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NUREG-2111, Vol. 1

Final Environmental Impact Statement for Combined Licenses (COLs) for William States Lee III Nuclear Station Units 1 and 2

U.S. Nuclear Regulatory Commission
Office of New Reactors
Washington, DC 20555-0001

Regulatory Division
Special Projects Branch
Charleston District
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Charleston, SC 29403-5107

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Abstract

This environmental impact statement (EIS) has been prepared in response to an application submitted to the U.S. Nuclear Regulatory Commission (NRC) by Duke Energy Carolinas, LLC (Duke) for two combined construction permits and operating licenses (combined licenses or COLs). The proposed actions requested in Duke's application are (1) NRC issuance of COLs for two nuclear power reactors at the William States Lee III Nuclear Station (Lee Nuclear Station) site in Cherokee County, South Carolina, and (2) U.S. Army Corps of Engineers (USACE) permit action on a Department of the Army individual permit application to perform certain construction activities on the site. The USACE is participating with the NRC in preparing this EIS as a cooperating agency and participates collaboratively on the review team.

This EIS includes the review team's analysis that considers and weighs the environmental impacts of building and operating two new nuclear units at the proposed Lee Nuclear Station site and at alternative sites, and mitigation measures available for reducing or avoiding adverse impacts. The EIS also addresses Federally listed species, cultural resources, and plant cooling-system design alternatives.

The EIS includes the evaluation of the proposed project's impacts on waters of the United States pursuant to Section 404 of the Clean Water Act. The USACE will conduct a public interest review in accordance with the guidelines promulgated by the U.S. Environmental Protection Agency under authority of Section 404(b) of the Clean Water Act. The public interest review, which will be addressed in the USACE's permit decision document, will include an alternatives analysis to determine the least environmentally damaging practicable alternative.

After considering the environmental aspects of the proposed NRC action, the NRC staff's recommendation to the Commission is that the COLs be issued as requested.[a] This recommendation is based on (1) the application, including Revision 1 of the environmental report (ER) and the supplement to the ER, submitted by Duke; (2) consultation with Federal, State, Tribal, and local agencies; (3) the staff's independent review; (4) the staff's consideration of comments related to the environmental review that were received during the two public scoping processes and the draft EIS comment period; and (5) the assessments summarized in this EIS, including the potential mitigation measures identified in the ER and this EIS. The USACE will issue its Record of Decision based, in part, on this EIS.

(a) As directed by the Commission in CLI-12-16, the NRC will not issue the COLs prior to completion of the ongoing rulemaking to update the Waste Confidence Decision and Rule (see Section 6.1.6 of this EIS).

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Executive Summary

This environmental impact statement (EIS) presents the results of an U.S. Nuclear Regulatory Commission (NRC) environmental review of an application for combined construction permits and operating licenses (combined licenses or COLs) for two new nuclear reactor units at a proposed site in Cherokee County, South Carolina. The U.S. Army Corps of Engineers (USACE) participated in the preparation of the EIS as a cooperating agency and as a member of the review team, which consisted of the NRC staff, its contractor staff, and the USACE staff.

Background

On December 12, 2007, Duke Energy Carolinas, LLC (Duke), submitted an application to the NRC for COLs for William States Lee III Nuclear Station (Lee Nuclear Station) Units 1 and 2 in Cherokee County, South Carolina. The application was revised (Revision 1) by a letter dated March 30, 2009, and a supplement to the environmental report (ER) was submitted on September 24, 2009, describing Duke's plans to construct and operate an additional offsite reservoir (known as Make-Up Pond C) as a source of supplemental cooling water for the proposed station.

Upon docketing of Duke's initial application, the NRC review team began the environmental review process as described in 10 CFR Part 51 by publishing in the *Federal Register* on March 20, 2008, a Notice of Intent to prepare an EIS and conduct scoping. With the submittal of the September 2009 supplement to the ER, a second Notice of Intent to conduct a supplemental scoping process was published in the *Federal Register* on May 24, 2010. As part of the environmental review, the review team:

- considered comments received during the 60-day scoping process beginning March 20, 2008, and conducted related public scoping meetings on May 1, 2008 in Gaffney, South Carolina.
- considered comments received during a supplemental scoping period specific to Make-Up Pond C from May 24, 2010 through July 2, 2010, and conducted a related public scoping meeting on June 17, 2010, also in Gaffney, South Carolina.
- conducted site audits from April 28, 2008 through May 2, 2008 and from August 9, 2010 through August 13, 2010.
- conducted public meetings on the draft EIS on January 19, 2011 in Gaffney, South Carolina. The review team also considered comments received during the 75-day comment period for the draft EIS beginning on December 12, 2011.

- reviewed Duke's ER and Supplemental ER and developed requests for additional information (RAIs) using guidance from NUREG-1555, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants."
- consulted with American Indian Tribes and Federal and State agencies such as U.S. Fish and Wildlife Service, Advisory Council on Historic Preservation, National Marine Fisheries Service, Federal Energy Regulatory Commission, South Carolina Department of Natural Resources, South Carolina Department of Health and Environmental Control, and South Carolina Archives and History Center.

Proposed Action

The proposed actions related to the Lee Nuclear Station Units 1 and 2 application are (1) NRC issuance of COLs for construction and operation of two new nuclear plants at the Lee Nuclear Station site and (2) USACE issuance of a permit pursuant to Section 404 of the Federal Water Pollution Control Act (Clean Water Act) as amended to perform certain construction activities on the site.

Purpose and Need for Action

The purpose of the proposed action—issuance of the COLs—is to construct and operate two new nuclear units to provide for additional baseload electric generating capacity in 2024 and 2026 within Duke's service territories. The objective of Duke's requested USACE action is to obtain a Department of the Army individual permit to perform regulated dredge-and-fill activities that would affect wetlands and other waters of the United States.

Public Involvement

A 60-day scoping period was held from March 20, 2008 through May 20, 2008. A supplemental scoping period specific to Make-Up Pond C was held from May 24, 2010 through July 2, 2010. On June 17, 2010, the NRC held supplemental public scoping meetings in Gaffney, South Carolina. The review team received many oral comments during the public meetings and a total of 35 e-mails and 14 letters from both scoping periods on topics such as surface-water hydrology, ecology, socioeconomics, uranium fuel cycle, energy alternatives, and benefit-cost balance.

Additionally, on January 19, 2012, during the 75-day comment period on the draft EIS, the review team held public meetings in Gaffney, South Carolina. Approximately 250 people attended the public meetings and many provided oral comments.

Affected Environment

As proposed, the Lee Nuclear Station would be constructed in Cherokee County, South Carolina, on the same site as the former Duke Power Company Cherokee Nuclear Station. The site is 8 mi southeast of Gaffney, South Carolina and 25 mi northeast of Spartanburg, South Carolina. The area around the site is shown in Figure ES-1.

