebraska, Ohio, Tennessee, Virginia, and Wisconsin (FWS 2004c). It has been largely reduced to a relatively few disjunct sites. The mussels at some of the sites may no longer be capable of reproduction because of loss of fish hosts or adverse environmental conditions (e.g., hypolimnetic releases from reservoirs) (NatureServe 2004). In Alabama, the spectaclecase is known from Limestone and Morgan Counties. The spectaclecase is usually found in areas with a strong current. In medium-sized rivers, it prefers coarse substrates such as cobble, gravel, or cracks in bedrock. In large rivers, substrates used are typically finer and include sand or mud. The spectaclecase may be associated with shoals, bars, and islands (NatureServe 2004). It is often found in small clusters of the same-aged individuals (NatureServe 2004). Fish hosts for the spectaclecase are unknown (Schulz and Marbain 1998). Live specimens have been collected in the main stem of the Tennessee River in Colbert, Lauderdale, Limestone, and Morgan Counties as recently as 2000. Recent collections in the mainstem of the Tennessee River have been made in the tailwaters downstream of dams. Weathered shells were collected in the Elk River, Limestone County, Alabama, in 1998 and 1974 (Butler 2002).

The staff visited the site and reviewed the life history information about the spectaclecase. On the basis of this information and information previously described for the TVA transmission line right-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the spectaclecase.

Cumberlandian Combshell (*Epioblasma brevidens*)

The Cumberlandian combshell is Federally listed as endangered throughout its entire range (FWS 1997a), except where proposed for establishment as a nonessential experimental population in the free-flowing reach of the Tennessee River from the base of Wilson Dam downstream to the backwaters of Pickwick Reservoir (about 19 km [12 mi]) and the lower 8 km (5 mi) of all tributaries to this reach in Colbert and Lauderdale Counties, Alabama (FWS 2001). A draft recovery plan has been prepared for the species (FWS 2003). The Cumberlandian combshell is known to occur in Alabama, Kentucky, Tennessee, and Virginia (FWS 1997a). The Cumberlandian combshell is now restricted to populations in limited areas of five drainages, and some of these may no longer be reproducing. The species was eliminated from much of its historic range by impoundments. Existing populations are in decline due to pollution (especially from mining activities), impoundments, and siltation (FWS 1997a). It was last collected from Muscle Shoals (the area now incorporated within the upper reaches of Pickwick Reservoir through Wilson Reservoir and into Wheeler Reservoir) in 1925 (Garner 1997). The Cumberlandian combshell is typically associated with riffle and shoal areas in medium and large rivers in substrates of coarse sand to cobble. It has been apparently eliminated from the main stem of the Tennessee and Cumberland Rivers (FWS 2004d). In Alabama, moribund specimens were found in the late 1990s in Bear Creek, a tributary of the Tennessee River (NatureServe 2004). Fish hosts for the Cumberlandian combshell include darters and sculpins (Schulz and Marbain 1998). Critical habitat has been designated for the species within the Tennessee and Cumberland River basins, including a portion of Bear Creek that flows through Colbert County, Alabama, and Tishomingo County, Mississippi (FWS 2004d). One of the BFN transmission lines crosses Bear Creek in Tishomingo County, Mississippi, within the proposed reach of critical habitat.

The staff visited the site and reviewed the life history information about the Cumberlandian combshell. On the basis of this information, information previously provided on the aquatic resources within the Wheeler Reservoir, and information previously described for the TVA transmission line right-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the Cumberlandian combshell.

Pink Mucket (*Lampsilis abrupta*)

The pink mucket is Federally listed as endangered throughout its entire range (FWS 1976). It is known to occur in Alabama, Arkansas, Illinois, Indiana, Kentucky, Louisiana, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia (NatureServe 2004). It is apparently surviving and reproducing in river segments that have been altered by impoundments; however, its range has diminished (e.g., it has been extirpated from Ohio, Pennsylvania, and Illinois) (NatureServe 2004). Within Alabama, the pink mucket occurs in Colbert, Lauderdale, Limestone, Madison, Marshall, and Morgan Counties (NatureServe 2004). Suitable hosts for the glochidia of the pink mucket include freshwater drum, largemouth bass, smallmouth bass, spotted bass, sauger, and walleye (Fuller 1974; Barnhart et al. 1997). Use of mostly piscivorous hosts by this mussel is consistent with the display of a relatively large fish-like lure used by the mussel to attach hosts (Barnhart et al. 1997). The pink mucket inhabits areas of large rivers with swift currents at depths ranging from 0.5 to 8.0 m (1.6 to 26.2 ft) and mixed sand/gravel/cobble substrate (Barclay 2004). They are generally collected in the tailwater areas downstream from the Tennessee River drainage dams (Barclay 2004). Therefore, it is unlikely that the pink mucket exists in Wheeler Reservoir in the areas near or downstream from BFN. The pink mucket has been found within 4.8 km (3.0 mi) of the Union transmission line in Lawrence County, Alabama (TVA 2004b). Sixteen specimens of the pink mucket were collected near Hobbs Island (over 64 km [40 mi] upstream of BFN) in 1998 (Yokely 1998). Past and ongoing threats to the pink mucket include habitat loss and modification from dams and dredging, water quality degradation, and commercial over-harvesting (NatureServe 2004). The zebra mussel would also pose a threat to the pink mucket in areas where they co-exist.

The staff visited the site and reviewed the life history information about the pink mucket. On the basis of this information, information previously provided on the aquatic resources in Wheeler Reservoir, and information previously described for the TVA transmission line right-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the pink mucket.

Slabside Pearlymussel (*Lexingtonia dolabelloides*)

The slabside pearlymussel is a candidate for Federal listing. Its historic range includes Alabama, Kentucky, Tennessee, and Virginia (FWS 2004c). Most surviving individuals are restricted to two or three populations; and the long-term viability of all extant occurrences is questionable (NatureServe 2004). It historically occurred in the Cumberland River, although it is now extirpated from the entire Cumberland River system. The slabside pearlymussel was once prevalent in the Tennessee River system. Historically, it was fairly common from Muscle Shoals (the area is now incorporated within the upper reaches of Pickwick Reservoir through Wilson Reservoir and into Wheeler Reservoir) to the Tennessee River headwater tributaries in Virginia and the Duck River drainage. It was last collected from Muscle Shoals in 1963 (Garner 1997). Remaining populations occur in a number of tributary streams of the Tennessee River system, but not in the main stem of the Tennessee River (NatureServe 2004). Bear Creek is the only one of these streams that is crossed by a BFN transmission line. Fish hosts for the slabside pearlymussel include the smallmouth bass and, possibly, various minnow species (Schulz and Marbain 1998). Threats to the species include channel alterations, impoundments, siltation, pollution, commercial clamming, and gravel and coal mining (NatureServe 2004). It is generally found in areas of moderate to swift current velocities with substrates ranging from coarse sand to heterogenous assemblages of larger-sized particles (NatureServe 2004).

The staff visited the site and reviewed the life history information about the slabside pearlymussel. On the basis of this information, information previously provided on the aquatic resources within the Wheeler Reservoir, and information previously described for the TVA transmission line rights-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the slabside pearlymussel.

Rough Pigtoe (*Pleurobema plenum*)

The rough pigtoe is Federally listed as endangered throughout its entire range (FWS 1976). It has a wide, but very fragmented, distribution in Alabama, Indiana, Kentucky, Pennsylvania, Tennessee, and Virginia (NatureServe 2004). The distribution of the rough pigtoe in Alabama includes Colbert, Lauderdale, Limestone, and Morgan Counties. Within the Tennessee River, the rough pigtoe is currently present in tailwaters downstream of Pickwick, Wilson, and Guntersville Dams (NatureServe 2004). The rough pigtoe occurs in medium to large rivers in sand, gravel, and cobble substrates in shoals, although it is occasionally found on flats and muddy sand (NatureServe 2004). It does not occur in the impounded sections of rivers (FWIE 1996). Therefore, it is unlikely that the rough pigtoe exists in Wheeler Reservoir in the areas near or downstream from BFN. One specimen was collected near Hobbs Island (over 64 km [40 mi] upstream of BFN) in 1998 (Yokely 1998). Possible host fish for the rough pigtoe are bluegill and rosefin shiner (*Lythrurus ardens*) (Schulz and Marbain 1998). The long-term viability of most populations is in jeopardy, particularly for those in large rivers where zebra mussels are established (NatureServe 2004). Other threats to the rough pigtoe include impoundments, channelization, dredging, industrial and residential discharges, siltation, herbicide and fertilizer run-off, loss of fish hosts, and natural predators (NatureServe 2004).

The staff visited the site and reviewed the life history information about the rough pigtoe. On the basis of this information and information previously described for the TVA transmission line right-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the rough pigtoe.

Slackwater Darter (*Etheostoma boschungi*)

The slackwater darter is Federally listed as threatened throughout its entire range (FWS 1977b). Critical habitat was also designated for the species (FWS 1977b). It is known to occur in Alabama and Tennessee. The slackwater darter occupies five tributaries of the Tennessee River: Buffalo River and upper Shoal Creek in Lawrence County, Tennessee; Flint River, Madison County, Alabama; Swan Creek, Limestone County, Alabama, and Cypress Creek, Lauderdale County, Alabama (NatureServe 2004). Swan Creek is crossed by the Maury transmission line. The slackwater darter has been found within 4.8 km (3.0 mi) of the Trinity and Maury transmission lines in Limestone County, Alabama (TVA 2004b). Critical habitat for the slackwater darter includes many of the permanent and intermittent streams that are tributaries to Cypress Creek in Lauderdale County, Alabama, and Wayne County, Tennessee (FWS 1977b). None of these streams are located near BFN transmission lines. The slackwater darter typically occurs in gravel-bottomed pools in sluggish areas of creeks and small rivers that are not more than 12 m (39 ft) wide and 2 m (6.6 ft) deep. They often inhabit slow waters beneath undercut banks or accumulations of leaf litter or detritus. Spawning occurs in very shallow (5 to 10 cm [2 to 4 in.]) clear, flowing seepage water characterized by the presence of *Juncus* spp. and *Eleocharis* spp. in fields and open woods. Threats to the species include habitat loss and degradation. In some locations, the heavy use of groundwater causes seepage areas used for spawning to dry up (NatureServe 2004).

The staff visited the site and reviewed the life history and distribution of the slackwater darter. On the basis of this information and information provided by TVA, the staff concludes that continued operation of BFN over the 20-year license renewal term may affect, but is not likely to adversely affect, the slackwater darter.

5.2.2 Additional Aquatic Species

In addition to the nine species discussed above, there are 29 additional Federally listed aquatic species (including one candidate species) whose distribution includes, or historically included, the Wheeler Reservoir portion of the Tennessee River or other streams, rivers, or caves within the counties of Alabama and Mississippi within which the BFN transmission lines occur (Table 3). However, these 29 species would not currently be expected to occur within Wheeler Reservoir near or downstream of BFN (i.e., the portions of the Tennessee River that could be affected by BFN operations) or within the streams crossed by the transmission lines associated with BFN. The rationale for this determination is based on the following: (1) the species are presumed extinct; (2) the species are presumed to be extirpated from the region; (3) there are no recent records of the species in the BFN project area; (4) there are no collection records for the species from pertinent locations; and/or (5) project areas of concern do not have appropriate habitat for the species (e.g., county records are for streams or caves that are not crossed by the BFN transmission lines). The notes column of Table 3 provides the rationale for each species. The staff reviewed the design, operation, and location of the intake and discharge structures at BFN and the impingement and entrainment data collected during plant operation. The staff also visited the site and reviewed the life history information about these 29 species. On the basis of this information, information previously provided on the aquatic resources within the Wheeler Reservoir, and information previously described for the TVA transmission line rights-of-way maintenance procedures, the staff concludes that continued operation of BFN over the 20-year license renewal Term would have no effect on these species. Therefore, these species are not evaluated in any detail in this BA.

