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

NUREG-1437
Supplement 50

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 50

Regarding Grand Gulf Nuclear Station, Unit 1

Draft Report for Comment

Office of Nuclear Reactor Regulation

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Manuscript Completed: October 2013
Date Published: November 2013

Office of Nuclear Reactor Regulation

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For any questions about the material in this report, please contact David Drucker, NRC Environmental Project Manager, at 1-800-368-5642, extension 6223, or by e-mail at david.drucker@nrc.gov

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ABSTRACT

This supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted by Entergy Operations, Inc. (Entergy) to renew the operating license for Grand Gulf Nuclear Station, Unit 1 (GGNS), for an additional 20 years.

This SEIS includes the preliminary analysis that evaluates the environmental impacts of the proposed action and alternatives to the proposed action. Alternatives considered include: new nuclear generation, natural gas-fired combined-cycle generation, supercritical coal-fired generation, combination alternative, and no renewal of the license (the no-action alternative).

The U.S. Nuclear Regulatory Commission's (NRC's) preliminary recommendation is that the adverse environmental impacts of license renewal for GGNS are not great enough to deny the option of license renewal for energy-planning decisionmakers. This recommendation is based on the following:

- the analysis and findings in NUREG–1437, Volumes 1 and 2, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*,
- the Environmental Report submitted by Entergy,
- consultation with Federal, State, local, and Tribal government agencies,
- the NRC's environmental review, and
- consideration of public comments received during the scoping process.

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BACKGROUND

By letter dated October 28, 2011, Entergy Operations, Inc. (Entergy) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to issue a renewed operating license for Grand Gulf Nuclear Station, Unit 1 (GGNS), for an additional 20-year period.

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

Upon acceptance of Entergy's application, the NRC staff began the environmental review process described in 10 CFR Part 51 by publishing a notice of intent to prepare a supplemental EIS (SEIS) and conduct scoping. In preparation of this SEIS for GGNS, the NRC staff performed the following:

- conducted public scoping meetings on January 31, 2012, in Port Gibson, Mississippi;
- conducted a site audit at the plant in March 2012;
- reviewed Entergy's environmental report (ER) and compared it to the GEIS;
- consulted with other agencies;
- conducted a review of the issues following the guidance set forth in NUREG-1555, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal"; and
- considered public comments received during the scoping process.

PROPOSED ACTION

Entergy initiated the proposed Federal action—issuing a renewed power reactor operating license—by submitting an application for license renewal of GGNS, for which the existing license (NPF-29) for GGNS, will expire on November 1, 2024. The NRC's Federal action is the decision whether or not to renew the license for an additional 20 years.

PURPOSE AND NEED FOR ACTION

The purpose and need for the proposed action (issuance of a renewed license) is to provide an option that allows for power generation capability beyond the term of the current nuclear power plant operating license to meet future system generating needs. Such needs may be determined by other energy-planning decisionmakers, such as state, utility, and—where authorized, Federal (other than NRC). This definition of purpose and need reflects the NRC's recognition that, unless there are findings in the safety review required by the Atomic Energy Act or findings in the National Environmental Policy Act (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 whether a particular nuclear power plant should continue to operate.

If the renewed license is issued, the appropriate energy-planning decisionmakers, along with Entergy, will ultimately decide if the reactor unit will continue to operate based on factors such as the need for power. If the operating license is not renewed, then the facility must be shut down on or before the expiration date of the current operating license—November 1, 2024.

ENVIRONMENTAL IMPACTS OF LICENSE RENEWAL

The SEIS evaluates the potential environmental impacts of the proposed action. The environmental impacts from the proposed action are designated as SMALL, MODERATE, or LARGE. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

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

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

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

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

For Category 1 issues, no additional site-specific analysis is required in this SEIS unless new and significant information is identified. Chapter 4 of this report presents the process for identifying new and significant information. Site-specific issues (Category 2) are those that do not meet one or more of the criterion for Category 1 issues; therefore, an additional site-specific review for these non-generic issues is required, and the results are documented in the SEIS.

On June 20, 2013, the NRC published a final rule (78 FR 37282) revising its environmental protection regulation, 10 CFR Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions.” The final rule updates the potential environmental impacts associated with the renewal of an operating license for a nuclear power reactor for an additional 20 years. A revised GEIS, which updates the 1996 GEIS, provides the technical basis for the final rule. The revised GEIS specifically supports the revised list of NEPA issues and associated environmental impact findings for license renewal contained in Table B–1 in Appendix B to Subpart A of the revised 10 CFR Part 51. The final rule consolidates similar Category 1 and 2 issues, changes some Category 2 issues into Category 1 issues, and consolidates some of those issues with existing Category 1 issues. The final rule also adds new Category 1 and 2 issues.

The final rule became effective 30 days after publication in the *Federal Register*. Compliance by license renewal applicants is not required until 1 year from the date of publication (i.e., license renewal environmental reports submitted later than 1 year after publication must be compliant with the new rule). Nevertheless, under NEPA, the NRC must now consider and analyze, in its license renewal SEISs, the potential significant impacts described by the revised rule's new Category 2 issues, and to the extent there is any new and significant information, the potential significant impacts described by the revised rule's new Category 1 issues.

The NRC staff has reviewed Entergy's established process for identifying and evaluating the significance of any new and significant information (including the consideration and analysis of new issues associated with the recently approved revision to 10 CFR Part 51) on the environmental impacts of license renewal of GGNS. Neither Entergy nor NRC identified information that is both new and significant related to Category 1 issues that would call into question the conclusions in the GEIS. This conclusion is supported by NRC's review of the applicant's ER, other documentation relevant to the applicant's activities, the public scoping process and substantive comments raised, and the findings from the environmental site audit conducted by NRC staff. Further, the NRC staff did not identify any new issues applicable to GGNS that have a significant environmental impact. The NRC staff, therefore, relies upon the conclusions of the GEIS for all Category 1 issues applicable to GGNS.

Table ES-1 summarizes the Category 2 issues applicable to GGNS, if any, as well as the NRC staff's findings related to those issues. If the NRC staff determined that there were no Category 2 issues applicable for a particular resource area, the findings of the GEIS, as documented in Appendix B to Subpart A of 10 CFR Part 51, stand.

Table ES–1. NRC Conclusions Relating to Site-Specific Impacts of License Renewal

Resource Area	Relevant Category 2 Issues	Adverse Impacts
Land Use	None	SMALL
Air Quality	None	SMALL
Geology and Soils	None	SMALL
Surface Water Resources	None	SMALL
Groundwater Resources	Groundwater use conflicts	SMALL
	Radionuclides released to groundwater	SMALL
Aquatic Resources	None	SMALL
Terrestrial Resources	Non-cooling system impacts	SMALL
Protected Species	Threatened or endangered species	No effect/ may affect, but is not likely to adversely affect[a]
Human Health Issues	Electromagnetic fields—acute effects	SMALL
Socioeconomics	Housing Impacts Public services (public utilities) Offsite land use Public services (public transportation) Historic & archaeological resources	SMALL
Cumulative Impacts	Aquatic Resources	MODERATE
	Terrestrial Resources	MODERATE
	Protected Species & Habitats	May affect, but is not likely to adversely affect[a]
	All other evaluated resources	SMALL

(a): For Federally protected species, the GEIS and the final rule state that, in complying with the Endangered Species Act (ESA), the NRC will report the effects of continued operations and refurbishment in terms of its ESA findings, which varies by species for GGNS.

With respect to environmental justice, the NRC staff has determined that there would be no disproportionately high and adverse impacts to these populations from the continued operation of GGNS during the license renewal period. Additionally, the NRC staff has determined that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of water, local food, fish, and wildlife.

SEVERE ACCIDENT MITIGATION ALTERNATIVES

Since GGNS had not previously considered alternatives to reduce the likelihood or potential consequences of a variety of highly uncommon, but potentially serious, accidents at GGNS, 10 CFR 51.53(c)(3)(ii)(L) requires that Entergy evaluate severe accident mitigation alternatives (SAMAs) in the course of the license renewal review. SAMAs are potential ways to reduce the risk or potential impacts of uncommon, but potentially severe accidents, and they may include changes to plant components, systems, procedures, and training.

The NRC staff reviewed the ER's evaluation of potential SAMAs. Based on the staff's review, the NRC staff concluded that none of the potentially cost beneficial SAMAs relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of the license renewal, pursuant to 10 CFR Part 54.

ALTERNATIVES

The NRC staff considered the environmental impacts associated with alternatives to license renewal. These alternatives include other methods of power generation and not renewing the GGNS operating license (the no-action alternative). Replacement power options considered were as follows:

- new nuclear generation,
- natural gas-fired combined-cycle generation,
- supercritical pulverized coal-fired generation, and
- combination alternative.

The NRC staff initially considered a number of additional alternatives for analysis as alternatives to license renewal of GGNS; these were later dismissed due to technical, resource availability, or commercial limitations that currently exist and that the NRC staff believes are likely to continue to exist when the existing GGNS license expire. The no-action alternative by the NRC staff, and the effects it would have, were also considered. Where possible, the NRC staff evaluated potential environmental impacts for these alternatives located both at the GGNS site and at some other unspecified alternate location. Alternatives considered, but dismissed, were as follows:

- energy conservation and energy efficiency,
- wind power,
- solar power,
- hydroelectric power,
- wave and ocean energy,
- geothermal power,
- municipal solid waste,
- biomass,
- oil-fired power,
- fuel cells,
- purchased power, and
- delayed retirement.

The NRC staff evaluated each alternative using the same impact areas that were used in evaluating impacts from license renewal.

RECOMMENDATION

The NRC's preliminary recommendation is that the adverse environmental impacts of license renewal for GGNS are not great enough to deny the option of license renewal for energy-planning decisionmakers. This recommendation is based on the following:

- analysis and findings in the GEIS,
- ER submitted by Entergy,
- consultation with Federal, State, local, and Tribal government agencies,
- NRC staff's own independent review, and
- consideration of public comments received during the scoping process.

ABBREVIATIONS AND ACRONYMS

°C	degree(s) Celsius
°F	degree(s) Fahrenheit
AADT	average annual daily traffic
AAI	American Aquatics, Inc.
ac	acre(s)
ACAA	American Coal Ash Association
ACC	averted cleanup and decontamination costs
ACHP	Advisory Council on Historic Preservation
ADAMS	Agencywide Documents Access and Management System
AEA	Atomic Energy Authority
AEC	U.S. Atomic Energy Commission
ALARA	as low as is reasonably achievable
ANL	Argonne National Laboratory
ANS	American Nuclear Society
AOC	averted offsite property damage costs
AOE	averted occupation exposure
AOSC	averted onsite costs
APE	averted public exposure
AQCR	air quality control region
AQRV	air quality related values
ARI	Alternative Resources, Inc.
ASME	American Society of Mechanical Engineering
BACT	Best Available Control Technology
BEA	U.S. Bureau of Economic Analysis
BLM	Bureau of Land Management
BLS	U.S. Bureau of Labor Statistics
BMPs	best management practices
BP	before present
Btu	British thermal unit(s)
Btu/kWh	British thermal units per kilowatt-hour
Btu/lb	British thermal units per pound
BWR	boiling water reactor
BWROG	BWR Owners Group

CAA	Clean Air Act
CAES	compressed air energy storage
CAPS	Circular Area Profiling System
CCDPs	conditional core damage probabilities
CCP	coal combustion products
CDF	core damage frequency
CDM	Clean Development Mechanism
C_{eq}/kWh	carbon equivalent per kilowatt-hour
CEQ	Council on Environmental Quality
CET	containment event tree
CFR	*Code of Federal Regulations*
cfs	cubic feet per second
CH_4	methane
cm	centimeter(s)
CNWRA	Center for Nuclear Waste Regulatory Analyses
CO	carbon monoxide
CO_2	carbon dioxide
CO_{2e}	carbon dioxide equivalent
COE	cost of enhancement
COL	combined license
CP	construction permit
CS&I	Crossroads, Shiloh & Ingleside
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
dBA	decibels adjusted
DBA	design-basis accident
DC	direct current
DOE	U.S. Department of Energy
DOT	Department of Transportation
DSEIS	draft Supplemental Environmental Impact Statement
DSM	demand-side management
EA	Environmental Assessment
EAC	Electricity Advisory Committee
EDG	emergency diesel generator
EHV	Extra High Voltage

EIA	Energy Information Administration
EIS	environmental impact statement
ELF-EMF	extremely low frequency-electromagnetic field
EMI	Entergy Mississippi, Inc
EMS	environmental management systems
Entergy	Entergy Operations, Inc.
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPRI	Electric Power Research Institute
EPU	extended power uprate
ER	Environmental Report
ESA	Endangered Species Act of 1973, as amended
ESBWR	Economic Simplified Boiling Water Reactor
ESP	early site permit
FEIS	final environmental impact statement
FEMA	U.S. Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FES	final environmental statement
FIVE	Fire-Induced Vulnerability Evaluation
FLMs	Federal Land Managers
FONSI	Finding of No Significant Impact
FR	*Federal Register*
ft	foot (feet)
ft/s	feet per second
ft^3	cubic feet
FWS	U.S. Fish and Wildlife Service
gal	gallon(s)
gal/yr	gallons per year
GE	General Electric
GEA	Geothermal Energy Association
GEIS	*Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants*, NUREG–1437
GGNS	Grand Gulf Nuclear Station
GHG	greenhouse gas

GI	Generic Issue
gpd	gallons per day
gpm	gallons per minute
GSI	Generic Safety Issue
GW	gigawatt(s)
GWh	gigawatthour(s)
ha	hectare(s)
HAPs	hazardous air pollutants
H/E	high early
HFCs	hydrofluorocarbons
HMR	Hydro Meteorological Reports
HPCS	high-pressure core spray
HVAC	heating, ventilation, and air conditioning
IAEA	International Atomic Energy Agency
IEEE	Institute of Electrical and Electronics Engineers
IGCC	integrated gasification combined-cycle
in.	inch(es)
INEEL	Idaho National Engineering and Environmental Laboratory
IPCC	Intergovernmental Panel on Climate Change
IPE	individual plant examination
IPEEE	individual plant examination of external events
ISFSI	Independent Spent Fuel Storage Installation
kg	kilogram(s)
km	kilometer(s)
km^2	square kilometers
kV	kilovolt(s)
kWh	kilowatthour(s)
lb	pound(s)
lb/MWh	pounds per megawatthour
LERF	large early release frequency
LOCA	Loss of Coolant Accident
LOSP	loss of offsite power
LRA	license renewal application
m	meter(s)
m/s	meters per second

m^2	square meters
m^3	cubic meters
m^3/s	cubic meters per second
m^3/yr	cubic meters per year
mA	milliampere(s)
MAAP	Modular Accident Analysis Program
MACCS2	MELCOR Accident Consequence Code System 2
MBTA	Migratory Bird Treaty Act of 1918, as amended
MCEQ	Mississippi Commission on Environmental Quality
MCR	model change request
MDAH	Mississippi Department of Archives and History
MDEQ	Mississippi Department of Environmental Quality
MDES	Mississippi Department of Employment Security
MDH	Mississippi Department of Health
MDEQ	Mississippi Department of Environmental Quality
MDOT	Mississippi Department of Transportation
MDWFP	Mississippi Department of Wildlife, Fisheries, and Parks
mg/L	milligrams per liter
mGy	milligray
mi	mile(s)
mi^2	square miles
MIHL	Mississippi Institutions of Higher Learning
millirem	milliroentgen equivalent man
mm	millimeter(s)
MMBtu/MWh	one million Btu per megawatthour
MMNS	Mississippi Museum of Natural Science
MNHP	Mississippi Natural Heritage Program
MMPA	Marine Mammal Protection Act
MP&L	Mississippi Power & Light Company
mph	miles per hour
mrad	milliradiation absorbed dose
mrem	milliroentgen equivalent man
MSA	Magnuson–Stevens Fishery Conservation and Management Act, as amended through January 12, 2007
MSCEQ	Mississippi Commission of Environmental Quality

MSL	mean sea level
mSv	millisievert
MT	metric ton(s)
MTHM	metric ton of heavy metal
MWd/MTU	megawatt-days per metric ton of uranium
MWe	megawatt(s) electrical
MWt	megawatt(s) thermal
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NAS	National Academy of Sciences
NASS	National Agricultural Statistics Service
NCDC	National Climatic Data Center
NCES	National Center for Education Statistics
NCF	no containment failure
NEA	Nuclear Energy Agency
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NESC	National Electrical Safety Code
NETL	National Energy Technology Laboratory
NGCC	natural-gas-fired combined-cycle
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NO_x	nitrogen oxide(s)
NPDES	National Pollution Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRCS	National Resources Conservation Service
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NRR	Office of Nuclear Reactor Regulation
NS	Nuclear Station
NUREG	NRC technical report designation (Nuclear Regulatory Commission)
O_3	ozone

ODCM	Offsite Dose Calculation Manual
OECD	Organization for Economic Co-operation and Development
OECR	offsite economic cost risk
PAH	polycyclic aromatic hydrocarbon
Pb	lead
pCi/L	picocuries per liter
PDR	population dose risk
PDS	plant damage state
PFCs	perfluorocarbons
pH	hydrogen-ion concentration
PM_{10}	particulate matter >2.5 microns and ≤10 microns in diameter
$PM_{2.5}$	particulate matter ≤2.5 microns in diameter
PMP	probably maximum precipitation
PNNL	Pacific Northwest National Laboratory
POST	Parliamentary Office of Science and Technology
ppb	parts per billion
ppm	parts per million
PRA	probabilistic risk assessment
PSA	probabilistic safety assessment
PSD	Prevention of Significant Deterioration
RAI	request for additional information
RC	release category
RCRA	Resource Conservation and Recovery Act of 1976
REMP	radiological environmental monitoring program
RES	Nuclear Regulatory Research, Office of
RLE	review level earthquake
RM	river mile(s)
ROI	region of influence
ROW(s)	right(s)-of-way
RPC	replacement power cost
RPSEA	Research Partnership to Secure Energy for America
RPV	reactor pressure vessel
RRW	risk reduction worth
SAAQS	State Ambient Air Quality Standards
SAMA	Severe Accident Mitigation Alternative

SAR	safety analysis report
SCPC	supercritical pulverized coal
SDWA	Safe Drinking Water Act
SEIS	supplemental environmental impact statement
SERI	System Energy Resources, Inc.
SF_6	sulfur hexafluoride
SHPO	State Historic Preservation Office
SMA	seismic margins assessment
SNL	Sandia National Laboratory
SO_2	sulfur dioxide
SO_x	sulfur oxide(s)
SRP	Standard Review Plan
SSCs	systems, structures, and components
SSE	safe shutdown earthquake
SSW	standby service water
State	State of Mississippi
Sv	sievert(s)
TCPA	Texas Comptroller of Public Accounts
TEEIC	Tribal Energy and Environmental Information Center
TPWD	Texas Parks and Wildlife Department
TSS	total suspended solids
U.S.	United States
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish & Wildlife Service
USGCRP	U.S. Global Change Research Program
USGS	U.S. Geological Survey
USOWC	U.S. Offshore Wind Collaborative
VOCs	volatile organic compounds
WCD	Waste Confidence Decision Rule

1.0 PURPOSE AND NEED FOR ACTION

Under the U.S. Nuclear Regulatory Commission's (NRC's) environmental protection regulations in Title 10 of the *Code of Federal Regulations* Part 51 (10 CFR Part 51)—which carry out the National Environmental Policy Act (NEPA)—renewal of a nuclear power plant operating license requires the preparation of an environmental impact statement (EIS).

The Atomic Energy Act of 1954 originally specified that licenses for commercial power reactors be granted for up to 40 years. The 40-year licensing period was based on economic and antitrust considerations rather than on technical limitations of the nuclear facility.

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

1.1 Proposed Federal Action

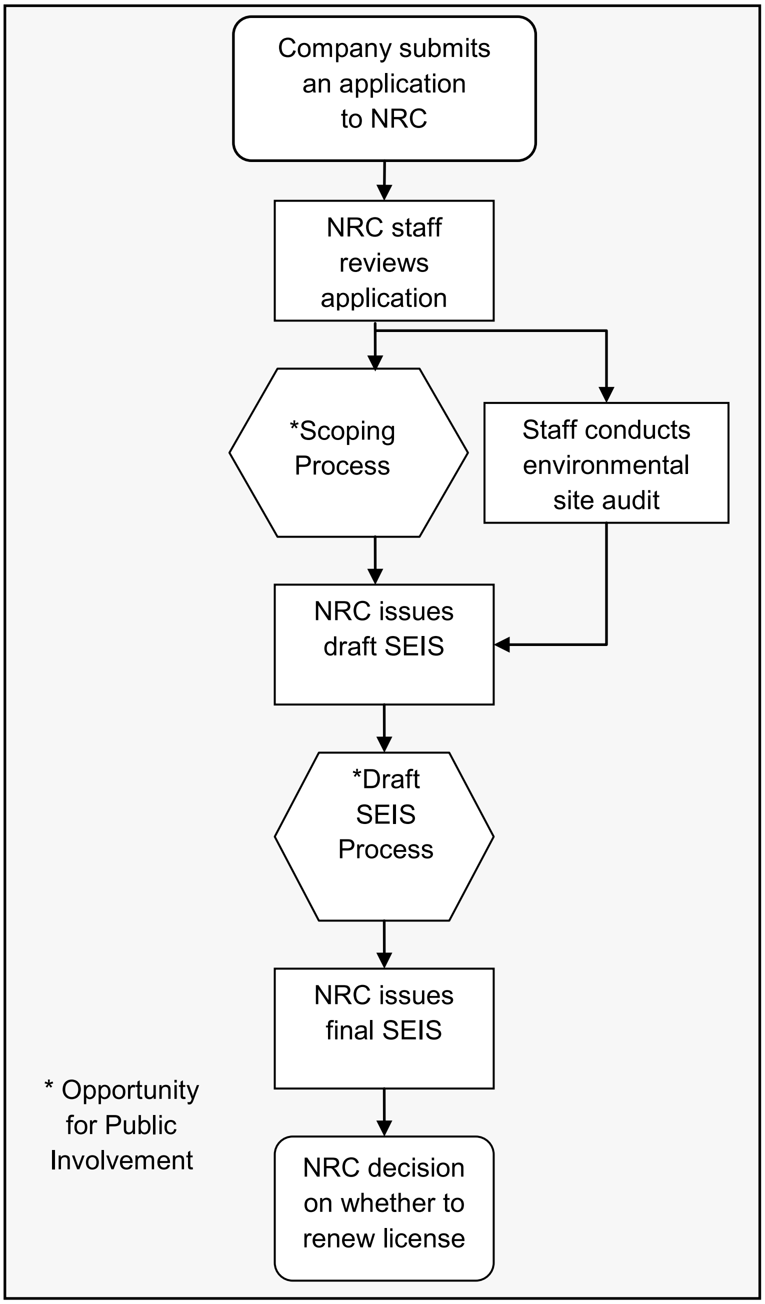
Entergy Operations, Inc. (Entergy) initiated the proposed Federal action by submitting an application for license renewal of Grand Gulf Nuclear Station, Unit 1 (GGNS), for which the existing license (NPF-29) expires on November 1, 2024. The NRC's Federal action is the decision whether to renew the license for an additional 20 years.

1.2 Purpose and Need for the Proposed Federal Action

The purpose and need for the proposed action (decision whether to renew the 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 other energy-planning decision-makers. 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 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.

If a renewed license is issued, State regulatory agencies and Entergy 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 a renewed license is denied, then the facility must be shut down on or before the expiration date of the current operating license—November 1, 2024.

Figure 1–1. Environmental Review Process



1.3 Major Environmental Review Milestones

Entergy submitted an Environmental Report (ER) (Entergy 2011a) as part of its License Renewal Application (Entergy 2011b) on November 1, 2011. After reviewing the application and ER for sufficiency, the staff published a *Federal Register* Notice of Acceptability and Opportunity for Hearing (76 FR 80980) on December 27, 2011. Then, on December 29, 2011, the NRC published another notice in the *Federal Register* (76 FR 81996) on the intent to conduct scoping, thereby beginning the 60-day scoping period.

Two public scoping meetings were held on January 31, 2012, in Port Gibson, Mississippi (NRC 2012a). The comments received during the scoping process are presented in

"Environmental Impact Statement, Scoping Process, Summary Report," published in April 2013 (NRC 2013a). The scoping process summary report presents NRC responses to comments that the NRC staff considered to be out-of-scope of the environmental license renewal review. The comments considered within the scope of the environmental license renewal review and the NRC responses are presented in Appendix A of this supplemental environmental impact statement (SEIS).

In order to independently verify information provided in the ER, NRC staff conducted a site audit at GGNS in March 2012. During the site audit, NRC staff met with plant personnel, reviewed specific documentation, toured the facility, and met with interested Federal, State, and local agencies. A summary of that site audit is contained in "Summary of Site Audit Related to the Environmental Review of the License Renewal Application for Grand Gulf Nuclear Station, Unit 1," published in May 2012 (NRC 2012b).

Upon completion of the scoping period and site audit, NRC staff compiled its findings in a draft SEIS (Figure 1–1). This document is made available for public comment for 45 days. During this time, NRC staff will host public meetings and collect public comments. Based on the information gathered, the NRC staff will amend the draft SEIS findings as necessary, and publish the final SEIS.

The NRC has established a license renewal process that can be completed in a reasonable period of time with clear requirements to assure safe plant operation for up to an additional 20 years of plant life. The safety review, which documents its finding in a Safety Evaluation Report, is conducted simultaneously with the environmental review. The findings in both the SEIS and the Safety Evaluation Report are factors in the Commission's decision to either grant or deny the issuance of a renewed license.

1.4 Generic Environmental Impact Statement

The NRC performed a generic assessment of the environmental impacts associated with license renewal to improve the efficiency of the license renewal process. The *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants*, NUREG-1437 (GEIS) (NRC 1996, 1999) documented the results of the NRC staff's systematic approach to evaluate the environmental consequences of renewing the licenses of individual nuclear power plants and operating them for an additional 20 years. NRC staff analyzed in detail and resolved those environmental issues that could be resolved generically in the GEIS.

The GEIS established 92 separate issues for NRC staff to independently verify. Of these issues, NRC staff determined that 69 are generic to all plants (Category 1) while 21 issues do not lend themselves to generic consideration (Category 2). Two other issues remained uncategorized; environmental justice and chronic effects of electromagnetic fields, and must be evaluated on a site-specific basis. A list of all 92 issues can be found in Appendix B.

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.

The NRC's standard of significance for impacts was established using the Council on Environmental Quality (CEQ) terminology for "significant." The NRC established three levels of significance for potential impacts: SMALL, MODERATE, and LARGE, as defined below.

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

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

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

> **Significance** indicates the importance of likely environmental impacts and is determined by considering two variables: **context** and **intensity**.
>
> **Context** is the geographic, biophysical, and social context in which the effects will occur.
>
> **Intensity** refers to the severity of the impact, in whatever context it occurs.

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

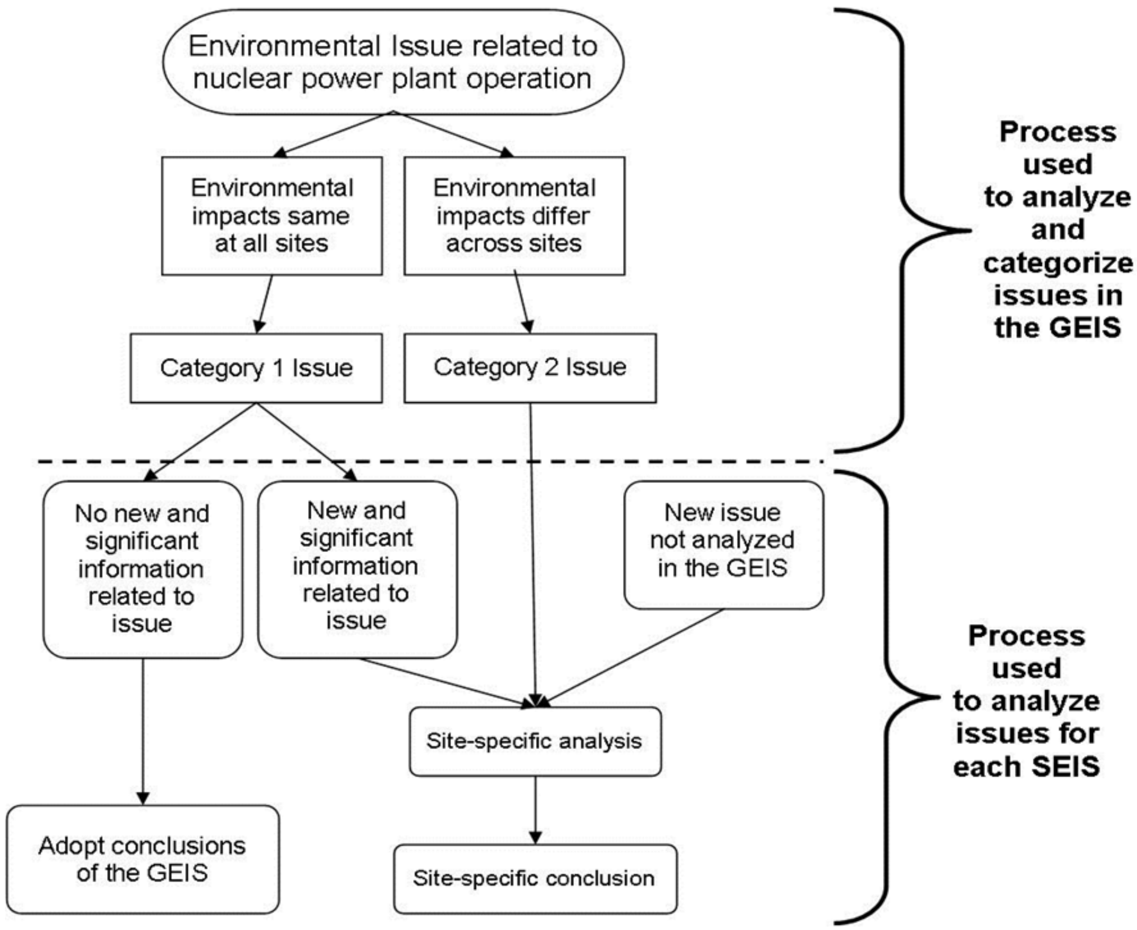
(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(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 generic issues (Category 1), no additional site-specific analysis is required in this SEIS unless new and significant information is identified. The process for identifying new and significant information is presented in Chapter 4. Site-specific issues (Category 2) are those that do not meet one or more of the criteria of Category 1 issues, and therefore, additional site-specific review for these issues is required. The results of that site-specific review are documented in the SEIS.

Figure 1–2. Environmental Issues Evaluated During License Renewal

The NRC staff initially evaluated 92 issues in the GEIS. Based on the findings of the GEIS, a site-specific analysis is required for 23 of those 92 issues.



On June 20, 2013, the NRC published a final rule (78 FR 37282) revising its environmental protection regulation, Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions.” Specifically, the final rule updates the potential environmental impacts associated with the renewal of an operating license for a nuclear power reactor for an additional 20 years. A revised GEIS (NRC 2013b), which updates the 1996 GEIS, provides the technical basis for the final rule. The revised GEIS specifically supports the revised list of NEPA issues and associated environmental impact findings for license renewal contained in Table B–1 in Appendix B to Subpart A of the revised 10 CFR Part 51. The revised GEIS and final rule reflect lessons learned and knowledge gained during previous license renewal environmental reviews. In addition, public comments received on the draft revised GEIS and rule and during previous license renewal environmental reviews were re-examined to validate existing environmental issues and identify new ones.

The final rule identifies 78 environmental impact issues, of which 17 will require plant-specific analysis. The final rule consolidates similar Category 1 and 2 issues, changes some Category 2 issues into Category 1 issues, and consolidates some of those issues with existing Category 1 issues. The final rule also adds new Category 1 and 2 issues. The new Category 1 issues include geology and soils, exposure of terrestrial organisms to radionuclides, exposure of aquatic organisms to radionuclides, human health impact from chemicals, and physical occupational hazards. Radionuclides released to groundwater, effects on terrestrial resources (non-cooling system impacts), minority and low-income populations (i.e., environmental justice), and cumulative impacts were added as new Category 2 issues.

The final rule became effective 30 days after publication in the *Federal Register*. Compliance by license renewal applicants is not required until 1 year from the date of publication (i.e., license renewal environmental reports submitted later than 1 year after publication must be compliant with the new rule). Nevertheless, under NEPA, the NRC must now consider and analyze, in its license renewal SEISs, the potential significant impacts described by the final rule's new Category 2 issues and, to the extent there is any new and significant information, the potential significant impacts described by the final rule's new Category 1 issues.

1.5 Supplemental Environmental Impact Statement

The SEIS presents an analysis that considers the environmental effects of the continued operation of GGNS, alternatives to license renewal, and mitigation measures for minimizing adverse environmental impacts. Chapter 8 contains analysis and comparison of the potential environmental impacts from alternatives while Chapter 9 presents the staff's preliminary recommendation to the Commission on whether or not the environmental impacts of license renewal are so great that preserving the option of license renewal would be unreasonable. The recommendation includes consideration of comments received during the public scoping period.

In the preparation of this SEIS for GGNS, the staff:

- reviewed the information provided in Entergy's ER,
- consulted with other Federal, State, and local agencies,
- conducted an independent review of the issues during a site audit, and
- considered the public comments received during the scoping process.

New information can be identified from a number of sources, including the applicant, NRC, other agencies, or public comments. If a new issue is revealed, then it is first analyzed to determine whether it is within the scope of the license renewal evaluation. If it is not addressed in the GEIS then the NRC determines its significance and documents its analysis in the SEIS.

> **New and significant information** either:
>
> (1) identifies a significant environmental issue not covered in the GEIS, or
>
> (2) was not considered in the analysis in the GEIS and leads to an impact finding that is different from the finding presented in the GEIS.

1.6 Cooperating Agencies

During the scoping process, no Federal, State, or local agencies were identified as cooperating agencies in the preparation of this SEIS.

1.7 Consultations

The *Endangered Species Act of 1973*, as amended; the *Magnuson–Stevens Fisheries Management Act of 1996*, as amended; and the *National Historic Preservation Act of 1966* require that Federal agencies consult with applicable State and Federal agencies and groups prior to taking action that may affect endangered species, fisheries, or historic and archaeological resources, respectively. Below are the agencies and groups with whom the NRC consulted; Appendix D to this report includes copies of consultation documents.

- Advisory Council on Historic Preservation
- National Marine Fisheries Service
- U.S. Fish and Wildlife Service, Mississippi Field Office
- U.S. Fish and Wildlife Service, Louisiana Field Office
- Mississippi Band of Choctaw Indians
- Jena Band of Choctaw Indians
- Choctaw Nation of Oklahoma
- Tunica-Biloxi Tribe of Louisiana

1.8 Correspondence

During the course of the environmental review, the NRC staff contacted the Federal, State, regional, local, and tribal agencies listed in Section 1.7, as well as the following:

- Mississippi Department of Archives and History
- Louisiana Division of Historic Preservation
- Mississippi Natural Heritage Program
- Louisiana Natural Heritage Program

Appendix E contains a chronological list of all the documents sent and received during the environmental review.

A list of persons who received a copy of this SEIS is provided in Chapter 11.

1.9 Status of Compliance

Entergy is responsible for complying with all NRC regulations and other applicable Federal, State, and local requirements. A description of some of the major Federal statutes can be found in Appendix H of the GEIS. Appendix C to this SEIS includes a list of the permits and licenses issued by Federal, State, and local authorities for activities at GGNS.

1.10 References

10 CFR Part 51. *Code of Federal Regulations*, Title 10, *Energy*, Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulator Activities.”

76 FR 80980. U.S. Nuclear Regulatory Commission, Washington DC, “Notice of Acceptance for Docketing of the Application and Notice of Opportunity for Hearing Regarding Renewal of Facility Operating License No. NPF-29 for an Additional 20-Year Period, Entergy Operations, Inc., Grand Gulf Nuclear Station.” *Federal Register* 76(248): 80980-80982, December 27, 2011.

76 FR 81996. U.S. Nuclear Regulatory Commission, Washington DC, “Entergy Operations, Inc.; Notice of Intent To Prepare an Environmental Impact Statement and Conduct Scoping Process for Grand Gulf Nuclear Station, Unit 1.” *Federal Register* 76(250): 81996–81998, December 29, 2011.

78 FR 37282. U.S. Nuclear Regulatory Commission. "Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses." *Federal Register* 78(119): 37282-37324. June 20, 2013.

Atomic Energy Act of 1954. 42 U.S.C. §2011, et seq.

Endangered Species Act of 1973, as amended. 16 U.S.C. §1531, et seq.

[Entergy] Entergy Operations, Inc. 2011a. *Grand Gulf Nuclear Station, Unit 1, License Renewal Application*, *Appendix E, Applicant's Environmental Report, Operating License Renewal Stage.* Agencywide Documents Access and Management System (ADAMS) Accession No. ML11308A234.

[Entergy] Entergy Operations, Inc. 2011b*. Grand Gulf Nuclear Station, Unit 1—License Renewal Application*. October 2011. ADAMS Accession No. ML11308A101.

Magnuson–Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996. 16 U.S.C. §1855, et seq.

National Environmental Policy Act of 1969, as amended. 42 U.S.C. §4321, et seq.

National Historic Preservation Act of 1966. 16 U.S.C. §470, et seq.

[NRC] U.S. Nuclear Regulatory Commission. 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, Volumes 1 and 2. Washington DC. May 1996. ADAMS Accession Nos. ML040690705 and ML040690738.

[NRC] U.S. Nuclear Regulatory Commission. 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report, "Section 6.3–Transportation, Table 9.1, Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants*, Final Report, NUREG-1437, Volume 1, Addendum 1. Washington DC. August 1999. ADAMS Accession No. ML040690720.

[NRC] U.S. Nuclear Regulatory Commission. 2012a. "Summary of Public Scoping Meetings Conducted on January 31, 2012, Related to the Review of the Grand Gulf Nuclear Station, Unit 1, License Renewal Application." February 2012. ADAMS Accession No. ML12044A151.

[NRC] U.S. Nuclear Regulatory Commission. 2012b. "Summary of Site Audit Related to the Environmental Review of the License Renewal Application for Grand Gulf Nuclear Station, Unit 1." May 21, 2012. ADAMS Accession No. ML12116A060.

[NRC] U.S. Nuclear Regulatory Commission. 2012c. Staff Requirements, SECY-12-0063 – Final Rule: Revisions to Environmental Review for Renewal of Nuclear Power Plant Operating Licenses (10 CFR Part 51; RIN 3150–AI42). December 6, 2012. ADAMS Accession No. ML12341A134.

[NRC] U.S. Nuclear Regulatory Commission. 2013a. "Environmental Impact Statement, Scoping Process, Summary Report," April 2013. ADAMS Accession No. ML12201A623.

[NRC] U.S. Nuclear Regulatory Commission. 2013b. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. Washington, DC: Office of Nuclear Reactor Regulation. NUREG-1437, Revision 1, Volumes 1, 2, and 3. June 2013. ADAMS Accession Nos. ML13106A241, ML13106A242, and ML13106A244.

2.0 AFFECTED ENVIRONMENT

Grand Gulf Nuclear Station (GGNS) is located in Claiborne County, Mississippi, on the east bank of the Mississippi River, approximately 25 miles (mi) (39 kilometers (km)) south-southwest of Vicksburg, Mississippi. Figure 2–1 and Figure 2–2 present the 50-mi (80-km) and 6-mi (10-km) vicinity maps, respectively. In this supplemental environmental impact statement (SEIS), the "affected environment" is the environment that currently exists at and around GGNS. Because existing conditions are at least partially the result of past construction and operation at the plant, the impacts of these past and ongoing actions, and how they have shaped the environment, are presented here. Section 2.1 of this SEIS describes the facility and its operation, and Section 2.2 discusses the affected environment.

2.1 Facility Description

GGNS is a single-unit nuclear power plant that began commercial operation in July 1985. The property boundary shown in Figure 2–3 encloses approximately 2,100 acres (ac), or 850 hectares (ha). Currently, the property is approximately 2,015 ac (816 ha) because of the loss of approximately 85 ac (34 ha) from erosion by the Mississippi River (Entergy 2011a). The original application submitted in 1972 for GGNS was for a two-unit nuclear power facility. Construction on Unit 2 was halted before completion in 1979. The majority of the Unit 2 power block buildings were completed, along with the outer cylindrical concrete wall of the reactor containment building. The switchyard was designed and constructed for two units (NRC 2006a).

The most conspicuous structures on the GGNS site include the natural draft cooling tower, the turbine building, the Unit 1 reactor containment building, the Unit 2 (cancelled) reactor containment outer cylindrical concrete wall, the auxiliary cooling tower, and various other buildings.

2.1.1 Reactor and Containment Systems

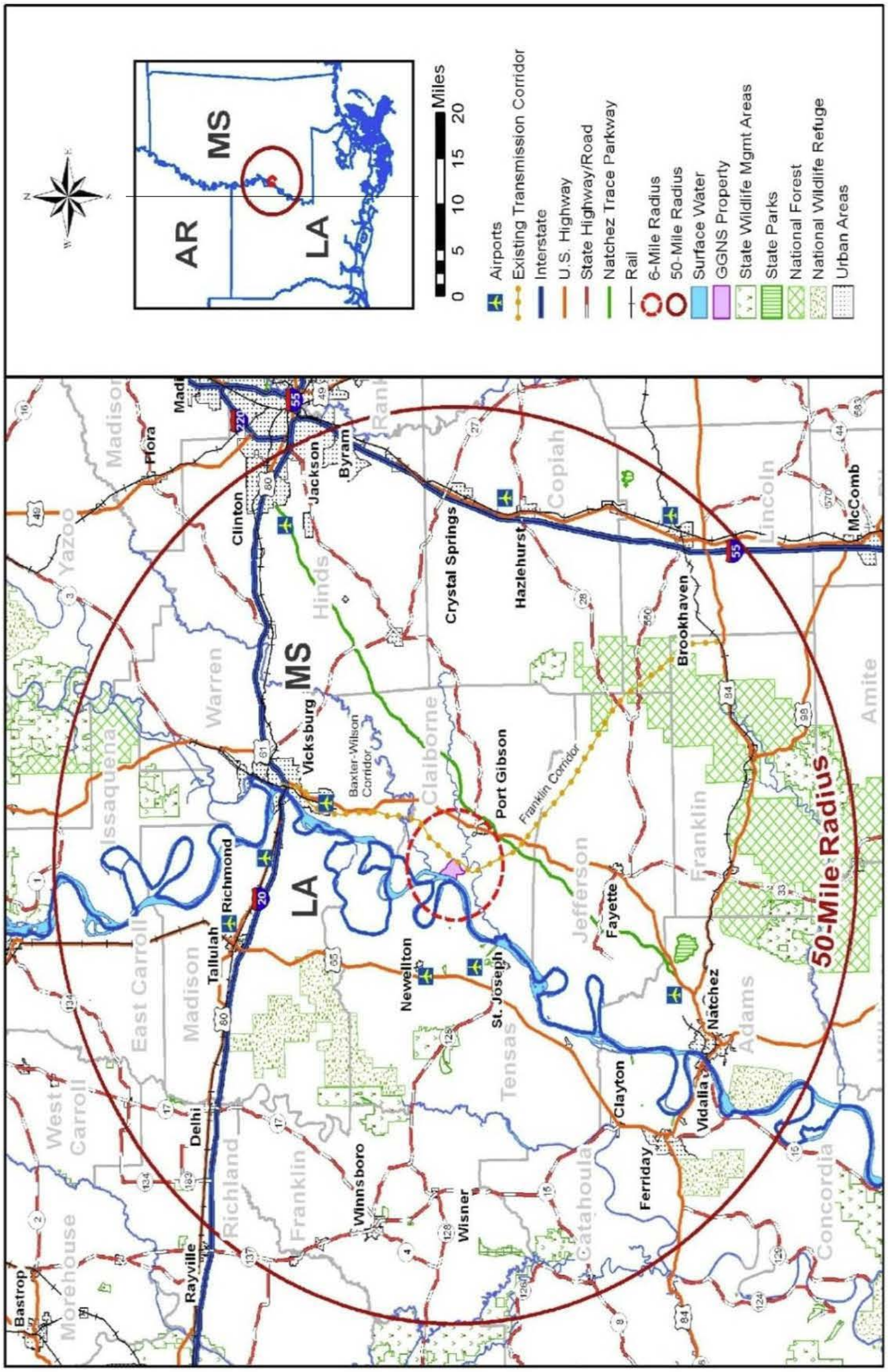
The GGNS nuclear reactor system is a single-cycle, forced-circulation, General Electric Mark III boiling water reactor (BWR). The reactor core heats water to make steam that is dried by steam separators and dryers located in the upper portion of the reactor vessel. The steam is then directed to the main turbine through the main steam lines where it turns the turbine generator to produce electricity.

Fuel for GGNS is made of low-enrichment (less than 5 percent by weight) high-density ceramic uranium dioxide fuel pellets, with a maximum average burnup level of less than 62,000 megawatt-days/metric ton of uranium. GGNS operates on an 18-month refueling cycle and plans to switch to a 24-month refueling cycle in the future.

The functional design basis of the containment, including its penetrations and isolation valves, is to contain, with adequate design margin, the energy released from a design basis loss-of-coolant accident. It also provides a leak-tight barrier against the uncontrolled release of radioactivity to the environment, even assuming a partial loss of engineered safety features.

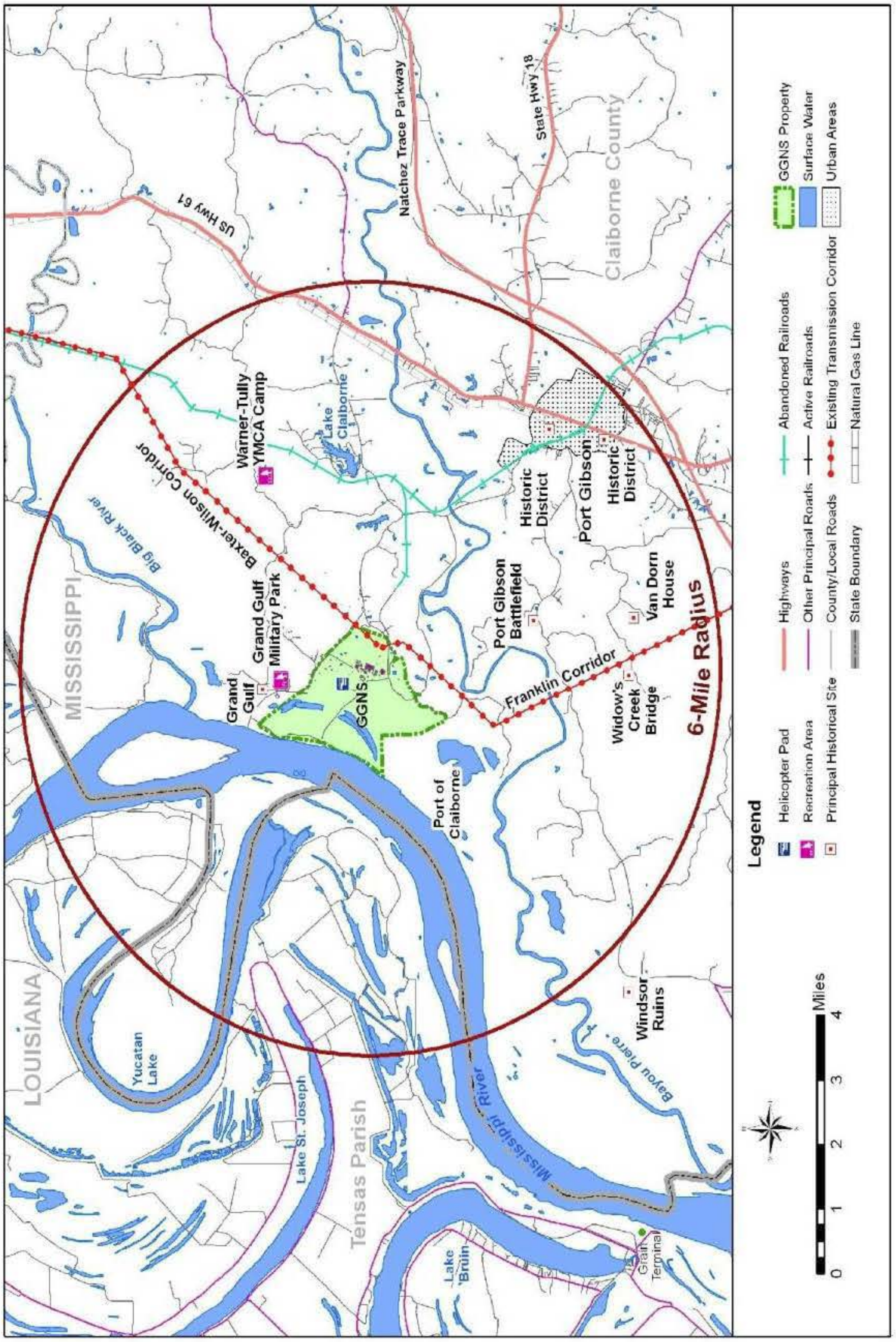
The reactor and related systems are enclosed in containment and enclosure structures. The containment structure encloses the reactor coolant system, drywell, suppression pool, upper pool, and some of the engineered safety feature systems and supporting systems. The enclosure building and auxiliary building are combined to form a secondary containment which

1 **Figure 2–1. Location of GGNS, 50-mi (80-km) Vicinity**



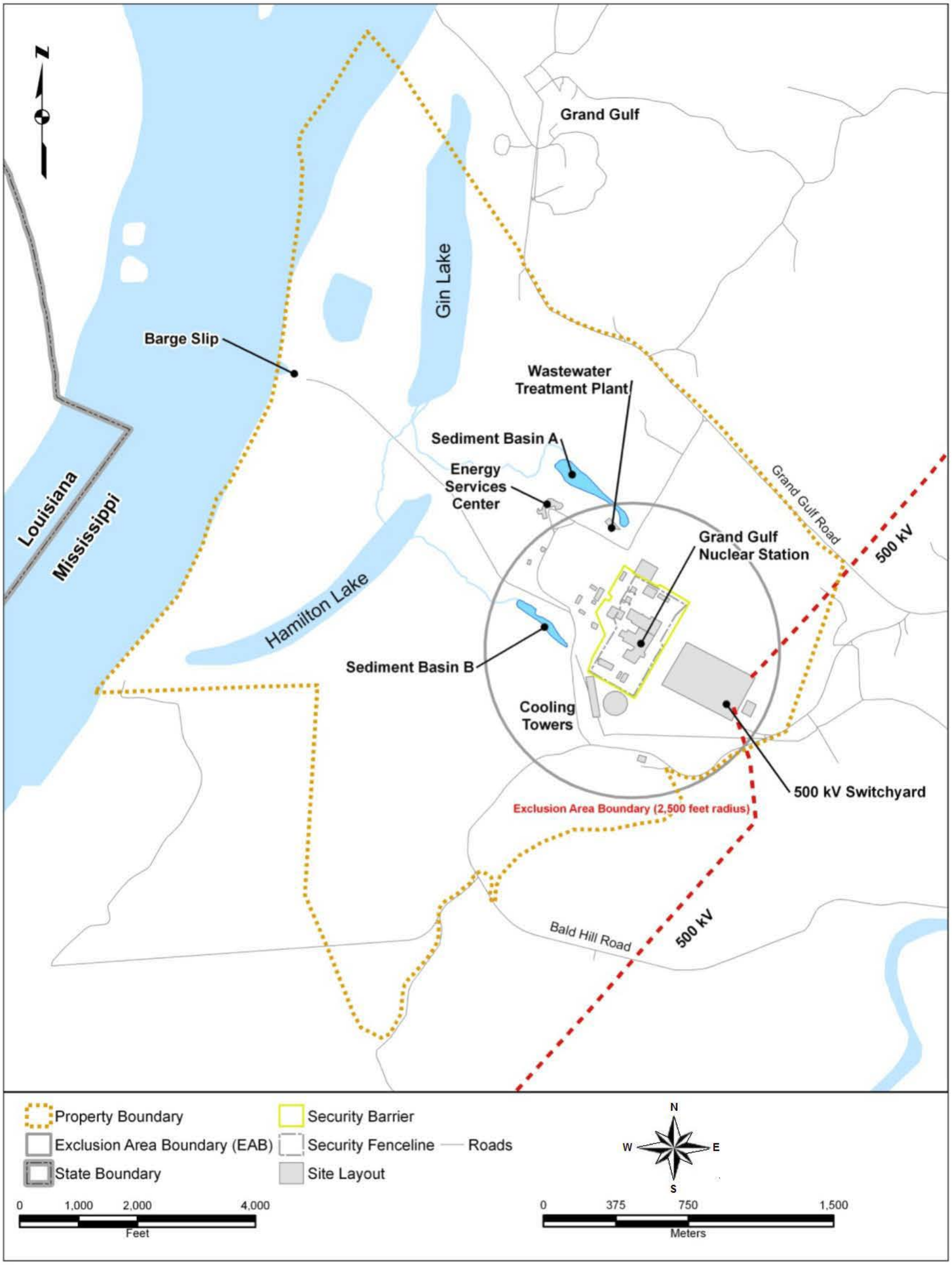
2 Source: Entergy 2011a

Figure 2–2. Location of GGNS, 6-mi (10-km) Vicinity



Source: Entergy 2011a

1 **Figure 2–3. GGNS, General Site Layout**



2 Source: Modified from Entergy 2011a

maintains a negative pressure in the volume between the containment and enclosure/auxiliary building. These two containment systems and associated engineered safety features are designed and maintained to minimize the release of airborne radioactive materials under accident conditions.

2.1.2 Radioactive Waste Management

GGNS radioactive waste systems collect, treat, and dispose of radioactive wastes that are byproducts of plant operations. These byproducts are activation products associated with nuclear fission, reactor coolant activation, and non-coolant material activation.

Release of liquid and gaseous effluents are controlled to meet the limits specified in Title 10, *Code of Federal Regulations* (CFR) Part 20 and 10 CFR Part 50, Appendix I, through the Radioactive Effluent Controls Program defined in the GGNS technical specifications. Operation procedures for the radioactive waste systems ensure that radioactive wastes are safely processed and discharged from GGNS. The systems are designed and operated to ensure that the quantities of radioactive materials released from GGNS are as low as is reasonably achievable (ALARA) and within the dose standards set forth in 10 CFR Part 20, "Standards for protection against radiation," and Appendix I to 10 CFR Part 50, "Domestic licensing of production and utilization facilities." The GGNS Offsite Dose Calculation Manual (ODCM) contains the methods and parameters used to calculate offsite doses resulting from radioactive effluents. These methods are used to ensure that radioactive material discharges from GGNS meet regulatory dose standards.

Radioactive wastes resulting from GGNS plant operations are classified as liquid, gaseous, or solid. Liquid radioactive wastes are generated from liquids received directly from portions of the reactor coolant system or were contaminated by contact with liquids from the reactor coolant system. Gaseous radioactive wastes are generated from gases or airborne particulates vented from reactor and turbine equipment containing radioactive material. Solid radioactive wastes are solids from the reactor coolant system, solids that came into contact with reactor coolant system liquids or gases, or solids used in the steam and power conversion system.

Reactor fuel that has exhausted a certain percentage of its fissile uranium content is referred to as spent fuel. Spent fuel assemblies that are removed from the reactor core are replaced with fresh fuel assemblies during routine refueling outages. Spent nuclear fuel from the GGNS reactor is stored on site in a spent fuel pool and an independent spent fuel storage installation (ISFSI) (Entergy 2011a).

2.1.2.1 Radioactive Liquid Waste

The GGNS liquid radwaste system collects, processes, recycles, and disposes of potentially radioactive wastes produced during operation of the plant. The liquid effluents from the liquid radwaste system are monitored continuously, and the discharges are terminated if the effluents exceed preset radioactivity levels, which are specified in the GGNS ODCM. The liquid radwaste system is comprised of a group of subsystems designed to collect and treat different types of liquid waste, designated as the equipment drain processing subsystem (clean radwaste), floor drain processing subsystem (dirty radwaste), chemical waste subsystem, and miscellaneous supporting subsystems.

Liquid wastes that accumulate in radwaste drain tanks or in sumps are transferred to collection and sample tanks in the radwaste building. The liquid wastes are processed through filters and demineralizers and returned to the condensate system or released from the plant.

Control of discharges from the radwaste system includes a radiation monitor, an effluent flow control valve, and dilution water flow rate monitoring equipment. Radioactive liquid wastes are subject to the sampling and analysis program described in the ODCM. This enables GGNS to handle radioactive liquid releases in accordance with applicable regulations and impacts to offsite areas will be consistent with ALARA concepts (Entergy 2011a).

2.1.2.2 Radioactive Gaseous Waste

The gaseous radwaste system processes and controls the release of gaseous radioactive effluents to the atmosphere. Gaseous effluents are released from the radwaste building vent, the turbine building vent, the containment vent, the auxiliary vent, and standby gas treatment system.

Radioactive gas is continuously removed from the main condenser by the air ejector during plant operation. It is then filtered, cooled, and discharged to the environment. GGNS uses continuous radiation monitors to ensure radioactive gaseous effluent discharges are within specifications in the ODCM (Entergy 2011a).

2.1.2.3 Radioactive Solid Waste

The solid waste management system collects, processes, and packages solid radioactive wastes for storage and offsite shipment and permanent disposal. GGNS has developed long-term plans that would ensure radwaste generated during the license renewal term would either be stored on site in existing structures or shipped to an offsite licensed facility for processing and disposal.

Wet wastes are collected, dewatered, packaged in containers and stored before offsite shipment.

Dry wastes usually consist of small tools, air filters, miscellaneous paper, rags, equipment parts that cannot be effectively decontaminated, wood, and solid laboratory waste. Compressible wastes can be shipped off site and compacted to reduce their volume. Noncompressible wastes are packaged in appropriate containers. Because of its low radiation levels, this waste can be stored until enough is accumulated to permit economic transportation off site for final disposal or further processing.

GGNS currently transports radioactive waste to licensed processing facilities in Tennessee, such as the Studsvik, Duratek (owned by Energy*Solutions*), or Race (owned by Studsvik) facilities, where wastes are further processed before they are sent to a facility such as Energy*Solutions* in Clive, Utah, for disposal. GGNS also may transport material from an offsite processing facility to a disposal site or back to the plant site for reuse or storage. GGNS radioactive waste shipments are packaged in accordance with both NRC and Department of Transportation (DOT) requirements (Entergy 2011a).

2.1.2.4 Low-Level Mixed Wastes

Currently, no mixed wastes are generated or stored on the GGNS site. If they were, they would be managed and transported to an offsite facility licensed to accept and manage the wastes in accordance with appropriate GGNS and Entergy procedures (Entergy 2011a).

2.1.3 Nonradiological Waste Management

The Resource Conservation and Recovery Act of 1976 (RCRA) governs nonradioactive hazardous and nonhazardous wastes produced at GGNS. The U.S. Environmental Protection Agency (EPA) is ultimately responsible for implementing RCRA and regulations governing the disposal of solid and hazardous waste are contained in 40 CFR Parts 239–299. Specifically, RCRA Subtitle D regulations for solid (nonhazardous) waste are contained in 40 CFR Parts 239–259. RCRA Subtitle C regulations for hazardous waste are contained in

40 CFR Parts 260–279. RCRA Subtitle C establishes a system for controlling hazardous waste from "cradle to grave." RCRA Subtitle D encourages states to develop comprehensive plans to manage nonhazardous solid waste and mandates minimum technological standards for municipal solid waste landfills. EPA authorizes states to implement the RCRA hazardous waste program through their rulemaking process.

EPA granted initial authorization to Mississippi to operate its hazardous waste program on June 13, 1984. The Mississippi Department of Environmental Quality (MDEQ) administers the State's hazardous waste regulations and addresses the identification, generation, minimization, transportation, and final treatment, storage, or disposal of hazardous and nonhazardous waste. Mississippi's hazardous waste regulations can be found in MDEQ, Office of Pollution Control, Hazardous Waste Management Regulations, HW-1. Mississippi's solid waste law is contained in Chapter 17, "Solid Wastes Disposal Law of 1974," of Title 17, "Local Government; Provisions Common to Counties and Municipalities." As EPA amends its RCRA regulations, Mississippi has amended its program to maintain consistency with the national standards.

2.1.3.1 Nonradioactive Waste Streams

GGNS generates nonradioactive waste as part of routine maintenance of equipment, cleaning activities, and plant operations. Nonradioactive waste generated at GGNS includes batteries, fluorescent lamps, scrap metals, used oil, used oil filters, used tires, electronics for reconditioning, and equipment containing mercury. Nonhazardous waste generated at GGNS consists of materials such as blasting media, oil contaminated wastes, wastewater, and wastewater sludges. Hazardous waste generated at GGNS is usually a small percentage of the total waste generated at the plant. Hazardous waste generated at GGNS includes aerosols, oils and solvents, paint, and out-of-date or off-specification chemicals.

EPA recognizes the following main types of hazardous waste generators (40 CFR 260.10) based on the quantity of the hazardous waste produced:

- large quantity generators that generate 2,200 pounds (lb) (1,000 kilograms (kg)) per month or more of hazardous waste, more than 2.2 lb (1 kg) per month of acutely hazardous waste, or more than 220 lb (100 kg) per month of acute spill residue or soil;
- small quantity generators that generate more than 220 lb (100 kg) but less than 2,200 lb (1,000 kg) of hazardous waste per month; and,
- conditionally exempt small quantity generators that generate 220 lb (100 kg) or less per month of hazardous waste, 2.2 lb (1 kg) or less per month of acutely hazardous waste, or less than 220 lb (100 kg) per month of acute spill residue or soil.

Mississippi has adopted EPA's regulations relating to RCRA Subpart C and Subpart D wastes and MDEQ recognizes GGNS as a small quantity generator of hazardous wastes. The NRC staff reviewed Waste Minimization Certified Reports that GGNS submitted to MDEQ, Environmental Permits Division, for the years 2006 through 2010. These reports document the types and quantities of nonradioactive waste generated at GGNS and verify the status of GGNS as a small quantity generator of hazardous waste.

Conditions and limitations for wastewater discharge by GGNS are specified in National Pollution Discharge Elimination System (NPDES) Permit No. MS0029521. Radioactive liquid waste is addressed in Section 2.1.2 of this SEIS. Section 2.2.4 provides more information about the GGNS NPDES permit and permitted discharges.

The Emergency Planning and Community Right-to-Know Act (EPCRA) requires applicable facilities to supply information about hazardous and toxic chemicals to local emergency planning authorities and the EPA (42 USC 11001). GGNS is subject to Federal EPCRA reporting requirements. As such, GGNS submits an annual Section 312 (Tier II) report on hazardous substances to the Claiborne County Emergency Planning Committee and to the Mississippi Emergency Management Agency.

2.1.3.2 Pollution Prevention and Waste Minimization

EPA encourages the use of environmental management systems (EMS) for organizations to assess and manage the environmental impacts associated with their activities, products, and services in an efficient and cost-effective manner. The EPA defines an EMS as "a set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency." EMSs help organizations fully integrate a wide range of environmental initiatives, establish environmental goals, and create a continuous monitoring process to help meet those goals. The EPA Office of Solid Waste especially advocates the use of EMSs at RCRA-regulated facilities to improve environmental performance, compliance, and pollution prevention (EPA 2010).

Related to the use of EMSs, Entergy, the parent company for GGNS, has established a Waste Minimization Plan for its fleet of nuclear power plants. The plan describes the activities plant personnel must take to reduce, to the extent feasible, the hazardous, hazardous/radioactive, and nonhazardous wastes generated, treated, stored, or disposed. The Waste Minimization Plan is used in conjunction with Entergy's fleet procedures and the individual plant's procedures to minimize, to the maximum extent possible, the generation of all types of waste.

Pollution-prevention and waste-minimization efforts that GGNS uses are summarized in annual Waste Minimization Certified Reports submitted to MDEQ. Entergy's Waste Minimization procedure (EN-EV-104) lists the practices used to minimize waste generation. The hierarchy for minimizing or managing waste is:

- source reduction – reduce or eliminate potential waste material,
- recycle – reuse or reclaim material instead of throwing it in the trash,
- treatment – neutralize acids or bases, and
- disposal – last resort when no other action can be taken.

2.1.4 Plant Operation and Maintenance

Maintenance activities conducted at GGNS include inspection, testing, and surveillance to maintain the current licensing basis of the facility and to ensure compliance with environmental and safety requirements. These maintenance activities include inspection requirements for reactor vessel materials, boiler and pressure vessel inservice inspection and testing, the monitoring program for maintaining structures, and maintenance of water chemistry.

Additional programs include those carried out to meet technical specification surveillance requirements, those implemented in response to the NRC generic communications, and various periodic maintenance, testing, and inspection procedures. Certain program activities are carried out during the operation of the unit, while others are carried out during scheduled refueling outages. Nuclear power plants must periodically discontinue the production of electricity for refueling, periodic inservice inspection, and scheduled maintenance. GGNS operates on an 18-month refueling cycle.

2.1.5 Power Transmission System

Three 500-kilovolt (kV) transmission lines were constructed to connect GGNS to the regional power grid: the Baxter-Wilson line, the Franklin line, and a short, unnamed tie-in line that connects the Unit 1 turbine building to the GGNS station switchyard. Entergy Mississippi, Inc. (EMI) owns and operates these lines. This section summarizes each line and discusses vegetative maintenance procedures. Figures 2–1 and 2–2 depict the transmission line corridors.

The Baxter-Wilson line is a 22-mi (35-km) single-circuit 500-kV line that extends north from the GGNS switchyard to the Baxter-Wilson Steam Electric Station Extra High Voltage (EHV) switchyard in Claiborne County, Mississippi. Its corridor is 200 feet (ft) (60 meters (m)) wide and traverses rural, sparsely populated agricultural and forested land.

The Franklin line is a 43.6-mi (70.2-km) single-circuit 500-kV line that extends southeast from the GGNS switchyard to the Franklin EHV Switching Station in Franklin County, Mississippi. Its corridor is 200 ft (60 m) wide and traverses four major highways, the Bayou Pierre and Homochitto Rivers, and a portion of the Homochitto National Forest.

The third transmission line extends 300 ft (90 m) from the Unit 1 turbine building to the GGNS switchyard.

> A transmission line right-of-way (ROW) is a strip of land used to construct, operate, maintain, and repair transmission line facilities. The transmission line is usually centered in the ROW. The width of a ROW depends on the voltage of the line and the height of the structures. ROWs must typically be clear of tall-growing trees and structures that could interfere with a powerline.

EMI inspects each transmission line right-of-way by air or ground at least three times per year to identify encroaching vegetation or other required maintenance. EMI follows an integrated vegetative plan that includes mechanical and manual clearing and herbicide application. The degree and type of clearance varies by line voltage and the type, growth rate, and branching characteristics of trees and vegetation. Large trees generally are trimmed or pruned to allow for adequate line clearance; smaller trees and woody vegetation may be mowed to prepare the area for followup herbicide treatments. In sensitive areas, such as streams, ponds, or other water features, EMI chooses maintenance techniques that minimize erosion. In wetlands and aquatic habitat, EMI personnel selectively apply herbicides that are EPA-approved for aquatic environments. These herbicides are applied on foot with backpack sprayers to minimize impacts. All EMI maintenance crew personnel have a U.S. Department of Agriculture (USDA) state-approved herbicide license.

Along the Franklin line, 38.6 ac (15.6 ha) of the transmission line corridor pass through the Bude Range District of the Homochitto National Forest. For this portion of the line, EMI holds a USDA Forest Service Special Use Permit for construction, operation, and maintenance of the line. EMI also uses a low-toxicity herbicide program for this portion of the transmission line corridor to promote open, grassy habitat as part of a partnership established in 2003 with the National Wild Turkey Federation (Entergy 2011a).

2.1.6 Cooling and Auxiliary Water Systems

A surface water structure to obtain cooling water from the Mississippi River does not exist at GGNS. Instead, water is pumped from Ranney wells located in an aquifer along the Mississippi River. The Ranney well system design and hydrogeology is discussed in greater detail in Section 2.1.7.

Entergy's Environmental Report (ER) (Entergy 2011a) provides information on the circulating water system that removes excess heat from the reactor. The circulating water system cools the main condenser. Heat is removed from the circulating water system by cooling towers, which dissipate the heat to the atmosphere. The main cooling tower is a natural draft cooling tower. It does not require the use of fans to operate. It may operate alone or it may operate in tandem with a forced draft auxiliary cooling tower, which use fans. When both tower systems are in service, the maximum temperature of the cooling water delivered to the main condenser by the circulating water system is 32.2 °C (90 °F).

Five Ranney wells provide makeup water to replace water lost from the cooling towers by drift, evaporation, and blowdown. During normal operation, as many wells and pumps as required are operated to meet the plant demand. Blowdown (water intentionally removed from the cooling water system to avoid concentration of impurities) is returned to the Mississippi River through a 54-inch (in.) (137-centimeter (cm)) diameter pipeline (Entergy 2011a).

The temperature of the water exiting the 54-in (137-cm) discharge pipeline is monitored throughout the year as required by MDEQ NPDES Permit MS0029521. GGNS has not violated the thermal conditions of the permit. Therefore, water temperatures in the Mississippi River as a result of this discharge have not exceeded a water temperature change of 2.8 °C (5.0 °F) relative to the upriver temperature, outside a mixing zone not exceeding a maximum width of 60 ft (18.5 m) from the river edge and a maximum length of 6,000 ft (1,829 m) downstream from the point of discharge, as measured at a depth of 5 ft (1.5 m). Further, the maximum water temperatures outside the mixing zone have not exceeded 32.2 °C (90 °F), except when ambient river temperatures approach or exceed this value (GGNS 2010a).

Should an emergency plant shutdown occur, a standby service water system would supply auxiliary cooling to the reactor. Makeup water is provided automatically by the Ranney wells to the standby service water system basins. However, if the Ranney wells were not operable, the plant service water basins contain enough water to ensure cooling for the shutdown reactor for 30 days (GGNS 2003a).

2.1.7 Facility Water Use and Quality

Cooling water for GGNS is supplied from Ranney wells located next to the Mississippi River. A Ranney well is a radial well used to extract water from an aquifer with direct connection to a river or lake. It consists of a vertical caisson constructed into sand or gravel below the surface level of an adjacent river or lake. Screened conduits are extended horizontally from ports in the caisson. The radial arrangement of the screened conduits extending outward from the central vertical caisson forms a large infiltration gallery (Figure 2–4). Groundwater flows into the horizontal screened conduits that make up the infiltration gallery. From there, the water flows to the central caisson, where it is pumped to the surface. One advantage of using a Ranney well to extract water from a river or lake is that less water treatment may be required than if the water is directly extracted from the river or lake.

At GGNS, Ranney wells supply water from the Mississippi River by pumping water from the aquifer, which underlies the Mississippi River (NRC 2006a). Pumping from the aquifer removes suspended sediment from Mississippi River water. With the exception of suspended sediment, the water quality obtained from these wells is nearly identical to that of the Mississippi River.

Fresh (potable) water for the plant is obtained from three wells located within the site boundary and from the Crossroads, Shiloh & Ingleside (CS&I) Water Association #1 located 6 mi away from GGNS (Entergy 2011a).

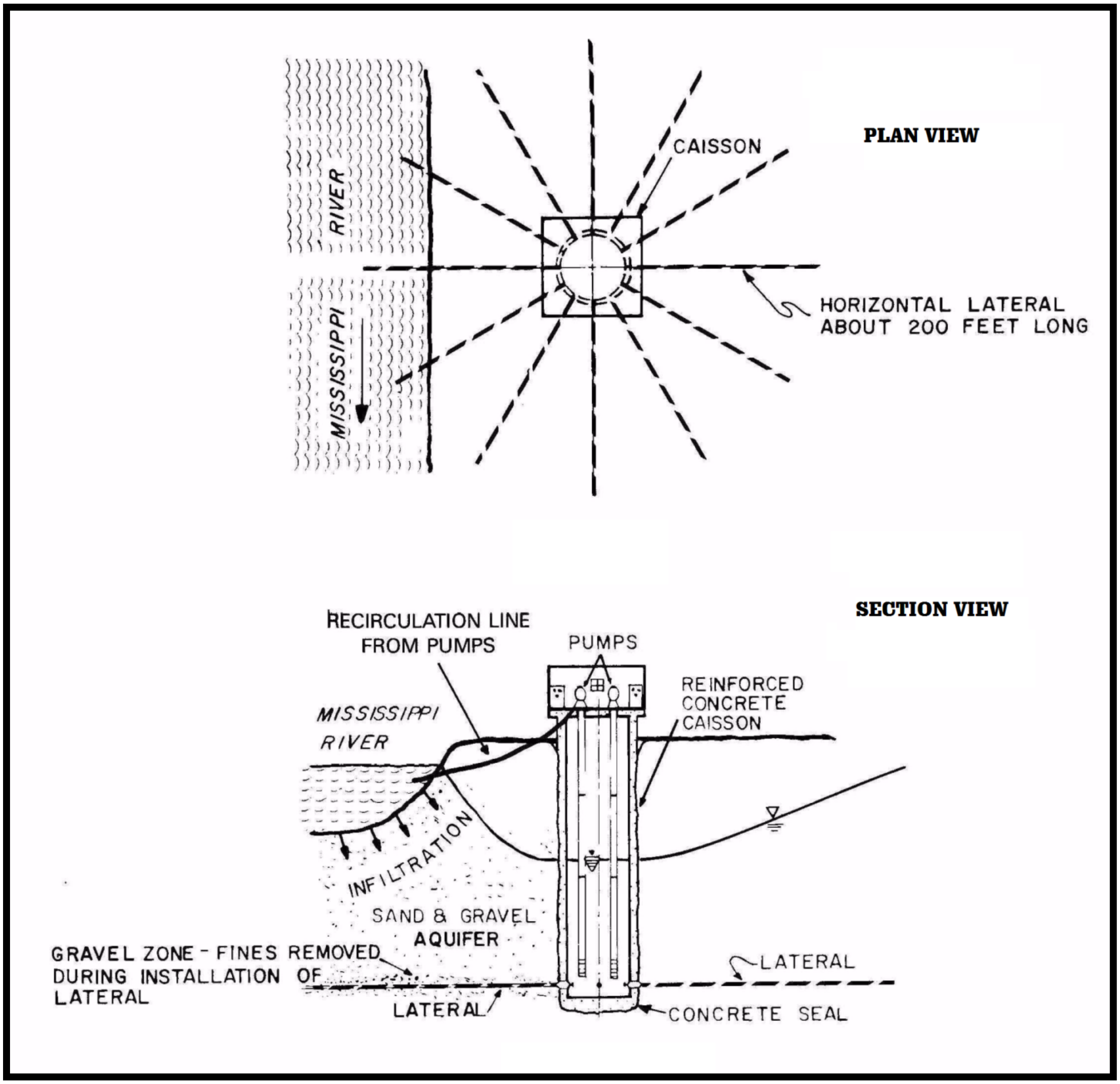
The following sections describe water use and relevant quality issues at GGNS.

2.1.7.1 Surface Water Use

Mississippi River water quality is generally hard to very hard, requiring softening to avoid scale formation when heated in a cooling system (NRC 2006). In March 2012, four Ranney wells supplied water from the Mississippi River by pumping water from the Mississippi River Alluvial Aquifer. Most of this water cooled the reactor, but some supplied makeup water to the standby service water cooling towers, administration building, and fire protection system. Each of the Ranney wells is permitted by MDEQ to operate at a maximum production rate of 10,000 gallons per minute (gpm) (0.63 cubic meters per second (m^3/s)) (Entergy 2011a). This would produce a total maximum production rate from the Mississippi River of 40,000 gpm (2.5 m^3/s). However, from 2005 through 2010, the four Ranney wells generated a combined annual water production rate that was much less than permitted amounts. This is because infiltration rates have declined over time due to sediment buildup in the screened conduits. Over this time period, the production rate from all four wells averaged approximately 22,396 gpm (1.4 m^3/s).

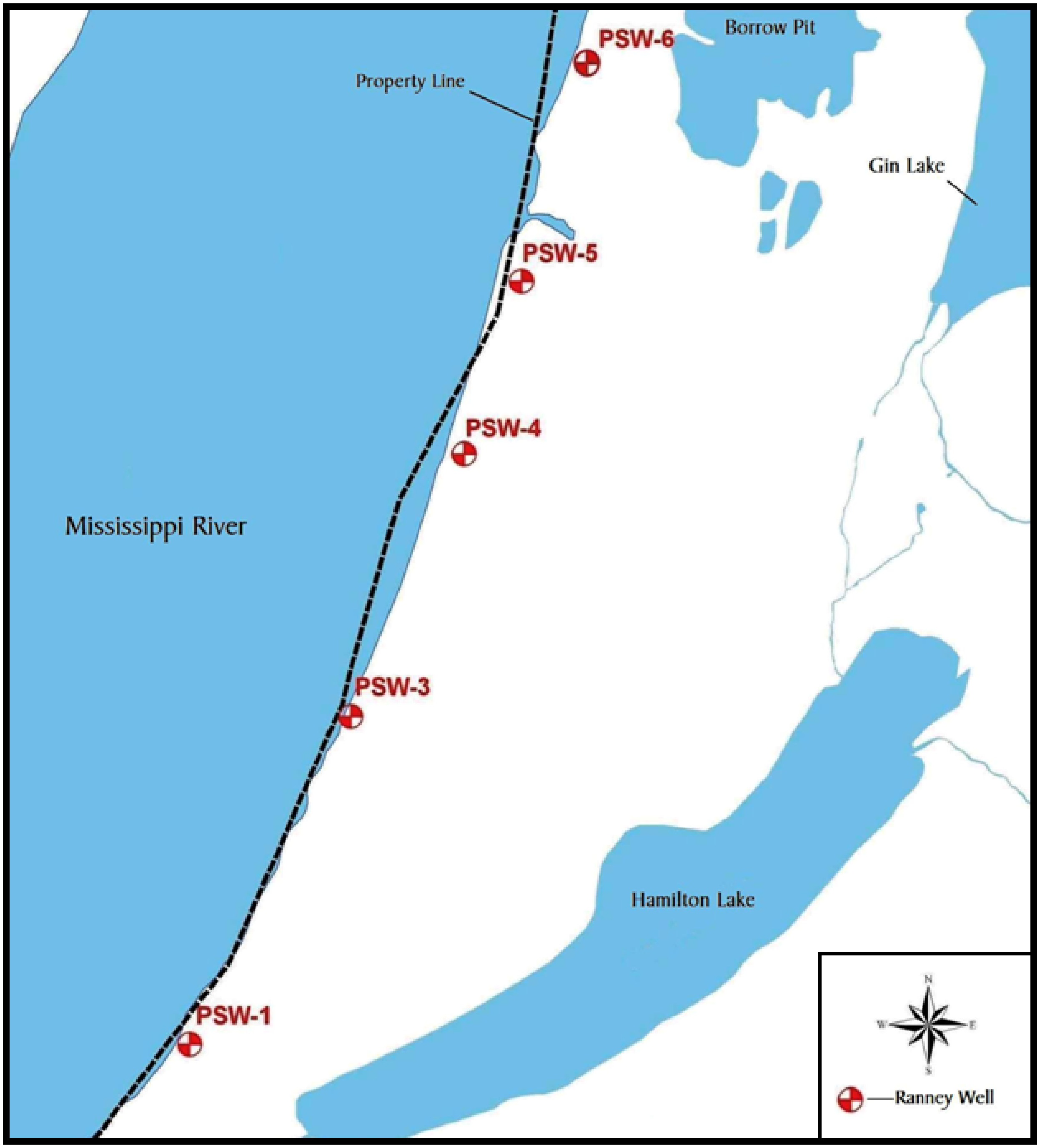
A new Ranney well (well number PSW-6 on Figure 2–5) was installed and became operational in August 2012. Its purpose is to ensure that adequate plant cooling water is maintained. As with the other Ranney wells, this well is located next to the Mississippi River. The estimated average combined production rate of Mississippi River water is approximately 27,860 gpm (1,758 m^3/s). Of this volume, 7,170 gpm (0.45 m^3/s) of blowdown is estimated to be returned to the Mississippi River through a 54-in. (137-cm) diameter discharge pipeline. An estimated 20,690 gpm (1.31 m^3/s) of water is lost to the atmosphere, mainly through evaporation and drift from the cooling towers (Entergy 2011a).

1 **Figure 2–4. Plan (Map) View and Cross Section View of Ranney Well at GGNS**



2 Source: Modified from Entergy 2011a

1 **Figure 2–5. GGNS Ranney Well Locations**



2 Source: Modified from Entergy 2011a

2.1.7.2 Groundwater Use

As discussed in Section 2.1.7.1, the GGNS reactor cooling system relies on induced infiltration from the Mississippi River obtained by a system of Ranney collector wells (Entergy 2012a). The total annual pumping from these four wells amounts to 10,800–13,100 million gallons (gal) (40.9–49.6 million m^3) per year (Entergy 2006, 2010b, 2011c).

Three wells (North Construction Well and the North and South Drinking Water Wells), located within the site boundary and northeast of the main plant buildings, produce water used for domestic purposes, once-through cooling for plant air conditioners, and for regenerating the water softeners (Figure 2–6). After it has been used, this water flows to the Mississippi River through a 54-in. (137-cm) diameter pipeline, either after it has been processed by the onsite sewage treatment facility or as other permitted surface water discharges. Total annual pumping from these three wells amounts to 32–39 million gal/yr (0.12–0.15 million m^3/yr) (Entergy 2006, 2010b, 2011c). The average rate of water these wells produce from the groundwater in the Upland Terrace Deposits is estimated to be 67 gpm (0.3 m^3/s).

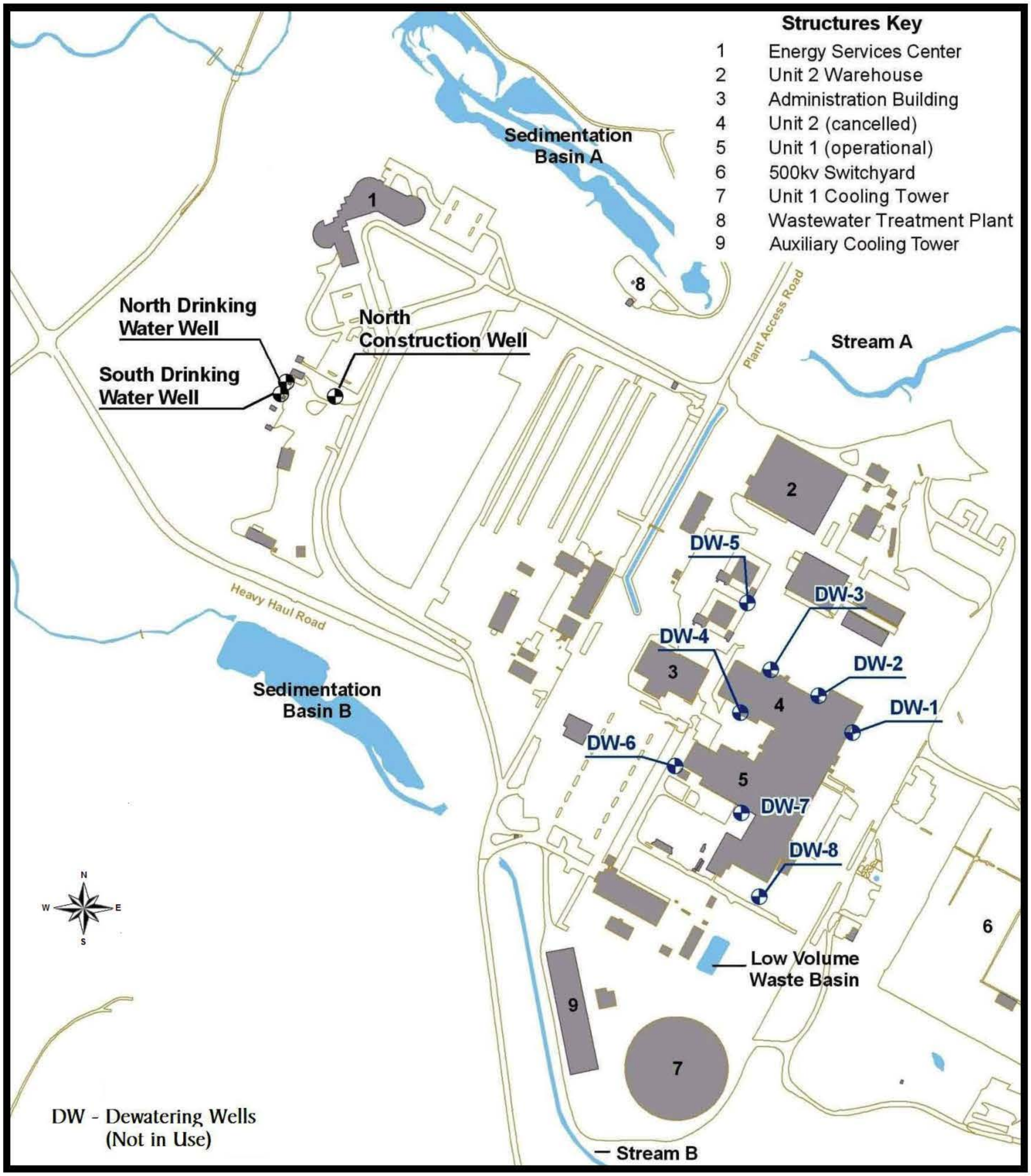
GGNS also obtains potable water from the CS&I Water Association #1. This public water system supplies potable water needs for the GGNS recreational vehicle trailer park, firing range, health physics calibration laboratory, and environmental garden areas. The water association obtains its water from three wells completed in the Catahoula Formation at a location 6 mi (10 km) to the east-northeast of GGNS. The amount of water supplied to GGNS by the water association is estimated to be 286,740 gal/yr (108.5 m^3/yr) (Entergy 2011a).

2.2 Surrounding Environment

GGNS is located in Claiborne County, Mississippi, on the east bank of the Mississippi River, approximately 25 mi (39 km) south-southwest of Vicksburg, Mississippi. The site is bounded by the Mississippi River on the west. The western half of the site lies in the Mississippi River floodplain. This portion of GGNS has generally level topography, with elevations varying from 55 to 75 ft (16.7 to 22.8 m) above mean sea level (MSL) (Figure 2–7). This area also contains Hamilton and Gin Lakes. These oxbow lakes were once a channel of the Mississippi River. They have an average depth of approximately 8 to 10 ft (2.4 to 3 m). The reactor building and most of the associated facilities are located in the eastern half of the site. This portion of GGNS is separated from the lowland plain by steep bluffs that trend north-south through the middle portion of the site. The topography in the upland area rises from the floodplain as rough, irregular bluffs, with steep slopes and deep-cut stream valleys and drainage courses. The surface topography in the upland area ranges from 80 to 200 ft (24 to 61 m) above MSL.

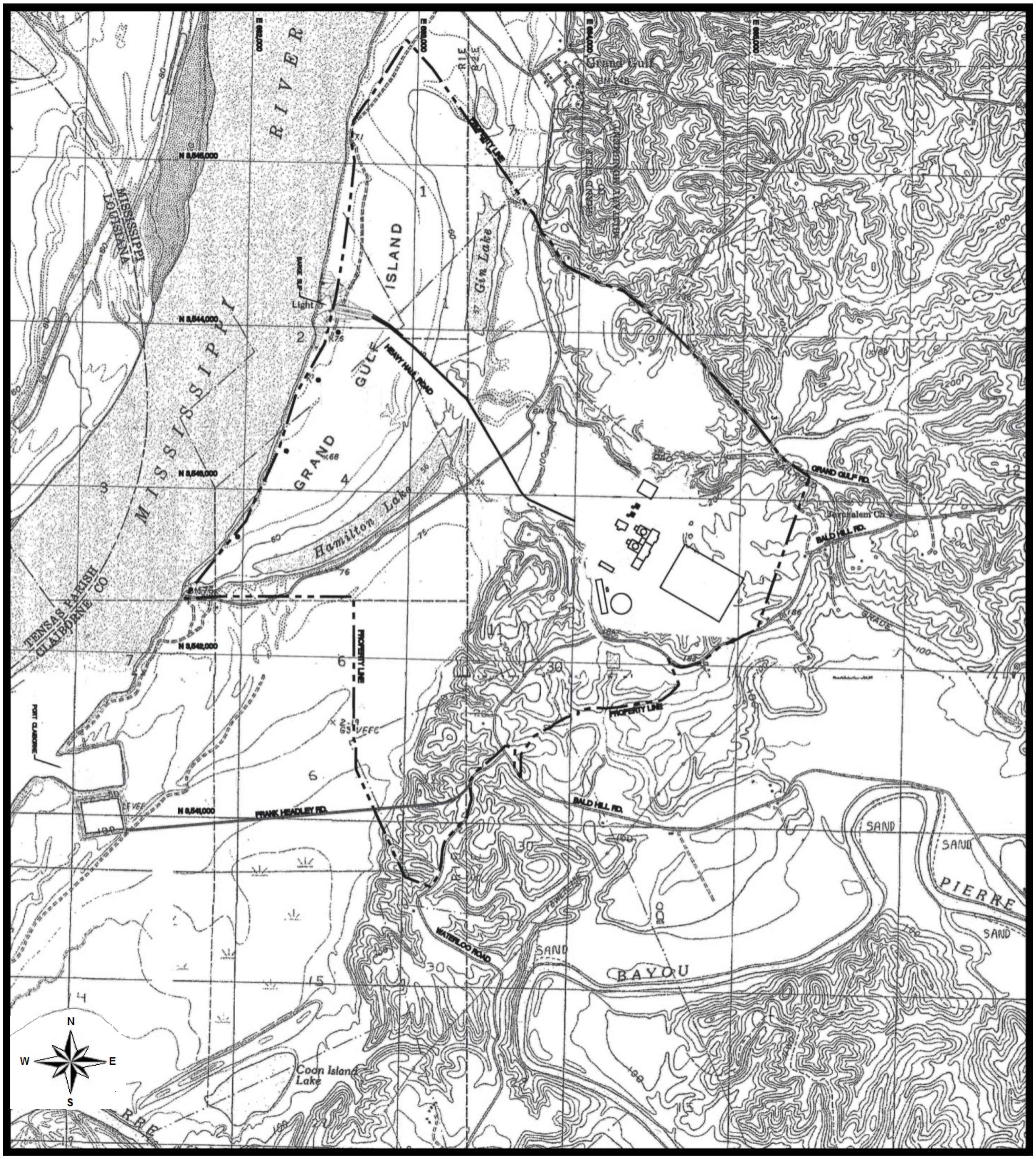
A 6-mile radius from the center of the power block location (Figure 2–2) includes a portion of Claiborne County, Mississippi, on the east side of the Mississippi River and Tensas Parish, Louisiana, on the west side of the Mississippi River. The nearest incorporated community is the City of Port Gibson, which has an estimated population of less than 1,600 people located about 6 mi (9 km) southeast of the site. The Grand Gulf Military Park, a Mississippi State park, borders part of the north side of the property. The region surrounding GGNS consists mainly of forest and agricultural lands (Entergy 2011a).

1 **Figure 2–6. GGNS Upland Complex Aquifer Permitted Wells**



2 Source: Modified from Entergy 2011a

Figure 2–7. Topographic Map of GGNS Facility



Source: Modified from GGNS 2003

2.2.1 Land Use

The GGNS site is comprised of 2,015 ac (815 ha). The western half of the site lies in the Mississippi River floodplain and is mostly undeveloped. The eastern half of the site contains the power block and support facilities (buildings, parking lots, and roads). A 2 ac (1 ha) privately-owned residential property is located in the southwest sector of the site and is totally surrounded by the GGNS site property boundary. No other industrial, commercial, institutional, or residential structures are on the site other than a private hunting lodge in the extreme southwest corner. Public access is allowed to parts of the site for recreational purposes (NRC 2006).

The immediate area surrounding GGNS is enclosed by a security fence shown in Figure 2–3. Road access to GGNS is through a security gate by a two-lane road connecting to Grand Gulf Road, north of the plant, and from Bald Hill Road on the east and south. The site also can be accessed to the west from a barge slip on the Mississippi River. No active railways traverse the site. Railways constructed for GGNS construction have been abandoned. One county-maintained road runs through the GGNS site. Bald Hill Road cuts through the south-southeast, south, south-southwest, and southwest sectors of the site. Another road (unpaved) traverses the GGNS site property in the north, north-northwest, northwest, west-northwest, and west sectors, providing access to the two lakes on the property. Two transmission lines traverse the eastern edge of the site.

The immediate area of GGNS is rural and largely undeveloped or agricultural. Nearby land across the Mississippi River in Louisiana is almost entirely agricultural land. Notable manmade features within a 6-mi (10-km) radius of GGNS (see Figure 2–2) include several Civil War monuments and historic plantations around the town of Port Gibson. The Port of Claiborne is located 2.2 mi (3.5 km) southwest of GGNS at river mile (RM) 404.8 of the Mississippi.

Nearby communities include the small community of Grand Gulf, about 1.6 mi (2.7 km) north, the town of Port Gibson, approximately 6 mi (10 km) southeast; the city of Vicksburg, 25 mi (40 km) north; and the city of Natchez, 37 mi (60 km) southwest. Several other small towns are located in the surrounding area in Mississippi and Louisiana. Alcorn State University (enrollment 3,252, fall 2011) is located 10.5 mi (17 km) southwest of GGNS. The nearest occupied residence is 0.83 mi (1.3 km) east of GGNS. Prominent features of the surrounding area, out to 50 mi (80 km), are shown in Figure 2–1 (Entergy 2011a).

2.2.2 Air Quality and Meteorology

GGNS is located on the east bank of the Mississippi River in Claiborne County in southwestern Mississippi (NRC 2006a). The site is located approximately 150 mi (240 km) from the coast of the Gulf of Mexico, which has a moderating effect on the climate. During most of the year, the dominant air mass in the region is maritime tropical. As a result, the climate of the region is significantly humid during most of the year, with long, warm summers and short, mild winters. Occasional cold spells are associated with outbreaks of continental polar air but are usually of short duration. In summer, temperatures above 100 °F (38 °C) are infrequent and extended periods of very hot temperatures in the summers are rare. The location and seasonal intensity of the Bermuda High, which is a semi-permanent area of high pressure, can dominate an entire season in Mississippi (NCDC 2012a).

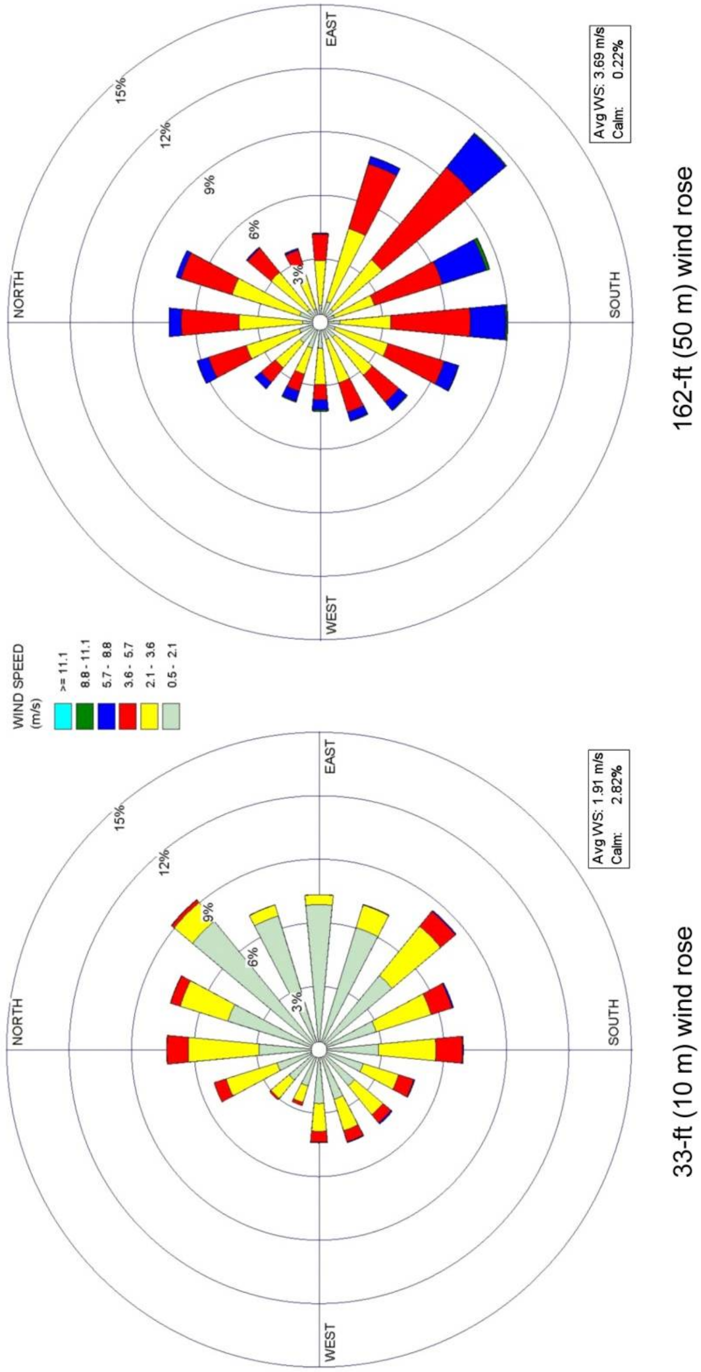
The nearby terrain consists mainly of forest and agricultural lands. The Louisiana side of the Mississippi River is typically a flat alluvial plain, while the Mississippi side is typically upland and rolling, forested hill country. These terrain features do not appreciably influence the local climate around the GGNS site (NRC 2006a).