Cooling water for the units would be obtained from the Broad River. Makeup water from the Broad River would be provided to the plant via Make-Up Pond A. During periods of low flow when withdrawals from the Broad River are limited, makeup water would be provided from Make-Up Ponds B and C to Make-Up Pond A. Make-Up Ponds A and B already exist on the Lee Nuclear Station site. Make-Up Pond C would be built on the London Creek watershed to the northeast of the site. Construction of Make-Up Pond C would disturb approximately 1100 ac with permanent or temporary loss and alteration from flooding and clearing.

The Lee Nuclear Station would use mechanical draft cooling towers to transfer waste heat to the atmosphere. A portion of the water obtained from the Broad River would be returned to the environment via a discharge structure located in the Broad River on the upstream side of Ninety-Nine Islands Dam. The remaining portion of the water would be released to the atmosphere via evaporative cooling.

Evaluation of Environmental Impacts

When evaluating the environmental impacts associated with nuclear power plant construction and operations, the NRC's authority is limited to construction activities related to radiological health and safety or common defense and security; that is, NRC-authorized activities are related to safety-related structures, systems, or components, and may include pile driving; subsurface preparation; placement of backfill, concrete, or permanent retaining walls within an excavation; installation of foundations; or in-place assembly, erection, fabrication, or testing. In this EIS, the NRC review team evaluates the potential environmental impacts of the construction and operation of two new nuclear units for the following resource areas:

- land use
- air quality
- aquatic ecology
- terrestrial ecology
- surface and groundwater
- waste (radiological and nonradiological)
- human health (radiological and nonradiological)
- socioeconomics
- environmental justice
- cultural resources

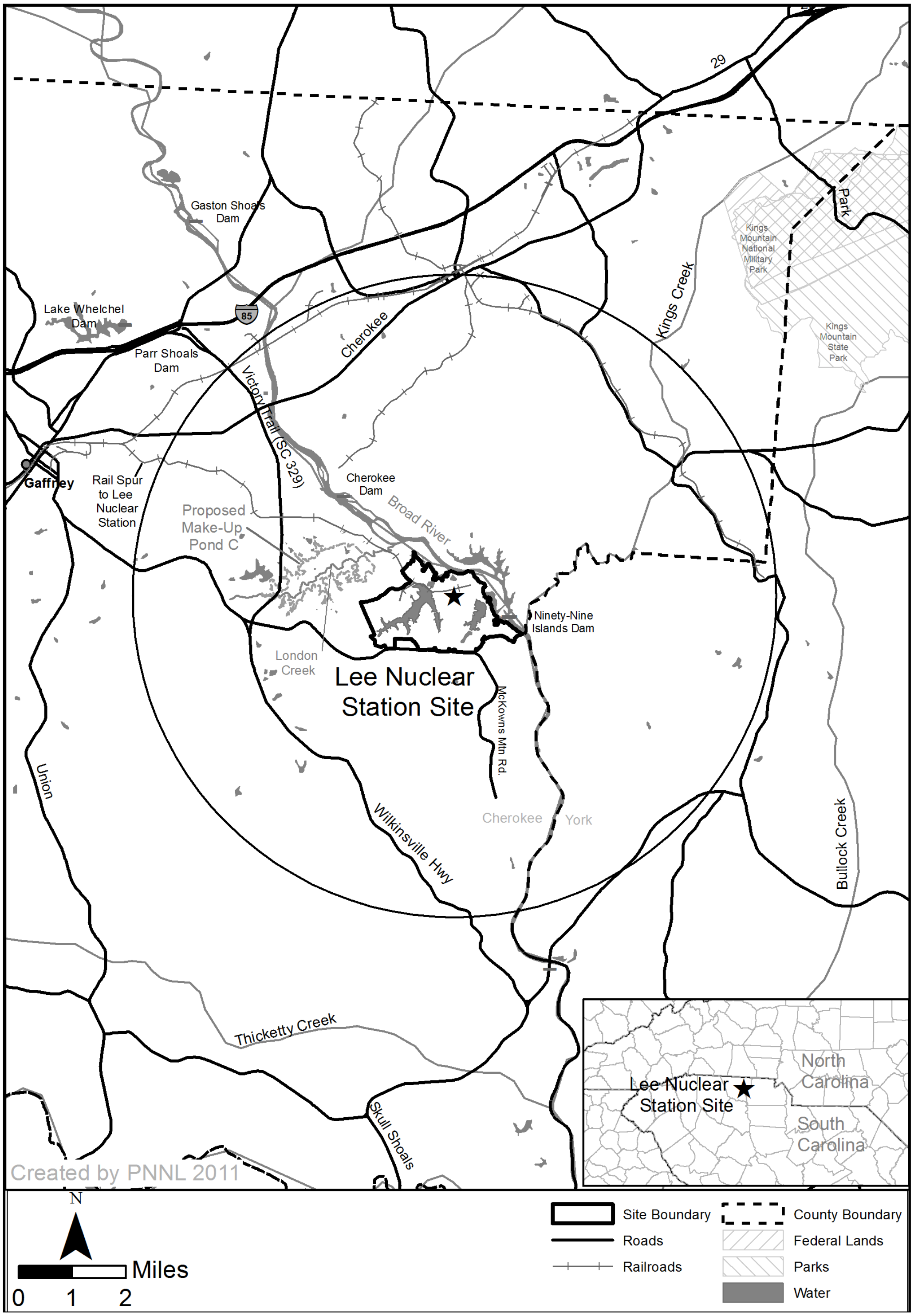

Figure ES-1. Lee Nuclear Station Site

It also evaluates impacts associated with accidents, the fuel cycle, decommissioning, and transportation of radioactive materials.

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

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

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

The impacts are designated as SMALL, MODERATE, or LARGE. The incremental impacts related to the construction and operations activities requiring NRC authorization are described and characterized, as are the cumulative impacts resulting from the proposed action when the effects are added to, or interact with, other past, present, and reasonably foreseeable future effects on the same resources.

The review team found that the cumulative environmental impacts on most aspects of water use and quality, most socioeconomic areas (adverse only), environmental justice, nonradiological and radiological health, severe accidents, fuel cycle, decommissioning, and transportation would be SMALL. The cumulative impacts for physical impacts and infrastructure and community services would be SMALL to MODERATE.

The review team found that the cumulative environmental impacts on land use, surface-water use, terrestrial and wetland ecosystems, aquatic ecosystems, air quality, and historic and cultural resources would be MODERATE. The impacts from NRC-authorized activities would be SMALL for all of the above-listed resource areas. The incremental impacts associated with the development of transmission lines and Make-Up Pond C would be the principal contributors to the MODERATE cumulative land-use impacts. Potential future water-supply issues in the Broad River Basin would be the primary driver for the MODERATE impact for surface-water use. Cumulative terrestrial and wetland ecosystem impacts would be MODERATE because of the loss of habitat from development of transmission-line corridors. The development of Make-Up Pond C would have cumulative aquatic ecosystem impacts on London Creek and its tributaries. The MODERATE cumulative impact on air quality would result from the existing concentration of greenhouse gases in the atmosphere. The review team found cumulative impacts from Make-Up Pond C development and transmission-line corridor development would contribute to the MODERATE impact for historic and cultural resources.