6.0 Conclusions

The staff identified nine terrestrial and nine aquatic species listed as threatened, endangered, or candidate under the Endangered Species Act that have a reasonable potential to occur in the vicinity of BFN or along the transmission line rights-of-way (including Wheeler Reservoir near and downstream of BFN and within streams crossed by the BFN transmission lines). Two terrestrial species were evaluated and determined that they would not occur in the project area. In addition, 29 aquatic species listed by FWS were identified by the staff as having no reasonable potential to occur in the project areas and were not evaluated in detail.

None of the terrestrial or aquatic species are known to inhabit areas within 4.8 km (3.0 mi) of BFN. The transmission line rights-of-way may cross or contain suitable habitat for some of these species, including designated critical habitat for the Cumberlandian combshell. Given this possibility, TVA has designed and implemented maintenance procedures for its transmission line rights-of-way that protect listed species and their habitats.

Table 3. Federally Listed Aquatic Species in Northwestern Alabama and Northeastern Mississippi that are Considered Unlikely to be Present Near the Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 Site or Its Transmission Line Rights-of-Way.

Scientific Name (Common Name)	Status[b]	County Listings[a] AL	County Listings[a] MS	Notes
Mussels				
Cyprogenia stegaria (fanshell)	E	Co	--	Relatively deep water in gravelly substrates with moderate currents in medium to large rivers. Last collected in Muscle Shoals[c] circa 1976 to 1978. Live specimen last reported from Wheeler Reservoir in 1979. Possibly extirpated from Alabama.
Dromus dromas (dromedary pearlymussel)	E	Co Li Mo	--	Sand and gravel substrates in riffles and shoals of medium to large rivers. Last collected in Muscle Shoals in 1931. Only current Tennessee River records are from Meigs County, Tennessee. Possibly extirpated from Alabama.
Epioblasma capsaeformis (oyster mussel)	E	Co	--	Usually in small- to medium-sized rivers in substrates of coarse sand to boulder substrates in moderate to swift currents. Last collected from Muscle Shoals circa 1925. No longer present in the mainstem of the Tennessee River. Presumed extirpated from Alabama.
Epioblasma florentina florentina (yellow-blossom pearlymussel)	E	Co	--	Riffle and shoal areas of small-sized to medium-sized streams. Last collected from Muscle Shoals circa 1925. Not collected anywhere since 1970. Possibly extinct.
Epioblasma florentina walkeri (tan riffleshell)	E	Li	--	Headwaters, riffles, and shoals in sand and gravel substrates. Only one reproducing population known (Indian Creek of the upper Clinch River, Virginia). Presumed extirpated from Alabama.

Table 3. (contd)

Scientific Name (Common Name)	Status[(b)]	County Listings[(a)] AL	County Listings[(a)] MS	Notes
Epioblasma penita (Southern combshell)	E	--	It	Riffles or shoals of medium-sized rivers with sandy gravel to gravel-cobble substrates in moderate to swift current. Currently limited to the East Fork Tombigbee River, Sipsey River, and Buttahatchie River, well south of the BFN project area. Presumed extripated from Alabama.
Epioblasma torulosa torulosa (tubercled blossom pearlymussel)	E	Co Li Mo	--	Sandy gravel substrates in riffles and shoals in rapid currents of medium to large rivers. Last collected from Muscle Shoals in 1931. Presumed extirpated from Alabama, species possibly extinct.
Epioblasma turgidula (turgid blossom pearlymussel)	E	Co Fr	--	Sand and gravel substrates of shallow, fast-flowing streams. Last collected from Muscle Shoals circa 1925. Not collected anywhere since the mid-1960s, possibly extinct.
Fusconaia cor (shiny pigtoe)	E	Co	--	Shoals and riffles in clear streams with moderate to fast current. Last collected from Muscle Shoals circa 1925. No recent collections from the Tennessee River or its tributaries that are crossed by the BFN transmission lines. Currently exists in the North Fork of the Holston River, the Clinch and Powell Rivers in Tennessee, and in the Paint Rock River in Alabama.
Fusconaia cuneolus (finerayed pigtoe)	E	Fr Li	--	Firm cobble and gravel substrates of clear, high-gradient streams. Last collected from Muscle Shoals circa 1925. No recent collections from the Tennessee River or its tributaries that are crossed by the BFN transmission lines. Currently persists in Clinch and Powell Rivers, the North Fork of the Holston River, and in the Paint Rock River.
Hemistena lata (cracking pearlymussel)	E	Co Li	--	Sand, gravel and cobble substrates in swift currents or mud and sand in slower currents of medium to large rivers. Last collected from Muscle Shoals circa 1925. Presumed extirpated from Alabama. May exist in the Clinch River, Tennessee.

Table 3. (contd)

Scientific Name (Common Name)	Status[b]	County Listings[a]		Notes
		AL	MS	
Lampsilis perovalis (orangenacre mucket)	T	--	It	Medium and large rivers in gravel/cobble or gravel/coarse sand substrates. Survives in a few Tombigbee, Black Warrior, and Alabama River tributaries well south of the BFN transmission lines.
Lampsilis virescens (Alabama lampmussel)	E	Co Fr	--	Sand and gravel substrates in shoal areas of medium to large rivers. Last collected from Muscle Shoals circa 1925. Extirpated from most of its range. Only one live specimen found in recent years from Paint Rock River drainage in Jackson County, Alabama, well upstream from the BFN project area.
Lemiox rimosus (birdwing pearlymussel)	E	Co Li	--	Riffle areas with sand and gravel substrates in moderate to fast currents of creeks to medium-sized rivers. Last collected from Muscle Shoals circa 1925. Presumed extirpated from Alabama. Only a few known occurrences in the Clinch, Powell, Elk, and Duck Rivers in Tennessee and Virginia.
Obovaria retusa (ring pink)	E	Co Li Mo	--	Gravel and sand bars of large rivers. Last collected from Muscle Shoals in 1992. Empty shells collected from Wheeler Reservoir in 1991. Possibly extirpated from Alabama.
Plethobasus cicatricosus (white wartyback pearlymussel)	E	Co	--	Gravel substrates of large rivers. No living specimens found in the Tennessee River since the 1960s, although fresh dead specimens collected in 1979 and 1982 downstream of Pickwick Dam near Savannah, Tennessee. Possibly extinct.
Plethobasus cooperianus (orangefoot pimpleback)	E	Co Li Mo	--	Sand, gravel, and cobble substrates in riffles and shoals in deep water and steady current of large rivers. Last collected from Muscle Shoals in 1978. Possibly extirpated from Alabama.
Pleurobema clava (clubshell)	E	Co	--	Medium to large rivers in clean gravel or mixed gravel and sand. Last collected from Muscle Shoals circa 1925. Presumed extirpated from Alabama.

Table 3. (contd)

Scientific Name (Common Name)	Status[b]	County Listings[a]		Notes
		AL	MS	
Pleurobema curtum (black clubshell)	E	--	It	Sandy gravel to gravel-cobble substrates in riffles and shoals with moderate to fast currents in medium to large rivers. Current range limited to the East Fork Tombigbee River. Possibly extinct.
Pleurobema decisum (southern clubshell)	E	--	It	Sand and gravel substrates of medium to large rivers. Very few viable populations occur in the Sipsey River (Tombigbee River drainage), Chewacla Creek (Tallapoosa River drainage), and the Conasauga River (upper Coosa River drainage); all three waterbodies located well outside the BFN project area. It does not occur in the Tennessee River drainage.
Pleurobema perovatum (ovate clubshell)	E	--	It	Moderate gradient pools and riffles of medium to large rivers. Currently found in Tombigbee River tributaries and Chewacla Creek in the Tallapoosa River drainage. It does not occur in the Tennessee River drainage.
Pleurobema taitianum (heavy pigtoe)	E	--	It	Riffles and shoals on sandy gravel to gravel-cobble substrates in areas of moderate to fast currents of medium to large rivers. Not known from the Tennessee River drainage. Currently only found in the Alabama River in Dallas and Lowndes Counties, Alabama.

Table 3. (contd)

Scientific Name (Common Name)	Status[b]	County Listings[a] AL	County Listings[a] MS	Notes
Ptychobranchus subtentum (fluted kidneyshell)	C	Li	--	Small to medium rivers in areas with swift current or riffles; larger rivers in shoal areas. Last collected from Muscle Shoals circa 1925. Presumed extirpated from Alabama.
Quadrula intermedia (Cumberland monkeyface)	E	Co Li	--	Sand and gravel substrates in shallow riffle and shoal areas of headwater streams to bigger rivers at depths to 0.6 m (2 ft). Last collected from Muscle Shoals circa 1925. Possibly extirpated from Alabama.
Toxolasma cylindrellus (pale lilliput)	E	Co	--	Firm rubble, gravel, and sand substrates in shallow riffles and shoals of clean, fast-flowing streams. Currently known only from the Paint Rock River drainage in Jackson County, Alabama, well upstream from the BFN project area.
Villosa trabalis (Cumberland bean)	E	Mo	--	Sand, gravel, and cobble substrates in waters of moderate to swift currents and depths less than 1m (3 ft) in medium to large rivers. Last collected from Muscle Shoals circa 1925. Presumed extirpated from Alabama.
Shrimp				
Palaemonias alabamae (Alabama cave shrimp)	E	Co	--	Silt-bottom pools in caves. Currently known to occur in two caves in Madison County, Alabama. No BFN transmission lines occur near these caves.
Fishes				
Cyprinella monacha (spotfin chub)	E	Co	--	Rocky riffles and runs of clean small to medium riffles. Currently only known to exist in Tennessee and North Carolina. It is possibly extirpated from Alabama.
Etheostoma wapiti (boulder darter)	E	Li	--	Fast, rocky riffles of small to medium rivers. Presently restricted to the Elk River in Tennessee and Alabama, and Richland and Indian Creeks in Giles County, Tennessee. No BFN transmission lines cross these waterbodies.

Table 3. (contd)

Scientific Name (Common Name)	Status[(b)]	County Listings[(a)]		Notes
		AL	MS	

(a) Co = Colbert; Fr = Franklin; It = Itawamba; La = Lawrence; Li = Limestone; Mo = Morgan. Ti = Tishomingo; – = not listed.
(b) Status: C = candidate, E = endangered, T = threatened.
(c) Muscle Shoals is the area now incorporated within the upper reach of Pickwick Reservoir, through Wilson Reservoir, and into Wheeler Reservoir.

Sources: ADCNR 2003; Ahlstedt and McDonough 1992; Cummings and Mayer 1992; FWS 1976, 1977a, b, 1987b, 1988a, b, 1989a, b, 1990a, b, c, 1993a,b, 1997a, 2000b, 2004c; Garner 1997; Johnson and Wehrle 2004; MMNS 2002; MNHP 2002; NatureServe 2004; NCWRC 2004; Page and Burr 1991; Rogers et al. 2001; TVA 2003, 2004a.

The staff has determined that license renewal for BFN would have no effect on the red-cockaded woodpecker, the American hart's tongue fern, and 29 of the aquatic species. License renewal may affect, but is not likely to adversely affect, the bald eagle, gray bat, Indiana bat, Price's potato bean, leafy prairie clover, Eggert's sunflower, fleshy-fruited gladecress, lyrate bladder pod, Tennessee yellow-eyed grass, Anthony's riversnail, slender campeloma, armored snail, spectaclecase, Cumberlandian combshell, pink mucket, slabside pearlymussel, rough pigtoe, and the slackwater darter.

7.0 References

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Appendix F

GEIS Environmental Issues Not Applicable to Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

Appendix F

GEIS Environmental Issues Not Applicable to Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

Table F-1 lists those environmental issues listed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) (NRC 1996; 1999)[(a)] and 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are not applicable to Browns Ferry Nuclear Plant, Units 1, 2, and 3 (BFN) because of plant or site characteristics.

Table F-1. GEIS Environmental Issues Not Applicable to Browns Ferry Nuclear Power Plant, Units 1, 2, and 3

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	Category	GEIS Sections	Comment
SURFACE WATER QUALITY, HYDROLOGY, AND USE (FOR ALL PLANTS)			
Altered salinity gradients	1	4.2.1.2.2 4.4.2.2	The BFN cooling system does not discharge to an estuary.
AQUATIC ECOLOGY (FOR PLANTS WITH COOLING TOWER BASED HEAT DISSIPATION SYSTEMS)			
Entrainment of fish and shellfish in early life stages	1	4.3.3	This issue is related to heat-dissipation systems that are not used at BFN.
Impingement of fish and shellfish	1	4.3.3	This issue is related to heat-dissipation systems that are not used at BFN.
Heat shock	1	4.3.3	This issue is related to heat-dissipation systems that are not used at BFN.