The area around the site is characterized by light winds. Based on 2006–2011 wind measurements taken at two levels at GGNS, average wind speeds are about 4.3 mph (1.9 m/s) at the lower level (a height of 33 ft (10 m)) and 8.3 mph (3.7 m/s) at the higher level (a height of 162 ft [50 m]) (GGNS 2012a, GGNS 2012c), as shown in Figure 2–8. During the same period, highest wind speeds of 22.7 mph (10.1 m/s) and 34.1 mph (15.2 m/s) were recorded at the lower and higher levels, respectively. Seasonal average wind speeds at both levels are highest in winter and about 50 percent higher than the lowest in summer. Although not prominent, prevailing wind directions are from the northeast (about 9.2 percent of the time) at the lower level and from the southeast (about 11.6 percent of the time) at the higher level. At the lower level, winds from the northeast and southeast quadrants are far more frequent than winds from the northwest and southwest quadrants. However, at the higher level, winds from the southeast are far more frequent than winds from the three other quadrants, which are equally distributed. By season, prevailing wind directions at the lower level are south in spring, northeast in summer and fall, and north in winter. In contrast, prevailing wind directions at the higher level swing from southeast to south-southwest throughout the year. The wind patterns at the higher level reflect the regional wind patterns, while those at the lower level seem to be influenced by local topography and nearby vegetation.

The long-term (48 years) annual average temperature at Jackson International Airport, which is located about 60 mi (96.5 km) east-northeast of GGNS, was 64.7 °F (18.2 °C) (NCDC 2012b). During these years, monthly average temperatures ranged from 45.7 °F (7.6 °C) in January to 81.8 °F (27.7 °C) in July. From 1971–2000, the average number of days with maximum temperatures greater than or equal to 90 °F (32.2 °C) was about 84. In contrast, about 46 days had minimum temperatures at or below freezing, and none of the days had minimum temperatures below 0 °F (-17.8 °C). During the last 47-year period, the highest temperature, 107 °F (41.7 °C), was reached in August 2000, and the lowest, 2 °F (-16.7 °C), in January 1985. Based on 2006–2011 measurements at GGNS, average temperature with an annual average of 64.9 °F (18.3 °C) and monthly averages ranging from 47.0 °F (8.3 °C) in January and 80.3 °F (26.8 °C) in August are similar to those at the Jackson International Airport. For the 2006–2011 period, the lowest and highest temperatures recorded at GGNS were 17.4 °F (-8.1 °C) and 99.7 °F (37.6 °C), respectively (GGNS 2012a, GGNS 2012c).

Mississippi, along with other coastal states along the Gulf of Mexico, is situated in one of the wettest regions in the United States. Based on data from 1971–2000, the annual average precipitation at Jackson International Airport was about 55.95 in. (142 cm) (NCDC 2012b). Annually, about one third of the days (about 110 days) experienced a measurable precipitation (0.01 in. [0.025 cm] or higher). Precipitation is fairly well-distributed throughout the year, with monthly precipitation ranging from 3.23–5.98 in. (8.20–15.19 cm). In general, monthly precipitation is lower from May through October, and higher from November through April (with the exception of February). At GGNS, the annual average precipitation for 2006–2011 was about 49.63 in. (126.1 cm) and ranged from 38.43–58.50 in. (97.6–148.6 cm). For the same period, the annual average precipitation and monthly precipitation patterns at the site are similar to those in Jackson, Mississippi (GGNS 2012a, GGNS 2012c). Snow in this area starts as early as November and continues as late as April. Most of the snow falls from December through March, with a peak in January that accounts for about 60 percent of snowfalls. The annual average snowfall at the Jackson International Airport is about 0.9 in. (2.3 cm) (NCDC 2012b).

Figure 2–8. GGNS Wind at 33-ft (10-m) and 162-ft (50-m), 2006–2011 (GGNS 2012)



The 30-year (1971–2000) relative humidity has an annual average of about 75 percent and diurnal variation from 58 percent at 12 p.m. to 91 percent at 6:00 a.m. Hourly average relative humidity ranges from 53 percent at 12 p.m. in April to 95 percent at 6:00 a.m. in August. For each hour, monthly variations in relative humidity are relatively small. When the relative humidity is near 100 percent, small water droplets (fog) form in the atmosphere and degrade visibility. At Jackson, heavy fog, defined as visibility of 1/4 mile (0.4 km) or less, occurs about

20 days per year based on the last 48 years of data. Heavy fog is more frequent in winter months than in summer months, with the lowest of 0.8 days in June and the highest of about 2.9 days in December (NCDC 2012b).

Severe weather events, such as floods, hail, high winds and thunderstorm winds, snow and ice storms, tornadoes, and hurricanes have been reported for Claiborne County (NCDC 2012c). Other significant weather can be associated with these events. For example, lightning, hail, and high winds frequently occur with thunderstorms, and tornadoes can occur with both thunderstorms and hurricanes (NRC 2006a).

Based on the data for the last 48-year period, thunderstorms occur about 67.3 days per year at Jackson (NCDC 2012b). Thunderstorms are least frequent in winter (the lowest of 2.3 days in December) and most frequent in summer (the highest of 12.7 days in July). In the warmer season, prevailing southerly winds provide humid, semitropical conditions often conducive to creating afternoon thunderstorms. Thunderstorms sometimes are accompanied by high winds, mostly occurring from March through June. The highest recorded thunderstorm wind speed of about 100 mph (45 m/s) occurred in April 1956 (NCDC 2012c).

Since 1999, 13 floods were reported in Claiborne County, 11 of which were classified as flash floods (NCDC 2012c). In Mississippi, the flood season is from November through June (coincident with the period of greatest rainfall), with peaks in March and April, but flooding is also associated with persistent thunderstorms in summer and tropical cyclones in late summer or early fall (NCDC 2012a).

Tornadoes occur frequently in Mississippi, many of which are violent. Based on 1991–2010 data, Mississippi is in the higher range among the U.S. states in terms of average number of tornadoes per unit area and average number of strong-violent (on the enhanced Fujita scale of EF3 to EF5) tornadoes per unit area (NCDC 2012d). From 1957 to March 2012, a total of 29 tornadoes were reported in Claiborne County, mostly occurring in non-summer months with a peak of 6 tornadoes in November (NCDC 2012c). Magnitudes of tornadoes for pre-2006 years are not available but, since 2006, the worst tornado in Claiborne County was an EF2 reported in March 2012. Historically, a tornado struck the GGNS site shortly after 11:00 p.m. on April 17, 1978, when two GGNS units were under construction (NRC 2006b). The damage path at the plant site was approximately 1,500–1,800 ft (457–549 m) wide, and the highest onsite wind speeds were estimated to be in the 125–150 mph (56–67 m/s) range. The collapse of construction cranes caused major damage to the power plant facility; high winds also extensively damaged the switchyard installation (NRC 2006a).

Tropical cyclones strike the Gulf Coast along the Louisiana and Mississippi coastlines with expected return periods of 7 to 14 years for any hurricane and 20 to 34 years for a major hurricane (Category 3 or higher) passing within 50 nautical miles (57.5 mi or 92.6 km) (Blake et al. 2011). In general, impacts due to high winds from hurricanes include loss of life and property damage but are limited mainly to the coastal areas. Most of these high winds are weakened by passage over land and could cause rain damage to crops and considerable flooding of inland areas (NCDC 2012a). Since 1851, 64 tropical cyclones have passed within 100 mi (161 km) of the GGNS site, 14 of which were classified as hurricanes (CSC 2012). Among the 14 hurricanes, the strongest ever recorded were 3 Category 3 hurricanes: 1 not named (1909), Camille (1969), and Elena (1985).

2.2.2.1 Air Quality

The Air Division of MDEQ is the regulatory agency whose primary responsibility is to ensure that air quality within Mississippi is protective of public health and welfare. MDEQ is charged with controlling, preventing, and abating air pollution to achieve compliance with air emission regulations pursuant to the Mississippi Air and Water Pollution Control Act, applicable regulations promulgated by the EPA, and the Federal Clean Air Act (MDEQ 2012a).

A facility is defined as a “major” source if it has the potential to emit 100 tons (90.7 metric tons) or more per year of one or more of the criteria pollutants, or 10 tons (9.07 metric tons) or more per year of any of the listed hazardous air pollutants (HAPs), or 25 tons (22.7 metric tons) or more per year of an aggregate total of HAPs. Major sources are subject to Title V of the Clean Air Act (CAA) (42 U.S.C. 7401 et seq.), which standardizes air quality permits and the permitting process across the United States. Permit stipulations include source-specific emission limits, monitoring, operational requirements, recordkeeping, and reporting. A “synthetic minor” (or “conditional major”) source has the potential to exceed major source emission thresholds but avoids major source requirements by accepting Federally enforceable permit conditions limiting emissions below major source thresholds. The “small” (or “minor”) source has no potential for exceeding major source emission thresholds.

GGNS has the following sources of criteria pollutants and HAPs (Entergy 2011a; GGNS 2008): (1) combustion sources: standby emergency diesel generators, fire water pump diesel engines, the Energy Services Center diesel generator, the Operations Support Center diesel generator, diesel start engines, water well diesel engine, outage equipment, and a telecommunications emergency diesel generator; (2) bulk material storage tanks: diesel, gasoline, lube oil, hydraulic oil, and used oil tanks; (3) other sources, such as: natural draft and auxiliary cooling towers, standby service water cooling towers, and sand blasting/painting; and (4) miscellaneous sources, such as: small diesel generators, welding, hand-held equipment, and laboratory hoods.

GGNS is classified as a “synthetic minor” source (air permit number 0420-00023) (GGNS 2008). Although GGNS may periodically use a portable auxiliary boiler or generator(s) during power outages, nonradioactive combustion-related gaseous effluents result primarily from testing and preventive maintenance of emergency generators and diesel pumps operating on an intermittent basis. To comply with the National Ambient Air Quality Standards (NAAQS) and to ensure that potential air quality impacts are maintained at minimal levels, the MDEQ governs the discharge of regulated pollutants by limiting operational run times and sulfur limits stipulated in the operating permit. GGNS reports operating hours for selected equipment to show compliance with permit limitations, but it has no requirements to report annual emissions inventory data to the MDEQ. Continuous emission sources at the GGNS site include cooling towers, which emit particulate matter as drift. The GGNS air permit does not require reporting of cooling tower operating hours.

Air emission sources at GGNS emit criteria pollutants, volatile organic compounds (VOCs), and HAPs into the atmosphere. Maximum allowable emissions from the entire facility, in accordance with operating permit requirements, are presented in Table 2–1, which includes air emissions from all stationary combustion and cooling tower sources at the site (GGNS 2008). Because emission sources are operating well below the maximum operating hours specified in the permit, actual emissions of criteria pollutants, VOCs, and HAPs are typically well below the maximum allowable emissions for a “synthetic minor” source. From 2006–2011, there have been no regulatory notices of violation issued to GGNS, based on a review of records associated with the air permit (Entergy 2011a).

As shown in Table 2–1, annual emissions for greenhouse gases (GHGs), which include those from stationary and mobile sources, are presented in terms of carbon dioxide equivalent (CO_{2e}). “Carbon dioxide equivalent” adjusts for different global warming potentials for different GHGs. Total annual GHG emissions from GGNS were estimated to be about 5,980 tons CO_{2e} (5,425 metric tons CO_{2e}) in 2011 (EPA 2011; GGNS 2012b), which is well below EPA’s mandatory reporting threshold of 25,000 metric tons CO_{2e} per year (74 FR 56264). GGNS emits GHGs such as CO_2, methane (CH_4), and nitrous oxide (N_2O) from combustion sources. Additionally, GGNS uses GHGs such as hydrofluorocarbons (HFCs) in the two plant cooling water chillers as refrigerants and sulfur hexafluoride (SF_6) in three electrical disconnect switches. GGNS does not use perfluorocarbons (PFCs).

Table 2–1. Permitted Maximum Allowable Emission Limits for Criteria Air Pollutants and Volatile Organic Compounds (VOCs)[(a)] and Estimated Annual CO_{2e} Emission Rate at GGNS

Pollutant[(b)]	Emission Limits and CO_{2e} Emission Rate (lb/hr)	(tons/yr)
CO	225.03	25.17
NO_x	850.41	98.18
PM_{10}	42.07	68.73
SO_2	264.13	26.44
VOCs	24.80	12.94
CO_{2e}	-[(c)]	5,980 (5,425)[(d)]

[(a)] Estimated based on maximum operating hours specified for permitted sources, including stationary combustion sources and cooling towers.

[(b)] CO = carbon monoxide; CO_2e = carbon dioxide equivalent; NO_x = nitrogen oxides; PM_{10} = particulate matter with an aerodynamic diameter of $\leq$10 μm; SO_2 = sulfur dioxide; and VOCs = volatile organic compounds.

[(c)] A hyphen denotes that the data are not available.

[(d)] Values in parentheses are in metric tons carbon dioxide equivalent.

Source: EPA (2011); GGNS (2008); GGNS (2012b).

Under the CAA, EPA has set NAAQS for pollutants considered harmful to public health and the environment (40 CFR Part 50). NAAQS are established for criteria pollutants: carbon monoxide (CO); lead (Pb); nitrogen oxides (NO_x); particulate matter with an *aerodynamic* diameter of 10 microns or less and 2.5 microns or less (PM_{10} and $PM_{2.5}$, respectively); ozone (O_3); and sulfur dioxide (SO_2) (EPA 2012a). The CAA established two types of NAAQS: primary standards to protect public health, including sensitive populations, such as asthmatics, children, and the elderly; and secondary standards to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. Individual states can have their own State Ambient Air Quality Standards (SAAQS), but SAAQS must be at least as stringent as the NAAQS. If a state has no standard corresponding to one of the NAAQS, or the SAAQS is not as stringent as the NAAQS, then the NAAQS apply. Except for odor, Mississippi has adopted the NAAQS (MDEQ 2012b), as presented in Table 2–2.

Table 2–2. National Ambient Air Quality Standards (NAAQS)[(a),(b)]

Pollutant[(c)]	Averaging Time	NAAQS	
		Value	Type[(d)]
CO	1-hour	35 ppm	P
	8-hour	9 ppm	P
Pb	Rolling 3-month average	0.15 µg/m^3	P, S
NO_2	1-hour	100 ppb	P
	Annual (arithmetic average)	53 ppb	P, S
O_3	8-hour	0.075 ppm	P, S
PM_{10}	24-hour	150 µg/m^3	P, S
$PM_{2.5}$	24-hour	35 µg/m^3	P, S
	Annual (arithmetic average)	15 µg/m^3	P, S
SO_2	1-hour	75 ppb	P
	3-hour	0.5 ppm	S

(a) Except for odor, the ambient air quality standards for Mississippi are the primary and secondary NAAQS as duly promulgated by EPA.

(b) Refer to 40 CFR Part 50 for detailed information on attainment determination and reference method for monitoring.

(c) CO = carbon monoxide; NO_2 = nitrogen dioxide; O_3 = ozone; Pb = lead; $PM_{2.5}$ = particulate matter with an aerodynamic diameter of ≤2.5 µm; PM_{10} = particulate matter with an aerodynamic diameter of ≤10 µm; and SO_2 = sulfur dioxide.

(d) P = primary standards, which set limits to protect public health, including the health of “sensitive” populations such as asthmatics, children, and the elderly; S = secondary standards, which set limits to protect public welfare including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

Sources: EPA (2012c); MDEQ (2012b).

EPA designates areas that meet NAAQS as “attainment areas.” Areas that exceed NAAQS are designated as “nonattainment areas.” Areas that previously were nonattainment areas but where air quality has improved to meet the NAAQS are redesignated “maintenance areas,” subject to an air quality maintenance plan. Claiborne County, Mississippi, where GGNS is located, is part of the Mobile (Alabama)-Pensacola-Panama City (Florida)-Southern Mississippi Interstate Air Quality Control Region (AQCR) (40 CFR 81.68), which includes 3 southwestern counties in Alabama, 10 northwestern panhandle counties in Florida, and 37 southern counties in Mississippi. The area across the Mississippi River from the site is in the Monroe (Louisiana)-El Dorado (Arkansas) Interstate AQCR (40 CFR 81.92). The EPA has designated all of the counties in these AQCRs adjacent to the GGNS site as in compliance with the NAAQS (40 CFR 81.301, 81.304, 81.310, 81.319, and 81.325). Mississippi is in attainment with primary and secondary NAAQS for all criteria pollutants, except De Soto County which is located about 200 miles (322 km) north-northeast of GGNS and part of which was recently designated as a marginal nonattainment area for the 2008 8-hour ozone standard. Outside of Mississippi, the nearest nonattainment areas include the Birmingham area in Alabama for $PM_{2.5}$ and the Houston-Galveston-Brazoria area in Texas for 8-hour ozone (O_3), both of which are located about 240 mi (386 km) east-northeast and west-southwest, respectively, of GGNS. The nearest maintenance area is the Baton Rouge area in Louisiana for 8-hour O_3, which is located about 90 mi (145 km) south of GGNS.

In recent years, three revisions to NAAQS have been announced. Effective January 12, 2009, EPA revised the Pb standard from a calendar-quarter average of 1.5 μg/m^3 to a rolling 3-month average of 0.15 μg/m^3 (73 FR 66964). Effective April 12, 2010, EPA established a new 1-hour primary NAAQS for NO_2 at 100 ppb (75 FR 6474) and effective August 23, 2010, EPA established a new 1-hour primary NAAQS for SO_2 at 75 ppb (75 FR 35520). Notwithstanding these revisions to the NAAQS, the attainment status for Claiborne County will not be affected because concentration levels at nearby monitoring stations are relatively low compared to the NAAQS and generally are trending downward as discussed below.

Through operation of a network of air monitoring stations, MDEQ evaluates compliance with NAAQS. The MDEQ monitors all criteria air pollutants, except CO and Pb. Monitoring for CO and Pb was discontinued because the measured concentrations were much lower than the NAAQS limits. Currently, no air monitoring data are available in Claiborne County (MDEQ 2011c), but air monitoring stations exist in nearby Adams County where the city of Natchez is located, and Hinds County where Jackson is located. Eight-hour O_3 and $PM_{2.5}$ data collected in these counties indicated a general downward trend for these pollutants from 2001–2010. Only Jackson County, which is located in the southeastern corner of the State and abuts the Gulf of Mexico, monitors NO_2 and SO_2 in Mississippi and also exhibits a general downward trend during the same period. As a result, Mississippi meets all NAAQS based on air monitoring data scattered around the State.

While the NAAQS place upper limits on the levels of air pollution, Prevention of Significant Deterioration (PSD) regulations (40 CFR 52.21) place limits on the total increase in ambient pollution levels above established baseline levels for SO_2, NO_2, PM_{10}, and $PM_{2.5}$, thus preventing “polluting up to the NAAQS.” These allowable increments are smallest in Class I areas, such as national parks and wilderness areas, and less limiting in other areas. A major new source or modification of an existing major source located in an attainment or unclassified area must meet stringent control technology requirements. As a matter of policy, EPA recommends that the permitting authority notify the Federal Land Managers (FLMs) when a proposed PSD source will be located within 62 mi (100 km) of a Class I area. If the source’s emissions are large, EPA recommends that sources beyond 62 mi (100 km) be brought to the attention of the FLMs. The FLMs then become responsible for determining whether the source’s emissions could have an adverse effect on air quality related values (AQRVs), such as scenic, cultural, biological, and recreational resources. There are no Class I areas in Mississippi and none of the Class I areas in other nearby states are located within the aforementioned 62-mi (100-km) range. The nearest Class I area is Breton Wilderness Area in Louisiana managed by the U.S. Fish and Wildlife Service (40 CFR 81.412), which is located about 186 mi (300 km) southeast of GGNS. Considering the locations of and intervening terrain features to any nearby Class I areas around GGNS, prevailing wind directions, distances from GGNS, and the minor nature of air emissions from GGNS, there is little likelihood that activities at GGNS would adversely impact air quality and AQRVs in this Class I area.

GGNS has a primary and backup tower for monitoring and collecting meteorological data. The primary tower is 162 ft (50 m) high. It has instrumentation at heights of 162 ft (50 m) and 33 ft (10 m). The backup tower is 33 ft (10 m) high. Along with an instrument shack, these towers are located in an open area surrounded by tall vegetation about 0.9 mi (1.4 km) north-northwest of the reactor control building. The backup tower and instrument shack are located about 300 and 430 ft (91 and 131 m), respectively, north-northeast of the primary tower. Onsite meteorological monitoring began in March 1972. The original meteorological monitoring system was replaced in December 2000. This current monitoring system will continue to serve for the period of extended operation, with no major changes or upgrades anticipated (GGNS 2010b).

The primary tower monitors wind speed, wind direction, and ambient temperature along with differential temperature and data used to determine atmospheric stability collected at both 162 ft (50 m) and 33 ft (10 m). Relative humidity data is collected only at 33 ft (10 m), while precipitation data using a tipping bucket rain gauge is collected at the ground level. Meteorological data from the primary tower is supplemented with those from the backup tower. The backup tower monitors wind speed, wind direction, ambient temperature, and atmospheric stability data. GGNS uses data processing procedures for analyzing meteorological data. Observations are averaged to 15-minute and hourly values and are made available to the GGNS plant computer and then this information is transmitted to the control room. Information from both towers is provided to the reactor control room (GGNS 2010b).

The data processing procedures for GGNS meteorological data involve three basic steps: (1) data collection (recorded in digital form); (2) data editing and consolidation; and (3) data analysis. For steps (2) and (3), computer software has been developed to process the collected data. The plant data computer receives data measurements at least every 10 seconds. Data is recorded each time a value varies by a preset amount. Each piece of data is checked to assure it is between the minimum and maximum instrument limits. This quality indication and the time are recorded with each value. An average is calculated every 15 minutes and each hour. The quality of the samples is reflected in the quality of the average. This quality indication and the time the average was calculated are recorded with each value. The meteorological data, for which readings are available every 10 seconds or less, a 15-minute average, and an hourly average, are relayed to the main control room by the plant computer (GGNS 2010b).

Based on the NRC's Regulatory Guide 1.23, "Meteorological Monitoring Programs for Nuclear Power Plants," meteorological instruments should be inspected and serviced at a frequency that will ensure data recovery of at least 90 percent annually. GGNS has established procedures for the inspection and maintenance of the onsite meteorological system. Routine inspections are made to ensure proper operation of equipment and that no damage to the towers, instrument shack, or any other structure or equipment has occurred. Semi-annual visual inspections of the tower and equipment are made to determine the conditions of sensors, cabinets, wiring, structures, and individual components. Semi-annual checks for proper instrumentation readings are performed. All calibrations at the site are performed in compliance with the recommendations of Regulatory Guide 1.23. Based on the 2006–2011 onsite meteorological data, the data recovery rates for all meteorological parameters from the meteorological monitoring system at GGNS were over 90 percent.

2.2.3 Geologic Environment

This section describes the current geologic environment of GGNS and vicinity, including topography, geology, soils, and seismic conditions.

2.2.3.1 Topography and Geology

GGNS is bounded by the Mississippi River on the west. The western half of the site is called the lowland plain and lies in the floodplain of the Mississippi River. This portion of GGNS has a generally level topography, with elevations that vary from 55–75 ft (16.7–22.8 m) above MSL (Figure 2–7). This area also contains Hamilton and Gin Lakes. These oxbow lakes were once a channel of the Mississippi River. They have an average depth of approximately 8–10 ft (2.4–3 m).

The reactor building and most of the associated facilities are located in the eastern half of the site, which is called the upland area. The upland area is separated from the lowland plain by steep bluffs that trend north-south through the middle portion of the site. The topography in the upland area rises from the floodplain as rough, irregular bluffs, with steep slopes and deep-cut stream valleys and drainage courses. The surface topography in the upland area ranges from 80–200 ft (24–61 m) above MSL. Most of the facilities are located about 132.5 ft (40.3 m) above MSL. The upland area has two drainage channels that trend east-west. One drainage channel (Stream A) is north of the reactor and site facilities and the other (Stream B) is south of the main plant complex.

The lowland plain is underlain by the Mississippi River Alluvium. At the land surface, it consists of a layer of clay and silt that overlies interbedded layers of stream-deposited sand, gravel, silt, and clay. The alluvium generally ranges from 95–182 ft (29–55 m) thick. On GGNS, the lowland plain extends from the Mississippi River to the bluffs of the upland area.

The upland area is underlain by loess deposits. The loess deposits are made up of about 75 ft (23 m) of fine-grained silt deposited by wind and comprise the bluffs that rise above the floodplain of the Mississippi River. The loess deposits are underlain by the Upland Complex, which is comprised of two stream-deposited terraces, the Upland Complex Alluvium and the Upland Complex Old Alluvium. These terrace deposits are thickest near the bluffs (up to 150 ft (46 m) thick) and thinnest near the power block area (about 40 ft (12 m) thick) (GZA GeoEnvironmental Inc. 2009). The Upland Complex Alluvium is typically comprised of sands and clayey, silty sands, while the Upland Complex Old Alluvium is comprised of clayey, silty sands with coarse grained sands and gravels. Neither upland complex unit is found west of the bluffs of the upland area, as they have been removed by the erosive activity of the Mississippi River and replaced by Mississippi River Alluvium.

The Upland Complex Alluvium, the Upland Complex Old Alluvium, and the Mississippi Alluvium are all underlain by the Catahoula Formation. The Catahoula Formation underlies the entire GGNS property. It consists of lenticular deposits of sand, clayey silt, and sandy-silty clay. The sand layers are predominantly fine-grained and range in thickness from a few inches to more than 100 ft (30 m) thick.

At the site, the Catahoula Formation is underlain by the Bucatunna Formation (Entergy 2011a). It is composed of clay and is about 100-ft (30-m) thick at the site. Underneath the Bucatunna Formation is the Glendon Formation, which is made up of beds of limestone. Figures 2–9, 2–10, and 2–11 contain generalized geologic cross-sections that illustrate the stratigraphy across the site from east to west.

2.2.3.2 Soils

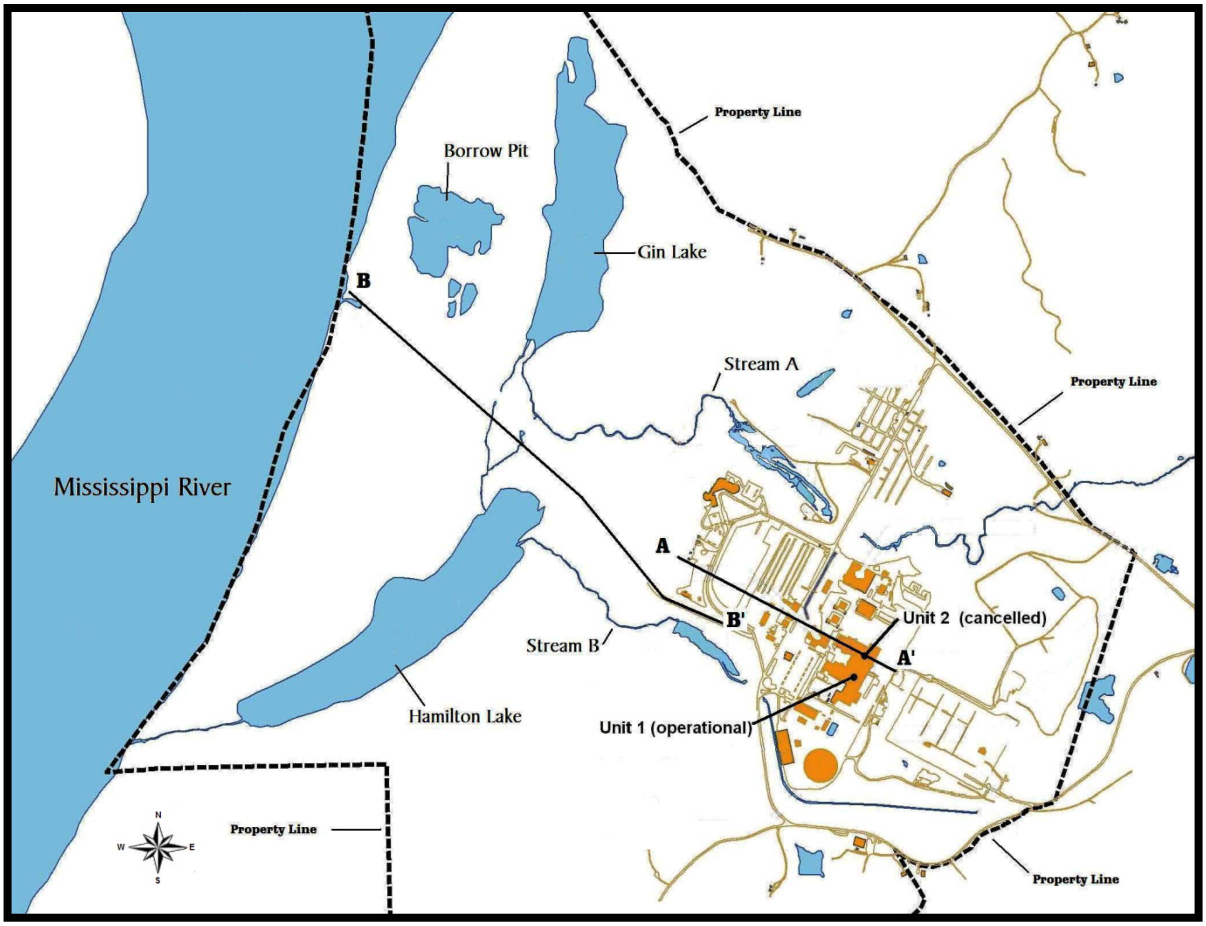
U.S. Department of Agriculture (USDA 2012) soil unit mapping identifies the area of the site on the Mississippi River alluvial valley (mostly Bowdre soil) as being made up of soils that are somewhat poorly drained, frequently flooded, and in locations where the water table is near the land surface. The soil is comprised of clayey alluvium over loamy alluvium. In areas that underlie surface drainage areas (Adler silt loam), soils are moderately well drained and occasionally flooded. These soils are made up of silt loam. The upland area of the site is largely made up of soils that developed in loess (mostly Memphis and Natchez silt loams). The depth to the water table for these soils generally is in excess of 6 ft (1.8 m). They are well drained and not prone to flooding. Their typical texture is silty loam to silty clay loam.

2.2.3.3 Seismic Setting

The region is characterized by extremely low rates of earthquake activity. The rate of earthquake activity in the Gulf Coastal Plain is among the lowest in the United States (Entergy 2011a).

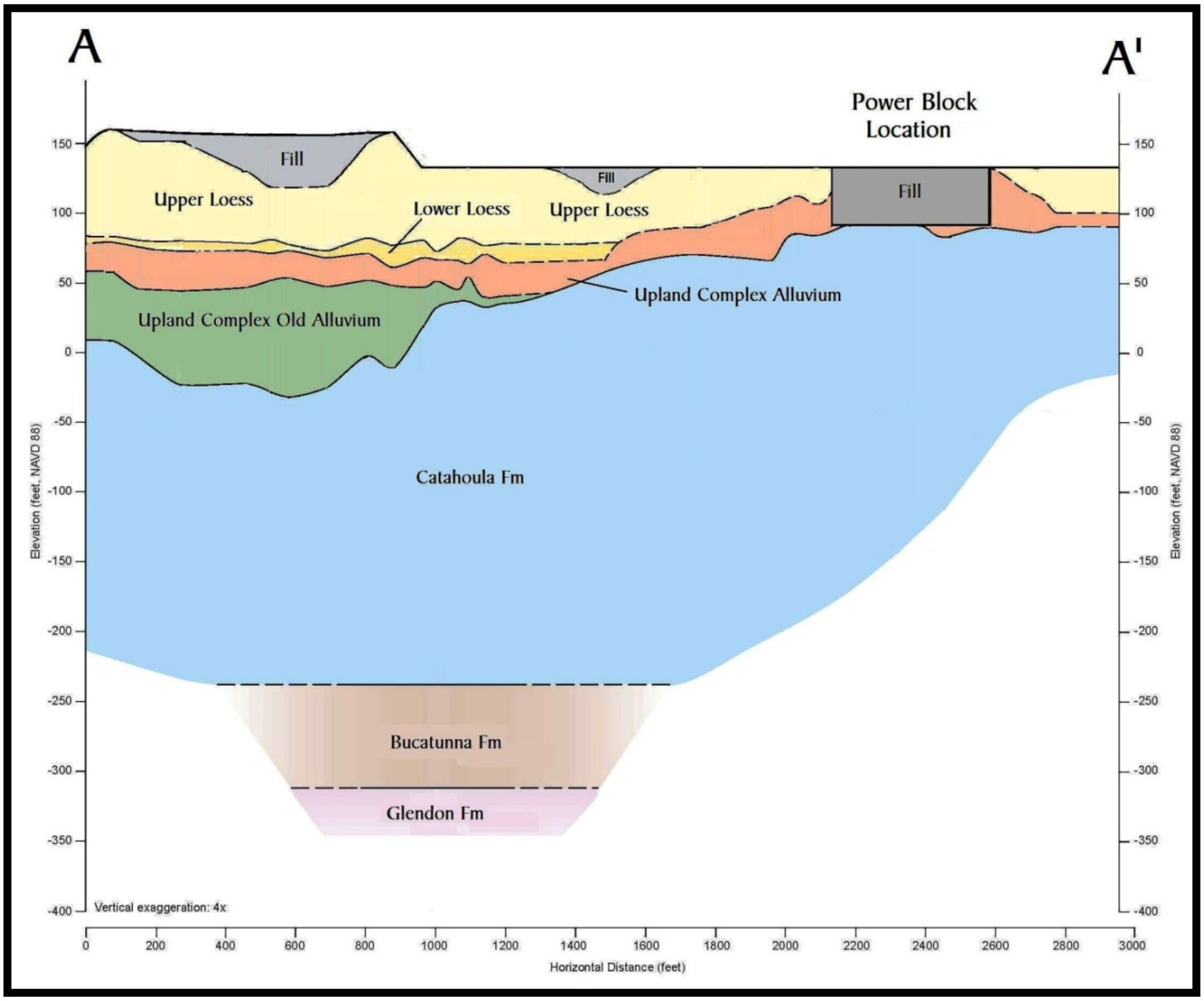
The earliest recorded and strongest earthquake (magnitude 4.6) within Mississippi occurred at Charleston, Mississippi, on December 16, 1931. In the area of maximum intensity, the walls and foundation of an agricultural high school cracked and several chimneys were thrown down. The shock was perceptible over a 65,000 square mile area, including the northern two-thirds of Mississippi and adjacent portions of Alabama, Arkansas, and Tennessee. Two earthquakes greater than a magnitude 3.5 occurred within Mississippi (USGS 2012a, 2012b) between 1976 and 2003. During that same time period, neighboring Louisiana had one earthquake greater than a magnitude 3.5.

Figure 2–9. Location Map for Geologic Cross-Sections A-A' and B-B'



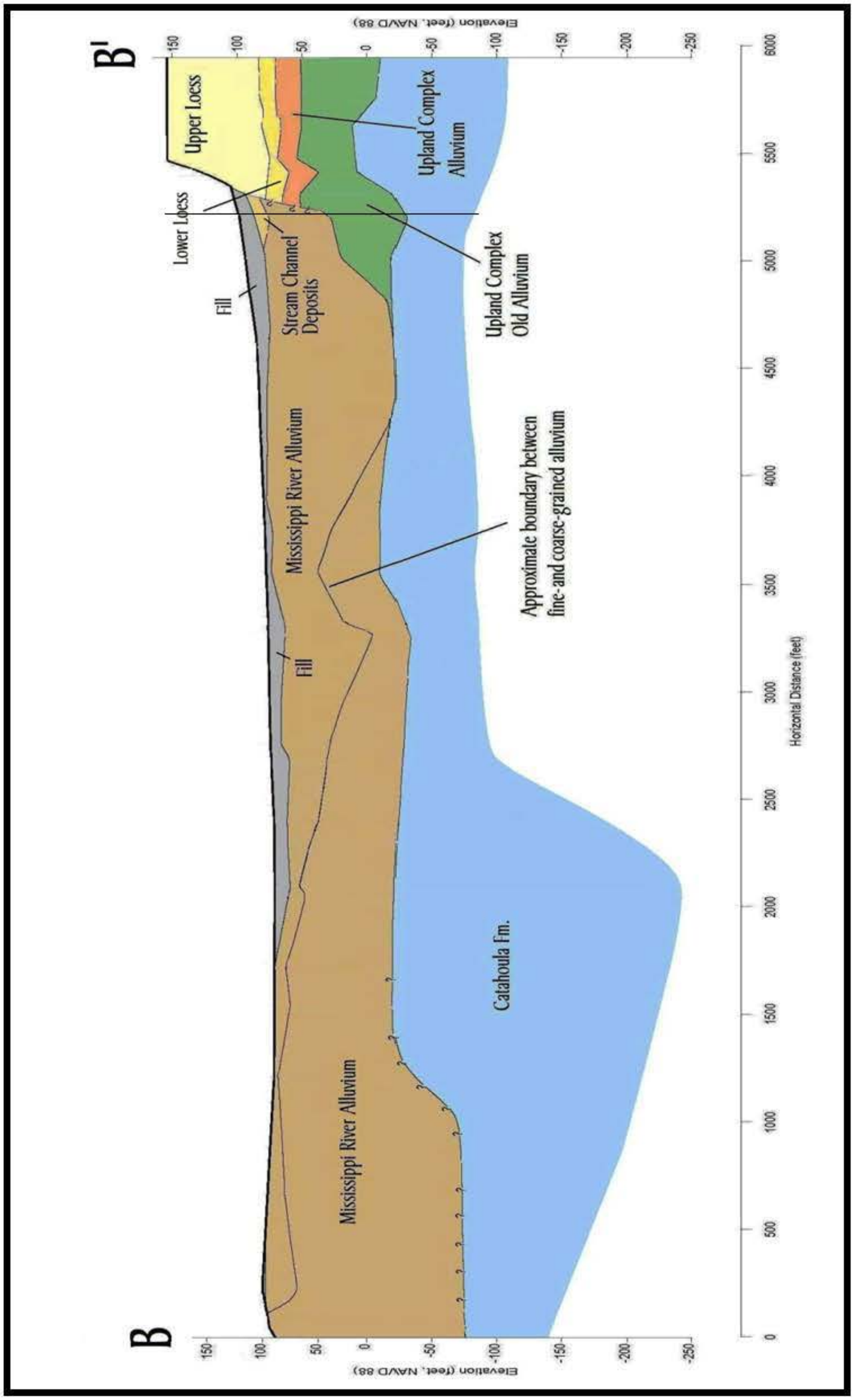
Source: Modified from Entergy 2011a

1 **Figure 2–10. Geologic Cross Section A-A'**



2 Source: Modified from Entergy 2011a

1 **Figure 2–11. Geologic Cross Section B-B'**



2 Source: Modified from Entergy 2011a

Although the number of earthquakes reported within Mississippi's boundaries is small, the State has been affected by numerous shocks located in neighboring states. In 1811 and 1812, a series of earthquakes (maximum magnitude 7.7) occurred, near New Madrid, in southeast Missouri and was felt as far south as the Gulf Coast. This series of earthquakes caused the banks of the Mississippi River to cave in as far south as Vicksburg, more than 300 mi (483 km) from the epicentral region. While earthquakes still occur in the New Madrid area, it is far enough away that only a very small probability exists of experiencing damaging earthquake effects in the area of GGNS (FEMA 2012).

The geologic setting and modern tectonic framework suggest that the earthquake hazard for the region will remain low for the foreseeable future. There have been no active faults found within a 5 mi (8 km) radius of the site (Entergy 2011a).

2.2.4 Surface Water Resources

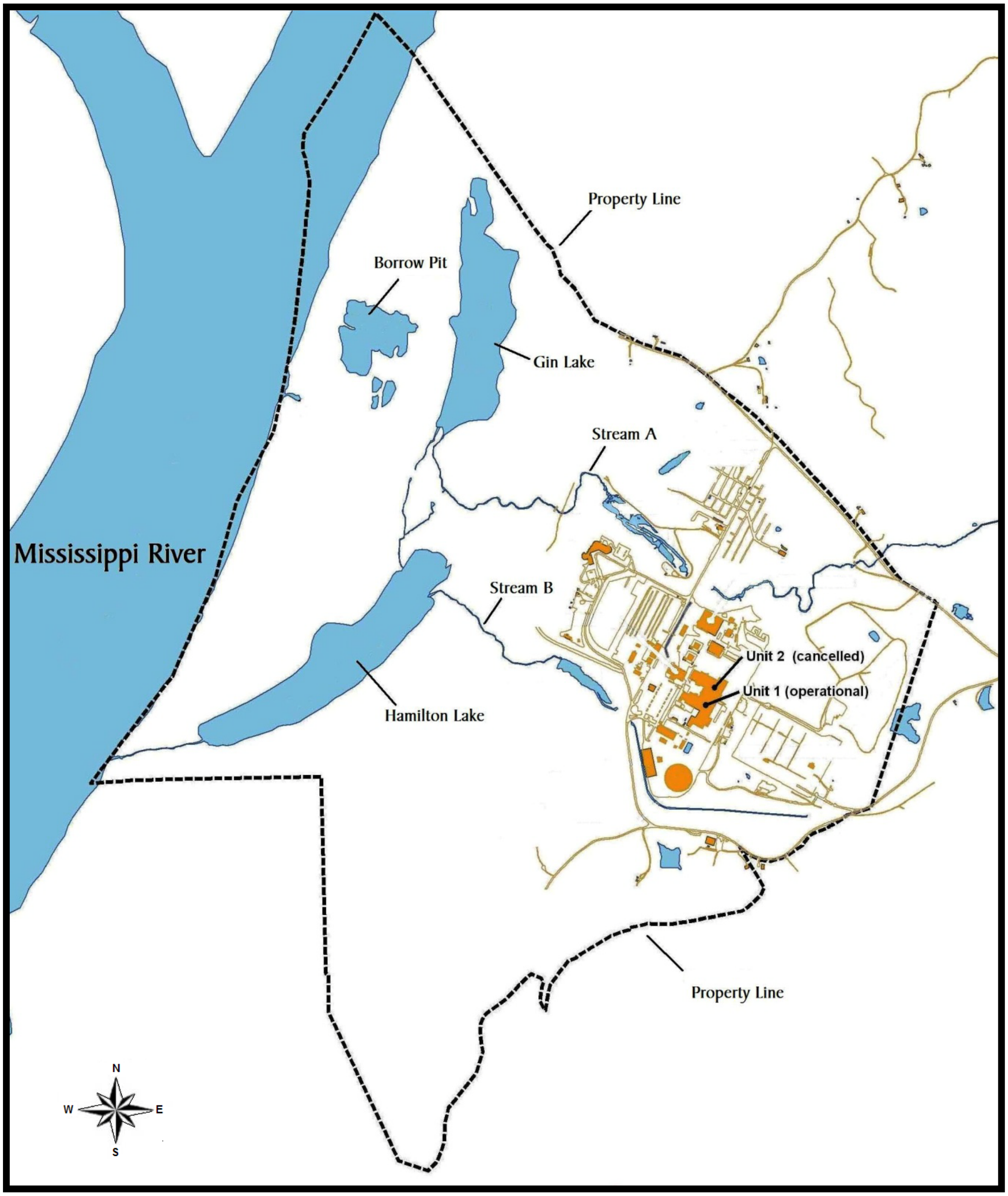
With an average discharge of 593,000 cfs (16,792 m^3/s), the Mississippi River is the largest river in the United States. The western boundary of the site begins at the river's eastern bank. At the site, the Mississippi River is about 0.5 mi (0.8 km) wide at low flow and about 1.4 mi (2.3 km) wide during a typical annual high-flow period. The lowland plain between the river and the upland area is subject to nearly annual flooding by the Mississippi River. The plain contains Hamilton and Gin Lakes, which are two shallow oxbow lakes (created in a now abandoned former river channel) and a small borrow pit (created during plant construction). Under non-flooding conditions, watersheds that drain the upland area discharge water into Hamilton or Gin Lakes. Gin Lake discharges water into Hamilton Lake through a culvert. Hamilton Lake discharges into the Mississippi River (Entergy 2011a).

The upland area is drained by two watersheds. Watershed A is north of Watershed B. The watersheds are drained by Stream A and Stream B, respectively. The estimated areas of Watershed A and Watershed B are 2.94 mi^2 (7.6 km^2) and 0.68 mi^2 (1.7 km^2), respectively. Water from each watershed flows through sedimentation basins before flowing into either Hamilton or Gin Lakes (Figure 2–12).

Surface water discharges that flow to the Mississippi River from the site are permitted by the MDEQ NPDES program. The current permit authorizes discharges at 11 outfalls (locations). Three of the outfalls monitor discharges to surface water outside the site boundary (external outfalls); eight of the outfall locations monitor discharges within the site boundary (internal outfalls).

The three external outfalls (Outfalls 001, 013, and 014) monitor all releases to surface water from GGNS. Outfall 001 is a 54-in. (137-cm) diameter pipe that discharges in the barge slip along the Mississippi River. It receives water from internal outfalls, including cooling tower blowdown, standby service water leakage, the low volume waste basin, liquid radwaste, and storm water. Outfall 013 is the discharge from the northwest end of Sedimentation Basin A to Hamilton Lake; it includes sanitary wastewater effluent from the onsite wastewater treatment plant and storm water. Outfall 014 is at the northwest end of Sedimentation Basin B. This basin receives various effluents at Outfall 007 through a large concrete structure at its southeast end with an approximately 20-ft (6-m) diameter corrugated metal pipe discharging water from Stream B (designed to convey storm water from the site from a 100-year storm event). Outfall 007 also receives miscellaneous wastewaters; such as heating, ventilation, and air conditioning (HVAC) blowdown; air conditioner cooling water; oily waste sumps; ionic reject water; and turbine building cooling water blowdown.

1 **Figure 2–12. GGNS Surface Water Features**



2 Source: Modified from Entergy 2011a

3 Permit conditions require flow reporting at all outfalls and value reporting or monthly average
4 and/or maximum of various other parameters. Depending on the outfall, these parameters may
5 include water temperature, free available chlorine, zinc, oil and grease, total suspended solids,

total residual chlorine, biochemical oxygen demand, and fecal coliform. Iron, arsenic, and copper must be reported at some outfalls, and a range of pH (6.0–9.0 standard units) is required at several outfalls. Details are provided in GGNS's Certificate of Permit Coverage under Mississippi's Baseline Storm Water General NPDES Permit (MDEQ 2010a). The permit also specifies a maximum Mississippi River water temperature increase of 5 °F (2.8 °C) beyond a mixing zone. Thermal monitoring is required during certain low-flow river conditions.

The Ranney wells each have their own service water system for motor cooling. Permitted discharge from each is back to the Mississippi River through an underground pipe (MDEQ 2011b).

In March 2011, GGNS had one EPA violation in its effluent monitoring at Outfall 007 for total suspended solids (TSS) (EPA 2012a). The violation was because of an average TSS of 31 mg/L, when the average limit is 30 mg/L. This was not considered a significant noncompliance effluent violation. The ER (Entergy 2011a) lists several other noncompliances from 2006–2010. These included three pH exceedances, a zinc exceedance, a free residual chlorine exceedance, and an unauthorized discharge.

As described above, GGNS has an NPDES permit (MDEQ 2011a) to discharge wastewater in accordance with effluent limits, monitoring requirements, and other permit conditions. Under Section 401 of the Clean Water Act (CWA), an entity requiring a Federal permit for any activity that may result in a discharge to navigable waters of the United States must obtain a 401 Water Quality Certification from the state in which the discharge will occur to ensure that the discharge complies with state water quality standards. Mississippi issued a water quality certification for GGNS in 1974. In a letter dated October 17, 2011, MDEQ stated that the water quality certification remains in effect as long as GGNS does not expand its footprint, increase its water discharge, engage in any new activity that would trigger the need for a new certification from the State, and remains in compliance with State and Federal regulations to refrain from violating the State's water quality standards (MDEQ 2011b).

A storm water pollution prevention plan (GGNS 2006) and a permit to discharge storm water (MDEQ 2010a) are also maintained for the site. The plan documents best management practices (BMPs), potential pollutant sources, and other aspects related to storm water quality. According to GGNS staff at the environmental site audit, no dredging takes place at the Mississippi River barge slip or at the sedimentation basins.

2.2.5 Groundwater Resources

2.2.5.1 Mississippi River Alluvium

The Mississippi River Alluvium forms an aquifer underlying both the river and the lowland plain. The water table in the lowland plain is at most a few feet beneath the ground surface (NRC 2006a). The Mississippi River Alluvial Aquifer is in close hydraulic connection with the river. Increases or decreases in Mississippi River water levels cause changes in the direction of flow in the Mississippi River Alluvial Aquifer and corresponding increases or decreases in groundwater level. Usually, the alluvium discharges to the river. However, during floods, the river may discharge to the aquifer.

This close hydraulic connection between the Mississippi River and the Mississippi River Alluvial Aquifer means that the Mississippi River forms a large, effective hydraulic boundary along the western boundary of the site. As a result, groundwater use, flow, and water quality west of the Mississippi River are unlikely to be influenced by groundwater use, flow, and water quality east of the Mississippi River (the plant side of the river).

The GGNS cooling system uses Ranney wells to pump water from the Mississippi River Alluvial Aquifer (see Section 2.1.7). Pumping from these wells induces river water to flow through the alluvial aquifer to the wells. The connection between the alluvium and the river means that GGNS is essentially using river water from which river water sediment has been removed (filtered out by the pore spaces of the aquifer) (NRC 2006a).

2.2.5.2 Perched Groundwater and the Upland Complex Aquifer

Some perched groundwater occurs in the loess deposits of the upland area (Entergy 2011a). Because of their small area extent, size, and low production rates, the perched groundwater is not considered a groundwater resource.

The water table occurs in the sand and gravel deposits of the Upland Complex Aquifer, which underlies the loess deposits. The Upland Complex Alluvium and the Upland Complex Old Alluvium form the Upland Complex Aquifer. West of the bluffs of the upland area, the Upland Complex Aquifer has been removed by the erosive activity of the Mississippi River and replaced by Mississippi River Alluvium. As a result, in the lowland plain, where the two aquifers are in contact, the Upland Complex Aquifer is hydraulically connected to the Mississippi River Alluvial Aquifer.

The Upland Complex Aquifer is recharged by local precipitation and the lateral movement of groundwater within the Upland Complex Aquifer. Groundwater flows laterally into the southeast corner of the plant property and moves in a northwest direction. From the west side of Unit 1 and Unit 2 power blocks, groundwater in the Upland Complex Aquifer flows west until it reaches the bluffs. At that point, groundwater in the Upland Complex Aquifer flows into the Mississippi River Alluvial Aquifer. From the east side of the power blocks, groundwater in the Upland Complex Aquifer flows towards the northeast, until it exits the site boundary. Downward vertical flow in the Upland Complex Aquifer is prevented by a thick clay layer at the top of the Catahoula Formation. This clay layer has a very low permeability and is approximately 50 ft (15 m).

2.2.5.3 Catahoula Aquifer

The Catahoula Formation underlies the Mississippi River Alluvial Aquifer in the lowland plain and underlies the Upland Complex Aquifer in the upland area. Sandstone layers, separated by layers of siltstone or clay, transmit water in the Catahoula Formation and make up the Catahoula Aquifer. The top of the Catahoula Formation contains approximately 50 ft (15 m) of clay that forms an effective flow barrier, preventing the downward movement of water from the Upland Complex Aquifer (NRC 2006a) into the sands of the Catahoula Aquifer. Hydraulic interconnection between the Upland Complex Aquifer and the Catahoula Aquifer has not been identified in pumping well tests, monitor well water levels, or by the collection of drill-hole data. The Catahoula Aquifer is fully saturated and a confined aquifer (water in a well would rise above the top of the Catahoula Aquifer sands). Water in the Catahoula Aquifer is not of local origin. Aquifer recharge occurs north of the site in Warren and Hinds Counties (Entergy 2011a).

The substructures (basements) of the plant power blocks penetrate through the loess deposits and the Upland Complex Aquifer and rest on top of the Catahoula Formation. The top of the Catahoula Formation is elevated in the area of the power block, forming a ridge beneath the power block that is oriented northwest-southeast. The elevation of the top of the Catahoula Formation generally decreases in elevation in all directions from the power block area (GZA GeoEnvironmental, Inc. 2009). The thick vertical flow barrier and change in elevation of the top of the Catahoula Formation and the excavation of the power block through the Upland Complex Aquifer is interpreted as causing two directions of lateral groundwater flow in the Upland Complex Aquifer in the power block area.

At the site, the Catahoula Aquifer is underlain by the Bucatunna Formation (Entergy 2011a). It is composed of clay and is about 100 ft (30 m) thick, forming a barrier to the downward movement of water in the Catahoula Aquifer. Of the three aquifers at the site, the Catahoula Aquifer is the least productive. Not only is it deeper, but the ability of the aquifer to transmit water to a well is much less that the other two aquifers. No wells at the site produce water from the Catahoula Aquifer or from any deeper aquifers.

On the lowland plain, the ancient Mississippi River eroded (cut into) the top of the Catahoula Aquifer and then deposited the Mississippi River Alluvial Aquifer on top of that surface (Entergy 2011a). Data from holes drilled on the lowland plain have not detected any hydraulic interconnection between the Catahoula Aquifer and the Mississippi River Alluvial Aquifer. However, it cannot be completely ruled out that some upper sands of the Catahoula Aquifer may be hydraulically connected to the Mississippi River Alluvial Aquifer, either under the river itself or under the lowland areas on either side of the river. This is because it is difficult to determine how deep the Mississippi River has eroded into the top of the Catahoula in the lowland plain or under the river.

Transmissivity is a measure of the ability of an aquifer to transmit water. It is more difficult to extract water from aquifers with low transmissivity than from aquifers with high transmissivity. At the site, the transmissivity of the Mississippi River Alluvium ranges from 21,500 to 163,500 gpd/ft (267 to 2,031 m^2/day), while the transmissivity of the Catahoula Aquifer sands has an estimated transmissivity of 300 gpd/ft (3.7 m^2/day) (Entergy 2011a). The transmissivity of the Catahoula Aquifer sands is so much less than the Mississippi River Alluvial Aquifer that if an interconnection between the two aquifers exists, wells pumping water from the Mississippi River Alluvial Aquifer would obtain their water as induced infiltration from the Mississippi River rather than from upward discharge of groundwater from the Catahoula Aquifer. Furthermore, should groundwater contamination enter the Mississippi River Alluvial Aquifer, it would be likely to remain in the Mississippi River Alluvial Aquifer or discharge into the Mississippi River.

The groundwater quality in Claiborne County is generally good. Onsite groundwater quality is adequate for a variety of uses. Except for less suspended sediment, the induced infiltration from the operation of the GGNS Ranney wells produces water nearly identical to the water quality of the Mississippi River (Entergy 2011a). Onsite Upland Complex Aquifer water quality is suitable for use as potable water. Water from the GGNS Upland Complex Aquifer wells is sampled as required by the Mississippi Department of Health (MDH), pursuant to the Safe Drinking Water Act. County residents obtain their water from the Catahoula Aquifer. Groundwater from the Catahoula Aquifer, although very hard, is suitable for potable uses. Water quality generally decreases for aquifers underlying the Catahoula Formation (NRC 2006a; Entergy 2011a).

EPA designated the Southern Hills Aquifer, which includes the Catahoula Aquifer that underlies GGNS, to be a sole-source aquifer (EPA 2012c). The designation protects an area's groundwater resource by requiring EPA to review all proposed projects within the designated area that will receive Federal financial assistance. All proposed projects receiving Federal funds are subject to review to ensure they do not endanger the groundwater source. As such, the MDEQ's Wellhead Protection Program is working to identify and manage potential sources of contamination located near public water supply wells. The Port Gibson and CS&I Water Association #1 well fields are the only wellhead protection areas identified within a 6-mi (10-km) radius of the site (Entergy 2011a; MDEQ 2010b).

2.2.5.4 Groundwater with elevated tritium

Groundwater with elevated tritium activities (above background levels) was recently found in backfill material and in the Upland Complex Aquifer near the northeast side of the Unit 2 power block. This power block does not contain a nuclear reactor. No other radionuclides have been detected above background levels in the Upland Complex Aquifer. Based on a review of available data, tritium contaminated groundwater has not migrated off site (GGNS 2012a). Contamination appears to be restricted to the area near the power block. No radionuclides above background levels have been detected in the Catahoula Aquifer or the Mississippi River Alluvial Aquifer (Entergy 2011a). Elevated tritium levels have not been detected in the GGNS potable water supply wells, or in any radiological environmental monitoring program monitoring wells (GGNS 2012a).

With the exception of dewatering well DW-01 and monitor well MW-07, all wells with tritium activities above background levels have levels significantly below the EPA primary drinking water standard for tritium (20,000 pCi/L) (40 CFR 141). Recent tritium values for DW-01 ranged from 8,407 to 21,100 pCi/L and for MW-07 ranged from 7,135 to 17,404 pCi/L. DW-01 exceeded the EPA drinking water standard in September 2011. These wells are located close together near the outer wall of the Unit 2 power block (Figure 2–13). These wells are located in backfill material between the power block and the tie-back wall. The backfill material was used to fill the excavation created to build the power blocks. The tie-back wall is a structure built to hold up the sides of the open excavation during construction. After the power blocks were built, this structure was left in place and the excavation was filled in. Outside of the tie-back wall, groundwater near the Unit 2 power block is moving away from the power block toward the northeast (GGNS 2012a).

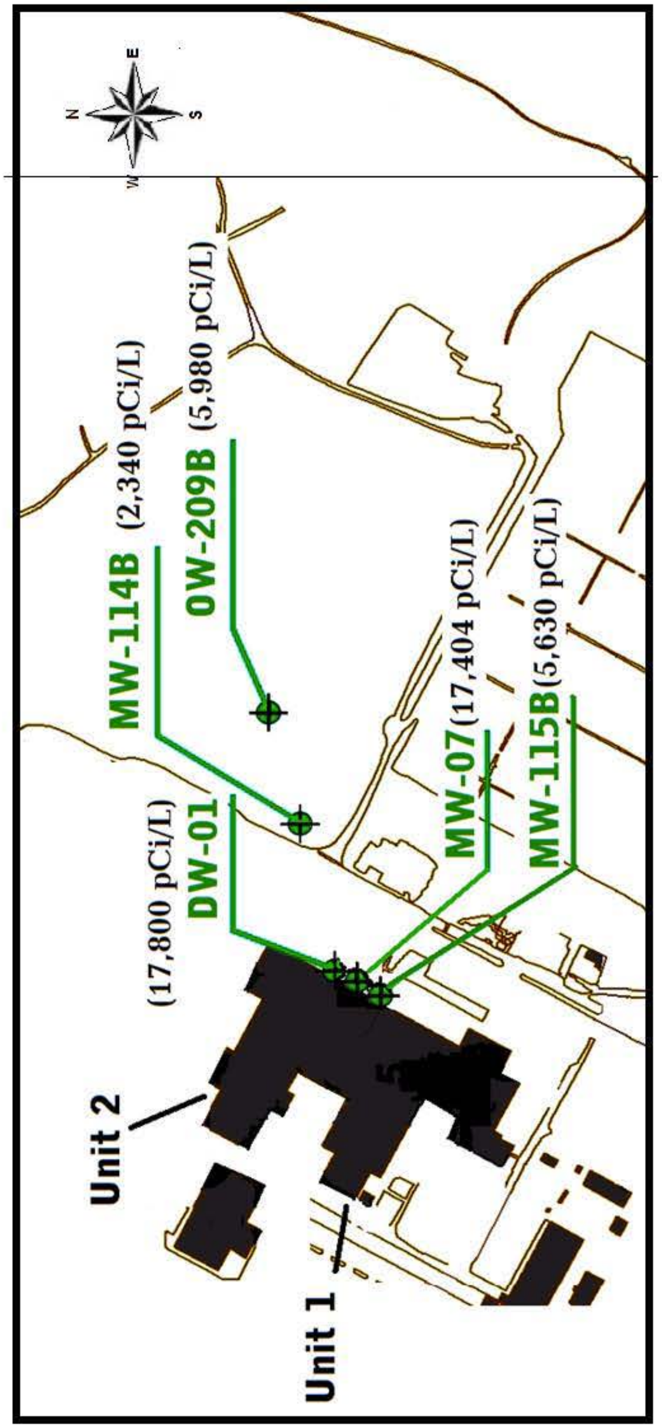
Elevated tritium values have not been detected in any wells located outside the site. The nearest wells outside GGNS that provide water from the Upland Complex Aquifer are located approximately 1 mi (1.6 km) south-southeast from the Unit 1 power block. One well provides water to two residences; the other well is not being used for human consumption. These wells are located in the opposite direction (i.e., upgradient), from the direction of contamination migration in the Upland Complex Aquifer. CS&I Water Association #1 provides water to the majority of the rural population in the area. The closest area of concentrated groundwater withdrawal is the Port Gibson municipal water system, which obtains water from the Catahoula Aquifer about 5 mi (8 km) southeast of the site (Entergy 2011a). Hydraulic interconnection between the Upland Complex Aquifer and the Catahoula Aquifer has not been identified.

Elevated tritium levels above background have not been detected in the three onsite Upland Complex Aquifer wells that supply potable water to GGNS. The wells, located near the bluffs between the Mississippi River and the power blocks, are in the opposite direction from any contamination moving northeast from the Unit 2 power block. These are the only drinking water wells that could be affected if groundwater contamination moved westward from the power block towards the Mississippi River Alluvial Aquifer. These wells are sampled annually for tritium and the results are reported to the NRC.

In 2007, the nuclear power industry began implementing its “Industry Ground Water Protection Initiative” (NEI 2007). Since 2008, the NRC has been monitoring implementation of this initiative at licensed nuclear reactor sites. The initiative identifies actions to improve utilities’ management and response to instances in which the inadvertent release of radioactive substances may result in low but detectible levels of plant-related materials in subsurface soils and water. It also seeks to identify those actions necessary for implementation of a timely and effective groundwater protection program. The areas of contamination were discovered as part of GGNS participation in this initiative. At this time, monitoring wells have been drilled on all sides of the power blocks and GGNS is monitoring them. Monitoring results from these wells are reported annually to the NRC.

1 **Figure 2–13. Most Recent GGNS Tritium Contaminated Well Data from February 2012***

2 **(*Most recent data for MW-07 is August 2011)**



3 Source: Modified from GGNS 2012a

2.2.6 Aquatic Resources

GGNS is located adjacent to the Mississippi River, which is part of the largest river basin in North America and the third largest river basin in the world (Brown et al. 2005). GGNS lies within the Lower Mississippi River, which is defined as the portion of the Mississippi River that extends from the confluence with the Ohio River in Illinois to the Gulf of Mexico in Louisiana (Brown et al. 2005). The site occurs within the Gulf Coastal Plain physiographic province.

The Lower Mississippi River has relatively high number of species, especially for fish. The high species richness is in part due to the variety of habitats within the Mississippi River, as well as nearby floodplain habitats hydraulically connected to the Mississippi River during flooding events. Other factors that contribute to the high species diversity include the length of the river, the unique habitats that the river's tributaries provide, and the connection with the Gulf of Mexico, which brings marine and anadromous species into the lower reaches of the Mississippi River (Brown et al. 2005).

2.2.6.1 Environmental Changes in the Lower Mississippi River

Human activities have had a large influence on the relative abundance of many species and their habitat within the Mississippi River. The major activities that altered aquatic resources near GGNS include: (1) efforts to control flooding and increase navigation; (2) chemical contamination from runoff as a result of industrial, urban, and agricultural activities; and (3) introduction of nonnative species (Brown et al. 2005).

To allow for ship traffic along the Mississippi River, several projects have changed the relative abundance and types of habitats within the river. Beginning in 1824, the U.S. government has removed snags, such as trees or tree roots, from the river. Snags provide natural habitat for invertebrates that require a firm attachment site. On the other hand, revetments, which are built to prevent erosion and river meandering, have increased availability of hard-surface habitats, but decreased the availability of soft-surface river bank habitats. Revetments such as timber, wooden or wire fences, rocks, and tires cover approximately 50 percent of the banks of the Lower Mississippi River (Baker et al. 1991; Brown et al. 2005). At GGNS, articulated concrete was installed on the river bank downstream of the discharge structure and barge slip to stabilize the river bank (NRC 1981).

In addition, the U.S. Army Corps of Engineers (USACE) has artificially created cutoffs that shortened the length of the river by cutting across a point bar or neck of a meander. Baker et al. (1991) estimate that artificially created cutoffs have shortened the length of the Lower Mississippi River by 25 to 30 percent, or approximately 500 km (310 mi). Cutoffs also can increase the river speed and erosion of river banks (Baker et al. 1991).

Levees have been built along the Mississippi River for more than 300 years to control flooding. By 1973, 29 km (18 mi) of levees lined the river near New Orleans. By 1844, levees were nearly continuous up to the confluence with the Arkansas River (Baker et al. 1991). As of 2005, nearly 3,000 km (1,864 mi) of levees lined the Lower Mississippi River and an additional 1,000 km (621 mi) of levees lined its tributaries (Brown et al. 2005). The levees decrease the frequency of flooding events, during which aquatic biota can move between the Mississippi and floodplain habitats. The movement of aquatic resources from floodplain habitats into the river is one reason that the Lower Mississippi is so rich in species diversity. USACE continues to dredge, install river bank revetments and levees, and regulate upstream reservoirs to minimize the historical movements of the river and create a relatively stable channel.

In addition to physical changes, runoff from over 40 percent of the conterminous 48 states drains into the Mississippi River. Land use changes over time have increased the concentration of industrial, chemical, and sediment inputs into the river. For example, forests have been cleared to farm cotton, soybeans, rice, and corn near GGNS. Farming practices currently include the use of fertilizers, pesticides, and herbicides, which wash into the Mississippi River, especially after large rain events (Brown et al. 2005). Plowed fields, as compared to forested areas, increase the amount of sediments entering the Mississippi River.

From 1963 through 1965, a catastrophic fish kill occurred from Memphis to the Mississippi River mouth as a result of industrial releases of endrin, a pesticide made from a chlorinated hydrocarbon. Mississippi Power & Light Company (MP&L) suggests that the endrin release may have reduced species diversity near GGNS by extirpating some species that were highly sensitive to the chlorinated hydrocarbon pesticide (MP&L 1981). As of 2002, testing has indicated that several of the older “first generation” chlorinated insecticides can be detected in low concentrations in bed sediments, although none of the chemical were detected in the water column.

2.2.6.2 Description of the Aquatic Resources Associated With GGNS

Aquatic resources in the vicinity of GGNS include the following:

- the Mississippi River,
- Hamilton and Gin Lakes,
- a flooded borrow pit,
- three small upland ponds,
- Stream “A” and Stream “B,” and
- ephemeral drainages.

In 1972, MP&L conducted aquatic studies on the GGNS site to determine baseline conditions of the aquatic environment before construction. MP&L conducted aquatic ecology surveys from June 1972 to August 1973 and documented 86 fish species, more than 100 plankton taxa, and more than 50 macroinvertebrate taxa (MP&L 1981). System Energy Resources, Inc. (SERI) conducted reconnaissance-level surveys from August 19 to 24, 2002, and October 29 to November 1, 2002, in support of the early site permit (ESP) for GGNS (SERI 2005). These surveys primarily resulted in qualitative data and general observations. In November 2006, Entergy hired a consultant to conduct a mussel survey along the Mississippi River in support of the COL application. Entergy is not aware of any other aquatic studies that have been conducted at GGNS (GGNS 2012a).

SERI (2005) concluded that similar aquatic resources were present in 2002 as in 1972 and 1973 at GGNS. SERI (2005) based this finding primarily upon the results of the 2002 reconnaissance-level surveys. SERI (2005) also noted that the only major change that could have substantial impacts on aquatic biota was the installation of the articulated concrete mats along the river bank in 1979. The staff notes the operation of GGNS and its discharge of effluent into the Mississippi River is another change that has occurred since 1973.

The staff notes that the current aquatic resources may vary from that recorded in 1972 and 1973. As described above, the relative abundance of human-made habitats in the Mississippi River, such as deep channels and hard substrates, have increased, while meandering portions of the river and soft substrates have decreased. Therefore, species that prefer human-made habitats have likely increased in relative abundance. Similarly, the relative abundance of pollution-sensitive species has likely increased because of the improved water quality in the Mississippi River since the implementation of the CWA and other environmental regulations (Caffey et al. 2002).

The staff compared aquatic surveys from 1972 through 1974 with more recent surveys from 2006 through 2008. The surveys were recorded on FishNet (2012), which is a collaborative effort by the Mississippi Natural History Museum and other natural history museums and biodiversity institutions to compile a database of fish survey data. Aquatic surveys from the Mississippi River near GGNS from 1972 through 1974 captured a total of 215 fish, representing 25 different species belonging to 12 families. Aquatic surveys from the Mississippi River near GGNS from 2006 through 2008 captured a total of 205 fish, representing 20 different species belonging to 9 families. Of the 25 species recorded from 1972 through 1974, 8 species (32 percent) were collected and 17 species (68 percent) were not collected in the more recent surveys. In addition, 12 species were collected from 2006 through 2008 that were not collected during the earlier surveys. Of the 12 families recorded from 1972 through 1974, 8 families (67 percent) were collected and 4 families (37 percent) were not collected in the more recent surveys. In addition, one family was collected from 2006 through 2008 that was not collected during the earlier surveys. These results suggest that the aquatic resources from 1972 through 1974 have changed, although some of the same species and many of the same families likely still inhabit the aquatic environments near GGNS. In addition, some new species have likely been introduced into the Mississippi River near GGNS. The staff also notes that degree of species overlap reported above is likely lower than what occurs in nature given that the studies likely used different capture methods, occurred at different seasons, and sampled in different areas or habitats in the river.

<u>Mississippi River</u>

The Mississippi River's eastern bank defines the western boundary of the GGNS site. The width of the river ranges from approximately 0.5 mi (0.8 km) at low flow to 1.4 mi (2.3 km) at high flow. The deepest part of the channel is about 16 ft (4.9 m). Three predominate habitat types occur within the Mississippi River near GGNS: backwater habitat, river bank habitat, and the main channel (Entergy 2011a). GGNS-related aquatic surveys within these habitats are described below.

Sampling Methods for Preconstruction Studies

MP&L (1981) sampled aquatic biota in the Mississippi River from September 1972 through August 1973. MP&L sampled areas within each of the three main habitats between RM 400 and RM 410.

For fish, MP&L (1981) collected monthly samples for 3 to 15 consecutive days using various mesh sizes of gill, trammel, and hoop nets in backwater and river bank habitats. MP&L set nets for 24 hours, or for as long as conditions permitted. Along the channel, MP&L sampled fish once in September 1972 and monthly from June through September 1973, using an otter trawl and fish-locating echo sounder. MP&L collected larval fish monthly or semi-monthly from January through July 1973.

For macroinvertebrates, which are invertebrates that are visible without a microscope, MP&L sampled monthly using a Shipek sediment sampler from September 1972 through August 1973. Starting in January 1973, drifting benthic macroinvertebrate samples were collected near the water surface at two stations in the Mississippi River using a 1-m (3-ft) diameter plankton net (505-micron mesh). MP&L collected shrimp monthly using 4 x 2 x 1 ft (1.2 x 0.6 x 0.3 m) box traps (MP&L 1981).

MP&L sampled plankton monthly to semi-monthly from September 1972 through August 1973. Sample stations were similar to that described for fish.

The results of this sampling are discussed in the following sections.

Biological Communities in Backwater Habitat

Backwater habitat occurs in the slow, relatively shallow waters created by the large bend in the Mississippi River near the site. The substrate is generally loosely consolidated, silty clay sediment of low plasticity. MP&L documented an abundant assemblage of fish, macroinvertebrates, and plankton in this habitat. The relatively high number of macroinvertebrates provides food and shelter for spawning fish, eggs, and larvae.

Fish. MP&L collected 35 fish species within the backwater habitat. Ten fish species comprised 85 percent of the fish captured. The most common species included gizzard shad (*Dorosoma cepedianum*), blue catfish (*Ictalurus furcatus*), river carpsucker (*Carpiodes carpio*), freshwater drum (*Aplodinotus grunniens)*, and shovelnose sturgeon (*Scaphirhynchus platorynchus*). Catch-per-unit-effort (CPUE) was highest in the fall (MP&L 1981).

Invertebrates. Benthic invertebrates, which inhabit the bottom of the river, were the most abundant and dense within backwater habitats as compared to river bank and river channel habitats. The most common taxa included tubificid worms, chironomid larvae (dipteran), burrowing mayfly (*Hexagenia*) larvae, leeches, and bivalves (mussels and clams) (MP&L 1981; NRC 2006a). The abundance of benthic invertebrates in backwaters increased from September 1972 through June 1973 and then decreased through August. MP&L determined that backwaters provide an important feeding ground for fish based on the dry weight standing stock of benthic macroinvertebrates (MP&L 1981).

Biological Communities in River Bank Habitat

The river bank provides habitat with moderate to swift currents passing by steep banks. The substrate is generally consolidated, high-plastic clay (SERI 2005). In 1979, the river bank downstream of the discharge structure and barge slip was stabilized with articulated concrete mats (NRC 1981).

Juvenile and Adult Fish. MP&L collected 34 fish species within river bank habitat. The most commonly collected fish were gizzard shad, freshwater drum, silver chub (*Macrhybopsis storeriana*), flathead catfish (*Pylodictis olivaris*), and blue catfish. Gizzard shad comprised 52 percent of the relative abundance of fish. CPUE was highest in late winter, right before larval fish were observed. Therefore, MP&L conjectured that these fish were likely moving toward spawning habitat in late winter (MP&L 1981).

Ichthyoplankton. MP&L first observed larval fish in March 1973 and observed seven species during this time. The most abundant early-spawning species included shad, Mississippi silverside (*Menidia audens*), and mosquitofish (*Gambusia affinis*) larvae. The density of larval fish increased throughout the spring with peak spawning activity occurring in April and May. MP&L observed lower densities of larvae through July, although spawning activity likely occurs through the fall (MP&L 1981).

The spawning periods and number of spawning peaks varied for different species. For example, shad spawning began in early April, peaked in May and June, and extended through July. Drum, on the other hand, spawned during a shorter period of time with two spawning peaks: once in June and again in mid-July. MP&L observed a relatively long spawning period for minnow as larvae were collected throughout the entire sampling period. While MP&L commonly observed adult catfish and suckers, their larvae were not collected near the river bank probably because adults spawn in backwaters where larvae mature until they enter the riverine environment as juveniles (MP&L 1981).

Most fish eggs near GGNS are demersal (sinking), adhesive, and small (between 0.02 and 0.03 in. (0.5 mm) diameter. As such, eggs spawned in backwaters typically adhere to vegetation or logs and eggs spawned over gravelbars and sandbars typically adhere to the bottom substrate during development. Therefore, MP&L caught relatively few fish eggs in its 0.02 in. (0.5 mm)-mesh plankton net. Specifically, MP&L caught 20 fish eggs compared to 16,596 larvae (MP&L 1981).

Invertebrates. MP&L collected benthic invertebrates on stable river banks, but did not observe benthic invertebrates on unstable river banks because these river banks likely eroded before invertebrates could establish in sufficient numbers. Highly erosive clay and sand river banks make for a highly dynamic benthic invertebrate community. In some locations, MP&L observed benthic invertebrates during one sampling period, but not during the following month, because of recently eroded clay river banks. The most common taxa included tubificids, the midges *Cryptochironomus* and *Chaoborus*, the mayflies *Pentagenia* and *Tortopus*, chironomids, and amphipods (MP&L 1981).

MP&L also collected river shrimp (*Macrobrachium ohione*) in the nearshore habitat along the river bank. River shrimp abundance was highest from August through October and close to zero from November 1972 through April 1973. MP&L attributed the decline in river shrimp to the river temperature dropping below 7.5 °C (46 °F) in November 1972 and not rising above 20 °C (68 °F) until April 1973 (MP&L 1981).

In November 2006, American Aquatics, Inc. (AAI) conducted a mussel survey in support of Entergy's COL application. The purpose of the survey was to determine whether any mussels occurred along the east Mississippi River bank near RM 406 (Entergy 2008c). Survey methods included visual surveys of dead mussel shells along four shoreline sites and visual underwater surveys for live mussels along six transects. One of the four shoreline sampling sites was in the area of the discharge structure. AAI did not observe any live mussels. AAI found dead mussel shells of two non-native species, zebra mussels *(Dresissena polymorpha*) and Asiatic Clam (*Corbicula fluminea*). River currents likely transported the dead shells from upriver locations. As a result of these surveys, AAI concluded that mussel colonization near GGNS was not likely (Entergy 2008b).

Biological Communities in Main Channel Habitat

The most prominent aquatic habitat in the vicinity of GGNS is the main channel. This area provides deep water habitat with strong and turbulent currents. The coarse grained river bottom typically consists of gravelly sand sediments (MP&L 1981; SERI 2005). MP&L documented relatively low productivity within the main channel as few benthic invertebrates inhabited the river bottom and the water column contained less fish compared to other river habitats. However, difficult conditions during sampling techniques, such as rapid currents, irregular bed configurations, and bottom associated debris, also may have contributed to the relatively low numbers of fish captured (MP&L 1981).

Fish. Commonly observed species included gizzard shad and drum. During June and July trawls, all captured fish were young-of-the-year. Commonly collected species during trawl sampling in August and September included blue and channel catfish (*Ictalurus punctatus*), shovelnose sturgeon, and four chub species, most of which were juveniles. Adult fish also were likely present in the main channel, but they may have avoided capture more easily because of faster swim speeds (MP&L 1981).

Invertebrates. MP&L collected 36 benthic samples from the bottom of the main channel in September and October 1972, and March, June, July, and August 1973. MP&L did not observe any macroinvertebrates.

Overall Biological Community in Mississippi River

Fish. MP&L captured a total of 69 fish species (MP&L 1981). A similar study conducted at the same time period captured the same number of species at the River Bend Nuclear Station, 232 km (144 mi) downstream from GGNS (MP&L 1981; NRC 2006). Gizzard shad was the most abundant species, and the relative numerical abundance varied from 3 to 76 percent (MP&L 1981). The relative abundances of other dominant species captured were freshwater drum (10 percent), blue catfish (8 percent), flathead catfish, and river carpsucker (5 percent) (MP&L 1981).

Plankton. MP&L (1981) characterized plankton in the Mississippi River as either zooplankton or phytoplankton. Zooplankton are small animals that float, drift, or weakly swim in the water column of any body of water, whereas phytoplankton are plants. Zooplankton density ranged over two orders of magnitude during the study period. MP&L identified 46 taxa and dominant zooplankton that included a stalked protozoan (*Carchesium* sp.), various cladocerans, and a colonial rotifer. *Carchesium* sp. can be an indicator of pollution, especially where sewage is not treated properly. MP&L identified a total of 49 phytoplankton genera and the most dominant were centric diatoms (MP&L 1981).

Hamilton and Gin Lakes

Hamilton and Gin Lakes are remnants of a former Mississippi River channel after the river moved west. The lakes are relatively shallow, approximately 2 to 3 m (8 to 10 ft deep (Energy 2011a). SERI (2005) examined aerial photography from 2001 and estimated the surface area of Hamilton Lake to be 26 ha (64 ac) and Gin Lake to be 22 ha (55 ac). The lakes have decreased in size since 1973.

Water enters and leaves Hamilton and Gin Lakes when the Mississippi River floods. Hamilton Lake also receives water from Streams “A” and “B,” which transport storm water from GGNS. Gin Lake is connected to Hamilton Lake through a culvert beneath the Heavy Haul Road (MP&L 1981; SERI 2005).

MP&L characterized the oxbow lakes as similar to backwater habitat in physical characteristics. The lakes are relatively shallow with no current and the bottom habitat is loosely consolidated, highly plastic clay sediments. Relatively productive biotic assemblages inhabit the lakes (MP&L 1981).

Biological Communities in Hamilton and Gin Lakes

Fish. MP&L sampled for fish in Hamilton and Gin Lakes bimonthly from June 1972 through August 1973 using electrofishing gear or gill and trammel nets (MP&L 1981). MP&L set nets for 24 hours, or for as long as conditions permitted.

Although both lakes have similar habitats, MP&L collected 46 fish species in Hamilton Lake and 36 species from Gin Lake. The greater number of species in Hamilton Lake likely is due to the more frequent connection with the Mississippi River (MP&L 1981). For example, eight of the species observed in Hamilton Lake, but not in Gin Lake, were species that typically inhabit the Mississippi River.

Despite the difference in species diversity, the most common species in both lakes were the same: Eighty percent of the fish were gizzard shad, bluegill (*Lepomis macrochirus*), threadfin shad (*Dorosoma petenense*), or largemouth bass (*Micropterus salmoides*). In both lakes, gizzard shad was the most common species within open-water habitats, whereas bluegill was the most common species within shoreline-covered habitats.

Fish communities within oxbow lakes are relatively dynamic. When the Mississippi River floods, aquatic biota can enter and leave the lakes. For example, in April and May 1973, the Mississippi River flooded to Hamilton Lake and the silvery minnow (a river species) comprised 17 and 2 percent of the lake, respectively. In June, after the flood subsided, MP&L did not observe silvery minnow in the lakes. Therefore, MP&L’s one-year study provides a basic characterization of the lakes that may vary considerably both on a short-term and long-term basis.

Invertebrates. MP&L sampled benthic invertebrates in Hamilton and Gin Lakes using a Ponar bottom grab starting in October 1972 through August 1973. Benthic macroinvertebrates in Hamilton and Gin Lakes resembled the macroinvertebrate community MP&L observed in backwater habitats of the Mississippi River. Grab samples during the fall and winter indicated that the most common taxa included larvae of the phantom midge *Chaoborus* and various genera of chironomid midges (e.g., *Coelotanypus*, *Procladius, Cryptochironomus, Pentaneura* and *Tanypus*). During the spring, common taxa included tubificid worms and bivalves (MP&L 1981). MP&L also observed several species not included in grab samples, such as large unionid mussels (*Carunculinus*, *Anodonta,* and *Lampsilus*), large snails (*Campeloma* and *Viviparus),* whirligig beetles (*Gyrinus*), water striders (Notonectidae), crayfish (*Procambarus)*, and the grass shrimp *Palaemonetes kadiakensis.*

Benthic invertebrate density in Hamilton Lake was relatively stable, whereas MP&L observed several peaks of benthic invertebrate density in Gin Lake (MP&L 1981).

Plankton. During the 1972 and 1973 studies, MP&L observed that the frequency and duration of Mississippi River flooding, which allowed the plankton to enter or leave the lakes, had a strong influence on the plankton composition and abundance. When the lakes were not flooded, plankton developed into distinct populations that differed from the river communities. However, during flood events, the plankton community more closely resembled plankton communities within the Mississippi River (MP&L 1981).

Flooded Borrow Pit

MP&L created a borrow pit north of the barge slip in the 1970s to obtain fill for use in GGNS construction. Water enters and leaves the borrow pit when the Mississippi River floods. The depth of the pit is not known. SERI (2005) examined aerial photography from 2001 and estimated the surface area to be 6.5 ha (16 ac) in size. The pit does not appear to be hydrologically connected to the lakes, except when the Mississippi River floods and the flood water flows between the lakes and burrow pit. The bottom habitat within the burrow pit is likely similar to that of the oxbow lakes (SERI 2005).

Three Small Upland Ponds

Three small upland ponds exist on the GGNS site. Each pond is approximately 0.25–0.50 ac (0.1–0.2 ha). MP&L (1981) concluded that previous land owners stocked the ponds with bluegill and channel catfish.

Biological Communities in Upland Ponds

MP&L sampled the upland ponds using electrofishing and mark-recapture methods (MP&L 1981). The most common species include bluegill and mosquitofish. One pond also contained a few channel catfish.

Streams A and B

Streams A and B are perennial streams that run through the GGNS site. Stream A flows west from the GGNS sanitary waste water treatment facility. Stream A receives continual flow from facility storm water and processed discharge from the waste water treatment facility (NRC 2006a). Stream B flows west from the cooling towers on the south side of Heavy Haul Road. Flow in Stream B is intermittent, consisting mostly of storm runoff, and runs into Hamilton Lake. MP&L constructed sedimentation basins on both Stream A and B, referred to as Outfall 13 and 14, respectively (MP&L 1981; SERI 2005).

Biological Communities in Stream A and B

MP&L sampled Stream A twice between 1972 and 1973 (MP&L 1981). MP&L observed a total of 21 fish species, including bluntnose minnow, green sunfish (*Lepomis cyanellus*), longear sunfish (*Lepomis megalotis*), silvery minnow (*Hybognathus nuchalis*, a river species), and blackspotted top minnow (*Fundulus olivaceus*). Aquatic biota likely entered the stream during spring floods (SERI 2005). For example, several species, such as largemouth bass, river shiner (*Notropus blennius*), and warmouth (*Lepomis gulosus*), also inhabit Hamilton and Gin Lakes and the Mississippi River (MP&L 1981). In addition to the small number of fish, MP&L observed unidentified bivalves and snails in Stream A. As a result of the preconstruction studies, SERI (2005) concluded that Stream A is relatively unproductive. For example, species diversity in Stream A was lower than similar streams near Vicksburg, Mississippi (MP&L 1981).

NRC is not aware of any aquatic surveys in Stream B. Stream A and B likely provide similar habitat for aquatic resources (SERI 2005), and therefore contain similar species. However, the aquatic community within Stream B may be smaller than the community in Stream A due to the intermittent flow of water. In addition, the species in Stream B would need to be able to survive in a wide-range of environmental conditions due to the intermittent flow of water.

Ephemeral Drainages

SERI (2005) calculated 24,140 linear ft (7.4 km) of ephemeral drainage channels throughout the GGNS site. These ephemeral drainage channels occur on the upland bluffs primarily on the eastern portion of the GGNS site. Several drainages support small wetlands (SERI 2005).

Commercially and Recreationally Important Fish

Limited commercial fishing occurs in the area. Most commercial fishing occurs on the Mississippi River near GGNS and on the Big Black and Bayou Pierre Rivers (NRC 2006a). Predominate harvest species include bigmouth (*Ictiobus cyprinellus*) and smallmouth buffalo (*Ictiobus bubalus*) (SERI 2005).

In 1973, MP&L estimated that there may have been 10–15 full-time and 30–40 part-time commercial fishermen operating between Grand Gulf and Natchez. Commonly collected species from a creel study in January through February 1973 included bigmouth and smallmouth buffalo (MP&L 1981).

Recreational fishing occurs on the Mississippi River and Hamilton and Gin Lakes (SERI 2005; NRC 2006a). Recreational fisherman generally fish from boats and the bank as well as use trotlines in the lakes. The most common fish caught include catfish, bluegill, and bass (MP&L 1981; SERI 2005).

Nuisance Species

The ERs associated with the Operating Permit (MP&L 1981), ESP (SERI 2005), COL (Entergy 2008c), and LRA (Entergy 2011a) did not identify aquatic nuisance species in the waters associated with GGNS. As described above, in November 2006, AAI observed dead mussel shells of two exotic species, zebra mussels *(Dresissena polymorpha*) and Asiatic Clam (*Corbicula fluminea*), while conducting mussel surveys in support of the COL application (Entergy 2008c). River currents likely transported the dead shells from an unknown upriver location. Zebra mussels also have been observed 35 river miles upriver of GGNS, near Vicksburg and throughout the Lower Mississippi River (Benson 2011). The Asiatic clam has been observed in the Big Black River north of GGNS and throughout the Lower Mississippi River (USGS 2012c).

Aquatic Resources Associated with Transmission Line Rights-of-Way

Transmission line rights-of-way for GGNS cross waterways in Claiborne County. The Baxter-Wilson right-of-way crosses the Big Black River approximately 12 km (7.5 mi) to the northeast of the GGNS site. In addition, the Baxter-Wilson substation in Warren County is less than 0.75 km (0.47 mi) from the shores of the Mississippi River. The Franklin right-of-way crosses the Bayou Pierre approximately 5.5 km (3.4 mi) to the south of GGNS (NRC 2006a). The Franklin right-of-way also crosses the Homochitto River (Entergy 2011a).

Neither the ER for the ESP (SERI 2005), the ER for the COL (Entergy 2008c), nor the ER for license renewal (Entergy 2011a) provide a description of the aquatic resources along the transmission lines. NRC (2006a) determined that information on aquatic resources was not available from the transmission and distribution system owner and operator, EMI.

2.2.7 Terrestrial Resources

2.2.7.1 GGNS Ecoregion

GGNS lies where the Mississippi Valley Alluvial Plain and Mississippi Valley Loess Plain meet. The Mississippi Valley Alluvial Plain ecoregion consists of a broad, flat alluvial plain. River terraces, swales, and levees provide the main elements of relief. Soils are typically finer-textured and poorly drained compared to the upland soils of the adjacent Mississippi Valley Loess Plains ecoregion. The Mississippi Valley Loess Plains consist of a thin strip of land that extends from western Kentucky southward to Louisiana. It is about 750 km (470 mi) long, 110 km (70 mi) wide, and covers about 43,775 km^2 (16,901 mi^2) of land (USGS 2011). This ecoregion consists of irregular plains with a thick layer of highly erodible loess deposits, oak-hickory and oak-hickory-pine forests, and streams with low gradients and silty substrates.

2.2.7.2 Summary of Past GGNS Site Surveys and Reports

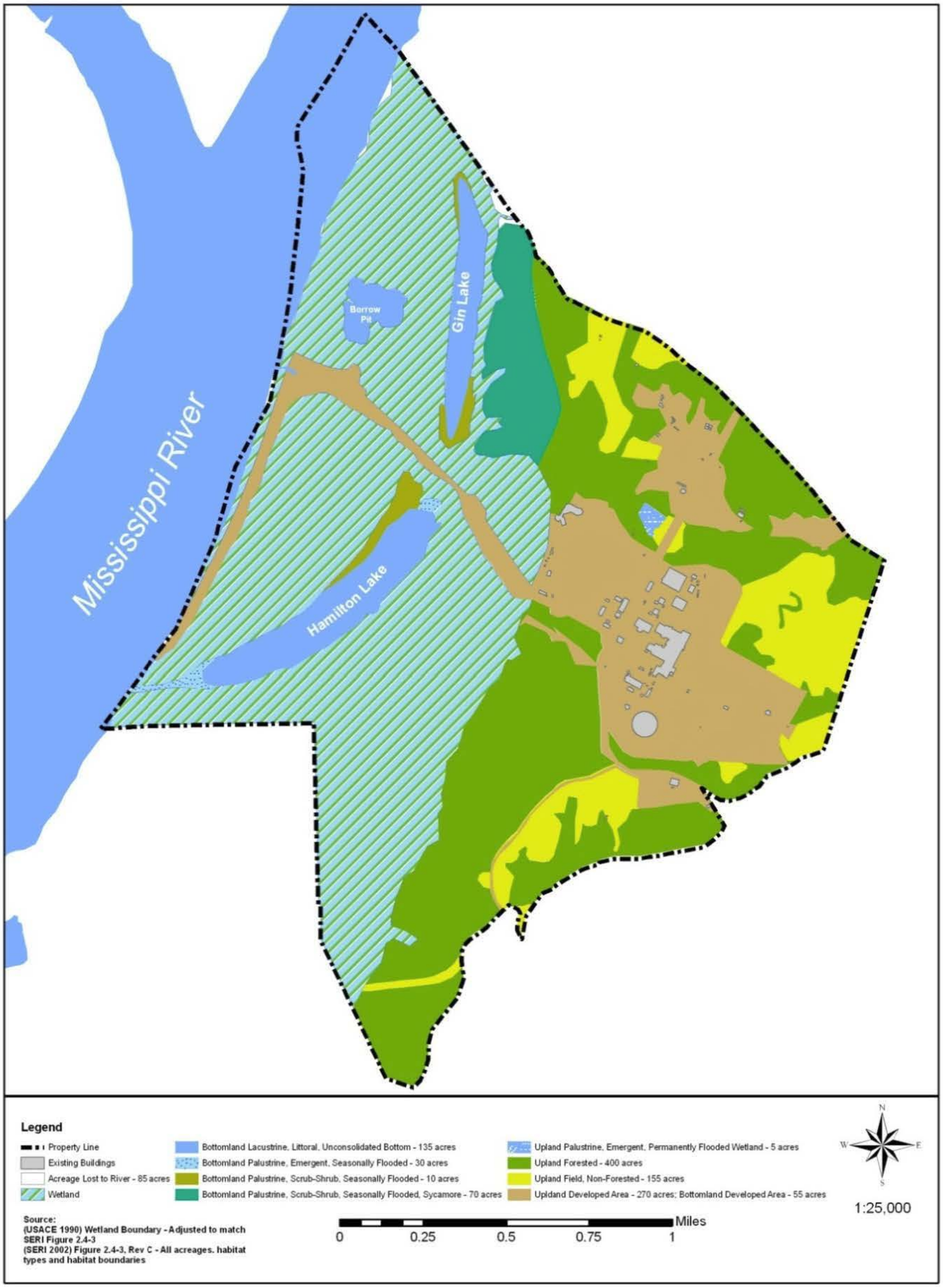
In 1972, MP&L conducted vegetation and wildlife studies on the GGNS site to determine baseline conditions of the terrestrial environment before construction. As part of these studies, MP&L mapped overstory and understory vegetation and conducted wildlife surveys to determine the occurrence and relative abundance of mammals, birds, reptiles, and amphibians on the site. The U.S. Atomic Energy Commission (NRC's predecessor agency) summarized the results of these studies and described the terrestrial environment in its *Final Environmental Statement Related to Construction of Grand Gulf Nuclear Station, Units 1 and 2* (FES) (AEC 1973).

In 2003, SERI submitted an application to the NRC for an ESP on the GGNS site. As part of its ESP application, SERI prepared an ER (SERI 2005). In its preparation of the ESP ER, SERI conducted qualitative reconnaissance site visits to compare the ecological conditions with those described in the 1973 FES. The ESP ER identified little change in undeveloped portions of the site; the report largely summarized the findings in AEC's 1973 FES. The NRC developed an environmental impact statement (EIS) (NRC 2006a) during its review of the ESP application, which it published in 2006.

In 2008, Entergy submitted an application for a combined license (COL) to the NRC for the proposed Grand Gulf, Unit 3. Entergy requested that the NRC suspend its review of this application in January 2009 until further notice. Nevertheless, the application contained an ER (Entergy 2008c) that included an assessment of the terrestrial environment. Entergy conducted several new surveys during the preparation of its ER for the COL specific to protected species. Section 2.2.8 discusses these surveys in more detail. In 2011, Entergy submitted an application for license renewal to the NRC. The associated ER (Entergy 2011a) also described the terrestrial environment. Entergy did not conduct any new surveys for the license renewal application. Entergy does not conduct any ongoing terrestrial monitoring on the site beyond that associated with the site's radiological environmental monitoring program (REMP) (Entergy 2011a). Section 4.8 of this SEIS describes the REMP.

Since multiple, previously published reports describe the GGNS site in detail, the following section provides a brief overview of the site habitats and wildlife. Refer to the reports referenced above for a more detailed description of the GGNS site.

Figure 2–14. GGNS Property Habitat Types (Source: Entergy 2011a)



2.2.7.3 GGNS Site

The GGNS site lies along the east bank of the Mississippi River. North-south bluffs run parallel to the river and divide seasonally inundated bottomlands from upland habitat atop the bluffs.