The review team found no LARGE, adverse cumulative impacts.

Table ES-1 provides a summary of the cumulative impacts for the proposed site.

Table ES-1. Cumulative Impacts on Environmental Resources, Including the Impacts of Proposed Lee Nuclear Station

Resource Category	Impact Level
Land use	MODERATE
Water-related	
Surface-water use	MODERATE
Groundwater use	SMALL
Surface-water quality	SMALL
Groundwater quality	SMALL
Ecology	
Terrestrial ecosystems	MODERATE
Aquatic ecosystems	MODERATE
Socioeconomic	
Physical impacts	SMALL to MODERATE
Demography	SMALL
Economic impacts on the community	SMALL to LARGE (beneficial)
Infrastructure and community services	SMALL to MODERATE
Aesthetics and recreation	SMALL
Environmental justice	SMALL
Historic and cultural resources	MODERATE
Air quality	MODERATE
Nonradiological health	SMALL
Radiological health	SMALL
Severe accidents	SMALL
Fuel cycle, transportation, and decommissioning	SMALL

Alternatives

The review team considered the environmental impacts associated with alternatives to issuing COLs for Lee Nuclear Station. These alternatives included a no-action alternative (i.e., not issuing the COLs), and alternative energy sources, siting locations, or system designs.

The **no-action alternative** would result in the COLs not being granted or the USACE not issuing its permit. Upon such a denial, construction and operation of the two units at the Lee Nuclear Station site would not occur and the predicted environmental impacts would not take place. If no other facility would be built or strategy implemented to take its place, the benefits of the additional electrical capacity and electricity generation to be provided would also not occur and the need for baseload power would not be met.

Based on the review team's review of **energy alternatives**, the review team concluded that, from an environmental perspective, none of the viable alternatives is clearly environmentally preferable to building a new baseload nuclear power generation plant at the Lee Nuclear Station site. The review team eliminated several energy sources (i.e., wind, solar, and biomass) from full consideration because they are not currently capable of meeting the need of this project. None of the viable baseload alternatives (natural gas, coal, or a combination of alternatives) was environmentally preferable to the proposed nuclear units.

After comparing the cumulative effects of the proposed site against those of the **alternative sites**, the review team concluded that none of the alternative sites would be environmentally preferable to the proposed site for building and operating a new nuclear power plant. The three alternatives sites selected were the following:

- Perkins site (previously considered for the Perkins Nuclear Station), Davie County, North Carolina (Figure ES-2),
- Keowee site (adjacent to Oconee Nuclear Station), Oconee County, South Carolina (Figure ES-3),
- Middleton Shoals site, Anderson County, South Carolina (Figure ES-4).

Table ES-2 provides a summary of the cumulative impacts for the alternative sites. The review team concluded that all of the sites were generally comparable, and it would be difficult to state that one site is preferable to another from an environmental perspective. In such a case, the proposed site prevails because none of the alternatives is clearly environmentally preferable.

The review team considered various **alternative systems designs**, including seven alternative heat-dissipation systems and multiple alternative intake, discharge, and water-supply systems. The review team identified no alternatives that were environmentally preferable to the proposed Lee Nuclear Station plant systems design.