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

Table F-1. (contd)

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	Category	GEIS Sections	Comment
GROUNDWATER USE AND QUALITY			
Groundwater-use conflicts (potable and service water, and dewatering; plants that use >100 gpm)	2	4.8.1.1 4.8.2.1	BFN uses <100 gpm of groundwater.
Groundwater-use conflicts (Ranney wells)	2	4.8.1.4	BFN does not have or use Ranney wells.
Groundwater quality degradation (Ranney wells)	1	4.8.2.2	BFN does not have or use Ranney wells.
Groundwater quality degradation (saltwater intrusion)	1	4.8.2.1	BFN does not currently use groundwater and is not near a saltwater body.
Groundwater quality degradation (cooling ponds in salt marshes)	1	4.8.3	This issue is related to a heat-dissipation system that is not installed at BFN.
Groundwater quality degradation (cooling ponds at inland sites)	2	4.8.3	This issue is related to a heat-dissipation system that is not installed at BFN.
TERRESTRIAL RESOURCES			
Cooling pond impacts on terrestrial resources	1	4.4.4	This issue is related to a heat-dissipation system that is not installed at BFN.

F.1 References

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Appendix G

NRC Staff Evaluation of Severe Accident Mitigation Alternatives (SAMAs) for Browns Ferry Nuclear Plant, Units 1, 2, and 3, in Support of the License Renewal Application Review

Appendix G

NRC Staff Evaluation of Severe Accident Mitigation Alternatives (SAMAs) for Browns Ferry Nuclear Plant, Units 1, 2 and 3, in Support of the License Renewal Application Review

G.1 Introduction

Tennessee Valley Authority (TVA) submitted an assessment of SAMAs for Browns Ferry Nuclear Plant (BFN) Units 1, 2, and 3 as part of the Environmental Report (ER) (TVA 2003). This assessment considers all three Browns Ferry units, each operating at 120 percent of their original licensed power level. Ideally, this assessment would take advantage of a plant-specific Probabilistic Safety Assessment (PSA) that reflects operation of all three units at 120 percent of their original licensed power. However, such a PSA is not currently available. Because of the progressive screening nature of the SAMA evaluation, TVA relied on the available PSA information, along with engineering knowledge of the plant, to form a basis for the three-unit SAMA assessment. This assessment was based on the most recent PSA for Unit 2 and Unit 3 available at that time, insights from a Multiple-Unit PSA performed in 1995 to bound the effects of three-unit operation, a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer program, and insights from the Browns Ferry Individual Plant Examination of External Events (IPEEE) (TVA 1995a, 1996, 1997). In identifying and evaluating potential SAMAs, TVA considered SAMA candidates that addressed the major contributors to core damage frequency (CDF) and large early release frequency (LERF), as well as generic SAMAs considered in analyses performed for other operating plants which have submitted license renewal applications. TVA identified 135 potential SAMA candidates. This list was reduced to 43 unique SAMA candidates by eliminating SAMAs that were not applicable to BFN due to design differences, had already been implemented, were similar in nature and could be combined with another SAMA, or cost more than $6M to implement. TVA assessed the costs and benefits associated with each of the remaining SAMAs and concluded in the ER that none of the candidate SAMAs evaluated would be cost-beneficial for BFN.

Based on a review of the SAMA assessment, the NRC issued a request for additional information (RAI) to TVA by letter dated April 28, 2004 (NRC 2004). Key questions concerned: the mapping of key plant damage states to release categories; reasons for the relatively large reduction in CDF since the individual plant examination (IPE); dominant risk contributors at BFN and the SAMAs that address these contributors; the rationale for increasing the Unit 2 and 3 CDFs to account for Unit 1 operation; the sequence-specific impact of Unit 1 operation on the candidate SAMAs; consideration of the potential impact of external events; and details on certain SAMAs. TVA submitted additional information by letter dated July 7, 2004 (TVA 2004a) including: summaries of peer review comments and their impact on the SAMA analysis; a description of the various changes to the PSA model since the IPE; an explanation of how of key plant damage states were mapped to release categories; a cross reference of the major contributors to CDF to candidate SAMAs; discussions of the impact of the operation of Unit 1 and the impact of external events. TVA's responses addressed the staff's concerns.

Based on its review, the staff concluded that the contribution to risk from fire events would be higher than assumed in TVA's SAMA analysis. The staff adjusted TVA's risk reduction estimates to account for the contribution to risk (and risk reduction) from fire events, and found that none of the candidate SAMAs would be cost-beneficial.

An assessment of SAMAs for BFN is presented below.

G.2 Estimate of Risk for BFN

TVA's estimates of offsite risk at BFN are summarized in Section G.2.1. The summary is followed by the staff's review of TVA's risk estimates in Section G.2.2.

G.2.1 TVA's Risk Estimates

Two distinct analyses are combined to form the basis for the risk estimates used in the SAMA analysis: (1) the BFN PSA Unit 2 and Unit 3 models, and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PSA model) developed specifically for the SAMA analysis. The SAMA analysis is based on the most recent PSA models available at the time of the ER, referred to as the Extended Power Uprate (EPU) PSA for Unit 2, and the EPU PSA for Unit 3. (A PSA for Unit 1 was not available at the time of the SAMA analysis.) The PSAs include a Level 1 analysis to determine the CDF from internally-initiated events and a Level 2 analysis to assess containment performance during severe accidents. The scope of the BFN PSAs does not include external events.

The baseline CDFs for the purpose of the SAMA evaluation are approximately 2.6×10^{-6} per year for Unit 2 and 3.6×10^{-6} per year for Unit 3. The CDFs are based on the risk assessment for internally-initiated events at EPU conditions, i.e., 120 percent of their original licensed power level. TVA did not include the contribution to risk from external events within the BFN risk estimates. This is discussed further in Sections G.2.2 and G.6.2.

The breakdown of CDF by initiating event is provided in Table G-1. As shown in this table, transients and loss of offsite power initiated events are dominant contributors to the CDF. Bypass events (i.e., interfacing systems loss of coolant accident) contribute two percent or less to the total internal events CDF. Anticipated transients without scram (ATWS) events and station blackout (SBO) events are not specifically identified in the internal events CDF breakdown. In response to an RAI, TVA stated that the ATWS CDF is estimated to be 2.3×10^{-7} per year for each unit, and the SBO CDF is 3.7×10^{-8} per year for Unit 2 and 3.9×10^{-8} per year for Unit 3 (TVA 2004a). SAMAs to address ATWS and SBO events were considered in the SAMA evaluation.

Table G-1. BFN Core Damage Frequency

Initiating Event or Accident Class	Unit 2		Unit 3	
	CDF (Per Year)	**% Contribution to CDF**	**CDF (Per Year)**	**% Contribution to CDF**
Transients	1.6×10^{-6}	63	1.8×10^{-6}	52
Loss of offsite power (LOOP)	4.8×10^{-7}	19	1.1×10^{-6}	32
Support system failures	2.2×10^{-7}	8	2.3×10^{-7}	7
Internal Flooding	1.0×10^{-7}	4	1.6×10^{-7}	5
Loss of coolant accidents (LOCAs)	5.3×10^{-8}	2	5.4×10^{-8}	2
Stuck open relief valves	4.7×10^{-8}	2	5.8×10^{-8}	2
Interfacing system LOCA (ISLOCA)	4.6×10^{-8}	2	4.6×10^{-8}	1
Total CDF (from internal events)	**2.6×10^{-6}**	**100**	**3.4×10^{-6}**	**100**

The Level 2 analysis utilized the plant damage state (PDS) assignment rules developed for the BFN IPE to assign each of the Level 1 accident sequences that leads to core damage to a PDS in the PDS matrix from the BFN IPE. The assignment rules consider the status of containment (intact, bypassed, not isolated/failing early, or failing late), the status of key plant systems (drywell sprays, suppression pool cooling, torus vent and reactor protection system) and other conditions (vessel pressure and water on drywell floor) at the time of core damage in assigning each sequence to one of 37 possible PDSs. These PDSs are then condensed into a reduced set of eight key plant damage states (KPDSs). TVA states that this mapping is done conservatively on the basis of phenomenological parameters except in a few cases where PDSs with very low relative frequencies are mapped to nonconservative KPDSs. TVA states that the overall result is a conservative estimate of risk.

Each of these KPDSs was then mapped directly to a single release category whose release fractions and other parameters were determined by MAAP analyses of representative sequences. This mapping of KPDSs to release categories on a one to one basis was done conservatively to simplify the analysis. For example, the fraction of the KPDS which includes the dominant CDF sequences which would not be expected to lead to containment failure are all assumed to lead to early containment failure for the purpose of determining the fission product release fractions. This leads to sequences, which would normally be categorized as having no containment failure, that dominate the offsite risk.

The offsite consequences and economic impact analyses use the MACCS2 code to determine the offsite risk impacts on the surrounding environment and public. Inputs for this analysis include plant-specific and site-specific input values for core radionuclide inventory, source term and release characteristics, site meteorological data, projected population distribution (within a 80 km [50-mi] radius) for the year 2036, emergency response evacuation modeling, and economic data.

In the ER, TVA estimated the dose to the population within 80 km (50 mi) of the BFN site to be approximately 0.0164 person-Sv (1.64 person-rem) per year for Unit 2, and approximately 0.0195 person-Sv (1.95 person-rem) per year for Unit 3. The breakdown of the total population

Table G-2. Breakdown of Population Dose by Containment Release Mode for BFN

	Unit 2		Unit 3	
Containment Release Mode	**Population Dose (Person-Rem[1] Per Year)**	**% Contribution**	**Population Dose (Person-Rem[1] Per Year)**	**% Contribution**
Early containment failure or Containment isolation failure	0.636	39	0.706	36
Bypass	0.009	<1	0.009	<1
Late containment failure	0.111	7	0.156	8
No containment failure[2]	0.882	54	1.072	55
Total Population Dose	**1.64**	**100**	**1.95**	**100**

[1] One person-Rem = 0.01 person-Sv

[2] Release mode is dominated by KPDSs that are assigned to release categories in which containment is assumed to fail.

dose by containment release mode is summarized in Table G-2. The apparent conclusion that population does is dominated by events involving no containment failure is due to the aforementioned assumption. Except for this, early containment failure resulting from ATWS events dominates the population dose risk.
The above CDF and population dose risk for BFN Units 2 and 3 are based on the assumption that Unit 1 is in extended lay-up and not operating. The proposed operation of Unit 1 would increase the CDF and risk for Units 2 and 3 due to the decreased availability of equipment shared between units, including diesel generators, the residual heat removal (RHR) service water system, and the emergency cooling water system. The estimation of the CDF for Unit 1, and the impact of Unit 1 operation on the CDF for Units 2 and 3 are accounted for in the SAMA analysis by applying a multiplier to the estimated SAMA benefits for Units 2 and 3. This is discussed further in Section G.6.

G.2.2 Review of TVA's Risk Estimates

TVA's determination of offsite risk at BFN is based on the following major elements:

- the Level 1 and 2 risk models that form the bases for the 1992 IPE submittal for Unit 2 (TVA 1992)

- the major modifications to the IPE models that have been incorporated in the BFN Unit 2 and Unit 3 PSAs, and

- the MACCS2 analyses performed to translate fission product source terms and release frequencies from the Level 2 PSA models into offsite consequence measures.

Each of these elements was reviewed to determine the acceptability of TVA's risk estimates for the SAMA analysis, as summarized below.