Roughly half of the site consists of upland habitats and half the site consists of bottomland habitats. Two small lakes—Hamilton and Gin Lakes—lie within the bottomlands. During construction, about 270 ac (109 ha) of upland habitat was cleared for GGNS buildings and related infrastructure. Upland areas are more diverse than bottomland areas because they do not experience prolonged periods of river inundation as do the bottomland habitats (Entergy 2011a). The South Woods, which lies to the south and west of the cooling tower, is an especially diverse area because of its complex topography of narrow ridges with steep slopes, ravines, and bluffs. Figure 2–14 shows the GGNS property by habitat type. This figure outlines the historical property boundary, which encompasses 2,100 ac (850 ha), although the actual property size today is 2,015 ac (815 ha) because of erosional loss from the Mississippi River.

Table 2–3 summarizes the GGNS site habitats. Since the only terrestrial site surveys were conducted before construction, the table primarily relies on information from these surveys as they were presented in the AEC's 1973 FES. However, the table includes updated or more specific habitat information, as available in the ESP ER (SERI 2005), the COL ER (Entergy 2008c), and the license renewal ER (Entergy 2011a). Two primary habitat changes between preconstruction and present day are in the bottomland scrub-shrub wetlands (east of Gin Lake) and the upland open fields and clearings, in which Entergy has planted American sycamore (*Platanus occidentali*) and loblolly pine (*Pinus taeda*), respectively.

Table 2–3. Dominant Vegetation by Habitat Type

Bottomland Hardwood Forest	
Community types:	bottomland deciduous forest
Area:	985 ac (398 ha)[(a)]
Dominant vegetation:	Overstory box elder (*Acer negundo*) pecan (*Carya illinoiensis*) sugarberry (*Celtis laevigata*) swamp privet (*Forestiera acuminate*) green ash (*Fraxinus pennsylvanica*) black willow (*Salix nigra*) Understory aster (*Aster* spp.) buckvine [or ambervine] (*Ampelopsis arborea*) false nettle (*Boehmeria cylindrica*) trumpet creeper (*Campsis radicans*) sugarberry (*Celtis laevigata*) ladies'-eardrops (*Fuchsia megellanica*) dewberry (*Rubus* spp.) Johnson grass (*Sorghum halepense*) poison ivy (*Toxicodendron radicans*)
Bottomland Emergent Wetlands	
Community types:	palustrine, emergent seasonally flooded
Area:	30 ac (12 ha)
Dominant vegetation:	redtop panicgrass (*Panicum rigidulum*) sedges (*Carex* spp.)
Bottomland Scrub-Shrub Wetlands (east of Gin Lake)	
Community types:	palustrine, seasonally flooded
Area:	70 ac (28 ha)
Dominant vegetation:	American sycamore (*Platanus occidentali*)

Bottomland Scrub-Shrub Wetlands (north, northwest, and south of Gin Lake)	
Community types:	palustrine, seasonally flooded
Area:	10 ac (4 ha)
Dominant vegetation:	black willow (*Salix nigra*) swamp privet (*Forestiera acuminate*) common button bush (*Cephalanthus occidentalis*)
Upland Loessial Bluff Hardwood Forest	
Community types:	oak forests American elm forests oak-sweetgum forests
Area:	400 ac (162 ha)
Dominant vegetation:	<u>Overstory</u> bitternut hickory (*Carya cordiformis*) pecan (*C. illinoiensis*) sweetgum (*Liquidambar styraciflua*) cherrybark oak (*Quercus pagoda*) southern red oak (*Q. falcata*) Texas oak (*Q. texana*) water oak (*Q. nigra*) American elm (*Ulmus americana*) <u>Understory</u> aster (*Aster* spp.) switchcane (*Arundinaria gigantean*) sedges (*Carex* spp.) Japanese honeysuckle (*Lonicera japonica*) poison ivy (*Toxicodendron radicans*) oaks (*Quercus* spp.) greenbriers (*Similax* spp.) winged elm (*Ulmus alata*) grasses
Upland Open Fields and Clearings	
Community types:	upland early successional field
Area:	155 ac (63 ha)
Dominant vegetation:	loblolly pine (*Pinus taeda*) goldenrod (family Asteraceae) sida (*Sida* spp.) goatweed (*Ageratum conyzoides*) mare's-tail (*Hippuris* spp.) common ragweed (*Ambrosia artemisiifolia*) dog fennel (*Anthemis* spp.)

[a] Habitat acreage in each of the references varies because of the loss of riparian habitat along the Mississippi River to erosion over time. This table uses those areas that appear in the most recent reference, the license renewal ER (Entergy 2011a). However, the FES (AEC 1973) is the only reference that specifies acreage for the bottomland hardwood forest area. Therefore, for this habitat type, the staff used the acreage estimate from the FES.

Sources: AEC 1973; Entergy 2008c; Entergy 2011a; SERI 2005

The 1972 pre-operational wildlife surveys documented 96 species of birds on the site out of an estimated 141 species likely to occur in the area (AEC 1973). Additionally, the AEC (1973) notes that 45 mammalian species, 67 reptiles, and 25 amphibians are likely to occupy the GGNS site. Tables D–1 through D–5 in the AEC's 1973 FES list these species. Table 2–4 below lists the most common or abundant species on the site. Common or abundant birds and mammals are those identified in the ESP EIS (NRC 2006a). The ESP EIS, however, does not include information on reptiles or amphibians. Thus, reptile and amphibian species listed in Table 2–4 are those identified as being abundant in the license renewal ER (Entergy 2011a) or in the FES (AEC 1973).

Table 2–4. Most Common or Abundant Wildlife Documented on GGNS

Birds[(a)]	
Passerines and Near Passerines	
Acadian flycatcher [S] (*Empidonax virescens*)	**mourning dove** [Y] (*Zenaida macroura*)
American robin [W] (*Turdus migratorius*)	**northern cardinal** [Y] (*Cardinalis cardinalis*)
belted kingfisher [Y] (*Ceryle alcyon*)	**northern rough-winged swallow** [S] (*Stelgidopteryx serripennis*)
blue jay [Y] (*Cyanocitta cristata*)	**orchard oriole** [S] (*Icterus spurius*)
field sparrow [W] (*Spizella pusilla*)	**red-winged blackbird** [Y] (*Agelaius phoeniceus*)
lark sparrow [W] (*Chondestes grammacus*)	**ruby-crowned kinglet** [W] (*Regulus calendula*)
Herons, Egrets, and Storks	
American coot [W] (*Fulica americana*)	**tricolored heron** [S] (*Egretta tricolor*)
cattle egret [S] (*Bubulcus ibis*)	**white ibis** [S] (*Eudocimus albus*)
great blue heron [Y] (*Ardea Herodias*)	**wood stork** [S] (*Mycteria americana*)
great egret [S] (*Ardea alba*)	**yellow-billed cuckoo** [S] (*Coccyzus americanus*)
Waterfowl and Grebes	
pied-billed grebe [W] (*Podilymbus podiceps*)	**northern pintail** [S] (*Anas acuta*)
mallard [S] (*Anas platyrhynchos*)	**wood duck** [Y] (*Aix sponsa*)
Birds of Prey	
black vulture [Y] (*Coragyps atratus*)	**American kestrel** [M] (*Falco sparverius*)
turkey vulture [Y] (*Cathartes aura*)	**Mississippi kite** [S] (*Ictinia mississippiensis*)
broad-winged hawk [S] (*Buteo lineatus*)	**great horned owl** [Y] (*Bubo virginianus*)
red-tailed hawk [Y] (*Buteo jamaicensis*)	**northern harrier** [M] (*Circus cyaneus*)
red-shouldered hawk [Y] (*Buteo lineatus*)	**eastern screech owl** [Y] (*Otus asio*)
sharp-shinned hawk [M] (*Accipiter striatus*)	

Mammals	
beaver (*Castor canadensis*)	**least shrew** (*Cryptotis parva*)
bobcat (*Lynx rufus*)	**marsh rice rat** (*Oryzomys palustris*)
cotton mouse (*Peromyscus gossypinus*)	**nine-banded armadillo** (*Dasypus novemcinctus*)
eastern chipmunk (*Tamias striatus*)	**opossum** (*Didelphis marsupialis*)
eastern cottontail (*Sylvilagus floridanus*)	**raccoon** (*Procyon lotor*)
eastern fox squirrel (*Sciurus niger*)	**shorttail shrew** (*Blarina brevicauda*)
eastern gray squirrel (*Sciurus carolinensis*)	**striped skunk** (*Mephitis mephitis*)
fulvous harvest mouse (*Reithrodontomys fulvescens*)	**swamp rabbit** (*Sylvilagus aquaticus*)
golden mouse (*Ochrotomys nuttalli*)	**white-footed mouse** (*Peromyscus leucopus*)
gray fox (*Urocyon cinereoargenteus*)	**whitetail deer** (*Odocoileus virginianus*)
hispid cotton rat (*Sigmodon hispidus*)	**woodland vole** (*Microtus pinetorum*)
house mouse (*Mus musculus*)	
Reptiles[(b)]	
American alligator [AQ, TR] (*Alligator mississippiensis*)	**ground skink**[TR] (*Lygosoma laterale*)
American toad [TR] (*Bufo americanus*)	**red-eared turtle** [AQ] (*Pseudemys scripta*)
black racer [TR] (*Coluber constrictor*)	**southern black racer** [TR] (*Coluber constrictor priapus*)
broad-banded water snake [AQ, TR] (*Natrix sipedon*)	**southern copperhead** [TR] (*Agkistrodon contortrix contortrix*)
diamond-backed water snake [AQ, TR] (*Natrix rhombifera*)	**spade foot toad** [LB] (*Scaphiopus holbrookii*)
eastern hognose [TR] (*Heterodon platyrhinos*)	**speckled kingsnake** [TR] (*Lampropeltis getulus*)
Fowler's toad [TR] (*Bufo woodhousel fowleri*)	**stinkpot**[AQ] (*Sternotherus odoratus*)
gray rat snake [TR] (*Elaphe obsolete*)	**three-toed box turtle** [TR] (*Terrapene carolina triunguis*)
green anole [TR] (*Anolis carolinensis carolinensis*)	**western cottonmouth** [AQ, TR] (*Agkistrodon piscivorus leucostoma*)

Amphibians[b]	
amphiuma salamander [BL] (*Amphiuma* spp.)	**lesser siren** [BL] (*Siren intermedia*)
bronze frog [AQ, TR] (*Rana clamitans*)	**mole salamander** [LB] (*Ambystoma talpoideum*)
bullfrog [AQ, TR] (*Rana catesbeiana*)	**slimy salamander** [LB] (*Plethodon glutinosus*)

[a]Codes following bird names signify seasonal use of the GGNS site; S = summer; M = migratory stopover; W = fall and winter; Y = year-round.

[b]Codes following amphibian names signify habitat use; AQ = aquatic habitat; BL = bottomlands; LB = loessial bluffs; TR = terrestrial habitat (general).

Sources: AEC 1973; Entergy 2011a; NRC 2006a

2.2.7.4 Transmission Line Corridors

Section 2.1.5 of this SEIS describes the three transmission lines (two full-length lines and one short tie that terminates on the site) associated with GGNS construction. The majority of the land (77.7 percent) that the transmission lines traverse is undeveloped. About 15 percent of the transmission line corridors is agricultural lands. Table 2–5 provides the land use by acreage and percent along the transmission line corridors.

Table 2–5. Transmission Line Corridor Land Use by Area

Land Use	Acres (Hectares)	Percent
Agricultural	246 (100)	14.7
Developed (Residential)	28 (11)	1.6
Developed (Non-residential)	3 (1)	0.2
Undeveloped	1,296 (525)	77.7
Water or Wetlands	96 (39)	5.8

Source: Entergy 2011a; NRC 2006a

The Baxter-Wilson line runs through hardwood forest, loessial bluffs, hardwood-forested Big Black River bottomland, farmland, and sparsely populated rural areas. The Franklin line runs through loessial bluff hardwood forest and fields, pine and hardwood forest, and farmland (Entergy 2011a). The Franklin line also runs through Homochitto National Forest to the southeast of the GGNS site. Homochitto National Forest is an 189,000 ac (76,500 ha) National Forest that spans seven Mississippi counties.

2.2.8 Protected Species and Habitats

The U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) jointly administer the Endangered Species Act (ESA) of 1973, as amended. The FWS manages the protection of and recovery effort for listed terrestrial and freshwater species, while the NMFS manages the protection of and recovery effort for listed marine and anadromous species. Within Mississippi, the Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP) lists species as State endangered under the Mississippi Nongame and Endangered Species Conservation Act of 1974 (MNHP 2011).

The NMFS has not designated any essential fish habitat under the Magnuson–Stevens Fishery Conservation and Management Act, as amended, within affected waterbodies within the vicinity of GGNS (NMFS 2012a); therefore, this section does not discuss species with essential fish habitat.

This section also discusses those species protected under the Bald and Golden Eagle Protection Act of 1940, as amended, and the Migratory Bird Treaty Act of 1918, as amended.

The FWS and NMFS have not designated any critical habitat under the ESA within the action area, nor has either agency proposed the listing or designation of any new species or critical habitat within the action area.

2.2.8.1 Action Area

For purposes of its protected species and habitat discussion and analysis, the NRC considers the action area, as defined by the ESA regulations at 50 CFR 402.02, to include the lands and waterbodies described below. The following sections only consider terrestrial and aquatic species that occur or have the potential to occur within this action area.

Terrestrial, wetland, and riparian habitat on the GGNS site and surrounding area within a 2-mi (10-km) radius. The 2,015-ac (815-ha) GGNS site lies within Claiborne County, Mississippi. The site includes hardwood forest, open fields and clearings, and several areas of emergent wetlands and riparian habitat bordering the Mississippi River. Section 2.2.7 describes the site terrestrial ecology.

Mississippi River 6 river miles (10 river kilometers) upstream and downstream of GGNS and site aquatic features. This area includes the extent of the maximum thermal plume from GGNS discharge into the Mississippi River. The action area also includes the aquatic features at GGNS, including Hamilton and Gin Lakes, the borrow pit, streams “A” and “B,” three small upland ponds, and ephemeral drainages. Section 2.2.6 describes the site aquatic ecology.

Transmission line corridors and 1-mi (1.6-km) buffer on either side of the lines. The transmission lines associated with GGNS travel through Claiborne, Franklin, Jefferson, and Warren Counties. The transmission line corridors traverse pine and hardwood forest, loessial bluffs, farmland, and sparsely populated rural areas and cross several rivers, including the Mississippi, Bayou Pierre, and Big Black Rivers. One of the lines (the Franklin line) also runs through Homochitto National Forest to the southeast of the GGNS site.

2.2.8.2 Overview of Protected Aquatic and Terrestrial Species

Sections 2.2.6 and 2.2.7 summarize past aquatic and terrestrial surveys that have been conducted on the GGNS site. MP&L captured pallid sturgeon (*Scaphirhynchus albus*), chestnut lamprey (*Ichthyomyzon castaneus),* black buffalo (*Ictiobus niger*), blue sucker (*Cycleptus elongates),* and paddlefish (*Polyodon spathula)* during the 1972 through 1973 preconstruction surveys (AEC 1973). However, neither the preconstruction surveys, the recent reconnaissance surveys associated with the ESP application, nor the surveys associated with the COL application identified any other Federally or State-listed species on the GGNS site. Several of these Federally listed species (see Table 2–6) have the potential to occur in the action area.

Table 2–6 identifies Federally and State-listed species that occur in Claiborne County, in which GGNS is located, or within one of the four counties through which the transmission line corridors traverse. The NRC compiled this table from FWS’s online search by county (FWS 2012b); the Mississippi Natural Heritage Program’s online database (MNHP 2011); and correspondence from the FWS (2012c, 2012d), MDWFP (2012), and NMFS (2012b). The MNHP online database lists about 30 additional State-listed animal species and about 30 additional plant species that do not appear in Table 2–6; however, the MDWFP (2012) did not identify any of these additional species as occurring within 2 mi (3.2 km) of the GGNS site or transmission line corridors. Therefore, this section does not include these species in its discussion.

In response to the NRC's request for endangered and threatened species that could be affected by the proposed license renewal, NMFS (2012b) stated that no species under its jurisdiction occur within the action area, but that gulf sturgeon (*Acipenser oxyrinchus desotoi)* are known to occur in the Mississippi River and have been collected upstream of the project site in the region of Vicksburg, Mississippi. NMFS (2012b) suggested that the NRC contact the FWS Panama City Office about the gulf sturgeon. In response to the NRC's inquiry, the FWS Panama City Office stated that it defers to the letters written by the Louisiana FWS Office (FWS 2012c) and Mississippi FWS Office (FWS 2012d) regarding Section 7 consultation. FWS (2012c, 2012d) did not identify any concerns related to the proposed project on gulf sturgeon. Furthermore, FWS, which has jurisdiction over the gulf sturgeon in the Mississippi River, did not identify the species as occurring within the action area or within Claiborne, Franklin, Jefferson, or Warren Counties (FWS 2012b, 2012c, 2012d). Therefore, the NRC will not consider this species in any further detail in this SEIS.

Table 2–6. Federally and State-Listed Species

Scientific Name	Common Name	Federal Status[a]	State Status[a]	State Rank[b]	County(ies) of Occurrence[c]			
					Claiborne	Franklin	Jefferson	Warren
Amphibians								
Plethodon websteri	Webster's salamander	-	-	S3	x		x	
Birds								
Eudocimus albus	white ibis	-	-	S2B, S3N	x	x	x	x
Haliaeetus leucocephalus	bald eagle	-	E	S1B, S2N	x	x	x	x
Mycteria americana	wood stork	E	E	S2N	x	x	x	x
Picoides borealis	red-cockaded woodpecker	E	E	S1		x	x	
Sterna antillarum	least tern (interior pop.)	E	E	S3B	x		x	x
Fish								
Crystallaria asprella	crystal darter	-	E	S1	x	x		
Cycleptus elongatus	blue sucker	-	-	S3	x			
Etheostoma rubrum	bayou darter	T	T	S1	x			
Ichthyomyzon castaneus	chestnut lamprey	-	-	S3	x			
Ictiobus niger	black buffalo	-	-	S3	x			x
Macrhybopsis meeki	sicklefin chub	-	-	SA				x
Polyodon spathula	paddlefish	-	-	S3	x			x
Scaphirhynchus albus	pallid sturgeon	E	E	S1	x		x	x
Mammals								
Ursus americanus luteolus	Louisiana black bear	T	E	S1	x	x	x	x
Ursus americanus	American black bear	T(SA)	E	S1	x	x	x	x
Mussels								
Potamilus capax	fat pocketbook	E	E	S1	x		x	x
Quadrula cylindrica ssp. cylindrica	rabbitsfoot	PT	-	-	x			x

[a] E = endangered; T = threatened; T(SA) – threatened due to similarity of appearance to another listed species; PT = proposed threatened.

[b] S1 = critically imperiled in MS because of extreme rarity; S2 = imperiled in MS because of rarity; S3 = rare or uncommon in MS; SA = accidental or casual in MS (i.e., infrequent and far outside usual range); B = applies to breeding populations; N = applies to migratory or non-breeding populations.

[c] GGNS is located in Claiborne County, Mississippi. The transmission lines associated with GGNS traverse Claiborne, Franklin, Jefferson, and Warren Counties.

Sources: FWS 2012b, 2012c, 2012d; Mann et al. 2011; MDWFP 2012

2.2.8.3 Species and Habitats Protected Under the Endangered Species Act

Wood Stork (U. S. Breeding Population)

The U.S. Fish and Wildlife Service (FWS) listed the U.S. breeding population of wood stork (*Mycteria americana*) as endangered in 1984 (49 FR 7332). The wood stork is a large, white wading bird with black flight and tail feathers. Its head is not feathered, and both the head and bill are grey to brownish-grey in color. Wood storks' historic breeding range extends from South Carolina to Florida, west to Texas, and throughout most of South America. Today, the species breeds in South Carolina, Florida, and Georgia, though it still migrates west and south. Within Mississippi, the wood stork occurs along the western edge of the State along the Mississippi River in late summer and fall near freshwater wetlands, ponds, bayheads, oxbow lakes, and ditches (MMNS 2001).

The AEC's 1973 FES notes that pre-construction surveys recorded the wood stork as occurring in the summer on or near Hamilton and Gin Lakes. The license renewal ER (Entergy 2011a) does not provide any updated information on the species' occurrence but notes that the wood stork is a possible non-breeding transient to the GGNS site and surrounding area. Thus, the staff assumes that the wood stork occurs in the action area. However, individuals in Mississippi represent migrants from Mexican breeding colonies (49 FR 7332), and thus, would not be part of the U.S. breeding population. Therefore, the NRC will not analyze this species in any further detail in this SEIS.

The FWS has not designated critical habitat for this species.

Red-cockaded Woodpecker

In 1970, under the Endangered Species Preservation Act of 1966, the predecessor regulation to the Endangered Species Act (ESA) (35 FR 16047), the FWS listed the red-cockaded woodpecker (*Picoides borealis*) as endangered wherever found. The red-cockaded woodpecker is a medium-sized woodpecker that is distinguishable by barred black and white horizontal stripes on its back and black cap and nape encircling white cheek patches. Males have a small red streak along the back portion of their heads.

Red-cockaded woodpeckers live in family groups with one breeding pair and several non-breeding birds that help raise young (FWS 2003). Males more often are helpers, but females also may take on the helper role. If a breeder dies, a helper can replace the breeder. Helpers also may increase fledgling success and reduce the workload of breeders, which increases breeder survivorship (Khan and Walters 2002). Therefore, the effective population size depends more on the number of breeding groups instead of the number of young successfully raised in a given year. This cooperative breeding system makes the red-cockaded woodpecker resistant to many environmental and demographic changes, but highly sensitive to habitat spatial characteristics (FWS 2003).

Red-cockaded woodpeckers inhabit open pine woodlands and savannahs with large old pines that serve as cavity trees for nesting and roosting. The species uses mature pine stands with open canopies, little to no midstory, and native bunchgrass and forbs for foraging. Cavity tree availability is often the limiting factor for growth in most populations (FWS 2003).

The red-cockaded woodpecker does not occur in Claiborne County; therefore, it does not occur on the GGNS site. The Homochitto National Forest, which spans seven Mississippi counties, including Franklin and Jefferson Counties, contains a secondary core population of the species (FWS 2003). As of 2000, this national forest contained 51 active breeding clusters (FWS 2003). The recovery plan sets forth a goal of 254 active breeding clusters for this population. The Franklin transmission line (discussed in Section 2.1.5) travels through the northern section of

Homochitto National Forest in Jefferson and Franklin Counties before its termination point at the Franklin EHV Switching Station in Franklin County. Thus, the species is likely to occur within the action area in the vicinity of the Franklin transmission line corridor within the Homochitto National Forest.

The FWS has not designated critical habitat for this species.

Least Tern (Interior Population)

The FWS listed the interior population of the least tern (*Sterna antillarum*) as endangered in 1985 (50 CFR 21784). The least tern is an 8- to 9-in. bird that has a white body, gray back and wings, a black crown on its head, orange legs, and a yellow bill.

Least terns arrive in the United States from early April to early June and spend 3 to 5 months in breeding grounds (TPWD 2012). The species inhabits barren to sparsely vegetated sandbars along the Missouri, Mississippi, Ohio, Red, and Rio Grande Rivers; sand and gravel pits; and lake and reservoir shorelines (Sidle and Harrison 1990). Least terns nest in small colonies in such areas, and females create nests by scraping shallow holes in sandy areas or exposed flats. Females lay two to three eggs over a period of several days in late May. Chicks hatch within 20 to 22 days and are capable of flight within 3 weeks. Because least terns nest on sandbars and shorelines, annual nesting success in a given location varies greatly due to water level fluctuations. Least terns generally stay close to their breeding colony and limit their activity to that portion of the river near the colony. The species is territorial and individuals communally will defend the colony against invaders. Least terns are opportunistic feeders and prey on a variety of small fish, crustaceans, and insects. Least terns migrate south to fall and winter habitats beginning in late August. (TPWD 2012)

Since 1986, biologists from the U.S. Army Corps of Engineers and Dyersburg State Community College have conducted least tern surveys along the Mississippi River from Cape Girardeau, Missouri, to Baton Rouge, Louisiana. The least tern occurs along this entire stretch of the Mississippi River. During the most recent survey conducted in July 2011, Jones (2011) recorded a total of 12,247 least terns and 45 nesting colonies. Two nesting colonies occur within the action area: the Yukatan Dikes (RM 410; 4 RM upriver of GGNS) colony and the Bondurant Towhead Dikes (RM 393; 13 RM downriver of GGNS) colony. The Baxter-Wilson transmission line lies 0.46 mi (0.74 km) from the Mississippi River at its closest point, and the nearest least tern colonies are at least 2 mi (3.2 km) away from the transmission line corridor; thus, these colonies are outside the action area.

The FWS has not designated critical habitat for this species.

Bayou Darter

The FWS listed the bayou darter (*Etheostoma rubrum*) as threatened in 1975 (40 FR 17590). Bayou darter are small fish; adults range from 1.0–1.8 in. (2.5–4.6 cm) in length. These fish are the smallest representative of the subgenus *Nothonotus*. Bayou darters are endemic to the Bayou Pierre and also occur in the lower reaches of its tributaries, including White Oak Creek, Foster Creek, and Turkey Creek. Bayou darter habitat includes meandering stream with stable gravel riffles or sandstone exposures (FWS 2012d). Such habitat is often found downstream of a headcutting area. In these areas, the stream becomes shallow (less than 6-in. (15-mm) depth), the flow is moderate to swift, and riffles become numerous. Primary prey includes midges, blackflies, water mites, caddisflies, and mayflies (FWS 2012d). Bayou darter spawn when water temperatures rise to between 72 and 84 °F (22 and 29 °C), which generally occurs from April to early June (FWS 2012d). Past and current threats to the Bayou darter include human-induced habitat alteration, such as floodplain or channel modification, petroleum exploration and transportation, and farming and forestry (FWS 2012d).

At GGNS, MP&L did not observe bayou darter during preconstruction studies from 1972 through 1973 (Entergy 2011a). However, bayou darter is endemic to Bayou Pierre, which flows within 2 mi (3.2 km) of the GGNS site and is crossed by the Franklin transmission line. Therefore, the bayou darter is likely to occur within the action area.

The FWS has not designated critical habitat for this species.

Pallid Sturgeon

In 1990, the FWS listed the pallid sturgeon (*Scaphirhynchus albus*) as endangered wherever found (55 FR 36641). Pallid sturgeon have a long, uniformly grayish-white body and a flattened, shovel-shaped snout. Pallid sturgeon inhabit the Mississippi and Missouri Rivers from Montana to Louisiana. Within the Mississippi River, primary habitat includes the main channel, especially near the river bottom. Primary prey include fish and aquatic insects (FWS 2007a). Although information on reproduction is limited, pallid sturgeon likely spawn between June and August (FWS 2007a). Larval fish drift downstream from the hatching site (Kynard et al. 2002). Eleven to 17 days after hatching, larvae settle from the lower portion of the water column (FWS 2007a). Current threats include commercial and recreational harvest because of misidentification by fishermen, habitat modification (e.g., channelization of the Mississippi River), and curtailment of the species' habitat range due to the operation of dams along the Missouri River (FWS 2009).

During the 1972–1973 preconstruction studies, a specimen was collected offshore of the future GGNS site (Entergy 2011a). Spawning habitat may exist within 10 mi (16 km) of the site. In 2001, FWS, the Mississippi Museum of Natural Science, and the Lower Mississippi River Conservation Committee conducted trawl surveys for pallid sturgeon approximately 38 mi (61 km) upstream of GGNS (Hartfield et al. 2001 in SERI 2005). The team observed nine adult pallid sturgeon and seven intermediates (sub-adults) within a variety of channel habitats that included moderate to strong currents, sand or gravel substrates, 20–40 ft (6.1–12.2 m) depths, and usually some type of habitat structure. From 2000–2005, USACE sampled the lower Mississippi River from river miles (RMs)145 to 954. USACE collected 162 pallid sturgeon from more than 130 locations (FWS 2005). FWS (2012c) stated that pallid sturgeon may occur within 50 mi (80 km) of GGNS. Similarly, MDFWP (2012) stated that pallid sturgeon may occur within 2 mi (3.2 km) of GGNS. Therefore, the pallid sturgeon may occur within the action area.

The FWS has not designated critical habitat for this species.

Louisiana and American Black Bears

The Louisiana black bear (*Ursus americanus luteolus*) is one of 16 recognized subspecies of American black bear (*U. americanus*). In 1992, the FWS published a final rule listing the Louisiana black bear as threatened (57 FR 588). This final rule also listed the American black bear as threatened because of its similarity in appearance to the Louisiana black bear. The American black bear is listed as threatened within all Louisiana counties and those Mississippi and Texas counties within the historic range of the Louisiana black bear.

The Louisiana black bear is distinguished from the American black bear by its longer and narrower skull and larger molar teeth. The species has a brown muzzle and generally uniformly black fur, although its fur can range from shades of brown to red. Adult males weigh between 200 and 400 lbs (90 to 180 kg), and females weigh between 120 and 200 lbs (55 to 90 kg) (FWS undated a).

The Louisiana black bear is an opportunistic omnivore whose diet varies with food availability and season. From 2002 through 2004, Benson and Chamberlain (2006) studied the diets of two subpopulations in the Tensas River Basin, which lies west of the GGNS site and runs parallel to the Mississippi River. The study identified corn; pokeberry (*Phytolacca americana*), muscadine

(*Vitis rotundifolia*), and other shrubs or vine fruit; and invertebrates as the primary sources of food in spring. In the fall, acorns made up a significant portion of the Louisiana black bear's diet. In the winter, the species relied on acorns, grasses, sedges, and invertebrates. Louisiana black bears also consume small mammals and carrion opportunistically. In areas where bears are in close proximity to agricultural fields, they often consume large amounts of wheat, oats, and other cereal grains (Benson 2005).

Louisiana black bears prefer bottomland hardwood forest habitat with relatively inaccessible terrain, thick understory vegetation, and abundant hard (acorns and nuts) and soft (leaf buds, berries, drupes) mast (74 FR 10350). Studies indicate that individual home ranges of Louisiana black bears are rather large and habitat use varies widely by gender, season, food availability, and reproductive status. In a movement ecology study, Marchinton (1995) found that males have a mean home range of about 52 km^2 (20 mi^2), while females have a mean home range of about 13 km^2 (5 mi^2), and that ranges for both sexes were largest in fall. The Louisiana Black Bear Recovery Plan (FWS 1995) indicates that in the Tensas River Basin, males and females may have a home range of up to 162 km^2 (63 mi^2) and 73 km^2 (28 mi^2), respectively. The smaller mean range of females could correlate with reproduction. Females may restrict their ranges while rearing cubs because of the limited mobility of young in the first few months of life (Lindzey and Meslow 1977). Availability of covered corridors between fragmented forest habitats also affects individual ranges.

Females breed at three to four years of age and give birth to one to three cubs in late January to early February while hibernating. Females and their cubs emerge from dens in late March to late May, and females continue to care for cubs until their second summer. Thus, females reproduce at most every other year.

Historically, the species occurred across North America as far north as Alaska and south to Mexico. The species now occurs in two core populations within the Tensas and Atchafalaya River Basins in Louisiana and in small, scattered populations in Mississippi. Continued habitat fragmentation from transportation development, agricultural activities, and urban sprawl as well as human-induced mortality from poaching and vehicle strikes threaten the continued existence of the Louisiana black bear (74 FR 10350).

The FES for construction of GGNS (AEC 1973) did not identify either the Louisiana or American black bears as likely to occur on the GGNS site. However, the Final ER for operation of GGNS (MP&L 1981) indicates that black bears (subspecies unidentified) were observed on the GGNS site four times in 1977, and several bear tracks and other signs of inhabitance were observed in the bottomlands south of the GGNS property line. MP&L (1981) did not indicate that these observations were part of any formal surveys; they appear to have been causal sightings recorded by construction or site staff.

Entergy commissioned a field survey for suitable Louisiana black bear habitat on GGNS in December 2006 (Wenstrom 2007a). The survey identified 30 trees that met the FWS's criteria of candidate trees for black bear den habitat. The trees included water oak (*Quercus nigra*), chinquapin oak (*Quercus muehlembergii*), and other oaks, pecans (*Carya* spp.), and elms (*Ulmus* spp.) of 36 in. (91 cm) diameter at breast height or larger. Only one tree had a cavity, which was open and exposed. None of the trees had enclosed cavities, claw marks, or other evidence of black bear use. The survey also identified one potential ground den about 400 ft (121 m) north of the heavy haul road and 3,800 ft (1,200 m) east of the Mississippi River. The survey noted numerous foraging areas containing blackberry (*Rubus trivialis*) thickets or shallow water in bottomlands scattered throughout the GGNS site. Wenstrom (2007a) concluded that the site contains suitable habitat for black bear foraging and denning, but the survey did not reveal any evidence of current use by bears.

Based on historic occurrence and recent habitat surveys of the GGNS site, the NRC assumes that the Louisiana and American black bears occur in the action area.

Designated critical habitat for the Louisiana black bear is discussed below. The FWS has not designated critical habitat for the American black bear.

Louisiana Black Bear Critical Habitat

The FWS published a final rule to designate Louisiana black bear critical habitat in 2009 (74 FR 10350). The FWS did not designate any land within Mississippi as critical habitat; the closest critical habitat lies along the Tensas River Basin about 16 mi (26 km) west of the GGNS site at its closest point (Entergy 2011a; NRC 2006a). The FWS has designated a total of 628,505 ac (254,347 ha) of habitat as critical within this basin, of which about a third is owned by the Federal or State government (74 FR 10350). However, because no critical habitat occurs within the action area, the NRC will not analyze designated Louisiana black bear habitat in any further detail in this SEIS.

Fat Pocketbook Mussel

In 1976, the FWS listed the fat pocketbook mussel (*Potamilus capax*) as endangered wherever found (41 FR 24062). Fat pocketbook mussels are large freshwater mussels that grow up to 130 mm (5.1 in) in length (FWS 2012e). The shells are shiny and tan or light brown without rays. Fat pocketbook mussels inhabit sand, mud, and silt substrates (FWS 2007b). Similar to other freshwater mussels, fat pocketbook mussels filter feed by siphoning phytoplankton, zooplankton, detritus, and diatoms from the water.

During the reproductive cycle, males release sperm into the water column that are sucked in by females through their siphons during feeding and respiration. Fertilized eggs develop into larvae (glochidia) within the gills of females. After releasing the mussel glochidia into the water, the glochidia must attach to the appropriate species of fish, which they parasitize until they develop into juvenile mussels (FWS 2012e).

Historically, fat pocketbook mussels inhabited a significant portion of the Mississippi River, from the confluence of the Minnesota and St. Croix rivers, in Minnesota, downstream to the White River system in Arkansas (FWS 2007b). While most historical records are from the upper Mississippi River, FWS (2007b) was not aware of any records of occurrence within the upper Mississippi River within the past two decades. Within the Lower Mississippi River, these mussels currently inhabit some secondary channels and side channels along a 300-mi (480-km) stretch of the Mississippi River that includes the GGNS area (FWS 2007b). In 2003, Mississippi Museum of Natural Science biologists collected 16 dead shells and 1 live fat pocketbook in the Ben Lomond Dike Field near Vicksburg in the Mississippi River channel (FWS 2004). These mussels also occur downstream of GGNS in St. Catherine Creek Wildlife Refuge on the Mississippi River near Natchez (FWS 2006).

At GGNS, MP&L did not observe fat pocketbook mussels during preconstruction studies from 1972–1973 (Entergy 2011a). In November 2006, AAI conducted a mussel survey in support of Entergy's COL application. The purpose of the survey was to determine whether any mussels occurred along the east Mississippi River bank near RM 406, which is near the discharge structure (Entergy 2008b). Survey methods included visual surveys of dead mussel shells along four shoreline sites and visual underwater surveys for live mussels along six transects. AAI did not observe any dead or live fat pocketbook mussels. As a result of these surveys, AAI concluded that mussel colonization near GGNS was not likely (Entergy 2008b).

In correspondence with the NRC, FWS Louisiana Ecological Services Office stated that the fat pocketbook occurs within 50 mi (80 km) of GGNS (FWS 2012c). However, MDWFP (2012) did not identify the fat pocketbook as occurring within 2 mi (3.2 km) of GGNS. Given that MP&L and AAI did not observe any dead or live fat pocketbook mussels at GGNS and MDFWP (2012) did not identify fat pocketbook mussels within 2 mi (3.2 km) of GGNS, the NRC staff concludes that this species is not likely to occur within the action area. The FWS has not designated critical habitat for this species.

Rabbitsfoot Mussel

The FWS issued a proposed rule to list the rabbitsfoot mussel (*Quadrula cylindrica* ssp. *cylindrica*) as threatened under the ESA in October 2012 (77 FR 63439). The ESA allows the FWS one year from the publication of its proposed rule to make a final determination as to whether to list the rabbitsfoot mussel as threatened.

Rabbitsfoot mussels are freshwater, medium to large-sized mussels that grow to about 6 in. (15 cm) in length (FWS 2010). Rabbitsfoot mussels filter feed by siphoning phytoplankton, zooplankton, detritus, and diatoms from the water. Similar to fat pocketbook and other freshwater mussels, male rabbitsfoot mussels release sperm into the water column that are sucked in by females and develop into glochidia (FWS 2010).

At GGNS, MP&L did not observe rabbitsfoot mussels during preconstruction studies from 1972–1973 (Entergy 2011a). As described above, in November 2006, AAI conducted a mussel survey in support of Entergy's COL application (Entergy 2008b). AAI did not observe any dead or live rabbitsfoot mussels. As a result of these surveys, AAI concluded that mussel colonization near GGNS was not likely (Entergy 2008b).

In correspondence with natural resource agencies, FWS Louisiana Ecological Services Office, FWS Mississippi Field Office, and MDWFP did not include rabbitsfoot mussel as a species that occurs within the action area (FWS 2012d, 2012c; MDWFP 2012). Therefore, the NRC staff concludes that this species is not likely to occur within the action area.

Rabbitsfoot Mussel Proposed Critical Habitat

The FWS proposed critical habitat for the rabbitsfoot mussel with its October 2012 Federal Register notice issuing a proposed rule to list the species as threatened under the ESA (77 FR 63439). The rule proposes critical habitat within 10 states in the midwest and southeastern U.S. Within Mississippi, proposed critical habitat occurs within Hinds, Sunflower, Tishomingo, and Warren Counties. The only county applicable to the proposed GGNS license renewal action area is Warren County, in which one proposed critical habitat unit occurs: RF17 (Big Black River). RF17 includes 43.3 river kilometers (26.9 river miles) of the Big Black River from the Porter Creek confluence west of Lynchburg, Hinds County, Mississippi, downstream to Mississippi Highway 27 west of Newman, Warren County, Mississippi (77 FR 63439).

Within the action area, the Baxter-Franklin transmission line corridor traverses the Big Black River in Claiborne County. However, the corridor does not traverse this river within Warren County where the proposed critical habitat unit RF17 is located. The portion of the Baxter-Franklin transmission line in Warren County is a 2.2-mi (3.5-km) stretch in the western portion of the county. RF17 occurs in the eastern portion of the county. Thus, the NRC will not analyze proposed rabbitsfoot mussel critical habitat in any further detail in this SEIS.

2.2.8.4 Species Protected by the State of Mississippi

Aquatic Species

Crystal Darter The State of Mississippi considers crystal darters (*Crystallaria asprella)* endangered. These fish are elongated, cigar-shaped fish that grow to a maximum length of approximately 150 mm (6 in.). The body is light-olive with dark lateral bands and dark blotches along each side (MDWFP 2001). Crystal darters inhabit larger creeks and rivers with sand and gravel bottoms and a depth of 60 cm (2 ft) or more. These fish prefer moderate to strong currents. The historical range of crystal darters included Wisconsin east to Ohio and south to Oklahoma, Louisiana and Florida, although they currently are absent from all of Ohio, Indiana, and Illinois (MDWFP 2001). Crystal darters inhabit the Bayou Pierre River and tributaries, which flow as close as 2 mi (3.2 km) east of GGNS (MDWFP 2001; Entergy 2011a). The FES for construction of GGNS (AEC 1973) and the ESP EIS (NRC 2006a) did not identify crystal darter as occurring on the GGNS site.

Crystal darters may occur in suitable habitat along the transmission line corridors. For example, crystal darters inhabit the Bayou Pierre, which is crossed by the Franklin transmission line. However, no GGNS-related aquatic surveys have been conducted along the transmission lines.

Species of Special Concern In the State of Mississippi, a species of special concern includes "any species that is uncommon in Mississippi, or has unique or highly specific habitat requirements or scientific value and therefore requires careful monitoring of its status" (MDWFP 2011). In its correspondence with the NRC, the MDWFP (2012) identified five fish species considered species of special concern by the State of Mississippi: blue sucker (*Cycleptus elongates*), chestnut lamprey (*Ichthyomyzon castaneus*), black buffalo (*Ictiobus niger*), sicklefin chub (*Macrhybopsis meeki*), and paddlefish (*Polyodon spathula*). These species inhabit portions of the Mississippi River (NatureServe 2010). MP&L observed paddlefish, black buffalo, blue sucker, and chestnut lamprey during preconstruction surveys in 1972 and 1973 (AEC 1973). The FES for construction of GGNS (AEC 1973) and the ESP EIS (NRC 2006a) did not identify sicklefin chub as occurring on the GGNS site.

Chestnut lamprey, blue sucker, black buffalo sicklefin chub, and paddlefish may occur in suitable habitat along the transmission line corridors. For example, crystal darter, chestnut lamprey, blue sucker, and chestnut lamprey inhabit the Bayou Pierre, which is crossed by the Franklin transmission line. However, no GGNS-related aquatic surveys have been conducted along the transmission lines.

Terrestrial Species

In its correspondence with the NRC, the MDWFP (2012) identified two State-listed species that may occur in the action area: Webster's salamander (*Plethodon websteri*) and the white ibis (*Eudocimus albus*). Webster's salamander is a small salamander with several color morphs that occurs in mesophytic forest bordering rocky streams. It generally seeks shelter under logs, bark, or leaf litter on the forest floor or on rocky stream beds. The white ibis is a large white bird that nests in large groups in coastal marshes along the Atlantic and Gulf coasts. The FES for construction of GGNS (AEC 1973) and the ESP EIS (NRC 2006a) identify the white ibis as occurring on the GGNS site. The species is also likely to occur in suitable habitat along the transmission line corridors. Because the MDWFP (2012) did not identify any impacts of the proposed license renewal that would affect these species, neither the Webster's salamander nor the white ibis will be considered in further detail in this SEIS.

2.2.8.5 Species Protected Under the Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act prohibits anyone from taking bald eagles (*Haliaeetus leucocephalus*) or golden eagles (*Aquila chrysaetos*), including their nests or eggs, without an FWS-issued permit. The term "take" in the Act is defined as to "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb" (50 CFR 22.3). "Disturb" means to take action that (1) causes injury to an eagle, (2) decreases its productivity by interfering with breeding, feeding, or sheltering behavior, or (3) results in nest abandonment (50 CFR 22.3).

Bald eagles live and nest along the Mississippi River, but no studies are available on nesting or population status in the action area. However, Entergy commissioned a one-day reconnaissance field survey to identify bald eagle nests along the Mississippi River in the vicinity of GGNS in December 2006 (Wenstrom 2007b). The survey did not identify any bald eagle nests or any eagles scavenging or perched in the survey area that would indicate bald eagles may nest along this portion of the river (Wenstrom 2007b).

2.2.8.6 Species Protected Under the Migratory Bird Treaty Act

The FWS administers the Migratory Bird Treaty Act (MBTA), which prohibits anyone from taking native migratory birds or their eggs, feathers, or nests. The MBTA definition of a "take" differs from that of the ESA and is defined as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or any attempt to carry out these activities" (50 CFR 10.12). Unlike a take under the ESA, a take under the MBTA does not include habitat alteration or destruction. The MBTA protects a total of 1,007 migratory bird species (75 FR 9282). Of these 1,007, the FWS allows for the legal hunting of 58 species as game birds (FWS undated b). Within Mississippi, the MDWFP manages migratory bird hunting seasons and associated licenses for turkeys, waterfowl, quail, and doves. The Federally and State-listed bird species that appear in Table 2–6 are protected under the MBTA. Table 2–4 lists other bird species that commonly occur on or near the GGNS site, all of which are protected by the MBTA. Additionally, all U.S. native bird species that belong to the families, groups, or species listed at 10 CFR 10.13 are protected under the MBTA.

Entergy holds a depredation permit from the FWS that authorizes Entergy to take 200 cliff swallows (*Petrochelidon* spp.), 200 cliff swallow nests (including eggs), 200 barn swallows (*Hirundo rustica*), and 200 barn swallow nests (including eggs) per year to mitigate the safety-related concern that the birds pose when nesting on certain plant structures (FWS 2012a). The permit directs Entergy to favor the use of hazing, harassment, or other non-lethal techniques over lethal techniques. From 2006 through 2010, Entergy took 13 cliff swallows and 7 eggs in 2006 and 4 barn swallows in 2009 (Entergy 2007, 2008a, 2009, 2010a, 2011b).

2.2.9 Socioeconomics

This section describes current socioeconomic factors that have the potential to be directly or indirectly affected by changes in operations at GGNS. GGNS, and the communities that support it, can be described as a dynamic socioeconomic system. The communities supply the people, goods, and services required to operate the nuclear power plant. Power plant operations, in turn, supply wages and benefits for people and dollar expenditures for goods and services. The measure of a community's ability to support GGNS operations depends on its ability to respond to changing environmental, social, economic, and demographic conditions.

The socioeconomics region of influence (ROI) is defined by the areas where GGNS employees and their families reside, spend their income, and use their benefits, thus affecting the economic conditions of the region. GGNS employs a permanent workforce of approximately 690 employees (Entergy 2011a). Approximately 81 percent live in Claiborne, Hinds, Jefferson, and Warren counties (see Table 2–7). Most of the remaining 19 percent of the workforce are spread among 13 counties in Mississippi, with numbers ranging from one to 31 employees per county. Given the residential locations of GGNS employees, the most significant effects of plant operations are likely to occur in Claiborne, Hinds, Jefferson, and Warren counties; therefore, these four counties are the GGNS ROI. The focus of the socioeconomic impact analysis in this document is, therefore, on the impacts of continued GGNS operation on these four counties.

Table 2–7. 2009 GGNS Employee Residence by County

County	Number of Employees	Percentage of Total
Mississippi		
Warren	240	35
Claiborne	142	21
Hinds	94	14
Jefferson	82	12
Copiah	31	4
Adams	30	4
Lincoln	23	3
Other	37	5
Other states	11	2
Total	**690**	**100**

Source: Entergy 2011a

Refueling outages at the GGNS typically have occurred at 18-month intervals. During refueling outages, site employment increases by as many as 700–900 temporary workers for approximately 25–30 days (Entergy 2011a). Outage workers are drawn from all regions of the country; however, the majority would be expected to come from Mississippi, Louisiana, and other southeastern states. The following sections describe the housing, public services, offsite land use, visual aesthetics and noise, population demography, and the economy in the ROI surrounding GGNS.

2.2.9.1 Housing

The socioeconomic ROI is dominated by Hinds County, which is part of the Jackson metropolitan area. The size of the Jackson area weighs heavily on the housing statistics, as the rural counties of Claiborne and Jefferson are considerably different than the ROI averages would indicate. Table 2–8 lists the total number of occupied and vacant housing units, vacancy rates, and median home value in the four-county ROI. According to the 2010 Census, there were approximately 133,096 housing units in the socioeconomic region, of which approximately 113,607 were occupied. The median values of owner-occupied housing units in the ROI range from $53,500 in Claiborne County to $105,000 in Hinds County. The vacancy rate also ranged considerably, from 11.5 percent in Warren County to 23.8 percent in Jefferson County (USCB 2012).

Table 2–8. Housing in GGNS ROI

	2006–2010, 5-year Estimate				
	Claiborne	Hinds	Jefferson	Warren	ROI
Total	4,255	103,351	3,717	21,773	133,096
Occupied housing units	3,308	88,201	2,831	19,267	113,607
Vacant units	947	15,150	886	2,506	19,489
Vacancy rate (percent)	22.3	14.7	23.8	11.5	14.6
Median value (dollars)	53,500	105,000	67,000	99,700	101,400

Source: USCB 2012

2.2.9.2 Public Services

This section presents information on public services that include water supply, education, and transportation.

Water Supply

Information about municipal water suppliers in close proximity to GGNS and maximum design yields, reported annual peak usage, and population served are presented in Table 2–9. The source of potable water at GGNS is Entergy's private water system accessing groundwater.

Table 2–9. Claiborne County Public Water Supply Systems

Water System	Capacity (GPM)	Usage (GPM)	Population Served
Alcorn State University	1,136	646	3,824
CS&I Water Association #1	288	185	1,100
Hermanville Water Association	552	160	1,230
Pattison Water Association–West	982	389	2,994
Reedtown Water Association	243	35	504
Romola Water Association	556	155	650
Town of Port Gibson	850	587	4,308
Entergy Operations Inc. (private)	1,335	223	1,000

Sources: Entergy 2011a; EPA 2012e

Beyond the water systems near GGNS, larger systems supply water to Vicksburg, Clinton, and Jackson, Mississippi. These systems use groundwater wells with the exception of the City of Jackson, which relies on Lake Jackson to provide water to a population of approximately 176,000 (EPA 2012e).

Education

The Claiborne County School District has one elementary school, one middle school, and one high school. During the 2009–2010 school year, enrollment was 1,723 students (NCES 2012a).

Hinds County has four public school districts and 42 elementary schools, 17 middle schools, 11 high schools, and 16 alternative or special needs schools. The enrollment in 2009 was over 42,200 students (NCES 2012a).

The Jefferson County School District has two elementary schools, one middle school, one high school, and two alternative or vocational schools. The enrollment during the 2009–2010 school year was 1,465 students (NCES 2012a).

The Vicksburg-Warren School District serves all of Warren County and includes eight elementary schools, four middle schools, two high schools, and two alternative or vocational schools. During the 2009–2010 school year, enrollment was 8,871 students (NCES 2012a).

Transportation

The area surrounding GGNS is largely rural. Highway access to Claiborne County and GGNS from population centers is via US-61, a principal arterial paralleling the Mississippi River along much of its course. Interstate 20 is a four-lane divided highway that runs east and west, connecting Dallas, TX with Jackson, MS, and passes through Vicksburg—about 25 mi north of GGNS. US-84 is also a four-lane divided highway that lies about 30 mi south of GGNS, and runs east-west, connecting Interstate 49 in Louisiana with Interstate 55 in central Mississippi. The Natchez Trace Parkway, administered by the National Park Service, preserves a transportation route of Civil War historical significance and provides tourist access to Jefferson and Claiborne counties as it traverses a route between Natchez and Clinton.

Table 2–10 lists commuting routes to GGNS and average annual daily traffic (AADT) volume values. The AADT values represent traffic volume during the average 24-hour period during 2011.

Table 2–10. Major Commuting Routes Near GGNS 2011 Average Annual Daily Traffic

Roadway and Location	Average Annual Daily Traffic
Grand Gulf Road at GGNS main gate	1,600
Old Mill Road between Grand Gulf Road and Bald Hill Road	860
Grand Gulf Road between Lake Claiborne Road and Old Mill Road	980
Grand Gulf Road between US Hwy 61 and Lake Claiborne Road	1,200
US Hwy 61 between Shiloh Road and Willow Road	7,500
US Hwy 61 between Natchez Trace Pkwy and McComb Avenue	6,600

Source: MDOT 2012

2.2.9.3 Offsite Land Use

Land use in the GGNS ROI primarily consists of agricultural lands, with small urban areas and undeveloped forested land.

Claiborne County occupies approximately 487 mi^2 (1,247 square kilometers (km^2)) (USCB 2012). Agricultural and forested lands make up the majority of the land used, with urban lands making up about 4 percent of the total county land area (USDA NASS 2012). The principal agriculture land use is pasture and hay crops and livestock products, with the market value of crops (mostly cotton and soybeans) being about double that of livestock, poultry, and their products. The number of farms in Claiborne County decreased about 12 percent from 2002–2007. Farmland acreage in the county decreased 7 percent during the same period, and the average size of a farm increased 6 percent to 360 ac (146 ha) (USDA NASS 2009).

Hinds County occupies approximately 869 mi^2 (2,251 km^2) (USCB 2012). Hinds County is home to part of Jackson, the State capital and largest city in Mississippi, along with Clinton, a principal suburb of Jackson. Nearly 14 percent of the county is urbanized (USDA NASS 2012). The majority of the county land area is either forested (40 percent) or agricultural land (30 percent). The principal crop is livestock forage (i.e., hay and grass silage), followed by cotton and nursery and greenhouse products. Livestock (mostly cattle and calves) is about 23 percent the market value for all agriculture products. The number of farms in Hinds County decreased from 2002–2007 by 14 percent. Farmland acreage in the county decreased seven percent during the same period, and the average size of a farm increased 9 percent to 24 ac (98 ha) (USDA NASS 2009).

Jefferson County covers approximately 519 mi^2 (1,344 km^2) (USCB 2012). Jefferson County is mainly rural, with just 4 percent of the county urbanized (USDA NASS 2012). Undeveloped forest, grassland, and wetlands make up over 87 percent of the county's land area. The principal crop is livestock forage (i.e., hay and grass silage), followed by cotton and nursery and greenhouse products. Livestock (mostly poultry and cattle) is about 70 percent the market value for all agriculture products. The number of farms in Jefferson County increased from 2002–2007 by 13 percent. Farmland acreage in the county also increased 10 percent during the same period, and the average size of a farm increased 2 percent to 282 ac (114 ha) (USDA NASS 2009).

Warren County occupies approximately 587 mi^2 (1,520 km^2) (USCB 2012). Nearly seven percent of the county is urbanized (USDA NASS 2012), with Vicksburg being the principal city. The majority of the county land area is either forested (about 40 percent) or wetlands (about 30 percent). The principal crops are soybeans and cotton, making up over 85 percent of the value of all agricultural products. The number of farms in Warren County remained stable over the 2002–2007 period, as has farmland acreage. The average size of a farm is 403 ac (163 ha) (USDA NASS 2009).

2.2.9.4 Visual Aesthetics and Noise

GGNS is situated on a relatively flat bluff above the shore of the Mississippi River. Predominant features include the containment structure, turbine building, auxiliary building, control building, diesel generator building, standby service water cooling towers and basins, enclosure building, radwaste building, independent spent fuel storage installation (ISFSI), auxiliary cooling tower, and the natural draft cooling tower (Entergy 2011a).

There is often a visible plume of condensation rising up from the cooling towers. Its height and visibility depend on weather conditions such as temperature, humidity, and wind speed. It is typically several hundred feet tall and can be seen from several miles away. Because of the open and flat terrain on the Louisiana side of the Mississippi River, the plume and the cooling tower are clearly seen from US-65 in Louisiana for many miles in all directions. The rolling and forested terrain of Claiborne County provides significant visual screening in the immediate vicinity of GGNS.

Noise from nuclear plant operations can be detected off site. There are no local noise ordinances that limit allowable sound levels at GGNS. The staff determined background noise levels at GGNS are expected to range from 45 to 55 dBA at the nearest site boundary (NRC 2006a). Noise levels may sometimes exceed the 55-decibel adjusted level that the EPA uses as a threshold level to protect against excess noise during outdoor activities. However, according to the EPA this threshold does “not constitute a standard, specification, or regulation,” but was intended to give a basis for state and local governments establishing noise standards (EPA 1974).

2.2.9.5 Demography

According to the 2010 Census, an estimated 23,406 people live within 20 mi (32 km) of GGNS, which equates to a population density of 19 persons per mi^2 (Entergy 2011a). This translates to a Category 1, “most sparse” population density using the GEIS measure of sparseness (less than 40 persons per mi^2 and no community with 25,000 or more persons within 20 mi). An estimated 329,043 people live within 50 mi (80 km) of GGNS with a population density of 42 persons per mi^2 (Entergy 2011a). Since Jackson is located beyond 50 mi from GGNS, this translates to a Category 1 density, using the GEIS measure of proximity (no cities with 100,000 or more persons and less than 50 persons per mi^2 within 50 mi). Therefore, GGNS is located in a low population area based on the GEIS sparseness and proximity matrix.

Table 2–11 shows population projections and growth rates from 1970–2050 in the four-county GGNS ROI. The net population growth rate in the ROI has been negative over the last two decades. Based on State forecasts, rural counties are expected to continue to decline in population through 2025, while more developed urban counties are expected to continue modest growth through 2025 (MIHL 2012). Beyond 2025, the staff applied the 50-year trend in population, observed between 1970 and 2020 projections, to approximate long-term trends.

Table 2–11. Population and Percent Growth in GGNS ROI Counties from 1970–2009 and Projected for 2010–2050

	Claiborne		Hinds		Jefferson		Warren	
Year	Population	Percent growth[(a)]	Population	Percent growth[(a)]	Population	Percent growth[(a)]	Population	Percent growth[(a)]
1970	10,086	–	214,973	–	9,295	–	44,981	–
1980	12,279	21.7%	250,998	16.8%	9,181	-1.2%	51,627	14.8%
1990	11,370	-7.4%	254,441	1.4%	8,653	-5.8%	47,880	-7.3%
2000	11,831	4.1%	250,800	-1.4%	9,740	12.6%	49,644	3.7%
2010	9,604	-18.8%	245,285	-2.2%	7,726	-20.7%	48,773	-1.8%
2020	8,700	-9.4%	250,264	2.0%	7,074	-8.4%	48,030	-1.5%
2030	8,676	-0.3%	251,086	0.3%	7,040	-0.5%	48,095	0.1%
2040	8,652	-0.3%	251,910	0.3%	7,006	-0.5%	48,160	0.1%
2050	8,628	-0.3%	252,737	0.3%	6,973	-0.5%	48,225	0.1%

– = No data available.

[(a)] Percent growth rate is calculated over the previous decade.

Sources: Population data for 1970 through estimated population data for 2009 (USCB 2012); population projections for 2020 by Mississippi Institutions of Higher Learning (MIHL2012); 2030-2050 calculated.

Demographic Profile

According to the 2010 Census, minority populations were estimated to have increased by over 17,100 persons and comprised 69.4 percent of the ROI population (see Table 2–12). Most of this increase was due to an estimated influx of African Americans to urban centers such as Jackson and Vicksburg, while minority populations in rural counties declined over the same period.

1 **Table 2–12. Demographic Profile of the Population in the GGNS ROI in 2010**

	Claiborne	Hinds	Jefferson	Warren	ROI
Total Population	9,604	245,285	7,726	48,773	311,388
Race (percent of total population, Not-Hispanic or Latino)					
White	14.1	28.0	13.7	49.5	30.6
Black or African American	84.0	68.8	85.4	46.8	66.3
American Indian and Alaska Native	0.1	0.1	0.2	0.2	0.2
Asian	0.4	0.8	0.0	0.8	0.7
Native Hawaiian Other Pacific Islander	0.0	0.0	0.0	0.0	0.0
Some other race	0.1	0.1	0.0	0.0	0.1
Two or more races	0.5	0.7	0.3	0.7	0.7
Ethnicity					
Hispanic or Latino	74	3,630	28	896	4,628
Percent of total population	0.8	1.5	0.4	1.8	1.5
Minority population (including Hispanic or Latino ethnicity)					
Total minority population	8,251	176,676	6,670	24,630	216,227
Percent minority	85.9	72.0	86.3	50.5	69.4

Source: USCB 2012.

2 Transient Population

3 Within 50 mi (80 km) of GGNS, colleges and recreational opportunities attract daily and
4 seasonal visitors who create demand for temporary housing and services. In 2010, there were
5 approximately 21,859 students attending colleges and universities within 50 mi (80 km) of
6 GGNS (NCES 2012b).

7 Based on the 2010 Census, approximately 10,471 seasonal housing units are located within
8 50 mi of GGNS. Of those, 1,536 are located in the GGNS four-county ROI. Table–13 supplies
9 information on seasonal housing for the counties located all or partly within 50 mi of GGNS.

Table 2–13. 2010 Seasonal Housing in Counties within 50 miles of GGNS

County[(a)]	Housing Units	Vacant Housing Units: for Seasonal, Recreational, or Occasional Use	Percent
Mississippi			
Adams	14,771	649	4.4
Amite	6,638	553	8.3
Claiborne	4,255	388	9.1
Copiah	12,056	323	2.7
Franklin	4,170	482	11.6
Hinds	103,351	458	0.4
Issaquena	712	46	0.4
Jefferson	3,717	350	6.5
Lincoln	15,101	411	9.4
Madison	37,349	375	2.7
Rankin	55,200	544	1.0
Sharkey	2,065	167	1.0
Simpson	11,837	94	8.1
Warren	21,773	340	0.8
Wilkinson	5,085	928	1.6
Yazoo	10,094	374	18.2
County Subtotal	**308,174**	**6,482**	**2.1**
Louisiana			
Caldwell	5,014	622	12.4
Catahoula	4,987	779	15.6
Concordia	9,369	931	9.9
East Carroll	2,813	65	2.3
Franklin	8,987	295	3.3
Madison	4,827	235	4.9
Richland	8,557	442	5.2
Tensas	3,357	620	18.5
County Subtotal	**47,911**	**3,989**	**8.3**
Total	**356,085**	**10,471**	**2.9**

(a) Counties within 50 mi (80 km) of GGNS with at least one block group located within the 50-mi (80-km) radius.

Source: USCB 2012.

<u>Migrant Farm Workers</u>

Migrant farm workers are individuals whose employment requires travel to harvest agricultural crops. These workers may or may not have a permanent residence. Some migrant workers follow the harvesting of crops, particularly fruit, throughout rural areas of the United States. Others may be permanent residents near GGNS and travel from farm to farm harvesting crops.

Migrant workers may be members of minority or low-income populations. Because they travel and can spend a significant amount of time in an area without being actual residents, migrant workers may be unavailable for counting by census takers. If uncounted, these workers would be "underrepresented" in U.S. Census Bureau (USCB) minority and low-income population counts.

Information on migrant farm and temporary labor was collected in the 2007 Census of Agriculture. Table 2–14 supplies information on migrant farm workers and temporary farm labor (less than 150 days) within 50 mi of GGNS. According to the 2007 Census of Agriculture, approximately 6,440 farm workers were hired to work for less than 150 days and were employed on 1,419 farms within 50 mi of GGNS. The county with the largest number of temporary farm workers (1,152) on 185 farms was Franklin County, Louisiana (USDA NASS 2009).

Table 2–14. Migrant Farm Workers and Temporary Farm Labor in Counties Located within 50 Miles of GGNS

County[a]	Number of Farms with Hired Farm Labor	Number of Farms Hiring Workers for Less than 150 days	Number of Farm Workers Working for Less than 150 days	Number of Farms Reporting Migrant Farm Labor
Mississippi				
Adams	30	24	(b)	3
Amite	91	72	339	7
Claiborne	49	47	176	3
Copiah	108	86	438	2
Franklin	22	20	64	2
Hinds	142	108	344	9
Issaquena	28	15	76	3
Jefferson	56	38	143	0
Lincoln	125	100	401	6
Madison	134	95	280	9
Rankin	138	108	364	5
Sharkey	38	7	171	4
Simpson	114	95	300	5
Warren	50	40	157	2
Wilkinson	49	38	155	0
Yazoo	121	77	508	7
Subtotal	**1,295**	**970**	**3,916**	**67**
Louisiana				
Caldwell	65	58	139	4
Catahoula	61	36	218	4
Concordia	61	33	198	1
East Carroll	75	25	178	2
Franklin	250	185	1152	6
Madison	67	28	156	4
Richland	112	74	250	13
Tensas	59	10	233	5
Subtotal	**750**	**449**	**2,524**	**39**
Total	**2,045**	**1,419**	**6,440**	**106**

[a] Counties within 50 miles of GGNS with at least one block group located within the 50-mi radius.

[b] Data not disclosed by USDA.

Source: 2007 Census of Agriculture—County Data (USDA NASS 2009).

In the 2002 Census of Agriculture, farm operators were asked for the first time whether or not they hired migrant workers—defined as a farm worker whose employment required travel—to do work that prevented the migrant worker from returning to their permanent place of residence the same day. A total of 106 farms, in the 50-mi radius of GGNS, reported hiring migrant workers in the 2007 Census of Agriculture. Richland County, Louisiana, reports the most farms with migrant farm labor (13 farms) (USDA NASS 2009).

2.2.9.6 Economy

This section contains a discussion of the economy, including employment and income, unemployment, and taxes.

<u>Employment and Income</u>

From 2000 to 2012, the civilian labor force in the GGNS ROI declined by about 5 percent to just over 147,000. The number of employed persons declined by about 7 percent over the same period, to about 135,000. Consequently, the number of unemployed people in the ROI has increased over 36 percent in the same period, to over 12,200, or about 8.3 percent of the current workforce (BLS 2012).

In 2010, state and local government made up the largest sector of the economy in terms of employment (19.6 percent), followed by health care and social assistance (13.9 percent), retail trade (8.2 percent), administrative services (6.4 percent) and accommodations and food services (6.2 percent) (BEA 2012). A list of selected major employers in the ROI is given in Table 2–15. As shown in the table, GGNS is the 22nd largest employer in the ROI and the second largest in Claiborne County.

1 **Table 2–15. Major Employers of the GGNS ROI in 2012**

Employer	Number of Employees	County
State of Mississippi	31,556	Hinds
University Medical Center	8,000	Hinds
U.S. Government	5,500	Hinds
Jackson Public Schools	4,814	Hinds
Baptist Health Systems	2,875	Hinds
St. Dominic Health Services	2,600	Hinds
City of Jackson	2,323	Hinds
Jackson State University	1,667	Hinds
USACE Engineer Research & Development Center	1,600	Warren
River Region Health Systems	1,500	Warren
AT&T Mississippi	1,300	Hinds
Vicksburg-Warren School District	1,300	Warren
Central MS Medical Center	1,200	Hinds
USACE, Division/District	1,100	Warren
Trustmark National Bank	1,075	Hinds
Delphi Mississippi	1,075	Hinds
Ameristar Casino	900	Warren
Saks Incorporated	800	Hinds
Entergy Mississippi	765	Hinds
Alcorn State University	750	Claiborne
LeTourneau Technologies	750	Warren
Grand Gulf Nuclear Station	691	Claiborne
Tyson Foods	680	Warren
Eaton Aerospace	625	Hinds
DiamondJacks Casino Hotel	588	Warren
City of Vicksburg	586	Warren
Walmart Supercenter	550	Warren
Jefferson Co School District	100	Jefferson
Southern Lumber Co., Inc.	80	Claiborne
MMC Materials, Inc.	32	Claiborne

Source: Port Gibson Chamber (2012), Warren Co. Port Commission (2012), Hinds Co. Economic Development Authority (2008). Smaller Jefferson and Claiborne County employers are shown to be representative.

Estimated income information for the GGNS ROI is presented in Table 2–16. According to the USCB's 2006–2010 American Community Survey 5-Year Estimates, people living in Claiborne and Jefferson Counties had median household and per capita incomes below the State average, while Hinds and Warren counties had median incomes higher than the State average. The same trend is evident for families and individuals living below the official poverty level. The relative lack of economic development in Claiborne and Jefferson counties contributes to higher than average poverty and lower than average median incomes compared to the more economically developed counties of Hinds and Warren. The State of Mississippi, as a whole, is positioned between the economically developed and the economically undeveloped county groupings of the GGNS ROI for both median income and living below poverty level.

Table 2–16. Estimated Income Information for the GGNS ROI in 2010

	Claiborne	Hinds	Jefferson	Warren	Mississippi
Median household income (dollars)[a]	24,150	39,215	24,304	40,404	37,881
Per capita income (dollars)[a]	12,571	20,676	12,534	22,079	19,977
Individuals living below the poverty level (percent)	35.0	22.5	39.0	21.4	16.7
Families living below the poverty level (percent)	27.6	17.7	29.3	16.5	21.2

[a] In 2010 inflation adjusted dollars.

Source: USCB 2012.

Unemployment

Unemployment rates in the GGNS ROI have mirrored State and national trends from 2007 to 2012. Table 2–17 illustrates the not-seasonally-adjusted unemployment rates for the GGNS ROI counties compared to State and national rates.

The effects of the recent economic recession on employment are visible in all counties. Claiborne and Jefferson Counties have had consistently higher unemployment rates than their urban neighboring counties through this period.

Table 2–17. 2007–2012 Unemployment Rates in the GGNS ROI

ROI Counties	2007	2008	2009	2010	2011	2012
Claiborne	9.8	9.1	14.3	12.8	14.3	11.8
Hinds	5.4	5.0	7.1	8.9	8.8	7.6
Jefferson	11.2	10.7	14.7	14.4	14.5	13.0
Warren	6.0	5.3	8.7	10.5	11.3	9.3
Mississippi	5.9	5.5	8.3	9.9	10.0	8.3
United States	4.3	4.8	8.6	9.5	8.7	7.7

Source: MDES (2012); for consistency all values not seasonally adjusted.

Taxes

Mississippi Code Title 27 addresses taxation of nuclear generating plants and the distribution of tax revenues from nuclear plants. This code states that any nuclear generating plant located in the State, which is owned or operated by a public utility, is exempt from county, municipal, and district ad valorem taxes. In lieu of the payment of county, municipal, and district ad valorem taxes, the nuclear power plant pays the Mississippi State Tax Commission a sum based on the assessed value of the nuclear generating plant.

GGNS is taxed by the State for a sum equal to 2 percent of the assessed value but not less than $20 million annually, $7.8 million of which is provided to Claiborne County. Of this amount, $3 million is contingent upon Claiborne County upholding its commitment to the GGNS offsite emergency plan. The $7.8 million provided by the State represents roughly 83 percent of all Claiborne County revenues.

The Mississippi State Tax Commission transfers $160,000 annually to the city of Port Gibson, provided the city maintains its commitment to the GGNS offsite emergency plan. Ten percent of the remainder of the payments are transferred from the Mississippi Tax Commission to the General Fund of the State. The balance of the tax revenue from the GGNS site is transferred to the counties and municipalities in the State of Mississippi where electric service is provided. The tax revenues are distributed in proportion to the amount of electric energy consumed by the retail customers in each county, with no county receiving an excess of 20 percent of the funds. This distribution, based on energy consumed, also includes Claiborne County. (Mississippi Code Title 27)

2.2.10 Historic and Archaeological Resources

This section discusses the cultural background and known historic and archaeological resources in and around GGNS.

2.2.10.1 Cultural Background

The area in and around GGNS has a high potential for significant prehistoric and historic resources. Human occupation in the Mississippi Valley area is generally characterized based on the following chronological sequence (Peacock 2005):

- Paleoindian Period (14,000+ to 9,000 years before present (BP))
- Archaic Period (9,000 to 3,000 BP)
- Woodland Period (3,000 to 1,000 BP)
- Mississippian Period (1,000 to 300 BP)
- Protohistoric/Historic Period (300 BP to present)

<u>Paleoindian Period (14,000 to 9,000 BP)</u>

The Paleoindian Period is generally characterized by highly mobile bands of hunters and gatherers. Little information is known about Paleoindian methods of subsistence, but it is assumed that they would have hunted now-extinct megafauna (e.g., mammoth, ground sloth, and saber-tooth tiger), in addition to hunting smaller game and gathering wild plants. No Paleoindian sites are currently known in the GGNS vicinity; however, Paleoindian sites in the Southeastern U.S. generally consist of isolated projectile points or other tools such as flaked stone end scrapers or bone tools (Peacock 2005).

<u>Archaic Period (9,000 to 3,000 BP)</u>

The Archaic Period is generally distinguished from the preceding Paleoindian Period by changes in the environment, technology, and population. The warmer and dryer part of the Early Archaic Period facilitated groups' ability to exploit more diverse resources, and consequently their tool kit also became more diversified. Technological changes are evidenced by the manufacture of notched projectile points, which were smaller than Paleoindian points, likely reflecting a reliance on smaller game (Neusius and Gross 2007). Groups became sedentary as the climate became wetter and warmer as the Archaic Period progressed, and ceremonialism (e.g., mounds, effigies) is evident in the archaeological record during this time. Archaic sites have been documented on GGNS property (Entergy 2011a; MDAH 2012).

Woodland Period (3,000 to 1,000 BP)

The Woodland Period is often divided into early, middle, and late periods. One of the most notable aspects in the archaeological record of the Woodland Period is widespread pottery use; the period is sometimes referred to as the Early Ceramic Period. Groups living permanently in one place dominated the settlement pattern during the Woodland Period, an aspect that may have facilitated the widespread development of pottery (Peacock 2005). Mounds were frequently built in the Middle Woodland Period, but this practice dissipated by the end of the period. Sites dating to the Late Woodland Period are the most common sites found in Mississippi. These sites are found in various types of landforms; valleys, hills, deltas, and prairies (Peacock 2005). Another important development during the latter portion of the Woodland Period is the bow-and-arrow, which is evidenced by smaller projectile points and likely involved significant changes in the way warfare and hunting were conducted (Lee 2010).

The GGNS property contains an example of a Middle Woodland mound. The Grand Gulf Mound Site (22Cb522) is located on a loess bluff 220 ft above sea level, overlooking the Mississippi River. Clarence Moore identified the mound in 1911. Members of Harvard’s Peabody Museum visited the site in the 1940s, and it was excavated in 1973 by the Mississippi Department of Archives and History (MDAH) (Brookes 1976). Unfortunately, two-thirds of the mound was bulldozed before its excavation and the portion that was not destroyed was vandalized by looters. Human remains (mandible with teeth, several ribs, and a humerus) were found in the dirt from the bulldozed section of the mound (Stone 1972). Artifacts found during excavation of the mound include copper pieces (of non-local origin), ceramics, and a platform pipe (found by a collector) (Brookes 1976). These artifacts suggest that those living at the Grand Gulf Mound Site likely participated in an extensive trading network, the Hopewell Interaction Sphere, with groups throughout the Eastern Woodlands. Potentially significant deposits in the vicinity of the mound are still possible.

Two other mounds were documented at GGNS. They were located close to each other and likely were farther back on the bluff than the Grand Gulf Mound Site; however, they have since been destroyed (Brookes 1976). Additionally, Brookes (1976) noted that the area just north of the Grand Gulf Mound Site had many surface finds and suggested that the area may have been an Archaic Site or Woodland work area. Woodland sites also have been documented on the western side of the Mississippi River across from the town of Grand Gulf located just north of GGNS (Brookes 1976).

Mississippian Period (1,000 to 300 BP)

The Mississippian Period is arguably the most intensely studied period in the American Southeast. With sites as far north as Wisconsin and extending to the Gulf Coast, Mississippian peoples maintained a vast cultural and trading network. In the vicinity of GGNS, the Mississippian Period was preceded by an Emergent Mississippian Period, referred to as the Coles Creek Culture, beginning around A.D. 700 and lasting until about A.D. 1200 (Roe and Schilling 2010). This period is characterized by changes in settlement patterns, mortuary practices, and ceramic technology and decoration, as well as distinctive ceremonial centers (Roe and Schilling 2010). Subsistence during the Emergent Mississippian Period in this area continued to rely on hunting and gathering, with small amounts of maize and domesticated crops beginning to appear (Roe and Schilling 2010). Around A.D. 1200, the Mississippian Culture took hold in the region and is expressed locally as the Plaquemine Culture. The type site of the culture is the Medora Site in West Baton Rouge Parish, Louisiana (Rees 2010). Characterized by ceremonial mound centers, shell-tempered pottery, ceramic and stone smoking pipes, stone axes, game stones and small stemmed projectile points, it is commonly accepted that the Mississippian Period saw more social stratification than previous periods, and these high-status individuals likely lived on top of the platform mounds constructed (Rees 2010). In other parts of the Southeast, the Mississippian Period is seen to decline around A.D. 1500, but in the Lower Mississippi Valley the Mississippian Period appears to have continued into the Protohistoric Period, with historically known groups such as the Natchez and Chitimacha persisting in the Mississippian culture until contact with Europeans changed their way of life.

Protohistoric/Historic Period (300 BP to Present)

Hernando de Soto undertook the earliest European expedition into the Southeast United States that passed by the GGNS study area. While he did not stop near GGNS, the impact of this expedition was felt by Native American tribes throughout the Southeast United States, which were decimated by the diseases that the Europeans brought. Until fall 1543, de Soto and his expedition attacked and enslaved the Native populations throughout the Southeast United States, often exhausting Native food supplies (Neusius and Gross 2007).

An early historic reference to Grand Gulf comes from French explorer René Robert Cavelier, Sieur de La Salle's 1862 voyage down the Mississippi River to find water passages into Spanish territory. He traveled passed the GGNS vicinity and his subsequent maps referred to the locale as "Grand Gouffre," designating a large whirlpool (Wright 1982). The whirlpool was formed by the Black River entering the Mississippi River, and the eddy was made more treacherous with a large rock outcropping known as "Point of Rock," which is located within the Grand Gulf Military Monument Park near GGNS.

Significant political and social reorganization took place among most of the Southeastern tribes after European contact. Many of the historically known tribes were formed from refugee populations or around the remnants of once great chiefdoms (Saunt 2004); however, in the vicinity of GGNS little is known about the period between the end of the Mississippian Period and European settlement. It has been suggested that early historic period groups moved frequently based on the location of Europeans on the landscape (Kidder 2004). There are no historical records of the tribal affiliation of groups in the GGNS vicinity; however, the Natchez had significant settlements south of the property and the Taensa were located on the other side of the Mississippi River in Louisiana.

An established European presence in the region came in 1699, when the French formed a colony at Biloxi Bay near D'Iberville, Mississippi, about 170 mi southeast of GGNS. At this time, the Mississippi River was one of the most important transportation and trade routes in the country, and Europeans set up temporary camps along the river to float their cargo downriver to the commercial center of New Orleans. The location of Grand Gulf on the Mississippi River, along with the construction of a railroad connecting Grand Gulf and Port Gibson in 1830, provided the opportunity for Grand Gulf's citizens to flourish as cotton shippers (Wright 1982). Unfortunately, the prosperity would not last, when, after several floods, a tornado hit the town in 1853 and the town was unable to recover.

During the Civil War, Union General William Sherman's "total war" campaign decimated several parts of the State of Mississippi. Union forces destroyed homes, factories, and infrastructure as they battled throughout the State. After the fall of New Orleans in April 1862, Grand Gulf began to play an increasingly important role in the Confederate defense of Vicksburg. Leading up to the eventual 1863 Union victory at Vicksburg, Confederate installations at Grand Gulf successfully defended Vicksburg and surrounding towns against several Union maneuvers (Wright 1982). However, in April 1863, Union forces made the largest amphibious landing in American History (before World War II) at Grand Gulf. The outnumbered Confederates held onto their positions for 18 hours before abandoning the fortifications and retreating to Bayou

Pierre. The Union forces moved into the town and used Grand Gulf as a base until early June. This was by far the largest battle fought at Grand Gulf, but an additional skirmish occurred between a Union patrol and Confederate partisans on July 16, 1864, and a Union boat was destroyed by Confederate forces in December 1864 (Wright 1982). The 1863 Union capture of Vicksburg is viewed as one of the critical turning points in the war that helped to ensure a Union victory (Smith 2010).

At the end of the war, a main feature of Reconstruction was the introduction of the sharecropper system to the area surrounding GGNS. In this system, land owners rented parcels of their land to those who farmed it in exchange for a percentage of the crop. Many newly freed slaves participated in this system and potential sharecropper sites were documented at GGNS during a survey in 2006 (22Cb824 and 22Cb827). Most of the African-American sharecroppers began resettling at the end of the 19th century in nearby towns, and the area around GGNS remained rural farmland until GGNS acquired it in the 1970s (Entergy 2011a). GGNS began commercial operations in July 1985, as the first and only nuclear power plant in Mississippi.

2.2.10.2 Historic and Archaeological Resources

Before the construction of the approximately 2,015-ac (816-ha) GGNS site, the area was used as farmland. The Mississippi River bounds the property on the west, with other land owners to the north, south, and east. Both historic and prehistoric resources have been documented on the GGNS property; however, any extant cultural resources are most likely subsurface remains and would not be discovered unless land-disturbing operations took place.

The GGNS property has been subject to several archaeological surveys and consultations with the Mississippi State Historic Preservation Office. In June 1972, Mississippi Power & Light Company (MP&L), a precursor of Entergy, contracted the MDAH to perform archaeological, architectural, and historical surveys of the property and transmission routes in Claiborne County. Eight sites were recorded as a result of this survey, only one of which (the Grand Gulf Mound) was considered potentially eligible for inclusion in the National Register of Historic Places (NRHP).

The architectural survey of Claiborne County identified one additional resource, the Callendar house. This was a mid-19th century Greek Revival style house, located on the eastern portion of the GGNS property. The house was in poor condition during the 1970s and is no longer extant. The 164 acres of land GGNS donated to the Grand Gulf Military Monument Park contained vestiges of the town of Grand Gulf that has been preserved with the protection the park provides (Entergy 2011a).

Two transmission lines, which leave GGNS property, were constructed to connect GGNS to the regional power grid: the Baxter-Wilson line and the Franklin line. Neither of these transmission lines are documented as having been formally surveyed before construction. Other surveys conducted in the vicinity of the transmission lines have identified at least seven cultural resource sites that are present either in the path of the Baxter-Wilson and Franklin transmission lines or in very close proximity to them. One of the sites along the Baxter-Wilson right-of-way is the Loosa Yokena site (22Wr691), which is a Middle- to Late-Archaic stone and gem working workshop and occupation site that is listed on the NRHP. The Yokena Mound Group (Site 22Wr500/544) consists of three pyramid mounds damaged by a railroad cut, and Site 22Wr530 is a small occupational area on the Mississippi River floodplain. The current eligibility status of these two sites is undetermined and would require further investigation to assess their eligibility. Site 22Li558 is a Woodland site very near to the Franklin right-of-way with lithics (stone tools and other chipped stone artifacts) and ceramics that requires further testing before an NRHP eligibility determination can be made. Site 22Cb642 is also a

Woodland period site with undetermined eligibility status. Sites 22Je581 and 22Je584 are not eligible for listing in the NRHP (MDAH 2012).

The Archaeological Research Laboratory of the University of Tennessee conducted a Phase I survey of areas of potential construction for a proposed new reactor at GGNS. The survey identified two previously recorded sites (22Cb524 and 22Cb528), as well as nine newly discovered sites (22Cb820, 22Cb821, 22Cb822, 22Cb823, 22Cb824, 22Cb825, 22Cb826, 22Cb827, and 22Cb828). Site 22Cb528 is an Archaic Period village consisting of ceramics and lithics at various stages of production. It was determined that the site should be avoided or tested further to determine eligibility (Entergy 2011a; MDAH 2012). A portion of the Grand Gulf to Port Gibson railroad passes through the site boundary and was inspected by NRC staff on April 13, 2004. It was determined that because the only extant remnants of the railroad are the bed and berm, this section of the railroad does not retain enough integrity to warrant preservation (Stapp 2004).

Overall, 17 archaeological sites have been documented on GGNS property; only one (22Cb528) is considered potentially eligible for listing in the NRHP. Fifteen of these sites are prehistoric, and two of them have both prehistoric and historic components. Even though the Grand Gulf Mound (22Cb522) has been excavated, mound sites were typically part of larger village sites, and it is possible that significant subsurface deposits exist in the vicinity of the mound complex. Within 10 mi of GGNS, 219 archaeological sites have been documented, 9 of which are listed on the NRHP, 2 are eligible, 40 are potentially eligible, 138 are of unknown potential, and 30 are not eligible. Claiborne County maintains 38 properties in the NRHP; the closest listed properties to GGNS are the Grand Gulf Military Park and historic sites in the town of Port Gibson (Entergy 2011a; MDAH 2012).

2.3 Related Federal and State Activities

The staff reviewed the possibility that activities of other Federal agencies might affect the renewal of the operating license for GGNS. Any such activity could result in cumulative environmental impacts and the possible need for a Federal agency to become a cooperating agency in the preparation of NRC's SEIS for GGNS.

There are no Federal projects that would make it necessary for another Federal agency to become a cooperating agency in the preparation of this document. There are no known American Indian lands within 50 mi (80 km) of GGNS. Federally owned facilities within 50 mi (80 km) of GGNS are listed below:

- Tensas River National Wildlife Refuge
- Bayou Cocodrie National Wildlife Refuge
- Poverty Point National Monument
- Natchez Trace Parkway and National Scenic Trail
- Vicksburg National Military Park
- Natchez National Historical Park
- Homochitto National Forest
- Saint Catherine Creek National Wildlife Refuge
- Delta National Forest

The NRC is required, under Section 102(2)(c) of the National Environmental Policy Act, 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. For example, during the course of preparing this DSEIS, the NRC consulted with the FWS and the NMFS. Federal agency consultation correspondence is presented in Appendix D.

2.4 References

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3.0 ENVIRONMENTAL IMPACTS OF REFURBISHMENT

Facility owners or operators may need to undertake or, for economic or safety reasons, may choose to perform refurbishment activities in anticipation of license renewal or during the license renewal term. The major refurbishment class of activities characterized in the *Generic Environmental Impact Statement* (GEIS) *for License Renewal of Nuclear Plants* (NRC 1996) is intended to encompass actions that typically take place only once in the life of a nuclear plant, if at all. Examples of these activities include, but are not limited to, replacement of boiling water reactor recirculation piping and pressurized water reactor steam generators. These actions may have an impact on the environment beyond those that occur during normal operations and that require evaluation, depending on the type of action and the plant-specific design. Table 3–1 lists the environmental issues associated with refurbishment that the U.S. Nuclear Regulatory Commission (NRC) staff (the staff) determined to be Category 1 issues in the GEIS.

Table 3–1. Category 1 Issues Related to Refurbishment

Issue	GEIS section(s)
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
Table source: Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51	

Table 3–2 lists environmental issues related to refurbishment that the NRC staff determined to be plant-specific or inconclusive in the GEIS. These issues are Category 2 issues. The definitions of Category 1 and 2 issues can be found in Section 1.4.

Table 3–2. Category 2 Issues Related to Refurbishment

Issue	GEIS section(s)	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[(a)]	Not addressed	Not addressed

[(a)] Guidance related to environmental justice was not in place at the time the U.S. Nuclear Regulatory Commission (NRC) prepared the GEIS and the associated revision to 10 CFR Part 51. If an applicant plans to undertake refurbishment activities for license renewal, the applicant's environmental report (ER) and the staff's environmental impact statement must address environmental justice.

Table source: Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51

Table B.2 of the GEIS identifies systems, structures, and components (SSCs) that are subject to aging and might require refurbishment to support continued operation during the license renewal period of a nuclear facility. In preparation for its license renewal application, Entergy Operations, Inc. (Entergy) performed an evaluation of these SSCs pursuant to Section 54.21 of Title 10 of the *Code of Federal Regulation* (10 CFR 54.21) in order to identify the need to undertake any major refurbishment activities that would be necessary to support the continued operation of Grand Gulf Nuclear Station (GGNS) during the proposed 20-year period of extended operation.

In its SSC evaluation, Entergy did not identify the need to undertake any major refurbishment or replacement actions associated with license renewal to support the continued operation of GGNS beyond the end of the existing operating license (Entergy 2011). Therefore, the staff will not assess refurbishment activities in this SEIS.

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."

[Entergy] Entergy Operations, Inc. 2011. *Grand Gulf Nuclear Station, Unit 1, License Renewal Application*. Port Gibson, MS: Entergy. Appendix E, Applicant's Environmental Report. October 2011. 425 p. Agencywide Documents Access and Management System (ADAMS) Accession No. ML11308A234.

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4.0 ENVIRONMENTAL IMPACTS OF OPERATION

This chapter addresses potential environmental impacts related to the license renewal term of Grand Gulf Nuclear Station (GGNS). These impacts are grouped and presented according to resource. Generic issues (Category 1) rely on the analysis presented in the *Generic Environmental Impact Statement* (GEIS) *for License Renewal of Nuclear Plants* (NRC 1996, 1999a, 2013a), unless otherwise noted. Most site-specific issues (Category 2) have been analyzed for GGNS and assigned a significance level of SMALL, MODERATE, or LARGE. For Protected Species and Habitats and Historic and Archaeological Resources the impact significance determination language is specific to the authorizing legislation (e.g., Endangered Species Act, National Historic Preservation Act). Also, environmental justice and chronic effects of electromagnetic fields were considered. Some issues are not applicable to GGNS because of site characteristics or plant features. Section 1.4 of this supplemental environmental impact statement (SEIS) provides an explanation of the criteria for Category 1 and Category 2 issues, as well as the definitions of SMALL, MODERATE, and LARGE. As also described in Section 1.4, the U.S. Nuclear Regulatory Commission (NRC) has published a final rule (78 FR 37282, June 20, 2013) revising its environmental protection regulation, Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." The final rule consolidates similar Category 1 and 2 issues, changes some issues from Category 2 to Category 1 issues, and consolidates some of those issues with existing Category 1 issues. The final rule also adds new Category 1 and 2 issues.

The NRC staff also considers new and significant information on environmental issues related to operation during the renewal term. New and significant information is information that identifies a significant environmental issue not covered in the GEIS and codified in Table B–1 of Appendix B to Subpart A of 10 CFR Part 51 or 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. Section 4.11 of this SEIS describes the process used to identify and evaluate new and significant information.

4.1 Land Use

Table 4–1 identifies the two land use issues applicable to GGNS during the renewal term. Section 2.2.1 of this SEIS describes the land use conditions near GGNS.

Table 4–1. Land Use Issues

Issue	GEIS section	Category
Onsite land use	4.5.3	1
Power line right-of-way (ROW)	4.5.3	1

Table source: Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51

The NRC staff did not find any new and significant information during the review of the applicant's Environmental Report (ER) (Entergy 2011a), the site audit, the scoping process, or the evaluation of other available information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. Consistent with the GEIS, the staff concludes that the impacts are SMALL.

4.2 Air Quality

Table 4–2 identifies the air quality issue applicable to GGNS during the renewal term. Section 2.2.2 of this SEIS describes the meteorology and air quality in the vicinity of GGNS.

Table 4–2. Air Quality Issues

Issue	GEIS Section	Category
Air quality effects of transmission lines	4.5.2	1
Table source: Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51		

The NRC staff did not find any new and significant information during the review of the applicant's ER (Entergy 2011a), the site audit, the scoping process, or the evaluation of other available information. Therefore, the staff concludes that there are no impacts related to this issue beyond those discussed in the GEIS. Consistent with the GEIS, the staff concludes that the impacts are SMALL.

4.3 Geologic Environment

4.3.1 Geology and Soils

As described in Section 1.4 of this SEIS, the NRC has approved a revision to its environmental protection regulation, 10 CFR Part 51, "Environmental protection regulations for domestic licensing and related regulatory functions." With respect to the geologic environment of a plant site, the final rule amends Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51, by adding a new Category 1 issue, "Geology and soils." This new issue has an impact level of SMALL. This new Category 1 issue considers geology and soils from the perspective of those resource conditions or attributes that can be affected by continued operations during the renewal term. An understanding of geologic and soil conditions has been well established at all nuclear power plants and associated transmission lines during the current licensing term, and these conditions are expected to remain unchanged during the 20-year license renewal term for each plant. The impact of these conditions on plant operations and the impact of continued power plant operations and refurbishment activities on geology and soils are SMALL for all nuclear power plants and not expected to change appreciably during the license renewal term. Operating experience shows that any impacts to geologic and soil strata would be limited to soil disturbance from construction activities associated with routine infrastructure renovation and maintenance projects during continued plant operations. Implementing best management practices would reduce soil erosion and subsequent impacts on surface water quality. Information in plant-specific SEISs prepared to date and reference documents has not identified these impacts as being significant.

Section 2.2.3 of this SEIS describes the local and regional geologic environment relevant to GGNS. The NRC staff did not identify any new and significant information with regard to this Category 1 (generic) issue based on review of the ER (Entergy 2011a), the public scoping process, or as a result of the environmental site audit. As discussed in Chapter 3 of this SEIS and as identified in the ER (Entergy 2011a), Entergy has no plans to conduct refurbishment or replacement actions associated with license renewal to support the continued operation of GGNS. Further, Entergy anticipates no new construction or other ground-disturbing activities or changes in operations and that operation and maintenance activities would be confined to previously disturbed areas or existing ROWs. Based on this information, it is expected that any incremental impacts on geology and soils during the license renewal term would be SMALL.

4.4 Surface Water Resources

Table 4–3 identifies the surface water issues applicable to GGNS during the renewal term. Section 2.2.4 of this SEIS describes surface water at GGNS.

Table 4–3. Surface Water Issues

Issue	GEIS Section	Category
Impact of refurbishment on surface water quality	3.4.1	1
Impacts of refurbishment on surface water use	3.4.1	1
Altered salinity gradients	4.2.1.2.1	1
Temperature effects on sediment transport capacity	4.2.1.2.3	1
Scouring caused by discharged cooling water	4.2.1.2.3	1
Eutrophication	4.2.1.2.3	1
Discharge of chlorine or other biocides	4.2.1.2.4	1
Discharge of sanitary wastes and minor chemical spills	4.2.1.2.4	1
Discharge of other metals in wastewater	4.2.1.2.4	1

Table source: Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51

The NRC staff did not find any new and significant information during the review of the applicant's ER (Entergy 2011a), the site audit, the scoping process, or the evaluation of other available information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the GEIS concludes that the impacts are SMALL.

4.5 Groundwater Resources

Table 4–4 identifies the issues related to groundwater that are applicable to GGNS during the renewal term. Section 2.2.5 of this SEIS describes groundwater at GGNS.

Table 4–4. Groundwater Issues

Issue	GEIS Section	Category
Groundwater use conflicts (potable and service water; plants that use <100 gpm)	4.8.1.1	1
Groundwater use conflicts (Ranney wells)	4.8.1.4	2
Groundwater quality degradation (Ranney wells)	4.8.2.2	1
Radionuclides released to groundwater	4.5.1.2[a]	2

Table source: Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51; [a] NRC 2013a

4.5.1 Generic Groundwater Issues

The NRC staff did not identify any new and significant information associated with the Category 1 groundwater issues during the review of the applicant's ER (Entergy 2011a), the site audit, the scoping process, or the evaluation of other available information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. Consistent with the GEIS, the staff concludes that the impacts are SMALL.

4.5.2 Groundwater Use Conflicts (Ranney Wells)

For nuclear power plants using Ranney wells or pumping more than 100 gpm (0.006 m^3/s) of groundwater (total on site), the potential impact on groundwater is considered a Category 2 issue, therefore requiring a plant-specific assessment. The requirement for this assessment is specified by 10 CFR 51.53(c)(3)(ii)(C). This groundwater aspect was classified as a site-specific (Category 2) issue because groundwater levels might be lowered beyond the site boundary. The staff previously concluded in the GEIS that "[t]he impact of cooling water intake on groundwater at the Grand Gulf plant (the only plant employing Ranney wells) does not conflict with other groundwater uses in the area" (NRC 1996). In evaluating the potential impacts resulting from groundwater use conflicts associated with license renewal, the NRC staff uses as its baseline the existing groundwater resource conditions described in Sections 2.1.7 and 2.2.5 of this SEIS. These baseline conditions encompass the existing hydrogeologic framework and conditions (including aquifers) potentially affected by continued operations as well as the nature and magnitude of groundwater withdrawals for cooling and other purposes (as compared to relevant appropriation and permitting standards). The baseline also considers other downgradient or in-aquifer uses and users of groundwater.

Future activities at the GGNS site are not expected to lower groundwater levels beyond the plant boundary. The original evaluation of groundwater withdrawal impacts in the GGNS final environmental statement (FES) was for an estimated 42,636 gpm (2.69 m^3/s) for makeup cooling water needs. This evaluation was for two nuclear reactors (NRC 1973). However, only one reactor was constructed. Groundwater withdrawals during the license renewal term are expected to be approximately 27,860 gpm (1.76 m^3/s), which is about 65 percent of the withdrawal rate previously evaluated and found to be acceptable (Entergy 2011a). Groundwater level changes are not detected far from the Ranney wells (Entergy 2011a) because water from the Mississippi River continuously flows into the Mississippi River Alluvial Aquifer, which supplies the Ranney wells, and the aquifer is a thick water table aquifer. Consistent with the GEIS, the staff concludes that the impact for this issue is SMALL.