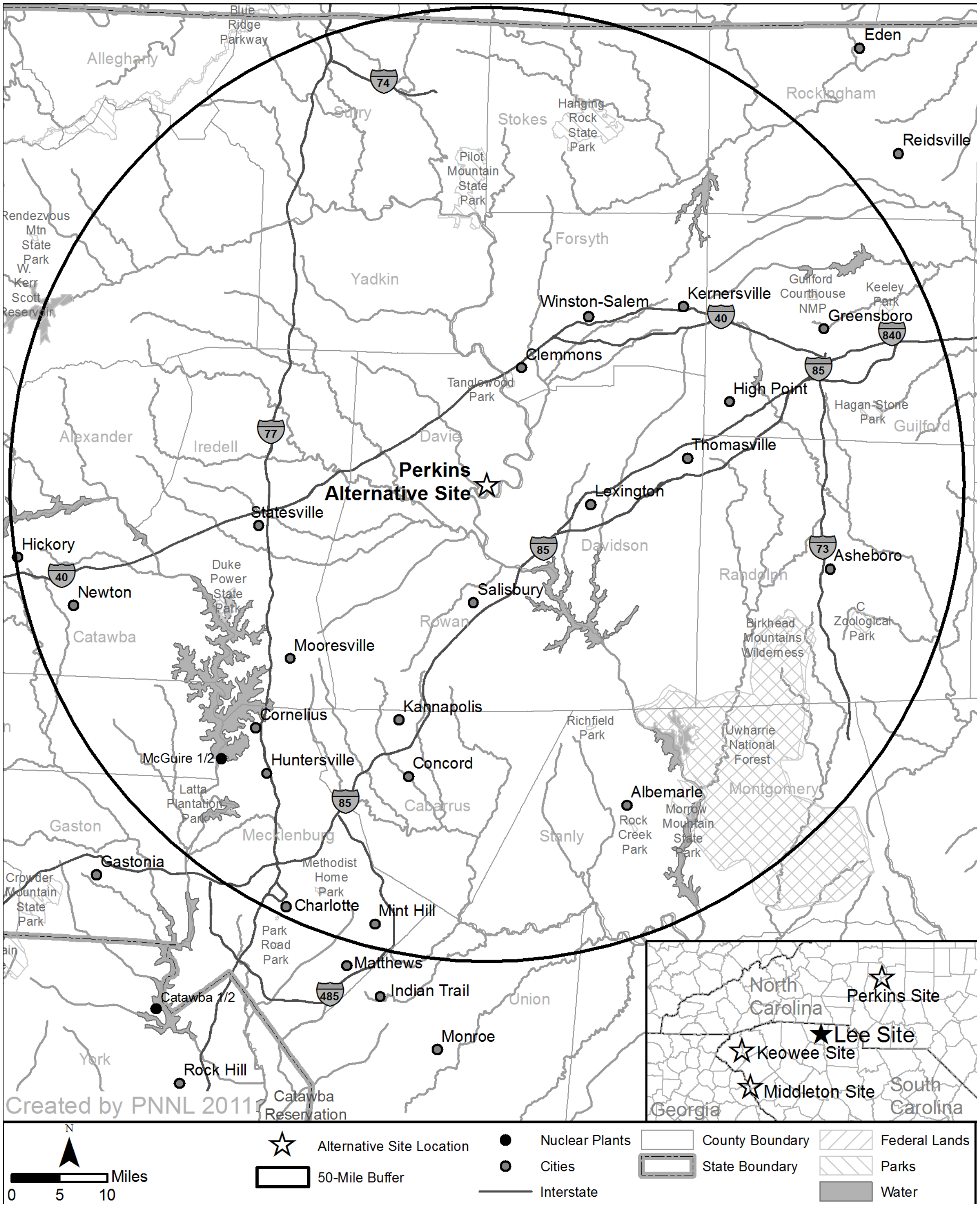

Figure ES-2. Perkins Site

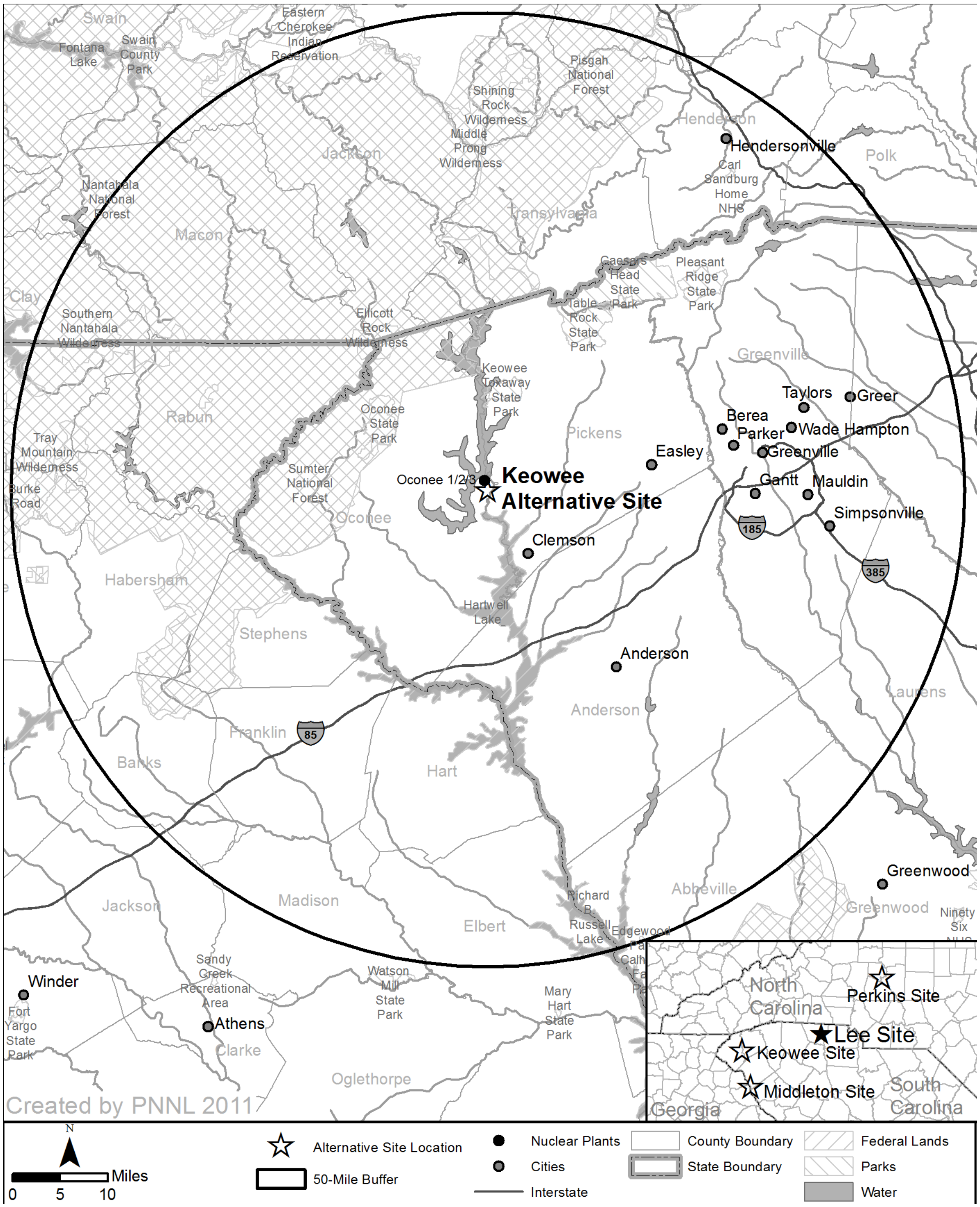

Figure ES-3. Keowee Site

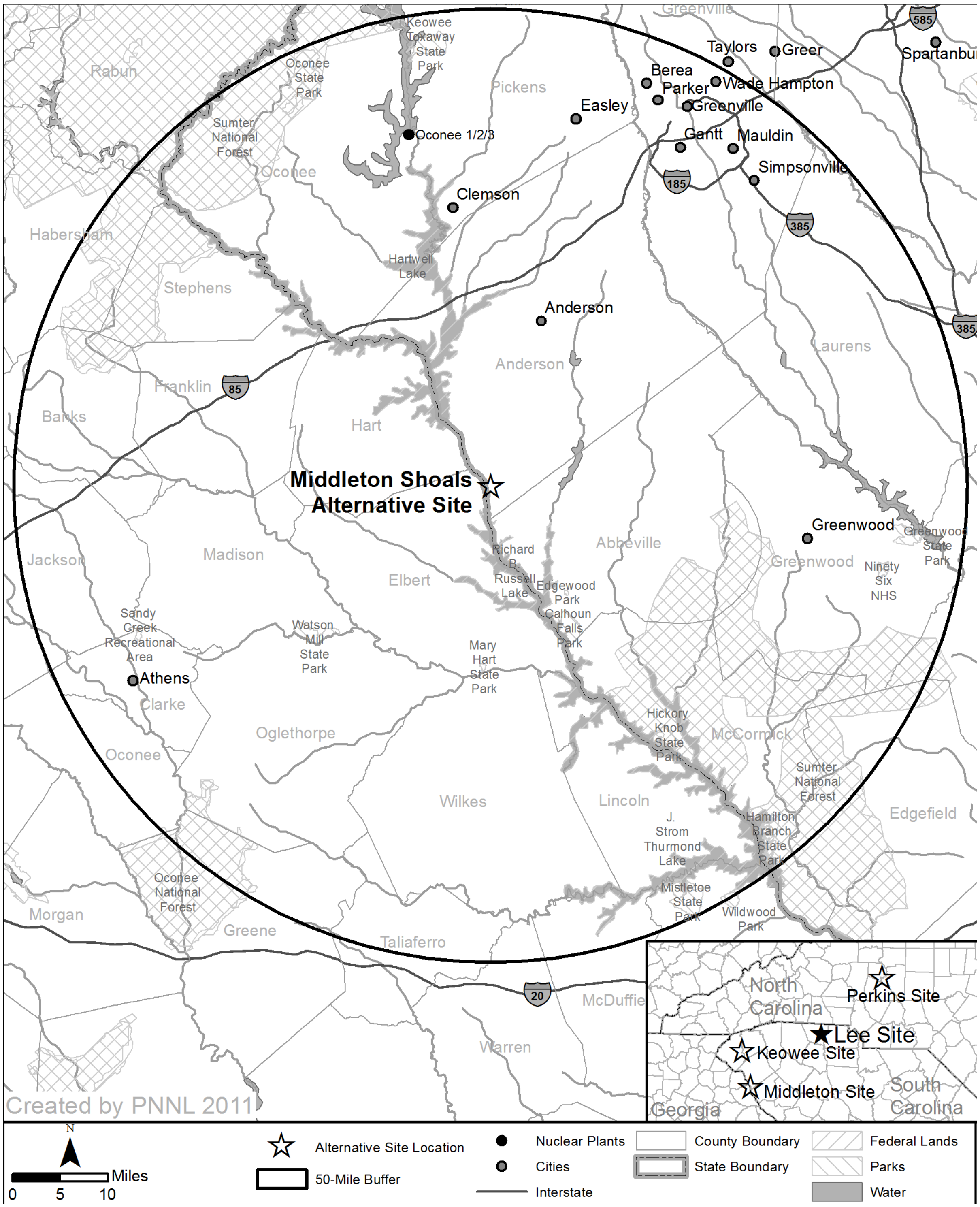

Figure ES-4. Middleton Shoals Site

Benefits and Costs

The review team compiled and compared the pertinent analytical conclusions reached in the EIS. It gathered all of the expected impacts from building and operating the proposed Lee Nuclear Station and aggregated them into two final categories: (1) the expected environmental costs and (2) the expected benefits to be derived from approval of the proposed action. Although the analysis in Section 10.6 is conceptually similar to a purely economic benefit-cost analysis, which determines the net present dollar value of a given project, the intent of the section is to identify potential societal benefits of the proposed activities and compare them to the potential internal (i.e., private) and external (i.e., societal) costs of the proposed activities. In general, the purpose is to inform the COL process by gathering and reviewing information that demonstrates the likelihood that the benefits of the proposed activities outweigh the aggregate costs.

On the basis of the assessments in this EIS, the building and operation of the proposed Lee Nuclear Station, with mitigation measures identified by the review team, would accrue benefits that most likely would outweigh the economic, environmental, and social costs. For the NRC-proposed action (i.e., NRC-authorized construction and operation), the accrued benefits would also outweigh the costs of preconstruction, construction, and operation of the proposed Lee Nuclear Station.

Recommendation

The NRC's recommendation to the Commission related to the environmental aspects of the proposed action is that the COLs should be issued as proposed.

This recommendation is based on the following:

- the application, including the ER and its revisions, submitted by Duke
- consultation with Federal, State, Tribal, and local agencies
- consideration of public comments received during scoping and on the draft EIS
- the review team's independent review and assessment detailed in this EIS.

In making its recommendation, the review team determined that none of the alternative sites is environmentally preferable (and, therefore, also not obviously superior) to the Lee Nuclear Station site. The review team also determined that none of the energy or cooling-system alternatives assessed is environmentally preferable to the proposed action.

The NRC's determination is independent of the USACE's determination of whether the Lee Nuclear Station site is the least environmentally damaging practicable alternative pursuant to Clean Water Act Section 404(b) (1) Guidelines. The USACE will conclude its analysis of both offsite and onsite alternatives in its Record of Decision.