The staff's review of the BFN Unit 2 IPE is described in an NRC report dated September 28, 1994 (NRC 1994). In that review, the staff evaluated the methodology, models, data, and assumptions used to estimate the CDF and characterize containment performance and fission product releases. The staff concluded that TVA's analysis met the intent of Generic Letter 88-20 (NRC 1988a), with the exception of TVA's response to two parts of the containment improvement program recommendations. Although the staff reviewed certain aspects of the IPE in more detail than others, it primarily focused on the licensee's ability to examine BFN Unit 2 for severe accident vulnerabilities and not specifically on the detailed findings or quantification estimates. Overall, the staff believed that TVA demonstrated an overall appreciation of severe accidents and had an understanding of the most likely severe accident sequences that could occur at the BFN Unit 2 facility.

There have been several revisions to the BFN PSA since the IPE was submitted. A comparison of internal events risk profiles between the IPE and the PSA used in the SAMA analysis indicates a decrease of almost 95 percent in the total CDF for Unit 2 (from 4.8×10^{-5} per year to 2.6×10^{-6} per year). The reduction is attributed to plant and modeling improvements that have been implemented at BFN since the IPE was submitted. A summary listing of those changes that resulted in the greatest impact on the total CDF was provided in the ER and in response to RAIs (TVA 2003, 2004a, 2004b), and are provided in Table G-3. As noted in this table, model changes to address the two CPI issues identified in the staff's SER for the IPE were also incorporated in the updated PRA.

At the time the SAMA analysis was performed, TVA did not have a completed PSA model for Unit 1. TVA completed the PSA model for Unit 1 in August 2004, and subsequently provided a summary report to the staff describing the Unit 1 PSA results (TVA 2004b). The initial conditions of the Unit 1 PSA model are with Unit 1 operating at EPU power with Units 2 and 3 in service at EPU operating conditions. The CDF for Unit 1 is 1.86×10^{-6} per year. This compares to the CDF ascribed to Unit 1 in the SAMA analysis of approximately 1×10^{-5} per year. The breakdown of the Unit 1 CDF by initiating event is similar to that shown in Table G-1 for Units 2 and 3.

The results of the recently completed Unit 1 PSA suggest that the use of the multipliers to estimate the impacts of multiple-unit operation in the SAMA analysis is conservative. These results indicate than either multiple-unit operation reduces the CDF for Units 1 and 2 (rather than increase it, as assumed in the SAMA analysis), or that the CDF for Unit 1 is noticeably lower than that for Unit 2. The staff has not reviewed the details of the Unit 1 PSA, and cannot validate the stated values. However, even if the Unit 1 CDF is substantially greater than the value estimated in the Unit 1 PSA, it would likely be bounded by the benefits assumed in the SAMA analysis (which were based on applying a multiplier of four to the benefit estimates for Unit 2 CDF, as discussed in Section G.6).

Table G-3. Level 1 PSA Summary

Level 1 PSA Version	Unit Operating Status	Summary of Changes from Prior Version	Mean CDF (per year)
Unit 2 IPE Rev. 0 1992 (TVA 1992)	Unit 2 operating, Units 1 and 3 in lay-up	original IPE submittal, addressed only single unit operation	$4.8x10^{-5}$ (Unit 2)
Unit 2 IPE Rev. 1A 1994	Unit 2 operating, Units 1 and 3 in lay-up	- used plant-specific diesel generator failure rates - credited powering of the Unit 2 4 KV shutdown boards - used the electric power recovery curves from NUREG/CR-5032 (NRC 1988b)	$7.6x10^{-6}$ (Unit 2)
Multiple-Unit PSA 1995 (TVA 1995b)	All units operating	- modeled multiple-unit initiators, e.g., loss of offsite power - changed success criteria for shared systems, e.g., residual heat removal service water - addressed and closed out the two containment performance improvement program (CPI) open items from the Unit 2 IPE SER	$2.8x10^{-5}$ (Unit 2)
Unit 2 PSA with Unit 3 operating May 1996 (NRC 1997c)	Units 2 and 3 operating, Unit 1 in lay-up	- refined the model for floods in the turbine building	$5.4x10^{-6}$ (Unit 2)
Unit 3 PSA with Unit 2 operating June 1996 (NRC 1997c)	Units 2 and 3 operating, Unit 1 in lay-up	responded to staff request for a Unit 3 PSA	$9.2x10^{-6}$ (Unit 3)
PSA Rev. 0 2002	Units 2 and 3 operating, Unit 1 in lay-up	- used revised transient initiating event frequencies from NUREG/CR-5750 (NRC 1999) - used updated plant-specific component failure rates, and - used revised common cause failure parameters - reevaluated human error probability - resolved BWROG certification facts and observations	$1.3x10^{-6}$ (Unit 2) $1.9x10^{-6}$ (Unit 3)

Table G3. (Contd)

Level 1 PSA Version	Unit Operating Status	Summary of Cha (Contd) nges from Prior Version	Mean CDF (per year)
EPU PSA 2004 (TVA 2004b)	Units 2 and 3 operating at uprated (120 percent) conditions , Unit 1 in lay-up	- eliminated credit for the control rod drive (CRD) system alone as makeup to the reactor pressure vessel at high pressure	2.6×10^{-6} (Unit 2) 3.4×10^{-6} (Unit 3)
PSA Rev. 2 August 2004 (TVA 2004b)	Unit 1 at uprated (120 percent) conditions, with Units 2 and 3 in service at uprated conditions	- incorporated all applicable design changes planned for implementation up to Unit 1 restart	1.86×10^{-6} (Unit 1)

The CDF value for BFN is comparable to the CDF values reported in the IPEs for other boiling water reactor (BWR) plants. Figure 11.2 of NUREG-1560 shows that the IPE-based total internal events CDF for BWR 3/4 plants ranges from 1×10^{-6} to 8×10^{-5} per year (NRC 1997a). It is recognized that other plants have reduced the values for CDF subsequent to the IPE submittals due to modeling and hardware changes. The current internal events CDF results for BFN remain comparable to other plants of similar vintage and characteristics.

The staff considered the peer reviews performed for the BFN PSA, and the potential impact of the review findings on the SAMA evaluation. In 1997, the Unit 2 PSA (with Unit 3 operating) was reviewed by the Boiling Water Reactor Owners Group (BWROG) Peer Review Team. The results of the review are summarized in response to an RAI (TVA 2004a). The following areas were deemed sufficiently important to require enhancement in the model:

- use of plant-specific data for system unavailabilities
- incorporation of common cause miscalibration of low pressure interlock
- additional containment features (e.g., external ring header) and loading issues (e.g., high blowdown)
- reassessment of the truncation value used quantification process
- incorporation of containment flood and reactor pressure vessel vent into the Level 2, along with a definition of LERF consistent with the PSA Application Guide.

According to TVA, the areas noted above have all been resolved in the PSA model used for the SAMA analysis (TVA 2004a).

Improvements were needed in three additional PSA elements. These elements were in the areas of thermal hydraulic analysis, data analysis, and containment performance analysis. The Peer Review Team recommended that five specific model enhancements be implemented to address these three elements. A subsequent self assessment by TVA concluded that the facts and observations associated with the three elements have been resolved.

Given that the BFN PSA has been peer reviewed and the recommended enhancements to resolve known issues have been incorporated, that TVA satisfactorily addressed staff questions regarding the PSA (TVA 2004a and 2004b), that PSA reflects the current units designs and the planned EPU condition, and that the CDF is in the range of contemporary CDFs for similar BWR plants, the staff concludes that the Level 1 PSA model is of sufficient quality to represent the risk from the plant given the operational configuration assumed for the PSAs, that is, Units 2 and 3 operating and Unit 1 in a defueled lay-up condition.

TVA submitted an IPEEE by letters dated July 24, 1995 (TVA 1995a), June 28, 1996 (TVA 1996) and July 11, 1997 (TVA 1997). TVA did not identify any fundamental weaknesses or vulnerabilities to severe accident risk in regard to the external events related to fire, high winds, floods, and other external events. However, a number of areas were identified for improvement in both the seismic and fire areas. In a letter dated June 22, 2000 (NRC 2000), the staff concluded that the submittal met the intent of Supplement 4 to Generic Letter 88-20, and that the licensee's IPEEE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities.

The IPEEE uses a focused scope EPRI seismic margins analysis. This method is qualitative and does not provide numerical estimates of the CDF contributions from seismic initiators. TVA found that, based on the EPRI assessment methodology, all of the plant's high confidence low probability of failure (HCLPF) values were at least equal to the 0.3g review level earthquake used in the IPEEE except for two 4kV/480V transformers located in the Units 1 and 2 diesel generator building. These transformers were to be replaced as part of TVA's long-term polychlorinated biphenyls and asbestos removal program. In response to an RAI, TVA indicated that these transformers are still scheduled to be removed. Specific HCLPF values for other structures or components are not provided in the IPEEE; however, TVA stated that there are no other structures or components with HCLPF values less than the review level earthquake acceleration of 0.3g.

In a subsequent submittal by TVA for another risk-informed application (TVA 2004c), TVA used a published simplified methodology to estimate the seismic CDF as 2.5 x10^{-6} per year. This is based on the assumption that the plant HCLPF is equal to that for the two transformers mentioned above (0.26g).

The staff has considered the impact of seismic events on the SAMA analysis from two aspects. First, would any seismic-specific SAMA be expected to be cost-beneficial and second, would the benefit of non-seismic SAMAs be increased significantly due to their impact on seismic sequences. For the first situation, using the simplified methodology used by TVA (TVA 2004c), an increase in plant HCLPF value from 0.3g (assuming the previously limiting transformers have been removed) to 0.35g reduces the seismic CDF by approximately 0.7 $\times 10^{-6}$ per year or approximately 30 percent of the Unit 2 CDF due to internal events. From information provided in the ER (Table IV-8) this would correspond to an averted cost benefit in the range of $20,000 to $80,000, depending on the discount rate used. Increases in the seismic capacity of the plant would involve modifications and reanalysis of multiple components since it is expected that there are numerous components whose current HCLPF values are in the 0.3g to 0.35g range. The costs associated with the modifications and analyses would be well in excess of the estimated benefits, even when the impacts of alternative seismic hazard curves (i.e., the LLNL curves rather than the EPRI curves), multiple-unit operation, and analysis uncertainties are considered. Based on this, the staff concludes that it is unlikely that any cost effective seismic SAMAs would be found.

For the second situation, the additional benefit of internal event SAMAs due to their impact on seismic-initiated sequences are most likely realized in relatively low-g seismic events that are of sufficient magnitude to result in either non-recoverable loss of offsite power (LOOP) events or other more ordinary transient events similar to those evaluated in the internal events PSA. Plant trips due to seismic events might start to occur in the peak ground acceleration range of 0.15g to 0.2g (BFN has an operating basis earthquake of 0.1g.). The exceedance frequency for these magnitude earthquakes is approximately 5 $\times 10^{-5}$ per year. For a seismic LOOP event, the CDF can be estimated using this frequency and the conditional core damage probability for a non-recoverable station blackout. This is estimated to be on the order of 1 $\times 10^{-3}$, giving a CDF or 5 $\times 10^{-8}$ per year. This is small compared to the internal events CDFs for BFN of 3 $\times 10^{-6}$ per year. While the seismic SBO CDF estimated above is the same order of magnitude as the internal events SBO CDF, the frequencies are so low that a cost-beneficial SBO related SAMA would not be expected. (This conclusion is supported by the analysis of SAMA B04, "add dedicated blackout diesel generator," which indicates that this would not be cost effective even if the benefit is doubled due to the benefit from seismic events. For non-SBO sequences, the seismic transient initiating event frequency estimated above of 5 $\times 10^{-5}$ per year is several orders of magnitude lower than the internal initiating event frequencies, therefore, the added benefit due to seismic sequences for the non-SBO SAMA is expected to be small.

Based on the above assessment, the staff concludes that the opportunity for seismic-related SAMAs has been adequately explored and that there are no cost-beneficial, seismic-related SAMA candidates.

The BFN fire analysis employed the Fire Induced Vulnerability Evaluation (FIVE) methodology for screening of compartments. The licensee's overall approach in the IPEEE fire analysis is similar to other fire analysis techniques, employing a graduated focus on the most important fire zones using qualitative and quantitative screening criteria. The fire zones or compartments were subjected to at least two screening phases. In the first phase, a compartment was screened out if it was found to not contain any safety-related equipment or reactor trip initiators.