4.5.3 Radionuclides Released to Groundwater

As described in Section 1.4 of this SEIS, the NRC has approved a revision to its environmental protection regulation, 10 CFR Part 51. With respect to groundwater quality, the final rule amends Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51 by adding a new Category 2 issue, "Radionuclides released to groundwater," with an impact level range of SMALL to MODERATE, to evaluate the potential impact of discharges of radionuclides from plant systems into groundwater. This new Category 2 issue has been added to evaluate the potential impact to groundwater quality from the discharge of radionuclides from plant systems, piping, and tanks. This issue was added because, within the past several years, there have been events at nuclear power reactor sites that involved unknown, uncontrolled, and unmonitored releases of radioactive liquids into the groundwater. In evaluating the potential impacts on groundwater quality associated with license renewal, the NRC staff uses as its baseline the existing groundwater conditions described in Section 2.2.5 of this SEIS. These baseline conditions encompass the existing quality of groundwater potentially affected by continued operations (as compared to relevant state or EPA primary drinking water standards) as well as the current and potential onsite and offsite uses and users of groundwater for drinking and other purposes. The baseline also considers other downgradient or in-aquifer uses and users of groundwater.

Section 2.2.5.4 of this SEIS contains a description of tritium contamination on the northeast side of the Unit 2 power block. The groundwater contamination appears to be restricted to the backfill material and the Upland Complex Aquifer near the power block. This power block does not contain a nuclear reactor. No other radionuclides have been detected above background levels in the Upland Complex Aquifer. Tritium-contaminated groundwater has not migrated off site. No radionuclide concentrations above background levels have been detected in the Catahoula Aquifer or the Mississippi River Alluvial Aquifer or in any other areas in the Upland Complex Aquifer.

GGNS is actively involved in defining the extent of contamination and determining its cause (Entergy 2011a). Should the contamination continue unchecked, it is very unlikely to move downward into the Catahoula Aquifer because of the thick clay bed on top of the aquifer. Rather, the areas of contamination should move laterally with the direction of groundwater flow (northeast) within the Upland Complex Aquifer.

At this time, it is unknown if the plume will continue in that direction or if it will eventually flow into the Mississippi River Alluvial Aquifer and from there to the Mississippi River. In any case, dispersion, radioactive decay, and dilution would decrease the tritium activity concentration in the plume.

In 2007, the nuclear power industry began implementing its “Industry Ground Water Protection Initiative” (NEI 2007). Since 2008, the staff has been monitoring implementation of this initiative at licensed nuclear reactor sites. The initiative identifies actions to improve utilities’ management and response to instances in which the inadvertent release of radioactive substances may result in low but detectible levels of plant-related materials in subsurface soils and water. It also seeks to identify those actions necessary for implementation of a timely and effective groundwater protection program. The areas of contamination were discovered as part of GGNS participation in this initiative. At this time, monitoring wells have been drilled on all sides of the power blocks and GGNS is monitoring them. Monitoring results from these wells are reported annually to the NRC.

The NRC staff’s analysis of groundwater monitoring results and the site’s hydrogeologic regime indicates there is no immediate threat to groundwater resources. Water use in the area should not be affected even if tritium-contaminated groundwater were ever to move off site. Therefore, the NRC staff concludes that inadvertent releases of tritium have not substantially impaired site groundwater quality or affected groundwater use. With continued NRC attention and GGNS action, the NRC staff further concludes that groundwater quality impacts would remain SMALL during the license renewal term.

4.6 Aquatic Resources

Sections 2.1.6 and 2.2.6 of this SEIS describe the GGNS cooling system and aquatic environment, respectively. Table 4–5 identifies the Category 1 issues related to aquatic resources that are applicable to GGNS during the renewal term. There are no Category 2 issues that apply to aquatic resources at GGNS. The staff did not find any new and significant information during the review of the applicant’s ER (Entergy 2011a), the site audit, the scoping process, or the evaluation of other available information; therefore, the staff concludes that there are no impacts related to aquatic resource issues beyond those discussed in the GEIS. For these issues, the GEIS concludes that the impacts are SMALL.

Table 4–5. Aquatic Resource Issues

Issues	GEIS Section	Category
For All Plants		
Accumulation of contaminants in sediments or biota	4.1.1.2.4	1
Entrainment of phytoplankton & zooplankton	4.2.2.1.1	1
Cold shock	4.2.2.1.5	1
Thermal plume barrier to migrating fish	4.2.2.1.6	1
Distribution of aquatic organisms	4.2.2.1.6	1
Premature emergence of aquatic insects	4.2.2.1.7	1
Gas supersaturation (gas bubble disease)	4.2.2.1.8	1
Low dissolved oxygen in the discharge	4.2.2.1.9	1
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	4.2.2.1.10	1
Stimulation of nuisance organisms	4.2.2.1.11	1
Exposure of aquatic organisms to radionuclides	4.6.1.2[a]	1
For Plants with Cooling Tower-Based Heat Dissipation Systems		
Entrainment of fish and shellfish in early life stages	4.3.3	1
Impingement of fish and shellfish	4.3.3	1
Heat shock	4.3.3	1

Table source: Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51; [a] NRC 2013a

4.6.1 Exposure of Aquatic Organisms to Radionuclides

As described in Section 1.4 of this SEIS, the NRC has approved a revision to its environmental protection regulation, 10 CFR Part 51. With respect to the aquatic organisms, the revision amends Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51 by adding a new Category 1 issue, “Exposure of aquatic organisms to radionuclides,” among other changes. This new Category 1 issue considers the impacts to aquatic organisms from exposure to radioactive effluents discharged from a nuclear power plant during the license renewal term. An understanding of the radiological conditions in the aquatic environment from the discharge of radioactive effluents within NRC regulations has been well established at nuclear power plants during their current licensing term. Based on this information, the NRC concluded that the doses to aquatic organisms are expected to be well below exposure guidelines developed to protect these organisms and assigned an impact level of SMALL.

The NRC staff has not identified any new and significant information related to the exposure of aquatic organisms to radionuclides during its independent review of the applicant’s ER, the site audit, and the scoping process. Section 2.1.2 of this SEIS describes the applicant’s radioactive waste management program to control radioactive effluent discharges to ensure that they comply with NRC regulations in 10 CFR Part 20. Section 4.9.2 of this SEIS contains the NRC staff’s evaluation of GGNS’s radioactive effluent and radiological environmental monitoring programs. GGNS’s radioactive effluent and radiological environmental monitoring programs provide further support for the conclusion that the impacts to aquatic organisms from radionuclides are SMALL. The NRC staff concludes that there would be no impacts to aquatic organisms from radionuclides beyond those impacts contained in the GEIS (NRC 2013a) and therefore, the impacts to aquatic organisms from radionuclides are SMALL.

4.7 Terrestrial Resources

The Category 1 (generic) and Category 2 (site-specific) terrestrial resources issues applicable to GGNS are discussed in the following sections and listed in Table 4–6. Terrestrial resources issues that apply to GGNS are described in Sections 2.2.7 and 2.2.8.

Table 4–6. Terrestrial Resource Issues

Issue	GEIS Section	Category
Cooling tower impacts on crops and ornamental vegetation	4.3.4	1
Cooling tower impacts on native plants	4.3.5.1	1
Bird collisions with cooling towers	4.3.5.2	1
Power line right-of-way management (cutting, herbicide application)	4.5.6.1	1
Bird collisions with power lines	4.5.6.1	1
Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	4.5.6.3	1
Floodplains and wetland on power line right-of-way	4.5.7	1
Exposure of terrestrial organisms to radionuclides	4.6.1.1[(a)]	1
Effects on terrestrial resources (non-cooling system impacts)	4.6.1.1[(a)]	2

Table source: Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51; [(a)] NRC 2013a

4.7.1 Generic Terrestrial Resource Issues

For the Category 1 terrestrial resources issues listed in Table 4–6, the NRC staff did not identify any new and significant information during the review of the ER (Entergy 2011a), the NRC staff's site audit, the scoping process, or the evaluation of other available information. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the GEIS concludes that the impacts are SMALL.

4.7.2 Exposure of Terrestrial Organisms to Radionuclides

As described in Section 1.4 of this SEIS, the NRC has approved a revision to its environmental protection regulation, 10 CFR Part 51. With respect to the terrestrial organisms, the revision amends Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51 by adding a new Category 1 issue, "Exposure of terrestrial organisms to radionuclides," among other changes. This new issue has an impact level of SMALL. This new Category 1 issue considers the impacts to terrestrial organisms from exposure to radioactive effluents discharged from a nuclear power plant during the license renewal term. An understanding of the radiological conditions in the terrestrial environment from the discharge of radioactive effluents within NRC regulations has been well established at nuclear power plants during their current licensing term. Based on this information, the NRC concluded that the doses to terrestrial organisms are expected to be well below exposure guidelines developed to protect these organisms and assigned an impact level of SMALL.

The NRC staff has not identified any new and significant information related to the exposure of terrestrial organisms to radionuclides during its independent review of the applicant's ER, the site audit, and the scoping process. Section 2.1.2 of this SEIS describes the applicant's radioactive waste management program to control radioactive effluent discharges to ensure that they comply with NRC regulations in 10 CFR Part 20. Section 4.9.2 of this SEIS contains the NRC staff's evaluation of GGNS's radioactive effluent and radiological environmental monitoring programs. GGNS's radioactive effluent and radiological environmental monitoring programs provide further support for the conclusion that the impacts from radioactive effluents are SMALL.

Therefore, the NRC staff concludes that there would be no impact to terrestrial organisms from radionuclides beyond those impacts contained in the GEIS (NRC 2013a). For this issue, the GEIS concludes that the impacts are SMALL.

4.7.3 Effects on Terrestrial Resources (Non-cooling System Impacts)

As described in Section 1.4 of this SEIS, the NRC has approved a revision to its environmental protection regulation, 10 CFR Part 51. With respect to the terrestrial organisms, the revision amends Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51 by expanding the Category 2 issue, "Refurbishment impacts," among others, to include normal operations, refurbishment, and other supporting activities during the license renewal term. This issue remains a Category 2 issue with an impact level range of SMALL to LARGE; however, the GEIS (NRC 2013a) renames this issue "Effects on terrestrial resources (non-cooling system impacts)."

The geographic scope for the assessment of this issue is the GGNS site and area near the site, and the baseline is the condition of the terrestrial resources under the no-action alternative. Section 2.2.7 describes the terrestrial resources on and in the vicinity of the GGNS site, and Section 2.2.8 describes protected species and habitats. During construction of GGNS, approximately 14 percent of the plant site (270 ac [109 ha]) was cleared for buildings, parking lots, roads, and other infrastructure. The remaining terrestrial and associated wetland habitats have not changed significantly since construction, except for reforestation activities performed by Entergy (see Section 2.2.7). As discussed in Chapter 3 of this SEIS and according to the applicant's ER (Entergy 2011a), Entergy has no plans to conduct refurbishment or replacement actions associated with license renewal to support the continued operation of GGNS. Further, Entergy (2011a) anticipates no new construction or other ground-disturbing activities, changes in operations, or changes in existing land use conditions due to license renewal. Entergy (2011a) reports that operation and maintenance activities would be confined to previously disturbed areas or existing ROWs. As a result, Entergy (2011a) anticipates no new impacts on the terrestrial environment on the GGNS site or along the in-scope transmission line corridors during the license renewal term. Based on the staff's independent review, the staff concludes that operation and maintenance activities that Entergy might undertake during the renewal term, such as maintenance and repair of plant infrastructure (e.g., roadways, piping installations, onsite transmission lines, fencing and other security infrastructure), would likely be confined to previously-disturbed areas of the GGNS site. Therefore, the staff expects non-cooling system impacts on terrestrial resources during the license renewal term to be SMALL.

4.8 Protected Species and Habitats

Section 2.2.8 of this SEIS describes the action area, as defined by the Endangered Species Act of 1973, as amended (ESA), regulations at 50 CFR 402.02, and describes the protected species and habitats within the action area associated with the GGNS license renewal.

Table 4–7 identifies the one Category 2 issue related to protected species and habitats that is applicable to GGNS.

Table 4–7. Threatened or Endangered Species

Issue	GEIS Section	Category
Threatened or endangered species	4.1	2

Table source: Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51

4.8.1 Correspondence with Federal and State Agencies

As part of its National Environmental Policy Act (NEPA) and ESA reviews, the NRC staff contacted the Louisiana and Mississippi Field Offices of the U.S. Fish and Wildlife Service (FWS), the National Marine Fisheries Service (NMFS), the Louisiana Department of Wildlife and Fisheries (LDWF) and the Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP) to gather information on protected species and habitats that may occur in the action area.

The NRC staff sent letters to the Louisiana and Mississippi FWS Field Offices and the NMFS on January 19, 2012 (NRC 2012a, 2012b, 2012c), requesting concurrence with the NRC's list of Federally protected species in the vicinity of GGNS. The Mississippi FWS Field Office replied in a letter dated February 3, 2012 (FWS 2012a). In that letter, the FWS did not address the list of Federally protected species, but it stated that no Federally listed species or their habitats are likely to be affected from the proposed GGNS license renewal and that no further consultation under the ESA would be necessary with that office. The Louisiana FWS Field Office concurred with the NRC's list of Federally protected species in the vicinity of GGNS in a letter dated February 29, 2012 (FWS 2012b). The NMFS replied to the NRC on March 1, 2012, as described in Section 2.2.8 (NMFS 2012).

The NRC sent a letter to the MDWFP on January 20, 2012 (NRC 2012d), requesting information on both Federally and State-listed species. The MDWFP replied in a letter dated February 13, 2012 (MDWFP 2012), that provided the NRC with a list of species that occur within 2 mi (3.2 km) of the GGNS site and transmission line corridors.

The NRC (2012e) sent a letter to the LDWF on February 6, 2012, requesting information on both Federally and State-listed species. The LDWF (2012) replied in a letter dated February 16, 2012, that stated, "After careful review of our database, no impacts to rare, threatened or endangered species or critical habitats are anticipated from the proposed project."

Pursuant to the ESA, the NRC intends to submit this draft SEIS to the FWS with a request for concurrence on the NRC's effect determinations for Federally listed species and designated critical habitat. The results of this consultation will be documented in the final SEIS.

4.8.2 Species and Habitats Protected Under the Endangered Species Act

4.8.2.1 Wood Stork

Section 2.2.8 concludes that the wood stork (*Mycteria americana*) occurs in the action area, but that the individuals within Mississippi do not represent members of the endangered U.S. breeding populations. Thus, the staff concludes that the proposed GGNS license renewal would have no effect on the wood stork.

4.8.2.2 Red-cockaded Woodpecker

Section 2.2.8 concludes that the red-cockaded woodpecker occurs in the action area along the portion of the Franklin transmission line corridor that travels through the Homochitto National Forest and the corresponding 1-mi (0.6-km) buffer.

Because the red-cockaded woodpecker does not occur on the GGNS site, ongoing operations and maintenance activities associated with the proposed license renewal would have no effect on the species.

In 2003, the U.S. Forest Service (USFS) completed an environmental assessment that considered the environmental effects of managing utility corridors with practices intended to enhance wildlife habitat within the Homochitto National Forest (USFS 2003). The environmental assessment included a biological evaluation of the effects of transmission line maintenance on the red-cockaded woodpecker. The biological evaluation concluded that herbicide application and other activities associated with transmission line maintenance would have no direct or indirect effects on the species (USFS 2003). Since EMI's transmission line maintenance procedures have not changed since 2003, the NRC adopts the USFS's conclusion of "no effect." Additionally, in correspondence with the NRC, the FWS (2012a) indicated that no Federally listed species would be affected by the proposed license renewal.

The staff concludes that the proposed license renewal would have no effect on the red-cockaded woodpecker.

4.8.2.3 Least Tern (Interior Population)

Section 2.2.8 concludes that the least tern occurs within the action area along the Mississippi River upstream and downstream of the GGNS site. The proposed GGNS license renewal would not include new construction, refurbishment, ground-disturbing activities, or changes to existing land use conditions that would affect any of the natural habitats on the site or any offsite areas. Additionally, in its correspondence with the NRC, the FWS (2012b) indicated that no Federally listed species would be affected by the proposed license renewal.

The staff concludes that the proposed action would have no effect on the least tern.

4.8.2.4 Bayou Darter

Section 2.2.8 concludes that bayou darters occur in the action area along the portion of the Franklin transmission line corridor that crosses Bayou Pierre. Although highly unlikely, transmission line and vegetation maintenance requiring in-stream work could adversely affect bayou darters directly or indirectly. Potential indirect effects could include a temporary decline in habitat quality from increased sedimentation and turbidity during maintenance activities. Entergy Mississippi, Inc. (EMI), takes a number of precautions to avoid impacts to bayou darters and their habitat when performing maintenance in or near water bodies. As described in Section 2.1.5, EMI chooses maintenance techniques that minimize impacts in streams and other water features. In wetlands and aquatic habitats, EMI personnel selectively apply Environmental Protection Agency (EPA) approved herbicides for wetlands and aquatic area applications. Personnel spray areas on foot with backpack sprayers to minimize impacts. All EMI maintenance crew personnel hold U.S. Department of Agriculture (USDA) State-approved herbicide licenses. Therefore, the continued operation and maintenance of the Franklin transmission line would have discountable or insignificant effects on bayou darters.

Bayou darters do not occur on the GGNS site because the species is endemic to the Bayou Pierre, which does not flow through GGNS, as described in Section 2.2.8. Because bayou darters do not occur on the GGNS site, ongoing operations and maintenance activities associated with the proposed license renewal would have no effect on the species.

In correspondence with the NRC, the FWS Mississippi Field Office concluded that neither bayou darters nor their habitat would likely be affected from the proposed GGNS operating license renewal (FWS 2012a). Similarly, MDFWP (2012) stated that the proposed project likely poses no threat to listed species or their habitat if best management practices are properly implemented. Based on FWS (2012a), MDWFP (2012), and the NRC staff's assessment that the continued operation and maintenance of the Franklin transmission line would have discountable or insignificant effects on bayou darters, the NRC staff concludes that the proposed GGNS license renewal may affect, but is not likely to adversely affect bayou darters.

4.8.2.5 Pallid Sturgeon

Section 2.2.8 concludes that pallid sturgeon could occur in the action area in the Mississippi River. Increased water temperature and other conditions near GGNS's discharge could affect pallid sturgeon. Direct effects to pallid sturgeon from heat shock would be highly unlikely because the thermal plume does not create a barrier across the Mississippi River; therefore, the fish could avoid the warmer temperature water (NRC 1972). Indirect effects could include a decrease in habitat quality from thermal discharge in the Mississippi River. GGNS's NPDES permit limits the flow, temperature, and other conditions of GGNS's discharge into the Mississippi River. Therefore, the continued discharge from GGNS would have discountable or insignificant effects on pallid sturgeon.

In correspondence with the NRC, the FWS Mississippi Field Office concluded that neither pallid sturgeon nor their habitat would likely be affected from the proposed GGNS operating license renewal (FWS 2012a). Similarly, MDFWP (2012) stated that the proposed project likely poses no threat to listed species or their habitat if best management practices are implemented properly. Based on FWS (2012a), MDWFP (2012), and the staff's assessment that the continued discharge from GGNS would have discountable or insignificant effects on pallid sturgeon, the NRC staff concludes that the proposed GGNS license renewal may affect, but is not likely to adversely affect the pallid sturgeon.

4.8.2.6 Louisiana and American Black Bears

Section 2.2.8 concludes that the Louisiana (*Ursus americanus luteolus*) and American (*U. americanus*) black bears occur in the action area in bottomland hardwood forest habitat or other suitable habitat. Black bears would be expected to avoid areas of human activity and would be unlikely to occur on the developed portion of the GGNS site. Within the GGNS site, the proposed license renewal would include maintenance and operation activities within developed or previously disturbed areas and would not involve new construction, refurbishment, ground-disturbing activities, or changes to existing land use conditions in either natural or developed areas. The continued operation of GGNS during the license renewal term would preserve the existing natural habitats on the site. The large tracts of bottomland and upland hardwood forests on the site are relatively remote, restricted from public access, and provide contiguous habitat with offsite areas of hardwood forest. Therefore, continued operation of the GGNS site could result in beneficial effects to the species.

The continued operation and maintenance of the Baxter-Wilson and Franklin transmission lines would have discountable or insignificant effects on black bears. Within the transmission line corridors, black bears could take in herbicides that have been sprayed on berries or shrubs. Noise from machinery and human activity could temporarily alter the behavior of black bears during transmission line maintenance activities. However, none of these effects would be measurable or detectable or reach the scale in which a take would occur. Transmission line maintenance could require removal of mature trees if they pose a threat to the transmission lines; however, black bears are unlikely to den at the edge of forest habitat, so tree removal should not affect denning habitat.

Based on the staff's assessment that the continued operation and maintenance of the Baxter-Wilson and Franklin transmission lines would have discountable or insignificant effects on bears, the NRC staff concludes that the proposed GGNS license renewal may affect, but is not likely to adversely affect the Louisiana and American black bears.

4.8.2.7 Louisiana Black Bear Critical Habitat

Section 2.2.8 concludes that no designated Louisiana black bear critical habitat occurs within the action area, but notes that the closest designated critical habitat lies about 16 mi (26 km) west of the GGNS site at its closest point. Because no designated critical habitat lies within the action area, the staff concludes that the proposed GGNS license renewal would have no effect on designated Louisiana black bear critical habitat.

4.8.2.8 Fat Pocketbook Mussel

Section 2.2.8 concluded that fat pocketbook mussels are not likely to occur within the action area. In correspondence with the NRC, the FWS Mississippi Field Office concluded that neither fat pocketbook mussels nor their habitat would likely be affected from the proposed license renewal (FWS 2012a). Similarly, MDFWP (2012) stated that the proposed project likely poses no threat to listed species or their habitat if best management practices are implemented properly. Therefore, the staff concludes that the proposed GGNS license renewal would have no effect on fat pocketbook mussels.

4.8.2.9 Rabbitsfoot Mussel

Section 2.2.8 concluded that rabbitsfoot mussels are not likely to occur within the action area. In correspondence with natural resource agencies, FWS Mississippi Field Office, FWS Louisiana Field Office, and MDWFP did not include rabbitsfoot mussel as a species that would be affected by the proposed license renewal (FWS 2012a, 2012b; MDFWP 2012). Therefore, the staff concludes that the proposed GGNS license renewal would have no effect on rabbitsfoot mussels.

4.8.2.10 Rabbitsfoot Mussel Proposed Critical Habitat

Section 2.2.8 concludes that no proposed rabbitsfoot mussel critical habitat occurs within the action area. Thus, the staff concludes that the proposed GGNS license renewal would have no effect on proposed rabbitsfoot mussel critical habitat.

4.8.3 Species Protected by the State of Mississippi

4.8.3.1 Aquatic Species

Section 2.2.8 concluded that the chestnut lamprey, black buffalo, paddlefish, blue sucker, and sicklefin chub inhabit portions of the Mississippi River (NatureServe 2010). Section 2.2.8 also concluded that crystal darter, chestnut lamprey, blue sucker, black buffalo sicklefin chub, and paddlefish may occur in suitable habitat along the transmission line corridors, such as the transmission line crossings along the Mississippi, Big Black, and Bayou Pierre rivers. No GGNS-related aquatic surveys have been conducted along the transmission lines.

In the Mississippi River, increased water temperature and other conditions near GGNS's discharge could affect State-protected fish. As described above, GGNS's NPDES permit limits the flow, temperature, and other conditions of GGNS's discharge into the Mississippi River. In addition, the thermal plume would not extend the width of the Mississippi River; therefore, fish could swim away to avoid the plume (NRC 1972).

The continued operation and maintenance of the transmission lines would have discountable or insignificant effects on State-protected fish. Although highly unlikely, line and vegetation maintenance requiring in-stream work could adversely affect fish directly and indirectly. Potential adverse effects include a temporary decline in habitat quality from increased sedimentation and turbidity during maintenance activities. As described in Section 2.1.5, EMI takes a number of precautions to avoid impacts to State-protected fish and their habitat when performing transmission line maintenance in or near water bodies. As described in Section 2.1.5, EMI chooses maintenance techniques that minimize erosion in streams and other water features. In wetlands and aquatic habitats, EMI personnel selectively apply EPA-approved herbicides on foot with backpack sprayers to minimize impacts. All EMI maintenance crew personnel hold USDA state-approved herbicide licenses.

In correspondence with the NRC, MDWFP (2012) did not identify any impacts of the proposed license renewal that would affect State-protected species, assuming that best management practices are implemented properly

4.8.3.2 Terrestrial Species

Section 2.2.8 discusses two species protected under the Mississippi Nongame and Endangered Species Conservation Act of 1974: Webster's salamander (*Plethodon websteri*) and the white ibis (*Eudocimus albus*). In its correspondence with the NRC, the MDWFP (2012) concluded that "the proposed project likely poses no threat to listed species or their habitats."

4.8.4 Species Protected Under the Bald and Golden Eagle Protection Act

Though bald eagles occur throughout the action area, no known nests are in close proximity to the GGNS site or along the transmission line corridors that could be disturbed by operations or maintenance activities associated with the proposed license renewal. Since the proposed license renewal does not involve construction or land disturbances, the proposed license renewal would not affect any bald eagle habitat.

4.8.5 Species Protected Under the Migratory Bird Treaty Act

Section 2.2.7 discusses a variety of migratory birds that inhabit the GGNS site and surrounding region. Section 2.2.8 describes Entergy's depredation permit for cliff swallows (*Petrochelidon* spp.) and barn swallows (*Hirundo rustica*). In the past 5 years of available depredation reports, Entergy has taken a small number of birds to ensure the safety and integrity of plant structures. This small number of takes would not be expected to destabilize or noticeably alter either species' populations. Also, the FWS reviews Entergy's depredation reports and renews the depredation permit annually to ensure that impacts to migratory birds are minimal. The proposed license renewal does not involve construction or other land disturbances that might adversely affect migratory birds.

4.9 Human Health

Table 4–8 lists the issues related to human health that are applicable to GGNS.

Table 4–8. Human Health Issues

Issue	GEIS Section	Category
Microbiological organisms (occupational health)	4.3.6	1
Noise	4.3.7	1
Radiation exposures to public (license renewal term)	4.6.2	1
Occupational radiation exposures (license renewal term)	4.6.3	1
Electromagnetic fields—acute effects (electric shock)	4.5.4.1	2
Electromagnetic fields—chronic effects	4.5.4.2	Uncategorized
Human health impact from chemicals	4.9.1.1.2[a]	1
Physical occupational hazards	4.9.1.1.5[a]	1

Table source: Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51; [a] NRC 2013a

4.9.1 Generic Human Health Issues

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B–1, applicable to GGNS in regard to human health are listed in Table 4–9. Entergy stated in its ER (Entergy 2011a) that it was not aware of any new and significant human health issues associated with the renewal of the GGNS operating license. The NRC staff did not identify any new and significant information during its independent review of the applicant's ER, the staff's site audit, the scoping process, or the evaluation of other available information. Therefore, there are no impacts related to Category 1 human health issues beyond those discussed in the GEIS. For these issues, the GEIS concluded that the impacts are SMALL, and additional site-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation. These impacts are expected to remain SMALL through the license renewal term.

4.9.1.1 New Category 1 Human Health issues

As described in Section 1.4 of this SEIS, the NRC has approved a revision to its environmental protection regulation, 10 CFR Part 51. With respect to the human health, the revision amends Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51 by adding two new Category 1 issues, "Human health impact from chemicals" and "Physical occupational hazards." The first issue considers the impacts from chemicals to plant workers and members of the public. The second issue only considers the non-radiological occupational hazards of working at a nuclear power plant. An understanding of these non-radiological hazards to nuclear power plant workers and members of the public have been well established at nuclear power plants during those plants' current licensing terms. The impacts from chemical hazards are expected to be minimized through the licensee's use of good industrial hygiene practices as required by permits and Federal and State regulations. Also, the impacts from physical hazards to plant workers will be of small significance if workers adhere to safety standards and use protective equipment as required by Federal and State regulations. The impacts to human health for each of these new issues from continued plant operations are SMALL.

The NRC staff has not identified any new and significant information related to these non-radiological issues during its independent review of the applicant's ER, the site audit, and the scoping process. Therefore, the NRC staff concludes that there would be no impact to human health from chemicals or physical hazards beyond those impacts described in the GEIS (NRC 2013a) and, therefore, the impacts are SMALL.

4.9.2 Radiological Impacts of Normal Operations

Entergy stated in its ER that it was not aware of any new and significant radiological impacts related to human health issues associated with the renewal of the GGNS operating license. The NRC staff has not identified any new and significant information radiological impacts related to human health issues during its independent review of the applicant's ER, the site audit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there would be no impact from radiation exposures to the public or to workers during the renewal term beyond those discussed in the GEIS.

The findings in the GEIS are as follows:

- Radiation exposures to public (license renewal term)—Based on information in the GEIS, the NRC found that radiation doses to the public will continue at current levels associated with normal operations.
- Occupational exposures (license renewal term)—Based on information in the GEIS, the NRC 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.

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

The information presented below is a discussion of selected radiological programs conducted at GGNS.

4.9.2.1 GGNS Radiological Environmental Monitoring Program

GGNS conducts a radiological environmental monitoring program (REMP) to assess the radiological impact, if any, to its employees, the public, and the environment from operations. The REMP measures aquatic, terrestrial, and atmospheric radioactivity, as well as ambient radiation.

The REMP also measures background radiation (i.e., cosmic sources, global fallout, and naturally occurring radioactive material, including radon). The REMP supplements the radioactive effluent monitoring program, discussed later in this section, by verifying that any measurable concentrations of radioactive materials and levels of radiation in the environment are not higher than those calculated using the radioactive effluent release measurements and transport models.

An annual radiological environmental operating report is issued, which contains a discussion of the results of the monitoring program performed for the previous year. The REMP collects samples of environmental media to measure the radioactivity levels that may be present. The media samples are representative of the radiation exposure pathways that may have an impact on the public.

The GGNS radiological environmental monitoring program consists of four categories based on exposure pathways to the public. These categories are: airborne, waterborne, ingestion, and direct radiation. The airborne samples taken around GGNS are airborne particulate and airborne iodine. The waterborne pathway samples are taken from surface water and groundwater sources. Sediment samples also are included in this pathway. The ingestion pathway samples include fish and broadleaf vegetation. GGNS will also sample milk for this pathway if it is available commercially within 8 km (5 mi) of the site. For 2012, there was no commercial milk available to sample. The direct radiation pathway measures direct exposure from environmental radiation doses using thermoluminescent dosimeters.

In addition to the REMP, GGNS has an onsite groundwater protection program designed to monitor the onsite environment for detection of leaks from plant systems and pipes containing radioactive liquid (Entergy 2011a). Additional information on the groundwater protection program is contained later in this section and in the groundwater quality section in Chapter 2 of this document.

The NRC staff reviewed the GGNS annual radiological environmental operating reports for 2008 through 2012 for significant impacts to the environment or unusual trends in the data (Entergy 2009a, 2010a, 2011b, 2012a, 2013a). Five years provides a data set that covers a broad range of activities that occur at a nuclear power plant, including refueling outages, non-refueling outage years, routine operation, and years where there may be significant maintenance activities. Based on the staff's review, no adverse trends (i.e., steadily increasing build-up of radioactivity levels) were observed and the data showed no measurable impact to the environment from operations at GGNS.

4.9.2.2 Ground Water Protection Program

In 2007, the Nuclear Energy Institute (NEI) established a standard for monitoring and reporting radioactive isotopes in groundwater: NEI 07-07, "Industry Ground Water Protection Initiative – Final Guidance Document" (NEI 2007). GGNS implemented the recommendations of this industry standard after initial sampling efforts in 2007. Results of Entergy's groundwater protection program are contained in the annual radioactive effluent release report submitted annually to the NRC.

Information on the GGNS groundwater protection program is located in Sections 2.2.5 and 4.5.3 in this SEIS.

4.9.2.3 GGNS Radioactive Effluent Release Program

All nuclear plants were licensed with the expectation that they would release radioactive material to both the air and water during normal operation. However, NRC regulations require that radioactive gaseous and liquid releases from nuclear power plants must meet radiation dose-based limits specified in 10 CFR Part 20, and the as low as is reasonably achievable (ALARA) criteria in Appendix I to 10 CFR Part 50. Regulatory limits are placed on the radiation dose that members of the public can receive from radioactive effluents that a nuclear power plant releases. In addition, 10 CFR 50.36(a) requires nuclear power plants to submit an annual report to the NRC that lists the types and quantities of radioactive effluents released into the environment.

The NRC staff reviewed the annual radioactive effluent release reports for 2008 through 2012 (Entergy 2009b, 2010b, 2011c, 2012b, 2013b). The review focused on the calculated doses to a member of the public from radioactive effluents released from GGNS. The doses were compared to the radiation protection standards in 10 CFR 20.1301 and the ALARA dose design objectives in Appendix I to 10 CFR Part 50 and EPA’s 40 CFR Part 190.

Dose estimates for members of the public are calculated based on radioactive gaseous and liquid effluent release data and atmospheric and aquatic transport models. The 2012 annual radioactive effluent release report (Entergy 2013b) contains a detailed presentation of the radioactive discharges and the resultant calculated doses. The following summarizes the calculated dose to a member of the public located outside the GGNS site boundary from radioactive gaseous and liquid effluents released during 2012:

- The total-body dose to an offsite member of the public from GGNS radioactive liquid effluents was 3.02×10^{-01} mrem (3.02×10^{-03} mSv), which is well below the 3 mrem (0.03 mSv) dose criterion in Appendix I to 10 CFR Part 50.

- The organ (liver) dose to an offsite member of the public from GGNS radioactive liquid effluents was 5.64×10^{-01} mrem (5.64×10^{-03} mSv), which is well below the 10 mrem (0.10 mSv) dose criterion in Appendix I to 10 CFR Part 50.

- The air dose at the site boundary from gamma radiation in gaseous effluents from GGNS was 4.23×10^{-01} mrad (4.23×10^{-03} mGy), which is well below the 10 mrad (0.1 mGy) dose criterion in Appendix I to 10 CFR Part 50.

- The air dose at the site boundary from beta radiation in gaseous effluents from GGNS was 2.16×10^{-01} mrad (2.16×10^{-03} mGy), which is well below the 20 mrad (0.2 mGy) dose criterion in Appendix I to 10 CFR Part 50.

- The dose to an organ (bone) from radioactive iodine, radioactive particulates, and carbon-14 from GGNS was 7.06 mrem (7.06×10^{-02} mSv), which is below the 15 mrem (0.15 mSv) dose criterion in Appendix I to 10 CFR Part 50.

4.9.2.4 Summary

The NRC staff’s review of the GGNS radioactive effluent control program showed that radiation doses to members of the public for the years 2008–2012 comply with Federal radiation protection standards contained in Appendix I to 10 CFR Part 50, 10 CFR Part 20, and 40 CFR Part 190.

The applicant has no plans to conduct refurbishment activities during the license renewal term; however, routine plant refueling and maintenance activities currently performed will continue during the license renewal term. Based on the past performance of the radioactive waste system to maintain the dose from radioactive effluents to be ALARA, similar performance is expected during the license renewal term. Continued compliance with regulatory requirements is expected during the license renewal term; therefore, the staff concludes that the impacts from radioactive effluents would be SMALL.

4.9.3 Electromagnetic Fields—Acute Effects

Based on the GEIS, the NRC found that electric shock resulting from direct access to energized conductors or from induced charges in metallic structures has not been a problem at most operating nuclear power plants and generally is not expected to be a problem during the license renewal term. However, site-specific review is required to determine the significance of the electric shock potential along portions of the transmission lines within the scope of this document.

In the GEIS (NRC 1996), the NRC found that without a review of the conformance of each nuclear plant transmission line with National Electrical Safety Code (NESC) criteria, it was not possible to determine the significance of the electric shock potential (IEEE 2002). Evaluation of individual plant transmission lines is necessary because 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 upgraded line voltage. The NRC uses the NESC criteria as its baseline to assess the potential human health impact of the induced current from an applicant’s transmission lines. As discussed in the GEIS, the issue of electric shock is of small significance for transmission lines that are operated in adherence with the NESC criteria. To comply with 10 CFR 51.53(c)(3)(ii)(H), Entergy provided an assessment of the impact of the proposed action on the potential shock hazard from the transmission lines.

GGNS electrical output is delivered to the Baxter-Wilson Steam Electric Station Extra High Voltage (EHV) switchyard and the Franklin EHV Switching Station through two 500-kilovolt (kV) transmission lines. The Baxter-Wilson transmission line is a 22-mi (35-km) single-circuit line that spans from the 500-kV switchyard located at GGNS to the Baxter-Wilson Steam Electric Station EHV switchyard. The Franklin transmission line is a 43.6-mi (70.2-km) single-circuit line that spans from the 500-kV switchyard located at GGNS to the Franklin EHV Switching Station. There is also a 500-kV line that spans approximately 300 ft (90 m) from the GGNS Turbine Building to the 500-kV switchyard located on site. Entergy Mississippi, Inc. (EMI) owns and operates the transmission lines constructed to connect GGNS to the electric grid.

Entergy completed an acute shock analysis for the transmission lines using the software “EMF-10 Electric Field Induction” developed by the Electric Power Research Institute (EPRI). The input parameters included the design features of the Franklin and Baxter-Wilson transmission lines and a large tractor-trailer was assumed to be the maximum vehicle size under the lines. The minimum clearance on the Franklin line above any of the travel ways mentioned was 35.4 ft (10.8 m). The minimum clearance above any of the travel ways mentioned on the Baxter-Wilson line was 44.5 ft (13.6 m). The maximum induced current calculated for those power lines was 2.03 mA on the Franklin transmission line. The minimum clearance at any point on the 500-kV line that spans approximately 300 ft (90 m) from the GGNS Turbine Building to the 500-kV switchyard located on site was 70 ft (21.3 m). Since that clearance is almost twice the clearance used in the acute shock analyses for the Baxter-Wilson and Franklin transmission lines, this span would not induce a current greater than the NESC 5 mA criterion. Therefore, the lines meet the NESC 5 mA criterion (Entergy 2011a).

The GGNS transmission line corridor crosses over mostly rural agricultural and forest land, with the exception of the Franklin transmission line, which crosses over portions of highways and rivers in the area. EMI inspects all transmission lines 230-kV and above at least three times each year. Any problems or hazards related to vegetation are recorded in an electronic database and assigned to crews for mitigation. Also, transmission lines 230-kV and above are presently scheduled to receive herbicide every 2 years to maintain proper clearances from conductors. EMI also uses aerial patrols to inspect their transmission lines and works with internal and external customers to investigate and resolve potential problems, such as building or roadway construction projects and pipeline installation or maintenance. EMI's current maintenance practices associated with maintaining transmission line clearances will continue during the license renewal term (Entergy 2011a).

The NRC staff reviewed the information Entergy provided to document the results of its acute shock evaluation of its transmission lines. The staff notes that Entergy used appropriate assumptions in its calculations: identification of the transmission lines covered by 10 CFR 51.53(c)(3)(ii)(H), the use of the maximum vehicle size to be located below the transmission lines, and software developed by EPRI—the nationally recognized expert in this area. Based on this information, the NRC staff concludes that the potential impacts from electric shock during the renewal period would be SMALL.

4.9.4 Electromagnetic Fields—Chronic Effects

In the GEIS, the effects of chronic exposure to 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 effects of chronic exposure from these fields continue to be studied and are not known at this time. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the U.S. Department of Energy (DOE).

The report by NIEHS (NIEHS 1999) contains the following conclusion:

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

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

4.10 Socioeconomics

The socioeconomic issues applicable to GGNS are shown in Table 4–9. Section 2.2.9 of this SEIS describes the socioeconomic conditions near GGNS.

Table 4–9. Socioeconomics Issues

Issues	GEIS Section	Category
Housing impacts	4.7.1	2
Public services: public safety, social services, tourism & recreation	4.7.3, 4.7.3.3, 4.7.3.4, 4.7.3.6	1
Public services: public utilities	4.7.3.5	2
Public services: education (license renewal)	4.7.3.1	1
Offsite land use (license renewal term)	4.7.4	2
Public Services: transportation	4.7.3.2	2
Historic & archaeological resources	4.7.7	2
Aesthetic impacts (license renewal term)	4.7.6	1
Aesthetic impacts of transmission lines (license renewal term)	4.5.8	1
Environmental justice: minority and low-income populations	4.10.1[a]	2

Table source: Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51; [a]NRC 2013a

4.10.1 Generic Socioeconomic Issues

The applicant's ER, scoping comments, and other available data records on GGNS, were reviewed and evaluated for new and significant information. The review included a data gathering site visit to GGNS. No new and significant information was identified during this review that would change the conclusions presented in the GEIS. Therefore, for these Category 1 issues, impacts during the renewal term are not expected to exceed those discussed in the GEIS. For GGNS, the staff incorporates the GEIS conclusions by reference. Impacts for Category 2 issues and the uncategorized issue (environmental justice) are discussed in Sections 4.10.2 through 4.10.7. In evaluating the potential socioeconomic impacts resulting from license renewal, the NRC uses as its baseline the existing socioeconomic conditions described in Section 2.2.9 of this SEIS. These baseline socioeconomic conditions include existing housing, transportation, offsite land use, demographic, public services, and economic conditions affected by ongoing operations at the nuclear power plant.

4.10.2 Housing

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

According to the 2010 Census, an estimated 23,406 people lived within 20 mi (32 km) of GGNS, which equates to a population density of 19 persons per mi^2 (Entergy 2011a). This translates to a Category 1, "most sparse" population density using the GEIS measure of sparseness (less than 40 persons per mi^2 and no community with 25,000 or more persons within 20 mi). An estimated 329,043 people live within 50 mi (80 km) of GGNS with a population density of 42 persons per mi^2 (Entergy 2011a). This translates to a Category 1 density, using the GEIS measure of proximity (no cities with 100,000 or more persons and less than 50 persons per mi^2

within 50 mi). Therefore, GGNS is located in a low population area based on the GEIS sparseness and proximity matrix.

Table B–1 of 10 CFR Part 51, Subpart A, Appendix B, states that impacts on housing availability may be SMALL, MODERATE, or LARGE. MODERATE or LARGE housing impacts of the workforce associated with refurbishment may be associated with plants located in sparsely populated areas or in areas with growth control measures that limit housing development. Since Entergy has no planned refurbishment activities at GGNS and Claiborne, Hinds, Jefferson, and Warren counties are not subject to growth-control measures that would limit housing development; any changes in employment at GGNS would have little noticeable effect on housing availability in these counties. Since Entergy has no plans to add non-outage employees during the license renewal period, employment levels at GGNS would remain relatively constant with no additional demand for permanent housing during the license renewal term. Based on this information, there would be no impact on housing during the license renewal term beyond what already has been experienced. Therefore, the NRC staff concludes that the impacts would be SMALL.

4.10.3 Public Services—Public Utilities

Impacts on public utility services (e.g., water, sewer) are considered SMALL if the public utility has the ability to respond to changes in demand and would have no need to add or modify facilities. Impacts are considered MODERATE if service capabilities are overtaxed during periods of peak demand. Impacts are considered LARGE if additional system capacity is needed to meet ongoing demand.

Analysis of impacts on the public water systems considered both plant demand and plant-related population growth. Section 2.1.7 describes the permitted withdrawal rate and actual use of water for reactor cooling at GGNS.

Since Entergy has no plans to add non-outage employees during the license renewal period, employment levels at GGNS would remain relatively unchanged with no additional demand for public water services. Public water systems in the region are adequate to meet the demands of residential and industrial customers in the area. Therefore, there would be no impact to public water services during the license renewal term beyond what is already being experienced. Therefore, the NRC staff concludes that the impacts would be SMALL.

4.10.4 Public Services—Transportation

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

> Transportation impacts (level of service) of highway traffic generated...during the term of the renewed license are generally expected to be of SMALL significance. However, the increase in traffic associated with additional workers and the local road and traffic control conditions may lead to impacts of MODERATE or LARGE significance at some sites.

The regulation in 10 CFR 51.53(c)(3)(ii)(J) requires all applicants to assess the impacts of highway traffic generated by the proposed project on the level of service of local highways during the term of the renewed license. Since Entergy has no plans to add non-outage employees during the license renewal period, traffic volume and levels of service on roadways in the vicinity of GGNS would not change. Therefore, there would be no transportation impacts during the license renewal term beyond what is already being experienced. Therefore, the NRC staff concludes that the impacts would be SMALL.

4.10.5 Offsite Land Use

Offsite land use during the license renewal term is a Category 2 issue (10 CFR Part 51, Subpart A, Appendix B, Table B–1). Table B–1 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 SMALL when there will be little new development and minimal changes to an area's land use pattern, as MODERATE when there will be considerable new development and some changes to the land use pattern, and LARGE when there will be large-scale new development and major changes in the land use pattern.

Tax revenue can affect land use because it enables local jurisdictions to provide the public services (e.g., transportation and utilities) necessary to support development. Section 4.7.4.1 of the GEIS states that the assessment of tax-driven land use impacts during the license renewal term should consider the size of the plant's tax payments relative to the community's total revenues, the nature of the community's existing land use pattern, and 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 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 tax payments are 10 to 20 percent of the community's total revenue, new tax-driven land use changes would be MODERATE. If tax payments are greater than 20 percent 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. As discussed in Sections 4.10.2, 4.10.3, and 4.10.4, it is not expected that there would be any change in the staffing levels at GGNS or increased demand for additional housing, public services related to public utilities, and transportation during the license renewal period. Therefore, the NRC staff concludes that the impacts would be SMALL.

4.10.5.1 Population-Related Impacts

Since Entergy has no plans to add non-outage employees during the license renewal period, there would be no plant operations-driven population increase in the vicinity of GGNS. Therefore, there would be no population-related offsite land use impacts during the license renewal term beyond what has already been experienced. Therefore, the NRC staff concludes that the impacts would be SMALL.

4.10.5.2 Tax Revenue-Related Impacts

As discussed in Chapter 2, Entergy pays property taxes for GGNS to the State of Mississippi. Part of these taxes are distributed to counties near GGNS. Since Entergy started making property tax payments, local county populations have been in decline and land use conditions have generally remained unchanged. Therefore, tax revenue from GGNS as a proportion of total tax revenue in the ROI has had little or no effect on land use conditions within these counties. Since employment levels would remain relatively unchanged with no increase in the assessed value of GGNS, annual property tax payments also would be expected to remain relatively unchanged throughout the license renewal period. Based on this information, there would be no tax-revenue-related offsite land use impacts during the license renewal term beyond those already being experienced. Therefore, the NRC staff concludes that the impacts would be SMALL.

4.10.6 Historic and Archaeological Resources

The National Historic Preservation Act (NHPA) requires Federal agencies to consider the effects of their undertakings on historic properties. Historic properties are defined as resources eligible for listing on the National Register of Historic Places (NRHP). The criteria for eligibility are listed in 36 CFR 60.4 and include association with significant events in history; association with the lives of persons significant in the past; embodiment of distinctive characteristics of type, period, or construction; and sites or places that have yielded or are likely to yield important information. The historic preservation review process (Section 106 of the National Historic Preservation Act of 1966, as amended [NHPA]) is outlined in regulations issued by the Advisory Council on Historic Preservation (ACHP) in 36 CFR Part 800. In accordance with 36 CFR 800.8(c), the NRC has elected to use the NEPA process to comply with the obligations found under Section 106 of the NHPA.

In accordance with 36 CFR 800.8(c), the NRC initiated Section 106 consultation with the ACHP and the Mississippi and Louisiana State Historic Preservation Offices (SHPOs) in January 2012, by notifying them of the agency's intent to review a request from Entergy to renew the GGNS operating license (NRC 2012f, 2012g, 2012h). On February 28, 2012, the Mississippi SHPO responded to the NRC's letter stating its opinion that the proposed license renewal will have no adverse effect on historic properties (MDAH 2012a). No comments were received from the ACHP or the Louisiana SHPO as a result of these consultation letters.

The NRC also initiated consultation on the proposed GGNS license renewal with four Federally recognized tribes: the Jena Band of Choctaw Indians, the Mississippi Band of Choctaw Indians, the Choctaw Nation of Oklahoma, and the Tunica-Biloxi Tribe of Louisiana (NRC 2012i). In letters to the tribes, the NRC supplied information about the proposed action (license renewal) and the definition of the area of potential effect, and stated that the NHPA review would be integrated with the NEPA process, according to 35 CFR 800.8. The NRC invited the Tribes to participate in the identification of potentially affected historic properties near GGNS and the scoping process. The Choctaw Nation of Oklahoma, Jena Band of Choctaw Indians, and the Mississippi Band of Choctaw Indians responded. The Tribes did not raise any concerns through scoping comments and requested updates throughout the review process (see Appendix D).

The staff reviewed information on historic and archaeological resources provided in the applicant's ER. It also conducted a review at the Mississippi Department of Archives and History (MDAH) and identified 17 previously recorded archaeological resources on GGNS property; surveys conducted in 1972 and 2006 of the archaeological, architectural, and historic resources on and around GGNS property; and multiple surveys that intersected the transmission lines (MDAH 2012b). One site identified in these surveys, 22Cb528, is located on GGNS property and is considered potentially eligible for listing in the NRHP. Site 22Cb528 is an Archaic Period village consisting of ceramics and lithics at various stages of production, and it has been determined that the site should be avoided or tested further to determine eligibility (Entergy 2011a; MDAH 2012b). Along the transmission lines, seven sites were identified as being within or very near to the transmission line rights-of-way; one is listed in the NRHP; four others would require further evaluation to determine eligibility status and are considered potentially eligible until a determination is made; and the remaining two are ineligible. Background research also identified nine NRHP-listed resources within a 10-mi (16km) radius of the facility; however, none are located within the boundaries of the GGNS property.

As noted in Section 2.2.10.1, the area near where the Grand Gulf Mound was located has high potential for subsurface archaeological deposits. Additionally, areas on the property could have historic resources related to the Grand Gulf town site or the Civil War battles that took place on and near the GGNS property. Because the GGNS property has been surveyed for historic and archaeological resources, it is likely that the undiscovered resources would be subsurface deposits.

Entergy currently has no planned changes or ground-disturbing activities associated with license renewal at GGNS. However, given the high potential for the discovery of additional historic and archaeological resources at GGNS, Entergy has formal guidelines in its *Environmental Reviews and Evaluations Nuclear Management Manual* (EN-EV-115) for protecting archaeological resources. The procedure advises Entergy staff on consulting with the appropriate SHPO, and the NRC, as applicable, before ground-disturbing activities take place at GGNS. An additional procedure (EN-EV-121) requires work to be stopped if evidence of a historical or archaeological artifact is found during ground disturbance. The vegetation management plan for transmission lines, however, does not specifically mention vegetation maintenance near cultural resources (AM-ERS-FAC-001). Entergy could minimize any possible effects to cultural resources found within transmission line corridors by adding procedures for maintenance near cultural resources. GGNS also is governed by Mississippi State burial law, which requires a work stoppage if human remains are unexpectedly uncovered.

Based on the review of Mississippi SHPO files for the region, published literature, and information Entergy and consulting parties provided, the staff concludes that the potential impact from license renewal of GGNS on historic or archaeological resources is SMALL, and there would be no adverse effect on historic properties as specified in 36 CFR 800.4(d)(1). Entergy could further reduce any potential effect to historic and archaeological resources at the GGNS site by referencing its formal guidelines for protecting historic and archaeological resources in its vegetation management plan.

4.10.7 Environmental Justice

As described in Section 1.4 of this SEIS, the NRC has approved a revision to its environmental protection regulation, 10 CFR Part 51. With respect to environmental justice concerns, the revision amends Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51 by adding a new Category 2 issue, “Minority and low-income populations,” to evaluate the impacts of continued operations and any refurbishment activities during the license renewal term on minority populations and low-income populations living in the vicinity of the plant. Environmental justice was listed in Table B–1 as a concern but was not evaluated in the 1996 GEIS and therefore, is addressed in each SEIS.

Under Executive Order (EO) 12898 (59 FR 7629, February 16, 1994), Federal agencies are responsible for identifying and addressing, as appropriate, disproportionately high and adverse human health and environmental impacts on minority and low-income populations. In 2004, the Commission issued a *Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions* (69 FR 52040, August 24, 2004), which states, “The Commission is committed to the general goals set forth in EO 12898, and strives to meet those goals as part of its NEPA review process.”

The Council of Environmental Quality (CEQ) provides the following information in *Environmental Justice: Guidance Under the National Environmental Policy Act* (CEQ 1997):

> **Disproportionately High and Adverse Human Health Effects.** Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts on human health. Adverse health effects may include bodily impairment, infirmity, illness, or death. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant (as employed by NEPA) and appreciably exceeds the

risk or exposure rate for the general population or for another appropriate comparison group.

Disproportionately High and Adverse Environmental Effects. A disproportionately high environmental impact that is significant (as defined by NEPA) refers to an impact or risk of an impact on the natural or physical environment in a low-income or minority community that appreciably exceeds the environmental impact on the larger community. Such effects may include ecological, cultural, human health, economic, or social impacts. An adverse environmental impact is an impact that is determined to be both harmful and significant (as employed by NEPA). In assessing cultural and aesthetic environmental impacts, impacts that uniquely affect geographically dislocated or dispersed minority or low-income populations or American Indian tribes are considered.

The environmental justice analysis assesses the potential for disproportionately high and adverse human health or environmental effects on minority populations and low-income populations that could result from the operation of GGNS during the renewal term. In assessing the impacts, the following definitions of minority individuals and populations and low-income population were used (CEQ 1997):

- **Minority individuals.** Individuals who identify themselves as members of the following population groups: Hispanic or Latino, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, or two or more races, meaning individuals who identified themselves on a Census form as being a member of two or more races (e.g., Hispanic and Asian).
- **Minority populations.** Minority populations are identified when (1) the minority population of an affected area exceeds 50 percent or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.
- **Low-income population.** Low-income populations in an affected area are identified with the annual statistical poverty thresholds from the Census Bureau's Current Population Reports, Series P60, on Income and Poverty.

4.10.7.1 Minority Population

According to 2010 Census data, 53.2 percent of the population residing within a 50-mi (80-km) radius of GGNS identified themselves as minority individuals. The largest minority group was Black or African American (51.3 percent), followed by Hispanic or Latino (of any race) (2.0 percent) (CAPS 2012).

According to 2010 Census data, minority populations in the socioeconomic region of influence (ROI) (Claiborne, Hinds, Jefferson, and Warren Counties) comprised 69.4 percent of the total four-county population (see Table 2–12). Figure 4–1 shows minority population block groups, using 2010 Census data for race and ethnicity, within a 50-mi (80-km) radius of GGNS.

Census block groups were considered minority population block groups if the percentage of the minority population within any block group exceeded 53.2 percent (the percent of the minority population within the 50-mi [80-km] radius of GGNS). A minority population exists if the percentage of the minority population within the block group is meaningfully greater than the minority population percentage in the 50-mi (80-km) radius. Approximately 144 of the 294 census block groups located within the 50-mi (80-km) radius of GGNS were determined to have meaningfully greater minority populations.

Minority population block groups are concentrated on the east side of the Mississippi River and include the census block group containing GGNS. According to the 2010 Census, approximately 85.4 percent of the Port Gibson population identified themselves as minority.

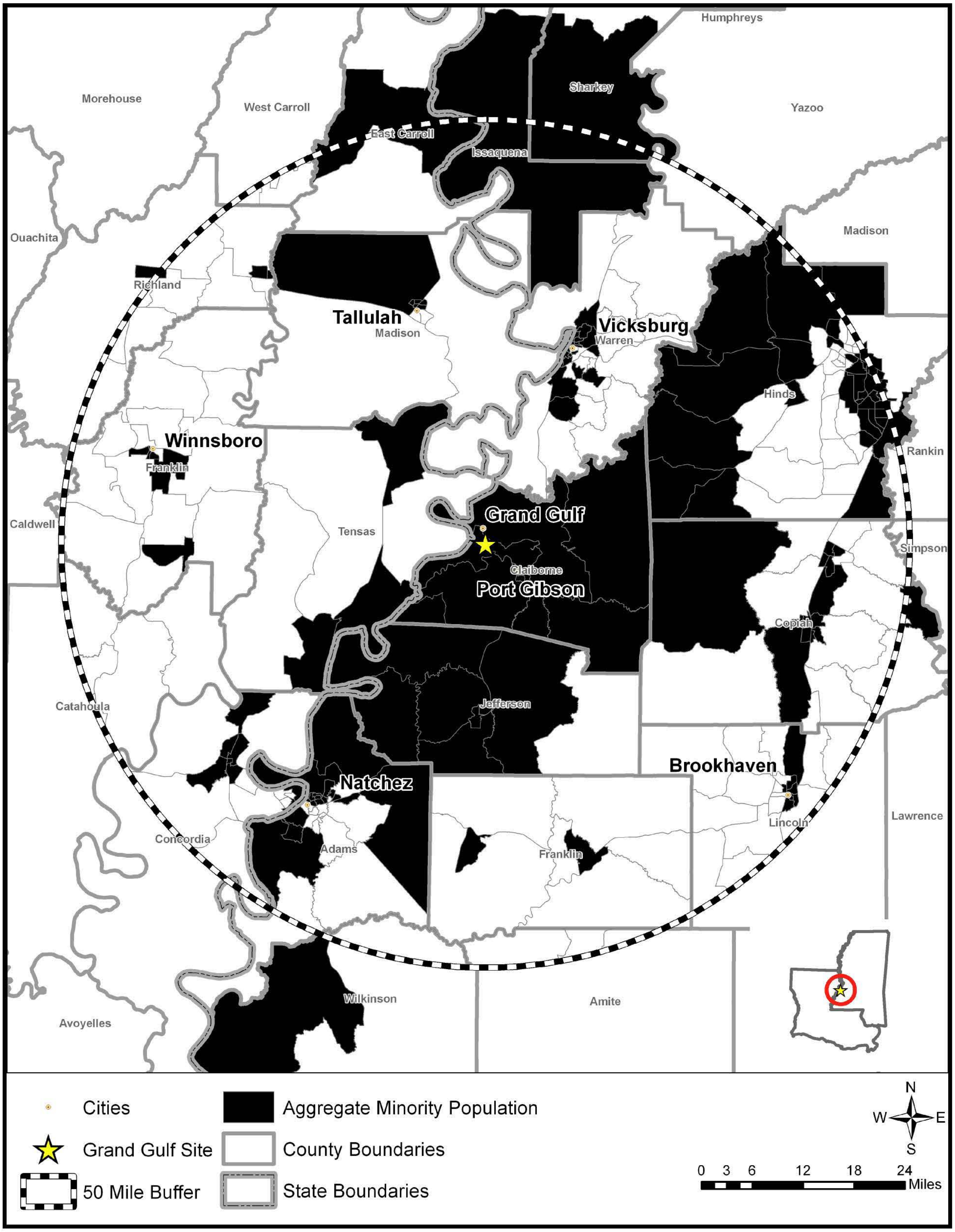
4.10.7.2 Low-Income Population

According to 2010 American Community Survey Census data, an average of 16.3 percent of families and 21.1 percent of individuals residing in the 24 counties within a 50-mi (80-km) radius of GGNS were identified as living below the Federal poverty threshold in 2010. The 2010 Federal poverty threshold was $22,314 for a family of four (USCB 2012).

According to the 2010 Census, 16.7 percent of families and 21.2 percent of individuals in Mississippi were living below the Federal poverty threshold in 2010, and the median household income for Mississippi was $37,881 (USCB 2012). Claiborne and Jefferson Counties had lower median household incomes and higher percentages of families and individuals living in poverty compared to State averages. Hinds and Warren Counties had higher median incomes when compared to the State average. Claiborne County had a median household income average of $24,150 and 35.0 percent of individuals and 27.6 percent of families living below the poverty level. Hinds County had a median household income average of $39,215 and 22.5 percent of individuals and 17.7 percent of families living below the poverty level. Jefferson County had a median household income of $24,304 and 39.0 percent of individuals and 29.3 percent of families living below the poverty level. Warren County had a median household income average of $40,404 and 21.4 percent of individuals and 16.5 percent of families living below the poverty level (USCB 2012).

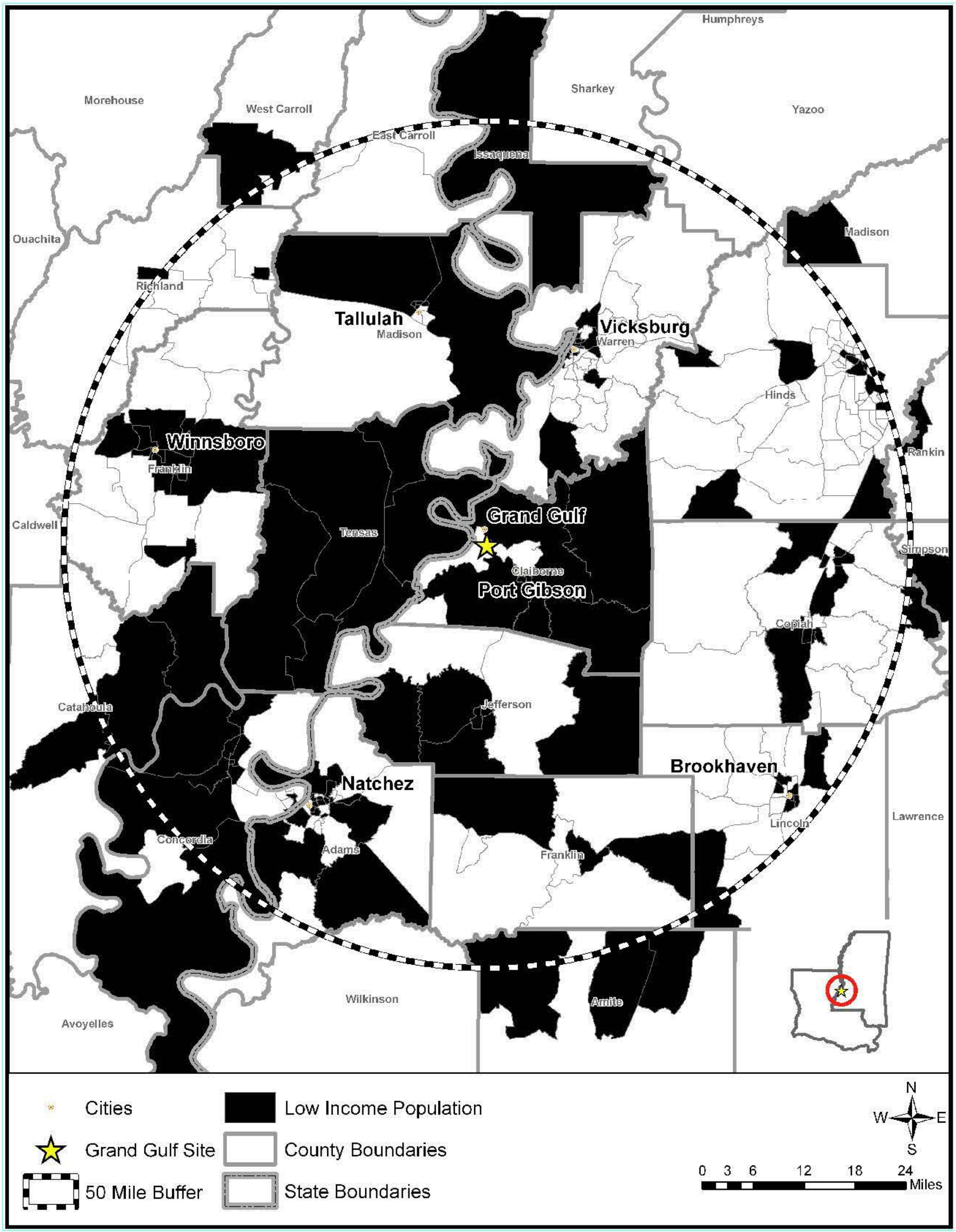
Figure 4–2 shows low-income census block groups within a 50-mi (80-km) radius of GGNS. Census block groups were considered low-income population block groups if the percentage of individuals living below the Federal poverty threshold within any block group exceeded the percent of the individuals living below the Federal poverty threshold within the 50-mi (80-km) radius of GGNS. Approximately 120 of the 294 census block groups located within the 50-mi (80-km) radius of GGNS were determined to have meaningfully greater low-income populations.

1 **Figure 4–1. 2010 Census Minority Block Groups Within a 50-mi Radius of GGNS**



2 Source: USCB 2012

1 **Figure 4–2. 2010 Census Low-Income Block Groups Within a 50-mi Radius of GGNS**



2 Source: USCB 2012

Low-income block groups are distributed across the 50-mi (80-km) radius area around GGNS, with no particular concentrations. The nearest low-income population to GGNS is located in Port Gibson, Mississippi, and several other low-income block groups are in close proximity to GGNS.

4.10.7.3 Analysis of Impacts

The NRC addresses environmental justice matters for license renewal through (1) identifying the location of minority and low-income populations that the continued operation of the nuclear power plant may affect during the license renewal term, and (2) determining whether there would be any potential human health or environmental effects to these populations and special pathway receptors, and (3) determining if any of the effects may be disproportionately high and adverse.

Figures 4–1 and 4–2 identify the location of minority and low-income block group populations residing within a 50-mi (80-km) radius of GGNS. This area of impact is consistent with the impact analysis for public and occupational health and safety, which also focuses on populations within a 50-mi (80-km) radius of the plant. Chapter 4 presents the assessment of environmental and human health impacts for each resource area. The analyses of impacts for all environmental resource areas indicated that the impact from license renewal would be SMALL.

Potential impacts to minority and low-income populations (including migrant workers or Native Americans) mostly would consist of socioeconomic and radiological effects; however, radiation doses from continued operations during the license renewal term are expected to continue at current levels and would remain within regulatory limits. Chapter 5 of this SEIS discusses the environmental impacts from postulated accidents that might occur during the license renewal term, which include both design-basis and severe accidents. In both cases, the staff has generically determined that impacts associated with design-basis accidents are SMALL because nuclear plants are designed and operated to successfully withstand such accidents, and the probability weighted impact risks associated with severe accidents also were SMALL.

Therefore, based on this information and the analysis of human health and environmental impacts presented in Chapters 4 and 5 of this SEIS, there would be no disproportionately high and adverse impacts to minority and low-income populations from the continued operation of GGNS during the license renewal term.

4.10.7.4 Subsistence Consumption of Fish and Wildlife

As part of addressing environmental justice concerns associated with license renewal, the staff also assessed the potential radiological risk to special population groups (such as migrant workers or Native Americans) from exposure to radioactive material received through their unique consumption and interaction with the environment. These include subsistence consumption of fish, native vegetation, surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of airborne radioactive material released from the plant during routine operation. This analysis is presented below.

The special pathway receptors analysis is an important part of the environmental justice analysis because consumption patterns may reflect the traditional or cultural practices of minority and low-income populations in the area, such as migrant workers or Native Americans.

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

The following is a summary discussion of the staff's evaluation from Section 4.9.2 of the radiological environmental monitoring programs that assess the potential impacts for subsistence consumption of fish and wildlife near the GGNS site.

Entergy has an ongoing comprehensive REMP to assess the impact of GGNS operations on the environment. To assess the impact of nuclear power plant operations, samples are collected annually from the environment and analyzed for radioactivity. A plant effect would be indicated if the radioactive material detected in a sample was significantly larger than background levels. Two types of samples are collected. The first type, control samples, are collected from areas beyond the measurable influence of the nuclear power plant or any other nuclear facility. These samples are used as reference data to determine normal background levels of radiation in the environment. These samples are then compared with the second type of samples, indicator samples, collected near the nuclear power plant. Indicator samples are collected from areas where any contribution from the nuclear power plant will be at its highest concentration. These samples are then used to evaluate the contribution of nuclear power plant operations to radiation or radioactivity levels in the environment. An effect would be indicated if the radioactivity levels detected in an indicator sample were significantly larger than the control sample or background levels.

Samples of environmental media are collected from the aquatic and terrestrial pathways in the vicinity of GGNS. The aquatic pathways include groundwater, surface water, drinking water, fish, and shoreline sediment. The terrestrial pathways include airborne particulates and food products (i.e., broad leaf vegetation). During 2011, analyses performed on samples of environmental media at GGNS showed no significant or measurable radiological impact above background levels from site operations (Entergy 2012a).

Based on the radiological environmental monitoring data from GGNS, the staff finds that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of water, local food, fish, and wildlife.

4.11 Evaluation of New and Potentially Significant Information

The staff has not identified new and significant information on environmental issues related to operation during the renewal term. The staff also determined that information provided during the public comment period did not identify any new issue that requires site-specific assessment. The staff reviewed the discussion of environmental impacts associated with operation during the renewal term in the GEIS and has conducted its own independent review, including a public involvement process (e.g., public meetings) to identify issues with new and significant information.

New and significant information is 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 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 accordance with 10 CFR 51.53(c), the ER that the applicant submits must provide an analysis of the Category 2 issues in Table B–1 of 10 CFR Part 51, Subpart A, Appendix B. Additionally, it must discuss actions to mitigate any adverse impacts associated with the proposed action and environmental impacts of alternatives to the proposed action. In accordance with 10 CFR 51.53(c)(3), the ER does not need to contain an analysis of any Category 1 issue unless there is new and significant information on a specific issue.

The NRC also has a process for identifying new and significant information. That process is described in NUREG–1555, Supplement 1, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal* (NRC 1999b, 2013b). The search for new information includes:

- review of an applicant's ER and the process for discovering and evaluating the significance of new information,
- review of public comments,
- review of environmental quality standards and regulations,
- coordination with Federal, State, and local environmental protection and resource agencies, and
- review of the technical literature.

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

4.12 Cumulative Impacts

As described in Section 1.4 of this SEIS, the NRC has approved a revision to its environmental protection regulation, 10 CFR Part 51. With respect to cumulative impacts, the revision amends Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51 by adding a new Category 2 issue, "Cumulative impacts," to evaluate the potential cumulative impacts of license renewal.

The staff considered potential cumulative impacts in the environmental analysis of continued operation of GGNS during the renewed license term. Cumulative impacts may result when the environmental effects associated with the proposed action are overlaid or added to temporary or permanent effects associated with other past, present, and reasonably foreseeable actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. It is possible that an impact that may be SMALL by itself could result in a MODERATE or LARGE cumulative 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.

For the purposes of this cumulative analysis, past actions are those before the receipt of the license renewal application. Present actions are those related to the resources at the time of current operation of the power plant, and future actions are those that are reasonably foreseeable through the end of plant operation including the period of extended operation. Therefore, the analysis considers potential impacts through the end of the current license terms as well as the 20-year license renewal term. The geographic area over which past, present, and reasonably foreseeable actions would occur is dependent on the type of action considered and is described below for each resource area.

To evaluate cumulative impacts, the incremental impacts of the proposed action, as described in Sections 4.1–4.10, are combined with other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. The staff used the information provided in the ER, responses to requests for additional information; information from other Federal, State, and local agencies; scoping comments, and information gathered during the audit at the GGNS site to identify other past, present, and reasonably foreseeable actions.

To be considered in the cumulative analysis, the staff determined if the project would occur within the noted geographic areas of interest and within the period of extended operation, if it was reasonably foreseeable, and if there would be potential overlapping effect with the proposed project. For past actions, consideration within the cumulative impacts assessment is resource and project specific. In general, the effects of past actions are included in the description of the affected environment in Chapter 2, which serves as the baseline for the cumulative impacts analysis. However, past actions that continue to have an overlapping effect on a resource potentially affected by the proposed action are considered in the cumulative analysis. Other actions and projects that were noted during this review and considered in the cumulative impact analysis are described below:

- modification and management of the Mississippi River basin
- construction of fossil-fuel power plant(s) to meet regional electricity demands
- climate change
- increased agricultural activities
- maintenance of transmission line crossings through the Homochitto National Forest
- continued operation of independent spent fuel storage installation (ISFSI) at GGNS

Additionally, NRC prepared an FEIS in 2006 in response to an application for an early site permit (ESP) for the construction and operation of a new nuclear power plant at GGNS (NRC 2006). On April 5, 2007, the NRC issued an ESP for the GGNS site. In 2008, Entergy submitted an application for a combined license for a new boiling-water reactor at GGNS, designated as Unit 3. However, in January 2009, Entergy informed the NRC that it was considering alternate reactor design technologies and requested the NRC suspend its review effort until further notice. Accordingly, the construction of Unit 3 at GGNS is considered a reasonably foreseeable future action and is included in the cumulative impacts assessment (NRC 2006).

4.12.1 Air Quality

This section addresses the direct and indirect effects of license renewal on air quality when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. In evaluating the potential impacts on air quality associated with license renewal, the NRC staff uses as its baseline the existing air quality conditions described in Section 2.2.2.1 of this SEIS. These baseline conditions encompass the existing air quality conditions (EPA's National Ambient Air Quality Standard (NAAQS) county designations) potentially affected by air emissions from continued operations. As described in Section 2.2.2.1, the Mobile (Alabama)-Pensacola-Panama City (Florida)-Southern Mississippi Interstate Air Quality Control Region (AQCR) (40 CFR 81.68), which encompasses GGNS, is designated as an attainment area for all criteria pollutants except for part of De Soto County, Mississippi, which is designated as a marginal nonattainment area for the 2008 8-hour ozone standard and is located about 200 miles (322 km) north-northeast of GGNS. Other nearby nonattainment areas include the Birmingham area in Alabama for $PM_{2.5}$ and the Houston-Galveston-Brazoria area in Texas for 8-hour ozone, located about 240 mi (386 km) east-northeast and west-southwest of GGNS, respectively. The nearest maintenance area for 8-hour ozone is located about 90 mi (145 km) south of GGNS.

Currently, GGNS is operating under a "synthetic minor" permit, which covers site-wide combustion emission sources, such as diesel generators, fire water pump engines, and cooling towers (GGNS 2008a). GGNS operations are in compliance with its air permit and Entergy has no plans for refurbishments or other license renewal-related construction activities that would affect permitted operations for the license renewal term (Entergy 2011a). Annual emissions of criteria pollutants, volatile organic compounds (VOCs), and hazardous air pollutants (HAPs) at GGNS vary from year to year but are well below the plant's permitted "synthetic minor" emissions limits (see Table 2–1), based on actual operating hours reported to MDEQ. Considering the distances to the nearest nonattainment and maintenance areas around GGNS, prevailing wind directions, and the minor nature of air emissions from GGNS, emissions from GGNS operations are not anticipated to affect current attainment or maintenance area status. Accordingly, air emissions from continued operation of the plant and associated effects on ambient air quality would not be expected to change during the license renewal term.

As discussed in Section 2.2.2.1, operations at GGNS release greenhouse gas (GHG) emissions as follows: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) from fuel combustion; hydrofluorocarbons (HFCs) in the two plant cooling water chillers; and sulfur hexafluoride (SF_6) in three electric disconnect switches. Perfluorocarbons (PFCs) currently are not used at GGNS. Combustion-related GHG emissions (such as CO_2, CH_4, and N_2O) at GGNS are minor. The permitted combustion sources are designed for efficiency and operated intermittently throughout the year (i.e., often only for testing and preventive maintenance). Other combustion-related GHG emission sources at GGNS include commuter, visitor, support, and delivery vehicle traffic within, to, and from the plant. In addition, small amounts of HFCs and SF_6 are released into the atmosphere during normal operations or at various stages of the equipment's life cycle. Total annual GHG emissions from the GGNS site were estimated to be about 5,980 tons CO_{2e} (5,425metric tons CO_{2e}) in 2011 (GGNS 2012a; EPA 2011b), which is well below the EPA's mandatory reporting threshold of 25,000 metric tons CO_2e per year (74 FR 56264).

To estimate the amount of GHG releases potentially avoided by continued GGNS operation, its electricity generation can be compared to an equivalent amount of electricity generation in fossil-fuel power plant(s). For 2009, the composite CO_{2e} emission factor (representing an average of all operating fossil-fuel power plants) is approximately 1,107 lb/MWh for the Mississippi Valley subregion (EPA 2012a). GGNS generates approximately 11,500 GWh per year, at 1,475 MWe and a capacity factor of 89 percent based on a 2007–2009 average (Entergy 2011a). Thus, GGNS's generating capacity avoids the release of approximately 6.4 million tons (5.8 million metric tons) of CO_{2e}. This is approximately 23.5 percent of the 27.0 million tons (24.5 million metric tons) CO_{2e} emitted by fossil fuel electricity generation in Mississippi in 2009 (EPA 2012a). This also equals about 0.08 percent of total U.S. GHG emissions of 7,520 million tons (6,822 million metric tons) CO_{2e}, in 2010 (EPA 2012b).

The Intergovernmental Panel on Climate Change (IPCC 2011) also estimated GHG emission factors during the life cycle of nuclear power plants along with other renewable and conventional power generation technologies. Estimated median GHG emission factors of 16 g CO_{2e}/kWh for nuclear energy are comparable to those for renewable energy (ranging from 4 g CO_{2e}/kWh for hydropower to 46 g CO_{2e}/kWh for photovoltaic solar energy) but far lower than those for fossil fuel energy (ranging from 469 g CO_2e/kWh for natural gas to 1,001 g CO_2e/kWh for coal).

Entergy did not report any foreseeable projects that could contribute to cumulative impacts to air quality (Entergy 2011a). If a project with the potential to affect air quality did occur, permitting and licensing requirements would limit its impact. The review of the GGNS Unit 3 combined license (COL) application is currently on hold. However, if the facility were to be built in the future, impacts on air quality that may result from construction will be temporary. The impacts of construction on air quality would be from ground-clearing, grading and excavation activities that raise dust, emissions from construction equipment, and emissions resulting from construction workforce transportation. The impacts of operation on air quality would be from releases to the environment of heat and moisture from the cooling towers, emissions from operation of auxiliary equipment, and emissions from the workforce. The operation of Unit 3 would have air emissions similar to those of the existing GGNS plant. NRC (2006) concluded that the impacts of construction and operation of a proposed unit would be SMALL.

As discussed in Section 2.2.2, patterns of ambient temperature and precipitation at Jackson International Airport generally are increasing slowly based on data from 1960 to 2011 (NCDC 1990, 2012). Recent research on climate change effects in the United States done by the U.S. Global Change Research Program (USGCRP), a Federal Advisory Committee (USGCRP 2009), was considered in preparation of this document. In the near term (2010–2029 projected average change), which includes the first 5 years of the period of extended operation, the temperatures around GGNS are projected to rise an additional 2–3 °F (1.1–1.7 °C), compared to the recent past (1961–1979). In 2040–2059, which includes the last 5 years of the period of extended operation, the temperatures around GGNS are projected to rise an additional 3–4 °F (1.7–2.2 °C) compared to the recent past. Over the past 50 years, average precipitation around GGNS has increased about 5–10 percent. Future changes in total precipitation are more difficult to project than those in temperatures, but models generally predict that in the Southeast region of the United States, encompassing GGNS, precipitation rates will decrease in winter, spring, and summer relative to current precipitation rates (USGCRP 2009). During the past 50 years, more severe weather, such as tornadoes and severe thunderstorms, has been reported. This increase is widely believed to be due to improvements in monitoring technologies such as Doppler radars combined with changes in population and increasing public awareness. Considering these factors, there is no clear trend in the frequency or strength of tornadoes since the 1950s in the United States as a whole. The power and frequency of Atlantic hurricanes has increased in recent decades, and the intensity of these storms is likely to increase in this century. However, an increase in the frequency of hurricanes making landfall has not been observed in recent decades; therefore, there may not necessarily be an increase in the number of these storms that make landfall in the future (USGCRP 2009). Changes in hurricanes are difficult to project because many countervailing forces are involved.

Given that there is no planned site refurbishment associated with the GGNS license renewal and, therefore, no additional air emissions beyond those noted in Section 2.2.2.1 from continued operations of GGNS, the incremental impacts to cumulative air quality impacts near GGNS would be SMALL. Although not identified, other reasonably foreseeable projects could result in cumulative impacts to air quality. However, permitting and licensing requirements and various mitigation measures likely would limit air quality impacts such that air quality continues to meet applicable air quality standards.

Based on the above discussion, the staff concludes that combined with the emissions from other past, present, and reasonably foreseeable future actions, cumulative impacts on ambient air quality and global climate change from operations at GGNS would be SMALL.

4.12.2 Water Resources

This section addresses the direct and indirect effects of license renewal on water resources when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. The geographic area considered in the cumulative aquatic resources analysis includes the vicinity of GGNS, including the Mississippi River basin near GGNS. As described in Sections 4.4 and 4.5, the incremental impacts on water resources from continued operation of GGNS during the license renewal term would be SMALL.

4.12.2.1 Cumulative Impacts on Surface Water Resources

The review of the GGNS Unit 3 COL application is currently on hold. However, this facility, if built in the future, has the potential to influence surface water use and availability within the geographic area. NRC (2006) determined that the normal makeup flow rate of the new nuclear facility would be approximately 3,175 L/s (50,320 gpm), and the maximum expected makeup flow would be 5,400 L/s (85,000 gpm). In addition, approximately 25 percent of this water would be returned to the Mississippi River as blowdown. NRC (2006) concluded that a new nuclear unit would withdraw only a small amount of water relative to the total river flow (about 0.2 percent) at even the lowest minimum river discharge conditions recorded for the area. Climate patterns and increased water demands upstream of GGNS, also may increase the number of water users and rate of withdrawal from the Mississippi River (Caffey et al. 2002). Continued regulation of the flow by the U.S. Army Corps of Engineers is expected to preserve the course and flow of the Mississippi River. Building and operating a new nuclear unit and other activities beyond GGNS would not be expected to noticeably alter water resources within the Mississippi River because the Mississippi River is an abundant source of surface water.

Similar to surface water use and availability, the proposed new nuclear unit at GGNS has potential to influence surface water quality within the geographic area considered because the proposed new unit would discharge into the Mississippi River. However, the flow of water in the Mississippi River is so large that a new reactor is unlikely to change the river's basic water quality. As discussed in Section 4.12.3.2, historically the Mississippi River has experienced decreased water quality from other land-use activities such as agriculture, industrial development, and urban sprawl. However, with the implementation of the Clean Water Act, the water quality of the past few decades has progressively improved. In addition, the proposed new units and other water discharges in the area would obtain and comply with its NPDES permit, which would define the limits of certain chemical and thermal properties of the discharge.

Therefore, the staff concludes that the cumulative impact on the site's surface water use and quality are SMALL.

4.12.2.2 Cumulative Impacts on Groundwater Resources

Activities that could potentially impact groundwater use in the area of interest include public water supply companies, the construction and operating of the proposed new nuclear reactor, and continued operations of GGNS. Most groundwater users outside of the GGNS site obtain their water from public water supply companies that get their water from deep aquifers (Catahoula Aquifer and deeper aquifer). The public water supply companies distribute the water to customers via buried pipes and this operation is expected to continue for the reasonably foreseeable future. The existing unit and the new nuclear unit proposed in the COL application (review currently on hold) at GGNS have the potential to influence groundwater use within the geographic area considered. However, it is expected the future reactor would not consume groundwater from the deep underlying aquifers (GGNS 2008a) used by the public water supply companies, similar to the existing unit at GGNS. Instead, makeup water and potable water for the new reactor would be drawn from groundwater near surface aquifers that either have a direct or indirect hydraulic connection to the Mississippi River. These aquifers near GGNS are not connected to the deep aquifers. In addition, abundant water supplies exist from the deeper aquifer accessed by the water supply companies to supply the needs of other future land-use activities in the area.

Activities that could potentially impact groundwater quality in the area of interest include the construction and operation of the proposed new nuclear reactor, continued operations of GGNS, and other land use actions that could result in contaminants reaching groundwater. However, the groundwater quality of aquifers used as a source of public water is not likely to be noticeably altered by present and future activities at GGNS or in the region. This is due to the large thickness of low permeability geologic deposits that overly (i.e. protect) these aquifers from surface contaminants. In addition, as discussed in Section 2.2.5, the EPA has identified the Catahoula Aquifer as a sole source aquifer and will work to protect the deep groundwater resources from contamination from projects that receive federal financial assistance. As such, the MDEQ’s Wellhead Protection Program will manage potential present and future sources of contamination that are located near public water supply wells that obtain water from the Catahoula Aquifer. No activities have been identified at or near GGNS that could impact the quality of the Catahoula and deeper aquifers. These regulatory programs are expected to continue to protect groundwater quality from future land-use activities.

Therefore, the staff concludes that the cumulative impact on the site’s ground water use and quality are SMALL.

4.12.3 Aquatic Resources

This section addresses the direct and indirect effects of license renewal on aquatic resources, including protected aquatic species, when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. The cumulative impact is the total effect on the aquatic resources of all actions taken, no matter who has taken the actions. The geographic area considered in the cumulative aquatic resources analysis includes the vicinity of GGNS, including the Mississippi River basin near GGNS and on site aquatic features such as Hamilton and Gin Lakes, the borrow pit, three small ponds, streams “A” and “B,” and ephemeral drainages. Consistent with other agencies use of the term “baseline” and CEQ’s NEPA guidance, the term “baseline” pertains to the condition of the resource without the action, i.e., under the no-action alternative. Under the no action alternative, the plant would shut down and the resource would conceptually return to its condition without the plant (which is not necessarily the same as the condition before the plant was constructed). The baseline, or benchmark, for assessing cumulative impacts on aquatic resources takes into account the pre-operational environment as recommended by the EPA (1999) for its review of NEPA documents:

> Designating existing environmental conditions as a benchmark may focus the environmental impact assessment too narrowly, overlooking cumulative impacts of past and present actions or limiting assessment to the proposed action and future actions. For example, if the current environmental condition were to serve as the condition for assessing the impacts of relicensing a dam, the analysis would only identify the marginal environmental changes between the continued operation of the dam and the existing degraded state of the environment. In this hypothetical case, the affected environment has been seriously degraded for more than 50 years with accompanying declines in flows, reductions in fish stocks, habitat loss, and disruption of hydrologic functions. If the assessment took into account the full extent of continued impacts, the significance of the continued operation would more accurately express the state of the environment and thereby better predict the consequences of relicensing the dam.

Sections 2.2.6 and 2.2.8 present an overview of the conditions of the Mississippi River basin near GGNS and the history and factors that led to its current condition. Since the 1700s, efforts to control flooding and increase navigation along the Mississippi River have changed the relative abundance of various habitats within the river. In addition, levees have decreased the connectivity of aquatic life within floodplain habitats and the Mississippi River because of the decrease in flooding events when biota can move in between floodplain habitats and the river. In addition to physical changes to aquatic habitat, runoff has led to habitat degradation and decreased water quality. Land use changes within the Mississippi River basin have introduced new industrial and chemical inputs into the river (Brown et al. 2005). The introduction of non-native species also has threatened many protected, native species near GGNS. As described in Section 2.2.6.2, the staff compared aquatic surveys from 1972 through 1974 with surveys from 2006 through 2008 (FishNet 2012). Of the 25 species recorded in the earlier surveys, 8 species (32 percent) were collected and 17 species (68 percent) were not collected in the later surveys (FishNet 2012). These results indicate that many species that once inhabitated the Mississippi River may no longer exist near GGNS.

Many natural and human activities can influence the current and future aquatic life in the area surrounding GGNS. Potential biological stressors include continued potential thermal stress from GGNS as described in Section 4.8.2.5; modifications to the Mississippi River; runoff from industrial, agricultural, and urban areas; other water users and dischargers; and, climate change, as described in Section 4.12.3.4.

4.12.3.1 Modifications to the Mississippi River

The relative abundance of hard substrate, deep channel, and river bank habitat has been largely influenced by human activities to decrease flooding events and increase navigability. The U.S. Army Corps of Engineers (USACE) and Mississippi River Commission continue to oversee a comprehensive river management program that includes:

- levees for containing flood flows;
- floodways for the passage of excess flows past critical reaches of the Mississippi River;
- channel improvement and stabilization to provide an efficient and reliable navigation channel, increase the flood-carrying capacity of the river, and protect the levee system; and,
- tributary basin improvements for major drainage basins to include dams and reservoirs, pumping plants, auxiliary channels and pumping stations (MRC 2012).

Implementing this management program will continue to affect the relative availability of aquatic habitats, resulting in, for example, a decrease in the amount of soft sediment river bank habitat and an increase in the amount of hard substrates (e.g., riprap or other materials used to line the river bank). Consequently, invertebrates that depend on a hard surface for attachment, and can colonize human-made materials, such as tires, concrete, or riprap used to line river banks, likely will continue to increase in relative abundance as compared to species that require soft sediments along the river bank.

The Mississippi River Commission also implements various programs to support the sustainability of aquatic life within the Mississippi River. For example, the Davis Pond and Caernarvon freshwater diversion structures divert more than 18,000 ft^3/s (510 m^3/s) of fresh water to coastal marshlands. The input of freshwater helps to preserve the marsh habitat and reduce coastal land loss (MRC 2012). In addition, the Mississippi River Commission conducted research and determined that using grooved articulated concrete mattresses to line river banks can help support benthic invertebrate and fish populations. For example, using grooved articulated concrete mattresses increases larval insect production, which is an important source of prey for many fish (MRC 2012).

4.12.3.2 Runoff from Industrial, Agricultural, and Urban Areas

Nearly 40 percent of the land within the contiguous United States drains into the Mississippi River. Land use changes and industrial activities within this area have had a substantial impact on aquatic habitat and water quality within the Mississippi River. For example, historically, the Mississippi River has experienced decreased water quality as a result of industrial discharges, agricultural runoff, municipal sewage discharges, surface runoff from mining activity, and surface runoff from municipalities. However, over the past few decades, water quality within the Mississippi River has improved because of the implementation of the Clean Water Act and other environmental regulations (Caffey et al. 2002). For example, most of the older, first-generation chlorinated insecticides have been banned since the late 1970s. Similarly, the addition and upgrading of numerous municipal sewage treatment facilities, rural septic systems, and animal waste management systems have helped to significantly decrease the concentration of median fecal coliform bacteria in the Mississippi River (Caffey et al. 2002). Despite the trend of improving water quality within the Mississippi River, trace levels of some contaminants and increased nutrients from agricultural lands remain a source of concern for aquatic life (Caffey et al. 2002; Rabalais et al. 2009).

4.12.3.3 Other Water Users and Discharges

Several other currently existing and proposed facilities withdraw water from the Mississippi River. For example, Entergy previously proposed to build a new nuclear reactor at the GGNS site, which would withdraw water from the Mississippi River as a source of cooling water (NRC 2006). In addition, climate patterns and increased water demands upstream of GGNS also may increase the number of water users and rate of withdrawal from the Mississippi River (Caffey et al. 2002). Aquatic life, especially threatened and endangered species, rely on sufficient flow within streams and rivers to survive. Also, fish and other aquatic life could be impinged and entrained within the new nuclear unit and other facility water intake systems. Entergy proposed to use a closed-cycle cooling system, which would minimize impingement and entrainment (NRC 2006). In addition, as described in Section 4.12.3.1, continued regulation of the flow by the U.S. Army Corps of Engineers is expected to preserve the course and flow of the Mississippi River. Building and operating a new nuclear unit and other activities beyond GGNS would not be expected to noticeably alter aquatic resources within the Mississippi River.

A new reactor at GGNS and other water users along the Mississippi River also would discharge cooling water and other effluents into the Mississippi River. NRC (2006) considered the impacts to aquatic resources from discharge of heated effluent (e.g., water temperature, dissolved oxygen, thermal stratification, impact to fauna), cold shock, and chemical treatment of the cooling water and determined that the effluent would not noticeably alter aquatic resources. Additionally, Entergy and other water dischargers would be required to comply with NPDES permits that must be renewed every 5 years, allowing MDEQ to ensure the permit limits provide the appropriate level of environmental protection.

4.12.3.4 Climate change

Climate change could noticeably alter aquatic resources near GGNS. In the southeastern United States, precipitation during the fall has increased 30 percent from 1901 to 2007 and the overall amount of heavy downpours also has increased (USGCRP 2009). Heavy downpours can increase the rate of runoff and pollutants reaching the Mississippi River because the heavier precipitation, and the pollutants washed away in the runoff, have less time to be absorbed in the soil before reaching the river and other surface waterbodies. Climate change models predict continued increases in heavy downpours in the southeastern United States.

Climate models also predict increasing temperatures in the southeast, especially during spring and summer (USGCRP 2009). Increased temperatures and nutrients in runoff could lead to a decline in oxygen within small streams, lakes, and shallow aquatic habitats. During periods of low oxygen, many fish and other aquatic life may not be able to survive. Increased temperatures also may increase the frequency of shellfish-borne illness, alter the distribution of native fish, increase the local loss of threatened and endangered species, and increase the displacement of native species by non-native species (USGCRP 2009).

Since the 1970s, there has been an increase in the amount of moderate to severe drought, especially during spring and summer. Climate models predict a continued increase in the amount and severity of droughts, which can lead to water use conflicts (USGCRP 2009). Regulatory programs will be required to ensure sufficient water and flow is available within surface waterbodies to provide habitat for aquatic life, especially threatened and endangered species.

4.12.3.5 Conclusion

The direct and indirect impacts to aquatic resources from historical Mississippi River modifications and pollutants and sediments introduced into the river have had a substantial effect on aquatic life and their habitat. The incremental impacts from GGNS are SMALL for aquatic resources because GGNS operation would have minimal impacts on aquatic life due to use of a closed-cycle cooling system and Ranney wells. The cumulative stress from the activities described above, spread across the geographic area of interest depends on many factors that the NRC staff cannot quantify. This stress may noticeably alter some aquatic resources. For example, climate change may increase the temperature of the Mississippi River and rate of runoff into the river. This may noticeably alter the habitat for species most sensitive to nutrient loading, high levels of contaminants, and higher temperatures. In addition, a comparison of fish surveys from 1972 through 1974 and from 2006 through 2008 suggests that some species no longer inhabitate the Mississippi River near GGNS (FishNet 2012). Therefore, the staff concludes that the cumulative impacts from the proposed license renewal and other past, present, and reasonably foreseeable projects would be MODERATE.

4.12.4 Terrestrial Resources

This section addresses past, present, and future actions that could result in cumulative impacts on the terrestrial species and habitats described in Section 2.2.7, including protected terrestrial species. For purposes of this analysis, the geographic area considered in the evaluation includes the GGNS site and the in-scope transmission line corridors. As explained for aquatic resources, the baseline for this assessment is the condition of the resource without the action, i.e., under the no-action alternative.

4.12.4.1 Historic Conditions

Section 2.2.7 discusses the ecoregions in which the GGNS site lies—the Mississippi Valley Alluvial Plain and Mississippi Valley Loess Plain. This region consists of irregular plains with a thick layer of highly erodible loess deposits, oak-hickory and oak-hickory-pine forests, and streams with low gradients and silty substrates. When GGNS was built, forests and agriculture were the dominant land types. Between 1973 and 2000, agricultural lands decreased by 6.8 percent, while developed land increased by 4.0 percent (USGS 2001). Forested land remained relatively constant and accounted for 43 to 44 percent of land cover over the time period (USGS 2001).

On the immediate site, Mississippi Power & Light Company cleared about 270 ac (109 ha) of upland habitat for GGNS buildings and related infrastructure. The terrestrial habitats on the undeveloped portions of the site have not changed significantly since GGNS's construction (Entergy 2011a). The two primary habitat changes between preconstruction and present day are in the bottomland scrub-shrub wetlands (east of Gin Lake) and the upland open fields and clearings, in which Entergy has planted American sycamore (*Platanus occidentali*) and loblolly pine (*Pinus taeda*), respectively.

4.12.4.2 GGNS Unit 3

The review of the GGNS Unit 3 COL application is currently on hold. However, if the facility were to be built in the future, Entergy (2011a) anticipates that onsite land disturbance would be primarily limited to previously disturbed areas of the site. GGNS Unit 3 may require the construction of new transmission lines. The impacts from such construction would vary depending on the types of habitat the lines would cross and whether such transmission lines are routed along existing transmission line corridors. Terrestrial resource impacts resulting from operation of GGNS Unit 3 would be similar to impacts of operation of GGNS and would be SMALL.

4.12.4.3 Agricultural Runoff

Within Claiborne County, 531 ac (126,073 ha) of land were used for cultivation of major crops as of 2006 (NRC 2006). The 2000 National Water Quality Inventory reported that agricultural nonpoint source pollution accounted for the second largest source of impairments to wetlands (EPA 2012a). Fertilizers and pesticides can affect wetlands and bottomlands in a variety of ways. Because wetlands and bottomlands are often at lower elevation than surrounding land, these habitats receive much of the runoff first, and that runoff persists because it is unable to drain to lower ground. This can result in bioaccumulation of pollutants and changes to species composition and abundance. Species that rely on wetlands, such as birds and amphibians, are more sensitive to these environmental stressors than other animal groups.