Table ES-2 provides a summary of the EIS-derived cumulative impacts for the proposed site in comparison with the no-action alternative, alternative sites, and energy alternatives.

Table ES-2. Comparison of Environmental Impacts

Resource Areas	Proposed Site[a]	Alternative Sites[b]			Energy Alternatives[c]		
	Lee	Perkins	Keowee	Middleton Shoals	Coal	Natural Gas	Combination
Land Use	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE	SMALL to MODERATE	SMALL to MODERATE
Surface Water	MODERATE	MODERATE	MODERATE	MODERATE	SMALL	SMALL	SMALL
Groundwater	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Aquatic Ecosystems	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
Terrestrial Ecosystems	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
Air Quality	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	MODERATE	SMALL to MODERATE	SMALL to MODERATE
Socioeconomics	MODERATE (adverse) to LARGE (beneficial)	MODERATE (adverse) to LARGE (beneficial)	MODERATE (adverse) to LARGE (beneficial)	MODERATE (adverse) to LARGE (beneficial)	MODERATE (adverse) to LARGE (beneficial)	MODERATE (adverse) to MODERATE (beneficial)	MODERATE (adverse) to MODERATE (beneficial)
Environmental Justice	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Cultural Resources	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
Human Health	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Waste Management	SMALL	SMALL	SMALL	SMALL	MODERATE	SMALL	SMALL

(a) Cumulative impact determinations taken from Table 7-4 in the EIS.
(b) Cumulative impact determinations taken from Table 9-18 in the EIS.
(c) Impacts taken from Table 9-4 in the EIS. These conclusions for energy alternatives should be compared to NRC-authorized activities reflected in Chapters 4, 5, 6.1, and 6.2.

Abbreviations/Acronyms

7Q10	lowest flow for 7 consecutive days expected to occur once per decade
AADT	annual average daily traffic
ac	acre(s)
ac-ft	acre feet
ACS	American Community Survey
AD	Anno Domini
ADAMS	Agencywide Documents Access and Management System
ALARA	as low as reasonably achievable
AP1000	Advanced Passive 1000 pressurized water reactor
APE	Area of Potential Effect
AQCR	Air Quality Control Region
ARRA	American Recovery and Reinvestment Act of 2009
BACT	Best Available Control Technologies
BC	before Christ
BEA	Bureau of Economic Analysis
BEIR	Biological Effects of Ionizing Radiation
BGEPA	Bald and Golden Eagle Protection Act
BLS	Bureau of Labor Statistics
BMP	best management practice
BOD	biochemical oxygen demand
Bq	becquerel(s)
Btu	British thermal unit(s)
°C	degree(s) Celsius
CAES	compressed air-energy storage
CAIR	Clean Air Interstate Rule
CDC	U.S. Centers for Disease Control and Prevention
CDF	core damage frequency
CESQG	conditionally exempt small quantity generator
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic foot/feet per second
Ci	curie(s)
cm	centimeter(s)
CMC	criterion maximum concentration
CO	carbon monoxide
CO_2	carbon dioxide