In the second phase, a CDF criterion of $1x10^{-6}$ per year was applied. The licensee used the PSA model (IPE Rev. 1 August 1994) of internal events to quantify the CDF resulting from a fire initiating event. The conditional core damage probability (CCDP) was based on the equipment and systems unaffected by the fire. The CDF for each zone was obtained by multiplying the frequency of a fire in a given fire zone by the conditional core damage probability associated with that fire zone. The screening methodology applied by the licensee makes less and less conservative assumptions (e.g., equipment that may survive the fires in the area) until a fire zone is screened out. The fire CDF (based on a summation of the fire zone CDFs) was estimated in the staff's SER to be less than $1.24x10^{-5}$ per year for Unit 2, and $7.5x10^{-6}$ per year for Unit 3, which are about factors of five and two higher than the internal events CDF used in the SAMA analysis, respectively. The zones that contributed more than $1x10^{-6}$ per year are listed below.

Fire Zone	CDF
Unit 2:	
2-5 621' and North 639'	$1.1x10^{-6}$
Control room, Unit 1 & 2	$5.6x10^{-6}$
Unit 3:	
Control room	$3.0x10^{-6}$

In light of these values, the staff asked TVA to assess the impact on the initial and final screenings if the internal events risk reduction estimates were increased by a factor that would bound the risk from fire and seismic events (NRC 2004). In response to the RAI, TVA stated that such an assessment is inappropriate since it contains an implicit assumption that the systems, structures and components (SSCs) important to the risk from internal events have equivalent importance to the risk from fire and seismic events (TVA 2004a). Additionally, TVA stated that the CDF values in NUREG-1742 (used by the staff to estimate the ratio of external to internal events risk) should be considered as upper bound values only, and that the mean CDF due to fire-related initiating events in each of the fire areas is judged to be considerably lower than these values (TVA 2004a).

The staff agrees that the BFN fire analysis contains numerous conservatisms and that a more realistic assessment could result in a substantially lower fire CDF. Based on evaluations of past ERs submitted in support of license renewal applications, the staff believes that a more realistic fire CDF is likely a factor of two to three less than the screening values used in the FIVE methodology. Given a factor of three reduction, the resulting fire CDF would be comparable to the internal events CDF used in the SAMA analysis. This would justify use of a multiplier of two to the averted cost estimates (for internal events) to represent the additional SAMA benefits in external events. The staff's review is described in Section G.6.2.

The BFN IPEEE evaluated high winds, floods and other events using the progressive screening approach recommended in NUREG-1407 (NRC 1991). Based on this evaluation, the licensee determined that the risk from high winds, floods and other events (transportation and nearby facility accidents) were not significant vulnerabilities at the plant.

The staff reviewed the process used by TVA to extend the containment performance (Level 2) portion of the PSA to an assessment of offsite consequences (essentially a Level 3 PSA). This included consideration of the source terms used to characterize fission product releases for the applicable containment release category and the major input assumptions used in the offsite consequence analyses. The MACCS2 code was utilized to estimate offsite consequences. Plant-specific input to the code includes the BFN reactor core radionuclide inventory, source terms for each release category, site-specific meteorological data, projected population distribution within a 80 km (50 mile) radius for the year 2036, and emergency evacuation modeling. This information is provided in Attachment E to the ER (TVA 2003).

The reactor core inventory input to the MACCS2 code was developed for an average bundle thermal power level of 5.28 MW(t)h, which is representative of EPU conditions. Three fission product inventories were utilized–GE Uprated, Framatome Commercial, and Framatome Blended LEU. The fission product inventory for each radionuclide group is provided in Table II-3 of Attachment E to the ER (TVA 2003).

TVA grouped the key plant damage states into a set of eight release categories based on their expected source term results. The release fractions for each of the release categories are reported in Table II-4 of Attachment E to the ER (TVA 2003). The staff concludes that the process used to assign release categories and source terms is consistent with typical PSA practices and acceptable for use in the SAMA analysis.

TVA used site-specific meteorological data obtained from the plant meteorological tower, processed from hourly measurements for the calendar year 1980. In response to an RAI, TVA stated that the 1980 data is representative, and the year 1980 was slightly wetter than average. TVA further stated that use of more recent data would not yield a more accurate prediction of weather for the term of license renewal (TVA 2004a).

The population distribution the applicant used as input to the MACCS2 analysis is given in Tables II–1 and II-2 of Attachment E to the ER (TVA 2003). The population distribution is based on the U. S. Census Bureau data from 1990 and 2000. The data were linearly extrapolated to 2036. Sectors with a negative growth rate were estimated to have the same population as in the year 2000 (TVA 2004b). The staff considers the methods and assumptions for estimating population reasonable and acceptable for purposes of the SAMA evaluation.

The emergency evacuation model was modeled as a single evacuation zone extending out 16 km (10 mi) from the plant. It was assumed that 95 percent of the population evacuates radially at an average speed of 0.234 meters/second 120 minutes after the alarm (TVA 2004a). This assumption is conservative relative to the NUREG-1150 study (NRC 1990), which assumed evacuation of 99.5 percent of the population within the emergency planning zone.

Economic data were specified for the area surrounding the plant, to a distance of 50 miles. The agricultural economic data were obtained from Statistical Abstracts of the United States, 1998 (TVA 2004b). The values obtained from the reference document were inflated to the year 2016 using both seven-percent and three-percent discount factors.

The staff concludes that the methodology used by TVA to estimate the offsite consequences for BFN provides an acceptable basis from which to proceed with an assessment of risk reduction potential for candidate SAMAs. Accordingly, the staff based its assessment of offsite risk on the CDF and offsite doses reported by TVA.

G.3 Potential Plant Improvements

The process for identifying potential plant improvements, an evaluation of that process, and the improvements evaluated in detail by TVA are discussed in this section.

G.3.1 Process for Identifying Potential Plant Improvements

TVA's process for identifying potential plant improvements (SAMAs) consisted of the following elements:

- review of the major contributors to CDF and LERF for Units 2 and 3 in the current for BFN PSA,

- review of other NRC and industry documentation discussing potential plant improvements, e.g., NUREG-1560, and

- review of generic SAMAs from past submittals in support of original licensing and license renewal activities for other operating nuclear power plants.

Based on this process, an initial set of 135 candidate SAMAs was identified, as reported in the ER. Of these, 20 are specific to BFN, and 115 are generic SAMAs from past submittals. All BFN-specific SAMAs were assumed to pass the Phase 1 screening and were explicitly evaluated in Phase 2. For the 115 generic SAMAs, TVA performed a qualitative screening and eliminated SAMAs from further consideration using the following criteria:

- the SAMA is not applicable at BFN or for a BWR 4/Mark I design due to design differences,

- the SAMA had already been implemented at BFN

- the SAMA is similar in nature to and could be combined with another SAMA, or

- the SAMA costs more than $6M to implement (the maximum avoided cost for completely eliminating severe accidents, including the effects of multiple-unit operation and uncertainties).

Based on this screening, 92 SAMAs were eliminated. Of the 92 SAMAs eliminated, 45 were eliminated because they were not applicable to BFN, 19 were eliminated because they already had been implemented at BFN, 15 were similar to and combined with other SAMAs, and 11 exceeded $6M in cost, and two were eliminated for other reasons (TVA 2003). A benefit analysis was performed for each of the 43 remaining SAMA candidates.

The 43 remaining SAMAs were further evaluated and subsequently eliminated in the final screening, as described in Sections G.4 and G.6.1 below.

G.3.2 Review of TVA's Process

TVA's efforts to identify potential SAMAs focused primarily on areas associated with internal initiating events. The initial list of SAMAs generally addressed the accident categories that are dominant CDF and LERF contributors at BFN.

The preliminary review of BFN's SAMA identification process raised some concerns regarding the completeness of the set of SAMAs identified and the inclusion of plant-specific risk contributors. The staff requested clarification regarding the portion of risk represented by the dominant risk contributors. Because a review of the importance ranking of basic events in the PSA could identify SAMAs that may not be apparent from a review of the top cut sets, the staff also questioned whether an importance analysis was used to confirm the adequacy of the SAMA identification process. In response to the RAI, TVA stated that the reviews of the importance rankings and a review of the highest frequency CDF and LERF sequences from the Unit 2 and Unit 3 PSA models were utilized to identify groups of sequences contributing to CDF and LERF. TVA provided tables that cross referenced the ten CDF and LERF significant groups with important human actions and systems (TVA 2004a). TVA also provided a cross reference of the significant groups to the SAMAs evaluated in the ER. TVA explained that if an appropriate generic SAMA did not address the plant-specific risk contributor, a BFN-specific SAMA was developed (TVA 2004a).

While TVA did identify BFN-specific candidate SAMAs for fire (B16), earthquakes (B17) and high winds, floods, transportation and other extreme external events (B19), none were quantitatively evaluated due to the findings of the IPEEE that no vulnerabilities existed and/or that all outliers had been satisfactorily resolved as part of the IPEEE or related programs. Even though no BFN-specific external events SAMAs were quantitatively evaluated, candidate SAMAs selected because of their potential risk reduction on the risk from internal events will, in most cases, also reduce the risk due to external event initiators. The use of a multiplier of two to the benefits estimated for the internal events for these SAMAs in part addresses the lack of BFN-specific SAMAs for external events.

The staff notes that the set of SAMAs submitted is not all inclusive, since additional, possibly even less expensive, design alternatives can always be postulated. However, the staff concludes that the benefits of any additional modifications are unlikely to exceed the benefits of the modifications evaluated and that the alternative improvements would not likely cost less than the least expensive alternatives evaluated, when the subsidiary costs associated with maintenance, procedures, and training are considered.

The staff concludes that TVA used a systematic and comprehensive process for identifying potential plant improvements for BFN, and that the set of potential plant improvements identified by TVA is reasonably comprehensive and therefore acceptable. This search included reviewing insights from the IPE and IPEEE and other plant-specific studies, reviewing plant improvements considered in previous SAMA analyses, and using the knowledge and experience of its personnel. While explicit treatment of external events in the SAMA identification process was limited, it is recognized that the absence of external event vulnerabilities reasonably justifies examining primarily the internal events risk results for this purpose.

G.4 Risk Reduction Potential of Plant Improvements

TVA evaluated the risk-reduction potential of the 43 SAMAs that were applicable to BFN. Many of the SAMA evaluations were performed in a bounding fashion in that the SAMA was assumed to completely eliminate the risk associated with the proposed enhancement. Such bounding calculations overestimate the benefit and are conservative.

For a majority of the Phase 2 SAMAs, new PSA models that incorporate individual SAMAs were developed and quantified. For several of the SAMAs, information from the PSA (e.g., system importance measures) was used to estimate their potential benefit. The CDF and population dose reductions were estimated using the EPU PSAs for Units 2 and 3. The new models or changes made to models to quantify the impact of SAMAs are detailed in Section VI of Attachment E to the ER (TVA 2003) and in response to an RAI (TVA 2004a). Table G-4 lists the assumptions considered to estimate the risk reduction for each of the 43 Phase 2 SAMAs, the estimated risk reduction in terms of percent reduction in CDF and population dose, and the estimated total benefit (present value) of the averted risk. The determination of the benefits for the various SAMAs is further discussed in Section G.6.

The staff has reviewed TVA's bases for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the staff based its estimates of averted risk for the various SAMAs on TVA's risk reduction estimates reported in the ER, but applied a multiplier to the associated benefits to account for benefits in external events as discussed in Section G.6.2.

G.5 Cost Impacts of Candidate Plant Improvements

TVA estimated the costs of implementing the 43 candidate SAMAs through the application of engineering judgment and review of prior BFN completed capital projects for similar improvements. The cost estimates provided in the ER accounted for inflation (three percent per year) to arrive at year 2016 estimated costs (TVA 2003).