4.12.4.4 National Forests

The Franklin transmission line crosses through the Homochitto National Forest to the southeast of the GGNS site. This national forest will continue to provide valuable habitat to native wildlife and migratory birds during the proposed license renewal period. As habitat fragmentation resulting from various types of development increases, these areas will become ecologically more important because they will provide large areas of natural habitat.

4.12.4.5 Climate Change

Since 1970, the average annual temperature in the southeastern United States has risen by about 2 °F (1.1 °C) and the number of freezing days has declined by 4 to 7 days per year (USGCRP 2009). Over the next several decades, the U.S. Global Change Research Program (USGCRP 2009) estimates that the average temperatures in the region will rise by an additional 4.5 °F (2.5 °C). The Gulf Coast states, including Mississippi, will have less rainfall in winter and spring, and higher temperatures will increase the frequency, duration, and intensity of drought. Hurricane intensity also will likely increase (USGCRP 2009). Changes in the climate will shift many wildlife population ranges and alter migratory patterns. Such changes could favor non-native invasive species and promote population increases of insect pests and plant pathogens. Climate change will likely alter the severity or frequency of precipitation, flooding, and fire. Climate change may also exacerbate the effects of existing stresses in the natural environment, such as those caused by habitat fragmentation, invasive species, nitrogen deposition and runoff from agriculture, and air emissions.

4.12.4.6 Conclusion

Section 4.7 of this SEIS concludes that the impact from the proposed license renewal would not noticeably alter the terrestrial environment, and, thus, would be SMALL. However, as environmental stressors such as agricultural runoff and climate change continue over the proposed license renewal term, certain attributes of the terrestrial environment (such as species diversity and distribution) are likely to noticeably change. The staff does not expect these impacts to destabilize any important attributes of the terrestrial environment because such impacts will cause gradual change, which should allow the terrestrial environment to appropriately adapt. The staff concludes that the cumulative impacts of the proposed license renewal of GGNS plus other past, present, and reasonably foreseeable future projects or actions would result in MODERATE impacts to terrestrial resources.

4.12.5 Human Health

The NRC and EPA have developed radiological dose limits for protection of the public and workers to address the cumulative impact of acute and long-term exposure to radiation and radioactive material. These dose limits are codified in 10 CFR Part 20 and 40 CFR Part 190. For the purpose of this analysis, the area within a 50-mi (80-km) radius of GGNS was included. The radiological environmental monitoring program Entergy conducted in the vicinity of the GGNS site measures radiation and radioactive materials from all sources (i.e., hospitals and other licensed users of radioactive material); therefore, the monitoring program measures cumulative radiological impacts. There currently are no other nuclear power reactors or uranium fuel cycle facilities within the 50-mi (80-km) radius of the GGNS site.

Radioactive effluent and environmental monitoring data for the 5-year period from 2008 to 2012 were reviewed as part of the cumulative impacts assessment. In Section 4.9.1 of this SEIS, the staff concluded that impacts of radiation exposure to the public and workers (occupational) from operation of GGNS during the renewal term are SMALL. The NRC and the State of Mississippi would regulate any future actions in the vicinity of the GGNS site that could contribute to cumulative radiological impacts.

Entergy constructed an independent spent fuel storage installation (ISFSI) on the GGNS site in 2000 for the storage of its spent fuel. The installation and monitoring of this facility is governed by NRC requirements in 10 CFR Part 72, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor–Related Greater Than Class C Waste.” Radiation from this facility, as well as from the operation of GGNS, is required to be within the radiation dose limits in 10 CFR Part 20, 40 CFR Part 190, and 10 CFR Part 72. The NRC carries out periodic inspections of the ISFSI to verify its compliance with its licensing and regulatory requirements.

In September 2010, Entergy applied to the NRC for an extended power uprate (EPU). In July 2012, the NRC issued an amendment approving the power increase (NRC 2012j). The staff considered the environmental impacts of the EPU in this evaluation.

As discussed in Section 4.12, review of the application for the proposed new nuclear reactor designated as GGNS Unit 3 is on hold. However, GGNS Unit 3 is considered in the cumulative impacts section since it is a reasonable and foreseeable future action.

The cumulative radiological impacts from GGNS Unit 1, the ISFSI, and the proposed GGNS Unit 3, would be required to meet the radiation dose limits in 10 CFR Part 20 and 40 CFR Part 190. For these reasons, the staff concludes that cumulative radiological impacts would be SMALL.

4.12.6 Socioeconomics

This section addresses socioeconomic factors that have the potential to be affected directly or indirectly by changes in operations at GGNS in addition to the aggregate effects of other past, present, and reasonably foreseeable future actions. The primary geographic area of interest considered in this cumulative analysis is Claiborne, Hinds, Jefferson, and Warren Counties where approximately 81 percent of GGNS employees reside (see Table 2–7). This is where the economy, tax base, and infrastructure most likely would be affected since GGNS workers and their families reside, spend their income, and use their benefits within these counties.

As discussed in Section 4.10 of this SEIS, continued operation of GGNS would have no impact on socioeconomic conditions in the region during the license renewal term beyond what is already being experienced. Since Entergy has no plans to hire additional non-outage workers during the license renewal term, overall expenditures and employment levels at GGNS are expected to remain relatively unchanged with no additional or increased demand for permanent housing and public services. In addition, since employment levels and tax payments would not change, there would be no population or tax revenue-related land use impacts. Based on this and other information presented in Chapter 4 of this SEIS, there would be no contributory effect from the continued operation of GGNS on socioeconomic conditions in the region beyond what is currently being experienced. The only cumulative contributory effects would come from the other planned activities in the region independent of GGNS operations. Therefore, the staff concludes that the cumulative socioeconomic impacts would be SMALL.

4.12.6.1 Environmental Justice

The environmental justice cumulative impact analysis assesses the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from past, present, and reasonably foreseeable future actions including GGNS operations during the renewal term. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts or risk of impact on the natural or physical environment in a minority or low-income community that are significant and appreciably exceed the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been identified in resource areas presented in Chapter 4 of this SEIS. Minority and low-income populations are subsets of the general public residing in the area and all would be exposed to the same hazards generated from GGNS operations. As previously discussed in this chapter, the impact from license renewal for all resource areas (e.g., land, air, water, ecology, and human health) would be SMALL.

As discussed in Section 4.10.7 of this SEIS, there would be no disproportionately high and adverse impacts to minority and low-income populations from the continued operation of GGNS during the license renewal term. Since Entergy has no plans to hire additional non-outage workers during the license renewal term, employment levels at GGNS are expected to remain relatively unchanged with no additional or increased demand for housing or increased traffic. Based on this information and the analysis of human health and environmental impacts presented in Chapters 4 and 5, it is not likely there would be any disproportionately high and adverse contributory effect on minority and low-income populations from the continued operation of GGNS during the license renewal term.

4.12.7 Historic and Archaeological Resources

This section addresses the direct and indirect effects of license renewal on historic and cultural resources, in and around GGNS, when added to the aggregate effects of other past, present, and reasonably foreseeable actions. Section 2.2.10 discusses the cultural background and known historic and archaeological resources in and around GGNS.

As described in Section 4.10.6, the NRC staff concluded that license renewal would have a SMALL impact on historic and cultural resources at GGNS. However, any future ground-disturbing maintenance and operations activities during the license renewal term could affect undiscovered historic and archaeological resources. In addition, future construction and operation of a new nuclear power plant site at GGNS would have the potential to result in impacts on cultural resources through inadvertent discovery during ground-disturbing activities. Future urbanization near GGNS could also affect historic and archaeological resources.

Given the high potential for historic and archaeological resources to be present at GGNS, as well as the existing historic and archaeological resources presented in Section 2.2.10.2, GGNS has procedures regarding protection of cultural resources. Any ground-disturbing maintenance and operations activities during the GGNS license renewal term or construction of a new nuclear power plant would be reviewed in accordance with these procedures. These procedures are designed to ensure that investigations and consultations are conducted as needed and that existing or potentially existing cultural resources are adequately protected. Should historic or archaeological resources be encountered during construction, work would cease until Entergy environmental personnel would perform an evaluation and consider possible mitigation measures through consultation with the Mississippi SHPO. Any future urbanization that might directly or indirectly affect historic or archaeological resources (i.e. inadvertent discovery, viewshed impacts) would be required to comply with applicable State and Federal laws regarding protection of cultural and archaeological resources, and any impacts would be mitigated accordingly.

Based on this information, the NRC staff finds that the continued operation of GGNS during the license renewal term would not incrementally contribute to cumulative impacts on historic and archaeological resources within GGNS and in the surrounding area. Therefore, the cumulative impact on historic and archaeological resources during the license renewal term would be SMALL.

4.12.8 Summary of Cumulative Impacts

The staff considered the potential impacts resulting from the operation of GGNS during the period of extended operation and other past, present, and reasonably foreseeable future actions near GGNS. The preliminary determination is that the potential cumulative impacts would range from SMALL to LARGE, depending on the resource. Table 4–10 summarizes the cumulative impacts on resources areas.

Table 4–10. Summary of Cumulative Impacts on Resource Areas

Resource area	Cumulative impact
Air Quality	Considering the distances to the nearest nonattainment and maintenance areas around GGNS, prevailing wind directions, and the minor nature of air emissions from GGNS, emissions from GGNS operations are not anticipated to affect current attainment or maintenance area status. Accordingly, air emissions from continued operation of the plant and associated impacts on ambient air quality would not be expected to change during the license renewal term. Based on the above discussion, the NRC staff concludes that combined with the emissions from other past, present, and reasonably foreseeable future actions, cumulative impacts on ambient air quality and global climate change from operations at GGNS would be SMALL.
Water Resources	The watersheds contributing flow to the two streams on the GGNS site are nearly contained within the site, and the remaining drainage area outside the site area would not be expected to change significantly. Therefore, changes in surface water supply outside the site would not alter the surface water conditions of the site's two streams. No activity at the GGNS site by itself, nor other activities outside the site, would be expected to alter fundamentally the character of the Mississippi River. The cumulative impacts from past, present, and reasonably foreseeable future actions on surface water resources during the license renewal term would be SMALL. In the region around GGNS, public water is obtained from deep underlying aquifers. Past, present and future activities at the GGNS site have not and will not use these aquifers as a source of water. Throughout the region, the groundwater quality of the deep underlying aquifers is protected from land-use activities by thick layers of low permeability geologic deposits and by government regulatory programs. The cumulative impact on groundwater use will be SMALL because abundant good water quality groundwater is and will continue to be readily available for public use. Based on the above considerations, the cumulative impacts from past, present, and reasonably foreseeable future actions on groundwater resources during the license renewal term would be SMALL.
Aquatic Ecology	The direct and indirect impacts to aquatic resources from historical Mississippi River modifications and pollutants and sediments introduced into the river have had a substantial effect on aquatic life and their habitat. The incremental impacts from GGNS are SMALL for aquatic resources because GGNS uses a closed-cycle cooling system and Ranney wells. The cumulative stress from the activities described in Section 4.12.3, spread across the geographic area of interest depends on many factors that NRC staff cannot quantify. This stress may noticeably alter some aquatic resources. The cumulative impacts from the proposed license renewal and other past, present, and reasonably foreseeable projects would be MODERATE.
Terrestrial Ecology	The NRC staff examined the cumulative effects of the construction of GGNS, agricultural runoff, nearby parks and conservation areas, and climate change. The NRC staff concludes that the minimal terrestrial impacts of continued GGNS operations would not contribute to the overall decline in the condition of terrestrial resources. The NRC staff believes that the cumulative impacts of other and future actions during the term of license renewal on terrestrial habitat and associated species, when added to past, present, and reasonably foreseeable future actions, would be MODERATE.

Resource area	Cumulative impact
Human Health	The radiological dose limits for protection of the public and workers have been developed by the NRC and EPA to address the cumulative impact of acute and long-term exposure to radiation and radioactive material. The NRC and the State of Mississippi would regulate any future actions in the vicinity of the GGNS site that could contribute to cumulative radiological impacts. In addition, the cumulative radiological impacts from operation of GGNS, the ISFSI, and a projected additional reactor unit would be required to meet the radiation dose limits in 10 CFR Part 20 and 40 CFR Part 190. For these reasons, cumulative radiological impacts would be SMALL.
Socioeconomics	As discussed in Section 4.10, continued operations during the license renewal term would have no impact on socioeconomic conditions in the region beyond those already being experienced. In addition, there would be no disproportionately high and adverse impacts to minority and low-income populations from the continued operations during the license renewal term. The cumulative effects on socioeconomic conditions and environmental justice populations in the region from past, present, and reasonably foreseeable future actions including continued operations combined with other planned activities in the region is not expected to increase appreciably beyond what is currently being experienced. Therefore, cumulative socioeconomic impacts would be SMALL.
Cultural Resources	As discussed in Section 4.10.6 of this SEIS, continued operation of GGNS during the license renewal term is likely to have a SMALL impact on historical or archaeological resources. Any future ground-disturbing activities may affect undiscovered historic and archaeological resources; however, any such activity would be reviewed in accordance with Entergy procedures designed to adequately protect historic and archaeological resources. Future urbanization would be governed by appropriate State and Federal laws to mitigate impacts on historic and archaeological resources. Therefore, the cumulative impacts on historic and archaeological resources during the license renewal term would be SMALL.

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5.0 ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

This chapter describes environmental impacts from postulated accidents that might occur during the period of extended operation. The term “accident” refers to any unintentional event outside the normal plant operational envelope that results in a release or the potential for release of radioactive materials into the environment. Two classes of postulated accidents are evaluated in NUREG–1437, *Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants* (NRC 1996). These are design-basis accidents (DBAs) and severe accidents.

5.1 Design-Basis Accidents

To receive U.S. Nuclear Regulatory Commission (NRC) approval to operate a nuclear power facility, an applicant for an initial operating license must submit a safety analysis report (SAR) as part of its application. The SAR presents the design criteria and design information for the proposed reactor and comprehensive data on the proposed site. The SAR also discusses various hypothetical accident situations and the safety features that are provided to prevent and mitigate accidents. The NRC staff reviews the application to determine whether the plant 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 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 Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, “Domestic Licensing of Production and Utilization Facilities,” and 10 CFR Part 100, “Reactor Site Criteria.”

The environmental impacts of DBAs are evaluated during the initial licensing process, and the ability of the plant to withstand these accidents is demonstrated to be acceptable before issuance of the operating license. The results of these evaluations are found in licensee documentation, such as the applicant’s final safety analysis report, the safety evaluation report, the final environmental statement, and Section 5.1 of this supplemental environmental impact statement. A licensee is required to maintain the acceptable design and performance criteria throughout the life of the plant, including any extended-life operation. The consequences for these events are evaluated for the hypothetical maximum 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 the period of extended operation, the environmental impacts, as calculated for DBAs, should not differ significantly from initial licensing assessments over the life of the plant, including the period of extended operation. Accordingly, the design of the plant relative to DBAs during the period of extended operation is considered to remain acceptable, and the environmental impacts of those accidents were not examined further in the GEIS.

The Commission has determined that the environmental impacts of DBAs are of SMALL significance for all plants because the plants were designed to successfully withstand these accidents. Therefore, for the purposes of license renewal, DBAs are designated as a Category 1 issue (Table 5–1). The early resolution of the DBAs makes 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, “Matters Not Subject to Renewal Review,” is not subject to review under license renewal.

Table 5–1. Issues Related to Postulated Accidents

Issue	Category
Design-basis accidents	1
Severe accidents	2

Two issues related to postulated accidents are evaluated under the National Environmental Policy Act in the license renewal review, design-basis accidents, and severe accidents.

No new and significant information related to DBAs was identified during the review of the Entergy Operations, Inc., (Entergy) Environmental Report (ER) (Entergy 2011) or evaluation of other available information. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS.

5.2 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. In the GEIS, the NRC staff 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.

Severe accidents initiated by external phenomena such as tornadoes, floods, earthquakes, fires, and sabotage have not traditionally been discussed in quantitative terms in final environmental statements and were not specifically considered for the Grand Gulf Nuclear Station (GGNS) site in the GEIS (NRC 1996). However, the GEIS did evaluate existing impact assessments performed by the NRC and by the industry at 44 nuclear plants in the United States and concluded that the risk from beyond-design-basis earthquakes at existing nuclear power plants is SMALL. The GEIS for license renewal performed a discretionary analysis of terrorist acts in connection with license renewal and concluded that the core damage and radiological release from such acts would be no worse than the damage and release expected from internally initiated events. In the GEIS, the Commission concludes that the probability-weighted consequences of severe accidents are SMALL and, additionally, that the risks from other external events are adequately addressed by a generic consideration of internally initiated severe accidents (NRC 1996).

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.

The NRC staff identified no new and significant information related to postulated accidents during the review of Entergy’s ER (Entergy 2011, 2012c) or evaluation of other available information. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. However, in accordance with 10 CFR 51.53(c)(3)(ii)(L), the NRC staff has reviewed severe accident mitigation alternatives (SAMAs) for GGNS. The results of the review are discussed in Section 5.3.

5.3 Severe Accident Mitigation Alternatives

If the NRC 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, 10 CFR 51.53(c)(3)(ii)(L) requires that license renewal applicants consider alternatives to mitigate severe accidents. 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 previously been considered for GGNS; therefore, the remainder of Chapter 5 addresses those alternatives.

5.3.1 Overview of SAMA Process

This section presents a summary of the results of the SAMA evaluation for GGNS conducted by Entergy, as described in Attachment E of Entergy's ER (Entergy 2011, 2012c), the NRC staff's review of Entergy's SAMA evaluation provided in detail in Appendix F, and associated requests for additional information (RAIs) issued by the NRC staff and responses from Entergy (Entergy 2012a, 2012b, 2012c, 2012d). The NRC staff performed its review with contract assistance from the Center for Nuclear Waste Regulatory Analyses.

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

In the second step, Entergy 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.

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

In the fourth step, Entergy compared the cost and benefit of each of the remaining SAMAs to determine whether the SAMA was cost-beneficial, meaning the benefits of the SAMA were greater than the cost (a positive cost-benefit ratio). Finally, the four potentially cost-beneficial SAMAs are evaluated to determine if they are in the scope of license renewal, i.e., are they subject to aging management.

5.3.2 Estimate of Risk

Entergy submitted an assessment of SAMAs for the GGNS as part of the ER (Entergy 2011, 2012c). The assessments were based on the most recent GGNS PRA available at that time, a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer code, and insights from the GGNS individual plant examination (IPE) (Entergy 1992) and individual plant examination of external events (IPEEE) (Entergy 1995).

Entergy combined two distinct analyses to form the basis for the risk estimates used in the SAMA analysis: (1) the GGNS Level 1 and 2 PRA model, and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PRA model) developed specifically for the SAMA analysis. The SAMA analysis is based on the most recent GGNS

Level 1 and Level 2 PRA model available at the time of the ER, referred to as the 2010 extended power uprate (EPU) model.

The GGNS core damage frequency (CDF) is approximately 2.9×10^{-6} per reactor year as determined from quantification of the Level 1 PRA model with the revised Level 2 model. This value was used as the baseline CDF in the SAMA evaluations (Entergy 2012c, 2012d). The CDF is based on the risk assessment for internally initiated events, which includes internal flooding. Entergy did not explicitly include the contribution from external events within the GGNS risk estimates; however, it did account for external event impacts on the potential risk reduction associated with SAMA implementation by multiplying the estimated risk reduction for internal events by a factor of 11. This is discussed further in Sections F.2.2 and F.6.2. Using the calculated risk reduction as a quantitative measure of the potential benefit from SAMA implementation, Entergy performed a cost-benefit comparison, as described in Section 5.3.5.

The breakdown of CDF by initiating event is provided in Table 5–2. As shown in this table, loss of offsite power and power conversion system available transient are the dominant contributors to the CDF. Not listed explicitly in Table 5–2 because multiple initiators contribute to their occurrence, station blackouts contribute about 37 percent (1.1×10^{-6} per reactor year) of the total CDF, while anticipated transients without scram contribute about 0.2 percent (4.4×10^{-9} per reactor year) to the total CDF (Entergy 2012c).

The Level 2 PRA model that forms the basis for the GGNS SAMA evaluation is essentially a new model and reflects power uprate conditions. The Level 2 model uses containment event trees (CETs) containing both phenomenological and systemic events. The Level 1 core damage sequences are binned into accident classes (or plant damage states) that provide the interface between the Level 1 and Level 2 CET analysis. The CETs are linked directly to the Level 1 event trees, and CET nodes are evaluated using subordinate trees and logic rules.

Table 5–2. GGNS Core Damage Frequency (CDF) for Internal Events

Initiating Event	CDF (per year)	% CDF Contribution
Loss of Offsite Power Initiator	1.2×10^{-6}	40
Power Conversion System Available Transient	5.9×10^{-7}	20
Loss of Power Conversion System Initiator	2.5×10^{-7}	8
Loss of Condensate Feed Water Pumps	2.3×10^{-7}	8
Loss of Instrument Air	1.4×10^{-7}	5
Closure of Main Steam Isolation Valves (Initiator)	1.2×10^{-7}	4
Loss of Service Transformer 21	1.2×10^{-7}	4
Large Loss of Coolant Accident (LOCA)	9.7×10^{-8}	3
Loss of Service Transformer 11	8.3×10^{-8}	3
Loss of Alternating Current Division 2 Initiator	6.2×10^{-8}	2
Other Initiating Events[1]	3.3×10^{-8}	1
Loss of Alternating Current Division 1 Initiator	2.7×10^{-8}	1
Intermediate LOCA	1.4×10^{-8}	1
Total CDF (Internal Events)	$\mathbf{2.9 \times 10^{-6}}$	**100**

[1] Multiple initiating events, with each contributing 0.3 percent or less

The CET considers the influence of physical and chemical processes on the integrity of the containment and on the release of fission products once core damage has occurred. The quantified CET sequences are binned into a set of end states that are subsequently grouped into 13 release categories (or release modes) that provide the input to the Level 3 consequence analysis. The frequency of each release category was obtained by summing the frequency of the individual accident progression CET endpoints binned into the release category. Source terms were developed for the release categories using the results of Modular Accident Analysis Program (MAAP 4.0.6) computer code calculations. From these results, source terms were chosen to be representative of the release categories. The results of this analysis for GGNS are provided in the revised Table E.1-9 of ER Attachment E (Entergy 2012c).

Entergy computed offsite consequences for potential releases of radiological material using the MACCS2 Version 1.13.1 code and analyzed exposure and economic impacts from its determination of offsite and onsite risks. Inputs for these analyses include plant-specific and site-specific input values for core radionuclide inventory, source term and release characteristics, site meteorological data, projected population distribution and growth within a 50-mile (80-kilometer) radius, emergency response evacuation modeling, and local economic data. Radionuclide inventory in the reactor core is based on a plant-specific evaluation and corresponds to that for the extended power uprate to 4,408 megawatts thermal (Entergy 2011). The estimation of onsite impacts (in terms of cleanup and decontamination costs and occupational dose) is based on guidance in NUREG/BR–0184, *Regulatory Analysis Technical Evaluation Handbook* (NRC 1997).

In the ER, the applicant estimated the dose risk to the population within 80 kilometers (50 miles) of the GGNS site to be 0.00609 person-sieverts (Sv) per year (0.609 person-roentgen equivalent in man (rem) per year) (Entergy 2012c). The breakdown of the population dose risk and offsite economic cost risk by containment release mode is summarized in Table 5–3. Medium releases provide the greatest contribution, totaling approximately 67 percent of the population dose risk and 75 percent of the offsite economic cost risk for all timings. High early (H/E) releases alone contribute only about 10 percent, and high releases for all timings contribute 17 percent of the population dose risk.

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

5.3.3 Potential Plant Improvements

Entergy's process for identifying potential plant improvements (SAMAs) consisted of the following elements:

- review of industry documents and consideration of other plant-specific enhancements not identified in published industry documents
- review of potential plant improvements identified in the GGNS IPE and IPEEE
- review of potential modifications for the risk-significant events in the current GGNS PRA Levels 1 and 2 models

Table 5–3. Base Case Mean Population Dose Risk and Offsite Economic Cost Risk for Internal Events

Release Mode		Population Dose Risk[1]		Offsite Economic Cost Risk	
ID[2]	Frequency (per year)	person-rem/yr	% Contribution	$/yr	% Contribution
H/E	1.0×10^{-7}	6.2×10^{-2}	10	$1.7 \times 10^{+2}$	11
H/I	1.2×10^{-8}	6.2×10^{-3}	1	$1.7 \times 10^{+1}$	1
H/L	9.2×10^{-8}	3.8×10^{-2}	6	$9.6 \times 10^{+1}$	6
M/E	3.7×10^{-7}	1.7×10^{-1}	28	$4.8 \times 10^{+2}$	32
M/I	1.8×10^{-7}	1.2×10^{-1}	20	$3.3 \times 10^{+2}$	22
M/L	3.0×10^{-7}	1.2×10^{-1}	19	$3.2 \times 10^{+2}$	21
L/E	4.1×10^{-9}	4.0×10^{-4}	<0.1	3.0×10^{-1}	<0.1
L/I	3.6×10^{-8}	1.2×10^{-2}	2	$2.7 \times 10^{+1}$	2
L/L	4.4×10^{-7}	7.8×10^{-2}	13	$7.4 \times 10^{+1}$	5
LL/E	2.2×10^{-9}	7.9×10^{-7}	<0.1	1.0×10^{-3}	<0.1
LL/I	2.1×10^{-9}	3.8×10^{-7}	<0.1	9.7×10^{-4}	<0.1
LL/L	7.1×10^{-9}	2.0×10^{-3}	<1	3.4×10	<1
NCF	1.4×10^{-6}	5.0×10^{-4}	<0.1	6.4×10^{-1}	<0.1
		6.1×10^{-1}	100	**$1.5 \times 10^{+3}$**	100

[1] Unit Conversion Factor: 1 Sv = 100 rem

[2] Release Mode Nomenclature (Magnitude/Timing)

Magnitude:

High (H) – Greater than 10 percent release fraction for Cesium Iodide

Medium (M) – 1 to 10 percent release fraction for Cesium Iodide

Low (L) – 0.1 to 1 percent release fraction for Cesium Iodide

Low-low (LL) – Less than 0.1 percent release fraction for Cesium Iodide

No containment failure (NCF) – Much less than 0.1 percent release fraction for Cesium Iodide

Timing:

Early (E) – Less than 4 hours

Intermediate (I) – 4 to 24 hours

Late (L) – Greater than 24 hours

Based on this process, Entergy identified an initial set of 249 candidate SAMAs, referred to as Phase I SAMAs. In Phase I of the evaluation, Entergy performed a qualitative screening of the initial list of SAMAs and eliminated SAMAs from further consideration using the following criteria:

- the SAMA modified features not applicable to GGNS.
- the SAMA has already been implemented at GGNS.
- the SAMA is similar in nature and could be combined with another SAMA candidate.

Based on this screening, 60 of the Phase I SAMA candidates were screened out because they were not applicable to GGNS, 98 candidates were screened out because they had already been implemented at GGNS, and 28 candidates were screened out because they were similar in nature and could be combined with another SAMA candidate. Thus, a total of 186 SAMAs were eliminated, leaving 63 SAMAs for further evaluation. The results of the Phase I screening analysis for each SAMA candidate were provided in a response to an NRC staff RAI (Entergy 2012a). The remaining SAMAs, referred to as Phase II SAMAs, are listed in Table E.2–2 of Attachment E to the ER in the original submittal (Entergy 2011) and in the revised analysis (Entergy 2012c). In Phase II, a detailed evaluation was performed for each of the 63 remaining SAMA candidates.

The NRC staff concludes that Entergy used a systematic and comprehensive process for identifying potential plant improvements for GGNS, and that the set of SAMAs evaluated in the ER, together with those evaluated in response to NRC staff inquiries, is reasonably comprehensive and, therefore, acceptable. This search included reviewing insights from the GGNS plant-specific risk studies that included internal initiating events, as well as fire, seismic, and other external initiated events, and reviewing plant improvements considered in previous SAMA analyses.

5.3.4 Evaluation of Risk Reduction and Costs of Improvements

In the ER, the applicant evaluated the risk-reduction potential of the 63 SAMAs that were not screened out in the Phase I analysis and retained for the Phase II evaluation. The SAMA evaluations were performed using generally conservative assumptions.

Except for two SAMAs associated with internal fires, Entergy used model re-quantification to determine the potential benefits for each SAMA. The CDF, population dose, and offsite economic cost reductions were estimated using the GGNS 2010 EPU PRA model for the nonfire SAMAs. The changes made to the model to quantify the impact of SAMAs are detailed in Section E.2.3 of Attachment E to the ER (Entergy 2011). Bounding evaluations (or analysis cases) were performed to address specific SAMA candidates or groups of similar SAMA candidates. For the two fire-related SAMAs (SAMA Nos. 54 and 55), the benefit was determined by assuming the CDF contribution for the fire area impacted by the SAMA was reduced to zero and that the resulting benefit was determined by the product of the fraction of the internal events total CDF represented by the fire area CDF and the maximum total internal events benefit.

For the SAMAs determined to be potentially cost-beneficial, Table 5–4 lists the assumptions considered to estimate the risk reduction, the estimated risk reduction in terms of percent reduction in CDF, population dose risk and offsite economic cost risk, and the estimated total benefit (present value) of the averted risk. The estimated benefits reported in Table 5–4 reflect the combined benefit in both internal and external events. The determination of the benefits for the various SAMAs is further discussed in Section F.6.

Entergy estimated the costs of implementing the 63 Phase II SAMAs through the use of other licensees' estimates for similar improvements and the development of site-specific cost estimates, where appropriate. Information on the assumptions, risk reduction, estimated total benefit, and implementation costs for the 63 Phase II SAMAs is presented in Table F–5.

Table 5–4. Severe Accident Mitigation Alternatives Cost-Benefit Analysis for GGNS. Percentage Risk Reductions are Presented for Core Damage Frequency (CDF), Population Dose Risk (PDR), and Offsite Economic Cost Risk (OECR)

Analysis Case, Analysis Assumption, Individual SAMA, and Cost Estimate		% Risk Reduction			Internal and External Benefit	Internal and External Benefit with Uncertainty
		CDF	PDR	OECR		
Case 28. Increase Availability of Containment Heat Removal *Assumption: Eliminates failure of cooled flow from residual heat removal pump A and B* SAMA No. 39—Procedural change to cross-tie open cycle cooling system to enhance containment spray system	$25,000	17.8%	45.6%	50.2%	$297,000	$892,000
Case 30. Increase Availability of the Condensate Storage Tank *Assumption: Eliminates failure of high pressure core spray and reactor core isolation cooling suction* SAMA No. 42—Enhance procedures to refill condensate storage tank from demineralized water or service water system	$200,000	4.4%	12.6%	13.5%	$77,000	$231,000
Case 43. Increase Recovery Time of Emergency Core Cooling System Upon Loss of Standby Service Water *Assumption: Eliminates failure of standby service water to the low pressure core spray room cooler* SAMA No. 59—Increase operator training for alternating operation of the low-pressure emergency core cooling system pumps (low-pressure coolant injection and low-pressure core spray) for loss of standby service water scenarios	$50,000	4.5%	5.2%	5.5%	$53,300	$160,000

Analysis Case, Analysis Assumption, Individual SAMA, and Cost Estimate		% Risk Reduction			Internal and External Benefit	Internal and External Benefit with Uncertainty
		CDF	PDR	OECR		
Case 22. Increase Availability of the Diesel Generator System through Heating, Ventilation, and Air Conditioning Improvements *Assumption: Eliminates failure of heating, ventilation, and air conditioning for diesel generator rooms*		23.9%	16.6%	12.3%	$237,000	$711,000
SAMA (Unnumbered) in Response to Request for Additional Information No. 8a—Revise procedures to direct the operator monitoring a running diesel generator to ensure that the ventilation system is running or take action to open doors or use portable fans	$50,000 to $200,000					

Entergy stated the following cost ranges were used based on the review of previous SAMA applications.

Table 5–5. Estimated Cost Ranges for SAMA Applications

Type of Change	Estimated Cost Range
Procedural only	$25K to $50K
Procedural change with engineering or training required	$50K to $200K
Procedural change with engineering and testing or training required	$200K to $300K
Hardware modification	$100K to >$1,000K

Source: Entergy 2011

Entergy stated that the GGNS site-specific cost estimates were based on the engineering judgment of project engineers experienced in performing design changes at the facility. The detailed cost estimates considered engineering, labor, materials, and support functions, such as planning, scheduling, health physics, quality assurance, security, safety, and fire watch. The estimates included a 20 percent contingency on the design and installation costs but did not account for inflation, replacement power during extended outages necessary for SAMA implementation, or increased maintenance or operation costs following SAMA implementation.

In response to an NRC staff RAI concerning the applicability of cost estimates taken directly from previous SAMA applications, Entergy stated that engineering judgment by project engineers familiar with the costs of modifications at Entergy plants was used to determine if the cited cost estimates from other SAMA analyses were valid for GGNS. If the GGNS project engineers' rough conceptual cost estimate of the modification was larger than the other plant's cost estimate, the other plant's estimate was adopted without further detailed cost analysis (Entergy 2012a).

The NRC staff reviewed the applicant's cost estimates, presented in Table E.2-2 of Attachment E to the ER in the original submittal (Entergy 2011) and as a response to NRC staff RAIs (Entergy 2012a, 2012c). For certain improvements, the NRC 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. The NRC staff concludes that, with the above clarifications, the cost estimates provided by Entergy are sufficient and appropriate for use in the SAMA evaluation.

5.3.5 Cost-Benefit Comparison

If the implementation costs for a candidate SAMA exceeded the calculated benefit, the SAMA was determined to be not cost-beneficial. If the benefit exceeded the estimated cost, the SAMA candidate was considered to be cost-beneficial. In Entergy's original submittal and revised analysis, three SAMA candidates were found to be potentially cost-beneficial (Entergy 2011, 2012c). In response to an RAI by NRC staff concerning potential low-cost alternatives, Entergy determined that a procedure revision to direct that the operator monitoring a running diesel ensure the ventilation system is running, or take action to open doors, or use portable fans would be potentially cost-beneficial (Entergy 2012a, 2012c). Results of the cost-benefit evaluation are presented in Table 5–4 for the four potentially cost-beneficial

SAMAs. Entergy initiated a condition report to evaluate these potentially cost-beneficial SAMAs within the corrective action process.

The potentially cost-beneficial SAMAs are:

- SAMA No. 39—Change procedure to cross tie open cycle cooling system to enhance containment spray system.
- SAMA No. 42—Enhance procedures to refill condensate storage tank from demineralized water or service water system.
- SAMA No. 59—Increase operator training for alternating operation of the low pressure emergency core cooling system pumps (low-pressure coolant injection and low pressure core spray) for loss of standby service water scenarios.
- SAMA (Unnumbered) in Response to RAI No. 8a—Revise procedures to direct the operator monitoring a running diesel generator to ensure that the ventilation system is running or take action to open doors or use portable fans.

A sensitivity analysis considered two cases: a discount rate of 7 percent with a 33-year period for remaining plant life and a lower (i.e., more conservative) discount rate of 3 percent with a 20-year license renewal period (Entergy 2011). Based on its sensitivity analysis, Entergy did not identify any additional cost-beneficial SAMAs. Sensitivity analysis results were recast in the revised SAMA analysis (Entergy 2012c). In response to an NRC RAI on the unexpected large increase in the sensitivity to the discount rate shown in the revised results, Entergy described that the sensitivity calculation for the lower discount rate of 3 percent inadvertently included the cumulative effect of both the longer time period of remaining plant life of 33 years and the lower discount rate (Entergy 2012d). Without the additional effect from a longer time period, increases in the benefit solely because of a lower discount rate would be smaller than those results reported by Entergy (2012c).

Individual (as well as cumulative) increases in the estimated benefits from the sensitivity parameters were smaller than the factor of 3 applied by the applicant to account for uncertainty. In the revised analysis, neither individual nor cumulative sensitivity effects resulted in benefit estimates for individual SAMAs that exceeded GGNS implementation costs beyond the SAMAs previously identified by Entergy to be potentially cost-beneficial. Based primarily on NUREG/BR–0184 (NRC 1997) and discount rate guidelines in NEI 05-01 (NEI 2005), the cost-benefit analysis performed by Entergy was consistent with the guidance. The applicant considered possible increases in benefits from analysis uncertainties on the results of the SAMA assessment. In the ER (Entergy 2011), Entergy stated that the 95th percentile value of the GGNS CDF was a factor of 2.38 greater than the mean CDF. A multiplication factor of 3 was selected by the applicant to account for uncertainty. This multiplication factor was applied in addition to a separate multiplication factor of 11 for CDF increases caused by external events. Entergy's assessment accounted for the potential risk-reduction benefits associated with both internal and external events. NRC staff considers the multipliers of 3 for uncertainty and 11 for external events provide adequate margin and are acceptable for the SAMA analysis.

5.3.6 Conclusions

Entergy considered 249 candidate SAMAs based on risk-significant contributors at GGNS from updated probabilistic safety assessment models, its review of SAMA analyses from other boiling-water reactor (BWR) plants, NRC and industry documentation of potential plant improvements, and GGNS individual plant examination of internal and external events, including available updates. Phase I screening reduced the list to 63 unique SAMA candidates by eliminating SAMAs that were not applicable to GGNS, had already been implemented at GGNS, or were combined into a more comprehensive or plant-specific SAMA.

For the remaining SAMA candidates, Entergy performed a cost-benefit analysis. Entergy's cost-benefit analysis identified three potentially cost-beneficial SAMAs (Phase II SAMA Nos. 39, 42, and 59). In response to an NRC staff RAI concerning potential low-cost alternatives, Entergy identified one additional cost-beneficial SAMA. Sensitivity cases were analyzed for the present value discount rate and time period for remaining plant life. No additional SAMAs were identified as potentially cost-beneficial from the sensitivity analysis.

NRC staff reviewed the Entergy SAMA analysis and concludes that, subject to the discussion in this chapter and Appendix F, the methods used and implementation of the methods were sound. On the basis of the applicant's treatment of SAMA benefits and costs, NRC staff finds that the SAMA evaluations performed by Entergy are reasonable and sufficient for the license renewal submittal.

The NRC staff agrees with Entergy's conclusion that four candidate SAMAs are potentially cost-beneficial, a decision based on a reasonable treatment of costs, benefits, and uncertainties. This conclusion of a small number of potentially cost-beneficial SAMAs is consistent with the low residual level of risk stated in the GGNS PRA and the fact that Entergy has already implemented the plant improvements identified from the IPE and IPEEE.

Finally, the four potentially cost-beneficial SAMAs are evaluated to determine if they are in the scope of license renewal, i.e., are they subject to aging management. This evaluation considers whether the systems, structures, and components (SSCs) associated with these SAMAs: (1) perform their intended function without moving parts or without a change in configuration or properties; and (2) that these SSCs are not subject to replacement based on qualified life or specified time period. Because the potentially cost-beneficial SAMAs do not relate to aging management during the period of extended operation, they do not need to be implemented as part of license renewal in accordance with 10 CFR Part 54. Nevertheless, Entergy issued a condition report under the corrective action process to evaluate these potentially cost-beneficial SAMAs. The NRC staff accepts this course of action.

5.4 References

[Entergy] Entergy Operations, Inc. 1992. "Individual Plant Examination (IPE) for Grand Gulf Nuclear Station Unit 1." December 1992.

[Entergy] Entergy Operations, Inc. 1995. Letter from M.J. Meisner, Entergy, to U.S. NRC Document Control Desk. Subject: "Grand Gulf Nuclear Station Docket No. 50–416 License No. NPF–29 Individual Plant Examination of External Events (IPEEE) Schedule Final Submittal." November 15, 1995 (*not publicly available*).

[Entergy] Entergy Operations, Inc. 2011. *Grand Gulf Nuclear Station, Unit 1, License Renewal Application*, *Appendix E, Applicant's Environmental Report, Operating License Renewal Stage.* Agencywide Documents Access and Management System (ADAMS) Accession No. ML11308A234.

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6.0 ENVIRONMENTAL IMPACTS OF THE URANIUM FUEL CYCLE, SOLID WASTE MANAGEMENT, AND GREENHOUSE GAS EMISSIONS

6.1 The Uranium Fuel Cycle

This section addresses issues related to the uranium fuel cycle and solid waste management during the period of extended operation (listed in Table 6–1). The uranium cycle includes uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low-level wastes and high-level wastes related to uranium fuel cycle activities. The generic potential impacts of the radiological and non-radiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes are described in detail in the Generic Environmental Impact Statement (GEIS) (NRC 1996, 1999). They are based, in part, on the generic impacts provided in Title 10, Part 51.51(b) of the *Code of Federal Regulations* (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 from One Light-Water-Cooled Nuclear Power Reactor."

Table 6–1. Issues Related to the Uranium Fuel Cycle and Solid Waste Management.

There are nine generic issues related to the fuel cycle and waste management. There are no site-specific issues.

Issues	GEIS Sections	Category
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	1
Offsite radiological impacts (collective effects)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6	1
Offsite radiological impacts (spent fuel and high-level waste disposal)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6	1
Non-radiological 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	1
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	1
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	1
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	1
Non-radiological waste	6.1; 6.5; 6.5.1; 6.5.2; 6.5.3; 6.6	1
Transportation	6.1; 6.3.1; 6.3.2.3; 6.3.3; 6.3.4; 6.6, Addendum 1	1

The NRC staff's evaluation of the environmental impacts associated with spent nuclear fuel is addressed in two issues in Table 6–1, "Offsite radiological impacts (spent fuel and high-level waste disposal)" and "Onsite spent fuel." However, as explained later in this section, the scope of the evaluation of these issues in this supplemental environmental impact statement (SEIS) has been revised. The issue, "Offsite radiological impacts (spent fuel and high-level waste disposal)," from Table 6–1 is not evaluated in this SEIS. In addition, the issue, "Onsite spent fuel" only evaluates the environmental impacts during the license renewal term.

For the term of license renewal, the NRC staff did not find any new and significant information related to the remaining uranium fuel cycle and solid waste management issues listed in Table 6–1 during its review of the GGNS environmental report (ER) (Entergy 2011), the site visit, and the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. For these Category 1 issues, the GEIS concludes that the impacts are SMALL, except for the issue, "Offsite radiological impacts (collective effects)," which the NRC has not assigned an impact level. This issue assesses the 100-year radiation dose to the U.S. population (i.e., collective effects or collective dose) from radioactive effluents released as part of the uranium fuel cycle for a nuclear power plant during the license renewal term compared to the radiation dose from natural background exposure. It is a comparative assessment for which there is no regulatory standard to base an impact level.

For the radiological impacts resulting from spent fuel and high-level waste disposal and the onsite storage of spent fuel, which will occur after the reactors have been permanently shutdown, the NRC's Waste Confidence Decision and Rule represented the Commission's generic determination that spent fuel can continue to be stored safely and without significant environmental impacts for a period of time after the end of the licensed life for operation. This generic determination meant that the NRC did not need to consider the storage of spent fuel after the end of a reactor's licensed life for operation in National Environmental Policy Act (NEPA) documents that support its reactor and spent fuel storage application reviews.

The NRC first adopted the Waste Confidence Decision and Rule in 1984. The NRC amended the decision and rule in 1990, reviewed them in 1999, and amended them again in 2010 (49 FR 34694; 55 FR 38474; 64 FR 68005; and 75 FR 81032 and 81037). The Waste Confidence Decision and Rule are codified in 10 CFR 51.23.

On December 23, 2010, the Commission published in the *Federal Register* a revision of the Waste Confidence Decision and Rule to reflect information gained from experience in the storage of spent fuel and the increased uncertainty in the siting and construction of a permanent geologic repository for the disposal of spent nuclear fuel and high-level waste (75 FR 81032 and 81037). In response to the 2010 Waste Confidence Decision and Rule, the states of New York, New Jersey, Connecticut, and Vermont—along with several other parties—challenged the Commission's NEPA analysis in the decision, which provided the regulatory basis for the rule. On June 8, 2012, the United States Court of Appeals, District of Columbia Circuit in *New York v. NRC*, 681 F.3d 471 (D.C. Cir. 2012) vacated the NRC's Waste Confidence Decision and Rule, after finding that it did not comply with NEPA.

In response to the court's ruling, the Commission, in CLI-12-16 (NRC 2012a), determined that it would not issue licenses that rely upon the Waste Confidence Decision and Rule until the issues identified in the court's decision are appropriately addressed by the Commission. In CLI-12-16, the Commission also noted that the decision not to issue licenses only applies to final license issuance; all licensing reviews and proceedings should continue to move forward.

In addition, the Commission directed, in SRM-COMSECY-12-0016 (NRC 2012b), that the NRC staff proceed with a rulemaking that includes the development of a generic environmental impact statement (EIS) to support a revised Waste Confidence Rule and to publish both the EIS and the revised decision and rule in the *Federal Register* within 24 months (by September 2014). The Commission indicated that both the EIS and the revised Waste Confidence Rule should build on the information already documented in various NRC studies and reports, including the existing environmental assessment that the NRC developed as part of the 2010 Waste Confidence Decision and Rule. The Commission directed that any additional analyses should focus on the issues identified in the court's decision. The Commission also directed that the NRC staff provide ample opportunity for public comment on both the draft EIS and the proposed rule.

The revised rule and supporting EIS are expected to provide the necessary NEPA analyses of waste confidence-related human health and environmental issues. As directed by the Commission, the NRC will not issue a renewed license before the resolution of waste confidence-related issues. This will ensure that there will be no irretrievable or irreversible resource commitments or potential harm to the environment before waste confidence impacts have been addressed.

If the results of the Waste Confidence Rule and supporting EIS identify information that requires a supplement to this SEIS, the NRC staff will perform any appropriate additional NEPA review for those issues before the NRC makes a final licensing decision.

6.2 Greenhouse Gas Emissions

This section discusses the potential impacts from greenhouse gases (GHGs) emitted from the nuclear fuel cycle. The GEIS does not directly address these emissions, and its discussion is limited to an inference that substantial carbon dioxide (CO_2) emissions may occur if coal- or oil-fired alternatives to license renewal are carried out.

6.2.1 Existing Studies

Since the development of the GEIS, the relative volumes of GHGs emitted by nuclear and other electricity generating methods have been widely studied. However, estimates and projections of the carbon footprint of the nuclear power lifecycle vary depending on the type of study done. Additionally, considerable debate also exists among researchers on the relative effects of nuclear and other forms of electricity generation on GHG emissions. Existing studies on GHG emissions from nuclear power plants generally take two different forms:

(4) qualitative discussions of the potential to use nuclear power to reduce GHG emissions and mitigate global warming, and

(5) technical analyses and quantitative estimates of the actual amount of GHGs generated by the nuclear fuel cycle or entire nuclear power plant life cycle and comparisons to the operational or life cycle emissions from other energy generation alternatives.

6.2.1.1 Qualitative Studies

The qualitative studies consist primarily of broad, large-scale public policy, or investment evaluations of whether an expansion of nuclear power is likely to be a technically, economically, or politically workable means of achieving global GHG reductions. Studies the staff found during the subsequent literature search include the following:

- Evaluations to determine if investments in nuclear power in developing countries should be accepted as a flexibility mechanism to assist industrialized nations in achieving their GHG reduction goals under the Kyoto Protocols (IAEA 2000, NEA 2002, Schneider 2000). Ultimately, the parties to the Kyoto Protocol did not approve nuclear power as a component under the clean development mechanism (CDM) because of safety and waste disposal concerns (NEA 2002).

- Analyses developed to assist governments, including the United States, in making long-term investment and public policy decisions in nuclear power (Hagen et al. 2001, Keepin 1988, MIT 2003).

Although the qualitative studies sometimes reference and critique the existing quantitative estimates of GHGs produced by the nuclear fuel cycle or life cycle, their conclusions generally rely heavily on discussions of other aspects of nuclear policy decisions and investment, such as safety, cost, waste generation, and political acceptability. Therefore, these studies typically are not directly applicable to an evaluation of GHG emissions associated with the proposed license renewal for a given nuclear power plant.

6.2.1.2 Quantitative Studies

A large number of technical studies, including calculations and estimates of the amount of GHGs emitted by nuclear and other power generation options, are available in the literature and were useful in the staff's efforts to address relative GHG emission levels. Examples of these studies include—but are not limited to—Mortimer (1990), Andseta et al. (1998), Spadaro (2000), Storm van Leeuwen and Smith (2008), Fritsche (2006), Parliamentary Office of Science and Technology (POST) (2006), Atomic Energy Authority (AEA) (2006), Weisser (2006), Fthenakis and Kim (2007), and Dones (2007). In addition, Sovacool (2008) provides a review and synthesis of studies in existence through 2008; however, the Sovacool synthesis ultimately uses only 19 of the 103 studies initially considered (the remaining 84 were excluded because they were more than 10 years old, not publicly available, available only in a language other than English, or they presented methodological challenges by relying on inaccessible data, providing overall GHG estimates without allocating relative GHG impacts to different parts of the nuclear lifecycle, or they were otherwise not methodologically explicit).

Comparing these studies and others like them is difficult because the assumptions and components of the lifecycles that the authors evaluate vary widely. Examples of areas in which differing assumptions make comparing the studies difficult include the following:

- energy sources that may be used to mine uranium deposits in the future,
- reprocessing or disposal of spent nuclear fuel,
- current and potential future processes to enrich uranium and the energy sources that will power them,
- estimated grades and quantities of recoverable uranium resources,
- estimated grades and quantities of recoverable fossil fuel resources,
- estimated GHG emissions other than CO_2, including the conversion to CO_2 equivalents per unit of electric energy produced,
- performance of future fossil fuel power systems,
- projected capacity factors for alternatives means of generation, and
- current and potential future reactor technologies.

In addition, studies may vary with respect to whether all or parts of a power plant's lifecycle are analyzed (i.e., a full lifecycle analysis will typically address plant construction, operations, resource extraction—for fuel and construction materials, and decommissioning), whereas a partial lifecycle analysis primarily focuses on operational differences. In addition, as Sovacool (2008) noted, studies vary greatly in terms of age, data availability, and methodological transparency.

In the case of license renewal, a GHG analysis for the portion of the plant's lifecycle attributable to license renewal (operation for an additional 20 years) would not involve GHG emissions associated with construction because construction activities already have been completed at the time of relicensing. In addition, the proposed action of license renewal also would not involve additional GHG emissions associated with facility decommissioning because that decommissioning must occur whether the facility is relicensed or not. However, in many studies, the specific contribution of GHG emissions from construction, decommissioning, or other portions of a plant's lifecycle cannot be clearly separated from one another. In such cases, an analysis of GHG emissions would overestimate the GHG emissions attributed to a specific portion of a plant's lifecycle. As Sovacool (2008) noted, many of the available analyses provide markedly lower GHG emissions per unit of plant output when one assumes that a power plant operates for a longer period of time. Nonetheless, available studies supply some meaningful information on the relative magnitude of the emissions among nuclear power plants and other forms of electric generation, as discussed in the following sections.

In Tables 6–2, 6–3, and 6–4, the staff presents the results of the above-mentioned quantitative studies to supply a weight-of-evidence evaluation of the relative GHG emissions that may result from the proposed license renewal compared to the potential alternative use of coal-fired, natural gas-fired, and renewable generation. Most studies from Mortimer (1990) onward (through Sovacool 2008) indicate that uranium ore grades and uranium enrichment processes are leading determinants in the ultimate GHG emissions attributable to nuclear power generation. These studies show that the relatively lower order of magnitude of GHG emissions from nuclear power, when compared to fossil-fueled alternatives (especially natural gas), could potentially disappear if available uranium ore grades drop sufficiently while enrichment processes continued to rely on the same technologies.

Sovacool's synthesis of 19 existing studies found that nuclear power generation causes carbon emissions in a range of 1.4 grams of carbon equivalent per kilowatt-hour (g C_{eq}/kWh) to 288 g C_{eq}/kWh, with a mean value of 66 g C_{eq}/kWh. The results of his synthesis and the results of others' efforts are included in the tables in this section.

6.2.1.3 Summary of Nuclear Greenhouse Gas Emissions Compared to Coal

Considering that coal fuels the largest share of electricity generation in the United States and that its burning results in the largest emissions of GHGs for any of the likely alternatives to nuclear power generation, including GGNS, many of the available quantitative studies focused on comparing the relative GHG emissions of nuclear to coal-fired generation. The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle (and, in some cases, the nuclear lifecycle), as compared to an equivalent coal-fired plant, are presented in Table 6–2. The following table does not include all existing studies, but it gives an illustrative range of estimates that various sources have developed.

1 **Table 6–2. Nuclear Greenhouse Gas Emissions Compared to Coal**

Source	GHG Emission Results
Mortimer (1990)	Nuclear—230,000 tons CO_2 Coal—5,912,000 tons CO_2 Note: Future GHG emissions from nuclear to increase because of declining ore grade.
Andseta et al. (1998)	Nuclear energy produces 1.4% of the GHG emissions compared to coal. Note: Future reprocessing and use of nuclear-generated electrical power in the mining and enrichment steps are likely to change the projections of earlier authors, such as Mortimer (1990).
Spadaro (2000)	Nuclear—2.5–5.7 g C_{eq}/kWh Coal—264–357 g C_{eq}/kWh
Fritsche (2006) (values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Coal—950 g C_{eq}/kWh
POST (2006) (nuclear calculations from AEA 2006)	Nuclear—5 g C_{eq}/kWh Coal—>1,000 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03% would raise nuclear to 6.8 g C_{eq}/kWh. Future improved technology and carbon capture and storage could reduce coal-fired GHG emissions by 90%.
Weisser (2006) (compilation of results from other studies)	Nuclear—2.8–24 g C_{eq}/kWh Coal—950–1,250 g C_{eq}/kWh
Sovacool (2008)	Nuclear—66 g Ceq/kWh Coal —960–1,050 g Ceq/kWh (coal adopted from Gagnon et al. 2002)

2 *6.2.1.4 Summary of Nuclear Greenhouse Gas Emissions Compared to Natural Gas*

3 The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle (and, in
4 some cases, the nuclear lifecycle), as compared to an equivalent natural gas-fired plant, are
5 presented in Table 6–3. The following table does not include all existing studies, but it gives an
6 illustrative range of estimates various sources have developed.

Table 6–3. Nuclear Greenhouse Gas Emissions Compared to Natural Gas

Source	GHG Emission Results
Spadaro (2000)	Nuclear—2.5–5.7 g C_{eq}/kWh Natural gas—120–188 g C_{eq}/kWh
Storm van Leeuwen and Smith (2008)	Nuclear fuel cycle produces 20–33% of the GHG emissions compared to natural gas (at high ore grades). Note: Future nuclear GHG emissions will increase because of declining ore grade.
Fritsche (2006) (values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Cogeneration combined cycle natural gas—150 g C_{eq}/kWh
POST (2006) (nuclear calculations from AEA, 2006)	Nuclear—5 g C_{eq}/kWh Natural gas—500 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03% would raise nuclear to 6.8 g Ceq/kWh. Future improved technology and carbon capture and storage could reduce natural gas GHG emissions by 90%.
Weisser (2006) (compilation of results from other studies)	Nuclear—2.8–24 g C_{eq}/kWh Natural gas—440–780 g C_{eq}/kWh
Dones (2007)	Author critiqued methods and assumptions of Storm van Leeuwen and Smith (2005), and concluded that the nuclear fuel cycle produces 15-27% of the GHG emissions of natural gas.
Sovacool (2008)	Nuclear—66 g Ceq/kWh Natural gas—443 g Ceq/kWh (natural gas adopted from Gagnon et al. 2002)

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

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle (and, in some cases, the nuclear lifecycle), as compared to equivalent renewable energy sources, are presented in Table 6–4. Calculation of GHG emissions associated with these sources is more difficult than the calculations for nuclear energy and fossil fuels because of the large variation in efficiencies and capacity factors because of their different technologies, sources, and locations. For example, the efficiency of solar and wind energy is highly dependent on the wind or solar resource in a particular location. Similarly, the range of GHG emissions estimates for hydropower varies greatly depending on the type of dam or reservoir involved (if used at all). Therefore, the GHG emissions estimates for these energy sources have a greater range of variability than the estimates for nuclear and fossil fuel sources. The following table does not include all existing studies, but it gives an illustrative range of estimates various sources have developed.

Table 6–4. Nuclear Greenhouse Gas Emissions Compared to Renewable Energy Sources

Source	GHG Emission Results
Mortimer (1990)	Nuclear—230,000 tons CO_2 Hydropower—78,000 tons CO_2 Wind power—54,000 tons CO_2 Tidal power—52,500 tons CO_2 Note: Future GHG emissions from nuclear are expected to increase because of declining ore grade.
Spadaro (2000)	Nuclear—2.5–5.7 g C_{eq}/kWh Solar PV—27.3–76.4 g C_{eq}/kWh Hydroelectric—1.1–64.6 g C_{eq}/kWh Biomass—8.4–16.6 g C_{eq}/kWh Wind—2.5–13.1 g C_{eq}/kWh
Fritsche (2006) (values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Solar PV—125 g C_{eq}/kWh Hydroelectric—50 g C_{eq}/kWh Wind—20 g C_{eq}/kWh
POST (2006) (nuclear calculations from AEA 2006)	Nuclear—5 g C_{eq}/kWh Biomass—25–93 g C_{eq}/kWh Solar PV—35–58 g C_{eq}/kWh Wave/Tidal—25–50 g C_{eq}/kWh Hydroelectric—5–30 g C_{eq}/kWh Wind—4.64–5.25 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03% would raise nuclear to 6.8 g C_{eq}/kWh.
Weisser (2006) (compilation of results from other studies)	Nuclear—2.8–24 g C_{eq}/kWh Solar PV—43–73 g C_{eq}/kWh Hydroelectric—1–34 g C_{eq}/kWh Biomass—35–99 g C_{eq}/kWh Wind—8–30 g C_{eq}/kWh
Fthenakis and Kim (2007)	Nuclear—16–55 g C_{eq}/kWh Solar PV—17–49 g C_{eq}/kWh
Sovacool (2008) (adopted from other studies)	Nuclear—66 g C_{eq}/kWh Wind—9–10 g C_{eq}/kWh Hydroelectric (small, distributed)—10–13 g C_{eq}/kWh Biogas digester—11 g C_{eq}/kWh Solar thermal—13 g C_{eq}/kWh Biomass—14–35 g C_{eq}/kWh Solar PV—32 g C_{eq}/kWh Geothermal (hot, dry rock)—38 g C_{eq}/kWh (solar PV value adopted from Fthenakis et al. 2008; all other renewable generation values adopted from Pehnt 2006)

6.2.2 Conclusions: Relative Greenhouse Gas Emissions

The sampling of data presented in Tables 6–2, 6–3, and 6–4 demonstrates the challenges of any attempt to determine the specific amount of GHG emission attributable to nuclear energy production sources because different assumptions and calculation methods will yield differing results. The differences and complexities in these assumptions and analyses will further increase when they are used to project future GHG emissions. Nevertheless, several conclusions can be drawn from the information presented.

First, the various studies show a general consensus that nuclear power currently produces fewer GHG emissions than fossil-fuel-based electrical generation (e.g., GHG emissions from a complete nuclear fuel cycle currently range from 2.5–66 grams of carbon equivalent per kilowatt hour (g C_{eq}/kWh), as compared to the use of coal plants (264–1,250 g C_{eq}/kWh) and natural gas plants (120-780 g C_{eq}/kWh)). The studies also provide estimates of GHG emissions from five renewable energy sources based on current technology. These estimates included solar-photovoltaic (17–125 g C_{eq}/kWh), hydroelectric (1–64.6 g C_{eq}/kWh), biomass (8.4–99 g C_{eq}/kWh), wind (2.5–30 g C_{eq}/kWh), and tidal (25–50 g C_{eq}/kWh). The range of these estimates is wide, but the general conclusion is that current GHG emissions from nuclear power generation are of the same order of magnitude as from these renewable energy sources.

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

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

- As shown in Tables 6–2 and 6–3, current estimates of GHG emissions from the nuclear fuel cycle are far below those for fossil fuel-based energy sources.
- License renewal of a nuclear power plant such as GGNS may involve continued GHG emissions caused by uranium mining, processing, and enrichment, but will not result in increased GHG emissions associated with plant construction or decommissioning (since the plant will have to be decommissioned at some point whether the license is renewed or not).
- Few studies predict that nuclear fuel cycle emissions will exceed those of fossil fuels within a timeframe that includes the GGNS period of extended operation. Several studies suggest that future extraction and enrichment methods, the potential for higher-grade resource discovery, and technology improvements could extend this timeframe.

With respect to the comparison of GHG emissions among the proposed GGNS license renewal action and renewable energy sources:

- It appears likely that there will be future technology improvements and changes in the type of energy used for mining, processing, manufacturing, and constructing facilities of all types.

- Currently, the GHG emissions associated with the nuclear fuel cycle and renewable energy sources are within the same order of magnitude.
- Because nuclear fuel production is the most significant contributor to possible future increases in GHG emissions from nuclear power—and since most renewable energy sources lack a fuel component—it is likely that GHG emissions from renewable energy sources will be lower than those associated with GGNS at some point during the period of extended operation.

The staff provides additional discussion on the contribution of GHG to cumulative air quality impacts in Section 4.11.2 of this supplemental EIS.

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7.0 ENVIRONMENTAL IMPACTS OF DECOMMISSIONING

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

Additionally, the incremental environmental impacts associated with decommissioning activities resulting from continued plant operation during the renewal term are discussed in NUREG-1437, *Generic Environmental Impact Statement* (GEIS) *for License Renewal of Nuclear* Plants (NRC 1996, 1999). The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues were then assigned a Category 1 or a Category 2 designation. Section 1.4 in Chapter 1 explains the criteria for Category 1 and Category 2 issues and defines the impact designations of SMALL, MODERATE, and LARGE. The staff analyzed site-specific issues (Category 2) for Grand Gulf Nuclear Station (GGNS) and assigned them a significance level of SMALL, MODERATE, or LARGE, or not applicable to GGNS because of site characteristics or plant features. There are no Category 2 issues related to decommissioning.

7.1 Decommissioning

Table 7–1 lists the Category 1 issues in Table B–1 of Title 10 of the *Code of Federal Regulations* (CFR) Part 51, Subpart A, Appendix B that are applicable to GGNS decommissioning following the renewal term.

Table 7–1. Issues Related to Decommissioning

Issues	GEIS section	Category
Radiation doses	7.3.1; 7.4	1
Waste management	7.3.2; 7.4	1
Air quality	7.3.3; 7.4	1
Water quality	7.3.4; 7.4	1
Ecological resources	7.3.5; 7.4	1
Socioeconomic impacts	7.3.7; 7.4	1

Decommissioning would occur whether GGNS were shut down at the end of its current operating license or at the end of the period of extended operation. There are no site-specific issues related to decommissioning.

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

Radiation doses. Based on information in the GEIS, the NRC noted that "[d]oses 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 person-rem (1 person-mSv) caused by buildup of long-lived radionuclides during the license renewal term."

Waste management. Based on information in the GEIS, the NRC noted that "[d]ecommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected."

Air quality. Based on information in the GEIS, the NRC noted that "[a]ir quality impacts of decommissioning are expected to be negligible either at the end of the current operating term or at the end of the license renewal term."

Water quality. Based on information in the GEIS, the NRC noted that "[t]he potential for significant water quality impacts from erosion or spills is no greater whether decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts."

Ecological resources. Based on information in the GEIS, the NRC noted that "[d]ecommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts."

Socioeconomic impacts. Based on information in the GEIS, the NRC noted that "[d]ecommissioning 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."

Entergy Operations, Inc. (Entergy) stated in its environmental report (ER) (Entergy 2011) that it is not aware of any new and significant information on the environmental impacts of GGNS license renewal. The staff has not found any new and significant information during its independent review of Entergy's ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts related to these issues, beyond those discussed in the GEIS. For all of these issues, the NRC staff concluded in the GEIS that the impacts are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

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."

[Entergy] Entergy Operations, Inc. 2011. *Grand Gulf Nuclear Station, Unit 1, License Renewal Application*. *Appendix E, Applicant's Environmental Report.* Agencywide Documents Access and Management System (ADAMS) Accession No. ML11308A234.

[NRC] U.S. Nuclear Regulatory Commission. 1996. *GEIS*. NRC. NUREG–1437. May 1996. ADAMS Accession Nos. ML040690705 and ML040690738.

[NRC] U.S. Nuclear Regulatory Commission. 1999. Section 6.3–Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants. In: *GEIS.* NRC. NUREG–1437, Volume 1, Addendum 1. August 1999. ADAMS Accession No. ML04069720.

[NRC] U.S. Nuclear Regulatory Commission. 2002. *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities Regarding the Decommissioning of Nuclear Power Reactors*. Washington, DC: NRC. NUREG–0586, Supplement 1. November 2002. ADAMS Accession Nos. ML023470304 and ML023500295.

8.0 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

The National Environmental Policy Act (NEPA) requires the consideration of a range of reasonable alternatives to the proposed action in an environmental impact statement (EIS). In this case, the proposed action is whether to issue a renewed license for Grand Gulf Nuclear Station (GGNS), which will allow the plant to operate for 20 years beyond its current license expiration date. A license is just one of many conditions that a licensee must meet in order to operate its nuclear plant. State regulatory agencies and the owners of the nuclear power plant ultimately decide whether the plant will operate, and economic and environmental considerations play a primary role in this decision. The U.S. Nuclear Regulatory Commission (NRC)'s responsibility is to ensure the safe operation of nuclear power facilities and not to formulate energy policy or encourage or discourage the development of alternative power generation (or replacement power alternatives).

The license renewal process is designed to assure safe operation of the nuclear power plant and protection of the environment during the license renewal term. Under the NRC's environmental protection regulations in Title 10, Part 51, of the *Code of Federal Regulations* (10 CFR Part 51), which implement Section 102(2) of NEPA, renewal of a nuclear power plant operating license requires the preparation of an EIS.

To support the preparation of these EISs, the NRC staff (the staff) prepared the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, in 1996. The license renewal GEIS was prepared to assess the environmental impacts of continued nuclear power plant operations during the license renewal term. The intent was to determine which environmental impacts would result in essentially the same impact at all nuclear power plants and which ones could result in different levels of impacts at different plants and would require a plant-specific analysis to determine the impacts. For those issues that could not be generically addressed, the NRC develops a plant-specific supplemental environmental impact statement (SEIS) to the GEIS.

NRC regulations in 10 CFR 51.71(d) for license renewal require that a SEIS consider and weigh

> the environmental effects of the proposed action [license renewal]; the environmental impacts of alternatives to the proposed action; and alternatives available for reducing or avoiding adverse environmental effects[.]

While the GEIS reached generic conclusions on many environmental issues associated with license renewal, it did not determine which alternatives are reasonable or reach conclusions about site-specific environmental impact levels. As such, the NRC must evaluate environmental impacts of alternatives on a site-specific basis.

As stated in Chapter 1 of this SEIS, alternatives to renewing GGNS's operating license must meet the purpose and need for the proposed action. They must do the following:

> 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]. (NRC 1996)

The NRC ultimately makes no decision about which alternative (or the proposed action) to carry out because that decision falls to the appropriate energy-planning decisionmakers.

Alternatives Evaluated In-Depth:

- new nuclear
- natural gas-fired combined cycle (NGCC)
- supercritical coal-fired
- combination alternative (NGCC, demand-side management, purchased power, and biomass)

Other Alternatives Considered:

- demand-side management
- wind power
- solar power
- hydroelectric power
- wave and ocean energy
- geothermal power
- municipal solid waste
- biomass
- oil-fired power
- fuel cells
- purchased power
- delayed retirement

Comparing the environmental effects of these alternatives will help the NRC decide if the adverse environmental impacts of license renewal are great enough to deny the option of license renewal for energy-planning decisionmakers (10 CFR 51.95(c)(4)). If the NRC acts to issue a renewed license, all of the alternatives, including the proposed action, will be available to energy-planning decisionmakers. If the NRC decides not to renew the license, then energy-planning decisionmakers may no longer elect to continue operating GGNS and will have to resort to another alternative—which may or may not be one of the alternatives considered in this section—to meet the energy needs that GGNS now satisfies.

In evaluating alternatives to license renewal, energy technologies or options currently in commercial operation are considered, as well as some technologies not currently in commercial operation but likely to be commercially available by the time the current GGNS operating license expires. The current GGNS operating license will expire on November 1, 2024, and reasonable alternatives must be available (constructed, permitted, and connected to the grid) by the time the current GGNS license expires to be considered likely to become available.

The staff eliminated alternatives that cannot meet future system needs and whose costs or benefits do not justify inclusion in the range of reasonable alternatives. The staff evaluated the remaining alternatives, which are discussed in-depth in this chapter. Each alternative eliminated from detailed study is briefly discussed in Section 8.5, and a basis for its removal is provided. In total, 16 energy technology options and alternatives to the proposed action were considered (see text box) and then narrowed to the four alternatives considered in Sections 8.1–8.4. The no-action alternative is considered in Section 8.6.

The GEIS presents an overview of some energy technologies but does not reach any conclusions about which alternatives are most appropriate. Since 1996, many energy technologies have evolved significantly in capability and cost, while regulatory structures have changed to either promote or impede development of particular alternatives.

As a result, the analyses include updated information from sources such as the Energy Information Administration (EIA), other organizations within the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), industry sources and publications, and information submitted by the applicant in its environmental report (ER).

The evaluation of each alternative considers the environmental impacts across seven impact categories: (1) air quality, (2) groundwater use and quality, (3) surface water use and quality, (4) ecology, (5) human health, (6) socioeconomics, and (7) waste management. A three-level standard of significance—SMALL, MODERATE, or LARGE—is used to show the intensity of environmental effects for each alternative that is evaluated in depth. The order of presentation is not meant to imply increasing or decreasing level of impact, nor does it imply that an energy-planning decisionmaker would select one or another alternative.

For each alternative where it is feasible to do so, the NRC considers the environmental effects of locating the alternative at the existing GGNS site. Selecting the existing plant site allows for the maximum use of existing transmission and cooling system infrastructures and minimizes the overall environmental impact.

In addition, to ensure that the alternatives analysis is consistent with State and regional energy policies, the NRC reviewed energy relevant statutes, regulations, and policies. The NRC also considered the current generation capacity mix and electricity production data within Mississippi, where GGNS is located and production data for Entergy's six operating companies that operate under a System Agreement. The System Agreement allows the operating companies to share generating capacity power reserves, provides the basis for the planning, construction and operation of electric generation and transmission, and regulates the price for wholesale electricity used or exchanged by the Entergy operating companies (Entergy 2012). In 2010, electric generators in Mississippi had an installed generating capacity of approximately 15,691 megawatts electric (MWe). This capacity included units fueled by natural gas (74 percent), coal (16 percent), nuclear (8 percent), and biomass-fired generation (1.5 percent) (EIA 2012a). In 2010, the electric industry in Mississippi provided approximately 54.5 million megawatt-hours of electricity. Electricity produced in Mississippi was dominated by natural gas (54 percent) followed by coal (25 percent), nuclear (18 percent), and biomass-fired generation (2.8 percent) (EIA 2012a).

Sections 8.1–8.4 describe the environmental impacts of alternatives to license renewal. These alternatives include a new nuclear generation option in Section 8.1; a new natural gas-fired combined-cycle (NGCC) plant in Section 8.2; a new supercritical pulverized coal (SCPC) plant in Section 8.3; and a combination alternative of NGCC, demand-side management (DSM), purchased power, and biomass-fired generation in Section 8.4. A summary of these alternatives considered in depth is provided in Table 8–1. In Section 8.5, alternatives considered but eliminated from detailed study are briefly discussed. Finally, Section 8.6 describes environmental effects that may occur if the NRC takes no action and does not issue a renewed license for GGNS. Section 8.7 summarizes the impacts of each of the alternatives considered in detail.

1 **Table 8–1. Summary of Alternatives Considered In Depth**

	New Nuclear Alternative	Natural Gas (NGCC) Alternative	Supercritical Pulverized Coal (SCPC) Alternative	Combination Alternative
Summary of Alternative	One unit ESBWR nuclear plant	Three 530-MWe units for a total of 1,590 MWe	Three 583-MWe SCPC units (total of 1,749 MWe)	One 530-MWe NGCC unit; Nine 50-MW biomass units (360 MWe total); 280 MWe from DSM; and 305 MWe from purchased power
Location	At GGNS; Would use existing infrastructure, including Ranney wells, draft cooling tower, and transmission lines	At GGNS; Would use existing infrastructure, including Ranney wells, draft cooling tower, and transmission lines	An existing power plant site (other than GGNS) in Mississippi; Some infrastructure upgrades may be required	NGCC at GGNS; Biomass units at 9 sites throughout Mississippi; DSM and purchased power throughout Mississippi
Cooling System	Ranney wells; Consumptive water use would be similar to GGNS Unit 1	Ranney wells; Consumptive water use would be less than GGNS Unit 1	Closed-cycle with natural-draft cooling towers; Consumptive water use would be similar to GGNS Unit 1	NGCC unit same as the NGCC alternative but water use would be 1/3 less; Closed-cycle cooling for biomass units
Land Requirements	234 ac (95 ha) (Entergy 2011); 1,000 ac (400 ha) for uranium mining and processing (NRC 1996)	195 acres (79 hectares) (NRC 1996); 5,700 ac (2,307 ha) for wells, collection site, pipeline (NRC 1996)	2,744 ac (1,110 ha) for the plant (NRC 1996); 35,508 ac (14,370 ha) for coal mining and waste disposal (NRC 1996)	NGCC unit approximately 1/3 the land as for the NGCC alternative; 15 ac (6 ha) for each 50-MWe biomass unit, for a total of 135 ac (55 ha) (NREL 2003, Palmer Renewable Energy 2011)
Work Force	3,150 during construction; 690 during operations (Entergy 2011)	1,900 during construction; 150 during operations (NRC 1996)	4,035 during construction; 404 during operations (NRC 1996)	NGCC portion would require 633 during construction and 50 during operations (NRC 1996); Biomass units would require 450 during construction and 198 during operations

2 ## 8.1 New Nuclear Generation

3 In this section, the NRC evaluates the environmental impacts of a new nuclear generation
4 alternative at the GGNS site.

The NRC considers the construction of a new nuclear plant to be a reasonable alternative to GGNS license renewal because nuclear generation currently provides baseload power in Entergy's service territory and Entergy has expressed interest in adding nuclear generation to its energy portfolio. For example, on October 16, 2003, an application was submitted for an early site permit (ESP) on the existing GGNS site and the NRC issued an ESP on April 7, 2007 (NRC 2012a). An ESP is an NRC approval of a site for one or more nuclear power facilities. Before construction and operation of any new nuclear unit(s), Entergy would need to obtain a construction permit and operating license. On February 27, 2008, Entergy submitted an application for a combined operating license (COL) for an Economic Simplified Boiling-Water Reactor (ESBWR) at the GGNS site. *On January 9, 2009, Entergy informed the NRC that it was considering alternate reactor design technologies and requested that the NRC suspend its review effort (NRC 2012b)*. Entergy continues to evaluate the potential for new nuclear generation and could pursue it as an option for meeting long-term baseload needs in the future (Entergy 2009, 2010). Although the ESP does not specify a scheduled timeline, the NRC determined that there is sufficient time for Entergy to prepare and submit an application, build, and operate a new nuclear unit before the GGNS license expires in November 2024. This section presents the environmental impacts of the new nuclear generation alternative, which includes constructing and operating one new nuclear plant at the GGNS site.

In evaluating the new nuclear alternative, the NRC assumed that a replacement reactor would be installed on the GGNS site, allowing for the maximum use of existing ancillary facilities such as the cooling system and transmission infrastructure. The GGNS site is situated on 2,100 acres (ac) (850 hectares [ha]), of which, approximately 1,000 ac (405 ha), is in a floodplain and not suitable for plant construction. The remaining 1,100 ac (445 ha) would be sufficient for construction of a new nuclear plant (Entergy 2011). The NRC assumed that the replacement reactor would be an ESBWR. Although the NRC has suspended its review of the COL application, it uses information from the ESP EIS in the following sections, where applicable, because it provides a site-specific environmental analysis of a new nuclear plant at the GGNS site.

For the purpose of this analysis, the NRC assumed that the new reactor would have a net electrical output of 1,475 MWe, which would be the same output as the existing reactor. Entergy (2008) estimated that 234 ac (95 ha) would be required for new reactor construction for the power block and ancillary facilities, and that sufficient acreage was available on the GGNS site. The heat-rejection demands of a new nuclear unit would be similar to those of the existing reactor. Therefore, the NRC assumed that the new reactor would use the existing cooling system (including natural draft cooling towers and intake and discharge structures), and that no structural modifications would be needed. The existing transmission lines leaving the site, as well as construction, drinking water and Ranney wells are expected to serve the new reactor with no modifications required.

The NRC also considered the installation of multiple small and modular reactors at the GGNS site as an alternative to renewing the GGNS license. The NRC established the Advanced Reactor Program in the Office of New Reactors because of considerable interest in small and modular reactors along with anticipated license applications by vendors. As of December 2012, the NRC has not received any applications. Because there are no applications to construct and operate small modular reactors on a commercial scale, this analysis focused on nuclear generation by larger nuclear units.

8.1.1 Air Quality

As discussed in Section 2.2.2.1, the GGNS site is located in Claiborne County, Mississippi, which is on the western edge of the Mobile (Alabama)-Pensacola-Panama City

(Florida)-Southern Mississippi Interstate Air Quality Control Region (AQCR) (40 CFR 81.68). The area across the Mississippi River from the site is in the Monroe (Louisiana)-El Dorado (Arkansas) Interstate AQCR (40 CFR 81.92). EPA has designated all of the counties in these AQCRs adjacent to the GGNS site as in compliance with the National Ambient Air Quality Standards (NAAQS) (40 CFR 81.310). The State of Mississippi is in attainment with primary and secondary NAAQS for all criteria pollutants, except De Soto County, which is located about 200 miles (322 km) north-northeast of GGNS and part of which is a marginal nonattainment area for the 2008 8-hour ozone standard.

Construction activities for a new nuclear alternative would cause some localized temporary air quality impacts because of fugitive dust emissions from operation of earth-moving and material-handling equipment. Emissions from construction worker vehicles and motorized construction equipment exhaust would be temporary. The NRC assumes that mitigation measures, including wetting of unpaved roads and construction areas, and seeding or mulching bare areas would control and reduce fugitive dust.

During operations, a new nuclear alternative would have air emissions similar to those of the existing GGNS plant. These emissions are primarily from testing of emergency generators and diesel pumps and the periodic use of auxiliary boilers or generators during outages (Entergy 2011). The NRC expects a new nuclear alternative to have similar air permitting conditions and regulatory requirements as the existing plant. For example, a new nuclear alternative would be subject to conditions in an air permit established by the Mississippi Department of Environmental Quality (MDEQ) (Entergy 2011).

Subpart P of 40 CFR Part 51 contains the visibility protection regulatory requirements, including the review of new sources to be constructed in attainment or unclassified areas that may affect visibility in any mandatory Class I Federal area (designated national parks and wilderness areas). If a new nuclear plant were located close to a mandatory Class I Federal area, additional air pollution control requirements may be required. As noted in Section 2.2.2.1, there are no mandatory Class I Federal areas within 186 mi (300 km) of the GGNS site.

8.1.1.1 Greenhouse Gases

Operation of a new nuclear alternative would have similar effects on climate change as the existing GGNS (which are discussed in Section 4.2). Operation of the reactor does not result in the release of GHGs. However, GHG emissions do result from some activities, such as the periodic use of auxiliary boilers or generators, worker vehicles, and motorized construction equipment exhaust. The impacts on climate from a new nuclear alternative on the GGNS site would be SMALL.

8.1.1.2 Conclusion

The overall air quality impacts of a new nuclear plant located at the GGNS site would not noticeably alter air quality, therefore, air quality impacts would be SMALL.

8.1.2 Groundwater Resources

The amount of groundwater required for construction of a new nuclear alternative would be much less than required during plant operation. Water for construction would be obtained from the existing Ranney wells. Groundwater quality and use impacts from construction of a new nuclear alternative are expected to be SMALL.

The amount of water required to operate a new nuclear power plant would be similar to that required for the existing power plant. Cooling water would be obtained from the existing Ranney wells. The potable water system would operate from existing wells using similar chemicals, processes, and withdrawal rates as the existing GGNS facility. Groundwater quality and use impacts from operation of a new nuclear alternative are expected to be SMALL.

8.1.3 Surface Water Resources

If dredging of streams or rivers occurs during construction, surface water quality immediately downstream of the dredging activities could be temporarily degraded by increases in suspended sediment concentration. During operation, a new nuclear alternative would discharge blowdown from the cooling system at approximately the same rate as the existing unit. Stormwater discharge, blowdown, sanitary, and other effluents, would be regulated under a National Pollutant Discharge Elimination System (NPDES) permit. Given that the discharge rate and composition would be similar to the existing plant and regulated by an NPDES permit and the effects of any dredging needed for construction would be temporary, the impacts to surface water use and quality are expected to be SMALL.

8.1.4 Aquatic Ecology

Construction activities for the new nuclear alternative (such as construction of heavy-haul roads and the power block) could affect onsite aquatic features, including the Mississippi River near GGNS, Hamilton and Gin Lakes, a borrow pit, three small ponds, streams “A” and “B,” and ephemeral drainages. Minimal impacts on aquatic ecology resources are expected because the plant operator would likely implement best management practices (BMPs) to minimize erosion and sedimentation. Stormwater control measures, which would be required to comply with Mississippi NPDES permitting, would minimize the flow of disturbed soils into aquatic features. To bring new materials to the site, the plant operator would dredge near the barge slip to transport some materials using barges, which could result in increased sedimentation and turbidity within aquatic habitats in the Mississippi River. Permits and certifications from the U.S. Army Corps of Engineers and other agencies would require the implementation of BMPs to minimize impacts. Due to the short-term nature of the dredging activities, the hydrological alterations to aquatic habitats would be localized and temporary.

During operations, the new nuclear alternative would require a similar amount of cooling water to be withdrawn from Ranney wells and a similar amount of water to be discharged into the Mississippi River as required for GGNS. The number of fish and other aquatic resources affected by cooling water discharge operations, such as thermal stress, would be similar to those of GGNS.

Consultation under several Federal acts, including the Endangered Species Act (ESA) and Magnuson-Stevens Act, would be required to assess the occurrence and potential impacts to Federally protected aquatic species and habitats within affected surface waters. Coordination with State natural resource agencies would further ensure that Entergy would take appropriate steps to avoid or mitigate impacts to State-listed species, habitats of conservation concern, and other protected species and habitats. The NRC assumes that these consultations would result in avoidance or mitigation measures that would minimize or eliminate potential impacts to protected aquatic species and habitats.

The impacts on aquatic ecology would be minor because erosion and sedimentation would be minimized by BMPs during construction and stormwater and surface water discharges would be managed by regulatory permits similar to the existing plant. Therefore, the staff concludes that impacts on aquatic ecology would be SMALL

8.1.5 Terrestrial Ecology

Entergy estimates that construction of a new nuclear alternative, including a reactor unit and auxiliary facilities would affect 234 ac (95 ha) of land on the GGNS site, which is a slightly smaller area of land than that disturbed for construction of GGNS. A new nuclear alternative would use existing site infrastructure, transmission lines, and cooling system to the extent practicable. Thus, only minimal disturbances to undisturbed land would occur for a new nuclear alternative. However, the level of direct impacts would vary based on the specific location of new buildings and infrastructure on the site. Erosion and sedimentation, fugitive dust, and construction debris impacts would be minor with implementation of appropriate BMPs. Construction noise could modify wildlife behavior; however, these effects would be temporary. Road improvements or construction of additional service roads to facilitate construction could result in the temporary or permanent loss of terrestrial habitat. Impacts to terrestrial habitats and species from the operation of a new nuclear alternative would be similar to those of GGNS and would, therefore, be SMALL. Impacts to terrestrial habitats and species from transmission line operation and corridor vegetation maintenance would be similar in magnitude and intensity to those resulting from operating nuclear reactors and would, therefore, be SMALL. The offsite land requirement (1,000 ac [400 ha]) and impacts associated with uranium mining and fuel fabrication to support a new nuclear alternative would be no different from those occurring in support of GGNS. Overall, the impacts from construction of a new nuclear alternative on terrestrial species and habitats would be MODERATE, and the impacts of operation would be SMALL.

As discussed under aquatic ecology impacts, consultation with U.S. Fish and Wildlife Service (FWS) under the ESA would avoid potential adverse impacts to Federally listed species or adverse modification or destruction of designated critical habitat. Coordination with State natural resource agencies would further ensure that Entergy would take appropriate steps to avoid or mitigate impacts to State-listed species, habitats of conservation concern, and other protected species and habitats. The NRC assumes that these consultations would result in avoidance or mitigation measures that would minimize or eliminate potential impacts to protected terrestrial species and habitats. Consequently, the impacts of construction and operation of a new nuclear alternative on protected species and habitats would be SMALL.

8.1.6 Human Health

Impacts on human health from construction of a new nuclear alternative would be similar to impacts associated with the construction of any major industrial facility. Compliance with worker protection rules would control those impacts on workers at acceptable levels. Impacts from construction on the general public would be minimal because the plant operator would limit active construction area access to authorized individuals assuming BMPs are followed. Impacts on human health from the construction of a new nuclear alternative would be SMALL.

The human health effects from the operation of a new nuclear alternative would be similar to those of the existing GGNS plant. Therefore, impacts on human health from the operation of a new nuclear alternative would be SMALL.

8.1.7 Land Use

The GEIS generically evaluates the impacts of constructing and operating various replacement power plant alternatives on land use, both on and off each plant site. The analysis of land use impacts focuses on the amount of land area that would be affected by the construction and operation of a new single-unit nuclear power plant at the GGNS site.

Entergy estimated 234 ac (95 ha) of land would be needed to construct and operate a new single-unit nuclear power plant on the GGNS site (Entergy 2011). A sufficient amount of land is available on the GGNS site for a new nuclear power plant. Maximizing the use of the established infrastructure at the existing nuclear power plant site would further reduce the amount of additional land needed to support the new unit. Land use impacts from constructing and operating one new unit at the GGNS site would be SMALL.

The GEIS also estimated an additional 1,000 acres (400 ha) of land would be affected by uranium mining and processing during the life of the new nuclear alternative. Impacts associated with uranium mining and fuel fabrication to support the new nuclear alternative would generally be no different from those occurring in support of the existing GGNS facility. Since the new unit would be located at GGNS, overall land use impacts from a new nuclear alternative would be SMALL.

8.1.8 Socioeconomics

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of a power plant could affect regional employment, income, and expenditures.

This alternative would create two types of jobs: (1) construction jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact; and (2) power plant operation jobs, which have a greater potential for permanent, long-term socioeconomic impacts. Workforce requirements for the construction and operation of the new nuclear generation alternative were evaluated to measure its possible effects on current socioeconomic conditions.

Entergy estimated a construction workforce of up to 3,150 (maximum) workers would be required to build a single-unit nuclear plant (Entergy 2011). The relative economic impact of construction workers on the local economy and tax base would vary, with the greatest impacts occurring in the communities where the majority of construction workers reside and spend their income. As a result, local communities could experience a short-term economic “boom” from increased tax revenue and income generated by construction worker expenditures and the increased demand for temporary (rental) housing and business services. After completing construction of the new nuclear plant, local communities could experience a return to pre-construction economic conditions. Given the magnitude of the estimated number of workers, socioeconomic impacts during construction in communities near the GGNS site could range from SMALL to LARGE.

Entergy estimated that 690 operations workers would be required at a new nuclear power plant, which is equivalent to the number of operations workers at GGNS (Entergy 2011). GGNS operations workers would likely transfer from the existing facility to the new nuclear power plant. This would not have a noticeable effect on socioeconomic conditions in the region. Socioeconomic impacts associated with the operation of a new nuclear alternative at the GGNS site would therefore be SMALL.

8.1.9 Transportation

Transportation impacts associated with construction and operation of a new nuclear alternative would consist of commuting workers and truck deliveries of construction materials to the power plant site. During periods of peak construction activity, up to 3,150 workers could be commuting daily to the site (Entergy 2011). Workers commuting to the construction site would use site access roads and the volume of traffic on nearby roads could increase substantially during shift changes. In addition to commuting workers, trucks would be transporting construction materials and equipment to the worksite, thus increasing the amount of traffic on local roads. The increase in vehicular traffic would peak during shift changes, resulting in temporary levels of service impacts and delays at intersections. Materials also could be delivered by barge to the GGNS site. Traffic-related transportation impacts during construction likely would range from MODERATE to LARGE.

Traffic-related transportation impacts on local roads would be greatly reduced after construction is completed. The estimated number of operations workers would be 690 (Entergy 2011). Transportation impacts would include daily commuting by the operating workforce, equipment and materials deliveries, and the removal of commercial waste material to offsite disposal or recycling facilities by truck. Traffic-related transportation impacts would be similar to those experienced during current operations at GGNS, because the new unit would employ the same number of workers as GGNS currently employs. Overall, for a new nuclear alternative, transportation impacts would be SMALL during operations.

8.1.10 Aesthetics

The analysis of aesthetic impacts focuses on the degree of contrast between the new nuclear alternative and the surrounding landscape and the visibility of the new power plant.

During construction, clearing and excavation would occur on site. Some of these activities may be visible from offsite roads. Since the GGNS site already appears industrial, construction of the new plant would appear similar to onsite activities during refueling outages.

During reactor operations, the visual appearance of the GGNS site would not change since the power block for the new nuclear reactor would look virtually identical to the existing GGNS power block. Adding a new reactor unit would increase the overall size of developed land at the GGNS site. Given the industrial appearance of the GGNS site and the similarity of the new unit to the existing unit, the new reactor unit would blend in with the surroundings. In addition, the amount of noise generated during reactor operations of a new nuclear alternative would be the same as those generated during existing GGNS operations, which consists predominantly of the noise from routine industrial processes and communications. In general, aesthetic changes would be limited to the immediate vicinity of the GGNS site, and any impacts would be SMALL.

8.1.11 Historic and Archaeological Resources

The potential for impacts on historic and archaeological resources from a new nuclear alternative would vary greatly depending on the location of the proposed plants on the GGNS site. Any construction on the GGNS site would need to avoid the previously identified Grand Gulf Mound area (Site 22Cb522) and Archaic Period village (22Cb528), as described in Section 2.2.10.2 of this document. As portions of the GGNS site have been previously identified as not containing significant historic and archaeological resources, use of these areas for the new nuclear alternative would result in a SMALL impact on historic and archaeological resources. Alternate plant locations on the GGNS site would need to be surveyed and inventoried for potential resources. Resources found in these surveys would need to be evaluated for eligibility on the National Register of Historic Properties (NRHP) and mitigation of adverse effects would need to be addressed if eligible resources were encountered. The level of impact at these locations would vary depending on the specific resources found to be present in the area of potential effect. However, given that the preference is to use previously surveyed and/or disturbed areas, avoidance of significant historic and archaeological resources should be possible and effectively managed under current laws and regulations. Therefore, the impacts on historic and archaeological resources from the new nuclear alternative would be SMALL.

8.1.12 Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health, environmental, and socioeconomic effects on minority and low-income populations that could result from the construction and operation of a new power plant. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts or risk of impact on the natural or physical environment in a minority or low-income community that are significant and appreciably exceed the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been discussed in the other sections of this chapter. For example, increased demand for rental housing during replacement power plant construction could disproportionately affect low-income populations that rely on inexpensive rental housing. Section 4.9.7, Environmental Justice, presents demographic information about minority and low-income populations living near the GGNS site.

Potential impacts to minority and low-income populations from the construction of a new nuclear power plant at the GGNS site would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). Noise and dust impacts during construction would be short-term and primarily limited to onsite activities. Minority and low-income populations residing along site access roads would be directly affected by increased commuter vehicle and truck traffic. However, because of the temporary nature of construction, these effects are not likely to be high and adverse and would be contained to a limited time period during certain hours of the day. Increased demand for rental housing during construction could cause rental costs to rise disproportionately affecting low-income populations living near GGNS who rely on inexpensive housing. However, given the proximity of GGNS to the Jackson and Vicksburg metropolitan areas, some workers could commute to the construction site, thereby reducing the need for rental housing.

Potential impacts to minority and low-income populations from nuclear power plant operations would be similar to those of the existing GGNS plant. Radiation doses from the new nuclear power plant are expected to be well below regulatory limits. People living near the power plant would be exposed to the same potential effects from the existing GGNS power plant operations and any impacts would depend on the magnitude of the change in ambient air quality conditions. Permitted air emissions are expected to remain within regulatory standards.

Based on this information and the analysis of human health and environmental impacts presented in this section, the construction and operation of a new nuclear power plant would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations living near GGNS.

8.1.13 Waste Management

During the construction of a new nuclear plant, land clearing and other construction activities would generate waste that could be recycled, disposed of on site, or shipped to an offsite waste disposal facility. Because the new nuclear plant would be constructed on the previously disturbed GGNS site, the amount of wastes produced would be less than comparable construction on an unimproved property.

During the operational stage, normal plant operations, routine plant maintenance, and cleaning activities would generate nonradioactive waste as well as mixed waste, low-level waste, and high-level waste. Quantities of nonradioactive waste (discussed in Section 2.1.3 of this document) and radioactive waste (discussed in Section 6.1 of this document) generated by GGNS would be comparable to that generated by a new nuclear alternative.

According to the GEIS (NRC 1996), the generation and management of solid nonradioactive and radioactive waste during the license renewal term is not expected to result in significant environmental impacts. A new single-unit nuclear plant would generate waste streams similar to the existing nuclear plant. Based on this information, waste impacts would be SMALL for a new single-unit nuclear plant located at the GGNS site.

8.1.14 Summary of Impacts of New Nuclear Generation

Table 8–2 summarizes the environmental impacts of the new nuclear alternative compared to continued operation of GGNS.

Table 8–2. Summary of Environmental Impacts of the New Nuclear Alternative Compared to Continued Operation of GGNS

Category	New Nuclear Generation (use existing infrastructure)	Continued GGNS Operation
Air Quality	SMALL	SMALL
Groundwater Resources	SMALL	SMALL
Surface Water Resources	SMALL	SMALL
Aquatic Ecology	SMALL	SMALL
Terrestrial Ecology	SMALL to MODERATE	SMALL
Human Health	SMALL	SMALL
Land Use	SMALL	SMALL
Socioeconomics	SMALL to LARGE	SMALL
Transportation	SMALL to LARGE	SMALL
Aesthetics	SMALL	SMALL
Historic and Archaeological Resources	SMALL	SMALL
Waste Management [a]	SMALL	SMALL

[a] As described in Chapter 6, the issue, "offsite radiological impacts (spent fuel and high level waste disposal)," is not evaluated in this EIS.

8.2 Natural Gas-Fired Combined-Cycle Generation

In this section, the NRC evaluates the environmental impacts of natural gas-fired combined-cycle (NGCC) generation at the GGNS site.

In 2010, natural gas accounted for 54 percent of all electricity generated in Mississippi, a 144 percent increase from 10 years earlier in 2000 (EIA 2012b). Natural gas provides the greatest share of electrical power in Mississippi (EIA 2012b). Development of new natural gas-fired plants may be affected by perceived or actual action to limit greenhouse gas (GHG) emissions. Like other fossil fuel sources, natural gas-fired plants are a source of GHG, principally carbon dioxide (CO_2). A gas-fired power plant, however, produces significantly fewer GHGs per unit of electrical output than other fossil fuel-powered plants. In addition, NGCC systems can have high capacity factors and are capable of economically providing baseload power. Natural gas-fired power plants are a feasible and commercially available option for providing baseload electrical generating capacity beyond GGNS's current license expiration.

Therefore, the NRC considered NGCC generation a reasonable alternative to GGNS license renewal.

NGCC plants differ considerably from coal-fired boilers and existing nuclear power plants. NGCC plants obtain the majority of their electrical output from a gas-turbine and subsequently generate additional power through a second steam turbine-cycle without any fuel combustion. This combined-cycle approach provides greater thermal efficiency than a single-cycle system, with efficiencies reaching 60 percent (as compared to typical thermal efficiencies of coal-fired plants of 39 percent) (Siemens 2007, NETL 2007). Because the natural gas-fired alternative generates much of its power from a gas-turbine combined-cycle plant and the overall thermal efficiency of this type of plant is high, an NGCC alternative would require less cooling water than GGNS. Thus, the NRC assumed that the NGCC alternative would use the existing cooling system (including natural draft cooling towers and intake and discharge structures), and that the cooling system at GGNS could meet the heat-rejection demands of the NGCC alternative with no structural modifications.