COL	combined construction permit and operating license
CORMIX	Cornell Mixing Zone Expert System
CPCN	Certificate of Environmental Compatibility and Public Convenience and Necessity
CSAPR	Cross-State Air Pollution Rule
CWA	Clean Water Act (aka Federal Water Pollution Control Act)
CWS	circulating-water system
d	day(s)
DA	Department of the Army
dB	decibel(s)
dBA	decibel(s) on the A-weighted scale
DBA	design basis accident
DBH	diameter breast high
DCD	Design Control Document
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
D/Q	deposition factor(s); annual normalized total surface concentration rate(s)
DSM	demand-side management
DTA	Devine Tarbell & Associates
Duke	Duke Energy Carolinas, LLC
Duke Energy	Duke Energy Corporation
EAB	exclusion area boundary
EE	energy efficiency
EECBG	Energy Efficiency and Conservation Block Grant
EIA	Energy Information Administration
EIS	environmental impact statement
ELF	extremely low frequency
EMF	electromagnetic field
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
EPT	Ephemeroptera-Plecoptera-Trichoptera (Index)
ER	environmental report
ESP	Early Site Permit
ESRP	Environmental Standard Review Plan
°F	degree(s) Fahrenheit
FAA	Federal Aviation Administration
FES	Final Environmental Statement
FEIS	Final Environmental Impact Statement

FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FP&S	Facilities Planning & Siting
fps	foot (feet) per second
FR	*Federal Register*
FSAR	Final Safety Analysis Report
FSER	Final Safety Evaluation Report
ft	foot/feet
ft^2	square foot/feet
ft^3	cubic foot/feet
FWS	U.S. Fish and Wildlife Service
µg	microgram(s)
g	gram(s)
gal	gallon(s)
GC	gas centrifuge
GCRP	U.S. Global Change Research Program
GD	gaseous diffusion
GDNR	Georgia Department of Natural Resources
GEIS	Generic Environmental Impact Statement
GHG	greenhouse gas
GIS	geographic information system
gpd	gallon(s) per day
gpm	gallon(s) per minute
GWh	gigawatt-hours
HAP	hazardous air pollutant
HDPE	high-density polyethylene
HLW	high-level waste
hr	hour(s)
Hz	hertz
HZI	hydraulic zone of influence
I	U.S. Interstate
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IGCC	integrated gasification combined cycle
in.	inch(es)
INEEL	Idaho National Engineering and Environmental Laboratory
IRP	Integrated Resource Plan
IRWST	in-containment refueling water storage tank

ISFSI	independent spent fuel storage installation
kg	kilogram(s)
km	kilometer(s)
km^2	square kilometer(s)
km/hr	kilometer(s) per hour
kV	kilovolt(s)
kW	kilowatt(s)
kW(e)	kilowatt(s) electric
kWh	kilowatt-hour(s)
L	liter(s)
LEDPA	least environmentally damaging practicable alternative
LFG	landfill-based gas
LLC	Limited Liability Company
LLW	low-level waste
LOS	level of service
LPZ	low-population zone
LWA	Limited Work Authorization
LWR	light water reactor
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
m^3/s	cubic meter(s) per second
MACCS2	Melcor Accident Consequence Code System Version 1.12
mg	milligram(s)
MEI	maximally exposed individual
Mgd	million gallon(s) per day
mGy	milligray(s)
mi	mile(s)
mi^2	square mile(s)
mL	milliliter(s)
mm	millimeter(s)
MMS	U.S. Department of Interior Minerals Management Service
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MOX	mixed oxides
mpg	mile(s) per gallon
mph	mile(s) per hour
mrad	millirad

mrem	millirem
MSDS	material safety data sheets
MSL	mean sea level
mSv	millisievert(s)
MSW	municipal solid waste
MT	metric ton(nes)
MTU	metric ton(nes) uranium
MW	megawatt(s)
MW(e)	megawatt(s) electric
MWh	megawatt-hour(s)
MW(t)	megawatt(s) thermal
MWd	megawatt-day(s)
MWd/MTU	megawatt-days per metric ton of uranium
NA	not applicable
NAAQS	National Ambient Air Quality Standard
NAGPRA	Native American Graves Protection and Repatriation Act
NC	North Carolina
NCDENR	North Carolina Department of Environment and Natural Resources
NCI	National Cancer Institute
NCRP	National Council on Radiation Protection and Measurements
NCUC	North Carolina Utility Commission
NCWRC	North Carolina Wildlife Resources Commission
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act of 1969, as amended
NERC	North American Electric Reliability Corporation
NESC	National Electrical Safety Code
NGCC	natural gas combined cycle
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NSPS	new source performance standard
NSR	new source review

NUREG	U.S. Nuclear Regulatory Commission technical document
NVC	National Vegetation Classification
NWI	National Wetlands Inventory
NWS	National Weather Service
OCS	outer continental shelf
ODCM	Offsite Dose Calculation Manual
OECD	Organization for Economic Cooperation and Development
OSHA	Occupational Safety and Health Administration
pH	measure of acidity or basicity in solution
PIRF	public interest review factor
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter 2.5 microns or less
PNNL	Pacific Northwest National Laboratory
pp.	pages
ppb	part(s) per billion
ppm	part(s) per million
PRA	probabilistic risk assessment
PSCSC	Public Service Commission of South Carolina
PSD	Prevention of Significant Deterioration (Permit)
PUC	public utility commission
PURC	Public Utility Review Committee
PURPA	Public Utility Regulatory Policies Act of 1978
PV	photovoltaic
PWR	pressurized water reactor
PWS	potable water service
rad	radiation absorbed dose
RAI	Request(s) for Additional Information
RCRA	Resource Conservation and Recovery Act of 1976, as amended
REC	renewable energy credit(s)
rem	roentgen equivalent man
REMP	radiological environmental monitoring program
REPS	renewable energy portfolio standard(s)
RFP	request for proposal
RIMS II	Regional Input-Output Modeling System
RM	river mile
ROI	region of interest

ROW	right-of-way
RRS	(SERC's) Reliability Review Subcommittee
RWS	raw water service
Ryr	reactor year
μS/cm	microsievert(s) per centimeter
s or sec	second(s)
SACTI	Seasonal/Annual Cooling Tower Impact (prediction code)
SAMA	severe accident mitigation alternative
SAMDA	severe accident mitigation design alternative
SC	South Carolina
SCBCB	South Carolina Budget and Control Board
SCDAH	South Carolina Department of Archives and History
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources
SCDOT	South Carolina Department of Transportation
SCDSS	South Carolina Department of Social Services
SCE&G	South Carolina Electric and Gas
SCIAA	South Carolina Institute of Archaeology and Anthropology
SCR	selective catalytic reduction
SDS	sanitary drainage system
SER	Safety Evaluation Report
SERC	Southeastern Electric Reliability Council
SHA	seismic hazard analysis
SHPO	State Historic Preservation Office (or Officer)
SMCL	secondary maximum concentration limits
SO_2	sulfur dioxide
SO_x	oxides of sulfur
SPCCP	Spill prevention, control, and countermeasure plan
SRS	Savannah River Site
Sv	sievert(s)
SWPPP	stormwater pollution prevention plan
SWS	service-water system
T	ton(s)
T&E	threatened and endangered
TDS	total dissolved solids
TEDE	total effective dose equivalent
THPO	Tribal Historic Preservation Officer
TRAGIS	Transportation Routing Analysis Geographic Information System