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

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

Table G-4. SAMA Cost/Benefit Screening Analysis

Phase 2 SAMA	Assumptions	% Risk Reduction (Unit 2) / (Unit 3)		Total Baseline Benefit ($)[1]	Estimated Cost[2] ($)
		CDF	Population Dose		
B01 Improve reliability of automatic depressurization system (ADS)	The failure probability of top event "operator depressurizes the reactor vessel" was set to 0	58 / 45	34 / 24	1,481,000	4,500,000
B02 Improve reliability of high pressure coolant injection (HPCI) and reactor core isolation cooling (RCIC) by adding redundant train	The failure probability of top events "start and short-term operation of HPCI and RCIC" were set to 0	57 / 50	32 / 31	1,489,000	21,900,000
B03 Improve reliability of safety relief valves (SRVs) by replacing valves with more reliable design	The failure probability of top event "hardware unavailability of SRVs" was set to 0	<1 / <1	0 / 0	6,600	21,900,000
B04 Add dedicated blackout diesel generator	The failure probability of top event "diesel B or 3EB" was set to 0	12 / 24	7 / 17	406,000	8,800,000
B05 Improve procedures and training to control pressure during ATWS	The failure probability of top event "operator depressurizes vessel" was set to 0	1 / 1	0 / <1	16,000	146,000[3]
B06 Automate standby liquid control (SLC) initiation to mitigate failure of SLC due to operator error during ATWS conditions	The failure probability of top event "operator initiates SLC injection" was set to 0	3 / 3	31 / 26	611,000	1,870,000
B07 Improve reliability of SLC by adding redundant train	The failure probability of top event "hardware unavailability of SLC injection" was set to 0	1 / 1	6 / 6	129,000	4,500,000

Table G-4. (Contd)

Phase 2 SAMA	Assumptions	% Risk Reduction (Unit 2) / (Unit 3)		Total Baseline Benefit ($)[1]	Estimated Cost[2] ($)
		CDF	Population Dose		
B08A Decrease frequency of ISLOCA through major hardware modifications to prevent overpressurization	The ISLOCA initiating event frequency was set to 0	2 / 1	<1 / <1	39,000	21,900,000
B08B Decrease frequency of ISLOCA through improved procedures and training or minor hardware modifications	ISLOCA frequency is reduced by 50 percent	1 / 1	0 / <1	20,000	146,000[3]
B09 Improve suppression pool cooling reliability for transients by adding redundant train or additional cross-tie capability	The failure probability of top events "heat exchangers A and B, RHR pumps A and B, and the alignment to suppression pool cooling" were set to 0	12 / 17	7 / 12	363,000	21,900,000
B10 Automate torus cooling on high torus temperature to avoid lack of torus cooling due to operator error	The failure probability of top event "operator initiates torus cooling" was set to 0	5 / 5	3 / 3	143,000	1,870,000
B11 Improve direct current (DC) reliability through increase/improved procedures to load shed	The failure probability of top events "battery boards 1, 2, and 3" were set to 0	2 / 1	1 / 1	54,000 [11,000][4]	146,000[3]
B12 Improve level control through improved procedures and training	The failure probability of top event "operator controls low pressure injection" was set to 0	<1 / <1	1 / 2	36,000	146,000[3]
B13 Improve suppression pool cooling by adding redundant train	The failure probability of top events "heat exchangers A, B, C, and D, RHR pumps A, B, C, and D; operator initiates suppression pool cooling mode; and switch to suppression pool cooling mode" were set to 0	3 / 2	1 / 1	67,000	8,800,000

Table G-4. (Contd)

Phase 2 SAMA	Assumptions	% Risk Reduction (Unit 2) / (Unit 3)		Total Baseline Benefit ($)[1]	Estimated Cost[2] ($)
		CDF	Population Dose		
B14 Reduce frequency of excessive LOCA by increasing reactor pressure vessel inspection frequency	The "Excessive LOCA" initiating event frequency was set to 0	<1 / <1	2 / 2	40,000	465,000
B15 Add motor-driven startup feedwater pump	A new top event, "startup feedwater pump" was inserted in the event model.. The unavailability of the startup feedwater pump if offsite power is available was set to $4.2x10^{-3}$	50 / 35	29 / 22	1,254,000	21,900,000
B16 Mitigate fire risk by adding new fire barriers, new cable routing, and training and procedures	No quantitative assessment was performed.	not assessed	not assessed	not assessed	>21,900,000
B17 Mitigate earthquake effects by strengthening structures and equipment	No quantitative assessment was performed.	not assessed	not assessed	not assessed	>21,900,000
B18 Implement internal flood prevention and mitigation enhancements	The frequency of all internal flood initiators were set to 0	4 / 5	2 / 4	118,000	>21,900,000
B19 Mitigate effects of high winds, floods, transportation, and other external events	No quantitative assessment was performed.	not assessed	not assessed	not assessed	not estimated
G01 Increase control rod drive (CRD) pump lube oil capacity	No quantitative assessment was performed.	not assessed	not assessed	not assessed	not estimated

Table G-4. (Contd)

Phase 2 SAMA	Assumptions	% Risk Reduction (Unit 2) / (Unit 3)		Total Baseline Benefit ($)[1]	Estimated Cost[2] ($)
		CDF	Population Dose		
G02 Replace emergency core cooling system (ECCS) pump motor with air-cooled motors	The dependency on all RHR and core spray pumps on emergency equipment cooling water (EECW) was eliminated. All split fractions associated with RHR pumps and core spray system were reduced by 20 percent	8 / 9	4 / 6	217,000	26,400,000
G03 Implement procedures to stagger CRD pump use after a loss of service water (SW)	No quantitative assessment was performed.[5]	not assessed	not assessed	not assessed	146,000[3]
G04 Develop/enhance procedural guidance for use of cross-tied component cooling or SW pumps	Actions necessary to align the swing pumps for EECW service are assumed to occur with a probability of 1. Reactor building closed cooling water (RBCCW) is assumed to be successful if raw cooling water (RCW) is available. The frequency of the initiator loss of RBCCW is set to 0.	2 / 2	2 / 2	74,000	146,000[3] [377,000][4]
G05 Enhance procedures and operator training in support system failure sequences, with emphasis on anticipating problems and coping	Each of the split fractions associated with recovery of key support systems were assumed to improve by a factor of 3	<1 / <1	0 / 0	900	146,000[3]
G06 Improve ability to cool the residual heat removal (RHR) heat exchangers	The failure fraction for top events SW2A, SW2C, SW2B, and SW2D were set to 0	<1 / 5	0 / 3	26,000	4,500,000
G07 Provide a redundant train of ventilation	The redundant train of ventilation has an availability of 1.0 and is independent of any support system such as electric power	2 / 9	2 / 2	71,000	26,400,000

Table G-4. (Contd)

Phase 2 SAMA	Assumptions	% Risk Reduction (Unit 2) / (Unit 3)		Total Baseline Benefit ($)[1]	Estimated Cost[2] ($)
		CDF	Population Dose		
G08 Improve diagnosis of loss of switchgear room HVAC a) install high temperature alarm b) install redundant louver and thermostat	Top events related to diesel support recovery were set to guaranteed success	<1 / <1	0 / 0	300	a) 587,000/bldg b) 8,800,000/bldg
G09 Install a containment vent large enough to remove ATWS decay heat	The relevant logic macro (AHEAT) was modified to reflect the vent as a potential success path	3 / 2	2 / 3	97,000	8,700,000
G10 Use fire protection system as a back-up source for the drywell spray system	The top event representing the containment spray function was set to success	<1 / <1	<1 / 3	14,000	2,200,000
G11 Install a passive containment spray system	The top event representing the containment spray function was set to success	<1 / <1	<1 / 3	14,000	26,400,000
G12a Provide additional DC battery capacity	Any sequence involving successful scram, no stuck open SRVs, and successful operation and control of either HPCI or RCIC was considered to be successfully mitigated	18 / 29	10 / 21	564,000 [61,000][4]	4,500,000
G12b Use fuel cells instead of lead acid batteries		18 / 29	10 / 21	564,000 [61,000][4]	26,400,000
G12c Add redundant DC control power for SW pumps		18 / 29	10 / 21	564,000 [61,000][4]	1,500,000
G13a Incorporate an alternate battery charging capability	Improve the unavailability of each of the three station batteries by a factor of 10	2 / 1	1 / 1	52,000	4,500,000
G13b Replace existing batteries with more reliable ones		2 / 1	1 / 1	52,000	26,400,000

Table G-4. (Contd)

Phase 2 SAMA	Assumptions	% Risk Reduction (Unit 2) / (Unit 3)		Total Baseline Benefit ($)[1]	Estimated Cost[2] ($)
		CDF	Population Dose		
G14 Develop procedures to repair or replace failed 4kV breakers	The transfer of power at the unit board level was assumed to occur without fault	<1 / <1	0 / 0	0	146,000[3]
G15 Use fire protection system (FPS) as a back-up source for diesel cooling	The FPS has sufficient capacity to service all 8 diesel generators. The FPS is aligned for diesel cooling in a timely manner. The FPS unavailability is set to 0.	8 / 9	4 / 6	217,000	1,500,000
G16 Improve inspection of rubber expansion joints on main condenser	The initiating event flooding frequencies were reduced from the base case by 25 percent. The new flooding frequencies for small and large turbine building floods became $1.15x10^{-2}$ and $1.76x10^{-3}$, respectively	<1 / <1	<1 / <1	21,000	440,000
G17 Develop procedure to instruct operators to trip unneeded RHR/core spray pumps on loss of room ventilation	All requirements for area cooling were removed for the top events representing RHR and core spray pumps by reducing each corresponding split fraction by 20 percent	2 / 2	2 / 2	71,000	146,000[3] [476,000][4]
G18 Increase the SRV reseat reliability	Any valves that lift will successfully reseat	<1 / 1	<1 / 2	30,000	3,100,000
G19 Reduce DC dependency between high pressure injection system and automatic depressurization system	DC dependency for HPCI was completely removed	<1 / 1	0 / <1	10,000	1,870,000

Table G-4. (Contd)

Phase 2 SAMA	Assumptions	% Risk Reduction (Unit 2) / (Unit 3)		Total Baseline Benefit ($)[1]	Estimated Cost[2] ($)
		CDF	Population Dose		
G20 Use CRD for alternate boron injection	Actions by the operator are necessary to initiate boron injection. Any additional operator actions associated with initiating the CRD are represented by a top event. Any additional failure modes of the CRD system over that analyzed in the base case were not significant contributors to CRD system unavailability in its postulated function of delivering boron solution to the reactor.	<1 / <1	5 / 5	105,000	8,700,000

[1] Values are based on TVA averted cost estimates (using seven-percent discount rate) reported in the ER. The values include multipliers to the estimated benefits for Units 2 and 3 to account for multiple-unit operation. The values also include a multiplier of two to account for additional risk reduction benefits in external events.
[2] Estimated costs are given in 2016 dollars, and are stated for site-wide implementation unless otherwise noted.
[3] Costs for a procedure and training were estimated to be $73,000/unit (year 2016). However, due to similarities between units and shared systems, this cost was doubled to obtain a site-wide implementation cost.
[4] The information within brackets indicates revised values were provided by the licensee in response to an RAI (TVA 2004b).
[5] This SAMA would provide little benefit since the CRD system is a backup for high pressure injection, and it does not rely on SW.

G.6 Cost-Benefit Comparison

TVA's cost-benefit analysis and the staff's review are described in the following sections.

5.1.1 G.6.1 TVA Evaluation

The methodology used by TVA was based primarily on NRC's guidance for performing cost-benefit analysis, i.e., NUREG/BR-0184, *Regulatory Analysis Technical Evaluation Handbook* (NRC 1997b). The guidance involves determining the net value for each SAMA according to the following formula:

Net Value = (APE + AOC + AOE + AOSC) - COE

where,

APE = present value of averted public exposure ($)
AOC = present value of averted offsite property damage costs ($)
AOE = present value of averted occupational exposure costs ($)
AOSC = present value of averted onsite costs ($)
COE = cost of enhancement ($).

If the net value of a SAMA is negative, the cost of implementing the SAMA is larger than the benefit associated with the SAMA and it is not considered cost-beneficial. TVA's derivation of each of the associated costs is summarized below. For the purposes of the SAMA analysis, TVA considered the "present" to be the year 2016; therefore, all values were recalculated to the year 2016 using a three percent per year inflation rate.