To replace the 1,475 MWe that GGNS generates, the NRC considered three hypothetical gas-fired units, each with a net capacity of 530 MWe, for the NGCC alternative. For purposes of this analysis, the hypothetical units would be similar to General Electric's (GE's) H-class gas-fired combined-cycle units. While any number of commercially available combined-cycle units could be installed in a variety of combinations to replace the power GGNS currently produces, GE's H-class units are highly efficient models that would minimize environmental impacts. Other manufacturers, such as Siemens, offer similar high efficiency models.

This 1,590 MWe NGCC plant would consume 70.7 billion cubic feet (ft^3) (2,000 million cubic meters [m^3]) of natural gas annually, assuming an average heat content of 1,020 British thermal unit(s) per cubic feet (BTU/ft^3). Natural gas would be extracted from the ground through wells, then treated to remove impurities (such as hydrogen sulfide), and blended to meet pipeline gas standards before arriving at the plant site. This gas-fired alternative would produce relatively little waste, primarily in the form of spent catalysts used for control of nitrogen oxide (NO_x) emissions.

GGNS is situated on a 2,100 ac (850 ha) site. Approximately 1,000 ac (405 ha) are located in a floodplain and not suitable for a NGCC plant, and 169 ac (68 ha) are dedicated to existing GGNS facilities and structures. Entergy's ER concluded that buildable land of sufficient acreage and appropriate location would be available to support an onsite NGCC plant (Entergy 2011). Site crews would clear vegetation, prepare the site surface and relocate existing facilities, if necessary, and begin excavations for foundations and buried utilities before other crews begin actual construction on the plant and associated infrastructure. The three NGCC units would be approximately 100 feet (ft) (30 meters [m]) tall, with two exhaust stacks up to 150 ft (46 m) tall. Also, offsite impacts would occur as a result of construction of a natural gas pipeline connecting the site to existing infrastructure.

8.2.1 Air Quality

The GGNS site is located in Claiborne County, Mississippi, which is on the western edge of the Mobile (Alabama)-Pensacola-Panama City (Florida)-Southern Mississippi Interstate Air Quality Control Region (AQCR) (40 CFR 81.68). The area across the Mississippi River from the site is in the Monroe (Louisiana)-El Dorado (Arkansas) Interstate AQCR (40 CFR 81.92). EPA has designated all of the counties in these AQCRs adjacent to the GGNS site as in compliance with the National Ambient Air Quality Standards (NAAQS) (40 CFR 81.310). The State of Mississippi is in attainment with NAAQS for all criteria pollutants, except De Soto County, which is located about 200 miles (322 km) north-northeast of GGNS and part of which recently was designated as a marginal nonattainment area for the 2008 8-hour ozone standard.

Construction activities for this alternative would generate fugitive dust. However, mitigation measures, including wetting of unpaved roads and construction areas, and seeding or mulching bare areas would minimize fugitive dust. Construction worker vehicles and motorized construction equipment would create exhaust emissions. However, these emissions would end upon completion of construction.

Various Federal and state regulations aimed at controlling air pollution would affect a fossil fuel-fired power plant, including an NGCC alternative located in Mississippi. A new NGCC plant, which will be located in an attainment or unclassified area, would qualify as a new major-emitting industrial facility and would be subject to Prevention of Significant Deterioration (PSD) requirements under the Clean Air Act (CAA) (EPA 2012a). The NGCC alternative would need to comply with the standards of performance for electric utility steam generating units set forth in 40 CFR Part 60 Subpart KKKK. The plant also would require an operating permit from MDEQ.

If the NGCC alternative were located close to a mandatory Class I area, additional air pollution control requirements would be required (Subpart P of 40 CFR Part 51) as mandated by the Regional Haze Rule. The rule would likely not apply to this NGCC alternative, however, because there are no Class I Federal areas within 186 mi (300 km) of the GGNS site (EPA 2012b).

The emissions from the NGCC alternative, projected by the staff based on published EIA data, EPA emission factors, performance characteristics for this alternative, and likely emission controls, would be:

- sulfur oxides (SO_x)—123 tons (111 metric tons [MT]) per year
- nitrogen oxides (NO_x)—469 tons (425 MT) per year
- particulate matter ≤ 10 μm (PM_{10}) and ≤ 2.5 μm ($PM_{2.5}$)—238 tons (216 MT) per year
- carbon monoxide (CO)—1,082 tons (982 MT) per year
- carbon dioxide (CO_2)—4.0 million tons (3.6 million MT) per year

8.2.1.1 Sulfur Oxide and Nitrogen Oxide

As stated above, the NGCC alternative would produce 123 tons (111 MT) per year of SO_x and 469 tons (425 MT) per year of NO_x based on the use of dry low-NO_x combustion technology and use of selective catalytic reduction to significantly reduce NO_x emissions. The new plant would be subjected to the continuous monitoring requirements of SO_2 and NO_x as specified in 40 CFR Part 75.

8.2.1.2 Greenhouse Gases

The NGCC alternative would release GHGs, such as CO_2 and methane. The NGCC alternative would emit approximately 4.0 million tons (approximately 3.6 million MT) per year of CO_2 emissions. The plant would be subjected to continuous monitoring requirements for CO_2, as specified in 40 CFR Part 75.

On July 12, 2012, EPA issued a final rule tailoring the criteria that determine which stationary sources and modification to existing projects become subject to permitting requirements for GHG emissions under the PSD and Title V Programs of the CAA (77 FR 41051). According to this rule, GHGs are a regulated new source review pollutant under the PSD major source permitting program if the source is otherwise subject to PSD (for another regulated new source review pollutant) and has a GHG potential to emit equal to or greater than 75,000 tons (68,000 MT) per year of CO_2 equivalent ("carbon dioxide equivalent" adjusts for different global warming potentials for different GHGs). Beginning January 2, 2011, operating permits issued to major sources of GHGs under the PSD or Title V Federal permit programs must contain provisions requiring the use of Best Available Control Technology (BACT) to limit the emissions of GHGs if those sources would be subject to PSD or Title V permitting requirements. If the NGCC alternative meets the GHG emission thresholds established in the rule, then GHG emissions from this alternative would be regulated under the PSD and Title V permit programs.

8.2.1.3 Particulates

The NGCC alternative would produce uncontrolled emission of 238 tons (216 MT) per year of particulates, all of which would be emitted as PM_{10} and $PM_{2.5}$. Small amounts of particulate would be released as drift from the cooling tower. However, because the NGCC facility would have a smaller heat rejection demand than GGNS, the drift would be less than what is currently released from the cooling tower at GGNS.

As described above, onsite activities during the construction of an NGCC plant would generate fugitive dust as well as exhaust emissions from vehicles and motorized equipment. These impacts would be short-term and construction crews would use applicable dust control measures to minimize dust generation.

8.2.1.4 Hazardous Air Pollutants

In December 2000, EPA issued regulatory findings (65 FR 79825) on emissions of hazardous air pollutants (HAPs) from electric utility steam-generating units, which identified that natural gas-fired plants emit HAPs such as arsenic, formaldehyde and nickel and stated:

> . . . the impacts due to HAP emissions from natural gas-fired electric utility steam generating units were negligible based on the results of the study. The Administrator finds that regulation of HAP emissions from natural gas-fired electric utility steam generating units is not appropriate or necessary.

As a result of the EPA Administrator's conclusion, the staff finds no significant air quality effects from HAPs.

8.2.1.5 Conclusion

The impact from SO_2 and NO_X emissions would be noticeable and subject to a Title V permit. GHG emissions also would be noticeable; CO_2 emissions would be almost two orders of magnitude larger than the threshold in EPA's tailoring rule for GHG (75,000 tons [68,000 MT] per year of carbon dioxide equivalent) that would trigger a regulated new source review. The overall air quality impacts associated with construction and operation of an NGCC alternative located at the GGNS site would be SMALL to MODERATE.

8.2.2 Groundwater Resources

The amount of groundwater required for construction of the NGCC alternative would be much less than required during plant operation. Water for construction would be obtained from the existing Ranney wells. Groundwater quality and use impacts from construction of the NGCC alternative are expected to be SMALL.

The amount of water required to operate the three-unit NGCC alternative would be less than that required for the existing power plant. Cooling water would be obtained from the existing Ranney wells. Potable water and other plant groundwater requirements would be similar to

GGNS. Groundwater quality and use impacts from operation of the NGCC alternative are expected to be SMALL.

8.2.3 Surface Water Resources

If dredging of streams or rivers occurs during construction, surface water quality immediately downstream of the dredging activities could be temporarily degraded by increased suspended sediment. During plant operations, an NGCC alternative would discharge cooling system blowdown at approximately half of the current facility rate. Stormwater discharge, blowdown, sanitary, and other effluents would be permitted under an NPDES permit. Given these assumptions, the impacts on surface water use and quality would be SMALL.

8.2.4 Aquatic Ecology

Construction activities for the NGCC alternative (such as construction of heavy-haul roads, a new pipeline, and the power block) could affect onsite aquatic features, including the Mississippi River near GGNS, Hamilton and Gin Lakes, a borrow pit, three small ponds, streams “A” and “B,” and ephemeral drainages. Minimal impacts on aquatic resources are expected because the plant operator would likely implement BMPs to minimize erosion and sedimentation. Stormwater control measures, which would be required to comply with Mississippi NPDES permitting, would minimize the flow of disturbed soils into aquatic habitats. To bring new materials to the site, NRC assumed the plant operator would dredge near the barge slip to transport some materials using barges, which could result in increased sedimentation and turbidity within aquatic habitats in the Mississippi River. Permits and certifications from the U.S. Army Corps of Engineers and other agencies would require the implementation of BMPs to minimize impacts. Due to the short-term nature of the dredging activities, the hydrological alterations to aquatic habitats would be localized and temporary.

During operations, the NGCC alternative would require less cooling water to be withdrawn from Ranney wells, and less water to be discharged into the Mississippi River than required for GGNS. Therefore, thermal impacts would be less for the NGCC alternative than GGNS. The cooling system for a new NGCC plant would have similar chemical discharges as GGNS. Air emissions from the NGCC plant would emit particulates that would settle onto the river surface and introduce a new source of pollutants as described in Section 8.1.1. However, the flow of the Mississippi River would likely dissipate and dilute the concentration of pollutants resulting in minimal exposure to aquatic biota.

Consultation under several Federal acts, including the ESA and Magnuson-Stevens Act, would be required to assess the occurrence and potential impacts to Federally protected aquatic species and habitats within affected surface waters. Coordination with State natural resource agencies would further ensure that the NGCC operator would take appropriate steps to avoid or mitigate impacts to State-listed species, habitats of conservation concern, and other protected species and habitats. The NRC assumes that these consultations would result in avoidance or mitigation measures that would minimize or eliminate potential impacts to protected aquatic species and habitats.

The impacts on aquatic ecology would be minor because construction activities would require BMPs and stormwater management permits. Also, surface water discharge for this alternative would be less than for GGNS. Deposition of pollutants into aquatic habitats from the plant’s air emissions would be minimal because the concentration of pollutants would be diluted with the river flow. Therefore, the staff concludes that impacts on aquatic ecology would be SMALL.

8.2.5 Terrestrial Ecology

Construction of an NGCC alternative would occur on the GGNS site and would use existing transmission lines. Because the onsite land requirement is relatively small (225 ac [91 ha]), the entire NGCC alternative construction footprint would likely be sited in already developed areas of the GGNS site, which would minimize impacts to terrestrial habitats and species. However, the level of direct impacts would vary based on the specific location of new buildings and infrastructure on the site. Offsite construction would occur mostly on land where gas extraction is already occurring. Erosion and sedimentation, fugitive dust, and construction debris impacts would be minor with implementation of BMPs. Construction noise could modify wildlife behavior; however, these effects would be temporary. Road improvements or construction of additional service roads to facilitate construction could result in the temporary or permanent loss of terrestrial habitat. Construction of gas pipelines along existing, previously disturbed utility corridors would result in temporary noise and displacement of wildlife, but would minimize the removal or destruction of undisturbed habitats. Impacts to terrestrial habitats and species from transmission line operation and corridor vegetation maintenance, and operation of the cooling towers would be similar in magnitude and intensity as those resulting from GGNS and would, therefore, be SMALL. Overall, the impacts of construction and operation of an NGCC alternative to terrestrial habitats and species would be SMALL to MODERATE.

As discussed under aquatic ecology impacts, consultation with the FWS under the ESA would ensure that the construction and operation of an NGCC alternative would not adversely affect any Federally listed species or adversely modify or destroy designated critical habitat. Coordination with State natural resource agencies would further ensure that the NGCC operator would take appropriate steps to avoid or mitigate impacts to State-listed species, habitats of conservation concern, and other protected species and habitats. The NRC assumes that these consultations would result in avoidance or mitigation measures that would minimize or eliminate potential impacts to protected terrestrial species and habitats. Consequently, the impacts of construction and operation of a new nuclear alternative on protected species and habitats would be SMALL.

8.2.6 Human Health

Impacts on human health from construction of the NGCC alternative would be similar to impacts associated with the construction of any major industrial facility. Compliance with worker protection rules would control those impacts on workers at acceptable levels. The plant operator would likely follow BMPs, such as limiting active construction area access to authorized individuals. Impacts on human health from the construction of the NGCC alternative would be SMALL.

During operations, human health effects of gas-fired generation are generally low. However, in Table 8.2 of the GEIS (NRC 1996), the staff identified cancer and emphysema as potential health risks from gas-fired plants. NO_x emissions contribute to ozone formation, which in turn contributes to human health risks. Emission controls on the NGCC alternative can be expected to maintain NO_x emissions well below air quality standards established to protect human health, and emissions trading or offset requirements mean that overall NO_x releases in the region would not increase. Health risks for workers also may result from handling spent catalysts used for NO_x control that may contain heavy metals. However, health risks can be minimized through the use of occupational health and safety procedures and protective equipment. Impacts on human health from the operation of the NGCC alternative would be SMALL.

8.2.7 Land Use

The GEIS generically evaluates the impact of constructing and operating various replacement power plant alternatives on land use, both on and off each plant site. The analysis of land use impacts focuses on the amount of land area that would be affected by the construction and operation of a three-unit NGCC power plant at the GGNS site. Locating the new NGCC power plant at the GGNS site would maximize the availability of support infrastructure and reduce the need for additional land.

Entergy estimated 195 acres (79 hectares) would be required for construction of power block, support facilities and a natural gas pipeline to the nearest natural gas distribution line for a 1,584 MWe NGCC alternative (Entergy 2011). Depending on the location and availability of existing natural gas pipelines, a 100-ft-wide right-of-way would be needed for a new pipeline. Land use impacts from NGCC construction would be SMALL to MODERATE.

In addition to onsite land requirements, land would be required off site for natural gas wells and collection stations. Scaling from GEIS estimates, approximately 5,700 ac (2,307 ha) (based on 3,600 ac per 1,000 MWe and 1,584 MWe for NGCC) (NRC 1996) would be required for wells, collection stations, and pipelines to bring the gas to the plant. Most of this land requirement would occur on land where gas extraction already occurs.

The elimination of uranium fuel for GGNS would partially offset some of the land requirements for an NGCC alternative. Scaling from GEIS estimates, approximately 1,033 ac (418 ha) (based on 35 ac/yr disturbed per 1,000 MWe for 20 yr) would no longer be needed for mining and processing uranium during the operating life of the plant (NRC 1996). Land use impacts during power plant operations would be SMALL.

8.2.8 Socioeconomics

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of a power plant could affect regional employment, income, and expenditures.

The alternative would create two types of jobs: (1) construction jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact; and (2) power plant operation jobs, which have a greater potential for permanent, long-term socioeconomic impacts. Workforce requirements for the construction and operation of the NGCC alternative were evaluated for their possible effects on current socioeconomic conditions.

Scaling from GEIS estimates, the construction workforce would peak at 1,900 workers. The relative economic impact of this many workers on the local economy and tax base would vary with the greatest impacts occurring in the communities where the majority of construction workers would reside and spend their income. As a result, local communities could experience a short-term economic “boom” from increased tax revenue and income generated by construction expenditures and the increased demand for temporary (rental) housing and business services.

After completing the installation of the three-unit NGCC plant, local communities could experience a return to pre-construction economic conditions. Based on this information and given the number of workers, socioeconomic impacts during construction in communities near the GGNS site could range from SMALL to MODERATE.

Scaling from GEIS estimates, an NGCC alternative would employ approximately 150 workers during operation. GGNS has an operation workforce of approximately 690. The potential reduction in overall employment at the GGNS site would likely affect property tax revenue and income in local communities and businesses. In addition, the permanent housing market could also experience increased vacancies and decreased prices if operations workers and their families move out of the region. Socioeconomic impacts during operations of an NGCC alternative could range from SMALL to MODERATE.

8.2.9 Transportation

Transportation impacts associated with construction and operation of an NGCC alternative would consist of commuting workers and truck deliveries of construction materials. During periods of peak construction activity, up to 1,900 worker would be commuting daily to GGNS, a substantial increase from the GGNS current operational force of 690 workers. The increase in vehicular traffic would peak during shift changes, resulting in temporary levels of service impacts and delays at intersections. Pipeline construction and modification to existing natural gas pipeline systems could also have a temporary impact. Materials also could be delivered by barge or rail. Traffic-related transportation impacts during construction likely would be MODERATE.

Traffic-related transportation impacts would be greatly reduced after completing the installation of the NGCC alternative. Transportation impacts would include daily commuting by the operating workforce, equipment and materials deliveries, and the removal of commercial waste material to offsite disposal or recycling facilities by truck. The estimated NGCC alternative operation workforce of approximately 150 is considerably less than the GGNS operation workforce of approximately 690. Traffic-related transportation impacts would be considerably less than current operations because an NGCC alternative would employ far fewer workers than the existing GGNS. Since fuel is transported by pipeline, the transportation infrastructure would experience little to no increased traffic from fuel operations. Overall, transportation impacts would be SMALL during plant operations.

8.2.10 Aesthetics

The analysis of aesthetic impacts focuses on the degree of contrast between an NGCC alternative and the surrounding landscape and the visibility of an NGCC alternative at the GGNS site. During construction, clearing and excavation would occur on site. Some of these activities may be visible from offsite roads. Since the GGNS site already appears industrial, construction of an NGCC alternative would appear similar to onsite activities during refueling outages.

The three NGCC units would be approximately 100 ft (30 m) tall, with exhaust stacks up to 150 ft (46 m) tall. The facility would be visible off site during daylight hours, and some structures may require aircraft warning lights. The plant would use the existing natural draft cooling tower, which is over 500 ft (152 m) high (Entergy 2011). Noise generated during NGCC power plant operations would be limited to routine industrial processes and communications. Pipelines delivering natural gas fuel could be audible off site near gas compressor stations.

In general, given the industrial appearance of the GGNS site, an NGCC alternative would blend in with the surroundings if the existing GGNS facility remains. Aesthetic changes would be limited to the immediate vicinity of the existing GGNS site, and any impacts would be SMALL.

8.2.11 Historic and Archaeological Resources

The potential for impacts on historic and archaeological resources from an NGCC alternative would vary greatly depending on the location of the proposed plants on the GGNS site. Any construction would need to avoid the previously identified Grand Gulf Mound area (Site 22Cb522) and Archaic Period village (22Cb528) as described in Section 2.2.10.2 of this document. As portions of the GGNS site have been previously identified as not containing significant historic and archaeological resources, use of these areas for an NGCC alternative would result in a SMALL impact on historic and archaeological resources. Alternate plant and new pipeline locations would need to be surveyed and inventoried for potential resources. Resources found in these surveys would need to be evaluated for eligibility on the National Register of Historic Places (NRHP) and mitigation of adverse effects would need to be addressed if eligible resources were encountered. The level of impact at these locations would vary depending on the specific resources found to be present in the area of potential effect. However, given that the preference is to use previously surveyed and/or disturbed areas, avoidance of significant historic and archaeological resources should be possible and effectively managed under current laws and regulations. Therefore, the impacts on historic and archaeological resources from the NGCC alternative would be SMALL.

8.2.12 Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health, environmental, and socioeconomic effects on minority and low-income populations that could result from the construction and operation of a new power plant. As previously discussed in Section 8.1.12, such effects may include human health, biological, cultural, economic, or social impacts. Section 4.10.7, Environmental Justice, presents demographic information about minority and low-income populations residing in the vicinity of the GGNS site.

Potential impacts to minority and low-income populations from the construction and operation of an NGCC alternative at the GGNS site would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). Noise and dust impacts during construction would be short-term and primarily limited to onsite activities. Minority and low-income populations residing along site access roads would be directly affected by increased commuter and truck traffic. However, because of the temporary nature of construction, these effects are not likely to be high and adverse and would be contained to a limited time period during certain hours of the day. Increased demand for rental housing during construction could cause rental costs to rise disproportionately affecting low-income populations living near GGNS who rely on inexpensive housing. However, given the proximity of GGNS to the Jackson and Vicksburg metropolitan areas, workers could commute to the construction site, thereby reducing the need for rental housing.

As discussed in Section 4.10.7.1, 144 of the 294 census block groups located within the 50-mi (80-km) radius of GGNS were determined to have meaningfully greater minority populations than the other census block groups within the 50-mi (80-km) radius of GGNS. However, emissions from the NGCC alternative are expected to be maintained within regulatory standards. Accordingly, disproportionately high and adverse impacts on minority and low income populations are not expected.

Based on this information and the analysis of human health and environmental impacts presented in this section, the construction and operation of an NGCC alternative would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations in the vicinity of GGNS.

8.2.13 Waste Management

During the construction stage of this alternative, land clearing and other construction activities would generate waste that can be recycled, disposed of on site, or shipped to an offsite waste disposal facility. Because an NGCC alternative would most likely be constructed on previously disturbed portions of the GGNS site, the amount of wastes produced during land clearing would be minimal.

During the operational stage, spent selective catalytic reduction catalysts used to control NO_x emissions would make up the majority of the industrial waste generated by this alternative. Because the specific NO_x emission control equipment cannot be specified at this time, the amount of spent catalysts that would be generated during each year of operation of the NGCC alternative also cannot be calculated with precision. However, the amount would be modest. During operations, domestic and sanitary wastes would be expected to decrease from amounts now generated because of a reduced operating workforce for the NGCC alternative in comparison to GGNS.

According to the GEIS (NRC 1996) a natural gas-fired plant would generate minimal waste; therefore, waste impacts would be SMALL for an NGCC alternative located at the GGNS site.

8.2.14 Summary of Impacts of NGCC Alternative

Table 8–3 summarizes the environmental impacts of the NGCC alternative compared to continued operation of GGNS.

Table 8–3. Summary of Environmental Impacts of the NGCC Alternative Compared to Continued Operation of GGNS

Category	NGCC Alternative (use existing infrastructure)	Continued GGNS Operation
Air Quality	SMALL to MODERATE	SMALL
Groundwater Resources	SMALL	SMALL
Surface Water Resources	SMALL	SMALL
Aquatic Ecology	SMALL	SMALL
Terrestrial Ecology	SMALL to MODERATE	SMALL
Human Health	SMALL	SMALL
Land Use	SMALL to MODERATE	SMALL
Socioeconomics	SMALL to MODERATE	SMALL
Transportation	SMALL to MODERATE	SMALL
Aesthetics	SMALL	SMALL
Historic and Archaeological Resources	SMALL	SMALL
Waste Management [a]	SMALL	SMALL

[a] As described in Chapter 6, the issue, "offsite radiological impacts (spent fuel and high level waste disposal)," is not evaluated in this EIS.

8.3 Supercritical Pulverized Coal-Fired Generation

In this section, the NRC evaluates the environmental impacts of supercritical pulverized coal (SCPC) generation.

In 2010, coal-fired generation accounted for 25 percent of all electricity generated in Mississippi, a 32 percent decrease from 10 years earlier in 2000 (EIA 2012b). Coal provides the second greatest share of electrical power in Mississippi (EIA 2012b). Historically, coal has been the largest source of electricity in the United States and is expected to remain so through 2035 (EIA 2011a). Supercritical coal-fired plants are a feasible, commercially available option for providing electrical generating capacity beyond GGNS's current license expiration. Therefore, the NRC considered supercritical coal-fired generation a reasonable alternative to GGNS license renewal.

Baseload coal units have proven their reliability and can routinely sustain capacity factors as high as 85 percent. Among the technologies available, pulverized coal boilers producing supercritical steam (SCPC boilers) are increasingly common for new coal-fired plants given their generally high thermal efficiencies and overall reliability. Although SCPC facilities are more expensive to construct than subcritical coal-fired plants, SCPC facilities consume less fuel per unit output, reducing environmental impacts. In a supercritical coal-fired power plant, burning coal heats pressurized water. As the supercritical steam and water mixture moves through plant pipes to a turbine generator, the pressure drops and the mixture flashes to steam. The heated steam expands across the turbine stages, which then spin and turn the generator to produce electricity. After passing through the turbine, any remaining steam is condensed back to water in the plant's condenser.

To replace the 1,475 MWe that GGNS generates, the NRC considered three hypothetical SCPC units, each with a net capacity of 538 MWe. The hypothetical SCPC alternative would be located at a site other than GGNS because insufficient space exists at the GGNS site to support this alternative (Entergy 2011). The NRC assumes that the SCPC site would be located in Mississippi. Using an existing site (such as an existing power plant site) would maximize availability of infrastructure and reduce disruption to land and populations. However, impacts would be greater if the SCPC alternative were located at a site that has been previously disturbed but not located at an existing power plant site. For example, the site might need new intake and discharge facilities and a new cooling system. The SCPC alternative would use about the same amount of water as GGNS, and the NRC assumes the cooling system would use a closed-cycle system with natural draft cooling towers.

Various coal sources are available to coal-fired power plants in Mississippi. For the purpose of this evaluation, the NRC assumes that the SCPC alternative would burn a combination of lignite, bituminous, and subbituminous coal, based on the type of coal used in electric plants in Mississippi. Coal-fired power plants in Mississippi are fueled by coal shipped primarily from Mississippi, Colorado, and Wyoming. EIA reported that in 2009, Mississippi produced electricity from coal with a heating value of 8,541 BTU/lb, sulfur content of 0.53 percent, and ash content of 11.27 percent (EIA 2010a). The NRC used a CO_2 emission factor of 210 lb/million BTU for CO_2 calculations in this evaluation, based on the type of coal burned in Mississippi and CO_2 emissions factors for types of coal as reported by the EIA (EIA 2012c). Based on technology forecasts from EIA, the staff expects that the SCPC alternative would operate at a heat rate of 8,740 BTU/kWh (EIA 2011b). Depending on the specific site, construction of onsite visible structures could include the boilers, exhaust stacks, intake/discharge structures, transmission lines, and an electrical switchyard. Based on GEIS estimates, the SCPC alternative would require approximately 2,744 ac (1,110 ha) of land, although it is assumed that most of this land would have been previously disturbed. To build the SCPC alternative, site crews would clear the plant site of vegetation, prepare the site surface, and begin excavation before other crews began actual construction on the plant and associated infrastructure. Construction materials would be delivered by rail spur, truck, or barge.

The NRC also considered an integrated gasification combined-cycle (IGCC) coal-fired plant. IGCC is an emerging technology for generating electricity with coal that combines modern coal gasification technology with both gas-turbine and steam-turbine power generation. The technology is cleaner than conventional pulverized coal plants because major pollutants can be removed from the gas stream before combustion. An IGCC alternative would also generate less waste than the pulverized coal-fired alternative. IGCC units do not produce ash or scrubber wastes. In spite of the advantages, the NRC concludes that a new IGCC plant is not a reasonable alternative for the following reasons:

- The few existing IGCC plants in the United States have considerably smaller capacity (approximately 250 MWe each) than GGNS (1,475 MWe);
- System reliability of existing IGCC plants has been lower than pulverized coal plants;
- IGCC plants are more expensive than comparable pulverized coal plants (NETL 2007);
- Existing IGCC plants have had an extended (though ultimately successful) operational testing period (NPCC 2005); and,
- A lack of overall plant performance warranties for IGCC plants has hindered commercial financing (NPCC 2005).

Mississippi Power is constructing a 582 MWe IGCC plant in Kemper County, Mississippi. The plant is scheduled to begin operations in May 2014 and is experiencing legal, regulatory, and financial challenges (Reuters 2012).

8.3.1 Air Quality

Mississippi contains three designated air quality control regions: the Northeast Mississippi Intrastate Air Quality Control Region (AQCR); the Mobile (Alabama)-Pensacola-Panama City (Florida)-Southern Mississippi Interstate AQCR; and, the Mississippi Delta Intrastate AQCR (40 CFR 81.62, 40 CFR 81.68, 40 CFR 81.122). The State of Mississippi is in attainment with national primary and secondary air quality standards for all criteria pollutants, except De Soto County which is located about 200 miles (322 km) north-northeast of GGNS and part of which is designated as a marginal nonattainment area for the 2008 8-hour ozone standard.

Construction activities for this alternative would generate fugitive dust. However, mitigation measures, including wetting of unpaved roads and construction areas, and seeding or mulching bare areas would minimize fugitive dust. Construction worker vehicles and motorized construction equipment would create exhaust emissions. However, these emissions would end upon completion of construction.

Various Federal and State regulations aimed at controlling air pollution would affect the SCPC alternative. A new SCPC plant would qualify as a new major-emitting industrial facility and would require a PSD permit if the location is in attainment or unclassifiable with the NAAQS and a Title V operating permit that would specify limits to emissions of all criteria pollutants.

The SCPC alternative would also need to comply with new source performance standards (see 40 CFR 60 Subpart Da and limits for particulate matter and opacity (40 CFR 60.42(a)), SO_2 (40 CFR 60.43(a)), and NO_x (40 CFR 60.44 Subpart Da(a)(1)). If the SCPC alternative were located close to a mandatory Class I area, additional air pollution control requirements would be required (Subpart P of 40 CFR Part 51) as mandated by the Regional Haze Rule. The rule would not apply to this coal-fired alternative, however, because there are no Class I Federal areas within 186 mi (300 km) of the GGNS site (EPA 2012b).

Emissions from the SCPC alternative, projected by the staff based on published EIA data, EPA emission factors, and performance characteristics for this alternative and likely emission controls, would be:

- sulfur oxides (SO_X)—2,869 tons (2,603 MT) per year
- nitrogen oxides (NO_X)—3,118 tons (2,829 MT) per year
- particulate matter ≤ 10 μm (PM_{10})—80 tons (73 MT) per year
- particulate matter ≤ 2.5 μm ($PM_{2.5}$)—21 tons (19 MT) per year
- carbon monoxide (CO)—1,547 tons (1,403 MT) per year
- carbon dioxide (CO_2)—11.1 million tons (10.1 million MT) per year

8.3.1.1 Sulfur Oxide and Nitrogen Oxide

As stated above, the SCPC alternative would produce 2,869 tons (2,603 MT) total SO_X emissions per year. SO_2 emissions from an SCPC alternative would be subject to the requirements of Title IV of the CAA. Title IV regulations were enacted to reduce emissions of SO_2 and NO_x by restricting emissions of these pollutants from power plants. Title IV caps aggregate annual power plant SO_2 emissions and imposes controls 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 secured allowances (or offsets) from existing sources to cover their SO_2 emissions. Owners of new units must therefore purchase allowances from owners of other power plants or reduce SO_2 emissions at other power plants they own. Allowances can be banked for use in future years. Thus, provided a new SCPC power plant is able to purchase sufficient allowances to operate, it would not add to net regional SO_2 emissions, although it might do so locally.

An SCPC alternative at an alternate site would most likely employ various available NO_x control technologies, which can involve combustion modifications, post-combustion controls, or both. Combustion modifications include low-NO_x burners, overfire air, and operational modifications. Post-combustion processes include selective catalytic reduction and selective non-catalytic reduction. An effective combination of the combustion modifications and post-combustion processes allow the reduction of NO_x emissions by up to 95 percent.

8.3.1.2 Greenhouse Gases

An SCPC alternative would release GHGs, such as CO_2 during operations as well as during mining, processing, and transportation, which the GEIS indicates could contribute to global warming and connected climate changes. The amount of CO_2 released per unit of power produced would depend on the quality of the fuel and the firing conditions and overall firing efficiency of the boiler. As discussed above, the NRC assumes that a coal-fired alternative would burn the same coal as was burned in Mississippi in 2009 with a CO_2 emission factor of 210 lb/million BTU.

On July 12, 2012, EPA issued a final rule tailoring the criteria that determine which stationary sources and modifications to existing projects become subject to permitting requirements for GHG emissions under the PSD and Title V Programs of the CAA (77 FR 41051). According to this rule, GHGs are a regulated new source review pollutant under the PSD major source permitting program if the source is otherwise subject to PSD (for another regulated new source review pollutant) and has a GHG potential to emit equal to or greater than 75,000 tons (68,000 MT) per year of CO_2 equivalent ("carbon dioxide equivalent" adjusts for different global warming potentials for different GHGs). Beginning January 2, 2011, operating permits issued to major sources of GHGs under the PSD or Title V Federal permit programs must contain provisions requiring the use of Best Available Control Technology (BACT) to limit the emissions of GHGs if those sources would be subject to PSD or Title V permitting requirements. If the SCPC alternative meets the GHG emission thresholds established in the rule, then GHG emissions from this alternative would be regulated under the PSD and Title V permit programs.

8.3.1.3 Particulates

As described above, onsite activities during the construction of an SCPC alternative would also generate fugitive dust as well as emissions from vehicles and motorized equipment. These impacts would be intermittent, temporary, and minimized by dust-control measures.

During operations, the SCPC alternative would produce 80 tons (73 MT) per year and 21 tons (19 MT) per year of particulate matter PM_{10} and $PM_{2.5}$, respectively. The SCPC alternative would use fabric filters to remove particulates from flue gases with an expected 99.9 percent removal efficiency (NETL 2007). Coal-handling equipment would introduce fugitive dust emissions when fuel is being transferred to onsite storage and then moved from storage for use in the plant.

8.3.1.4 Hazardous Air Pollutants

In addition to being major sources of criteria pollutants, coal-fired plants can also be sources of HAPs as a result of hazardous constituents contained in the coal. EPA has determined that coal- and oil-fired electric utility steam-generating units are significant emitters of the following HAPs: arsenic, beryllium, cadmium, chromium, dioxins, hydrogen chloride, hydrogen fluoride, lead, manganese, and mercury (EPA 2000b). EPA concluded that mercury is the HAP of greatest concern and that (1) a link exists between coal combustion and mercury emissions, (2) electric utility steam-generating units are the largest domestic source of mercury emissions, and (3) certain segments of the U.S. population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health effects resulting from mercury exposures caused by the consumption of contaminated fish (EPA 2000b). Consequently, the SCPC alternative would be subject to the Mercury and Air Toxics Standards rule that was finalized in March 2011. The rule set technology-based emission limitation standards for all HAPs. The rule applies to coal-fired power plants with a capacity of 25 MWe or greater.

8.3.1.5 Conclusion

While the GEIS mentions global warming from unregulated CO_2 emissions and acid rain from SO_2 and NO_x emissions as potential impacts, it does not quantify emissions from coal-fired power plants. However, the GEIS does imply that air impacts from coal plant operation would be substantial (NRC 1996). The above analysis shows that emissions of air pollutants, including SO_x, NO_x, CO, and particulates, far exceed those produced by the existing nuclear power plant during operation, as well as those of the other fossil fuel alternatives considered in this section. The NRC analysis of air quality impacts for an SCPC alternative indicates that impacts would have clearly noticeable effects, but given existing regulatory regimes, permit requirements, and emissions controls, the coal-fired alternative would not destabilize air quality. Federal and state regulations would require the installation of pollution control equipment to meet applicable local requirements and permit conditions and may eventually require participation in emissions trading scenarios. Therefore, air impacts from an SCPC alternative located at an alternate site would be MODERATE.

8.3.2 Groundwater Resources

The amount of groundwater required for construction of the SCPC alternative would be much less than required during plant operation. NRC assumes that ground water use for construction would comply with State and local permit and monitoring requirements. Groundwater quality and use impacts from construction of the SCPC alternative are expected to be SMALL.

The amount of water required to operate the SCPC alternative would be similar to that required for GGNS. Potable water and other plant groundwater requirements would be similar to GGNS.

Coal, fly ash, and clinker storage could cause groundwater contamination, but with proper storage facility design and operation, the impacts could be mitigated. Given these assumptions, the impacts to groundwater use and quality would be SMALL.

8.3.3 Surface Water Resources

The SCPC cooling system would consist of natural draft cooling towers requiring approximately the same amount of water as the existing nuclear plant. Within the service territory, the Mississippi River, other rivers, alluvial aquifers, or reservoirs might be a source of cooling water. If the Mississippi River or its alluvial aquifer was used, other consumers of surface water are unlikely to be affected because of the large volume of water flowing within the river and in its alluvium. In other rivers, if the amount of water flowing is large, the impact on other surface water users is likely to be minor. If the water flow is moderate and there are few other surface water users, the impact on other surface water users should also be minor. However, impacts on other surface water users could result in the case of a small river with many surface water users. The NRC assumes that the SCPC would not be sited on a small river with many surface water users. These impacts could be mitigated by the use of more efficient cooling technology or other water sources (i.e., import water, perhaps by pipeline from other surface water bodies).

If dredging of streams or rivers occurs during construction, surface water quality immediately downstream of the dredging activities could be temporarily degraded by increases in suspended sediment concentration. During plant operation, surface water discharges largely would consist of cooling tower blowdown similar to GGNS. Assuming public sewers are not available, process waste and treated sanitary wastewater effluent may also be discharged to the surface water body. An NPDES permit would regulate discharges. Runoff from coal storage, fly ash, and clinker material would be controlled and regulated by an NPDES permit. Overall, impacts to surface water use and quality would be SMALL.

8.3.4 Aquatic Ecology

Construction activities for the SCPC alternative (such as construction of heavy-haul roads and the power block) could affect onsite aquatic features. Minimal impacts on aquatic ecology resources are expected because the plant operator would likely implement BMPs to minimize erosion and sedimentation. Stormwater control measures, which would be required to comply with Mississippi NPDES permitting, would minimize the flow of disturbed soils into aquatic habitats. Depending on the available infrastructure at the selected site, the SCPC alternative may require modification or expansion of the existing intake or discharge structures, or construction of new intake and discharge structures. Construction of new or modified intake and discharge structures may require dredging. In addition, dredging may be required to transport new materials to the site, which could result in increased sedimentation and turbidity. Dredging activities would require BMPs for in-water work to minimize sedimentation and erosion. Due to the short-term nature of the dredging activities, the hydrological alterations to aquatic habitats would likely be localized and temporary.

During operations, the SCPC alternative would require a similar amount of cooling water as GGNS. However, the cooling water may be withdrawn from surface water bodies, rather than from groundwater. If the cooling water is withdrawn from surface water bodies, aquatic resources may be impacted from impingement and entrainment. Impingement and entertainment would be minimized because NRC assumes that the plant would use a closed-cycle cooling system. A similar amount of water would be discharged as at GGNS. Therefore, thermal impacts would be similar for the SCPC alternative as for GGNS. The cooling system for a new SCPC plant would have similar chemical discharges as GGNS, but the air emissions from the SCPC plant would emit ash and particulates that could settle onto a river surface and introduce a new source of pollutants. However, the flow of the river would likely dissipate and dilute the concentration of pollutants resulting in minimal exposure to aquatic biota.

Consultation under several Federal acts, including the ESA and Magnuson-Stevens Act, would be required to assess the occurrence and potential impacts to Federally protected aquatic species and habitats within affected surface waters. Coordination with Mississippi natural resource agencies would further ensure that the plant operator would take appropriate steps to avoid or mitigate impacts to state-listed species, habitats of conservation concern, and other protected species and habitats. The NRC assumes that these consultations would result in avoidance or mitigation measures that would minimize or eliminate potential impacts to protected aquatic species and habitats.

The impacts on aquatic ecology would be minor because construction activities would require BMPs and stormwater management permits. Deposition of pollutants into aquatic habitats from the plant's air emissions would be minimal because the concentration of pollutants would be diluted with the river flow. Therefore, the staff concludes that impacts on aquatic ecology would be SMALL.

8.3.5 Terrestrial Ecology

Construction of an SCPC alternative would require 2,744 ac (1,110 ha) of land, which would include construction of the plant and associated infrastructure. The SCPC alternative may require up to 35,508 ac (14,370 ha) of additional land for coal mining and processing. Because of the relatively large land requirement for the site, a portion of the site would likely be land that had not been previously disturbed, which would directly affect terrestrial habitat by destroying existing vegetation communities and displacing wildlife. This alternative could also include construction of new transmission lines and a railroad spur, depending on the specific site, which would require additional habitat loss and fragmentation. Thus, the level of direct impacts would vary substantially based on site selection. Offsite construction would occur mostly on land where coal extraction is ongoing. Erosion and sedimentation, fugitive dust, and construction debris impacts would be minor with implementation of appropriate BMPs. Construction noise could modify wildlife behavior; however, these effects would be temporary. Road improvements or construction of additional service roads to facilitate construction could result in the temporary or permanent loss of terrestrial habitat. Operational impacts to terrestrial habitats and species from transmission line operation and corridor vegetation maintenance, and operation of the cooling system would be similar in magnitude and intensity as those resulting from GGNS. Because of the potentially large area of undisturbed habitat that could be affected from construction of an SCPC alternative, the impacts of construction to terrestrial habitats and species could range from MODERATE to LARGE depending on the specific site location. The impacts of operation would be SMALL to MODERATE.

As discussed under aquatic ecology impacts, consultation with FWS under the ESA would avoid potentially adverse impacts to Federally listed species or adverse modification or destruction of designated critical habitat. Coordination with State natural resource agencies would further ensure that the plant operator would take appropriate steps to avoid or mitigate impacts to State-listed species, habitats of conservation concern, and other protected species and habitats. The NRC assumes that these consultations would result in avoidance or mitigation measures that would minimize or eliminate potential impacts to protected terrestrial species and habitats. Consequently, the impacts of construction and operation of a new nuclear alternative on protected species and habitats would be SMALL.

8.3.6 Human Health

Impacts on human health from construction of the SCPC alternative would be similar to impacts associated with the construction of any major industrial facility. Compliance with worker protection rules would control those impacts on workers at acceptable levels. Impacts from construction on the general public would be minimal because the plant operator would likely follow BMPs and limit access to the active construction area to authorized individuals. Impacts on human health from the construction of the SCPC alternative would be SMALL.

Coal-fired power plants introduce worker risks from coal and limestone mining, coal and limestone transportation, and disposal of coal combustion residues and scrubber wastes. In addition, there are public risks from inhalation of stack emissions and the secondary effects of eating foods grown in areas subject to deposition from plant stacks.

Human health risks of coal-fired power plants are described, in general, in Table 8.2 of the GEIS (NRC 1996). Cancer and emphysema as a result of the inhalation of toxins and particulates are identified as potential health risks to occupational workers and members of the public (NRC 1996). The human health risks associated with coal-fired power plants, both for occupational workers and members of the public, are greater than those of the current GGNS reactor, because of exposures to chemicals such as mercury; SO_x; NO_x; radioactive elements, such as uranium and thorium contained in coal and coal ash; and polycyclic aromatic hydrocarbon (PAH) compounds, including benzo(a)pyrene.

Regulations restricting emissions enforced by either EPA or delegated state agencies have reduced potential health effects, but have not entirely eliminated them. These agencies also impose site-specific emission limits as needed to protect human health. Even if the SCPC alternative were located in a nonattainment area, emission controls and trading or offset mechanisms could prevent further regional degradation; however, local effects could be visible. Many of the byproducts of coal combustion responsible for health effects are largely controlled, captured, or converted in modern power plants, although some level of health effects may remain.

Aside from emissions impacts, the SCPC alternative introduces the risk of coal pile fires and for those plants that manage coal combustion residue liquids and sludge in waste impoundments, the release of the waste may result because of a failure of the impoundment. Good housekeeping practices to control coal dust greatly reduce the potential for coal dust explosions or coal pile fires. Although there have been several instances in recent years, sludge impoundment failures are still rare. Free water could also be recovered from such waste streams and recycled and the solid or semi-solid portions removed to permitted offsite disposal facilities.

Overall, given extensive health-based regulation and controls likely to be imposed as permit conditions applicable to waste handling and disposal, the staff expects human health impacts from operation of the SCPC alternative at an alternate site to be SMALL.

8.3.7 Land Use

The GEIS generically evaluates the impact of constructing and operating various replacement power plant alternatives on land use, both on and off each power plant site. The analysis of land use impacts focuses on the amount of land area that would be affected by the construction and operation of an SCPC power plant at an existing power plant site other than GGNS.

Based on scaled GEIS estimates, approximately 2,744 ac (1,100 ha) would be needed to support an SCPC alternative to replace GGNS, excluding land needed for coal mining and processing. It is expected that the SCPC alternative would be located at an existing power plant site or otherwise disturbed industrial site, and thus the land use impacts from construction would range from SMALL to MODERATE.

Offsite land use impacts would occur from coal mining, in addition to land use impacts from the construction and operation of the new power plant. Using the GEIS estimate, the SCPC alternative might require up to 35,508 ac (14,370 ha) of land for coal mining and waste disposal during power plant operations, based on an assumption of 22,000 ac (8,903 ha) of land required per 1,000 MWe and a 1,614 MWe SCPC plant (NRC 1996). However, much of the land in existing coal mining areas has already experienced some level of disturbance.

The elimination of uranium fuel for GGNS would partially offset some of the land requirements for the SCPC alternative. Scaling from GEIS estimates, approximately 1,033 ac (418 ha) (based on an assumption of 35 ac/yr disturbed per 1,000 MWe) would no longer be needed for mining and processing uranium during the operating life of the SCPC plant (NRC 1996). Overall, land use impacts from SCPC power plant operations would be SMALL to MODERATE depending on the extent of coal mining.

8.3.8 Socioeconomics

As previously discussed, socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social condition of a region. For example, the number of jobs created by the construction and operation of a power plant could affect regional employment, income, and expenditures. This alternative would create two types of jobs: (1) construction jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impacts; and (2) power plant operation jobs, which have a greater potential for permanent, long-term socioeconomic impacts. Workforce requirements for the construction and operation of the SCPC alternative were evaluated to measure their possible effects on current socioeconomic conditions.

Scaling from GEIS estimates, the construction workforce would peak at 4,035 workers. The relative economic impact of this many workers on the local economy and tax base would vary, with the greatest impacts occurring in the communities where the majority of construction workers would reside and spend their income. As a result, local communities could experience a short-term “boom” from increased tax revenue and income generated by construction expenditures and the increased demand for temporary (rental) housing and business services. After construction, local communities could be temporarily affected by the loss of construction jobs, the associated loss in demand for business services, and the rental housing market could experience increased vacancies and decreased prices. The impact of construction on socioeconomic conditions could range from SMALL to MODERATE because of the fluctuation of the workforce.

Scaling from GEIS estimates, the workforce during plant operations would be 404 workers. This alternative would result in a loss of approximately 690 relatively high-paying jobs at GGNS, with a corresponding reduction in purchasing activity and tax contributions to the regional economy. However, a larger amount of property taxes may be paid to local jurisdictions under the SCPC alternative as more land may be required for coal-fired power plant operations than GGNS. Therefore, socioeconomic impacts during operations could range from SMALL to MODERATE.

8.3.9 Transportation

Transportation impacts associated with construction of the SCPC alternative would consist of commuting workers and truck deliveries of construction materials. During periods of peak construction activity, 4,035 workers could be commuting daily to the site significantly adding to the normal flow of traffic (NRC 1996). Vehicular traffic would peak during shift changes, resulting in temporary levels of service impacts and delays at intersections. Materials also could be delivered by rail or barge, depending on site location. Traffic-related transportation impacts during construction likely would range from MODERATE to LARGE.

Once construction of the SCPC alternative is complete, traffic-related transportation impacts on local roads would be greatly reduced. The estimated number of operations workers would be 404 (NRC 1996). Traffic on roadways would peak during shift changes, resulting in temporary levels of service impacts and delays at intersections. Frequent deliveries of coal and limestone by rail would cause levels of service impacts on certain roads because of delays at railroad crossings. Onsite coal storage would make it possible to receive several trains per day at a site with rail access. Limestone delivered by rail could also add additional traffic (though considerably less traffic than that generated by coal deliveries). If a site on navigable waters were used, barge delivery of coal and other materials would be feasible. Overall, the SCPC alternative transportation impacts would be SMALL to MODERATE during plant operations.

8.3.10 Aesthetics

The analysis of aesthetics impacts focuses on the degree of contrast between the SCPC alternative and the surrounding landscape and the visibility of the new SCPC plant at an existing power plant site or a former plant (brownfield) site. Most construction, clearing, and excavation activities would take place within the existing power plant or brownfield site, and these activities could be visible from offsite roads. Since power plant and brownfield sites look industrial, construction-related activities would appear similar to other ongoing industrial activities.

The SCPC plant buildings would be approximately 100 ft (30 m) tall, with two to four exhaust stacks up to 150 ft (46 m) tall. The SCPS alternative would be visible offsite during daylight hours and some structures may require aircraft warning lights. Condensate plumes from the cooling towers would add to the visual impact. The cooling towers would be 400–500 ft (122–152 m) in height. The power block of the SCPC alternative could look very similar to GGNS. Noise generated during power plant operations would be limited to routine industrial processes and communications.

In general, given the industrial appearance of existing industrial and brownfield sites, the SCPC alternative would blend in with the surroundings. Aesthetic changes would therefore be limited to the immediate vicinity of the existing power plant and brownfield sites, and any impacts would be SMALL.

8.3.11 Historic and Archaeological Resources

Lands needed to support construction of an SCPC plant and associated corridors would need to be surveyed for historic and archaeological resources. Resources found in these surveys would need to be evaluated for eligibility on the National Register of Historic Properties (NRHP) and mitigation of adverse effects would need to be addressed if eligible resources were encountered. When constructing an SCPC plant on a previously disturbed former plant (brownfield) site, an inventory may still be necessary if the site has not been previously surveyed or to verify the level of disturbance and evaluate the potential for intact subsurface resources. The potential for impacts on historic and archaeological resources from the SCPC alternative would vary greatly depending on the resource richness and location of the proposed site. However, given that the preference is to use a previously disturbed former plant site, avoidance of significant historic and archaeological resources should be possible and effectively managed under current laws and regulations. Therefore, the impacts on historic and archaeological resources from the SCPC alternative would be SMALL to MODERATE.

8.3.12 Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health, environmental, and socioeconomic effects on minority and low-income populations that could result from the construction and operation of a new power plant. As previously discussed in Section 8.1.12, such effects may include human health, biological, cultural, economic, or social impacts.

Potential impacts to minority and low-income populations from the construction of an SCPC alternative would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). Noise and dust impacts from construction would be short-term and primarily limited to onsite activities. Minority and low-income populations residing along site access roads would be directly affected by increased commuter vehicle traffic during shift changes and truck traffic. However, because of the temporary nature of construction, these effects are not likely to be high and adverse and would be contained to a limited time period during certain hours of the day. Increased demand for rental housing during construction could cause rental costs to rise disproportionately affecting low-income populations who rely on inexpensive housing. However, given the likelihood of locating the SCPC alternative at the site of an existing or former power plant and the proximity of most power plant sites to metropolitan areas, workers could commute to the construction site, thereby reducing the need for rental housing.

Potential impacts to minority and low-income populations from operation of an SCPC plant would consist mainly of the effects of emissions. Because permitted emissions are expected to remain within regulatory standards, impacts are not expected to be high and adverse.

Based on this information and the analysis of human health and environmental impacts presented in this section, the construction and operation of the SCPC alternative would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

8.3.13 Waste Management

During construction of an SCPC alternative, land clearing and other construction activities would generate waste that could be recycled, disposed of on site, or shipped to an offsite waste disposal facility. Because the alternative would be constructed at an existing power plant site, or a previously disturbed site, the amounts of wastes produced during land clearing would be reduced.

The burning of coal generates coal combustion products (CCP) such as bottom ash or fly ash (a dry solid) and sludge (a semi-solid byproduct of emission control system operation). According to the American Coal Ash Association, in 2010, approximately 130 million tons of CCPs were generated by coal-fueled electric utilities. Fly ash accounted for over 67 million tons of CCP, bottom ash accounted for over 17 million tons, and scrubber sludge about 22 million tons. Approximately 38 percent of the fly ash and 42 percent of the bottom ash was recycled. Approximately 48 percent of the scrubber sludge was recycled (ACAA 2010). The boilers comprising the SCPC alternative are assumed to have the following pollution control devices:

- fabric filter for particulate control, operating at 99.9 percent removal efficiency;

- wet calcium carbonate SO_2 scrubber, operating at 95 percent removal efficiency; and
- low-NO_x burners with overfire air and selective catalytic reduction for nitrogen oxide controls capable of attaining a NO_x removal of 86 percent.

This coal-fired alternative would produce roughly 696,839 tons (632,173 MT) of ash, and 50 percent (348,420 tons [316,086 MT]) of the ash would be recycled for beneficial use.

Disposal of the remaining waste could have noticeable effects. However, proper disposal, monitoring, and management practices as required by local ordinances and State regulations would minimize these impacts. After closure of the waste site and revegetation, the land could be available for other uses.

The impacts from waste generated during operation of this SCPC alternative would be MODERATE because the impacts would be clearly visible but would not destabilize important resources.

8.3.14 Summary of Impacts of SCPC Alternative

Table 8–4 summarizes the environmental impacts of the SCPC alternative compared to continued operation of GGNS.

Table 8–4. Summary of Environmental Impacts of the SCPC Alternative Compared to Continued Operation of GGNS

Category	SCPC Alternative	Continued GGNS Operation
Air Quality	MODERATE	SMALL
Groundwater Resources	SMALL	SMALL
Surface Water Resources	SMALL	SMALL
Aquatic Ecology	SMALL	SMALL
Terrestrial Ecology	SMALL to LARGE	SMALL
Human Health	SMALL	SMALL
Land Use	SMALL to MODERATE	SMALL
Socioeconomics	SMALL to MODERATE	SMALL
Transportation	SMALL to LARGE	SMALL
Aesthetics	SMALL	SMALL
Historic and Archaeological Resources	SMALL to MODERATE	SMALL
Waste Management [a]	MODERATE	SMALL

[a] As described in Chapter 6, the issue, "offsite radiological impacts (spent fuel and high level waste disposal)," is not evaluated in this EIS.

8.4 Combination Alternative

In this section, the NRC evaluates the environmental impacts from a combination of alternatives. This combination includes 530 MWe from one NGCC unit similar to the units described in Section 8.2, 360 MWe from biomass-fired units, 280 MWe from demand-side management (DSM), and 305 MWe from purchased power.

The NRC assumed that one new NGCC unit of the type described in Section 8.2 would be constructed and installed at the GGNS site with a capacity of 530 MWe. The NRC estimates that it would require about one third of the area necessary for the alternative considered in Section 8.2 and that construction and operational effects would scale accordingly.

The NRC assumed that biomass-fired generation, located in Mississippi, would replace 360 MWe of GGNS output. Electricity generation from biomass-fired generation is currently the only commercially available renewable resource in operation in Mississippi, with a total of 235 MWe installed capacity (EIA 2012a). The development of biomass resources is also consistent with Entergy's Strategic Resource Plan (SRP). The SRP estimates about 700 MWe of new renewable energy generation (spread across Entergy's six current operating companies) will come from biomass-fired generation from 2009 to 2019 (Entergy 2009). The SRP concluded that by 2019, commercially available renewable energy is expected to be limited primarily to biomass-fired generation in Mississippi. Mississippi currently does not require electric utilities to generate a portion of their electricity from renewable sources.

The NRC assumed a DSM program would replace 280 MWe of GGNS output. Although Mississippi does not require DSM programs, Entergy commissioned a study by ICF International to calculate possible savings through a DSM program (ICF 2009). According to the study, the potential energy savings across Entergy's six operating companies could reach 729 MWe by 2019 and 1,050 MWe by 2029 (Entergy 2009). Because Entergy Mississippi, Inc. (EMI) represents 13 percent of Entergy's total energy sales, the NRC estimates that the potential savings would reach 95 MWe by 2019 and 136 MWe by 2029 in Mississippi. In addition, the Federal Energy Regulatory Commission (FERC) evaluated potential energy savings using DSM in 5- and 10-year horizons for four development scenarios that varied in level of participation (FERC 2009). FERC's analysis indicates that by the year 2019, the achievable participation scenario would yield a 1,602 MWe peak demand reduction in Mississippi (FERC 2009). Since EMI provides 34 percent of Mississippi's electricity generation, if these demand reductions were achieved, it would translate to a reduction of 539 MWe for EMI. The 280 MWe reduction in energy use for this alternative falls between the ICF International and FERC study outcomes projecting potential DSM savings. Therefore, the NRC finds 280 MWe of DSM savings to be a reasonable portion of the combination alternative. No major construction would be necessary for the DSM component of the combination alternative.

For the combination alternative, the NRC assumes that nine 50 MWe biomass-fired units with a capacity factor of 80 percent would be required to replace 360 MWe of GGNS output. Biomass resources typically include forest residue, primary mill residues, secondary mill residues, and urban wood residues (NREL 2005). The biomass-fired units would be similar in appearance and operation to fossil fuel-fired power plants. The technology used for conversion of biomass to electricity would be direct combustion, which involves the burning of biomass, producing hot gases which, in turn, boil water to produce steam. The steam is used to spin a turbine that generates electricity. Biomass combustion systems also require feedstock storage and handling systems, as well as a cooling water system with cooling towers. The NRC assumes that approximately 15 ac (6 ha) of land would be required for each 50-MWe plant, for a total of 135 ac (55 ha) (NREL 2003, Palmer Renewable Energy 2011). The combustion of biomass resources would affect air quality, but would generate fewer SO_2 and NO_x emissions per unit of energy delivered than coal. In addition, environmental impacts would occur from harvesting wood resources. Biomass-fired power plants generate greater emissions than either natural gas or nuclear plants of equal electrical generation capacity (NREL 1999).

For the combination alternative, 305 MWe would be purchased to replace that amount of GGNS generation. In its Strategic Resource Plan, Entergy's Reference Planning Scenario assumes that by the time GGNS's license expires in November 2024, EMI will purchase 500 MWe from non-Entergy generation (Entergy 2009). Therefore, it is reasonable to assume that 305 MWe will be available for purchase. The impacts of purchased power could be wide-ranging, depending on the energy type and location selected. The power would likely come from the most common types of energy generation in the region: gas, coal, or nuclear plants.

Construction and operation impacts would be similar to those described in Sections 8.1 through 8.3. The purchased power would either be purchased from existing plants, or from new plant construction, depending on the availability of power sources. Additional impacts could occur if new plants need to be built to produce the additional 305 MWe of power.

8.4.1 Air Quality

Air quality impacts would result primarily from the energy generated from the NGCC and biomass-fired units. There also would be impacts to air quality from the purchased power portion of the alternative, with the magnitude of impact dependent on the source of the purchased power. As described in Section 8.4, the purchased power would likely come from the most common types of energy generation in the region: gas, coal, or nuclear plants. Therefore, air quality impacts would be similar to those described in Sections 8.1.1, 8.2.1, and 8.3.1. Impacts to air quality from the NGCC portion would be similar to the impacts in Section 8.2.1, but scaled down by approximately one-third.

Mississippi contains three designated air quality control regions: the Northeast Mississippi Intrastate Air Quality Control Region (AQCR); the Mobile (Alabama)-Pensacola-Panama City (Florida)-Southern Mississippi Interstate AQCR; and, the Mississippi Delta Intrastate AQCR (40 CFR 81.62, 40 CFR 81.68, 40 CFR 81.122). The State of Mississippi is in attainment with national primary and secondary air quality standards for all criteria pollutants, except De Soto County which is located about 200 miles (322 km) north-northeast of GGNS and part of which is designated as a marginal nonattainment area for the 2008 8-hour ozone standard.

Construction activities for this alternative would generate fugitive dust. However, mitigation measures, including wetting of unpaved roads and construction areas, and seeding or mulching bare areas would minimize fugitive dust. Construction worker vehicles and motorized construction equipment would create exhaust emissions. However, these emissions would end upon completion of construction.

Various Federal and State regulations aimed at controlling air pollution would impact NGCC and biomass-fired facilities located in Mississippi. Both the NGCC plant and biomass-fired units would be subject to NAAQS, which would limit emissions for criteria pollutants and reflect existing ambient air quality at the selected location. Biomass-fired generation produces air quality impacts similar to that of coal. Emissions from the 50-MWe facilities may not be large individually, but cumulatively could have more significant air quality impacts. Both the NGCC and biomass-fired plants would qualify as new major emitting industrial facilities and would be subject to PSD requirements under the Clean Air Act (CAA) (EPA 2012a). The NGCC and biomass-fired plants would require Title V operating permits that would specify limits to emissions of all criteria pollutants. The NGCC portion of the alternative would need to comply with new source performance standards (40 CFR Part 60 Subpart KKKK) and the biomass-portion of the alternative would need to comply with 40 CFR Part Subpart Db. If the NGCC or biomass-fired plants were located close to a mandatory Class I area, additional air pollution control requirements might be required (Subpart P of 40 CFR Part 51) as mandated by the Regional Haze Rule. The rule would not apply to this alternative, however, because there are no Class I Federal areas in Mississippi or within 186-mi (300-km) of the GGNS site (EPA 2012b).

The emissions from the NGCC portion of the combination alternative, projected by the staff based on published EIA data, EPA emission factors, and performance characteristics for this alternative, and likely emission controls, would be:

- sulfur oxides (SO_X)—41 tons (37 MT) per year
- nitrogen oxides (NO_X)—156 tons (142 MT) per year
- particulate matter ≤10 µm (PM_{10}) and ≤ 2.5 µm ($PM_{2.5}$)—79 tons (72 MT) per year
- carbon monoxide (CO)—361 tons (327 MT) per year
- carbon dioxide (CO_2)—1.3 million tons (1.2 million MT) per year

National Energy Technology Laboratory (NETL) estimated emissions factors for biomass-fired power plants by averaging 34 biomass facilities in California and based on a heat rate of 13.8 MMBTU/MWh. Emissions from the nine biomass-fired plants considered in this alternative could vary based on technology or other factors. The emissions from all nine of the biomass-fired plants under the combination alternative, based on emissions factors and the heat rate estimated by National Renewable Energy Laboratory (NREL) would be:

- SO_X—126 tons (114 MT) per year
- NO_X—2,681 tons (2,432 MT) per year
- Particulate matter ≤ 10 µm (PM_{10}) and ≤ 2.5 µm ($PM_{2.5}$)—650 tons (590 MT) per year
- CO—13,560 tons (12,302 MT) per year

8.4.1.1 Sulfur Oxide and Nitrogen Oxide

The natural gas-fired plant would produce SO_x and NO_x based on the use of the dry low-NO_x combustion technology and selective catalytic reduction to significantly reduce NO_x emissions. Both the NGCC and biomass-fired plants would be subject to the continuous monitoring requirements of SO_2 and NO_x specified in 40 CFR Part 75.

8.4.1.2 Greenhouse Gases

Both the NGCC and biomass-fired plants would release GHGs, such as CO_2 and methane, and would be subject to continuous monitoring requirements for CO_2, as specified in 40 CFR Part 75.

On July 12 2012, EPA issued a rule tailoring the criteria that determine which stationary sources and modifications to existing projects become subject to permitting requirements for GHG emissions under the PSD and Title V Programs of the CAA (77 FR 41051). According to this rule, GHGs are a regulated new source review pollutant under the PSD major source permitting program if the source is otherwise subject to PSD (for another regulated new source review pollutant) and has a GHG potential to emit equal to or greater than 75,000 tons (68,000 MT) per year of CO_2 equivalent ("carbon dioxide equivalent" adjusts for different global warming potentials for different GHGs). Beginning January 2, 2011, operating permits issued to major sources of GHGs under the PSD or Title V Federal permit programs must contain provisions requiring the use of Best Available Control Technology (BACT) to limit the emissions of GHGs if those sources would be subject to PSD or Title V permitting requirements. If the alternative meets the GHG emission thresholds established in the rule, then GHG emissions from this alternative would be regulated under the PSD and Title V permit programs.

8.4.1.3 Particulates

Both the NGCC and biomass-fired plants would produce particulates. For the biomass-fired plants, fugitive particulate matter emissions would be produced from the wood fuel receiving, processing, and storage operations, but they could be minimized using enclosures and a water misting system (Palmer Renewable Energy 2011).

As described above, construction activities associated with both the NGCC and biomass-fired plants would generate fugitive dust as well as exhaust emissions from vehicles and motorized equipment. These impacts would be short-term and would be minimized by dust control measures.

8.4.1.4 Hazardous Air Pollutants

In December 2000, EPA issued regulatory findings (EPA 2000) on emissions of HAPs from electric utility steam-generating units, which identified that natural gas-fired plants emit HAPs such as arsenic, formaldehyde and nickel and stated that

> . . . the impacts due to HAP emissions from natural gas-fired electric utility steam generating units were negligible based on the results of the study. The Administrator finds that regulation of HAP emissions from natural gas-fired electric utility steam generating units is not appropriate or necessary.

As a result of the EPA's conclusion, the staff finds no significant air quality effects from HAPs for the NGCC portion of the combination alternative. The biomass-fired plants would also release HAPs, but each 50-MWe unit is likely to emit less than 10 tons/yr (9.1 MT/yr) of any individual HAP or 25 tons/yr (22.7 MT/yr) for any combination of HAPs (Palmer Renewable Energy 2011).

8.4.1.5 Conclusion

Air quality impacts would result primarily from the NGCC and biomass-fired portions of the combination alternative. The purchased power portion would likely come from gas, coal, and/or nuclear sources, the largest sources of power generation in Mississippi. The impacts to air quality from gas, coal, and nuclear power are described in Sections 8.1.1, 8.2.1, and 8.3.1, but they would be proportionally smaller. Air quality impacts from the DSM portion of the combination alternative would be negligible. Based on this information, the overall air quality impacts of the combination alternative would be SMALL to MODERATE.

8.4.2 Groundwater Resources

Twenty-one percent of the power supplied by this alternative will be purchased power from some combination of natural gas, coal, or nuclear power plants. The impact of these types of power plants on groundwater use and quality are described in Sections 8.1 through 8.3. Impacts on groundwater for these types of facilities have been characterized as SMALL for both operation and construction. If power is purchased from existing facilities, impacts would be smaller than that described in Sections 8.1 through 8.3 because no construction would occur. Impacts on groundwater use and quality for purchased power would be SMALL.

Twenty-four percent of the power supplied by this alternative would come from biomass-fired generation. A biomass-fired plant would be similar in appearance and operation to a coal-fired power plant. Groundwater would be consumed to construct the new plants. The amount of construction water consumed would be much less than the amount consumed by long-term operation of the biomass-fired plants. Potable water and other plant groundwater requirements would be about one-third of GGNS requirements. Impacts from biomass-fired generation on groundwater use and quality would be SMALL.

Thirty-six percent of the power supplied by this alternative would come from the combustion of natural gas. The hydrologic impact of this type of power plant on groundwater use and quality would be less than that described in Section 8.2 because one NGCC unit, rather than three

NGCC units, would be built for the combination alternative. Therefore, impacts on groundwater use and quality would be SMALL.

Nineteen percent of the power for this alternative would come from DSM and impacts on groundwater use and quality would be SMALL.

The impact of the combination alternative on groundwater use and quality would be SMALL.

8.4.3 Surface Water Resources

Twenty-one percent of the power supplied by this alternative will be purchased power from some combination of gas, coal, or nuclear power plants. The impact of these types of power plants on surface water use and quality are SMALL and are described in Sections 8.1 through 8.3. The impact of the purchased power portion of this alternative on surface water would be SMALL.

Twenty-four percent of the power supplied by this alternative would come from biomass-fired generation. If dredging of streams or rivers occurs during construction of the biomass facilities, surface water quality immediately downstream of the dredging activities could be temporarily degraded by increases in suspended sediment concentration. In addition, the biomass facilities would require cooling water. Within the service territory, the Mississippi River, other rivers, or reservoirs might be a source of cooling water. The small size of these facilities means the impact on surface water use and quality would be SMALL.

Thirty-six percent of the power supplied by this alternative would come from the combustion of natural gas. The hydrologic impact of this type of power plant on surface water use and quality is described in Section 8.2. During plant operations, the NGCC plant in the combination alternative would discharge cooling system blowdown at approximately one-sixth of the existing GGNS rate. Stormwater discharge, blowdown, sanitary, and other effluents would be permitted under an NPDES permit. The impacts on surface water use and quality from the NGCC portion of this alternative would be SMALL.

Nineteen percent of the power for this alternative would come from DSM and impacts on surface water use and quality would be SMALL.

The impact of the combination alternative on surface water use and quality would be SMALL.

8.4.4 Aquatic Ecology

Construction activities for the combination alternative (such as construction of heavy-haul roads, and the power blocks for the NGCC and biomass-fired plants) could affect onsite aquatic features at GGNS for the NGCC plant and onsite aquatic features that may occur where the biomass-fired plants would be built. Minimal impacts on aquatic ecology resources are expected because BMPs would likely be used to minimize erosion and sedimentation. Stormwater control measures, which would be required to comply with Mississippi NPDES permitting, would minimize the flow of disturbed soils into aquatic features. Depending on the available infrastructure at the selected biomass-fired plant sites, new or expanded intake and discharge structures may be required. Construction of new or modified intake and discharge structures may require dredging. In addition, dredging may be required to transport new materials to the NGCC and biomass-fired plant sites, which could result in increased sedimentation and turbidity. Dredging activities would require BMPs for in-water work to minimize sedimentation and erosion. Due to the short-term nature of the dredging activities, the hydrological alterations to aquatic habitats would likely be localized and temporary.

During operations, the NGCC plant would require approximately one-third of the cooling water to be discharged into the Mississippi River compared to the NGCC alternative analyzed in Section 8.2. Therefore, the thermal impacts would be less for the combination alternative than for license renewal and the NGCC alternative. The cooling system for a new NGCC plant would have similar chemical discharges as GGNS, but the air emissions from the NGCC plant would emit particulates that would settle onto the river surface and introduce a new source of pollutants that would not exist if GGNS continued operating. However, the flow of the Mississippi River would dissipate pollutants, which would minimize the exposure of fish and other aquatic organisms to pollutants.

During operations, the biomass-fired plants would require cooling water. If cooling water is withdrawn from and discharged into surface water bodies, aquatic resources may be impacted from impingement, entrainment, and thermal stress. Impingement, entertainment, and thermal stress would be minimized because the NRC assumes that the biomass-fired plants would use closed-cycle cooling systems.

Consultation under several Federal acts, including the ESA and Magnuson–Stevens Act, would be required to assess the occurrence and potential impacts to Federally protected aquatic species and habitats within affected surface waters. Coordination with State natural resource agencies would further ensure that the plant operators would take appropriate steps to avoid or mitigate impacts to State-listed species, habitats of conservation concern, and other protected species and habitats. The NRC assumes that these consultations would result in avoidance or mitigation measures that would minimize or eliminate potential impacts to protected aquatic species and habitats.

The DSM portion of this alternative would have little to no impact on aquatic resources because there would be little to no water required.

The impacts to aquatic resources from purchased power would be similar to those already described for the NGCC, SCPC, and nuclear alternatives. If power is purchased at existing plants, the impacts would likely be smaller than those analyzed for the NGCC, SCPC, and nuclear alternatives because no construction impacts would occur.

The impacts on aquatic ecology would be minor for the combination alternative because construction activities would require BMPs and stormwater management permits and the discharge for this alternative would be similar to or less than for GGNS. Therefore, the impacts on aquatic ecology would be SMALL.

8.4.5 Terrestrial Ecology

The NGCC component of this alternative would be smaller and require less land than the NGCC plant described in Section 8.2. This alternative assumes that the NGCC plant would be located on the GGNS site, and predominantly previously developed or pre-disturbed land would be affected. The impacts of construction and operation of this alternative on terrestrial species and habitats would be SMALL because of this alternative's extensive use of developed land. The DSM portion of this alternative would have no impact on terrestrial species and habitats. The purchased power portion of the alternative would have wide-ranging impacts that are hard to specifically assess because this portion of the alternative could include a mixture of coal, gas, and nuclear across many different sites. However, the purchased power portion of this alternative would be more likely to intensify already existing effects at power generating facilities than create wholly new effects on terrestrial species and habitats. The biomass portion of this alternative would disturb a total of 135 ac (55 ha) over nine sites (an average of 15 ac [6 ha] per site). Depending on the location of the biomass-fired plant sites, terrestrial habitat could be destroyed or fragmented during construction. Particulate air pollution resulting from operation of the biomass-fired plants could accumulate in waterways and wetlands and be taken up by plants and animals. However, air emissions could be reduced by the use of advanced technologies aimed at lowering emissions. Because of the difficulty of characterizing impacts resulting from this combination alternative, the staff concludes that impacts could range from SMALL to MODERATE.

As discussed under aquatic ecology impacts, consultation with FWS under the ESA would avoid potential adverse impacts to Federally listed species or adverse modification or destruction of designated critical habitat. Coordination with State natural resource agencies would further ensure that plant operators would take appropriate steps to avoid or mitigate impacts to State-listed species, habitats of conservation concern, and other protected species and habitats. The NRC assumes that these consultations would result in avoidance or mitigation measures that would minimize or eliminate potential impacts to protected terrestrial species and habitats. Consequently, the impacts of construction and operation of a new nuclear alternative on protected species and habitats would be SMALL.

8.4.6 Human Health

Impacts on human health from construction of the NGCC, biomass-fired and purchased power portions of this alternative would be similar to impacts associated with the construction of any major industrial facility. Compliance with worker protection rules would control those impacts on workers at acceptable levels. Impacts from construction on the general public would be minimal since limiting active construction area access to authorized individuals is expected assuming the plant operator follows BMPs. Impacts on human health from the construction of the NGCC, biomass-fired and purchased power portions of this alternative would be SMALL.

Construction and operation impacts for the DSM portion of this alternative would be minimal and localized to activities such as weatherization efficiency of an end-user's home or facility. The GEIS notes that the environmental impacts are likely to be centered on indoor air quality (NRC 1996). This is because of increased weatherization of the home in the form of extra insulation and reduced air turnover rates from the reduction in air leaks. However, the actual impact is highly site specific and not yet well established. Impacts on human health from the construction activities involved in the DSM portion of this alternative would be SMALL.

Human health effects of gas-fired generation are generally low, although in Table 8.2 of the GEIS (NRC 1996), the staff identified cancer and emphysema as potential health risks from gas-fired plants. NO_x emissions contribute to ozone formation, which in turn contributes to human health risks. Emission controls on the NGCC portion of this alternative can be expected to maintain NO_x emissions well below air quality standards established to protect human health, and emissions trading or offset requirements mean that overall NO_x releases in the region would not increase. Health risks for workers may also result from handling spent catalysts used for NO_x control that may contain heavy metals. Impacts on human health from the operation of the NGCC portion of the combination alternative would be SMALL.

Using biomass for energy consists of the direct burning of forest residue/wood waste, which would likely include forest residue, primary mill residues, secondary mill residues, or urban wood residues. Given this method of fuel for power generation, the health impacts would be similar to those found in a fossil-fuel power generation facility. As discussed in the NGCC and the SCPC alternatives, regulations restricting emissions enforced by either EPA or delegated state agencies have reduced the potential health effects from plant emissions, but have not entirely eliminated them. These agencies also impose site-specific emission limits as needed to protect human health. As discussed in the NGCC and SCPC alternatives, proper emissions controls would protect workers and the public from the harmful effects of burning the biomass fuel. Therefore, impacts to human health from the biomass portion of the combination alternative would be SMALL.

Purchased power most likely would come from natural gas, coal, or nuclear power generating plants. The human health impacts from the operation of these types of plants are discussed in detail in the NGCC, SCPC, and nuclear alternatives sections of this chapter. The human health impacts from the operation of power-generation plants that would provide purchased power are SMALL.

Overall, human health risks to occupational workers and to members of the public from the combination alternative would be SMALL.

8.4.7 Land Use

The GEIS generically evaluates the impact of constructing and operating various replacement power plant alternatives on land use, both on and off each plant site. The analysis of land use impacts focuses on the amount of land area that would be affected by the construction and operation of a combination alternative consisting of a natural gas-fired power plant (one NGCC unit), biomass-fired power plants, DSM, and purchased power.

Land use impacts for the NGCC plant would be approximately one-third of that described for the NGCC alternative discussed in Section 8.2.7 as it would require three units and the combination alternative would require one unit.

The biomass power plants would require approximately 15 ac (6 ha) per 50-MWe unit for a total of 135 ac (55 ha) on an industrial zoned brownfield site. Forest residue and wood waste are byproducts of the timber industry, and thus activities associated with the production of this feedstock will occur regardless of whether a biomass-fired power plant is available to use the feedstock. Accordingly, the land use impacts associated with the production of this feedstock will be the same regardless whether the feedstock is used for electricity generation or not. However, additional land would be required for storing, loading, and transporting forest residue and wood waste power plant feedstock. Ultimately, land use impacts would depend on the characteristics of the affected forested lands and the effects of storing, loading and transporting the biomass feedstock. DSM would have little to no direct land use impacts. However, quickly replacing old inefficient appliances and other equipment could generate waste material and potentially increase the size of landfills. However, given time for program development and implementation, the cost of replacements, and the average life of an appliance; the replacement process likely would be gradual. For example, older appliances would be replaced by more efficient appliances as they fail (especially in the case of frequently replaced items, such as light bulbs). In addition, many appliances and industrial equipment have substantial recycling value and would not be disposed of in landfills.

Purchased power would also have no direct land use impacts. However, impacts could occur if existing power plants in the region could not support the demand for purchased power. The construction of any new replacement power generating facilities could substantially impact existing land-use. Purchased power from coal- and natural gas-fired plants could also have a noticeable impact on land use due to the amount of land required for coal mining and gas drilling. Wind energy projects would have a noticeable land-use impact because of the large amount of land required for wind farms. However, new replacement power generating facilities could be constructed at existing power plant sites to minimize land use impacts. Impacts could also be minimized by collocating any new transmission lines within existing right-of-ways.

The elimination of uranium fuel for GGNS would partially offset some of the land requirements for the NGCC and biomass-fired power plant. Scaling from GEIS estimates, approximately

1,033 ac (418 ha) (based on 35 ac/yr disturbed per 1,000 MWe for 20 years (see GEIS 6.2.2.6) and 1,475 MWe for GGNS) would no longer be needed for mining and processing uranium during the operating life of these power plants (NRC 1996). Based on this information, overall land use impacts from the construction and operation of the combination alternative could range from SMALL to LARGE.

8.4.8 Socioeconomics

As previously discussed, socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of NGCC and biomass-fired plants could affect regional employment, income, and expenditures. This alternative would create two types of jobs: (1) construction jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact; and (2) power plant jobs, which have a greater potential for permanent, long-term socioeconomic impacts. Workforce requirements for the construction and operation of an NGCC power plant, biomass-fired power plants, DSM, and purchased power components of this combination alternative were evaluated to estimate their possible effects on current socioeconomic conditions.

The NGCC component would be one-third the size of the NGCC alternative discussed in Section 8.2.8, and would require about 633 construction workers during peak construction and 50 operations workers. Fifty construction workers are required for each biomass-fired plant, totaling 450 construction workers if all nine units are constructed at the same time. Each biomass unit is assumed to require 22 operations workers, for a total of 198 operations workers for this component of the combination alternative.

The DSM component could generate additional employment, depending on the nature of the conservation programs and the need for direct measure installations in homes and office buildings. Jobs would likely be few and scattered throughout the region, and would not have a noticeable effect on the local economy.

Purchased power from existing power plants would not generate any additional employment opportunities as there would be no change in power plant operations or workforce. However, new employment opportunities could be created if new electrical power generating facilities were needed to support the demand for purchased power. Construction of a new replacement power facility could cause noticeable short-term socioeconomic impacts, similar to those described previously for the other replacement power alternatives. Operation of new replacement power generating facilities would cause long-term socioeconomic impacts through job creation, new housing demand, increased tax contribution, and additional purchasing activity. Construction and operational impacts would vary depending on the location and type of replacement power generating facility. Therefore, impacts from purchased power could range from SMALL to LARGE.

This combination alternative would also result in a loss of approximately 690 relatively high-paying jobs at GGNS, with a corresponding reduction in purchasing activity and tax contributions to the regional economy. However, a larger amount of property taxes may be paid to local jurisdictions from the NGCC, biomass, DSM, and purchased power components as more land may be required to support this combination alternative than GGNS.

Because of the relatively small number of construction workers needed for the NGCC and biomass-fired plants and the various locations of the biomass-fired plants, the socioeconomic impact of construction on local communities and the tax base would be SMALL. Given the small number of operations workers required, socioeconomic impacts associated with operation of this combination alternative would also be SMALL. Construction and operational impacts from purchased power would range from SMALL to LARGE. Therefore, overall socioeconomic impacts from this combination alternative could range from SMALL to LARGE.

8.4.9 Transportation

Transportation impacts during the construction and operation of the NGCC and biomass components of this combination alternative would be less than the impacts for any of the previous alternatives discussed in Sections 8.1.9, 8.2.9, and 8.3.9. This is because the construction workforce for each component and the volume of materials and equipment to be transported to each respective construction site would be smaller than each of the other alternatives. Additionally, the transportation impacts would not be concentrated as they are in the other alternatives; they would be spread out over a wider area.

During construction, commuting workers and trucks transporting construction materials and equipment to the work site would increase the amount of traffic on local roads. The increase in vehicular traffic would peak during shift changes, resulting in temporary levels of service impacts and delays at intersections. Transporting heavy and oversized components on local roads could have a noticeable impact over a large area. Some components and materials also could be delivered by rail or barge, depending on location. Traffic-related transportation impacts during construction could range from SMALL to MODERATE in the vicinity of the NGCC power plant at GGNS and biomass power plant units, depending on current road capacities and average daily traffic volumes. During operations, transportation impacts from the NGCC and biomass portions of the combination alternative would be less noticeable than during construction and would be SMALL.

No incremental operations impacts would be expected for the DSM or purchased power components of this alternative. As previously discussed, purchased power from existing power plants would not generate any additional employment opportunities as there would be no change in power plant operations or workforce. Traffic volumes on local roads would remain unchanged.

However, traffic conditions could be substantially impacted if new electrical power generating facilities were needed to support the demand for purchased power. Construction of new power generating facilities would cause noticeable short-term transportation impacts on local roads due to the increased volume of worker and truck delivery traffic required to build the new power plant, especially during shift changes. However, traffic volumes would decrease after construction is completed. Construction and operations-related transportation impacts would vary depending on the location and type of facility. Therefore, impacts from purchased power could range from SMALL to LARGE.

Based on this information, overall transportation impacts from the combination alternative could range from SMALL to LARGE.

8.4.10 Aesthetics

The analysis of aesthetics impact focuses on the degree of contrast between the NGCC and biomass power plants and surrounding landscapes and the visibility of a new NGCC plant at GGNS and the new biomass plants. In general, aesthetic changes would be limited to the immediate vicinity of these power plants, although minor visual impacts may be associated with the staging, processing, and transport of biomass feedstock.

Aesthetic impacts from the NGCC plant component of the combination alternative would be essentially the same as those described for the NGCC alternative in Section 8.2.10, except there would be one unit rather than three. Plant infrastructure generally would be smaller and less noticeable than GGNS containment and turbine buildings. In addition to the plant structures, construction of the natural gas pipeline would have a short-term impact. In general, aesthetic changes would be limited to the immediate vicinity of GGNS and would be SMALL. Most noise generated during NGCC plant operations would be limited to industrial processes and communications. Pipelines delivering natural gas fuel could be audible off site near gas compressor stations. Noise during construction activities for the NGCC alternative may be detectable off site, but would be for a short duration. Pipeline companies and the plant operator would need to adhere to local ordinances regarding maximum noise levels during construction and operations. Therefore, impacts from noise would be SMALL.

The biomass plant would look similar to other fossil fuel power plants with a boiler stack and cooling towers. In addition, it would have feedstock storage, handling, and processing facilities, similar to a timber mill. Combustion exhaust and cooling steam plumes may be visible in close proximity to the plant depending on atmospheric conditions. Noise during construction activities and plant operations may be detectable off site. The plant operator would need to adhere to local ordinances regarding maximum noise levels during construction and operations. Therefore, impacts from noise would be SMALL.

No aesthetic or noise impacts would be expected for the DSM and purchased power components of this alternative. However, impacts could occur if new electrical power generating facilities were needed to support the demand for purchased power. Impacts would vary depending on the location and type of power generating facility. If constructed at an existing power plant site, aesthetic changes would be limited and any impacts could range from SMALL to MODERATE due to the industrial appearance of the site. However, if constructed in a rural and previously undisturbed area, the effects could range from MODERATE to LARGE. Therefore, aesthetic impacts from purchased power could range from SMALL to LARGE.

Based on this information, overall aesthetic impacts from the combination alternative could range from SMALL to LARGE.

8.4.11 Historic and Archaeological Resources

Impacts on historic and archaeological resources from the NGCC and biomass power plant components of this alternative would be similar to those discussed for the NGCC alternative in Section 8.2. A cultural resource survey and inventory would be needed before construction could begin for either alternative. Resources found in these surveys would need to be evaluated for eligibility on the National Register of Historic Properties (NRHP) and mitigation of adverse effects would need to be addressed if eligible resources were encountered. Construction of either alternative on a brownfield site could minimize impacts to historic and archaeological resources, however a survey should still be performed to inventory cultural resources and verify level of disturbance. Given that the sites for biomass-fired units are small in size (approximately 15 acres) and a preference is given to use previously disturbed brownfield sites, avoidance of significant historic and archaeological resources should be possible and effectively managed under current laws and regulations. Impacts to historic and archaeological resources from the NGCC and biomass portions of this alternative would be SMALL to MODERATE.

No direct impacts on historic and archaeological resources are expected from DSM or purchased power . If new transmission lines were needed to convey power to consumers previously served by GGNS, surveys similar to those discussed for the NGCC unit would need to be performed. However, transmission lines would likely be collocated within existing right-of-ways minimizing any impacts to historic and archaeological resources, making direct impacts SMALL.

Indirectly, construction of new electrical power generating facilities and any new transmission lines needed to support the increased demand for power from the closure of GGNS could impact archaeological and historic resources. Any areas potentially affected by construction and operation would need to be surveyed and evaluated for NRHP eligibility. The potential for impacts on historic and archaeological resources would vary greatly depending on the location of the proposed sites; however, using previously disturbed sites could greatly minimize impacts to historic and archaeological resources. Areas with the greatest sensitivity could be avoided or effectively managed under current laws and regulations. Impacts would also vary by type of energy power facility chosen and the level of ground disturbance it would require for construction and operation. Therefore, depending on the resource richness of the sites chosen for construction and the type of electrical power generating facility chosen, the impacts could range from SMALL to LARGE.

The potential for impacts on historic and archaeological resources from the combination alternative would vary greatly depending on the resource richness of the location of the proposed sites associated with each component of the alternative. Therefore, the overall impact on historic and archaeological resources could range from SMALL to LARGE.

8.4.12 Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health, environmental, and socioeconomic effects on minority and low-income populations that could result from the construction and operation of a combination of NGCC and biomass-fired plants, and DSM and purchased power activities. As previously discussed in Section 8.1.12, such effects may include human health, biological, cultural, economic, or social impacts.

Potential impacts to minority and low-income populations from the construction and operation of a new NGCC and biomass power plants would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). Noise and dust impacts during construction would be short-term and primarily limited to onsite activities. Minority and low-income populations residing along site access roads would be directly affected by increased commuter vehicle traffic during shift changes and truck traffic. However, because of the temporary nature of construction, these effects are not likely to be high and would be contained to a limited time period during certain hours of the day. Increased demand for rental housing during construction could cause rental costs to rise disproportionately affecting low-income populations living near GGNS for the NGCC plant and the biomass-fired plant locations who rely on inexpensive housing. However, given the small number of construction workers and the possibility that workers could commute to the construction site, the potential increased demand for rental housing would not be significant. No incremental human health or environmental impacts related to construction would be expected from the purchased power or DSM component of this alternative.

Minority and low-income populations living in close proximity to the power generating facilities could be disproportionately affected by emissions associated with NGCC power plant and biomass operations. However, because emissions are expected to remain within regulatory standards, impacts from emissions are not expected to be high and adverse.

Low-income populations could benefit from weatherization and insulation programs in a DSM energy conservation program. This could have a greater effect on low-income populations than the general population, as low-income households generally experience greater home energy burdens than the average household. Low-income populations could also be disproportionately affected by increased utility bills due to the cost of purchased power. However, programs, such as the Mississippi Low Income Home Energy Assistance Program, are available to assist low-income families in paying for increased electrical costs, thus mitigating the adverse socioeconomic impact of this alternative on low-income populations.

Overall, the construction and operation of the NGCC and biomass-fired plants, and DSM and purchased power activities would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

8.4.13 Waste Management

During the construction stage for the NGCC plant, land clearing and other construction activities would generate wastes that could be recycled, disposed of on site, or shipped to an offsite waste disposal facility. During the operational stage, spent selective catalytic reduction catalysts, which control NO_X emissions from the NGCC plant, would make up the majority of waste generated by this alternative.

For DSM, there may be an increase in wastes generated during installation or implementation of energy conservation measures, such as appropriate disposal of old appliances, installation of control devices, and building modifications. New and existing recycling programs would help minimize the amount of generated waste.

For the purchased power portion of this alternative, the types of waste generated would be similar to the alternatives described in Sections 8.1.13, 8.2.13, and 8.3.13.

During construction of a the biomass-fired plants, land clearing and other construction activities would generate waste that could be recycled, disposed of on site, or shipped to an offsite waste disposal facility. A wood biomass-fired plant may use as fuel the residues from forest clear cut and thinning operations, noncommercial species, or harvests of forests for energy purposes. In addition to the gaseous emissions, wood ash is the primary waste product of wood combustion. Waste would be handled in accordance with appropriate Mississippi Commission of Environmental Quality waste management regulations (MSCEQ 2012).

Overall, waste impacts from the combination alternative would be SMALL.

8.4.14 Summary of Impacts of Combination Alternative

Table 8–5 summarizes the environmental impacts of the combination alternative compared to continued operation of GGNS.

Table 8–5. Summary of Environmental Impacts of the Combination Alternative Compared to Continued Operation of GGNS

Category	Combination Alternative	Continued GGNS Operation
Air Quality	SMALL to MODERATE	SMALL
Groundwater Resources	SMALL	SMALL
Surface Water Resources	SMALL	SMALL
Aquatic Ecology	SMALL	SMALL
Terrestrial Ecology	SMALL to MODERATE	SMALL
Human Health	SMALL	SMALL
Land Use	SMALL to LARGE	SMALL
Socioeconomics	SMALL to LARGE	SMALL
Transportation	SMALL to LARGE	SMALL
Aesthetics	SMALL to LARGE	SMALL
Historic and Archaeological Resources	SMALL to LARGE	SMALL
Waste Management [a]	SMALL	SMALL

[a] As described in Chapter 6, the issue, "offsite radiological impacts (spent fuel and high level waste disposal)," is not evaluated in this EIS.

8.5 Alternatives Considered But Dismissed

8.5.1 Demand-Side Management

Demand-side management (DSM) includes energy efficiency programs designed to improve the energy efficiency of facilities and equipment, reduce energy demand through behavioral changes (energy conservation), and demand response initiatives aimed to lessen customer usage or change energy use patterns during peak periods (ICF 2009). Energy conservation and energy efficiency would not require the addition of new generating capacity. To be considered a viable alternative, a DSM alternative would need to reduce the baseload demand within Entergy's Mississippi service territory by 1,475 MWe, which is equivalent to the amount GGNS provides.

In a 2009 staff report, the Federal Energy Regulatory Commission (FERC) outlined the results of a national assessment of demand response potential, required of FERC by Section 529 of the Energy Independence and Security Act of 2007. The report evaluated potential energy savings in 5- and 10-year horizons for four development scenarios: Business As Usual, Expanded Business As Usual, Achievable Participation, and Full Participation, each representing greater demand response program opportunities and proportionally increasing levels of customer participation (FERC 2009). FERC's Mississippi-specific analysis indicates that by 2019, the Full Participation scenario, in which the greatest level of reduction would occur, would yield a 2,247 MWe peak demand reduction in Mississippi (18.6 percent of projected peak demand). The Business as Usual scenario suggests that demand response programs would yield a reduction of 75 MWe (0.6 percent of projected peak demand) (FERC 2009). Entergy Mississippi provides 33.7 percent of Mississippi's electricity, indicating that if Entergy achieved the full participation demand reductions, it would yield a reduction of 765 MWe. This amount would not be sufficient to replace the 1,475 MWe GGNS provides. In addition, according to an ICF International study, the potential savings from energy conservation and energy efficiency across Entergy's six operating companies could reach 729 MWe by 2019 and 1,050 MWe by 2029, adjusted for a reasonable implementation and approval timeline. Mississippi offers voluntary financial incentive programs, an energy efficiency leasing program for public institutions and hospitals, and low interest loans for energy efficiency projects, but it does not require utilities to participate in DSM programs to reduce energy demand. While significant energy savings are possible in Mississippi through DSM, the NRC nevertheless does not consider DSM to be a reasonable alternative to license renewal of GGNS. NRC evaluated an alternative with DSM programs in combination with an NGCC plant, biomass-fueled plants, and purchased power in Section 8.4.

8.5.2 Wind Power

As an intermittent energy source, the feasibility of wind generation to serve as baseload power depends on the availability, constancy, and accessibility of wind resources within a specific region. At the current stage of wind energy technology, DOE's National Renewable Energy Laboratory (NREL) considers areas with annual average wind speeds around 6.5 meters per second (m/s) (21 ft/s) and greater (at a height of 80 m [262 ft]) to have a wind resource suitable for wind development (NREL 2012a). The majority of Mississippi has wind speeds between 4.0 and 5.0 m/s, although a small area in the northwest part of the state has wind speeds of 5.5 m/s (NREL 2012a). NREL has estimated the windy land area and wind energy potential, including potential megawatts of rated capacity and estimated potential annual wind energy generation, for each state (NREL 2012b). According to their analyses, Mississippi does not have sufficient wind resources for any utility-scale wind energy generation.

In addition, the issue of intermittent wind, and subsequent intermittent generation of power, must be overcome for wind generation to provide baseload power by 2024 when the current GGNS operating license expires. Currently, limited viable energy storage opportunities exist, although research is ongoing to connect wind farms with storage technologies such as pumped water storage, batteries, and compressed air energy storage (CAES) (EAC 2008). EIA is not projecting any growth in pumped water storage capacity through 2035 (EIA 2011a). As described below, the potential for new hydroelectric development in Mississippi is limited. Therefore, the NRC concludes that the use of pumped water storage in combination with wind farms is unlikely in Mississippi. A CAES plant is another potential storage option that could possibly serve as a way for wind to provide baseload power. A CAES plant compresses air in an underground storage cavern. To extract the stored energy, compressed air is combusted, through a gas-turbine connected to an electrical generator (NREL 2010a). Currently, besides pumped hydropower storage, deployment of storage technologies in the United States has been limited to a 110-MWe CAES facility in Alabama and two planned CAES projects with a combined capacity of 450 MWe (NREL 2010a, Sandia 2012). Current and proposed CAES projects have a much smaller capacity than would be necessary to replace GGNS; therefore, the NRC concludes that the use of CAES in combination with wind turbines to generate 1,475 MWe in Mississippi is unlikely.

Another solution to overcoming intermittency is the concept of interconnected wind farms. Wind farms located at a great distance from one another and connected through the transmission grid could increase the capacity factor compared to a single wind farm in one location. As more farms are interconnected, the probability that they will all experience the same wind environment decreases, and the array acts more like a single wind farm with a steady wind speed (Archer et al. 2007). In Mississippi, however, the wind generation potential is so low that even when combined with energy storage or interconnected wind farms, it is very unlikely that wind could serve as baseload power to replace GGNS.