Abbreviations/Acronyms

TSC	technical support center
UF_6	uranium hexafluoride
UMTRI	University of Michigan Transportation Research Institute
UO_2	uranium dioxide
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
US	U.S. (State Highway)
VACAR	Virginia-Carolinas (subregion)
VCSNS	Virgil C. Summer Nuclear Station
VEGP	Vogtle Electric Generating Plant
VOC	volatile organic compound
WCD	waste confidence decision
Westinghouse	Westinghouse Electric Company, LLC
WWS	wastewater service
χ/Q	atmospheric dispersion factor(s); annual average normalized air concentration value(s)
yd	yard(s)
yd^3	cubic yard(s)
yr	year(s)
yr^{-1}	per year

1.0 Introduction

By letter dated December 12, 2007, the U.S. Nuclear Regulatory Commission (NRC or the Commission) received an application from Duke Energy Carolinas, LLC (Duke) for two combined construction permits and operating licenses (combined licenses or COLs) for the proposed William States Lee III Nuclear Station (Lee Nuclear Station) Units 1 and 2 (Duke 2007a). This application was revised (Revision 1) by letter dated March 30, 2009 (Duke 2009a), and a supplement to the environmental report (ER), describing Duke's plans to construct and operate a supplemental cooling-water reservoir (known as Make-Up Pond C), was submitted on September 24, 2009 (Duke 2009b). The NRC staff's review is based on Revision 1 of the ER (Duke 2009c), the supplement to the ER regarding Make-Up Pond C, Duke's responses to the NRC staff's requests for additional information, and supplemental information.

The site proposed by Duke for the two new nuclear units is the Lee Nuclear Station site (Figure 1-1), which is located in the eastern portion of Cherokee County in north-central South Carolina, 40 mi southwest of Charlotte, North Carolina; 25 mi northeast of Spartanburg, South Carolina; and 8 mi southeast of Gaffney, South Carolina. The proposed Lee Nuclear Station would be constructed on the site of the former Duke Power Company Cherokee Nuclear Station, which is owned by Duke (Duke 2009c). In 1978, the NRC granted Duke Power Company permits to construct three 1280-MW(e) pressurized water reactors (PWRs) at the former Cherokee Nuclear Station site. In 1982 and 1983, Duke Power Company canceled the construction of those reactors (NRC 2012a). All of the construction and operation related to proposed Lee Nuclear Station Units 1 and 2 would be completely within the confines of the Lee Nuclear Station site, with four exceptions. Six road-improvement areas and a portion of the railroad spur are offsite. Transmission systems, which will be needed to route power from the proposed Lee Nuclear Station, will not be entirely located onsite (Duke 2009c). In addition, the offsite reservoir (Make-Up Pond C), which is proposed to ensure that the existing limits for downstream flow from Ninety-Nine Islands Reservoir are met (Duke 2009b), is not located on the Lee Nuclear Station site (Duke 2009c).

In November 2011, Duke submitted an application to the U.S. Army Corps of Engineers (USACE) for a Department of the Army individual permit to conduct construction activities that would result in alteration of waters of the United States, including wetlands (Duke 2011h). There are no navigable waters as defined in Section 10 of the Rivers and Harbors Appropriation Act of 1899 (33 U.S.C. 403) in the area that would be affected by the proposed Lee Nuclear Station.

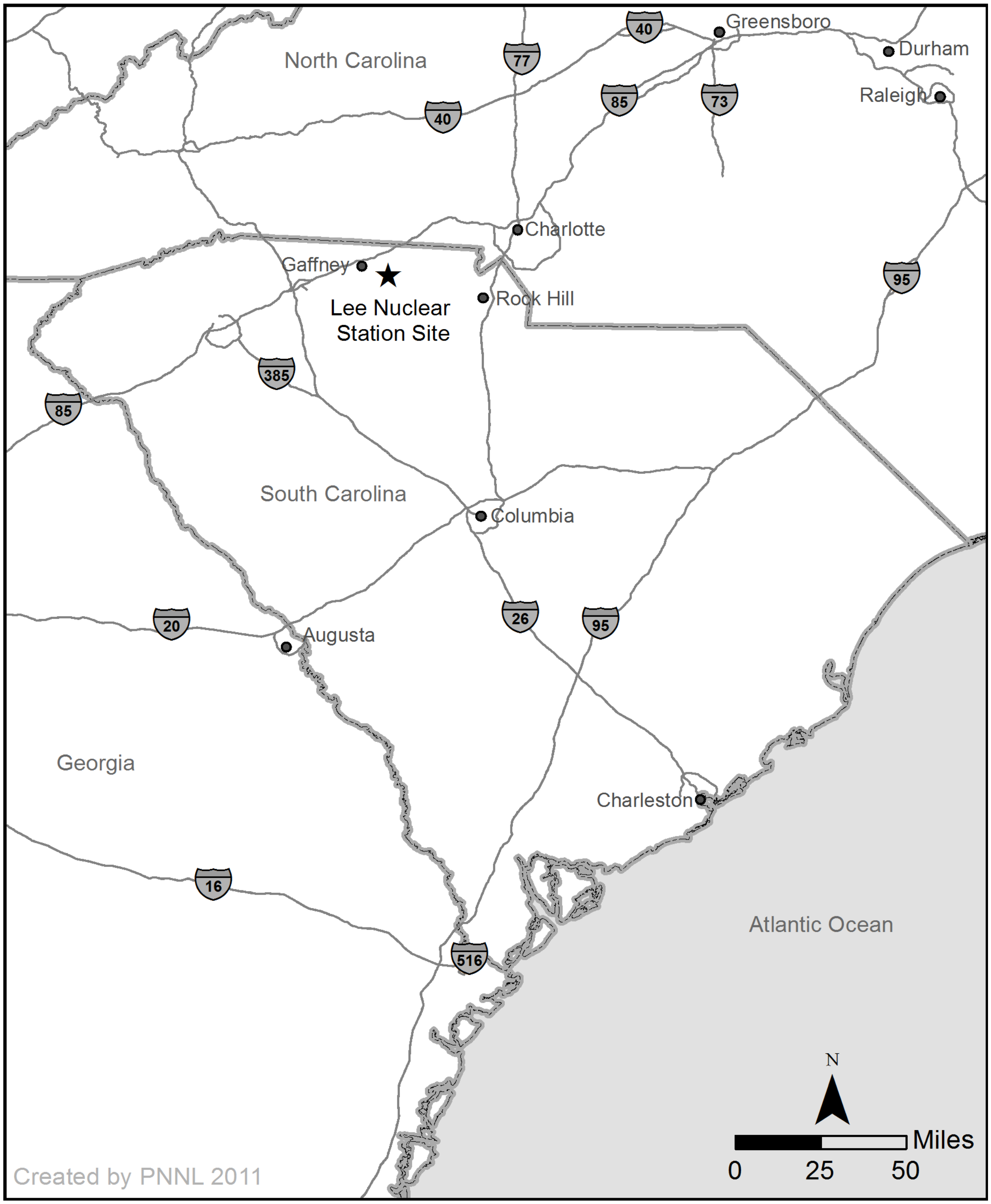

Figure 1-1. Lee Nuclear Station Site Location

The proposed actions in these applications are (1) NRC issuance of COLs for constructing and operating two new nuclear units at the Lee Nuclear Station site, and (2) USACE issuance of permits pursuant to Section 404 of the Federal Water Pollution Control Act (Clean Water Act), as amended (33 U.S.C. 1251 et seq.) to perform certain construction activities on the site. The USACE is participating in the preparation of this environmental impact statement (EIS) as a cooperating agency. The COL and Department of the Army permit applications and NRC and USACE review processes are described in Section 1.1.1.