TVA presented the results for both a three-percent and seven-percent real discount rate. For the purposes of the staff's evaluation, the staff relied on the values given by TVA for the seven-percent real discount rate, but also considered the impact on the results of a three-percent discount rate.

<u>Averted Public Exposure (APE) Costs</u>

The APE costs were calculated using the following formula:

APE = Annual reduction in public exposure (Δperson-rem/year)
x monetary equivalent of unit dose ($3,097 per person-rem, based on $2,000 per person-rem inflated at three percent to year 2016 values)
x present value conversion factor (10.76 based on a 20-year period with a seven-percent discount rate).

As stated in NUREG/BR-0184 (NRC 1997b), it is important to note that the monetary value of the public health risk after discounting does not represent the expected reduction in public health risk due to a single accident. Rather, it is the present value of a stream of potential losses extending over the remaining lifetime (in this case, the renewal period) of the facility. Thus, it reflects the expected annual loss due to a single accident, the possibility that such an accident could occur at any time over the renewal period, and the effect of discounting these potential future losses to present value. For the purposes of initial screening, TVA calculated an APE of approximately $54,700 (Unit 2) and $64,900 (Unit 3) for the 20-year license renewal period, which assumes elimination of all severe accidents.

Averted Offsite Property Damage Costs (AOC)

The AOCs were calculated using the following formula:

AOC = Annual CDF reduction
x offsite economic costs associated with a severe accident (on a per-event basis)
x present value conversion factor.

For the purposes of initial screening, which assumes all severe accidents are eliminated, TVA calculated an annual offsite economic risk of about $2,000 (Unit 2) and $2,100 (Unit 3) based on the Level 3 risk analysis. This results in a discounted value of approximately $21,200 (Unit 2) and $23,000 (Unit 3) for the 20-year license renewal period.

Averted Occupational Exposure (AOE) Costs

The AOE costs were calculated using the following formula:

AOE = Annual CDF reduction
x occupational exposure per core damage event
x monetary equivalent of unit dose
x present value conversion factor.

TVA derived the values for averted occupational exposure from information provided in Section 5.7.3 of the regulatory analysis handbook (NRC 1997b). Best estimate values provided for immediate occupational dose (3300 person-rem) and long-term occupational dose (20,000 person-rem over a 10-year cleanup period) were used. The present value of these doses was calculated using the equations provided in the handbook in conjunction with a monetary equivalent of unit dose of $3,097 per person-rem, based on $2,000 per person-rem inflated at three percent to year 2016 values, a real discount rate of seven-percent, and a time period of 20 years to represent the license renewal period. For the purposes of initial screening, which assumes all severe accidents are eliminated, TVA calculated an AOE of approximately $1,500 (Unit 2) and $2,000 (Unit 3) for the 20-year license renewal period.

Averted Onsite Costs (AOSC)

Averted onsite costs (AOSC) include averted cleanup and decontamination costs and averted power replacement costs. Repair and refurbishment costs are considered for recoverable accidents only and not for severe accidents. TVA derived the values for AOSC based on information provided in Section 5.7.6 of the regulatory analysis handbook (NRC 1997b).

TVA divided this cost element into two parts – the Onsite Cleanup and Decontamination Cost, also commonly referred to as averted cleanup and decontamination costs, and the replacement power cost.

Averted cleanup and decontamination costs (ACC) were calculated using the following formula:

ACC = Annual CDF reduction
x present value of cleanup costs per core damage event
x present value conversion factor.

The total cost of cleanup and decontamination subsequent to a severe accident is estimated in the regulatory analysis handbook to be $\$1.7 \times 10^9$, based on $\$1.1 \times 10^9$ inflated at three percent to year 2016 values. This value was converted to present costs over a 10-year cleanup period and integrated over the term of the proposed license extension. For the purposes of initial screening, which assumes all severe accidents are eliminated, TVA calculated an ACC of approximately $48,400 (Unit 2) and $62,000 (Unit 3) for the 20-year license renewal period.

Long-term replacement power costs (RPC) were calculated using the following formula:

RPC = Annual CDF reduction
x present value of replacement power for a single event
x factor to account for remaining service years for which replacement power is required
x reactor power scaling factor

TVA based its calculations on the value of 1190 MW(e), which is the current electrical output for Units 2 and 3. Therefore, TVA applied a power scaling factor of 1190 MW(e)/910 MW(e) to determine the replacement power costs. For the purposes of initial screening, which assumes all severe accidents are eliminated, TVA calculated an RPC of approximately $42,200 (Unit 2) and $54,000 (Unit 3) for the 20-year license renewal period.

In response to an RAI regarding the expected output under EPU conditions, TVA stated that using a scaling factor of 1250 MW(e)/910 MW(e) would result in a five-percent increase in the replacement power costs, and a 1.6 percent (Unit 2) and 1.7 percent (Unit 3) increase in the total avoidance costs.

Using the above equations, the total "present" (i.e., year 2016) dollar value equivalent associated with completely eliminating severe accidents from internal events at Browns Ferry to be about $168,000 (Unit 2) and $206,000 (Unit 3). Considering the effect of multiple-unit operation and uncertainties, TVA conservatively established a value of $6M for the initial screening of SAMAs that are not economically feasible.

TVA's Results

The total benefit associated with each of the 43 SAMAs was evaluated by TVA. These values were determined based on the above equations for the various averted costs together with the estimated annual reductions in CDF and person-rem dose.

The CDF and population dose risk for BFN Units 2 and 3, which are used to calculate the averted costs, are based on the assumption that Unit 1 is in extended lay-up and not operating. The license renewal application presumes that Unit 1 will be returned to operation. The operation of Unit 1 will increase the CDF values calculated in the Unit 2 and Unit 3 PSAs due to the impact of shared equipment including diesel generators, the residual heat removal (RHR) service water system, and the emergency cooling water system. This impact is estimated from the results of the Multiple-Unit PSA performed in 1995 (TVA 1995b). This study indicated that the mean CDF for Unit 2 with all 3 units operating (2.8×10^{-5} per year) is a factor of four greater than in the earlier PSA (Unit 2 IPE Rev. 1A) with only Unit 2 operating (7.6×10^{-6} per year). For the TVA SAMA evaluation, it is assumed that with all 3 units operational, the baseline CDFs and risks for Units 1 and 2 are equal and will be four times greater than the CDF from the Unit 2 EPU PSA. Because Unit 1 is more closely tied to Unit 2 than to Unit 3, it is expected that the impact of Unit 1 operation on the Unit 3 CDF and risk would be smaller than the above impact on Unit 2. Based on this reasoning, the operation of Unit 1 is assumed to result in a factor of two increase in Unit 3 CDF and risk from that indicated by the Unit 3 EPU PSA. Therefore, TVA applied a multiplier of four to the Unit 2 averted cost estimates (benefits), assumed these same benefits for Unit 1, and applied a multiplier of two to the Unit 3 averted cost estimates. As a result, all SAMAs that were evaluated were eliminated because the cost was expected to exceed the estimated benefit, as adjusted to account for multiple-unit operation.

As described below, the staff based its evaluation on TVA's estimated benefits for a seven-percent discount rate, applied the same multipliers as TVA to account for multiple-unit operation, and applied an additional multiplier of two to the averted cost estimates for each SAMA to account for the potential impact of external events. As a result, none of the SAMAs appeared to be potentially cost-beneficial. However, four SAMAs appeared to be within a factor of three of being cost-beneficial (i.e., SAMAs B11, G04, G12, and G17). TVA performed a more detailed assessment of each of these SAMAs to more realistically estimate the risk reduction and/or implementation costs for each SAMA. The revised values are denoted by brackets within Table G-4. Based on this re-assessment, none of the SAMAs is within a factor of three of being cost-beneficial.

G.6.2 Review of TVA's Cost-Benefit Evaluation

The cost-benefit analysis performed by TVA was based primarily on NUREG/BR-0184 (NRC 1997b) and was executed consistent with this guidance. However, TVA considered the "present" to be the year 2016, and therefore, inflated dollar values to the year 2016 using a three percent per year inflation rate. This was done for both implementation costs and SAMA benefits, and is therefore consistent.

The TVA BFN license renewal application is made assuming that Unit 1 is returned to service. As described above, the impact of all units operating is accounted for in the SAMA analysis by increasing the Unit 2 risk from the EPU PSA by a factor of four and the Unit 3 risk by a factor of two. The factor of four is obtained from the ratio of Unit 2 CDF in the Multiple-Unit PSA with all units considered operating (Multiple-Unit PSA - 2.8×10^{-5} per year) to the CDF from the revised Unit 2 IPE, which considered only Unit 2 operating (Unit 2 IPE Rev. 1A - 7.6×10^{-6} per year). The factor of two used to adjust the Unit 3 risk was based on the judgment that the impact of all units operating would be less for Unit 3 than for Unit 2 since Units 1 and 2 share more equipment than Unit 3 shares with Units 1 and 2. The CDF for Unit 1 was assumed to be equal to the adjusted CDF for Unit 2.

The staff notes that the adjustment factors for multiple-unit operation are based on the total CDF. However, the impact of all units operating will vary from sequence to sequence, depending on the failures involved in the sequences. For sequences that involve shared systems (e.g., loss of offsite power) the increase could be larger than the average factors of four (Units 1 and 2) and two (Unit 3), while for other sequences that do not involve significant shared systems, the increase could be smaller.

In response to an RAI (TVA 2004a), TVA assessed the impact of multiple-unit operation on an initiator-specific basis. The impact of multiple-unit operation was found to be greater than the multiplier of four used (for Units 1 and 2) for four initiating events. In three cases the modeling in the Multiple-Unit PSA was found to be conservative so that the correct impact of multiple-unit operation would be expected to be less than that used (four for unit 2 and two for unit 3). In the fourth case, the frequency of the CDF for the initiator is so small that, even if the multiplier of four is used, the benefit of any SAMA that eliminates this initiator would not be cost effective. The impact of three-unit operation could also reduce the availability of the emergency equipment cooling water (EECW) system and the residual heat removal service water (RHRSW) system which are shared between Units 1 and 2. This was also addressed by TVA in response to an RAI (TVA 2004b). While the impact of this on CDF may be larger than the multiplier of four used, the importance of these systems is small enough that the impact on CDF is expected to be so small that it would not lead to cost effective SAMAs.

There is considerable uncertainty in the validity of the above "correction factors," or multipliers. However, based on a review of the modeling changes made for the Multiple-Unit PSA, other results such as the change in CDF when Unit 3 operation is accounted for (Unit 2 PSA with Unit 3 operating versus Unit 2 IPE Rev. 1A), and the relatively large "effective" CDF after applying these factors compared to the CDF for other similar BWRs, the staff finds that these factors are acceptable for estimating the impact of multiple-unit operation. It is noted that during the course of the review, TVA completed a PSA for Unit 1, based on the expected configuration at the time of restart, including EPU conditions (TVA 2004b). The Unit 1 CDF is 1.86×10^{-6} per year, which is less than the EPU PSA CDF for Unit 2 used in the SAMA analysis. As such, the use of the Unit 2 CDF with a multiplier of four to represent the Unit 1 CDF appears to be bounding and conservative for the purposes of the SAMA analysis.

In the IPEEE SER, the staff estimated a fire CDF 1.24×10^{-5} per year for Unit 2, and 7.5×10^{-6} per year for Unit 3. In response to an RAI, TVA provided the control room fire CDF based on the latest fire analysis. The control room fire CDF for BFN is approximately 1×10^{-5} per year for Unit 2, which is about a factor of four greater than the internal events CDF of 2.6×10^{-6} per year for Unit 2 used in the SAMA analysis. TVA stated that the fire CDF values should be considered as upper bound values only, and that the mean CDF due to fire-related initiating events in each of the fire areas is judged to be considerably lower than these values (TVA 2004a).