<u>Offshore Wind</u>. The potential for offshore wind generation off the coast of Mississippi is not likely sufficient to replace GGNS. Although the wind resources are generally stronger in offshore areas, the wind speeds off the coast of Mississippi and Louisiana are weak compared to offshore resources in other areas of the United States. Off shore from the Louisiana coast, wind speeds range between 7.0–8.0 m/s at 90 m compared to 9.0–10.0 m/s at 90 m off the coast of the Northeast United States where the only utility-scale offshore wind farm has been

approved (NREL 2010b). Texas has the most potential for offshore wind development in the gulf coast with wind speeds reaching between 7.5–9.0 m/s (NREL 2010b), and is the only State in the region to express interest in developing offshore wind energy resources. The Texas General Land Office has approved leases for offshore wind projects; however none have started construction (offshorewindfarm.net 2012). Currently, no wind energy projects are proposed off the coasts of Mississippi or Louisiana (offshorewindfarm.net 2012).

The capital costs for offshore wind projects are much greater than the costs for land-based wind projects, which will likely prohibit offshore wind development in the near future. A paper published by the U.S. Offshore Wind Collaborative estimates that initial capital costs for offshore wind projects are 30 to 60 percent greater than for land-based wind projects. Construction costs are 33 percent higher for offshore wind farms (USOWC 2009). Foundations for wind turbines are much more expensive because they must be designed to withstand high winds and waves. Costs for facility foundations, towers, transmission, and installation are much more expensive than those for land-based farms (USOWC 2009). In addition, the current commercially available offshore wind turbines may not be able to withstand major hurricanes. Currently, the most stringent class of specifications for wind turbines assumes gusts no stronger than 70 m/s, while Category 4 and 5 hurricanes, which often come through coastal Mississippi and Louisiana, can have gusts greater than 80 m/s (NREL 2010c).

Conclusion. Given the low wind resource potential both on and off shore in Mississippi and the surrounding region, high costs, and intermittency experienced in wind generation, the NRC does not consider wind to be a reasonable alternative to license renewal.

8.5.3 Solar Power

Solar power, including solar photovoltaic and concentrated solar power technologies, produce power generated from sunlight. Photovoltaics convert sunlight directly into electricity using solar cells, made from silicon or cadmium telluride (NREL 2012c). By contrast, concentrating solar power uses heat from the sun to boil water and produce steam to drive a turbine connected to a generator to produce electricity (NREL 2012c).

In 2010, according to EIA, neither Mississippi, nor any of the surrounding States of Alabama, Louisiana, or Arkansas produced any large-scale electricity from solar energy (NREL 2012d). DOE's National Renewable Energy Laboratory (NREL) reports that Mississippi has average solar insolation useful for solar applications ranging between 4.0–5.9 kWh/m^2/day (NREL 2012d). For utility-scale development, insolation levels below 6.5 kWh/m^2/day are not considered economically viable given current technologies (BLM/DOE 2010). There is more potential for solar development with local photovoltaic applications, such as rooftop solar panels than through utility-scale solar facilities. In addition, a solar facility can only generate electricity when the sun is shining. Energy storage can be used to overcome intermittency for solar facilities, however, current and foreseeable storage technologies have a much smaller capacity than would be necessary to replace GGNS (as described above in the discussion of wind power). Taking all of the factors above into account, it is unlikely that solar photovoltaic or concentrated solar power technologies could serve as baseload power in Mississippi. Given the modest levels of solar energy available throughout the State, the lack of any installed solar capacity in Mississippi and the weather-dependent intermittency of solar power, the NRC does not currently consider solar energy to be a reasonable alternative to license renewal.

8.5.4 Hydroelectric Power

Hydroelectric power uses the force of water to turn turbines, which spins a generator to produce electricity. In a run-of-the-river system, the force of a river current provides the force to create the needed pressure for the turbine. In a storage system, water is accumulated in reservoirs created by dams and is released as needed to generate electricity. DOE's Idaho National Environmental Engineering Laboratory completed a comprehensive survey of hydropower resources in Mississippi in 1997. Mississippi has little hydroelectric potential, with a total generating potential of 92–128 MWe (INEEL 1997). EIA reported that Mississippi did not generate any electricity from conventional hydroelectric power in 2010 (EIA 2012a). Given the small potential capacities and actual power generation of hydroelectric facilities in Mississippi, the NRC does not consider hydroelectric power to be a reasonable alternative to license renewal.

8.5.5 Wave and Ocean Energy

Wave energy is generated by the movement of a device either floating on the surface of the ocean or anchored to the ocean floor. Kinetic energy from waves pumps fluid through turbines to create electric power (DOE 2009). Waves, currents, and tides are often predictable and reliable, making them attractive candidates for potential renewable energy generation.

There are modest wave energy resources available off the Gulf Coast. However, wave energy technology is still in the early stages of development. The potential for wave and ocean energy in Mississippi is limited because the Gulf of Mexico is shallow and semi-enclosed (TCPA 2008). Because most technologies are relatively undeveloped (and none are developed on the scale of GGNS), and because the Gulf of Mexico has limited potential for wave and ocean energy, the NRC did not consider wave and ocean energy as a reasonable alternative to GGNS license renewal.

8.5.6 Geothermal Power

Geothermal technologies extract the heat contained in geologic formations to produce steam to drive a conventional steam turbine generator. Facilities producing electricity from geothermal energy have demonstrated capacity factors of 95 percent or greater, making geothermal energy eligible as a source of baseload electric power. However, the feasibility of geothermal power generation to provide baseload power depends on the regional quality and accessibility of geothermal resources. Utility-scale geothermal energy generation requires geothermal reservoirs with a temperature above 200 °F (93 °C). Utility-scale power plants range from small 300 kWe to 50 MWe and greater (TEEIC 2012). In general, geothermal resources are concentrated in the western United States. Specifically, these resources are found in Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming (USGS 2008). The largest geothermal generation project in Mississippi was a 0.5 MWe geothermal coproduction demonstration project completed in 2011, which was funded by a Department of Energy's Research Partnership to Secure Energy for America (RPSEA) grant (GEA 2012). The project generated electricity from water produced as a byproduct of oil production. The 6-month demonstration project has since been concluded. The high cost to produce electricity using geothermal coproduction limited its commercial deployment, though the demonstration project established its technical viability (ElectraTherm 2012). No other electricity is currently being produced from geothermal resources in Mississippi (DOE 2012). Given the low resource potential in Mississippi, the NRC does not consider geothermal to be a reasonable alternative to GGNS license renewal.

8.5.7 Municipal Solid Waste

Municipal solid waste combustors use three types of technologies—mass burn, modular, and refuse-derived fuel. Mass burning is currently the method used most frequently in the

United States and involves no (or little) sorting, shredding, or separation. Consequently, toxic or hazardous components present in the waste stream are combusted, and toxic constituents are exhausted to the air or become part of the resulting solid wastes. As of 2010, approximately 86 waste-to-energy plants are in operation in 24 states, processing 97,000 tons of municipal solid waste per day (ERC 2010). These waste-to-energy plants have an aggregate capacity of 2,572 MWe and can operate at capacity factors greater than 90 percent. The average waste-to-energy plant produces about 50 MWe, with some reaching 77 MWe (ERC 2010). No waste-to-energy facilities operate in Mississippi (ERC 2010). More than 29 average-sized plants would be necessary to provide the same level of output as GGNS, increasing national waste-to-energy generation by 57 percent.

The decision to burn municipal waste to generate energy is usually driven by the need for an alternative to landfills rather than energy considerations. Given the improbability that additional stable supplies of municipal solid waste would be available to support approximately 29 new facilities and that no waste-to-energy plants operate in Mississippi, the NRC does not consider municipal solid waste combustion to be a reasonable alternative to GGNS license renewal.

8.5.8 Biomass

Biomass resources used for biomass-fired generation include crop residues, switch grass, forest residues, methane from landfills, methane from animal manure management, primary wood mill residues, secondary wood mill residues, urban wood wastes, and methane from domestic wastewater treatment. Using biomass-fired generation for baseload power depends on the geographic distribution, available quantities, constancy of supply, and energy content of biomass resources. As described in more detail in Section 8.4, the technology used for conversion of biomass to electricity would be direct combustion.

In the GEIS, the NRC indicated a wood waste facility could provide baseload power and operate with capacity factors between 70 and 80 percent (NRC 1996). Mississippi generated only 236 MWe from biomass fuels in 2010 (EIA 2012b). It is unlikely that Mississippi could increase its capacity by adding 1,475 MWe of electricity from biomass-fired generation by the time GGNS's license expires in 2024.

Biomass-fired generation plants generally are small and can reach capacities of 50 MWe, meaning that 30 new facilities would be required before 2024. In addition, according to an NREL report, Mississippi has almost 16 million tons/year total available biomass resources (NREL 2005). For the hypothetical biomass plant using wood residue described in Section 8.4, approximately 2,000 tons/day of fuel would be consumed to support one 50 MWe unit (ARI 2007). Based on a similar consumption rate, all of the available biomass in Mississippi could support 1,000 MWe of power generation. Therefore, there would be insufficient biomass in Mississippi to support 1,475 MWe of biomass-fired generation. In addition, small plant sizes (20–50 MWe) lead to higher capital costs per kWh. Biomass-fired power plants typically are less efficient than other energy sources; the biomass industry average is 20 percent compared to 35 percent average efficiency for U.S. electricity generation. An inefficient power plant can be more sensitive to changes in the price of fuel inputs (i.e., wood waste). High capital costs combined with low efficiency have led to electricity prices ranging from $0.08 to $0.12/kWh (NREL 2003). Given the large amount of biomass resources required to replace GGNS compared to available resources, and potentially high cost, the NRC does not consider biomass a reasonable alternative to GGNS. The NRC evaluated an alternative with biomass-fired generation in combination with an NGCC plant, DSM, and purchased power in Section 8.4.

8.5.9 Oil-Fired Power

EIA projects that oil-fired plants will account for a 2 percent increase in new electricity generation from 2010 to 2030 in the United States (EIA 2008b). In Mississippi, the percent of electricity from oil-fired generation fell from 7.9 percent to 0.1 percent from 2000 to 2012 (EIA 2012a).

The variable costs of oil-fired generation tend to be greater than those of nuclear or coal-fired operations, and oil-fired generation tends to have greater environmental impacts than natural gas-fired generation. The high cost of oil has resulted in a steady decline in its use for electricity generation. Given the high cost of oil and the decline in use of oil-fired power plants in Mississippi over the past 10 years, the NRC does not consider oil-fired generation a reasonable alternative to GGNS license renewal.

8.5.10 Fuel Cells

Fuel cells oxidize fuels without combustion and its environmental side effects. Fuel cells function as an energy conversion technology that allows the energy stored in hydrogen to be converted back into electrical energy for end use (EIA 2008a). The only byproducts (depending on fuel characteristics) are heat, water, and CO_2. Hydrogen fuel can come from a variety of hydrocarbon resources. Natural gas typically is used as the hydrogen source.

Presently, fuel cells are not economically or technologically competitive with other alternatives for electricity generation. EIA projects that fuel cells may cost $6,835 per installed kW (total overnight capital costs, 2010 dollars), which is high compared to other alternative technologies analyzed in this section (EIA 2010b). More importantly, fuel cell units are likely to be small in size (approximately 10 MWe). It would be extremely costly to replace the power GGNS provides; it would require approximately 148 units and modifications to the existing transmission system. Given the immature status of fuel cell technology and high cost, the NRC does not consider fuel cells to be a reasonable alternative to GGNS license renewal.

8.5.11 Purchased Power

Under a purchased power alternative, no new generating capacity would necessarily be built and operated by Entergy. Instead, 1,475 MWe would be purchased from other generators. Those generators could be located anywhere within or outside Entergy's service territory.

Entergy's six operating companies rely on purchased power for a third of their energy needs (Entergy 2009). Entergy's Strategic Resource Plan states that the six operating companies plan on purchasing 1,400 MWe in limited-term purchases (1- to 5-year contracts) by 2025 (Entergy 2010). Limited-term purchases expose the utility and its customers to risk associated with market price volatility and power availability. In its Strategic Resource Plan, Entergy outlines how it plans to manage this risk by seeking to limit the amounts of limited-term purchased power used to meet reliability requirements. Entergy also recognizes that the amount of uncommitted capacity in the region is declining, and that purchased power may not provide sufficient resources. In that case, Entergy acknowledges that it may need to build more capacity than currently anticipated (Entergy 2009). For Entergy to replace the 1,475 MWe provided by GGNS, it would have to double its amount of planned power purchases. If a sufficient amount of additional energy from existing plants is not available, new power plants would need to be constructed. Depending on location, the incorporation of new generation sources from locations that are remote or distant from load centers likely would involve significant expenditures in transmission infrastructure expansions. The NRC does not consider purchased power to be a reasonable alternative to GGNS license renewal.

8.5.12 Delayed Retirement

Currently, Entergy owns or controls 20,559 MWe of electricity generation and fails to meet their system reliability requirement by approximately 1 GW (Entergy 2009). This conclusion is based on current capacity ratings of the existing operating facilities, the expected peak load requirement, and the planning reserve margin target (Entergy 2011). In addition, the projected growth in demand over the next 20 years is expected to be 600 MWe/yr (Entergy 2011). Any currently operating units scheduled for retirement that could be delayed would be needed to meet this projected growth in demand and would be unavailable to replace existing generation. Therefore, the NRC does not consider delayed retirement to be a reasonable alternative to GGNS license renewal.

8.6 No-Action Alternative

This section examines environmental effects that would occur if the NRC took no action. No action in this case means that the NRC decides to not issue a renewed operating license for GGNS and the license expires at the end of the current license term, in November 2024. Under the no-action alternative, the plant would shut down at or before the end of the current license. After shutdown, plant operators would initiate decommissioning in accordance with 10 CFR 50.82.

This section addresses only those impacts that arise directly as a result of plant shutdown. The environmental impacts from decommissioning and related activities already have been addressed in several other documents, including Supplement 1 of NUREG–0586, *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities Regarding the Decommissioning of Nuclear Power Reactors* (NRC 2002); Chapter 7 of the license renewal GEIS (NRC 1996); and Chapter 7 of this SEIS. These analyses either directly address or bound the environmental impacts of decommissioning whenever Entergy ceases operating GGNS.

Even with a renewed operating license, GGNS will eventually shut down, and the environmental effects addressed in this section will occur at that time. Since these effects have not otherwise been addressed in this SEIS, the impacts will be addressed in this section. As with decommissioning effects, shutdown effects are expected to be similar whether they occur at the end of the current license or at the end of a renewed license.

8.6.1 Air Quality

Shutdown of GGNS would result in a reduction in emissions from activities related to plant operation, such as use of diesel generators and employee vehicles. The staff determined that these emissions would have a SMALL impact on air quality during the renewal term (see Chapter 4); therefore, if emissions decrease, the impact to air quality would also decrease and would be SMALL.

8.6.2 Groundwater Resources

Shutdown of GGNS would result in a reduction in groundwater use over that of continued plant operation. Since it was determined that continued plant operations would have a SMALL impact on groundwater use and quality during the renewal term (see Chapter 4), the impacts of shutdown on groundwater use and quality would also be SMALL.

8.6.3 Surface Water Resources

Shutdown of GGNS would result in a reduction in surface water use over that of continued plant operation. Since it was determined that continued plant operations would have a SMALL impact on surface water use and quality during the renewal term (see Chapter 4), the impacts of shutdown on surface water use and quality would also be SMALL.

8.6.4 Aquatic Ecology

If the plant were to cease operating, impacts on aquatic ecology would decrease because the plant would withdraw and discharge less water than it does during operations. Shutdown would reduce the already SMALL impacts on aquatic ecology.

8.6.5 Terrestrial Ecology

If the plant were to cease operating, the terrestrial ecology impacts would be SMALL, assuming that no additional land disturbances on or off site would occur during decommissioning activities.

8.6.6 Human Health

In Chapter 4 of this SEIS, the staff concluded that the impacts of continued plant operation on human health would be SMALL. After cessation of plant operations, the amounts of radioactive material released to the environment in gaseous and liquid forms, all of which are currently within respective regulatory limits, would be reduced or eliminated. Therefore, the staff concludes that the impact of plant shutdown on human health would also be SMALL. In addition, the potential for a variety of accidents would also be reduced to only those associated specifically with shutdown activities and fuel handling. In Chapter 5 of this SEIS, the staff concluded that impacts of accidents during operation would be SMALL. It follows, therefore, that impacts on human health from a reduced suite of potential accidents after reactor operation ceases would also be SMALL. Therefore, the staff concludes that impacts on human health from the no-action alternative would be SMALL.

8.6.7 Land Use

Plant shutdown would not affect onsite land use. Plant structures and other facilities would remain in place until decommissioning. Most transmission lines connected to GGNS would remain in service after the plant stops operating. Maintenance of most existing transmission lines would continue as before. The transmission lines could be used to deliver the output of any new replacement power-generating facilities added to the GGNS site. Impacts on land use from plant shutdown would be SMALL.

8.6.8 Socioeconomics

Plant shutdown would have a noticeable impact on socioeconomic conditions in the communities located in the immediate vicinity of GGNS. Should GGNS shut down, there would be immediate socioeconomic impact from the loss of jobs (some, though not all, of the 690 employees would begin to leave), and tax payments may be reduced. Since the majority of GGNS employees reside in Claiborne, Hinds, Jefferson, and Warren Counties, socioeconomic impacts from plant shutdown would be concentrated in these counties, with a corresponding reduction in purchasing activity and tax contributions to the regional economy. Revenue losses from GGNS operations would directly affect Claiborne County and other state taxing districts that are most reliant on the nuclear plant's tax revenue. The impact of the job loss, however, may not be as noticeable given the amount of time required for decommissioning of the existing facilities and the proximity of GGNS to metropolitan areas. The socioeconomic impacts of plant shutdown (which may not entirely cease until after decommissioning) would, depending on the jurisdiction, range from SMALL to LARGE.

8.6.9 Transportation

Traffic volumes on the roads in the vicinity of GGNS would be reduced after plant shutdown. Most of the reduction in traffic volume would be associated with the loss of jobs at the nuclear power plant. The number of deliveries to the power plant would be reduced until decommissioning. Transportation impacts would be SMALL as a result of plant shutdown.

8.6.10 Aesthetics

Plant structures and other facilities would remain in place until decommissioning. Once operations cease there would be no plume from the cooling tower. Therefore, aesthetic impacts of plant shutdown would be SMALL.

8.6.11 Historic and Archaeological Resources

In Chapter 4, the staff concluded that the impacts of continued plant operation on historic and archaeological resources would be SMALL. Onsite land use would not be affected immediately by the cessation of operations. Plant structures and other facilities are likely to remain in place until decommissioning. A separate environmental review would be conducted for decommissioning that would address the protection of known historic and archaeological resources at GGNS. Therefore, the impacts on historic and archaeological resources from plant shutdown would be SMALL.

8.6.12 Environmental Justice

Impacts to minority and low-income populations would depend on the number of jobs and the amount of tax revenues lost by communities in the immediate vicinity of the power plant after GGNS ceases operations. Closure of GGNS would reduce the overall number of jobs (there are currently 690 employees working at GGNS) and tax revenue attributed to nuclear plant operations. The reduction in tax revenue could decrease the availability of public services in Claiborne County. This could disproportionately affect minority and low-income populations that may have become dependent on these services. See also Appendix J of NUREG-0586, Supplement 1 (NRC 2002), for additional discussion of these impacts.

8.6.13 Waste Management

If the no-action alternative were implemented, the generation of high-level waste would stop, and generation of low-level and mixed waste would decrease. Waste management impacts from implementation of the no-action alternative are expected to be SMALL.

8.6.14 Summary of Impacts of Combination Alternative

Table 8–6 summarizes the environmental impacts of the no-action alternative compared to continued operation of GGNS.

Table 8–6. Summary of Environmental Impacts of the No-action Alternative Compared to Continued Operation of GGNS

Category	No-action Alternative	Continued GGNS Operation
Air Quality	SMALL	SMALL
Groundwater Resources	SMALL	SMALL
Surface Water Resources	SMALL	SMALL
Aquatic Ecology	SMALL	SMALL
Terrestrial Ecology	SMALL	SMALL
Human Health	SMALL	SMALL
Land Use	SMALL	SMALL
Socioeconomics	SMALL to LARGE	SMALL
Transportation	SMALL	SMALL
Aesthetics	SMALL	SMALL
Historic and Archaeological Resources	SMALL	SMALL
Waste Management [a]	SMALL	SMALL

[a] As described in Chapter 6, the issue, "offsite radiological impacts (spent fuel and high level waste disposal)," is not evaluated in this EIS.

8.7 Alternatives Summary

In this chapter, the staff considered the following alternatives to GGNS license renewal: new nuclear generation; NGCC generation; supercritical coal-fired generation; and a combination alternative of natural gas, biomass-fired generation, DSM, and purchased power. No action by NRC and its effects also were considered. The impacts for all alternatives to GGNS license renewal are summarized in Table 8–7.

The environmental impacts of the proposed action (issuing a renewed GGNS operating license) would be SMALL for all impact categories, except for the Category 1 issue, “Offsite radiological impacts (collective effects)” which the Commission concluded that the impacts are acceptable. The issue, “Offsite radiological impacts (spent fuel and high level waste disposal” was not reviewed in this SEIS because it relies on the Commission’s Waste Confidence Decision (WCD). The WCD was vacated on June 8, 2012, by the U.S. Court of Appeals for the District of Columbia Circuit. The WCD is explained in more detail in Chapter 6 of this SEIS.

In conclusion, the environmental impacts from all other alternatives would be larger than the impacts associated with license renewal. As Table 8–7 shows, all other alternatives capable of meeting the needs currently served by GGNS entail potentially greater impacts than the proposed action of license renewal of GGNS. To make up the lost generation if license renewal is denied, the no-action alternative would necessitate the implementation of one or a combination of alternatives, all of which have greater impacts than the proposed action. Hence, the staff concludes that the no-action alternative will have environmental impacts greater than or equal to the proposed license renewal action.

In this chapter, the NRC staff considered the following alternatives to GGNS license renewal: new nuclear generation; NGCC generation; supercritical coal-fired generation; a combination alternative of natural gas, biomass, DSM and purchased power. No action by NRC and its effects were also considered. The impacts for GGNS license renewal and for all alternatives to GGNS license renewal are summarized in Table 8–7.

In conclusion, the environmentally preferred alternative is the license renewal of GGNS. All other alternatives capable of meeting the needs currently served by GGNS entail potentially greater impacts than the proposed action of license renewal of GGNS. In order to make up the lost generation if license renewal is denied, the no-action alternative necessitates the implementation of one or a combination of alternatives, all of which have greater impacts than the proposed action. Hence, the NRC staff concludes that the no-action alternative will have environmental impacts greater than or equal to the proposed license renewal action.

Table 8–7. Summary of Environmental Impacts of Proposed Action and Alternatives

Alternative	Air Quality	Groundwater and Surface Water Resources	Aquatic and Terrestrial Ecology	Human Health	Land Use	Socioeconomics (including Transportation and Aesthetics)	Archaeological and Historic Resources	Waste Management
License renewal	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
New nuclear at GGNS site	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL	SMALL to LARGE	SMALL	SMALL
NGCC at GGNS site	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL	SMALL
SCPC at alternate site	MODERATE	SMALL	SMALL to LARGE	SMALL	SMALL to MODERATE	SMALL to LARGE	SMALL to MODERATE	MODERATE
Combination alternative	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL	SMALL to LARGE	SMALL to LARGE	SMALL to LARGE	SMALL
No-action alternative	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL TO LARGE	SMALL	SMALL

8.8 References

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9.0 CONCLUSION

This draft supplemental environmental impact statement (SEIS) contains the environmental review of Entergy Operations, Inc.'s (Entergy's) application for a renewed operating license for Grand Gulf Nuclear Station, Unit 1 (GGNS), as required by Title 10 of the *Code of Federal Regulations* Part 51 (10 CFR Part 51), the U.S. Nuclear Regulatory Commission's (NRC's) regulations that implement the National Environmental Policy Act (NEPA). This chapter presents conclusions and recommendations from the site-specific environmental review of GGNS and summarizes site-specific environmental issues of license renewal that the NRC staff (staff) noted during the review. Section 9.1 summarizes the environmental impacts of license renewal; Section 9.2 presents a comparison of the environmental impacts of license renewal and energy alternatives; Section 9.3 discusses unavoidable impacts of license renewal, energy alternatives, and resource commitments; and Section 9.4 presents conclusions and staff recommendations.

9.1 Environmental Impacts of License Renewal

Based on the staff's review of site-specific environmental impacts of license renewal presented in this SEIS, the staff concludes that issuing a renewed license would have SMALL impacts. The site-specific review included applicable Category 2 issues and uncategorized issues. The staff considered mitigation measures for each Category 2 issue, as applicable. The staff concluded that no additional mitigation measure is warranted.

The staff also considered cumulative impacts of past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes them. The staff concluded in Section 4.12 that cumulative impacts of GGNS's license renewal would be SMALL for all areas, except aquatic and terrestrial resources. For aquatic resources, the staff concluded that the cumulative impact would be MODERATE. For terrestrial resources, the cumulative impacts would be MODERATE.

9.2 Comparison of Alternatives

In the conclusion to Chapter 8, the staff considered the following alternatives to GGNS license renewal:

- new nuclear,
- natural gas-fired combined-cycle (NGCC),
- supercritical pulverized coal,
- combination alternative of NGCC, biomass, demand-side management and purchased power, and
- no-action.

The NRC staff concluded that the environmental impacts of renewal of the operating license for GGNS would be smaller than those of feasible and commercially viable alternatives. The no-action alternative would have SMALL environmental impacts in most areas, with the exception of socioeconomic impacts. Continued operation would have SMALL environmental impacts in all areas. The staff concluded that continued operation of the existing GGNS is the environmentally preferred alternative.

9.3 Resource Commitments

9.3.1 Unavoidable Adverse Environmental Impacts

Unavoidable adverse environmental impacts are impacts that would occur after implementation of all workable mitigation measures. Carrying out any of the energy alternatives considered in this SEIS, including the proposed action, would result in some unavoidable adverse environmental impacts.

Minor unavoidable adverse impacts on air quality would occur because of emission and release of various chemical and radiological constituents from power plant operations. Nonradiological emissions resulting from power plant operations are expected to comply with U.S. Environmental Protection Agency emissions standards. Chemical and radiological emissions are not expected to exceed the National Emission Standards for hazardous air pollutants.

During nuclear power plant operations, workers and members of the public would face unavoidable exposure to radiation and hazardous and toxic chemicals. Workers would be exposed to radiation and chemicals associated with routine plant operations and the handling of nuclear fuel and waste material. Workers would have higher levels of exposure than members of the public, but doses would be administratively controlled and would not exceed standards or administrative control limits. In comparison, the alternatives involving the construction and operation of a non-nuclear power generating facility also would result in unavoidable exposure to hazardous and toxic chemicals to workers and the public.

The generation of spent nuclear fuel and waste material, including low-level radioactive waste, hazardous waste, and nonhazardous waste, also would be unavoidable. In comparison, hazardous and nonhazardous wastes also would be generated at non-nuclear power generating facilities. Wastes generated during plant operations would be collected, stored, and shipped for suitable treatment, recycling, or disposal in accordance with applicable Federal and State regulations. Because of the costs of handling these materials, power plant operators would be expected to carry out all activities and optimize all operations in a way that generates the smallest amount of waste possible.

9.3.2 Short-Term Versus Long-Term Productivity

The operation of power generating facilities would result in short-term uses of the environment, as described in Chapters 4, 5, 6, 7, and 8. “Short-term” is the period of time that continued power generating activities take place.

Power plant operations require short-term use of the environment and commitment of resources (e.g., land and energy), indefinitely or permanently. Certain short-term resource commitments are substantially greater under most energy alternatives, including license renewal, than under the no-action alternative because of the continued generation of electrical power and the continued use of generating sites and associated infrastructure. During operations, all energy alternatives require similar relationships between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

Air emissions from power plant operations introduce small amounts of radiological and nonradiological constituents to the region around the plant site. Over time, these emissions would result in increased concentrations and exposure, but they are not expected to impact air quality or radiation exposure to the extent that public health and long-term productivity of the environment would be impaired.

Continued employment, expenditures, and tax revenues generated during power plant operations directly benefit local, regional, and State economies over the short term. Local governments investing project-generated tax revenues into infrastructure and other required services could enhance economic productivity over the long term.

The management and disposal of spent nuclear fuel, low-level radioactive waste, hazardous waste, and nonhazardous waste requires an increase in energy and consumes space at treatment, storage, or disposal facilities. Regardless of the location, the use of land to meet waste disposal needs would reduce the long-term productivity of the land.

Power plant facilities are committed to electricity production over the short term. After decommissioning these facilities and restoring the area, the land could be available for other future productive uses.

9.3.3 Irreversible and Irretrievable Commitments of Resources

This section describes the irreversible and irretrievable commitment of resources that have been noted in this SEIS. Resources are irreversible when primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources that are neither renewable nor recoverable for future use. Irreversible and irretrievable commitment of resources for electrical power generation include the commitment of land, water, energy, raw materials, and other natural and manmade resources required for power plant operations. In general, the commitment of capital, energy, labor, and material resources also are irreversible.

The implementation of any of the energy alternatives considered in this SEIS would entail the irreversible and irretrievable commitment of energy, water, chemicals, and—in some cases—fossil fuels. These resources would be committed during the license renewal term and over the entire life cycle of the power plant, and they would be unrecoverable.

Energy expended would be in the form of fuel for equipment, vehicles, and power plant operations and electricity for equipment and facility operations. Electricity and fuel would be purchased from offsite commercial sources. Water would be obtained from existing water supply systems. These resources are readily available, and the amounts required are not expected to deplete available supplies or exceed available system capacities.

9.4 Recommendations

The NRC staff's preliminary recommendation is that the adverse environmental impacts of license renewal for GGNS are not great enough to deny the option of license renewal for energy-planning decisionmakers. This recommendation is based on the following:

- the analysis and findings in NUREG-1437, Volumes 1 and 2, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*,
- the environmental report submitted by Entergy,
- consultation with Federal, State, and local agencies,
- the NRC's environmental review, and
- consideration of public comments received during the scoping process.

10.0 LIST OF PREPARERS

Members of the U.S. Nuclear Regulatory Commission's (NRC's) Office of Nuclear Reactor Regulation (NRR) prepared this supplemental environmental impact statement (SEIS) with assistance from other NRC organizations and contract support from Argonne National Laboratory (ANL), Pacific Northwest National Laboratory (PNNL), the Center for Nuclear Waste Regulatory Analyses (CNWRA) and a private contractor. Table 10–1 identifies each contributor's name, affiliation, and function or expertise.

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S. Klementowicz	NRR	Radiological, human health and alternatives
B. Ford	NRR	Hydrology and alternatives
M. Moser	NRR	Aquatic ecology and alternatives
B. Grange	NRR	Terrestrial ecology and alternatives
E. Larson	NRR	Cultural resources, cumulative impacts and alternatives
J. Rikhoff	NRR	Socioeconomic, environmental justice, and land use and alternatives
E. Keegan	NRR	Air quality and meteorology (climatology), alternatives and nonradiological waste management
N. Martinez	NRR	Air quality and meteorology (climatology)
J. Dozier	NRR	Severe Accident Mitigation Alternatives
	Contractor[a][b][c]	
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K. Wescott	ANL	Cultural resources and alternatives
E. Moret	ANL	Alternatives
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D. Anderson	PNNL	Socioeconomic, environmental justice, and land use
R. Benke	CNWRA	Severe Accident Mitigation Alternatives
E. R. Schmidt	Contractor	Severe Accident Mitigation Alternatives

[a] ANL is operated by UChicago Argonne, LLC, for the U.S. Department of Energy.
[b] PNNL is operated by Battelle for the U.S. Department of Energy.
[c] CNWRA is a federally funded research and development center sponsored by the NRC.

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12.0 INDEX

APPENDIX A
COMMENTS RECEIVED ON THE GGNS ENVIRONMENTAL REVIEW

A. COMMENTS RECEIVED ON THE GGNS ENVIRONMENTAL REVIEW

A.1 Comments Received During the Scoping Period

The scoping process began on December 29, 2011, with the publication of the U.S. Nuclear Regulatory Commission's (NRC's) Notice of Intent to conduct scoping in the *Federal Register* (76 FRN 81996). The scoping process included two public meetings held at the Port Gibson City Hall, Port Gibson, Mississippi, on January 31, 2012. Approximately 30 people attended the meetings. After the NRC's prepared statements pertaining to the license renewal process, the meetings were open for public comments. Attendees provided oral statements that were recorded and transcribed by a certified court reporter. Transcripts of the two meetings are available using the NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS Public Electronic Reading Room is accessible at http://www.nrc.gov/reading-rm/adams.html. Transcripts for the afternoon and evening meetings are listed under Accession Numbers ML12037A222 and ML12037A223, respectively.

Table A–1 identifies the individuals who provided comments and an accession number to identify the source document of the comments in ADAMS.

Table A–1. Individuals Who Provided Comments During the Scoping Comment Period

Commenter	Affiliation (If Stated)	Comment Source	ADAMS Accession Number
Jan Hillegas	Green Party of Mississippi	Regulations.gov	ML12060A334
Fred Reeves	Mayor of Port Gibson	Evening transcript	ML12037A223
Debra Chambliss	City of Port Gibson	Evening transcript	ML12037A223

Note - No comments were received during the afternoon meeting.

Comments received during the scoping comment period applicable to this environmental review are presented in this section along with the NRC response. The comments that are general or outside the scope of the environmental review for Grand Gulf Nuclear Station (GGNS) license renewal are not included here but can be found in the Scoping Summary Report (ADAMS Accession No. ML12201A623). Unless otherwise identified, comments presented in this section are from Ms. Jan Hillegas.

A.1.1 Waste Management

Comment: I did not receive an answer to my question (Transcript, p. 35) about "the approximate square footage or cubic yards" of radioactive waste now on site and "how much more accumulates every year." Mr. Smith's answer (Transcript, pp. 36-38) in terms of bundles, canisters, and so on, gave no dimensions. Please provide the dimensions and capacities of the containers and of the stored waste. And the NRC's Environmental Review needs to calculate and evaluate the onsite storage of spent fuel under current and other possible conditions through at least 2044.

Response: *There are two broad classifications of radioactive waste generated at GGNS: high-level and low-level waste. High-level radioactive waste results primarily from the fuel that has been used in a nuclear power reactor and is "spent" or is no longer efficient in generating power to the reactor to produce electricity. Low-level radioactive waste results from reactor operations and typically consists contaminated protective shoe covers and clothing, wiping rags, mops, filters, reactor water treatment residues, equipment, and tools.*

GGNS does not permanently store low-level radioactive waste on site. As stated on page 3-16 of the applicant's Environmental Report (ADAMS Accession No. ML11308A234): GGNS transports low level radioactive waste to a licensed processing facility in Tennessee where the wastes are further processed prior to being sent to a facility such as EnergySolutions in Clive, Utah.

GGNS stores its spent nuclear fuel in its spent fuel pool and in dry casks. The spent fuel pool is a strong structure, constructed of steel-reinforced concrete walls with a stainless steel liner, and filled with water. The spent fuel pool is located inside the plant's protected area. The NRC regularly inspects GGNS's spent fuel storage program to ensure the safety of the spent fuel stored in the spent fuel pool.

GGNS also stores spent nuclear fuel in NRC approved dry cask canisters made of leak-tight welded and bolted steel. These containers are approximately 16 feet high with an approximate exterior diameter of 6 feet. A canister with spent fuel is placed in a concrete cask forming a dry cask storage system. A typical dry cask storage system is detailed at the following website: http://www.nrc.gov/waste/spent-fuel-storage/diagram-typical-dry-cask-system.html. The concrete casks used at GGNS are approximately 20 feet high with an exterior diameter of 11 feet and are stored on a concrete pad within a secure area. The NRC regularly inspects GGNS's dry cask storage system to ensure it complies with NRC requirements. The latest NRC inspection report of the GGNS ISFSI is available at ADAMS Accession No. ML12303A002.

As reported on page 5 of the GGNS ISFSI Inspection Report 05000416/2012009 (ADAMS Accession No. ML12303A002) dated October 26, 2012: "The current ISFSI pad can hold 40 casks with provisions for four additional spaces to allow for cask unloading, if required. Future plans are to add a second pad that will increase the capacity of the ISFSI to 88 storage locations with 4 spare locations." Currently, 17 GGNS ISFSI storage locations are occupied. Every other year, GGNS adds five to seven casks to the ISFSI.

The existing license expiration date for GGNS is November 1, 2024. The requested renewal would extend the license expiration date to November 1, 2044. The NRC's safety requirements for the storage of spent nuclear fuel during licensed operations ensures that the expected increase in the volume of spent fuel during the license renewal term can be safely stored on site with small environmental effects.

Determining the square feet, cubic yards, and bundles of GGNS spent fuel is not necessary for the license renewal environmental review decision-making process.

High-level radioactive waste is discussed in Section 6.1 of this SEIS.

A.1.2 Extended Power Uprate

Comment: Mayor Fred Reeves asked "what effect would the current upgrade at Grand Gulf have to do with the process?" (Transcript, p. 39) The only answer he was given was that "The EPU process that [is] currently ongoing is its own independent process. There are aspect[s] of the plant modifications that are going on that could impact our review, but we have processes in place to account for that." (Transcript, pp. 39-40) Please provide Mayor Reeves and me with an actual answer to his question: What effect will the upgrade have on the processing of the application for license renewal? The NRC's Environmental Review needs to evaluate all aspects of the upgraded plant, after it has been operating at the upgraded capacity, before being able to make a credible report on the environmental impacts of consuming more land and water, having more personnel on-site, storing more spent fuel, transporting low-level waste, etc.

Comment from Mayor Reeves: My other question is what effect would the current upgrade at Grand Gulf have to do with the process? Would that have an impact on the process?

Response: *This comment expresses concern that the NRC's license renewal review should consider the impacts of the GGNS extended power uprate (EPU) license amendment request. The NRC granted the EPU license amendment request for GGNS on July 18, 2012 (ADAMS Accession No. ML121210020). In accordance with 10 CFR 51.21, the NRC prepared an Environmental Assessment (EA) with a Finding of No Significant Impact (FONSI) for the EPU. The EA was published in the Federal Register (77 FR 41814) on July 16, 2012, and can be found at ADAMS Accession No. ML12167A257.*

The license renewal environmental review process for GGNS considers environmental impacts based on the reactor power level requested in the EPU license amendment request. The impacts on land use are discussed in Section 4.1 of this SEIS. The impacts on water are discussed in Sections 4.4 and 4.5. A discussion of the number of employees at the site during the license renewal term is provided in Section 4.10.2 of this SEIS. The impacts of spent fuel, low-level waste, and transportation of radioactive materials are discussed in Section 6.1 of this SEIS.

A.1.3 Extended Power Uprate/Process

Comment: I asked about the date of the announcement of what turns out to have been a "license amendment request" (Transcript, p. 61) to increase the capacity of Grand Gulf, which was granted without general public knowledge, and the expansion is now under construction. Please provide the date of that request and the steps in the process between the filing of the request and the commencement of expansion, including any required public notices, meetings or comment periods, and whether those included any news releases in addition to *Federal Register* publication or legal ads. The NRC's Environmental Review needs to evaluate all aspects of the impacts of the additional capacity on Grand Gulf, the Mississippi River, and all people and properties possibly affected by any catastrophic events at the expanded plant.

Response: *This comment incorrectly asserts that an extended power uprate (EPU) license amendment request to increase the maximum reactor core power operating limit at GGNS was granted on or before February 27, 2012. This comment was received on February 27, 2012, and at that time a decision to grant or deny the EPU request had not been made.*

Entergy Operations, Inc., et al., submitted an EPU license amendment request (ADAMS Accession No. ML1002660403) on September 8, 2010, supplemented by 47 letters, dated from November 18, 2010 to June 12, 2012.

The NRC published a Notice of Consideration of Issuance of Amendments to Facility Operating Licenses, Proposed No Significant Hazards Consideration Determination, and Opportunity for a Hearing in the Federal Register (76 FR 1464) on January 11, 2011, regarding the GGNS EPU license amendment request with a 60-day public comment period. The NRC made a proposed determination that the GGNS EPU amendment request involved no significant hazards consideration. Under the NRC regulations in 10 CFR 50.92, this means that operation of the facility in accordance with the proposed amendment would not (1) involve a significant increase in the probability or consequences of an accident previously evaluated; or (2) create the possibility of a new or different kind of accident from any accident previously evaluated; or

(3) involve a significant reduction in a margin of safety. No comments were received on this notice.

In addition, in accordance with 10 CFR 51.21, the NRC prepared a draft Environmental Assessment (EA) with a preliminary Finding of No Significant Impact (FONSI) for the proposed action. The draft EA was published in the Federal Register (77 FR 27804) with a 30-day public comment period that ended on June 11, 2012. No comments were received on this draft EA. The final EA was published in the Federal Register (77 FR 41814) on July 16, 2012, and can be found at ADAMS Accession No. ML12167A257. The EPU license amendment request was granted on July 18, 2012, and can be found at ADAMS Accession No. ML121210020.

The license renewal environmental review process for GGNS considers environmental impacts based on the reactor power level requested in the EPU license amendment request. The environmental impacts on GGNS and vicinity are discussed in Chapter 4 and the environmental impacts of postulated accidents are discussed in Chapter 5 of this SEIS.

APPENDIX B
NATIONAL ENVIRONMENTAL POLICY ACT ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS

B. NATIONAL ENVIRONMENTAL POLICY ACT ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS

The table in this appendix summarizes the National Environmental Policy Act (NEPA) issues that the applicant was required to consider for potential environmental impacts in developing its license renewal application environmental report submitted to the U.S. Nuclear Regulatory Commission (NRC) on November 1, 2011. On June 20, 2013, the NRC published a final rule (78 FR 37282) revising the list of issues requiring consideration.

In addition to the issues listed in the table in this appendix, the NRC also considered the new issues contained in the June 20, 2013, final rule. The new Category 1 (generic) issues include geology and soils, exposure of terrestrial organisms to radionuclides, exposure of aquatic organisms to radionuclides, human health impact from chemicals, and physical occupational hazards. Radionuclides released to groundwater, effects on terrestrial resources (non-cooling system impacts), minority and low-income populations (i.e., environmental justice), and cumulative impacts were added as new Category 2 (site-specific) issues. The June 20, 2013, final rule revised list of NEPA issues is found in Table B–1 in Appendix B, Subpart A, to Title 10 of the *Code of Federal Regulations,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," (10 CFR Part 51). Data supporting this revised list are contained in NUREG–1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*.

Table B–1. Summary of Issues and Findings

Issue	Type of Issue	Findings
Surface Water Quality, Hydrology, and Use		
Impacts of refurbishment on surface water quality	Generic	SMALL. Impacts are expected to be negligible during refurbishment because best management practices are expected to be employed to control soil erosion and spills.
Impacts of refurbishment on surface water use	Generic	SMALL. Water use during refurbishment will not increase appreciably or will be reduced during plant outage.
Altered current patterns at intake and discharge structures	Generic	SMALL. Altered current patterns have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Altered salinity gradients	Generic	SMALL. Salinity gradients have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Altered thermal stratification of lakes	Generic	SMALL. Generally, lake stratification has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Temperature effects on sediment transport capacity	Generic	SMALL. These effects have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

Issue	Type of Issue	Findings
Scouring caused by discharged cooling water	Generic	SMALL. Scouring has not been found to be a problem at most operating nuclear power plants and has caused only localized effects at a few plants. It is not expected to be a problem during the license renewal term.
Eutrophication	Generic	SMALL. Eutrophication has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Discharge of chlorine or other biocides	Generic	SMALL. Effects are not a concern among regulatory and resource agencies, and are not expected to be a problem during the license renewal term.
Discharge of sanitary wastes and minor chemical spills	Generic	SMALL. Effects are readily controlled through a National Pollutant Discharge Elimination System (NPDES) permit and periodic modifications, if needed, and are not expected to be a problem during the license renewal term.
Discharge of other metals in wastewater	Generic	SMALL. These discharges have not been found to be a problem at operating nuclear power plants with cooling-tower-based heat dissipation systems and have been satisfactorily mitigated at other plants. They are not expected to be a problem during the license renewal term.
Water use conflicts (plants with once-through cooling systems)	Generic	SMALL. These conflicts have not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems.
Water use conflicts (plants with cooling ponds or cooling towers using makeup water from a small river with low flow)	Site-Specific	SMALL OR MODERATE. The issue has been a concern at nuclear power plants with cooling ponds and at plants with cooling towers. Impacts on in-stream and riparian communities near these plants could be of moderate significance in some situations. See 10 CFR 51.53(c)(3)(ii)(A).
Aquatic Ecology (all plants)		
Refurbishment	Generic	SMALL. During plant shutdown and refurbishment there will be negligible effects on aquatic biota because of a reduction of entrainment and impingement of organisms or a reduced release of chemicals.
Accumulation of contaminants in sediments or biota	Generic	SMALL. Accumulation of contaminants has been a concern at a few nuclear power plants but has been satisfactorily mitigated by replacing copper alloy condenser tubes with those of another metal. It is not expected to be a problem during the license renewal term.
Entrainment of phytoplankton and zooplankton	Generic	SMALL. Entrainment of phytoplankton and zooplankton has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.

Issue	Type of Issue	Findings
Cold shock	Generic	SMALL. Cold shock has been satisfactorily mitigated at operating nuclear plants with once-through cooling systems, has not endangered fish populations, or been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds, and is not expected to be a problem during the license renewal term.
Thermal plume barrier to migrating fish	Generic	SMALL. Thermal plumes have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Distribution of aquatic organisms	Generic	SMALL. Thermal discharge may have localized effects but is not expected to affect the larger geographical distribution of aquatic organisms.
Premature emergence of aquatic insects	Generic	SMALL. Premature emergence has been found to be a localized effect at some operating nuclear power plants but has not been a problem and is not expected to be a problem during the license renewal term.
Gas supersaturation (gas bubble disease)	Generic	SMALL. Gas supersaturation was a concern at a small number of operating nuclear power plants with once-through cooling systems but has been satisfactorily mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.
Low dissolved oxygen in the discharge	Generic	SMALL. Low dissolved oxygen has been a concern at one nuclear power plant with a once-through cooling system but has been effectively mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	Generic	SMALL. These types of losses have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Stimulation of nuisance organisms (e.g., shipworms)	Generic	SMALL. Stimulation of nuisance organisms has been satisfactorily mitigated at the single nuclear power plant with a once-through cooling system where previously it was a problem. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.

Issue	Type of Issue	Findings
Aquatic Ecology (for plants with once-through and cooling pond heat dissipation systems)		
Entrainment of fish and shellfish in early life stages	Site-Specific	SMALL, MODERATE, OR LARGE. The impacts of entrainment are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. Further, ongoing efforts in the vicinity of these plants to restore fish populations may increase the numbers of fish susceptible to intake effects during the license renewal period, such that entrainment studies conducted in support of the original license may no longer be valid. See 10 CFR 51.53(c)(3)(ii)(B).
Impingement of fish and shellfish	Site-Specific	SMALL, MODERATE, OR LARGE. The impacts of impingement are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. See 10 CFR 51.53(c)(3)(ii)(B).
Heat shock	Site-Specific	SMALL, MODERATE, OR LARGE. Because of continuing concerns about heat shock and the possible need to modify thermal discharges in response to changing environmental conditions, the impacts may be of moderate or large significance at some plants. See 10 CFR 51.53(c)(3)(ii)(B).
Aquatic Ecology (for plants with cooling-tower-based heat dissipation systems)		
Entrainment of fish and shellfish in early life stages	Generic	SMALL. Entrainment of fish has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Impingement of fish and shellfish	Generic	SMALL. The impacts of impingement have not been found to be a problem at operating nuclear power plants with this type of cooling system and are not expected to be a problem during the license renewal term.
Heat shock	Generic	SMALL. Heat shock has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Impacts of refurbishment on groundwater use and quality	Generic	SMALL. Extensive dewatering during the original construction on some sites will not be repeated during refurbishment on any sites. Any plant wastes produced during refurbishment will be handled in the same manner as in current operating practices and are not expected to be a problem during the license renewal term.

Issue	Type of Issue	Findings
Groundwater use conflicts (potable and service water; plants that use <100 gallons per minute [gpm])	Generic	SMALL. Plants using less than 100 gpm are not expected to cause any groundwater use conflicts.
Groundwater use conflicts (potable and service water, and dewatering plants that use >100 gpm)	Site-Specific	SMALL, MODERATE, OR LARGE. Plants that use more than 100 gpm may cause groundwater use conflicts with nearby groundwater users. See 10 CFR 51.53(c)(3)(ii)(C).
Groundwater use conflicts (plants using cooling towers withdrawing makeup water from a small river)	Site-Specific	SMALL, MODERATE, OR LARGE. Water use conflicts may result from surface water withdrawals from small water bodies during low flow conditions which may affect aquifer recharge, especially if other groundwater or upstream surface water users come on line before the time of license renewal. See 10 CFR 51.53(c)(3)(ii)(A).
Groundwater use conflicts (Ranney wells)	Site-Specific	SMALL, MODERATE, OR LARGE. Ranney wells can result in potential groundwater depression beyond the site boundary. Impacts of large groundwater withdrawal for cooling tower makeup at nuclear power plants using Ranney wells must be evaluated at the time of application for license renewal. See 10 CFR 51.53(c)(3)(ii)(C).
Groundwater quality degradation (Ranney wells)	Generic	SMALL. Groundwater quality at river sites may be degraded by induced infiltration of poor-quality river water into an aquifer that supplies large quantities of reactor cooling water. However, the lower quality infiltrating water would not preclude the current uses of groundwater and is not expected to be a problem during the license renewal term.
Groundwater quality degradation (saltwater intrusion)	Generic	SMALL. Nuclear power plants do not contribute significantly to saltwater intrusion.
Groundwater quality degradation (cooling ponds in salt marshes)	Generic	SMALL. Sites with closed-cycle cooling ponds may degrade groundwater quality. Because water in salt marshes is brackish, this is not a concern for plants located in salt marshes.
Groundwater quality degradation (cooling ponds at inland sites)	Site-Specific	SMALL, MODERATE, OR LARGE. Sites with closed-cycle cooling ponds may degrade groundwater quality. For plants located inland, the quality of the groundwater in the vicinity of the ponds must be shown to be adequate to allow continuation of current uses. See 10CFR 51.53(c)(3)(ii)(D).

Issue	Type of Issue	Findings
Terrestrial Ecology		
Refurbishment impacts	Site-Specific	SMALL, MODERATE, OR LARGE. Refurbishment impacts are insignificant if no loss of important plant and animal habitat occurs. However, it cannot be known whether important plant and animal communities may be affected until the specific proposal is presented with the license renewal application. See 10 CFR 51.53(c)(3)(ii)(E).
Cooling tower impacts on crops and ornamental vegetation	Generic	SMALL. Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Cooling tower impacts on native plants	Generic	SMALL. Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Bird collisions with cooling towers	Generic	SMALL. These collisions have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Cooling pond impacts on terrestrial resources	Generic	SMALL. Impacts of cooling ponds on terrestrial ecological resources are considered to be of small significance at all sites.
Power line right-of-way management (cutting and herbicide application)	Generic	SMALL. The impacts of right-of-way maintenance on wildlife are expected to be of small significance at all sites.
Bird collisions with power lines	Generic	SMALL. Impacts are expected to be of small significance at all sites.
Impacts of electromagnetic fields on flora and fauna	Generic	SMALL. No significant impacts of electromagnetic fields on terrestrial flora and fauna have been identified. Such effects are not expected to be a problem during the license renewal term.
Floodplains and wetland on power line right-of-way	Generic	SMALL. Periodic vegetation control is necessary in forested wetlands underneath power lines and can be achieved with minimal damage to the wetland. No significant impact is expected at any nuclear power plant during the license renewal term.

Issue	Type of Issue	Findings
Threatened or Endangered Species		
Threatened or endangered species	Site-Specific	SMALL, MODERATE, OR LARGE. Generally, plant refurbishment and continued operation are not expected to adversely affect threatened or endangered species. However, consultation with appropriate agencies would be needed at the time of license renewal to determine whether threatened or endangered species are present and whether they would be adversely affected. See 10 CFR 51.53(c)(3)(ii)(E).
Air Quality		
Air quality during refurbishment (nonattainment and maintenance areas)	Site-Specific	SMALL, MODERATE, OR LARGE. Air quality impacts from plant refurbishment associated with license renewal are expected to be small. However, vehicle exhaust emissions could be cause for concern at locations in or near nonattainment or maintenance areas. The significance of the potential impact cannot be determined without considering the compliance status of each site and the numbers of workers expected to be employed during the outage. See 10CFR 51.53(c)(3)(ii)(F).
Air quality effects of transmission lines	Generic	SMALL. Production of ozone and oxides of nitrogen is insignificant and does not contribute measurably to ambient levels of these gases.
Land Use		
Onsite land use	Generic	SMALL. Projected onsite land use changes required during refurbishment and the renewal period would be a small fraction of any nuclear power plant site and would involve land that is controlled by the applicant.
Power line right-of-way	Generic	SMALL. Ongoing use of power line rights-of-way would continue with no change in restrictions. The effects of these restrictions are of small significance.
Human Health		
Radiation exposures to the public during refurbishment	Generic	SMALL. During refurbishment, the gaseous effluents would result in doses that are similar to those from current operation. Applicable regulatory dose limits to the public are not expected to be exceeded.
Occupational radiation exposures during refurbishment	Generic	SMALL. Occupational doses from refurbishment are expected to be within the range of annual average collective doses experienced for pressurized-water reactors and boiling-water reactors. Occupational mortality risk from all causes, including radiation, is in the mid-range for industrial settings.

Issue	Type of Issue	Findings
Microbiological organisms (occupational health)	Generic	SMALL. Occupational health impacts are expected to be controlled by the continued application of accepted industrial hygiene practices to minimize worker exposures.
Microbiological organisms (public health)(plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	Site-Specific	SMALL, MODERATE, OR LARGE. These organisms are not expected to be a problem at most operating plants, except possibly at plants using cooling ponds, lakes, or canals that discharge to small rivers. Without site-specific data, it is not possible to predict the effects generically. See 10 CFR 51.53(c)(3)(ii)(G).
Noise	Generic	SMALL. Noise has not been found to be a problem at operating plants and is not expected to be a problem at any plant during the license renewal term.
Electromagnetic fields—acute effects (electric shock)	Site-Specific	SMALL, MODERATE, OR LARGE. Electric shock resulting from direct access to energized conductors or from induced charges in metallic structures has not been found to be a problem at most operating plants and generally is not expected to be a problem during the license renewal term. However, site-specific review is required to determine the significance of the electric shock potential at the site. See 10 CFR 51.53(c)(3)(ii)(H).
Electromagnetic fields—chronic effects	Uncategorized	UNCERTAIN. Biological and physical studies of 60-Hz electromagnetic fields have not found consistent evidence linking harmful effects with field exposures. However, research is continuing in this area and a consensus scientific view has not been reached.
Radiation exposures to public (license renewal term)	Generic	SMALL. Radiation doses to the public will continue at current levels associated with normal operations.
Occupational radiation exposures (license renewal term)	Generic	SMALL. Projected maximum occupational doses during the license renewal term are within the range of doses experienced during normal operations and normal maintenance outages, and would be well below regulatory limits.
Socioeconomic Impacts		
Housing impacts	Site-Specific	SMALL, MODERATE, OR LARGE. Housing impacts are expected to be of small significance at plants located in a medium- or high-population area and not in an area where growth control measures, that limit housing development, are in effect. Moderate or large housing impacts of the workforce, associated with refurbishment, may be associated with plants located in sparsely populated areas or in areas with growth control measures that limit housing development. See 10 CFR 51.53(c)(3)(ii)(I).

Issue	Type of Issue	Findings
Public services: public safety, social services, and tourism and recreation	Generic	SMALL. Impacts to public safety, social services, and tourism and recreation are expected to be of small significance at all sites.
Public services: public utilities	Site-Specific	SMALL OR MODERATE. An increased problem with water shortages at some sites may lead to impacts of moderate significance on public water supply availability. See 10 CFR 51.53(c)(3)(ii)(I).
Public services: education (refurbishment)	Site-Specific	SMALL, MODERATE, OR LARGE. Most sites would experience impacts of small significance but larger impacts are possible depending on site- and project-specific factors. See 10 CFR 51.53(c)(3)(ii)(I).
Public services: education (license renewal term)	Generic	SMALL. Only impacts of small significance are expected
Offsite land use (refurbishment)	Site-Specific	SMALL OR MODERATE. Impacts may be of moderate significance at plants in low population areas. See 10 CFR 51.53(c)(3)(ii)(I).
Offsite land use (license renewal term)	Site-Specific	SMALL, MODERATE, OR LARGE. Significant changes in land use may be associated with population and tax revenue changes resulting from license renewal. See 10 CFR 51.53(c)(3)(ii)(I).
Public services: transportation	Site-Specific	SMALL, MODERATE, OR LARGE. Transportation impacts (level of service) of highway traffic generated during plant refurbishment and during the term of the renewed license are generally expected to be of small significance. However, the increase in traffic associated with the additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites. See 10 CFR 51.53(c)(3)(ii)(J).
Historic and archaeological resources	Site-Specific	SMALL, MODERATE, OR LARGE. Generally, plant refurbishment and continued operation are expected to have no more than small adverse impacts on historic and archaeological resources. However, the National Historic Preservation Act requires the Federal agency to consult with the State Historic Preservation Officer to determine whether there are properties present that require protection. See 10 CFR 51.53(c)(3)(ii)(K).
Aesthetic impacts (refurbishment)	Generic	SMALL. No significant impacts are expected during refurbishment.
Aesthetic impacts (license renewal term)	Generic	SMALL. No significant impacts are expected during the license renewal term.

Issue	Type of Issue	Findings
Aesthetic impacts of transmission lines (license renewal term)	Generic	SMALL. No significant impacts are expected during the license renewal term.
Postulated Accidents		
Design-basis accidents	Generic	SMALL. The NRC staff has concluded that the environmental impacts of design-basis accidents are of small significance for all plants.
Severe accidents	Site-Specific	SMALL. The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives. See 10 CFR 51.53(c)(3)(ii)(L).
Uranium Fuel Cycle and Waste Management (impacts discussed further in Chapter 6 of this SEIS)		
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste)	Generic	SMALL. Offsite impacts of the uranium fuel cycle have been considered by the Commission in Table S-3 of this part. Based on information in the GEIS, impacts on individuals from radioactive gaseous and liquid releases, including radon-222 and technetium-99, are small.

Issue	Type of Issue	Findings
Offsite radiological impacts (collective effects)	Generic	The 100-year environmental dose commitment to the U.S. population from the fuel cycle, high-level waste, and spent fuel disposal is calculated to be about 14,800 person-rem, or 12 cancer fatalities, for each additional 20-year power reactor operating term. Much of this, especially the contribution of radon releases from mines and tailing piles, consists of tiny doses summed over large populations. This same dose calculation can theoretically be extended to include many tiny doses over additional thousands of years, as well as doses outside the United States. 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 effects which will not ever be mitigated (for example, no cancer cure in the next thousand years), and that these doses projected over thousands of years are meaningful. However, these assumptions are questionable. In particular, science cannot rule out the possibility that there will be no cancer fatalities from these tiny doses. For perspective, the doses are very small fractions of regulatory limits, and even smaller fractions of natural background exposure to the same populations. Nevertheless, despite all the uncertainty, some judgment as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgment in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective effects of the fuel cycle, this issue is considered Category 1 (Generic).

Issue	Type of Issue	Findings
Offsite radiological impacts (spent fuel and high-level waste disposal)	Generic	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 it is assumed that limits are developed along the lines of the 1995 National Academy of Sciences (NAS) report, "Technical Bases for Yucca Mountain Standards," and that in accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository can and likely will be developed at some site which will comply with such limits, peak doses to virtually all individuals will be 100 milliroentgen equivalent man (millirem) per year or less. However, while the Commission has reasonable confidence that these assumptions will prove correct, there is considerable uncertainty since the limits are yet to be developed, no repository application has been completed or reviewed, and uncertainty is inherent in the models used to evaluate possible pathways to the human environment. The NAS report indicated that 100 millirem per year should be considered as a starting point for limits for individual doses, but notes that some measure of consensus exists among national and international bodies that the limits should be a fraction of the 100 millirem per year. The lifetime individual risk from 100 millirem annual dose limit is about 3×10^{-3}. Estimating cumulative doses to populations over thousands of years is more problematic. The likelihood and consequences of events that could seriously compromise the integrity of a deep geologic repository were evaluated by the U.S. Department of Energy in the "Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste," October 1980. The evaluation estimated the 70-year whole-body dose commitment to the maximum individual and to the regional population resulting from several modes of breaching a reference repository in the year of closure, after 1,000 years, after 100,000 years, and after 100,000,000 years. Subsequently, the NRC and other Federal agencies have expended considerable effort to develop models for the design and for the licensing of a high-level waste repository, especially for the candidate repository at Yucca Mountain. More meaningful estimates of doses to the population may be possible in the future as more is understood about the performance of the proposed Yucca Mountain repository. Such estimates would involve 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

Issue	Type of Issue	Findings
Offsite radiological impacts (spent fuel and high-level waste disposal) *[continued from previous page]*	Generic	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, the U.S. Environmental Protection Agency's (EPA) generic repository standards in 40 CFR Part 191 generally provide an indication of the order of magnitude of cumulative risk to the 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 the amount of radioactive material released over 10,000 years. The cumulative release limits are based on the EPA's population impact goal of 1,000 premature cancer deaths worldwide for a 100,000-metric ton (MTHM)repository. Nevertheless, despite all the uncertainty, some judgment as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgment in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent fuel and high-level waste disposal, this issue is considered in Category 1 (Generic).
Nonradiological impacts of the uranium fuel cycle	Generic	SMALL. The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an operating license for any plant are found to be small.
Low-level waste storage and disposal	Generic	SMALL. The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts to the environment will remain small during the term of a renewed license. The maximum additional onsite 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.

Issue	Type of Issue	Findings
Mixed waste storage and disposal	Generic	SMALL. The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal will not increase the small, continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient mixed waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.
Onsite spent fuel	Generic	SMALL. The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated on site with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage is not available.
Nonradiological waste	Generic	SMALL. No changes to generating systems are anticipated for license renewal. Facilities and procedures are in place to ensure continued proper handling and disposal at all plants.
Transportation	Generic	SMALL. 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 the NRC up to 62,000 megawatt days per metric ton uranium (MWd/MTU) and the cumulative impacts of transporting high-level waste to a single repository, such as Yucca Mountain, Nevada are found to be consistent with the impact values contained in 10 CFR 51.52(c), Summary Table S-4, “Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor.” If fuel enrichment or burnup conditions are not met, the applicant must submit an assessment of the implications for the environmental impact values reported in 10 CFR 51.52.

Issue	Type of Issue	Findings
Decommissioning		
Radiation doses	Generic	SMALL. Doses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem caused by the buildup of long-lived radionuclides during the license renewal term.
Waste management	Generic	SMALL. Decommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected.
Air quality	Generic	SMALL. Air quality impacts of decommissioning are expected to be negligible either at the end of the current operating term or at the end of the license renewal term.
Water quality	Generic	SMALL. The potential for significant water quality impacts from erosion or spills is no greater whether decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts.
Ecological resources	Generic	SMALL. Decommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts.
Socioeconomic impacts	Generic	SMALL. Decommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year license renewal period, but they might be decreased by population and economic growth.
Environmental Justice		
Environmental justice	Uncategorized	NONE. The need for and the content of an analysis of environmental justice will be addressed in plant-specific reviews.

Table source: Table B–1 in Appendix B, Subpart A, to 10 CFR Part 51

APPENDIX C
APPLICABLE REGULATIONS, LAWS, AND AGREEMENTS

C. APPLICABLE REGULATIONS, LAWS, AND AGREEMENTS

The Atomic Energy Act of 1954, as amended (42 USC § 2011 et seq.), authorizes the U.S. Nuclear Regulatory Commission (NRC) to enter into agreement with any State to assume regulatory authority for certain activities (see 42 USC § 2012 et seq.). For example, through the Agreement State Program, Mississippi assumed regulatory responsibility over certain byproduct, source, and quantities of special nuclear materials not sufficient to form a critical mass. The Division of Radiological Health, Mississippi Department of Health, administers the Mississippi State Agreement Program.

In addition to carrying out some Federal programs, State legislatures develop their own laws. State statutes supplement, as well as implement, Federal laws for protection of air, water quality, and groundwater. State legislation may address solid waste management programs, locally rare and endangered species, and historic and cultural resources.

The Clean Water Act (33 USC § 1251 et seq., herein referred to as CWA) allows for primary enforcement and administration through State agencies, given that the State program is at least as stringent as the Federal program. The State program must conform to the CWA and to the delegation of authority for the Federal National Pollutant Discharge Elimination System (NPDES) program from the U.S. Environmental Protection Agency (EPA) to the State. The primary mechanism to control water pollution is the requirement for direct dischargers to obtain an NPDES permit, or in the case of States where the authority has been delegated from the EPA, a State Pollutant Discharge Elimination System permit, under the CWA. In Mississippi, the Mississippi Department of Environmental Quality issues and enforces NPDES permits.

One important difference between Federal regulations and certain State regulations is the definition of waters that the State regulates. Certain State regulations may include underground waters, whereas the CWA only regulates surface waters. The Mississippi Department of Environmental Quality is charged with conserving, managing and protecting the surface water and groundwater resources of Mississippi (MDEQ 2013).

C.1 Federal and State Environmental Requirements

Grand Gulf Nuclear Station (GGNS) is subject to Federal and State requirements for its environmental program.

Table C–1 lists the principle Federal and State environmental regulations and laws associated with the environmental review of the GGNS license renewal application.

Table C–1. Federal and State Environmental Requirements

Law/regulation	Requirements
Current operating license and license renewal	
Atomic Energy Act (42 U.S.C. § 2011 et seq.)	This Act is the fundamental U.S. law on both the civilian and the military uses of nuclear materials. On the civilian side, it provides for both the development and the regulation of the uses of nuclear materials and facilities in the United States. The Act requires that civilian uses of nuclear materials and facilities be licensed, and it empowers the NRC to establish by rule or order, and to enforce, such standards to govern these uses as “the Commission may deem necessary or desirable in order to protect health and safety and minimize danger to life or property.”

Law/regulation	Requirements
10 CFR Part 51. Title 10 Code of Federal Regulations (10 CFR) Part 51, Energy	"Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." This part contains environmental protection regulations applicable to the NRC's domestic licensing and related regulatory functions.
10 CFR Part 54	"Requirements for Renewal of Operating Licenses for Nuclear Power Plants." This part focuses on managing adverse effects of aging rather than noting all aging mechanisms. The rule is intended to ensure that important systems, structures, and components will maintain their intended function during the period of extended operation.
10 CFR Part 50	"Domestic Licensing of Production and Utilization Facilities." Regulations that the NRC issues under the Atomic Energy Act of 1954, as amended (68 Stat. 919), and Title II of the Energy Reorganization Act of 1974 (88 Stat. 1242), provide for the licensing of production and utilization facilities. This part also gives notice to all persons who knowingly supply—to any licensee, applicant, contractor, or subcontractor—components, equipment, materials, or other goods or services that relate to a licensee's or applicant's activities subject to this part, that they may be individually subject to NRC enforcement action for violation of § 50.5.
Air quality protection	
Clean Air Act (CAA) (42 USC § 7401 et seq.)	The Clean Air Act (CAA) is a comprehensive Federal law that regulates air emissions. Among other things, this law authorizes EPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and public welfare and to regulate emissions of hazardous air pollutants. EPA has promulgated NAAQS for six criteria pollutants: sulfur dioxide, nitrogen dioxide, carbon monoxide (CO), ozone, lead, and particulate matter. All areas of the United States must maintain ambient levels of these pollutants below the ceilings established by the NAAQS.
Mississippi Air and Water Pollution Control Act (Mississippi Code §§ 49-17-1 to 49-17-43)	The Mississippi Air and Water Pollution Control Act authorizes the setting of ambient air quality standards as necessary to protect the public health and welfare and emission standards for the purpose of controlling air contamination, air pollution, and the sources of air pollution.
Land use resources protection	
Coastal Zone Management Act (16 USC § 1451 et seq.)	The Coastal Zone Management Act (CZMA) was established to preserve, protect, develop and where possible, restore or enhance, the resources of the Nation's coastal zone.
Water resources protection	
Clean Water Act (CWA) (33 USC § 1251 et seq.) and the NPDES (40 CFR 122)	The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters.
Wild and Scenic River Act (16 USC § 1271 et seq.)	The Wild and Scenic River Act created the National Wild and Scenic Rivers System, which was established to protect the environmental values of free flowing streams from degradation by affecting activities, including water resources projects.
Safe Drinking Water Act (42 USC § 300f et seq.)	The Safe Drinking Water Act (SDWA) is the principal Federal law that ensures safe drinking water for the public. Under the SDWA, EPA is required to set standards for drinking water quality and oversees all states, localities, and water suppliers that implement these standards.
Mississippi Department of Environmental Quality Regulation WPC-1	Wastewater Regulations for National Pollutant Discharge Elimination System (NPDES) Permits, Underground Injection Control (UIC) Permits, State Permits, Water Quality Based Effluent Limitations and Water Quality Certification

Law/regulation	Requirements
Waste management and pollution prevention	
Resource Conservation and Recovery Act (RCRA) (42 USC § 6901 et seq.)	RCRA gives EPA authority to control hazardous waste. Before a material can be classified as a hazardous waste, it first must be a solid waste as defined under the Resource Conservation and Recovery Act (RCRA). Hazardous waste is classified under Subtitle C of the RCRA. Parts 261, "Identification and Listing of Hazardous Waste," and 262, "Standards Applicable to Generators of Hazardous Waste," of 40 CFR contain all applicable generators of hazardous waste regulations.
Pollution Prevention Act (42 USC § 13101 et seq.)	The Pollution Prevention Act formally established a national policy to prevent or reduce pollution at its source whenever feasible. The Act supplies funds for state and local pollution prevention programs through a grant program to promote the use of pollution prevention techniques by business.
Protected species	
Endangered Species Act (ESA) (16 USC § 1531 et seq.)	The Endangered Species Act (ESA) forbids any government agency, corporation, or citizen from taking (e.g., harming or killing) endangered animals without an Endangered Species Permit. The ESA also requires Federal agencies to consult with the U.S. Fish and Wildlife Service or National Marine Fisheries Service if any Federal action may adversely affect any listed species or designated critical habitat.
Magnuson–Stevens Fishery Conservation and Management Act (MSA) (P.L. 94-265), as amended through January 12, 2007	The Magnuson–Stevens Fishery Conservation and Management Act (MSA) includes requirements for Federal agencies to consider the impact of Federal actions on essential fish habitat and to consult with the National Marine Fisheries Service if any activities may adversely affect essential fish habitat.
Marine Mammal Protection Act (MMPA) (16 USC § 1361 et seq.)	The Marine Mammal Protection Act (MMPA) prohibits the take of marine mammals in U.S. waters or by U.S. citizens on the high seas without an MMPA Take Permit issued by the National Marine Fisheries Service. MMPA also prohibits importation of marine mammals and marine mammal products into the United States.
Fish and Wildlife Coordination Act (16 USC § 661 et seq.)	To minimize adverse impacts of proposed actions on fish and wildlife resources and habitat, the Fish and Wildlife Coordination Act requires that Federal agencies consult Government agencies regarding activities that affect, control, or modify waters of any stream or bodies of water. It also requires that justifiable means and measures be used in modifying plans to protect fish and wildlife in these waters.
Historic preservation	
National Historic Preservation Act (NHPA) (16 USC § 470 et seq.)	The National Historic Preservation Act (NHPA) directs Federal agencies to consider the impact of their actions on historic properties. To comply with NHPA, Federal agencies must consult with State Historic Preservation Officers and, when applicable, tribal historic preservations officers. NHPA also encourages state and local preservation societies.

C.2 Operating Permits and Other Requirements

Table C–2 lists the permits and licenses issued by Federal, State, and local authorities for activities at GGNS.

1 **Table C–2. Licenses and Permits**

Permit	Number	Dates	Responsible Agency
Operating license	NPF-29	Issued: 11/1/1984 Expires: 11/1/2024	NRC
401 Water Quality Certification	None	Issued: 2/5/1974 Expires: None	Mississippi Air and Water Pollution Control Commission
NPDES Permit	MS0029521	Expires: 08/31/2016	Mississippi Department of Environmental Quality (MDEQ)
Baseline Stormwater General NPDES Permit	MSR000883	Expires: 09/28/15	MDEQ
Large Construction General Permit - Discharge of stormwater to waters of the State	MSR10-5946	Expires: 12/31/15	MDEQ
Air Permit - Operation of air emission sources (emergency diesel generators, diesel engines and pumps, diesel fueled outage equipment, and cooling towers)	0420-00023	Expires: 05/31/09 Timely renewal application was submitted; therefore, permit has been administratively continued.	MDEQ
Hazardous waste generator identification	MSD000644617	Expires: N/A	MDEQ
Groundwater withdrawal	MS-GW-02972	Expires: 09/25/2016	MDEQ
Groundwater withdrawal	MS-GW-02971	Expires: 09/25/2016	MDEQ
Groundwater withdrawal	MS-GW-02970	Expires: 09/25/2016	MDEQ
Groundwater withdrawal	MS-GW-02969	Expires: 09/25/2016	MDEQ
Groundwater withdrawal	MS-GW-00371	Expires: 09/25/2016	MDEQ
Groundwater withdrawal	MS-GW-16714	Expires: 03/10/2020	MDEQ
Groundwater withdrawal	MS-GW-02967	Expires: 09/25/2016	MDEQ
Groundwater withdrawal	MS-GW-14989	Expires: 09/25/2016	MDEQ
Groundwater withdrawal	MS-GW-15026	Expires: 09/25/2016	MDEQ
Groundwater withdrawal	MS-GW-02979	Expires: 09/25/2016	MDEQ
Groundwater withdrawal	MS-GW-02978	Expires: 09/25/2016	MDEQ
Groundwater withdrawal	MS-GW-02977	Expires: 09/25/2016	MDEQ
Groundwater withdrawal	MS-GW-02976	Expires: 09/25/2016	MDEQ
Groundwater withdrawal	MS-GW-02975	Expires: 09/25/2016	MDEQ
Groundwater withdrawal	MS-GW-02974	Expires: 09/25/2016	MDEQ
Groundwater withdrawal	MS-GW-02973	Expires: 09/25/2016	MDEQ
Underground diesel fuel storage	5913	Expires: 06/30/2014	MDEQ
Transportation of radioactive waste through Mississippi	4600	Expires: 06/30/2014	Mississippi Emergency Management Agency
Radioactive and hazardous materials shipments	061013550003V	Expires: 06/30/2014	U.S. Department of Transportation
Taking of migratory birds	MB798276-0	Expires: 03/31/2014	U.S. Fish & Wildlife Service
Shipment of radioactive material into Tennessee to a disposal/processing facility	T-MS002-L13	Expires: 12/31/2013	Tennessee Department of Environmental Conservation

Source: Entergy 2011

C.3 References

[Entergy] Entergy Operations, Inc. 2011. *Grand Gulf Nuclear Station, Unit 1, License Renewal Application. Appendix E, Applicant's Environmental Report.* October 2011. ADAMS Accession No. ML11308A234

[MDEQ] Mississippi Department of Environmental Quality. 2013. *Home – The Office of Land and Water Resources*. Available at http://www.deq.state.ms.us/mdeq.nsf/page/l%26w_home (accessed 8 January 2013).

APPENDIX D
CONSULTATION CORRESPONDENCE

D. CONSULTATION CORRESPONDENCE

D.1 Background

The Endangered Species Act of 1973, as amended; the Magnuson Stevens Fisheries Management Act of 1996, as amended; and the National Historic Preservation Act of 1966 (NHPA) require that Federal agencies consult with applicable State and Federal agencies and groups before taking action that may affect threatened or endangered species, essential fish habitat, or historic and archaeological resources, respectively. Table D–1 contains a list of correspondence between the U. S. Nuclear Regulatory Commission (NRC) and other agencies pursuant to compliance with these Federal acts.

Table D-1. Consultation Correspondence

Author	Recipient	Date of Letter/Email
NRC (D. Wrona)	Advisory Council on Historic Preservation (R. Nelson)	January 19, 2012 (ML11348A088)
NRC (D. Wrona)	Tribal Nation— Mississippi Band of Choctaw Indians (P. Anderson)	January 19, 2012 (ML11342A121)
NRC (D. Wrona)	Tribal Nation— Jena Band of Choctaw Indians (B. Smith)	January 19, 2012 (ML11342A121)
NRC (D. Wrona)	Tribal Nation— Choctaw Nation of Oklahoma (G. Pyle)	January 19, 2012 (ML11342A121)
NRC (D. Wrona)	Tribal Nation— Tunica -Biloxi Tribe of Louisiana (E. Barbry)	January 19, 2012 (ML11342A121)
NRC (D. Wrona)	National Marine Fisheries Service (D. Bernhart)	January 19, 2012 (ML11350A173)
NRC (D. Wrona)	U.S. Fish & Wildlife Service (USFWS), Louisiana Field Office (R. Watson)	January 19, 2012 (ML11349A001)
NRC (D. Wrona)	Mississippi State Historic Preservation Office (SHPO)	January 19, 2012 (ML11348A090)
NRC (D. Wrona)	Mississippi Natural Heritage Program (S. Surrette)	January 20, 2012 (ML11349A003)
NRC (D. Wrona)	USFWS, Mississippi Field Office (S. Ricks)	January 20, 2012 (ML11348A354)
NRC (D. Wrona)	Louisiana SHPO (P. Boggan)	January 20, 2012 (ML11348A353)
USFWS Mississippi Field Office (S. Ricks)	NRC (D. Drucker)	February 3, 2012 (ML12047A113)
NRC (D. Wrona)	Louisiana Natural Heritage Program (C. Michon)	February 6, 2012 (ML12005A163)
Mississippi Natural Heritage Program (A. Sanderson)	NRC (D. Wrona)	February 13, 2012 (ML12055A312)
Tribal Nation— Mississippi Band of Choctaw Indians (C. Wallace)	NRC (D. Wrona)	February 13, 2012 (ML12047A127)

Author	Recipient	Date of Letter/Email
Louisiana Natural Heritage Program (C. Michon)	NRC (D. Wrona)	February 16, 2012 (ML12060A098)
Mississippi SHPO (G. Williamson)	NRC (D. Wrona)	February 28, 2012 (ML12073A084)
USFWS Louisiana Field Office (J. Weller)	NRC (D. Wrona)	February 29, 2012 (ML12082A141)
Jena Band of Choctaw Indians (D. Masters)	NRC (Chief, Rules, Announcements, & Directives Branch)	March 1, 2012 (ML12089A020)
National Marine Fisheries Service (D. Bernhart)	NRC (D. Wrona)	March 1, 2012 (ML12065A167)
Choctaw Nation of Oklahoma (J. Jacobs)	NRC (D. Wrona)	March 26, 2012 (ML12101A124)

APPENDIX E
CHRONOLOGY OF ENVIRONMENTAL REVIEW CORRESPONDENCE

E. CHRONOLOGY OF ENVIRONMENTAL REVIEW CORRESPONDENCE

This appendix contains a chronological listing of correspondence between the U.S. Nuclear Regulatory Commission (NRC) and external parties as part of its environmental review for Grand Gulf Nuclear Station (GGNS). All documents are available electronically from the NRC's 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 Documents Access and Management System (ADAMS), which provides text and image files of the NRC's public documents in ADAMS. The ADAMS accession number for each document is included in the following list.

E.1 Environmental Review Correspondence

Table E–1 lists the environmental review correspondence, by date, beginning with the request by Entergy to renew the operating license for GGNS.

Table E–1. Environmental Review Correspondence

Date	Correspondence Description	ADAMS No.
October 28, 2011	Transmittal of license renewal application (LRA) for GGNS, Unit 1	ML11308A052
November 9, 2011	Receipt and availability of GGNS, Unit 1 LRA	ML11293A013
December 16, 2011	Determination of acceptability and sufficiency for docketing, proposed review schedule, and opportunity for a hearing regarding the application from Entergy Operations, Inc. (Entergy), for renewal of the operating license for GGNS, Unit 1	ML11335A340
December 22, 2011	Notice of intent to prepare an environmental impact statement (EIS) and conduct scoping process for license renewal for GGNS, Unit 1	ML11342A073
January 6, 2012	Forthcoming meeting to discuss the license renewal process and environmental scoping for GGNS, Unit 1, LRA review	ML11362A433
January 19, 2012	GGNS LRA review Advisory Council on Historic Preservation	ML11348A088
January 19, 2012	Mississippi Band of Choctaw Indians—request for comments concerning GGNS LRA review	ML11342A121
January 19, 2012	Choctaw Nation of Oklahoma—request for comments concerning GGNS LRA review	ML11342A121
January 19, 2012	Tunica-Biloxi Tribe of Louisiana—request for comments concerning GGNS LRA review	ML11342A121
January 19, 2012	Jena Band of Choctaw Indians—request for comments concerning GGNS LRA review	ML11342A121

Date	Correspondence Description	ADAMS No.
January 19, 2012	Request for list of protected species within the area under evaluation for the GGNS, Unit 1, license renewal review application, U.S. Fish & Wildlife Service (USFWS), Louisiana Field Office	ML11349A001
January 19, 2012	GGNS LRA review, Mississippi State Historic Preservation Office (SHPO)	ML11348A090
January 19, 2012	GGNS LRA review, National Marine Fisheries Service (NMFS)	ML11350A173
January 20, 2012	GGNS LRA review Louisiana SHPO	ML11348A353
January 20, 2012	Request for list of protected species within the area under evaluation for GGNS license renewal review application, Mississippi Natural Heritage Program	ML11349A003
January 20, 2012	Request for list of protected species within the area under evaluation for GGNS license renewal review application, USFWS, Mississippi Field Office	ML11348A354
January 31, 2012	Transcript from afternoon public scoping meeting	ML12037A222
January 31, 2012	Transcript from evening public scoping meeting	ML12037A223
February 3, 2012	Response from USFWS, Mississippi Field Office, to NRC request for list of protected species within the area under evaluation for GGNS LRA review	ML12047A113
February 6, 2012	Request for list of protected species within the area under evaluation for GGNS, Unit 1, license renewal review application, Louisiana Natural Heritage Program	ML12005A163
February 13, 2012	Response from Mississippi Natural Heritage Program to NRC request for list of protected species within the area under evaluation for GGNS LRA review	ML12055A312
February 13, 2012	Response from Mississippi Band of Choctaw Indians to NRC request for comments on GGNS LRA review	ML12047A127
February 13, 2012	Scoping comment from the National Park Service referencing the GGNS LRA review	ML12048A674
February 16, 2012	Response from Louisiana Natural Heritage Program to NRC request for list of protected species within the area under evaluation for GGNS LRA review	ML12060A098
February 27, 2012	Scoping comments from J. Hillegas, Green Party of Mississippi	ML12060A334
February 28, 2012	Mississippi SHPO response to NRC letter referencing GGNS LRA review	ML12073A084
February 29, 2012	Response from USFWS, Louisiana Field Office, to NRC request for list of protected species within the area under evaluation for GGNS LRA review	ML12082A141
March 1, 2012	Response from Jena Band of Choctaw Indians to NRC request for comments concerning GGNS LRA review	ML12089A020

Date	Correspondence Description	ADAMS No.
March 1, 2012	Response from NMFS to NRC request for comments concerning GGNS LRA review	ML12065A167
March 22, 2012	Transmittal of environmental audit plan to Entergy	ML12060A112
March 26, 2012	Response from Choctaw Nation of Oklahoma to NRC request for comments concerning GGNS LRA review	ML12101A124
April 23, 2012	Transmittal of environmental requests for additional information (RAIs)	ML12083A188
May 8, 2012	Transmittal of air RAIs	ML12123A081
May 21, 2012	Transmittal of severe accident mitigation alterative (SAMA) RAIs	ML12115A101
May 23, 2012	Entergy response to environmental RAIs	ML12157A173
June 6, 2012	Entergy response to air RAIs	ML12158A445
July 19, 2012	Entergy response to SAMA RAIs	ML12202A056
August 23, 2012	Transmittal of 2nd round SAMA RAIs	ML12227A735
September 7, 2012	Schedule change letter	ML12242A545
October 10, 2012	Entergy partial response to 2nd round SAMA RAIs	ML12277A082
November 19, 2012	Entergy complete response to 2nd round SAMA RAIs	ML12325A174
December 19, 2012	Entergy response to SAMA clarification questions	ML12359A038
February 26, 2013	Schedule change letter	ML13002A430
April 16, 2013	Scoping Summary Report	ML12201A623
August 15, 2013	Schedule change letter	ML13207A156

APPENDIX F
U.S. NUCLEAR REGULATORY COMMISSION STAFF EVALUATION OF SEVERE ACCIDENT MITIGATION ALTERNATIVES FOR GRAND GULF NUCLEAR STATION IN SUPPORT OF LICENSE RENEWAL APPLICATION REVIEW

F. U.S. NUCLEAR REGULATORY COMMISSION STAFF EVALUATION OF SEVERE ACCIDENT MITIGATION ALTERNATIVES FOR GRAND GULF NUCLEAR STATION IN SUPPORT OF LICENSE RENEWAL APPLICATION REVIEW

F.1 Introduction

Entergy Operations, Inc. (Entergy or the applicant) submitted an assessment of severe accident mitigation alternatives (SAMAs) for Grand Gulf Nuclear Station, Unit 1 (GGNS), in Section 4.21 and Attachment E of the Environmental Report (ER) (Entergy 2011). This assessment was based on the most recent revision to the GGNS probabilistic risk assessment (PRA), including an internal events model and a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer code, as well as insights from the GGNS individual plant examination (IPE) (Entergy 1992) and individual plant examination of external events (IPEEE) (Entergy 1995). In identifying and evaluating potential SAMAs, Entergy considered SAMAs that addressed the major contributors to core damage frequency (CDF) and population dose at GGNS, as well as insights and SAMA candidates found to be potentially cost beneficial from the analysis of nine other boiling-water reactor (BWR) nuclear power generating stations. Entergy initially identified a list of 249 potential SAMAs. This list was reduced to 63 unique SAMA candidates by eliminating SAMAs that (a) were not applicable to GGNS, (b) had already been implemented at GGNS, or (c) were combined into a more comprehensive or plant-specific SAMA. Entergy concluded in the ER that three candidate SAMAs are potentially cost beneficial.

As a result of the review of the SAMA assessment, the U.S. Nuclear Regulatory Commission (NRC) staff issued requests for additional information (RAIs) to Entergy by letters dated May 21, 2012, (NRC 2012a) and August 23, 2012 (NRC 2012b). Key questions concerned:

- changes and updates to Level 1 and Level 2 PRA models that most affect CDF,
- differences in CDF values and importance measures reported in the ER,
- the impact of open items and issues from the peer review of the PRA,
- the process used to assign release categories to containment event tree (CET) end states for incorporating Level 1 results into the Level 2 analysis,
- selection of representative sequences for each release category in the Level 2 analysis,
- the impact of new information on fire and seismic initiated sequences, and
- further information on the cost-benefit analysis of several specific candidate SAMAs and low-cost alternatives.

Entergy submitted additional information by letters dated July 19, 2012 (Entergy 2012a), October 2, 2012 (Entergy 2012b), November 19, 2012 (Entergy 2012c), and December 19, 2012 (Entergy 2012d). In response to the staff RAIs, Entergy provided further information on:

- the history and key changes to PRA models,
- the resolution of peer review comments,

- the development of the Level 2 containment release model,
- the reasons for differences between CDF values given in the submittal,
- the results of an updated cost-benefit analysis based on resolution of CDF differences,
- the impact of new information on external events, and
- the cost of various SAMAs and potential low-cost alternatives.

Entergy's responses addressed the staff's concerns and resulted in the identification of one additional potentially cost-beneficial SAMA.

An assessment of the SAMAs for GGNS is presented below.

F.2 Estimate of Risk for GGNS

Section F.2.1 summarizes Entergy's estimates of offsite risk at GGNS. The summary is followed by the staff's review of Entergy's risk estimates in Section F.2.2.

F.2.1 Entergy's Risk Estimates

Two distinct analyses are combined to form the basis for the risk estimates used in the SAMA analysis: (1) the GGNS Level 1 and 2 PRA model, which is an updated version of the IPE (Entergy 1992), and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PRA model) developed specifically for the SAMA analysis. The original SAMA analysis was based on the most recent GGNS Level 1 and Level 2 PRA model available at the time of the ER, referred to as the 2010 extended power uprate (EPU) model (Entergy 2011). Subsequent to the original submittal, errors were found in the interpretation of the results of the Level 2 model that led Entergy to change the Level 2 model and cost-benefit analysis (Entergy 2012b, 2012c, 2012d). The results discussed in this appendix are for the updated analysis. The corrections to the model are discussed in Section F.2.2. The scope of the current GGNS PRA does not include external events.

The GGNS CDF is approximately 2.9×10^{-6} per reactor-year as determined from quantification of the Level 1 PRA model with the revised Level 2 model. This value was used as the baseline CDF in the SAMA evaluations (Entergy 2012c, 2012d). The CDF is based on the risk assessment for internally initiated events, which includes internal flooding. Entergy did not explicitly include the contribution from external events within the GGNS risk estimates; however, it did account for the potential risk reduction benefits associated with external events by multiplying the estimated benefits for internal events by a factor of 11. This is discussed further in Sections F.2.2 and F.6.2.

The breakdown of CDF by initiating event is provided in Table F–1. As shown in this table, loss of offsite power and power conversion system available transient are the dominant contributors to the CDF. While not listed explicitly in Table F–1 because they can occur as a result of multiple initiators, Entergy stated that station blackouts contribute about 37 percent (1.1×10^{-6} per reactor-year) of the total CDF; anticipated transients without scram contribute about 0.2 percent (4.4×10^{-9} per reactor-year) to the total CDF (Entergy 2012c).

The Level 2 GGNS PRA model that forms the basis for the SAMA evaluation is essentially a new model and reflects power uprate conditions. The Level 2 model uses CETs containing both phenomenological and systemic events. The Level 1 core damage sequences are binned into accident classes (or plant damage states) that provide the interface between the Level 1 and

Level 2 CET analysis. The CETs are linked directly to the Level 1 event trees and CET nodes are evaluated using subordinate trees and logic rules.

The CET considers the influence of physical and chemical processes on the integrity of the containment and on the release of fission products once core damage has occurred. The quantified CET sequences are binned into a set of end states that are subsequently grouped into 13 release categories (or release modes) that provide the input to the Level 3 consequence analysis. The frequency of each release category was obtained by summing the frequency of the individual accident progression CET endpoints binned into the release category. Source terms were developed for the release categories using the results of Modular Accident Analysis Program (MAAP 4.0.6) computer code calculations. From these results, source terms were chosen to be representative of the release categories. The results of this analysis for GGNS are provided in the revised Table E.1-9 of ER Attachment E (Entergy 2012c).

Entergy computed offsite consequences for potential releases of radiological material using the MACCS2 Version 1.13.1 code and analyzed exposure and economic impacts from its determination of offsite and onsite risks. Inputs for these analyses include plant-specific and site-specific input values for core radionuclide inventory, source term and release characteristics, site meteorological data, projected population distribution and growth within a 50-mile (mi) (80-kilometer (km)) radius, emergency response evacuation modeling, and local economic data. Radionuclide inventory in the reactor core is based on a plant-specific evaluation and corresponds to that for the EPU power of 4,408 megawatts thermal (MWt) (Entergy 2011, Attachment E). The estimation of onsite impacts (in terms of clean-up and decontamination costs and occupational dose) is based on guidance in NUREG/BR–0184, *Regulatory Analysis Technical Evaluation Handbook* (NRC 1997a). Additional details on the input parameter assumptions are discussed below.

Table F–1. Grand Gulf Nuclear Station Core Damage Frequency (CDF) for Internal Events

Initiating Event	CDF (per year)	% CDF Contribution
Loss of Offsite Power Initiator	1.2×10^{-6}	40
Power Conversion System Available Transient	5.9×10^{-7}	20
Loss of Power Conversion System Initiator	2.5×10^{-7}	8
Loss of Condensate Feed Water Pumps	2.3×10^{-7}	8
Loss of Instrument Air	1.4×10^{-7}	5
Closure of Main Steam Isolation Valves (Initiator)	1.2×10^{-7}	4
Loss of Service Transformer 21	1.2×10^{-7}	4
Large Loss of Coolant Accident (LOCA)	9.7×10^{-8}	3
Loss of Service Transformer 11	8.3×10^{-8}	3
Loss of Alternating Current Division 2 Initiator	6.2×10^{-8}	2
Other Initiating Events[1]	3.3×10^{-8}	1
Loss of Alternating Current Division 1 Initiator	2.7×10^{-8}	1
Intermediate LOCA	1.4×10^{-8}	1
Total Core Damage Frequency (Internal Events)	$\mathbf{2.9 \times 10^{-6}}$	**100**

[1] Multiple initiating events with each contributing 0.3 percent or less

In the ER, the applicant estimated the dose risk to the population within 80 km (50 mi) of the GGNS site to be 0.00609 person-sieverts (Sv) per year (0.609 person-roentgen equivalent in man (rem) per year) (Entergy 2012c). The breakdown of the population dose risk by containment release mode is summarized in Table F–2. Medium releases provide the greatest contribution, totaling approximately 67 percent of the population dose risk and 75 percent of the offsite economic cost risk for all timings. High early (H/E) releases alone contribute only about 10 percent, and high releases for all timings contribute 17 percent of the population dose risk.

F.2.2 Review of Entergy's Risk Estimates

Entergy's determination of offsite risk at GGNS is based on three major elements of analysis:

- the Level 1 and 2 risk models that form the bases for the 1992 IPE submittal (Entergy 1992), and the external event analyses of the 1995 IPEEE submittal (Entergy 1995);
- the major modifications to the IPE model that have been incorporated in the GGNS 2010 EPU PRA; and
- the combination of offsite consequence measures from MACCS2 analyses with release frequencies and radionuclide source terms from the Level 2 PRA model.

Table F–2. Base Case Mean Population Dose Risk and Offsite Economic Cost Risk for Internal Events

Release Mode		Population Dose Risk[1]		Offsite Economic Cost Risk	
ID[2]	Frequency (per year)	person-rem/yr	% Contribution	$/yr	% Contribution
H/E	1.0×10^{-7}	6.2×10^{-2}	10	$1.7 \times 10^{+2}$	11
H/I	1.2×10^{-8}	6.2×10^{-3}	1	$1.7 \times 10^{+1}$	1
H/L	9.2×10^{-8}	3.8×10^{-2}	6	$9.6 \times 10^{+1}$	6
M/E	3.7×10^{-7}	1.7×10^{-1}	28	$4.8 \times 10^{+2}$	32
M/I	1.8×10^{-7}	1.2×10^{-1}	20	$3.3 \times 10^{+2}$	22
M/L	3.0×10^{-7}	1.2×10^{-1}	19	$3.2 \times 10^{+2}$	21
L/E	4.1×10^{-9}	4.0×10^{-4}	<0.1	3.0×10^{-1}	<0.1
L/I	3.6×10^{-8}	1.2×10^{-2}	2	$2.7 \times 10^{+1}$	2
L/L	4.4×10^{-7}	7.8×10^{-2}	13	$7.4 \times 10^{+1}$	5
LL/E	2.2×10^{-9}	7.9×10^{-7}	<0.1	1.0×10^{-3}	<0.1
LL/I	2.1×10^{-9}	3.8×10^{-7}	<0.1	9.7×10^{-4}	<0.1
LL/L	7.1×10^{-9}	2.0×10^{-3}	<1	$3.4 \times 10^{+0}$	<1
NCF	1.4×10^{-6}	5.0×10^{-4}	<0.1	6.4×10^{-1}	<0.1
Total	$\mathbf{2.9 \times 10^{-6}}$	$\mathbf{6.1 \times 10^{-1}}$	100	$\mathbf{1.5 \times 10^{+3}}$	100

[1] Unit Conversion Factor: 1 Sv = 100 rem
[2] Release Mode Nomenclature (Magnitude/Timing)

Magnitude:
High (H) – Greater than 10 percent release fraction for Cesium Iodide
Medium (M) – 1 to 10 percent release fraction for Cesium Iodide
Low (L) – 0.1 to 1 percent release fraction for Cesium Iodide
Low-Low (LL) – Less than 0.1 percent release fraction for Cesium Iodide
No containment failure (NCF) – Much less than 0.1 percent release fraction for Cesium Iodide
Timing:
Early (E) – Less than 4 hours
Intermediate (I) – 4 to 24 hours
Late (L) – Greater than 24 hours

Each analysis element was reviewed to determine the acceptability of Entergy's risk estimates for the SAMA analysis, as summarized further in this section.

F.2.2.1 Internal Events CDF Model

The staff's review of the GGNS IPE is described in an NRC letter dated March 7, 1996 (NRC 1996). From its review of the IPE submittal, the staff concluded that the IPE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities, and therefore, that the GGNS IPE has met the intent of Generic Letter (GL) 88–20 (NRC 1988). Although no vulnerabilities were identified in the IPE, 11 improvements were identified by Entergy. The ER stated that five of these improvements have been implemented, one was considered to be no longer applicable, and five were retained as potential SAMAs.

The internal events CDF value from the 1992 IPE (1.7×10^{-5} per reactor-year) is near the average of the values reported for other General Electric (GE) BWR 5/6 units. Figure 11.2 of NUREG–1560, Volume 2, *Individual Plant Examination Program: Perspectives on Reactor Safety and Plant Performance Parts 2–5, Final Report* (NRC 1997b) shows that the IPE-based total internal events CDF for GE BWR 5/6 plants ranges from 1×10^{-6} per year to 4×10^{-4} per year, with an average CDF for the group of 2×10^{-5} per year. Other plants have updated the values for CDF subsequent to the IPE submittals to reflect modeling and hardware changes. The internal events CDF result for GGNS used for the SAMA analysis (2.9×10^{-6} per year) is somewhat lower than that for other plants of similar vintage.

GGNS was one of the units analyzed in considerable detail in the analysis of the risk of five nuclear power plants found in NUREG–1150, *Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants* (NRC 1990). NUREG–1150 stated that the mean internal events CDF for GGNS was 4×10^{-6} per year, which is very similar to the current Entergy estimate.

There have been four revisions to the IPE Level 1 model since the 1992 IPE submittal. A listing of the changes made to the GGNS PRA since the original IPE submittal was provided in the ER (Entergy 2011) and is summarized in Table F–3, including information requested by the NRC (Entergy 2012a, 2012d). A comparison of internal events CDF between the 1992 IPE and the current PRA model indicates a decrease of about a factor of six in the total CDF (from 1.7×10^{-5} per reactor-year to 2.9×10^{-6} per reactor-year). This reduction can be attributed to incorporation of plant-specific data, improved modeling details, and removal of conservatism.

Table F–3. Major GGNS Probabilistic Safety Assessment (PSA) Models

PSA Model	Summary of Significant Changes from Prior Model	CDF (per year)	LERF (per year)
1992 (IPE)		1.7×10^{-5}	5.2×10^{-7}
1997 (R1)	• Incorporation of updated plant-specific data for system maintenance and testing unavailability • Incorporation of updated plant-specific data for initiating event frequencies • Incorporation of updated plant-specific data for certain important components (i.e., diesel generators, high pressure core spray, and reactor core isolation cooling pumps) • Various modeling changes to system models to correct minor modeling errors and incorporate modifications since the original IPE	5.5×10^{-6}	Not Updated
2002 (R2)	• Modeling changes to reflect installation of new type of plant service water radial well pumps and support systems • Addition of heating, ventilation, and air conditioning (HVAC) systems to the model, including addition of the new standby service water pump-house high temperature alarm • Modeling of changes to the backup scram valves and logic in the anticipated transient without scram portion of the fault tree • Use of more comprehensive human reliability analysis methods • Use of the convolution method for recovery of loss of offsite power (LOSP) • Addition of an interfacing systems LOCA initiator • Inclusion of operating data through December 31, 2000	4.3×10^{-6}	2.0×10^{-7}
2010 (R3)	• Update of plant-specific data and initiator frequencies (through August 2006) and generic initiator frequencies • New initiators: loss of service transformer, reactor vessel rupture, Loss of control rod drive, and Break (LOCA) outside of containment • Major changes to LOSP modeling • Inclusion of modeling for loss of emergency core cooling system pumps due to containment failure • Revision of instrument air system modeling to incorporate new plant air compressors • Revision of modeling of control rod drive—less credit for control rod drive	2.7×10^{-6}	1.4×10^{-7}
2010 (EPU)	• Power level change (13 percent EPU) • Hardware changes • Procedural changes • Operational changes	2.9×10^{-6}	1.5×10^{-7} (Note 1)

Note 1. This LERF value is from the Revision 3 EPU LERF model and is different from the Table F–2 value for the High Early (H/E) release category, which was obtained from the full Level 2 model (Entergy 2012d). Refer to additional discussion in Section F.2.2.

The GGNS 2010 EPU model reflects GGNS design, component failure, and unavailability data as of August 2006, modified to reflect the EPU configuration. Entergy states that there have been no major plant hardware changes or procedural modifications since August 2006 that would have a significant impact on the results of the SAMA analysis. In response to the staff RAIs, Entergy (2012a) clarified what was meant by “significant” and also stated that a review of plant equipment performance since August 2006 indicated no degradation issues that would impair the SAMA analysis (Entergy 2011). A change that would have a significant impact is described as a grade A (extremely important and necessary to assure the technical adequacy or quality of the PRA) or grade B (important and necessary to address, but may be deferred until the next model update) model change request (MCR). The MCR database is used to track plant changes, procedure revisions, nuclear licensing revisions, and model improvements that impact the PRA models. The RAI response stated that there were one grade A and 12 grade B MCRs. The single grade A MCR involved modeling for the temporary condition when a low-pressure feedwater heater is taken out of service and would not impact the SAMA analysis; the grade B MCRs either impacted the fire model and not the SAMA model, involved systems that are not risk-significant, or would result in a decrease in risk (Entergy 2012a). The staff concludes that there have been no major plant hardware changes or procedural modifications since August 2006 that would have a significant impact on the results of the SAMA analysis.

In response to a staff RAI, Entergy explained that the maintenance rule system health reports indicated no equipment reliability issues that would impair the SAMA analysis and that the plant data issues identified during the expert panel reviews of the model updates or during the expert panel review of the Level 2 cutsets were resolved in the model used for the SAMA analysis (Entergy 2012b).

Although Entergy suggested the unavailability of the high-pressure core spray (HPCS) system and the B diesel-driven fire pump had increased recently, Entergy also stated that the unavailability for these systems remains within the error band of the unavailability distribution (Entergy 2012b). Based on this response and the staff's review of the GGNS SAMA analysis, the staff concludes that, while the inclusion of more recent plant data might increase the CDF contribution for these two systems, it would not be expected to change the conclusions related to cost-beneficial SAMAs.

The staff considered the peer reviews and other assessments performed for the GGNS PRA and the potential impact of the review findings on the SAMA evaluation. The most relevant of these are the peer review of the GGNS 1997, Revision 1 model and the staff review of the GGNS 2010 EPU model as part Entergy's EPU application.

The 1997 (Revision 1) Level 1 and large early release frequency (LERF) model was peer-reviewed before the 2002 PRA, Revision 2, using the BWR Owners Group (BWROG) process. The review team used the BWROG Probabilistic Safety Assessment (PSA) Peer Review Certification Implementation Guidelines, Revision 3, January 1997. Entergy stated that all of the “A” priority (extremely important and necessary to address to ensure the technical adequacy of the PSA) PRA peer review comments have been addressed and incorporated into the GGNS PRA model, as appropriate. It also stated that all of the “B” priority (important and necessary to address but may be deferred until the next PSA update) comments have been addressed, except for one documentation item related to the internal flood modeling.

In response to a staff RAI concerning A and B priority comments addressed by internal reviews in which Entergy concluded that changes to the model were not needed or the fact and observation was incorrect, Entergy stated that (a) those which were considered incorrect involved documentation issues that would not impact the SAMA PRA, (b) involved comments on the Level 2 model, which has since been completely updated, or (c) for the other observations for which no change was considered necessary, provided a discussion of additional information concerning the issues and confirmed that the disposition remained valid at the EPU power and the SAMA assessment (Entergy 2012a, 2012b). Entergy (2012b) provided clarification for Observation 85 concerning the Level 1 general transient event tree. Despite a disposition statement that no changes were necessary, Entergy stated that the structure of the event tree was changed subsequent to the peer review, and that the changes addressed the concern raised in the observation.

The staff review of Entergy's EPU application is documented in a safety evaluation report (SER) (NRC 2012c). In Section 2.13.1 of the EPU SER, the technical evaluation of the EPU focused on the impact on CDF and LERF while operating at EPU conditions. In its review of PRA quality, the staff noted the disposition of an additional nine findings on the Level 2 model. The internal flooding issue was determined to be solely a documentation issue, while eight of the nine Level 2 issues were resolved in the Level 2 model used for the SAMA analysis. In response to an RAI concerning the impact on the SAMA analysis, Entergy stated that vacuum breaker failures and low suppression pool level were incorporated in the SAMA Level 2 model and that personnel hatch seal failure was negligible when compared with hatch failure due to either overpressurization or buckling (Entergy 2012a). The staff found that the Level 2 issues were acceptably addressed and concluded that failure to model vacuum breakers, low suppression pool level, and personnel hatch seal would not significantly impact the delta risk results for the EPU application.

The EPU SER states:

> Based on its evaluation, the NRC staff concludes that the GGNS PRA models used to support the risk evaluation for this application have sufficient scope, level of detail, and technical adequacy to support the evaluation of the EPU.

The SER further states:

> The NRC staff concludes that the licensee's evaluation of the impact of the proposed EPU on at-power risk from internal events is reasonable and concludes that the base risk due to the proposed EPU is acceptable and that there are no issues that rebut the presumption of adequate protection provided by the licensee meeting the currently specified regulatory requirements.

The staff concludes that, while the EPU application is focused on delta CDF and LERF as opposed to absolute values, these conclusions do lend support for the adequacy for the SAMA application.

The staff noted that the LERF value of 1.48×10^{-7} per year (rounded to 1.5×10^{-7} per year in Table F–3) given in the ER for the EPU model is different from the value of 1.04×10^{-7} per year (rounded to 1.0×10^{-7} per year in Table F–2) for the H/E release category. In response to an RAI, Entergy (2012d) stated that the value of 1.48×10^{-7} per year is from a separate Revision 3 EPU LERF model and the value of 1.04×10^{-7} per year is from the full Level 2 model. In the analysis for GGNS, LERF is not a dominant contributor to the population dose risk or economic cost risk. The staff concludes that the H/E release category frequency obtained from the full Level 2 analysis (along with the other release category frequencies) is appropriate for use in the SAMA consequence analysis.

In the ER, Entergy describes two internal expert panel reviews of the Revision 2 and Revision 3 models before their finalization. Various departments (Training, Operations, Engineering, and Nuclear Safety) within the GGNS organization were invited to participate. Each of the top 100 cutsets was reviewed individually. In addition, cutsets from accident sequences representing approximately 99 percent of the total CDF also were reviewed if there were no cutsets from these sequences in the top 100. The focus of the review was to identify poor assumptions, over-simplifications, incorrect credit for human actions, sequence timing errors, system modeling errors, and incorrect event probabilities. The reviews resulted in modifications to the model and to the credit given for human actions.

In response to an RAI, Entergy briefly described the process and procedures for assuring technical quality of PRA updates since the peer review. The PRA maintenance and update procedure describes the process for maintaining the PRA models current with the as-built and as operated plants and gives specific instructions for identifying model change requests, documenting those requests, and incorporating those requests into the PRA model. The PRA analysts performing model updates are experienced, trained professionals, and each change is reviewed by a second, experienced, trained PRA analyst. In addition, as described above, expert panel reviews are used to enhance the technical quality of the PRA updates. Changes from the expert panel review for an update are immediately incorporated into that update of the model (Entergy 2012a).

In the original SAMA submittal (Entergy 2011), Entergy took the internal events CDF to be the sum of all the Level 2 release categories including the no containment failure (NCF) sequences. This summation resulted in a CDF value of 2.05×10^{-6} per year compared to the CDF from the Level 1 analysis value of 2.92×10^{-6} per year. In response to a staff RAI to explain this difference, Entergy stated that the Level 2 results were misinterpreted because it was assumed that the NCF sequences were adequately modeled and the resulting frequencies were valid. From investigating the reasons for the difference, Entergy found the assumption to be invalid, and it subsequently used the CDF value from the Level 1 model in a reanalysis of the SAMAs. Additionally, Entergy identified and addressed a number of discrepancies in the Level 2 recovery rule file. Typically, Level 2 model changes would not be expected to impact the Level 1 result; however, incorporated changes led to the CDF value of 2.93×10^{-6} per year used in the revised SAMA analysis (Entergy 2012b, 2012c, 2012d).

Given that the GGNS internal events PRA model has been peer-reviewed and the peer review findings were all addressed, that the model has been reviewed by the staff as part of the EPU application approval, that Entergy has satisfactorily addressed staff questions regarding the PRA, and that the misinterpretation of Level 2 results discussed above has been corrected in the revised SAMA analysis, the staff concludes that the internal events Level 1 PRA model is of sufficient quality to support the SAMA evaluation.

F.2.2.2 External Events

As stated above, the GGNS PRA does not include external events. The SAMA submittals cite the GGNS IPEEE to assess the impact of seismic, internal events and other external events. The final GGNS IPEEE was submitted in 1995 (Entergy 1995), in response to Supplement 4 of GL 88–20 (NRC 1991a). Except for one potential seismic vulnerability, no fundamental weaknesses or vulnerabilities to severe accident risk in regard to the external events were identified in the GGNS IPEEE. In a letter dated March 16, 2001 (NRC 2001), the staff stated that, on the basis of its review of the PRA and IPEEE submittal, the staff concludes that the GGNS IPEEE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities and, therefore, the GGNS IPEEE has met the intent of Supplement 4 to GL 88–20.

<u>Seismic Events</u>

The GGNS IPEEE seismic analysis was a reduced scope seismic margins assessment (SMA) following NRC guidance (NRC 1991a, 1991b). The SMA was performed using a Safe Shutdown Equipment List with plant walkdowns in accordance with the guidelines and procedures in Electrical Power Research Institute (EPRI) Report NP–6041–SL (EPRI 1991).

Since GGNS is a reduced scope SMA plant, the original design-basis safe shutdown earthquake (SSE) ground response spectra and corresponding in-structure response spectra were used as the review level earthquake (RLE) input for the walkdown and evaluation. The SMA approach is deterministic in nature and does not result in probabilistic risk information. As a reduced scope plant, the determination of high confidence of low probability of failure values also is not required.

The IPEEE submittal (Entergy 1995) concludes that GGNS is seismically rugged and that all components identified in the Safe Shutdown Path meet the seismic requirements. All anchorage to these components was found to be rugged. One potential vulnerability to a seismic event was identified, which has been corrected. The potential vulnerability involved the standby service water (SSW) piping in the Control Building where the grouted condition of several penetrations into the building were not accounted for in the stress analysis of the piping systems. To correct the situation and to meet design requirements, the grout was removed and a design change was issued to repair the penetration. The as-found grouted condition was evaluated for operability considerations and was determined not to be an operability concern. In addition, a number of "design enhancements" were implemented, including issuance of a new standard to address seismic housekeeping problems, securing of "S" hooks on lighting fixtures, installation of missing clips and screws on several items, and revision to several design-basis calculations (NRC 2001).

Based on the results of the IPEEE seismic assessment as described above, Entergy stated in the ER that since seismic events are not dominant contributors to external event risk and quantitative analysis of these events is not practical, they are assumed negligible in estimation of the external events multiplier. An August 2010 NRC report, "Generic Issue 199 (GI-199), Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants" (NRC 2010) shows a decrease in GGNS seismic CDF, using 2008 U.S. Geological Survey (USGS) seismic hazards curve when compared against 1994 Lawrence Livermore National Lab Hazard Curves, but an increase compared to the seismic CDF based on the EPRI hazard curves. Based on a simplified approach to estimate CDF from a seismic margins analysis and using the latest published USGS seismic hazards information, the staff estimates the GGNS seismic CDF is about 1×10^{-5} per year and is not negligible. In response to a staff RAI (Entergy 2012a), Entergy discussed the impact of this seismic CDF on the SAMA analysis. This topic is discussed further in Section F.3.2 and in the subsection on high winds, floods, and other external events of this section.

<u>Fire Events</u>

The GGNS IPEEE fire assessment is a fire PRA that uses key assumptions and the general approach specified in the EPRI Fire PRA Implementation Guide (EPRI 1994) and the Fire-Induced Vulnerability Evaluation (FIVE) methodology (EPRI 1992). Additionally, the fire PRA incorporates information from the GGNS Fire Hazards Analysis.

The overall approach involved four tasks: develop fire-induced sequences, develop fire scenarios, evaluate fire damage sequences and their uncertainties, and document and verify the analysis. In implementing these tasks, four levels of fire area screening were employed:

(1) screen fire compartments inside containment
(2) screen compartments with no safe shutdown or PRA equipment
(3) screen assuming all equipment in compartment fails
(4) credit detailed recovery

Fires inside containment were screened out because there are few combustible loads to ignite a fire inside containment and a fire in containment would have a minor impact on the ability to safely shutdown the plant because of the limited safe shutdown equipment and cables located inside containment. For the other screening steps, conditional core damage probabilities (CCDPs) were determined using the IPE internal events PRA with increasing refinements concerning the extent of fire damage and recovery actions and a screening CDF criteria of 1×10^{-6} per year. Thirteen fire areas not screened out after the last screening step were subjected to a more detailed analysis incorporating fire modeling to support fire propagation and suppression analyses, location of critical targets, definition of accident scenarios, evaluation of CCDPs for the scenarios, apportioning the compartment fire frequency among the scenarios, and evaluation of the probability of suppression before damage occurs. The estimated fire CDF for the unscreened areas is 8.9×10^{-6} per reactor-year.

The GGNS IPEEE fire PRA was reviewed by Sandia National Laboratory (SNL). The SNL review concluded that:

> Based on the GGNS IPEEE submittal and the response to RAIs on the submittal, the reviewers recommend that a sufficient level of documentation and appropriate bases for analysis have been established to conclude that the subject licensee submittal has met the intent of GL 88–20 (NRC 2001).

While no vulnerabilities with respect to fire were identified, the IPEEE submittal identifies one plant improvement related to reducing the impact of fires. The licensee stated that upgrades of existing thermo-lag barriers were scheduled to be completed by the end of 1996 (Entergy 1995). In a subsequent response to an IPEEE RAI, Entergy stated that the upgrades had been completed (Entergy 1998).

The ER includes a listing of all fire areas, screened and unscreened, in Table E.1-10. The CDF for the unscreened fire areas is provided below in Table F–4. In response to an RAI (Entergy 2012a), Entergy confirmed that these fire zone CDFs are directly from the IPEEE and are based on the IPE internal events model. Given that the current EPU internal events CDF is considerably lower than that from the IPE, the staff concludes that if the EPU PRA had been used to determine the CCDPs, the fire CDF would most likely be reduced. In response to a staff RAI to assess recent fire research and guidance in NUREG/CR–6850, *EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities* (NRC 2005), Entergy (2012a) cited a December 2010 industry assessment (NEI 2010) that concluded:

> Based on the results and insights from industry fire PRAs, it has been identified that the methods described in NUREG/CR–6850/EPRI TR–1011989 contain excess conservatisms that bias the results and skew insights. While the prior frequently asked question process made some incremental progress in addressing areas of excessive conservatism, many more remain in need of enhancement.

In the staff’s view, it is not clear if applying the new guidance to the GGNS fire assessment would result in excessive conservatism or not. The staff, however, notes the GGNS fire PRA makes use of CCDPs from the IPE internal events PRA to assess the impact of a fire. Based on the NRC review of existing information, the staff expects that the CCDPs using the EPU model would be lower than the CCDPs from the IPE model and, thus, would result in a lower fire CDF. Therefore, any increase in fire risk to using NUREG/CR–6850/EPRI TR–1011989, would be at least partially offset by the expected reduction in fire risk associated with using the EPU internal events models rather than the IPE models.

Considering that the GGNS fire PRA model has been reviewed by the staff for the IPEEE, and that Entergy has addressed staff RAIs regarding the fire PRA, the staff concludes that the fire PRA model, as discussed above, provides an acceptable basis for identifying and evaluating the benefits of SAMAs.

Table F–4. GGNS Fire IPEEE Core Damage Frequency (CDF) Results for Unscreened Compartments

Fire Compartment	Fire Compartment Description	Compartment CDF (per year)	% Contribution to Unscreened Fire CDF
CC502	Control Room	3.9×10^{-6}	43
CC202	Division 1 Switchgear Room	9.4×10^{-7}	11
CA301	Auxiliary Building Corridors. 139'-0" Elevation A422, 1A324	6.7×10^{-7}	8
CA201	Auxiliary Building Corridors. 119'-0" Elevation	6.4×10^{-7}	7
CC210	Division 3 (HPCS) Switchgear Room	6.1×10^{-7}	7
CA101	Auxiliary Building Corridors. 93'-0" Elevation	5.7×10^{-7}	7
CC215	Division 2 Switchgear Room	4.1×10^{-7}	5
CT100	Turbine Building Floor, 93'-0" Elevation	3.2×10^{-7}	4
CC402	Cable Spreading Room	2.8×10^{-7}	3
CC104	Hot Machine Shop	2.4×10^{-7}	3
CC302	HVAC Equipment Room	2.1×10^{-7}	2
CD306	Division 3 (HPCS) Diesel Generator Room	1.7×10^{-7}	2
CT200	Turbine Building Floor, 113'-0" Elevation	7.1×10^{-9}	<1
Total		$\mathbf{8.9 \times 10^{-6}}$	**100**[a]

[a] Column values may not total 100 percent because of rounding.

High Winds, Floods, and Other External Events

The GGNS IPEEE analysis of high winds, floods, and other external events followed the recommendations in GL 88–20, Supplement 4. The methodology employed a screening approach following the criteria of the 1975 Standard Review Plan (SRP).

The GGNS IPEEE submittal states that the plant's current licensing basis conforms with the 1975 SRP criteria for high winds, tornado loads, and tornado-generated missiles. The submittal notes that all safety-related structures and components, except the SSW system components, are protected against high winds, tornado wind loads, and tornado-generated missiles. For these components, a walkdown by Entergy confirmed that damage from high winds or tornado wind loads are not a concern and a frequency assessment of tornado-generated missiles was performed. This frequency was estimated to be 7.7×10^{-9} per reactor-year, an acceptably low value (NRC 2001).

With regard to external flooding, the IPEEE submittal states that the plant's current licensing basis for flood protection meets the 1975 SRP criteria. Therefore, in accordance with the guidance in NUREG–1407, *Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities*, external floods can be screened out as a significant hazard (NRC 1991b). In addition, the licensee performed reevaluations of the potential flooding from the Mississippi River and the probable maximum precipitation (PMP) induced flood (for site watershed). As part of their response to GL 89–22, the licensee also addressed Generic Safety Issue (GSI) 103, *Design for Probable Maximum Precipitation*, and made use of the latest rainfall data (Hydro Meteorological Reports (HMR) No. 51 and 52). While the roof drains and overflows were found adequate, GGNS implemented several improvements including: increased maintenance on drainage structures, revised procedures to explicitly include at-grade former Unit 2 doors, and revised procedures to periodically inspect roof drains and overflows to ensure they are not blocked. In addition, consideration of the new PMP led to the identification of five further improvements in local drainage and flood prevention provisions. These improvements were not implemented at the time of the IPEEE and, while listed in Table E.2-1 of the ER, are stated to not be cost beneficial due to the minor risk from external flooding. The response to a staff RAI to provide further support for this disposition is discussed below in Section F.3.2.

A review of transportation and nearby facility accidents confirmed that there were no severe accident vulnerabilities from these accidents. The licensee found that the plant's current licensing basis for these events meets the 1975 SRP criteria.

As stated in the ER (Entergy 2011), a multiplier of 11 was used to adjust the internal event risk benefit associated with a SAMA to account for external events. This multiplier was based on a fire CDF equal to the sum of the screened and unscreened fire zone CDF values or approximately 2.74×10^{-5} per year and the assumption that seismic and other external events are negligible. Using the original Level 1 internal event CDF of 2.92×10^{-6} per year the ratio of external to internal event CDFs is 9.4, which leads to a multiplier of 10.4 which was rounded up to 11. In response to an RAI concerning the impact of the GI–199 (NRC 2010) estimated seismic CDF, Entergy states that use of the GI–199 estimate of approximately 1×10^{-5} per year along with the IPEEE fire CDF for unscreened fire zones of 8.9×10^{-6} per year results in an external events multiplier of 7 using the 2.93×10^{-6} per year internal event CDF and the continued use of the multiplier of 11 more than compensates for the impact of the seismic CDF (Entergy 2012c). The staff agrees that the use of the unscreened fire CDF is valid and that the use of the multiplier of 11 appropriately incorporates the impact of seismic risk.

Given that the GGNS IPEEE external events assessments has been reviewed by the staff, and that Entergy has satisfactorily addressed staff questions regarding the assessment, the staff concludes that the external events assessments, combined with the results of the analysis of the impacts of new fire and seismic information, is of sufficient quality to support the SAMA evaluation.

F.2.2.3 Level 2 Fission Product Release Analysis

The staff reviewed the general process used by Entergy to translate the results of the Level 1 PRA into containment releases, as well as the results of the Level 2 analysis, as described in the ER and in responses to staff RAIs (Entergy 2012a, 2012b, 2012c). Plant damage states (PDSs) provide the link between the Level 1 and Level 2 CET analyses. In the PDS analyses, Level 1 results are grouped together according to characteristics that define the status of the reactor, containment, core cooling and heat removal systems at the time of core damage. The PDSs identify which CET the Level 1 results are to be transferred. The information specifically transferred through the PDSs and the direct linking of the Level 1 model with the Level 2 model is:

- Equipment failures in Level 1. The repair or recovery of failed equipment is not allowed unless an explicit evaluation has been performed as part of the Level 2 analysis.

- Reactor pressure vessel (RPV) status. The RPV pressure condition is explicitly transferred from the Level 1 analysis to the CET.
- Containment status. The containment status is explicitly transferred from the Level 1 analysis to the CET.
- Differences in accident sequence timing are transferred with the Level 1 sequences. Timing affects such sequences as: station blackout, internal flooding, and containment bypass (interfacing systems LOCA).

The Level 2 analysis is linked to the Level 1 model by extending the model to include the CET, which characterizes the accident phenomena. The CET considers the influence of physical and chemical processes on the integrity of the containment and on the release of fission products. The ER lists and describes 15 functional nodes incorporated in the GGNS Level 2 CETs. These nodes (or branches or questions) address events occurring before vessel breach (including post core damage depressurization and the potential for in-vessel recovery), the phenomena associated ex-vessel accident progression (including early drywell and containment failure caused by hydrogen ignition, high pressure melt ejection, steam explosions, and vapor suppression failure) and the impact of mitigating systems on containment integrity including containment sprays, containment heat removal, and containment venting.

The CET end points represent the outcomes of possible containment accident progression sequences with each end point representing a complete sequence from initiator to release to the environment. Associated with each CET end point or end state is an atmospheric radionuclide source term including the timing, magnitude, and other conditions associated with the release. Because of the large number of CET end points, they are grouped into release categories (RCs). Entergy has established 13 RCs based on magnitude of release (four levels) and timing of containment failure relative to the time of the declaration of a general emergency (three time groups) with one RC for NCF. In response to a staff RAI, Entergy states that the CET end points were assigned to the appropriate RC based on consideration of several fundamental variables, including Level 1 accident sequence, initial containment failure mode, RPV pressure at RPV breach, water availability for containment spray or flooding, and auxiliary building effectiveness (Entergy 2012a). As previously stated for the updated analysis, the frequency of the NCF release category was determined from the difference between the Level 1 CDF and the sum of frequencies for the other release categories (Entergy 2012c).

In developing the response to the staff RAI concerning the difference between the Level 1 and Level 2 results, Entergy discovered and corrected a number of discrepancies in the Level 2 analysis. Despite having a relatively minor impact on the release category frequencies, these corrections were described and incorporated in the updated analysis (Entergy 2012c, 2012d).

The release characteristic for each RC was determined from the results of MAAP 4.0.6 calculations for representative sequences selected for the RC. In response to staff RAIs concerning the selection of representative sequences and the resulting release magnitude and timings, Entergy identified the representative sequence for each RC and described the basis for the selection. The predominant accident class (based on frequency) that contributes to each of the radionuclide release categories was first identified. Once the accident class was identified, the timings and magnitudes of the releases from the results of the various Level 2 MAAP runs for that accident class were reviewed to select an appropriate sequence to represent the release category (Entergy 2012a).

In response to a staff RAI to justify the representative sequence as the sequence with the highest frequency versus selecting a sequence with a higher source term and a lower but still important frequency, Entergy, in its updated analysis, revised the Level 3 consequence analysis to use the sequence with the highest source term (in terms of cesium iodide release fraction) to represent each release category (Entergy 2012b, 2012c).

In the original ER Figure E.1-1, the NCF or negligible release category accounted for 44 percent of the total release frequency, yet the offsite consequences from this release category were not provided. In response to a staff RAI, Entergy revised the consequence analysis to incorporate releases appropriate for the no-containment-failure category (Entergy 2012c).

As stated above, the current GGNS Level 2 PRA model is a complete revision of that used in the IPE. No vulnerabilities were identified in the IPE back-end (i.e., Level 2) analysis performed by the applicant. Risk related insights and improvements discussed in the IPE submittal were discussed previously. The staff and contractor review of the IPE Level 2 analysis concluded that the applicant has made reasonable use of the PRA techniques in performing the back-end analysis and that the techniques employed are capable of identifying severe accident vulnerabilities (NRC 1996).

In response to a staff RAI regarding the steps taken to assure the technical adequacy of the new Level 2 model, Entergy stated that:

- The developing contractor performed a self assessment of the Level 2 model against the American Society of Mechanical Engineering (ASME)/American Nuclear Society (ANS) PRA Standard implemented in accordance with Regulatory Guide 1.200 (NRC 2009).
- A technical acceptance review was performed by Entergy, with comments resolved by the contractor.
- An expert panel review of the Level 2 cutsets was performed as further assurance of the quality of the Level 2 PRA. The expert panel consisted of members of the Grand Gulf engineering, PRA, and operations departments.

From its review of the Level 2 methodology, Entergy's responses to staff RAIs, and the subjection of the Level 2 model to an internal self-assessment and expert panel review, the staff concludes that the Level 2 PRA, as used in the revised SAMA analysis, provides an acceptable basis for evaluating the benefits associated with various SAMAs.

F.2.2.4 Level 3 Consequence Analysis

Entergy used the MACCS2 Version 1.13.1 code and a core inventory from a plant-specific calculation to determine the offsite consequences from potential releases of radioactive material (Entergy 2011). Using the ORIGEN 2.1 code, Entergy calculated the core inventory for 4,408 MWt, which is consistent with the EPU to 115 percent of the originally licensed thermal power that was approved in July 2012.

The staff reviewed the process used by Entergy to extend the containment performance (Level 2) portion of the PRA to an assessment of offsite consequences (Level 3 PRA model). Source terms used to characterize fission product releases for the applicable containment release categories and the major input assumptions used in the offsite consequence analyses were considered. In response to a staff RAI on radionuclides from the core inventory used in the radiological dose calculation, the applicant confirmed that all radionuclides listed in Table E.1-12 of Attachment E to the ER (Entergy 2011) were included in the Level 3 analysis (Entergy 2012a). Entergy clarified that consideration was given to the 24-month refueling cycles in the core radionuclide inventory determination and confirmed that no additional changes are planned or being considered that would affect the core radionuclide inventory (Entergy 2012a). Plant-specific input to the assessment includes the core release fractions and source terms for each release category (Entergy 2011, Table E.1-9), site-specific meteorological data, projected population distribution and expected growth out to the year 2044 within an 80-km (50-mi) radius, emergency evacuation modeling, and economic data. This information is provided in Section E.1.5 of Attachment E to the ER (Entergy 2011). Because the staff review determined Entergy's source term information is consistent with NRC guidance (NEI 2005) and includes satisfactory responses to NRC questions, the staff concludes that Entergy's source term estimates are acceptable for use in the SAMA analysis.

Entergy considered site-specific meteorological data for the calendar years 2005 through 2009 and selected meteorological data from 2009 for the analysis as input to the MACCS2 code because they resulted in the highest release quantities (Entergy 2011). Meteorological data was acquired from the meteorological monitoring system at GGNS and regional National Weather Service stations. Meteorological data included wind speed, wind direction, atmospheric stability class, precipitation, and atmospheric mixing heights. In response to an NRC RAI on the source of precipitation data, modeling of precipitation events, and precipitation influence on calculated doses, Entergy stated that the total population dose and offsite economic cost were calculated in determining the meteorological dataset for use in the SAMA analysis (Entergy 2012a).

Missing meteorological data were estimated by data substitution using valid data from the previous hour and other elevations on the meteorological tower. In response to questions on the amount of missing data, Entergy clarified that 1 hour of precipitation data and 95 hours of lower wind data were missing in the 8,760-hour data set for 2009. When missing temperature data were included, data substitution for missing data was applied to less than 3 percent of the meteorological records (Entergy 2012a). The sources of data and models for atmospheric dispersion used by the applicant are consistent with standard industry practice and acceptable for calculating consequences from potential airborne releases of radioactive material. Because multiple years of meteorological data were considered by the applicant and the annual data set that resulted in the largest total population dose and offsite economic cost was selected for the SAMA analysis, the staff finds that the data selection was performed in accordance with NRC guidance (NEI 2005) and, thus, the meteorological data are appropriate for use in the SAMA analysis.

Entergy projected population distribution and expected growth within a radius of 80 km (50 mi) out to the year 2044 to account for an anticipated 33-year period of remaining plant life for 13 years remaining on the original operating license plus a 20-year license renewal period (Entergy 2011). For counties or parishes with declining population projections, census data from earlier years were used to avoid underestimating future population and estimated population doses. The Entergy assessment incorporated U.S. Census 2010 data (Enercon 2011). Entergy also used data on Louisiana and Mississippi state tourism to calculate a transient to permanent population ratio to increase the projected population to account for visitors (Entergy 2011). The applicant provided additional information on the incorporation of transient population into the SAMA analysis (Entergy 2012a). Transient population was determined from annual visitor numbers for the state and an average stay duration. The ratio of transient additions to the permanent population was assumed to be the same for each county or parish in the state. The staff considers the methods and assumptions for estimating population reasonable and acceptable for purposes of the SAMA evaluation because its review of Entergy's assessment determined that Entergy considered appropriate data sources, used a reasonable approach for applying data, followed NRC guidance (NEI 2005), and added conservatism by not accounting for projected population decline.

Entergy analyzed evacuation travel times for the Mississippi and Louisiana sides of the Mississippi River within the 16-km (10-mi) emergency planning zone (Entergy 2011). The analysis stated that 100 percent of the population would be prepared to begin evacuation within

195 minutes from emergency notification for evacuation and 100 percent of the population could be evacuated in 250 minutes or less following an evacuation order. The applicant concluded that use of this information is still relevant because population within the emergency planning zone has declined since the analysis in 2006. Entergy performed sensitivity analyses on MACCS2 input parameters for an increased evacuation time delay and for a slower evacuation speed. Consequence deviations were found to be less than 1 percent (Entergy 2011). The staff notes that the percentage of population evacuated within the emergency planning zone used by Entergy in the SAMA analysis exceeded the generic value of 99.5 percent (NRC 1997a, Section 5.7.1). However, the staff finds the applicant's value to be acceptable because, based on the staff's review of the applicant's analysis, the staff determined that the value was derived from a recent site-specific analysis that adequately considered the spatial distribution of individuals in the two counties and one parish included within the emergency planning zone, accounted for response differences due to the time of the week when the evacuation order could be given, and addressed the influence of potential inclement weather conditions. Given that the applicant performed a site-specific analysis to determine evacuation assumptions and parameters, showed radiological consequence results were insensitive to changes to certain evacuation parameters in a sensitivity study, and furnished a rationale for the current appropriateness of the previously collected site-specific data, the staff concludes that the evacuation assumptions and analysis are reasonable and acceptable for the purposes of the SAMA analysis at GGNS.

Entergy used regional economic data from the 2007 U.S. Census of Agriculture, the U.S. Department of Commerce, the U.S. Bureau of Labor Statistics, and the Consumer Price Index for estimating farm and nonfarm values. County representation within a spatial element was based on the county with the greatest area contribution. Data for certain counties and parishes were not incorporated into the analysis because of small area contributions within a spatial element. Regional crop values, obtained from 2007 U.S. Census of Agriculture data, were summed with the 80-km (50-mi) area and applied to the MACCS2 crop categories. The staff considers these data sources used by the applicant to be current and finds them acceptable for the SAMA analysis. Entergy estimated present dollar values based on the internal events PRA at GGNS. Onsite economic costs provided the greatest contribution, about 70 percent of the total dollar value. Offsite economic costs contributed about 16 percent to the total dollar value (Entergy 2012c, Table 4.21-1) for a discount rate of 7 percent, 20-year license renewal period, and updated CDF of 2.9×10^{-6} per year. Offsite population doses and onsite doses contributed 13 and 1 percent of the total dollar value, respectively. Section F.6 provides more detailed information on the cost-benefit calculation and its evaluation.

In summary, the staff reviewed Entergy's assessments of the source term, radionuclide releases, meteorological data, projected population distribution, emergency response, and regional economic data and evaluated Entergy's responses to the staff's requests for additional information, as previously described in this subsection. Based on the staff's review, the staff concludes that Entergy's consequence analysis is acceptable and Entergy's methodology to estimate offsite consequences for GGNS and consideration of parameter sensitivities provide an acceptable basis to assess the risk reduction potential for candidate SAMAs. Accordingly, the staff based its assessment of offsite risk on the CDFs, population doses, and offsite economic costs reported by Entergy.

F.3 Potential Plant Improvements

The process for identifying potential plant improvements (SAMAs), an evaluation of that process, and the improvements evaluated in detail by Entergy are discussed in this section.

F.3.1 Process for Identifying Potential Plant Improvements

Entergy's process for identifying potential plant improvements consisted of the following elements:

- review of industry documents and consideration of other plant-specific enhancements not identified in published industry documents,
- review of potential plant improvements identified in the GGNS IPE and IPEEE, and
- review of the risk-significant events in the current GGNS PRA Levels 1 and 2 models modifications for inclusion in the comprehensive list of SAMA candidates.

Based on this process, Entergy identified an initial set of 249 candidate SAMAs, referred to as Phase I SAMAs. In Phase I of the evaluation, Entergy performed a qualitative screening of the initial list of SAMAs and eliminated SAMAs from further consideration using the following criteria:

- the SAMA modified features not applicable to GGNS,
- the SAMA has already been implemented at GGNS, or
- the SAMA is similar in nature and could be combined with another SAMA candidate.

Based on this screening, 60 of the Phase I SAMA candidates were screened out because they were not applicable to GGNS, 98 were screened out because they had already been implemented at GGNS, and 28 were screened out because they were similar in nature and could be combined with another SAMA candidate. Thus, a total of 186 SAMAs were eliminated, leaving 63 for further evaluation. The results of the Phase I screening analysis for each SAMA candidate were provided in a response to a staff RAI (Entergy 2012a). The remaining SAMAs, referred to as Phase II SAMAs, are listed in Table E.2-2 of Attachment E to the ER in the original submittal (Entergy 2011) and in the revised analysis (Entergy 2012c). In Phase II, a detailed evaluation was performed for each of the 63 remaining SAMA candidates, as discussed in Sections F.4 and F.6 below.

F.3.2 Review of Entergy's Process

Entergy's efforts to identify potential SAMAs included explicit consideration of potential SAMAs primarily for internal events because the current GGNS PRA does not include external events. Potential SAMAs for external events were included based on the GGNS IPEEE probabilistic analysis of internal fires and deterministic analysis of seismic and other external events.

The initial SAMA list was developed primarily from the review of generic industry SAMAs (NEI 2005), as well as SAMAs from nine previous BWR license renewal applications. To this list, a number of SAMAs were added based on improvements identified in the IPE and IPEEE. Finally, SAMAs were added based on the review of the GGNS PRA Level 1 and Level 2 LERF results.

Entergy provided a tabular listing of the Level 1 PRA basic event CDF importances, down to a risk reduction worth (RRW) of 1.005. SAMAs affecting these basic events would have the greatest potential for reducing risk. An RRW of 1.005 corresponds to a reduction in CDF of approximately 0.5 percent, given 100 percent reliability of the SAMA. Based on the maximum averted cost risk including external events and uncertainty (see Section F.6.1 below), this equates to a benefit of approximately $17,000. This is well below the minimum implementation cost associated with a procedure change given by Entergy of $25,000 (refer to Section F.5) and is not cost beneficial. All basic events in the Level 1 listing were reviewed to identify potential SAMAs and the listing annotated to indicate the Phase II SAMAs mitigating the failure associated with the basic event. All basic events, except flag events, which do not represent failures, were addressed by one or more Phase II SAMAs either from the list based on the generic industry SAMAs or GGNS specific SAMAs (Entergy 2011).

Entergy also provided and reviewed the basic events with large early release frequency RRWs down to 1.005. All basic events in the Level 2 LERF (or release category H/E) listing were reviewed to identify potential SAMAs and all were addressed by one or more Phase II SAMAs, except those that are flag or split fractions for which no SAMA would be appropriate (Entergy 2011). The staff notes that because LERF makes up only about 10 percent of the CDF and cost risk, LERF basic events with RRW less than about 1.1 would not be expected to be cost beneficial unless they are also important to CDF.

As a result of the review of the Level 1 and Level 2 LERF basic events, four additional SAMAs were identified as most of the basic events were addressed by SAMAs in the generic list.

Entergy also considered the potential plant improvements described in the GGNS IPE and IPEEE in the identification of plant-specific candidate SAMAs. As a result of the review of the IPE, 11 improvements were identified and are listed in Table E.2-1 of Attachment E of the ER. The ER stated that five of these improvements have been implemented, one considered no longer applicable and five retained as potential SAMAs.

As a result of the IPEEE, eight potential improvements concerning external flooding were identified and are listed in Table E.2-1 of Attachment E of the ER. The ER stated that three of these improvements have been implemented, but five are stated to not be cost beneficial because of the minor risk from external flooding. They are:

- Remove the wooden foot bridge crossing the northwest ditch near its upstream end.
- Remove the 38-cm (15-inch) corrugated metal pipe located in the small auxiliary ditch parallel to the northwest ditch.
- Re-hang the security fence gates west of the control building.
- Grade down and remove the access road, the raised berm parallel to the access road, and curbs adjacent to the access road.
- Replace the C8 × 1.5 channel forming the flood barrier across the SSW A equipment hatch opening.

In response to a staff RAI to provide further support for this disposition, Entergy stated that site topography has changed considerably since the time of the IPEEE, and it addressed the current status of the items listed above. All were either no longer applicable or otherwise adequately addressed. Although the channel identified in the last bullet has not been replaced, Entergy described features of the interior of the pump house, which minimize the impact of flooding, and it stated that contingency actions are available to place sand bags in front of the doors (Entergy 2012b).

In addition, Entergy stated it had re-evaluated the site during the 2011 Mississippi River flood and determined it to be adequately protected against external flooding. The NRC resident and region inspectors performed a review of the flooding procedures and site actions for seasonal extreme flooding of the Mississippi River. Additionally, the inspectors performed an inspection of the protected area to identify any modifications to the site that would inhibit site drainage or that would allow ingress past a barrier during a probable maximum precipitation event. No recommendations for improved flood protection were identified. Further, Entergy provided an estimate of $2,300 in the original response (Entergy 2012a) and $2,200 in the revised analysis (Entergy 2012c) for the benefit associated with the above probable maximum precipitation flooding modifications assuming they would eliminate the potential for core damage. This was based on the IPEEE-assessed frequency of the probable maximum participation with coincident wind wave activity. Based on the disposition of the cited improvements, the results of the recent inspection and the low benefit associated with the modifications, the staff agrees with the Entergy treatment of external flooding for the SAMA analysis.

Entergy also considered SAMAs for the two largest fire risk contributors based on the IPEEE evaluation whose results are summarized in Table F–4.

The staff review of the Phase I SAMA screening identified a number of questions concerning the adequacy of the basis for not considering the SAMA in the Phase II analysis. In response to an RAI, Entergy (Entergy 2012b, 2012c, 2012d) stated that:

- The Division 3 direct current (DC) system used for the HPCS is independent of the other DC buses; hence, a SAMA to reduce the DC dependence between high-pressure injection and the automatic depressurization system has essentially been implemented at GGNS.
- GGNS does not have another security or other emergency generator beyond the three now installed that could be used for providing DC power through direct connections to necessary loads following a station blackout. Therefore, providing a procedure for this connection is not feasible. Also, for nonstation-blackout situations, the benefit is less than the potential cost.
- GGNS SAMA No. 6, improve 4.16-kV bus cross-tie ability, already includes installing key-locked control switches to enable alternating current bus cross-ties; hence, a separate, new SAMA is not necessary.
- The benefit of a SAMA to provide capability for alternate injection via the reactor water cleanup system was evaluated and found to be less than the associated cost. Extensive modifications would be required to use the reactor water cleanup system for alternate injection. Piping modifications and a source of water would be needed because the only existing reactor water cleanup suction source is the reactor pressure vessel itself. Key-locked switches would have to be installed to permit bypassing existing reactor water cleanup interlocks to permit use for injection. Also, the system has power dependencies with the other alternate injection systems which would have to be modified to obtain a significant benefit.
- The severe accident guidelines implemented at GGNS included considerations of flooding the reactor pressure vessel and/or containment to various levels relative to the core and/or core debris and the impact on the need for containment venting. No further restrictions are deemed appropriate.
- Simulator training at GGNS includes training on severe accident scenarios.

The staff review of the identification of SAMAs from the Level 1 and Level 2 importance analysis identified several basic events for which the associated SAMA required further explanation or justification. For several human error basic events with high failure probabilities, Entergy was asked to consider improvements in procedures or training. In response, Entergy described each of the events as being combined with other human error basic events in the recovery rule application process so that the combined failure rate was lower and supported by procedures and training already in place. For several significant valve failures for high-pressure injection systems, Entergy was asked to consider the potential for lower cost alternatives than the SAMAs originally considered. In response, Entergy described the valves and stated that review of generic SAMAs did not identify any feasible lower cost alternative. The potential for manually opening the HPCS minimum flow isolation valve was considered and determined not to be feasible in the time available (Entergy 2012a, 2012b).

As stated above, the GGNS IPEEE used a seismic margins assessment, which neither provided quantitative risk information nor deterministic seismic capacities for specific GGNS systems, structures, or components. It is thus not possible to identify and evaluate GGNS-specific SAMAs to mitigate seismic risk. Based on the conclusions of the IPEEE seismic assessment "…that Grand Gulf Nuclear Station is seismically rugged and that all components identified in the Safe Shutdown Path have adequately considered the seismic input. All anchorage to these components was found to be rugged," the low GGNS internal events CDF, and the staff observation that SAMAs to mitigate the impact of seismic events are expected to be relatively costly and therefore are not likely to be cost beneficial, the staff concludes that the exclusion of seismic-specific SAMAs from the evaluation is acceptable.

On the basis of its review of the foregoing information, the staff concludes that the set of SAMAs evaluated in the ER, together with those identified in response to staff RAIs, addresses the major contributors to both internal and external event CDF.

The staff questioned the applicant about additional potentially lower cost alternatives to some of the SAMAs evaluated (NRC 2012a), including:

- Revise procedures for operators to manually initiate emergency diesel generator (EDG) heating, ventilation, and HVAC if the existing automatic logic fails and/or procedures for the plant auxiliary operators to check on any automatic start of the EDG could allow HVAC failures to be discovered and might eliminate the need for alarms.
- Provide directions to use jumpers to bypass the low reactor pressure interlock instead of installing a bypass switch to allow operators to bypass interlock circuitry.
- Consider using other air compressors (service air) that might be connected to the instrument air system instead of providing new compressors.
- Consider improving control room fire-detection system response for a limited number of key cabinets.

In response to the RAIs, the applicant addressed the suggested lower cost alternatives (Entergy 2012a), which are discussed further in Section F.6.2.

The staff notes that the set of SAMAs submitted is not all-inclusive because additional, possibly even less expensive, design alternatives can always be proposed. 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 likely would not cost less than the least expensive alternatives evaluated, when the subsidiary costs associated with maintenance, procedures, and training are considered.

The staff concludes that Entergy used a systematic and comprehensive process for identifying potential plant improvements for GGNS, and that the set of SAMAs evaluated in the ER, together with those evaluated in response to staff inquiries, is reasonably comprehensive and, therefore, acceptable. This search included reviewing insights from the GGNS plant-specific risk studies that included internal initiating events as well as fire, seismic and other external initiated events, and reviewing plant improvements considered in previous SAMA analyses.

F.4 Risk Reduction Potential of Plant Improvements

In the ER, the applicant evaluated the risk-reduction potential of the 63 SAMAs that were not screened out in the Phase I analysis and retained for the Phase II evaluation. The SAMA evaluations were performed using generally conservative assumptions.

Except for two SAMAs associated with internal fires, Entergy used model re-quantification to determine the potential benefits for each SAMA. The CDF, population dose, and offsite economic cost reductions were estimated using the GGNS 2010 EPU PRA model for the non-fire SAMAs. The changes made to the model to quantify the impact of SAMAs are detailed in Section E.2.3 of Attachment E to the ER (Entergy 2011). Bounding evaluations (or analysis cases) were performed to address specific SAMA candidates or groups of similar SAMA candidates. For the two fire-related SAMAs (SAMA Nos. 54 and 55), the benefit was determined by assuming the CDF contribution for the fire area impacted by the SAMA was reduced to zero and that the resulting benefit was determined by the product of the fraction of the internal events total CDF represented by the fire area CDF and the maximum total internal events benefit.

Table F–5 lists the assumptions considered to estimate the risk reduction for each of the evaluated SAMAs, the estimated risk reduction in terms of percent reduction in CDF, population dose risk and offsite economic cost risk, and the estimated total benefit (present value) of the averted risk. The estimated benefits reported in Table F–5 reflect the combined benefit in both internal and external events. The determination of the benefits for the various SAMAs is further discussed in Section F.6.

Phase II evaluation, Cases 6 and 10, were used to evaluate SAMA No. 7 (install an additional, buried offsite power source) and SAMA No. 18 (protect transformers from fire), respectively. Entergy stated that for these cases, loss of offsite power (LOSP) initiating event frequencies were multiplied by the ratios of 19/24 and 9/24 to account for severe weather and plant-centered causes of LOSP, respectively. In response to a staff RAI concerning the source of these values, Entergy stated that of the 24 LOSP events applicable to GGNS, 5 were weather-related, 15 were plant- or switchyard-related, and 4 were grid-related (Entergy 2012a). The ratio 19/24 then represents the fraction of LOSP frequency if severe weather causes are eliminated.

The ratio 9/24 then represents the fraction of LOSP frequency if the plant-centered causes are eliminated. The staff concludes that this approach is valid for the assessment of these SAMAs.

Table F–5. Severe Accident Mitigation Alternatives Cost/Benefit Analysis for Grand Gulf Nuclear Station. Percentage Risk Reductions are Presented for Core Damage Frequency (CDF), Population Dose Risk (PDR), and Offsite Economic Cost Risk (OECR)

Analysis Case, Analysis Assumption, Individual SAMAs, and Cost Estimates		% Risk Reduction CDF	PDR	OECR	Internal and External Benefit	Internal and External Benefit with Uncertainty
Case 1. Direct Current Power *Assumption: Eliminates all cutsets for station blackout* (Analysis Case for SAMA Nos. 1, 2, 11, 12, & 15)		37.1%	27.3%	21.3%	$374,000	$1,121,000
1—Provide additional direct current battery capacity	$2,131,000					
2—Replace lead-acid batteries with fuel cells	$4,080,000					
11—Portable generator for direct current power: This SAMA involves the use of a portable generator to supply direct current power to the battery chargers during a station blackout.	$1,278,000					
12—Portable generator for direct current power: This SAMA involves the use of a portable generator to supply direct current power to the individual panels during a station blackout.	$1,278,000					
15—Use direct current generators to provide power to operate the switchyard power control breakers while a 480-V alternating current generator could supply the air compressors for breaker support	$1,428,000					
Case 2. Improve Charger Reliability *Assumption: Failure of chargers contribution at zero* (Analysis Case for SAMA Nos. 3 & 13)		0.7%	2.0%	2.1%	$12,100	$36,200
3—Add battery charger to existing direct current system	$90,000					
13—Proceduralize battery charger high-voltage shutdown circuit inhibit	$50,000					
Case 3. Add Direct Current System Cross-Ties *Assumption: Eliminates failure of direct current power gates* (Analysis Case for SAMA No. 4)		3.6%	8.4%	9.0%	$57,000	$171,000
4—Provide direct current bus cross-ties	$300,000					

Table F–5. Severe Accident Mitigation Alternatives Cost/Benefit Analysis for Grand Gulf Nuclear Station. Percentage Risk Reductions are Presented for Core Damage Frequency (CDF), Population Dose Risk (PDR), and Offsite Economic Cost Risk (OECR) (continued)

Analysis Case, Analysis Assumption, Individual SAMAs, and Cost Estimates		% Risk Reduction			Internal and External Benefit	Internal and External Benefit with Uncertainty
		CDF	PDR	OECR		
Case 4. Increase Availability of Onsite Alternating Current Power *Assumption: Eliminates failure of diesel generators 11, 12, and 13 to their alternating current buses* (Analysis Case for SAMA Nos. 5 & 8)		42.1%	31.4%	25.6%	$427,000	$1,282,000
5—Provide an additional diesel generator	$20,000,000					
8—Install a gas turbine generator with tornado protection	$2,000,000					
Case 5. Improve Alternating Current Power *Assumption: Eliminates the loss of the most important 4.16-kV bus* (Analysis Case for SAMA Nos. 6 & 17)		7.5%	29.5%	23.5%	$145,000	$434,000
6—Improve 4.16-kV bus cross-tie ability	$656,000					
17—Provide alternate feeds to essential loads directly from an alternate emergency bus	$656,000					
Case 6. Reduce Loss of Offsite Power During Severe Weather *Assumption: Eliminates the weather centered loss of offsite power initiating event* (Analysis Case for SAMA No. 7)		8.4%	6.0%	4.8%	$84,200	$253,000
7—Install an additional, buried offsite power source	$2,485,000					
Case 7. Provide Backup Emergency Diesel Generator Cooling *Assumption: Eliminates failure of service water cooling to the emergency diesel generators* (Analysis Case for SAMA Nos. 9 & 10)		7.6%	6.4%	4.6%	$77,800	$234,000
9—Use fire water system as backup source for diesel cooling	$1,344,000					
10—Add new backup source of diesel cooling	$2,000,000					
Case 8. Increase Emergency Diesel Generator Reliability *Assumption: Eliminates failure of emergency diesel generators to run* (Analysis Case for SAMA No. 14)		4.0%	4.3%	4.0%	$45,500	$137,000
14—Provide a portable emergency diesel generator fuel oil transfer pump	$1,477,000					

Table F–5. Severe Accident Mitigation Alternatives Cost/Benefit Analysis for Grand Gulf Nuclear Station. Percentage Risk Reductions are Presented for Core Damage Frequency (CDF), Population Dose Risk (PDR), and Offsite Economic Cost Risk (OECR) (continued)

Analysis Case, Analysis Assumption, Individual SAMAs, and Cost Estimates		% Risk Reduction			Internal and External Benefit	Internal and External Benefit with Uncertainty
		CDF	PDR	OECR		
Case 9. Improve Diesel Generator Reliability *Assumption: Eliminates the common cause failure contribution of failure to start emergency diesel generators* (Analysis Case for SAMA No. 16)		0.8%	0.6%	0.4%	$7,850	$23,600
16—Provide a diverse swing diesel generator air start compressor	$100,000					
Case 10. Reduce Plant-Centered Loss of Offsite Power *Assumption: Removes contribution of plant- and switchyard-centered events* (Analysis Case for SAMA No. 18)		25.0%	17.6%	13.9%	$250,000	$749,000
18—Protect transformers from failure	$780,000					
Case 11. Redundant Power to Torus Hard Pipe Vent Valves *Assumption: Eliminates failure of power to containment vents* (Analysis Case for SAMA No. 19)		<0.1%	5.4%	6.0%	$18,600	$55,700
19—Provide redundant power to direct torus hard pipe vent valves to improve the reliability of the direct torus vent valves and enhance the containment heat removal capability.	$714,000					
Case 12. High Pressure Injection System *Assumption: Eliminates failure of the high pressure core spray* (Analysis Case for SAMA Nos. 20 & 61)		53.7%	62.2%	58.0%	$622,000	$1,867,000
20—Install an independent active or passive high-pressure injection system	$8,800,000					
61—Install a backup water supply and pumping capability that is independent of normal and emergency alternating current power	$6,410,000					

Table F–5. Severe Accident Mitigation Alternatives Cost/Benefit Analysis for Grand Gulf Nuclear Station. Percentage Risk Reductions are Presented for Core Damage Frequency (CDF), Population Dose Risk (PDR), and Offsite Economic Cost Risk (OECR) (continued)

Analysis Case, Analysis Assumption, Individual SAMAs, and Cost Estimates		% Risk Reduction CDF	PDR	OECR	Internal and External Benefit	Internal and External Benefit with Uncertainty
Case 13. Extend Reactor Core Isolation Cooling Operation *Assumption: Eliminates failure of trip due to pressure* (Analysis Case for SAMA No. 21)		<0.1%	<0.1%	<0.1%	<$1	<$1
21—Raise backpressure trip set points for high-pressure coolant injection/reactor core isolation cooling [High-pressure coolant injection backpressure trip set point has already been raised. This SAMA evaluates raising the reactor core isolation cooling backpressure trip set point.]	$200,000					
Case 14. Improve Automatic Depressurization System *Assumption: Eliminates failure of automatic depressurization system valves* (Analysis Case for SAMA No. 22)		33.6%	12.7%	13.1%	$310,000	$930,000
22—Modify automatic depressurization system components to improve reliability [This SAMA will add larger accumulators thus increasing reliability during station blackouts].	$1,177,000					
Case 15. Improve Automatic Depressurization System Signals *Assumption: Eliminates failure of the safety relief valve failing to open* (Analysis Case for SAMA No. 23)		6.0%	4.5%	4.2%	$61,900	$186,000
23—Add signals to open safety relief valves automatically in a main steam isolation valve closure transient.	$1,500,000					
Case 16. Low Pressure Injection System *Assumption: Eliminates failure of the low pressure coolant injection and low pressure core spray* (Analysis Case for SAMA No. 24)		11.4%	45.4%	40.5%	$229,000	$687,000
24—Add a diverse low-pressure injection system.	$8,800,000					

Table F–5. Severe Accident Mitigation Alternatives Cost/Benefit Analysis for Grand Gulf Nuclear Station. Percentage Risk Reductions are Presented for Core Damage Frequency (CDF), Population Dose Risk (PDR), and Offsite Economic Cost Risk (OECR) (continued)

Analysis Case, Analysis Assumption, Individual SAMAs, and Cost Estimates		% Risk Reduction			Internal and External Benefit	Internal and External Benefit with Uncertainty
		CDF	PDR	OECR		
Case 17. Emergency Core Cooling System Low-Pressure Interlock *Assumption: Eliminates emergency core cooling system permissives and interlock failure* (Analysis Case for SAMA No. 25)		<0.1%	<0.1%	<0.1%	$0	$0
25—Install a bypass switch to allow operators to bypass the low reactor pressure interlock circuitry that inhibits opening the low-pressure coolant injection or core spray injection valves following sensor or logic failures that prevent all low pressure injection valves from opening.	$1,000,000					
Case 18. Residual Heat Removal Heat Exchangers *Assumption: Eliminates failure of standby service water to provide cooling to the residual heat removal heat exchangers* (Analysis Case for SAMA No. 26)		12.5%	30.9%	34.1%	$205,000	$616,000
26—Implement modifications to allow manual alignment of the fire water system to residual heat removal heat exchangers.	$1,950,000					
Case 19. Emergency Service Water System Reliability *Assumption: Eliminates failure of service water pumps* (Analysis Case for SAMA No. 27)		3.5%	6.0%	6.3%	$47,200	$142,000
27—Add service water pump to increase availability of cooling watei	$5,900,000					
Case 20. Main Feedwater System Reliability *Assumption: Eliminates failure to inject from feedwater* (Analysis Case for SAMA No. 28)		7.5%	22.2%	23.7%	$134,000	$402,000
28—Add a motor-driven feed water pump	$1,650,000					
Case 21. Increase Availability of Room Cooling *Assumption: Eliminates failure of room cooling to low-pressure core spray, high-pressure core spray, standby service water and safeguard switchgear battery rooms* (Analysis Case for SAMA No. 29)		17.9%	15.1%	16.0%	$193,000	$580,000
29—Provide a redundant train or means of ventilation	$2,203,000					

Table F–5. Severe Accident Mitigation Alternatives Cost/Benefit Analysis for Grand Gulf Nuclear Station. Percentage Risk Reductions are Presented for Core Damage Frequency (CDF), Population Dose Risk (PDR), and Offsite Economic Cost Risk (OECR) (continued)

Analysis Case, Analysis Assumption, Individual SAMAs, and Cost Estimates		% Risk Reduction CDF	PDR	OECR	Internal and External Benefit	Internal and External Benefit with Uncertainty
Case 22. Increase Availability of the Diesel Generator System through HVAC Improvements *Assumption: Eliminates failure of HVAC for diesel generator rooms* (Analysis Case for SAMA Nos. 30, 32, & 33)		23.9%	16.6%	12.3%	$237,000	$711,000
30—Add a diesel building high temperature alarm or redundant louver and thermostat	$1,305,000					
32—Diverse emergency diesel generator HVAC logic	$1,148,000					
33—Install additional fan and louver pair for emergency diesel generator HVAC	$6,000,000					
Case 23. Increased Reliability of Room Cooling for High-Pressure Coolant injection and Reactor Core Isolation Cooling *Assumption: Eliminates failure of power to the high-pressure core spray pump room cooler (Reactor core isolation cooling pump continued operation is not dependent on room cooling.)* (Analysis Case for SAMA No. 31)		<0.1%	<0.1%	<0.1%	$0	$0
31—Create ability to switch high-pressure coolant injection and reactor core isolation cooling room fan power supply to direct current in an station blackout event	$300,000					
Case 24. Increase Reliability of Instrument Air *Assumption: Eliminates failure of the instrument air* (Analysis Case for SAMA Nos. 34 & 35)		10.6%	17.1%	18.7%	$143,000	$428,000
34—Modify procedure/hardware to provide ability to align diesel power to more air compressors	$1,200,000					
35—Replace service and instrument air compressors with more reliable compressors which have self-contained air cooling by shaft-driven fans	$1,395,000					

Table F–5. Severe Accident Mitigation Alternatives Cost/Benefit Analysis for Grand Gulf Nuclear Station. Percentage Risk Reductions are Presented for Core Damage Frequency (CDF), Population Dose Risk (PDR), and Offsite Economic Cost Risk (OECR) (continued)

Analysis Case, Analysis Assumption, Individual SAMAs, and Cost Estimates		% Risk Reduction CDF	PDR	OECR	Internal and External Benefit	Internal and External Benefit with Uncertainty
Case 25. Backup Nitrogen to Safety Relief Valve *Assumption: Eliminates operator failure to install air bottles* (Analysis Case for SAMA No. 36)		5.9%	0.1%	0.0%	$46,900	$141,000
36—Install nitrogen bottles as backup gas supply for safety relief valves	$1,723,000					
Case 26. Improve Availability of Safety Relief Valves and Main Steam Isolation Valves *Assumption: Eliminates failure of non-automatic-depressurization-system safety relief valves* (Analysis Case for SAMA No. 37)		33.7%	12.9%	13.3%	$312,000	$935,000
37—Improve safety relief valve and main steam isolation valve pneumatic components	$1,500,000					
Case 27. Improve Suppression Pool Cooling *Assumption: Eliminates the failure of flow to the residual heat removal heat exchangers* (Analysis Case for SAMA No. 38)		12.5%	30.9%	34.1%	$206,000	$617,000
38—Install an independent method of suppression pool cooling	$5,800,000					
Case 28. Increase Availability of Containment Heat Removal *Assumption: Eliminates failure of cooled flow from residual heat removal pump A and B* (Analysis Case for SAMA Nos. 39 & 41)		17.8%	45.6%	50.2%	$297,000	$892,000
39—Procedural change to cross-tie open cycle cooling system to enhance containment spray system	$25,000					
41—Use the fire water system as a backup source for the drywell spray system	$1,950,000					

Table F–5. Severe Accident Mitigation Alternatives Cost/Benefit Analysis for Grand Gulf Nuclear Station. Percentage Risk Reductions are Presented for Core Damage Frequency (CDF), Population Dose Risk (PDR), and Offsite Economic Cost Risk (OECR) (continued)

Analysis Case, Analysis Assumption, Individual SAMAs, and Cost Estimates		% Risk Reduction			Internal and External Benefit	Internal and External Benefit with Uncertainty
		CDF	PDR	OECR		
Case 29. Decay Heat Removal Capability – Drywell Spray *Assumption: Eliminates failure of residual heat removal spray* (Analysis Case for SAMA No. 40)		17.8%	45.6%	50.2%	$297,000	$892,000
40—Install a passive drywell spray system to provide redundant drywell spray method	$5,800,000					
Case 30. Increase Availability of the Condensate Storage Tank *Assumption: Eliminates failure of high-pressure core spray and reactor core isolation cooling suction* (Analysis Case for SAMA No. 42)		4.4%	12.6%	13.5%	$77,000	$231,000
42 – Enhance procedures to refill condensate storage tank from demineralized water or service water system	$200,000					
Case 31. Filtered Vent to Increase Heat Removal Capacity for Non-Anticipated Transient without Scram Events *Assumption: Reduces the baseline accident progression source terms by a factor of 2* (Analysis Case for SAMA No. 43)		0.0%	31.6%	40.6%	$118,000	$354,000
43—Install a filtered containment vent to provide fission product scrubbing	$1,500,000					
Case 32. Reduce Hydrogen Ignition *Assumption: Eliminates failure of hydrogen igniters* (Analysis Case for SAMA Nos. 44 & 45)		0.0%	18.8%	19.9%	$62,500	$188,000
44—Provide post-accident containment inerting capability	$2,665,000					
45—Install a passive hydrogen control system	$760,000					

Table F–5. Severe Accident Mitigation Alternatives Cost/Benefit Analysis for Grand Gulf Nuclear Station. Percentage Risk Reductions are Presented for Core Damage Frequency (CDF), Population Dose Risk (PDR), and Offsite Economic Cost Risk (OECR) (continued)

Analysis Case, Analysis Assumption, Individual SAMAs, and Cost Estimates		% Risk Reduction CDF	PDR	OECR	Internal and External Benefit	Internal and External Benefit with Uncertainty
Case 33. Controlled Containment Venting *Assumption: Eliminates failure of air-operated valves to open* (Analysis Case for SAMA Nos. 46 & 47)		1.3%	3.1%	3.5%	$21,200	$63,600
46—Provide passive overpressure relief by changing the containment vent valves to fail open and improving the strength of the rupture disk	$1,000,000					
47—Enable manual operation of all containment vent valves via local controls	$150,000					
Case 34. Interfacing Systems Loss of Coolant Accident *Assumption: Removes all interfacing systems LOCA initiators* (Analysis Case for SAMA Nos. 48, 50, & 51)		0.0%	0.1%	0.1%	$128	$385
48—Increase frequency of valve leak testing to reduce interfacing systems LOCA frequency	$100,000					
50—Revise emergency operating procedures to improve interfacing systems LOCA identification	$50,000					
51—Improve operator training on interfacing systems LOCA coping	$112,000					
Case 35. Main Steam Isolation Valve Design *Assumption: Eliminates failure of the main steam isolation valves to close or remain closed* (Analysis Case for SAMA No. 49)		0.0%	0.1%	0.0%	$5	$15
49—Improve main steam isolation valve design to decrease the likelihood of containment bypass scenarios	$1,000,000					

Table F–5. Severe Accident Mitigation Alternatives Cost/Benefit Analysis for Grand Gulf Nuclear Station. Percentage Risk Reductions are Presented for Core Damage Frequency (CDF), Population Dose Risk (PDR), and Offsite Economic Cost Risk (OECR) (continued)

Analysis Case, Analysis Assumption, Individual SAMAs, and Cost Estimates		% Risk Reduction			Internal and External Benefit	Internal and External Benefit with Uncertainty
		CDF	PDR	OECR		
Case 36. Standby Liquid Control System *Assumption: Eliminates failure to initiate standby liquid control and failures of alternate boron injection* (Analysis Case for SAMA No. 52)		0.1%	0.1%	0.1%	$590	$1,771
52—Increase boron concentration in the standby liquid control system [Reduced time required to achieve shutdown provides increased margin in the accident timeline for successful initiation of standby liquid control]	$50,000					
Case 37. Safety Relief Valve Reseat *Assumption: Eliminates the initiator for safety relief valves inadvertently being open and basic events for stuck open safety relief valves* (Analysis Case for SAMA No. 53)		4.2%	3.9%	4.1%	$46,500	$139,000
53—Increase safety relief valve reseat reliability to address the risk associated with dilution of boron caused by the failure of the safety relief valves to reseat after standby liquid control injection	$2,200,000					
Case 38. Add Fire Suppression[a] *Assumption: Eliminates fire CDF from the critical switchgear rooms* (Analysis Case for SAMA No. 54)		n/a	n/a	n/a	$32,600	$97,800
54—Add automatic fire suppression systems to the dominant fire zones	$375,000					
Case 39. Reduce Risk from Fires that Require Control Room Evacuation[a] *Assumption: Eliminates fire CDF from the main control room* (Analysis Case for SAMA No. 55)		n/a	n/a	n/a	$134,000	$402,000
55—Upgrade the alternate shutdown system panel to include additional system controls for opposite division	$787,000					

Table F–5. Severe Accident Mitigation Alternatives Cost/Benefit Analysis for Grand Gulf Nuclear Station. Percentage Risk Reductions are Presented for Core Damage Frequency (CDF), Population Dose Risk (PDR), and Offsite Economic Cost Risk (OECR) (continued)

Analysis Case, Analysis Assumption, Individual SAMAs, and Cost Estimates		% Risk Reduction CDF	PDR	OECR	Internal and External Benefit	Internal and External Benefit with Uncertainty
Case 40. Large Break Loss of Coolant Accident *Assumption: Eliminates large break LOCA* (Analysis Case for SAMA No. 56)		3.3%	13.3%	14.5%	$71,300	$214,000
56—Provide digital large break LOCA protection to identify symptoms and/or precursors of a large break LOCA (a leak before break)	$2,000,000					
Case 41. Trip/Shutdown Risk *Assumption: Reduces all initiating events except pipe breaks, floods, and loss of offsite power by 10 percent* (Analysis Case for SAMA No. 57)		5.7%	6.1%	6.5%	$65,800	$197,000
57—Generation risk assessment implementation into plant activities (trip/shutdown risk modeling)	$500,000					
Case 42. Increase Availability of Pump House Ventilation System for Standby Service Water *Assumption: Eliminates failure of standby service water pump house ventilation* (Analysis Case for SAMA No. 58)		1.5%	1.6%	1.6%	$16,800	$50,400
58—Increase the training emphasis and provide additional control room indication on the operational status of standby service water pump house ventilation system	$100,000					

Table F–5. Severe Accident Mitigation Alternatives Cost/Benefit Analysis for Grand Gulf Nuclear Station. Percentage Risk Reductions are Presented for Core Damage Frequency (CDF), Population Dose Risk (PDR), and Offsite Economic Cost Risk (OECR) (continued)

Analysis Case, Analysis Assumption, Individual SAMAs, and Cost Estimates		% Risk Reduction			Internal and External Benefit	Internal and External Benefit with Uncertainty
		CDF	PDR	OECR		
Case 43. Increase Recovery Time of Emergency Core Cooling System Upon Loss of Standby Service Water *Assumption: Eliminates failure of standby service water to the low pressure core spray room cooler* (Analysis Case for SAMA No. 59)		4.5%	5.2%	5.5%	$53,300	$160,000
59—Increase operator training for alternating operation of the low-pressure emergency core cooling system pumps (low-pressure coolant injection and low-pressure core spray) for loss of standby service water scenarios	$50,000					
Case 44. Additional Containment Heat Removal *Assumption: Eliminates failure of suppression pool cooling and containment spray systems* (Analysis Case for SAMA No. 60)		17.8%	47.1%	51.9%	$302,000	$907,000
60—Install an additional method of heat removal from containment	$4,352,000					
Case 45. Improve Heat Exchanger Availability for Residual Heat Removal *Assumption: Eliminates failure of residual heat removal heat exchanger cooler inlet and outlet valves* (Analysis Case for SAMA No. 62)		2.0%	6.4%	7.0%	$37,800	$113,000
62—Add a bypass around the residual heat removal heat exchanger inlet and outlet valves	$2,832,000					
Case 46. Improve Lube Oil Cooling for Reactor Core Isolation Cooling *Assumption: Eliminates failure to cool lube oil for reactor core isolation cooling* (Analysis Case for SAMA No. 63)		7.4%	3.1%	2.5%	$68,200	$205,000
63—Add a redundant reactor core isolation cooling lube oil cooling path	$1,803,000					

[a] These analysis cases only affected external events and were evaluated differently.

[b] Clarified by the applicant to be reduced by 10 percent in response to a request for additional information.

Case 8, used to evaluate the benefit of SAMA No. 14 (provide a portable EDG fuel oil transfer pump), assumed that the EDGs' failure to run was eliminated. In its review, the staff noted that the failure to run of the Division 3, HPCS diesel was not eliminated. In response to an RAI, Entergy stated that the Division 3 diesel did not have a common fuel oil transfer pump with the other two EDGs and if the Division 3 diesel were included in the assessment, either two portable fuel transfer pumps would be needed, or the pump would have to be moved to fill the additional day tank. Entergy stated this would increase implementation costs and would not change the results of the cost-benefit assessment (Entergy 2012a). While the staff disagrees that the added cost of moving the portable transfer pump would be appreciable, in considering the conservatism in the assumption that all failures to run would be eliminated by having a portable pump, the staff concludes that the assessment of the benefit of SAMA No. 14 is acceptable.

Case 32, used to evaluate the benefit of SAMAs Nos. 44 and 45 (both changes to eliminate hydrogen ignition containment failures), was evaluated by eliminating failures of the hydrogen igniter system. A staff RAI on the original ER submittal (NRC 2012a) noted that Entergy results indicated the assumption would lead to a 16 percent reduction in CDF, whereas it should have no impact on CDF. In response, Entergy stated that the elimination of igniter failures in the Level 2 analysis was done by setting a gate to TRUE, which eliminated all hydrogen igniter failure cut sets from the Level 2 results, and therefore, led to the reduction in CDF in the original analysis (Entergy 2012a). This inconsistency was resolved in the revised SAMA analysis. In the revised analysis, there is no reduction in CDF for Case 32 (Entergy 2012c). The staff concludes that the revised evaluation, as described, is appropriate for the SAMA analysis.

In the description of the updated analysis, Entergy stated that the assumptions for evaluating the benefit for Case 5 used for SAMA No. 6 (Improve 4.16-kV bus cross-tie ability) and SAMA No. 17 (Provide alternate feeds to essential loads directly from an alternate emergency bus) were revised to remove some of the excess conservatism in the prior evaluation (Entergy 2012c). Because the applicant's additional information addressed the questions raised by the staff and provided a sufficient basis for justifying the cost-benefit conclusions, the staff concludes that the revised evaluation, as described, is appropriate for the SAMA analysis.

F.5 Cost Impacts of Candidate Plant Improvements

Entergy estimated the costs of implementing the 63 Phase II SAMAs through the use of other licensees' estimates for similar improvements and the development of site-specific cost estimates where appropriate.

Entergy stated that the following cost ranges were used based on the review of previous SAMA applications.

Table F–6. Estimated Cost Ranges for SAMA Applications

Type of Change	Estimated Cost Range
Procedural only	\$25K–\$50K
Procedural change with engineering or training required	\$50K–\$200K
Procedural change with engineering and testing or training required	\$200K–\$300K
Hardware modification	\$100K to > \$1000K

Entergy stated that the GGNS site-specific cost estimates were based on the engineering judgment of project engineers experienced in performing design changes at the facility. The detailed cost estimates considered engineering, labor, materials, and support functions, such as planning, scheduling, health physics, quality assurance, security, safety, and fire watch. The estimates included a 20 percent contingency on the design and installation costs but did not account for inflation, replacement power during extended outages necessary for SAMA implementation, or increased maintenance or operation costs following SAMA implementation.

In response to a staff RAI for more information concerning the applicability of cost estimates taken directly from previous SAMA applications, Entergy stated that engineering judgment by project engineers familiar with the costs of modifications at Entergy plants was used to determine if the cited cost estimates from other SAMA analyses were valid for GGNS. If the GGNS project engineers' rough conceptual cost estimate of the modification was larger than the other plant's cost estimate, the other plant's estimate was adopted without further detailed cost analysis (Entergy 2012a).

The staff reviewed the applicant's cost estimates, presented in Table E.2-2 of Attachment E to the ER in the original submittal (Entergy 2011) and in responses to staff RAIs (Entergy 2012a, 2012c). 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.

The staff noted that the new plant-specific cost estimates incorporated into the revised cost-benefit analysis for a number of SAMAs are considerably greater than those previously given and appear large compared to that implied by the SAMA description. In response to an RAI, Entergy provided more details on what is specifically included in the new cost estimates for SAMA Nos. 1, 9, 11, 14, and 63 to justify those estimates (Entergy 2012d). Based on the additional information provided, comparison of the costs with those provided in other SAMA submittals, conservatisms in the determination of the benefit, and consideration of the margins between the cost and the benefit, the staff concludes that the applicant's cost estimates are acceptable for determining the cost-benefit ratio of these SAMAs.

In the revised cost-benefit analysis, Entergy stated that the cost estimate for SAMA No. 6 (Improve 4.16-kV bus cross-tie ability) and SAMA No. 17 (Provide alternate feeds to essential loads directly from an alternate emergency bus) of $656,000 was taken from the Susquehanna SAMA analysis. In response to a staff RAI that pointed out the value used from Susquehanna was for two reactor units, Entergy described the basis for concluding that the cost for these SAMAs at GGNS would exceed the $656,000 value and justified use of this value for the GGNS SAMA analysis (Entergy 2012d) on the basis of extensive changes to the electrical bus control scheme, supporting calculations, documentation changes, required hardware, installation, and testing. Based on the information provided for implementing these SAMAs at GGNS, the staff concludes that Entergy's cost estimates are acceptable for determining the cost-benefit ratio of these SAMAs.

The staff concludes that, with the above clarifications, the cost estimates provided by Entergy are sufficient and appropriate for use in the SAMA evaluation.

F.6 Cost-Benefit Comparison

Entergy's cost-benefit analysis and the staff's review are described in the following sections.

F.6.1 Entergy's Evaluation

The methodology used by Entergy was based primarily on NRC's guidance for performing cost-benefit analysis; i.e., NUREG/BR–0184 (NRC 1997a). As described in Section 4.21.5.4 of the ER (Entergy 2011), the net value was determined for each SAMA according to the following formula:

Net Value = (APE + AOC + AOE + AOSC) – COE

where

APE (averted public exposure) = present value of APE costs ($)

AOC (averted offsite property damage costs) = present value of AOC costs ($)

AOE (averted occupational exposure) = present value of AOE costs ($)

AOSC (averted onsite costs) = present value of AOSC ($)

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 to be cost beneficial. Entergy's derivation of each of the associated costs is summarized next.

NEI guidance states that two sets of estimates should be developed for discount rates of 7 percent and 3 percent (NEI 2005). Entergy provided a base set of results using a discount rate of 7 percent and a 20-year license renewal period. Two sensitivity cases were developed by Entergy: one used a discount rate of 7 percent with a 33-year period for remaining plant life and another used a more conservative discount rate of 3 percent with a 20-year license renewal period.

F.6.1.1 Averted Public Exposure (APE) Costs

Entergy defined APE cost as the monetary value of accident risk avoided from population doses after discounting (Entergy 2011). The APE costs were calculated using the following formula:

APE = Annual reduction in public exposure (Δ person-rem per year)

× monetary equivalent of unit dose ($2,000 per person-rem)

× present value conversion corresponding to NRC (1997a, Equation on p. 5.27 for C when a facility is already operating)

The annual reduction in public exposure was calculated according to the following formula:

Annual reduction in public exposure = (Accident frequency without modification × accident population dose without modification) – (Accident frequency with modification × accident population dose with modification)

As stated in NUREG/BR–0184 (NRC 1997a), 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 20-year 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. As previously stated, Entergy also considered an extended period of 33 years for the remaining facility lifetime as a sensitivity case. For a discount rate of 7 percent and a 20-year license renewal period in the revised analysis with a CDF of 2.93×10^{-6} per year, the applicant calculated an APE cost of $13,116 for internal events (Entergy 2012c).

F.6.1.2 Averted Offsite Property Damage Costs (AOC)

Entergy defined AOC as the monetary value of risk avoided from offsite property damage after discounting (Entergy 2011). The AOC values were calculated using the following formula:

AOC = Annual reduction in offsite property damage × present value conversion corresponding to NRC (1997a, Equation for C on p. 5.27 for an operational facility).

The annual reduction in offsite property damage was calculated according to the following formula:

Annual reduction in offsite property damage = (Accident frequency without modification × accident property damage without modification) – (Accident frequency with modification × accident property damage with modification)

For a discount rate of 7 percent and a 20-year license renewal period in the revised analysis with a CDF of 2.93×10^{-6} per year, the applicant calculated an AOC of $16,264 for internal events (Entergy 2012c).

F.6.1.3 Averted Occupational Exposure (AOE) Costs

Entergy defined AOE as the avoided onsite exposure (Entergy 2011). Similar to the APE calculations, the applicant calculated costs for immediate onsite exposure. Long-term onsite exposure costs were calculated consistent with guidance in NUREG/BR–0184 (NRC 1997a), which included an additional term for accrual of long-term doses.

Entergy derived the values for averted occupational exposure from information provided in Section 5.7.3 of NUREG/BR–0184 (NRC 1997a). Best estimate values provided for immediate occupational dose (3,300 person-rem) and long-term occupational dose (20,000 person-rem over a 10-year clean-up 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 $2,000 per person-rem, a real discount rate of 7 percent, and a time period of 20 years to represent the license renewal period. Entergy assumed an accident frequency with modification of zero to overestimate and bound the long-term onsite exposure costs. Immediate and long-term onsite exposure costs were summed to determine AOE cost. For a CDF of 2.93×10^{-6} per year in its revised analysis, the applicant calculated an AOE cost of $1,115 for internal events (Entergy 2012c).

F.6.1.4 Averted Onsite Costs (AOSC)

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. The applicant derived the values for AOSC based on information provided in Section 5.7.6 of NUREG/BR–0184 (NRC 1997a). This cost element was divided into two parts: the onsite cleanup and decontamination cost, also commonly referred to as averted cleanup and decontamination costs; and the replacement power cost (RPC).

Averted cleanup and decontamination costs (ACC) were calculated using the following formula:

ACC = Annual CDF reduction

× present value of clean-up costs per core damage event

× present value conversion factor

The total cost of clean-up and decontamination subsequent to a severe accident is estimated in NUREG/BR–0184 to be \$1.5 × 10^9 (undiscounted). This value was converted to present costs over a 10-year clean-up period and integrated over the term of the proposed license extension.

Long-term RPCs were calculated using the following formula:

RPC = Annual CDF reduction

× present value of replacement power for a single event

× factor to account for remaining service years for which replacement power is required

× reactor power scaling factor

Accounting for the GGNS EPU, the applicant based its calculations on a net electric output of 1,475 megawatts-electric (MWe) and scaled up from the 910 MWe reference plant in NUREG/BR-0184 (NRC 1997a). Therefore, the applicant applied a power-scaling factor of 1.62 (1475 / 910 = 1.62) to determine the RPCs. For a CDF of 2.93 × 10^{-6} per year in its revised analysis, Entergy calculated an AOSC of \$71,500 from internal events for the 20-year license renewal period (Entergy 2012c).

Using the above equations, Entergy estimated the total present dollar value equivalent associated with completely eliminating severe accidents due to internal events at GGNS to be about \$101,995 (Entergy 2012c, Table 4.21-1). The applicant multiplied the internal events estimated benefit by 11 to account for the risk contributions from external events and yield the internal and external benefit. Additionally, internal and external benefits were multiplied by a factor of 3 to account for uncertainties in the CDF calculation (Entergy 2011). In total, a multiplication factor of 33 was applied to the estimated benefit from internal events to obtain the total estimated benefit for internal and external events with uncertainty, which was used in Entergy's cost-benefit comparisons.

F.6.1.5 Entergy's Results

If the implementation costs for a candidate SAMA exceeded the calculated benefit, the SAMA was determined to be not cost beneficial. If the benefit exceeded the estimated cost, the SAMA candidate was considered to be cost beneficial. In Entergy's original submittal and revised analysis, three SAMA candidates were found to be potentially cost beneficial (Entergy 2011, Section 4.21.6; Entergy 2012c, Table 4.21-2). Results of the cost-benefit evaluation are presented in Table F–5.

The potentially cost-beneficial SAMAs are:

- SAMA No. 39—Change procedure to cross tie open cycle cooling system to enhance containment spray system,
- SAMA No. 42—Enhance procedures to refill condensate storage tank from demineralized water or service water system), and
- SAMA No. 59—Increase operator training for alternating operation of the low-pressure emergency core cooling system pumps (low-pressure coolant

injection and low-pressure core spray) for loss of standby service water scenarios.

Entergy stated that a condition report to implement these potentially cost-beneficial SAMAs has been initiated within the corrective action process.

A sensitivity analysis considered two cases: a discount rate of 7 percent with a 33-year period for remaining plant life and a more conservative discount rate of 3 percent with a 20-year license renewal period (Entergy 2011, Section 4.21.5 and Table E.2-3; Entergy 2012c, 2012d). Based on its sensitivity analysis in the original submittal and revised analysis, Entergy did not identify any additional cost-beneficial SAMAs.

F.6.2 Review of Entergy's Cost-Benefit Evaluation

Based primarily on NUREG/BR–0184 (NRC 1997a) and NEI guidelines on discount rates (NEI 2005), the staff determined the cost-benefit analysis performed by Entergy was consistent with the guidance. Three SAMA candidates were found to be potentially cost beneficial.

The applicant considered possible increases in benefits from analysis uncertainties on the results of the SAMA assessment. In the ER (Entergy 2011), Entergy stated that the 95^{th} percentile value of the GGNS CDF was a factor of 2.38 greater than the mean CDF. A multiplication factor of 3 was conservatively selected by the applicant to account for uncertainty. This multiplication factor was applied in addition to a separate multiplication factor of 11 for CDF increases due to external events. Entergy's assessment accounted for the potential risk-reduction benefits associated with both internal and external events. The staff considers the multipliers of 3 for uncertainty and 11 for external events provide adequate margin and are acceptable for the SAMA analysis.

At the staff's request, Entergy provided further information on the uncertainty analysis that indicated the 95^{th} percentile CDF was 7.14×10^{-6}/yr for a cutset truncation of 1×10^{-11}/yr. The point estimate and mean values for CDF were 2.82×10^{-6}/yr and 3.00×10^{-6}/yr (Entergy 2012a). The ratio of the 95^{th} percentile to the point estimate, which should be used in determining the uncertainty multiplier, is therefore 2.53 versus the 2.38 discussed above. Because a multiplier of 3 was conservatively used in the assessment, the results of the SAMA assessment are not affected by this correction.

Sensitivity to the discount rate and time period for remaining plant life was analyzed by the applicant. Compared to Entergy's baseline benefits in the original submittal (Entergy 2011, Table E.2-3), benefit increases for individual SAMAs ranged from 20 to 59 percent and from 20 to 40 percent for the first and second sensitivity cases, respectively. Additional sensitivity analyses were performed on MACCS2 input parameters for an increased evacuation time delay and for a slower evacuation speed. The applicant indicated consequence deviations of less than 1 percent to the sensitivity case results for the MACCS2 parameters (Entergy 2011). The staff requested additional information related to costs for a few SAMAs within $10,000 of estimated benefits in the sensitivity analysis. Entergy provided additional information that the margin between the cost benefit and actual implementation cost would be greater than $10,000 (Entergy 2012a, 2012c). For SAMA No. 13 on a procedure change to inhibit high-voltage circuit shutdown for battery charging, Entergy explained that the cost-benefit ratio in the SAMA analysis is an overestimate because other failure mechanisms, not precluded by the procedure change, were included into the benefit calculation. The implementation cost selected by Entergy was the minimum value from the typical range for procedure changes with engineering or training required. For SAMA Nos. 14 and 63 (provide portable EDG fuel oil transfer pump and adding a redundant path for reactor core isolation cooling lube oil cooling), Entergy provided refined, plant-specific cost estimates of $1,477,000 and $1,803,000, respectively, for these modifications that involve piping changes to safety-related systems. Based on this additional information, additional cost-beneficial SAMAs were not identified.

Sensitivity analysis results were recast in the SAMA reanalysis (Entergy 2012c). In response to an NRC clarification question on the unexpected large increase in the sensitivity to the discount rate shown in the revised results, Entergy described that the sensitivity calculation for the lower discount rate of 3 percent inadvertently included the cumulative effect of both the longer time period of remaining plant life of 33 years and the lower discount rate (Entergy 2012d). Without the additional effect from a longer time period, increases in the benefit solely due to a lower discount rate would be smaller than those results reported in Entergy (2012c). Individual (as well as cumulative) increases in the estimated benefits from the sensitivity parameters were smaller than the factor of 3 applied by the applicant to account for uncertainty. In the revised analysis, neither individual nor cumulative sensitivity effects resulted in benefit estimates for individual SAMAs that exceeded GGNS implementation costs beyond the three SAMAs previously identified by Entergy to be potentially cost beneficial.

The staff asked the applicant to evaluate potentially lower cost alternatives to several candidates SAMAs, as summarized below:

- Revising procedures for operators to manually initiate EDG HVAC if the existing automatic logic fails or procedures for the plant auxiliary operators to check on any automatic start of the EDG that could allow HVAC failures to be discovered and might eliminate the need for alarms.
- Providing directions to use jumpers to bypass the low reactor pressure interlock instead of installing a bypass switch to allow operators to bypass interlock circuitry.
- Using other air compressors (service air) that might be connected to the instrument air system instead of providing new compressors.
- Improving control room fire-detection system response for a limited number of key cabinets.

Concerning the first alternative, Entergy agreed that a procedure revision to direct that the operator monitoring a running diesel ensure the ventilation system is running, or take action to open doors or use portable fans, would be potentially cost beneficial. Entergy stated that a condition report to implement this potentially cost-beneficial SAMA has been initiated within the corrective action process (Entergy 2012a).

Concerning the second alternative, Entergy concluded that because of system design and the number of failures that would initiate the need for this action, the likelihood of performing this action successfully would be low and the benefit small. Thus, this alternative was not considered cost beneficial (Entergy 2012a).

Concerning the third alternative, Entergy stated that a modification to connect service air with instrument air has already been implemented (Entergy 2012a).

Concerning the fourth alternative, Entergy stated that the control room is already protected by smoke detectors in the underfloor area and in every cabinet except P680 (i.e., the console at which the operator sits). Since the control room is continuously occupied and, thus, provides the capability of prompt detection and suppression, the use of “very early warning” or “incipient” detection is not expected to provide a significant improvement and would not be cost beneficial (Entergy 2012a).

The staff agrees with the Entergy disposition of the above lower-cost alternatives.

F.7 Conclusions

Entergy considered 249 candidate SAMAs based on risk-significant contributors at GGNS from updated probabilistic safety assessment models, its review of SAMA analyses from other BWR plants, NRC and industry documentation of potential plant improvements, and GGNS individual plant examination of internal and external events including available updates. Phase I screening reduced the list to 63 unique SAMA candidates by eliminating SAMAs that were not applicable to GGNS, had already been implemented at GGNS, or were combined into a more comprehensive or plant-specific SAMA.

For the remaining SAMA candidates, Entergy performed a cost-benefit analysis with results shown in Table F–5. The cost-benefit analysis identified three potentially cost-beneficial SAMAs (Phase II SAMA Nos. 39, 42, and 59). Sensitivity cases were analyzed for the present value discount rate and time period for remaining plant life. No additional SAMAs were identified as potentially cost beneficial from the sensitivity analysis. In response to a staff RAI concerning potential low-cost alternatives, Entergy determined that a procedure revision to direct that the operator monitoring a running diesel ensure the ventilation system is running, or take action to open doors, or use portable fans would be potentially cost beneficial.

The staff reviewed the Entergy SAMA analysis and concludes that, subject to the discussion in this appendix, the methods used and implementation of the methods were sound. On the basis of the applicant's treatment of SAMA benefits and costs, the staff finds that the SAMA evaluations performed by Entergy are reasonable and sufficient for the license renewal submittal.

The staff agrees with Entergy's conclusion that the four candidate SAMAs discussed in this section are potentially cost beneficial, which was based on generally conservative treatment of costs, benefits, and uncertainties. This conclusion of a small number of potentially cost-beneficial SAMAs is consistent with the low residual level of risk indicated in the GGNS PRA and the fact that Entergy has already implemented the plant improvements identified from the IPE and IPEEE. Because the potentially cost-beneficial SAMAs do not relate to aging management during the period of extended operation, they do not need to be implemented as part of license renewal in accordance with Title 10 of the *Code of Federal Regulations*, Part 54. Nevertheless, Entergy issued a condition report under the corrective action process to consider implementation of these potentially cost-beneficial SAMAs. The staff accepts this course of action.

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NRC FORM 335 (12-2010) NRCMD 3.7

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

1. REPORT NUMBER (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.)
NUREG-1437, Supplement 50
DRAFT

2. TITLE AND SUBTITLE
Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS)
Supplement 50
Regarding Grand Gulf Nuclear Station, Unit 1
Draft Report

3. DATE REPORT PUBLISHED

MONTH	YEAR
November	2013

4. FIN OR GRANT NUMBER

5. AUTHOR(S)
See Chapter 10 of the report

6. TYPE OF REPORT
Technical

7. PERIOD COVERED (Inclusive Dates)

8. PERFORMING ORGANIZATION - NAME AND ADDRESS (If NRC, provide Division, Office or Region, U. S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)
Division of License Renewal
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

9. SPONSORING ORGANIZATION - NAME AND ADDRESS (If NRC, type "Same as above", if contractor, provide NRC Division, Office or Region, U. S. Nuclear Regulatory Commission, and mailing address.)
same as (8) above

10. SUPPLEMENTARY NOTES
Docket Number 50-416

11. ABSTRACT (200 words or less)
This supplemental environmental impact statement has been prepared in response to an application by Entergy Operations, Inc. (Entergy) to renew the operating licenses for Grand Gulf Nuclear Station, Unit 1 (GGNS), for an additional 20 years. This supplemental environmental impact statement (SEIS) includes the preliminary analysis that evaluates the environmental impacts of the proposed action and alternatives to the proposed action. Alternatives considered include: new nuclear generation, natural gas-fired combined-cycle generation, supercritical coal-fired generation, combination alternative, and not renewing the license (the no-action alternative).

The U. S. Nuclear Regulatory Commission's (NRC's) preliminary recommendation is that the adverse environmental impacts of license renewal for GGNS are not great enough to deny the option of license renewal for energy planning decisionmakers. This recommendation is based on the following:

-the analysis and finding in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants;;"

-the environmental report submitted by GGNS;

-consultation with Federal, State, local, and Tribal government agencies;

-the NRC's environmental review; and

-consideration of public comments received during the scoping process.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)
Grand Gulf Nuclear Station, GGNS, Entergy Operations, Inc., Entergy, Supplement to the Generic Environmental Impact Statement; License Renewal; DSEIS; GEIS; National Environmental Policy Act; NEPA

13. AVAILABILITY STATEMENT
unlimited

14. SECURITY CLASSIFICATION
(This Page) unclassified
(This Report) unclassified

15. NUMBER OF PAGES

16. PRICE

Printed on recycled paper

Federal Recycling Program

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555-0001

OFFICIAL BUSINESS

NUREG-1437
Supplement 50
Draft

Generic Environmental Impact Statement for License Renewal of Nuclear Plants
Regarding Grand Gulf Nuclear Station, Unit 1

November 2013