The staff agrees that the BFN fire analysis contains numerous conservatisms and that a more realistic assessment could result in a substantially lower fire CDF. However, the staff believes that the information provided by TVA is not sufficient to ignore the risk contribution from external events. Based on evaluations of past ERs submitted in support of license renewal applications, the staff believes that a more realistic fire CDF is likely a factor of two to three less than the screening values used in the FIVE methodology. If a factor of three reduction is applied to the BFN fire CDF, the external events (fire) CDF and internal events CDF are comparable. As such, this would justify use of a multiplier of two to the averted cost estimates (for internal events) to represent the additional SAMA benefits in external events. Therefore, the staff applied a multiplier of two the averted cost estimates (for internal events) to obtain a baseline estimate of the benefits for each SAMA. This implicitly assumes that each SAMA would offer the same percentage reduction in external event CDF and population dose as it offers in internal event CDF and population dose. The adjusted benefit values are shown in Table G-4 for the 43 SAMAs. No SAMAs were found to be cost-beneficial, even after applying a multiplier of two to account for external events.

The staff notes that TVA evaluated a SAMA for a control room fire, which is a one of the zones that contributes largely to the fire CDF. The averted cost was estimated to be about $479,000 (Unit 2) and $239,000 (Unit 3). After accounting for multiple-unit operation, the maximum averted cost was estimated to be $4,300,000 for the site (TVA 2004b). The estimated cost to install redundant remote shutdown panels is $5M per unit. Therefore, this SAMA would not be cost-beneficial.

The staff also considered the impact that further increases in the contribution from analysis uncertainties would have on the estimated costs and benefits. TVA estimated that the ratio of the 95th percentile to the mean CDF is 3.2 and 2.8 for Units 2 and 3, respectively (TVA 2003). The staff considered the impact if the cost and benefits were altered by a factor of three to account for uncertainties. Four SAMAs had estimated benefits within a factor of three of the estimated implementation costs and were further evaluated.

In response to an RAI, TVA re-examined each of these SAMAs. This included re-examining the modeling assumptions that could lead to overestimation of the averted costs, and refining the implementations costs to better represent the actual costs that would be incurred. The results of this reassessment are provided in the RAI response (TVA 2004b), and summarized below. The revised values are also reported in Table G-4.

- SAMA B11 involves improving/enhancing procedures for load shedding, which would improve direct current (DC) reliability. The staff estimated the benefit of this SAMA to be $54,000 for the site based on TVA's risk reduction estimate reported in the ER and a multiplier of two to account for external events. Implementation costs were estimated by TVA to be $73,000/unit. However, this is a procedural modification and, therefore, the staff estimates that such a modification would not be three times the estimated cost for three units. Due to similarities between units and shared systems, the staff doubled TVA's implementation cost from $73,000 to $146,000 to obtain a site-wide implementation cost. Thus, this SAMA was within a factor of three of being cost-beneficial. TVA's initial risk reduction estimate was bounding, in that it set the unavailability of the three battery boards to zero. TVA reassessed the potential enhancement and determined that, more realistically, only a 20 percent improvement would be achieved (TVA 2004b). Therefore, the revised benefit, or averted cost, would be 20 percent of the initial value, or approximately $10,800. Additionally, TVA stated that an engineering analysis would be necessary to determine the improvement in unavailability, if any. When compared to the implementation cost of $146,000 for the site, this SAMA is not cost-beneficial, nor would it be when considering uncertainties.

- SAMA G04 involves both procedural improvements and hardware changes for use of cross-tied component cooling or service water (SW) pumps, which would reduce the frequency of a loss of component cooling water or SW. The staff estimated the benefit of this SAMA to be $74,000 for the site based on TVA's risk reduction estimate reported in the ER and a multiplier of two to account for external events. Implementation costs were initially estimated by TVA to be $73,000/unit. However, this is a procedural modification, and therefore, the staff estimates that such a modification would not be three times the estimated cost for three units. Due to similarities between units and shared systems, the staff doubled TVA's implementation cost from $73,000 to $146,000 to obtain a site-wide implementation cost. Thus, this SAMA was within a factor of three of being cost-beneficial. According to TVA, this SAMA would require a hardware modification as well as the procedural modification (TVA 2004b). The cost of the hardware modification was not included in the initial implementation cost, and would increase the implementation cost by $77,000/unit to $150,000/unit. Since a procedural modification is estimated by the staff to cost $146,000 for the site, the addition of the hardware modification ($77,000/unit or $231,000 for the site) would bring the implementation costs to $377,000 for the site. TVA also noted that the potential benefits are clearly over-stated since the frequency of the loss of RBCCW initiator is assumed to be zero, and that the action to align the swing pumps is assumed to occur without error. The staff agrees with the revised implementation costs because of the need to develop new procedure(s), to perform engineering analysis to support procedure development, and to install the required hardware. The staff also agrees that the benefits would be much less if more realistic assumptions are used. The staff concludes that this SAMA has a negative net value. Accordingly, the staff concurs that this SAMA would not be cost-beneficial at BFN even when considering uncertainties.

- SAMA G12c involves the addition of redundant DC control power for the SW pumps, which would increase the reliability of the SW system and decrease CDF due to a loss of SW. The staff estimated the benefit of this SAMA to be $564,000 for the site based on TVA's risk reduction estimate reported in the ER and a multiplier of two to account for external events. Implementation costs were estimated by TVA to be $1.5M for the site. Thus, this SAMA was within a factor of three of being cost-beneficial. TVA's initial risk reduction estimate was bounding, in that it assumed that charging capability is always available to extend the life of the batteries. The assessment also assumed that if high pressure coolant injection (HPCI) or reactor core isolation cooling (RCIC) maintain level for six hours, then the scenario is successfully terminated. TVA reassessed the potential enhancement using a more realistic, but still bounding, model that assumed that the reliability of every battery would be increased as a result of the addition of redundant DC control power; however, the unavailability of each battery was assumed to decrease by a factor of two (TVA 2004b). This resulted in a total site benefit of $61,000 (including the multiplier of two to account for external events). The staff finds the implementation cost to be reasonable and comparable to costs provided by other applicants for similar modifications. Additionally, the staff agrees that the original assessment over-estimated the benefit, and that the revised assessment is more realistic. Therefore, the staff agrees that this SAMA would not be cost-beneficial even when considering uncertainties.

- SAMA G17 involves the development of procedure(s) to instruct operators to trip unneeded residual heat removal/core spray pumps on loss of room ventilation. The staff estimated the benefit of this SAMA to be $71,000 based on TVA's risk reduction estimate reported in the ER and a multiplier of two to account for external events. Implementation costs were estimated to be $73,000/unit. However, this is a procedural modification, and therefore, the staff estimates that such a modification would not be three times the estimated cost for three units. Due to similarities between units and shared systems, the staff doubled TVA's implementation cost from $73,000 to $146,000 to obtain a site-wide implementation cost. Thus, this SAMA is within a factor of three of being cost-beneficial. TVA's initial analysis assumed that the unavailability of the RHR and core spray pumps would be decreased by 20 percent if dependence of room ventilation could be removed. This value was derived from a review of the system analyses; ventilation failures contribute approximately 20 percent to the unavailability of the RHR and core spray (CS) pumps. However, engineering analyses to support the assumption that environmental conditions would remain within pump operability limits if the unneeded pumps were tripped would be required. Additionally, local area temperature time histories would have to be conducted for all three units. TVA stated that the cost of these analyses (engineering and temperature histories) were not included in the original implementation costs (TVA 2004b). The cost for these analyses is estimated to be $110K/unit; therefore, the total implementation cost would be $476,000 for the site. The staff agrees with the revised implementation costs because of the need to develop new procedure(s) and to perform engineering analyses and other analyses. The staff concludes that this SAMA has a negative net value. Accordingly, the staff agrees that this SAMA would not be cost-beneficial at BFN even when considering uncertainties.

The staff reviewed the SAMAs analyzed by TVA to determine if lower cost alternatives had been evaluated, including the use of portable battery chargers. TVA did evaluate the use of portable battery chargers (SAMA G13) (TVA 2003). The estimated benefit associated with this SAMA is around $52,000 per site. The implementation cost provided by TVA was over $2M per site. This implementation cost is questionable; however, the staff expects that the realistic implementation costs would be greater than the estimated benefits. In SAMA G10, TVA assessed the use of the fire protection system as a backup source to the drywell spray system. The estimated benefit associated with this SAMA is around $14,000, which is less than the cost that would be incurred for such a modification. Although the implementation costs provided by TVA appear to be over-estimated, the expected costs would be significantly greater than the estimated benefits. The staff considers the evaluation and estimation of these lower cost alternatives reasonable and acceptable for purposes of the SAMA evaluation.

TVA estimated all costs based on three-percent and seven-percent real discount rates. When determining if a SAMA was cost-beneficial, TVA utilized the values based on the three-percent real discount rate. The use of a three-percent real discount rate (rather than seven percent used in the baseline) results in an increase in the maximum attainable benefit of approximately 54 percent. The results of using the three-percent discount rate are bounded by the staff's averted cost estimates, which applied a multiplier of two to the internal events benefits to obtain a baseline estimate for each SAMA.

The staff concludes that the costs of all of the SAMAs assessed would be higher than the associated benefits. Improvements realized as a result of the IPE and IPEEE processes and resolution of seismic outliers would minimize the likelihood of identifying further cost-beneficial enhancements.

G.7 Conclusions

TVA compiled a list of 135 SAMA candidates based on the major contributors to CDF and LERF at BFN, generic SAMAs based on analyses submitted in support of licensing activities for other nuclear power plants, NRC and industry documents discussing potential plant improvements, and insights from current PSA. A qualitative screening removed SAMA candidates that (1) were not applicable at BFN due to design differences, (2) were related to reactor coolant pumps (RCP) seal leakage, (3) had already been implemented at BFN, (4) were similar in nature to and could be combined with another SAMA, or (5) cost more than $6M to implement. A total of 92

SAMA candidates were eliminated based on the above criteria, leaving 43 SAMA candidates for further evaluation.

Using guidance in NUREG/BR-0184 (NRC 1997b), the current PSA model, and a Level 3 analysis developed specifically for SAMA evaluation, a more detailed assessment of the costs and benefits was developed for the 43 remaining SAMA candidates. TVA concluded in the ER that none of the candidate SAMAs evaluated would be cost-beneficial for BFN because their implementation costs exceeded their estimated benefits.

The staff reviewed the TVA analysis and concluded that the methods used and the implementation of those methods were sound. The unavailability of a seismic and fire PSA model precluded a detailed quantitative evaluation of SAMAs specifically aimed at reducing risk of these initiators. In view of the relative contribution to risk from fire events indicated from the BFN fire analysis, the staff applied a multiplier of two to the averted cost estimates for each SAMA to account for the potential impact of external events. Even then, however, none of the SAMAs were cost-beneficial.

The staff considered the impact if the cost and benefits were increased by a factor of three to account for uncertainties and determined that four SAMAs could be potentially cost-beneficial. TVA re-examined each of these SAMAs and provided a more realistic estimate of their benefits and/or implementation costs. As a result of this reassessment, the cost-benefit analyses showed that none of the candidate SAMAs was cost-beneficial.

Based on its review of the TVA SAMA analysis, the staff concurs that none of the candidate SAMAs is cost-beneficial. This is based on conservative treatment of costs and benefits. This conclusion is consistent with the low residual level of risk indicated in the BFN PSA and the fact that BFN has already implemented the plant improvements identified from the IPE and IPEEE processes, with the exception of the removal of the transformers, which is scheduled to occur in the future.

G.8 References

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Docket No. 50-259, 50-260, and 50-296

11. ABSTRACT *(200 words or less)*

This draft supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted to the NRC by Tennessee Valley Authority (TVA) to renew the operating licenses (OL) for Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 for an additional 20 years under 10 CFR Part 54. This draft SEIS includes the NRC staff's analysis that considers and weighs the environmental impacts of the proposed action, the environmental impacts of the alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the staff's preliminary recommendation regarding the proposed action.

The NRC staff's preliminary recommendation is that the Commission determine that the adverse environmental impacts of license renewal for Browns Ferry Nuclear Power Plant, Units 1, 2, and 3 are not so great that preserving the option of license renewal for energy planning decision makers would be unreasonable. The recommendation is based on (1) the analysis and findings in the GEIS; (2) the Environmental Report submitted by TVA; (3) consultation with Federal, State, and local agencies; (4) the staff's own independent review; and (5) the staff's consideration of the public comments received during the scoping process.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

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