1.1 Background

A COL is a Commission approval for the construction and operation of a nuclear power facility. NRC regulations related to COLs are found primarily in Title 10 of the *Code of Federal Regulations* (CFR) Part 52, Subpart C.

Section 102 of the National Environmental Policy Act of 1969, as amended (NEPA) (42 U.S.C. 4321 et seq.) directs that an EIS be prepared for major Federal actions that significantly affect the quality of the human environment. The NRC has implemented Section 102 of NEPA in 10 CFR Part 51. Further, in 10 CFR 51.20, the NRC has determined that the issuance of a COL under 10 CFR Part 52 is an action that requires an EIS.

According to 10 CFR 52.80(b), a COL application must contain an ER. The ER provides the applicant's input to the NRC's EIS. NRC regulations related to ERs and EISs are found in 10 CFR Part 51. Part 3 of Revision 1 of Duke's application contains the ER (Duke 2009c), which, together with the Make-Up Pond C supplement to the ER (Duke 2009b), provides a description of the proposed actions related to the application and the applicant's analysis of the potential environmental impacts of construction and operation of Lee Nuclear Station Units 1 and 2.

1.1.1 Applications and Reviews

The objective of Duke's requested NRC action is to obtain two COLs to construct and operate two baseload nuclear power reactors. In addition to the COLs, Duke must obtain and maintain permits from other Federal, State, and local agencies and permitting authorities. The objective of Duke's requested USACE action is to obtain a Department of the Army individual permit to perform regulated dredge-and-fill activities that would affect wetlands and other waters of the United States. Collectively, the NRC staff (including its contractor staff at Pacific Northwest National Laboratory and Idaho National Laboratory) and USACE staff who reviewed the ER and decided on impact levels are referred to as the "review team" throughout this EIS. Individual contributors to this EIS are listed in Appendix A.

1.1.1.1 NRC COL Application Review

The objective of the NRC environmental review of Duke's application is to determine whether two nuclear reactors of the proposed design can be constructed and operated at the Lee Nuclear Station site. Duke submitted an ER as part of its original COL application (Duke 2007b) that was superseded by Revision 1 of the ER (Duke 2009c) and further modified by the supplement to the ER (Duke 2009b). The ER focuses on the environmental effects of construction and operation of two Westinghouse Advanced Passive 1000 (AP1000) PWRs. NRC regulations that establish standards for review of a COL application are listed in 10 CFR 52.81. Detailed guidance for conducting the environmental portion of the COL review is found in NUREG-1555, the NRC's Environmental Standard Review Plan *(*ESRP*)* (NRC 2000a) and recent updates, hereinafter referred to as the ESRP. Additional guidance on conducting environmental reviews is provided in the NRC Staff Memorandum *Revision 1 - Addressing Construction and Preconstruction, Greenhouse Gas Issues, General Conformity Determinations, Environmental Justice, Need for Power, Cumulative Impact Analysis, and Cultural/Historical Resources Analysis Issues in Environmental Impact Statements* (NRC 2011a).

The Duke COL application references Revision 19 of the Westinghouse AP1000 reactor certified design (Westinghouse 2011). Subpart B of 10 CFR Part 52 contains NRC regulations related to standard design certification. An application for a standard design certification undergoes an extensive review. Revision 19 of the AP1000 design is codified in 10 CFR Part 52, Appendix D, and the final rulemaking for Revision 19 of the AP1000 design was published on December 30, 2011 (76 FR 82079). (Additional information about design certification is discussed in Section 3.2.1.)

In this EIS, the review team evaluates the environmental effects of two Westinghouse AP1000 PWRs at the Lee Nuclear Station site, each with thermal power ratings of 3400 MW(t). In addition to considering the environmental effects of the proposed action, this EIS addresses alternatives to the proposed action, including the no-action alternative and the building and operation of new reactors at alternative sites. The benefits of the proposed action (e.g., meeting an identified need for power) and measures and controls to limit adverse impacts are also evaluated. Duke's proposed action to construct and operate two new nuclear units includes requests for departures from the AP1000 design certification under 10 CFR 52.93. The environmental impacts of the requested departures are addressed in this EIS. The technical analysis for each design certification departure will be included in the NRC's Final Safety Evaluation Report, including a recommendation for approval or denial of each departure.

By letter dated February 25, 2008 (NRC 2008a), the NRC notified Duke that its application was accepted for docketing. Docket numbers 52-018 and 52-019 were established for proposed Units 1 and 2, respectively. After acceptance of Duke's COL application, the NRC began the environmental review process by publishing in the *Federal Register* on March 20, 2008, a

Notice of Intent to prepare an EIS and conduct scoping activities (73 FR 15009), in compliance with requirements set forth in 10 CFR Part 51. On May 1, 2008, a scoping meeting was held in Gaffney, South Carolina, to obtain public input on the scope of the environmental review. After receiving the September 2009 supplement to the ER describing Duke's plans to construct and operate an additional offsite reservoir (Make-Up Pond C) as a source of supplemental cooling water for the proposed Lee Nuclear Station, a second Notice of Intent to conduct a supplemental scoping process was published in the *Federal Register* on May 24, 2010 (75 FR 28822). On June 17, 2010, a second supplemental scoping meeting was held in Gaffney, South Carolina, to obtain public input on the supplement to the ER.

During both the initial and supplemental scoping periods, the NRC contacted Federal, State, Tribal, regional, and local agencies to solicit comments. A list of the organizations contacted is provided in Appendix B. The staff reviewed the comments received during both scoping processes and responses were written for each comment. All comments and responses for comment categories that are within the scope of the NRC environmental review are included in Appendix D. Complete listings of the scoping comments and responses from the initial and supplemental scoping meetings are documented in scoping summary reports (NRC 2008b, NRC 2010a). Meeting summaries of both scoping meetings are also available (NRC 2008c, NRC 2010b).

In April 2008, to gather information and to become familiar with the sites and their environs, the review team visited the preferred Lee Nuclear Station site and the alternative sites (Perkins, Keowee, and Middleton Shoals) (NRC 2008d). In August 2010, the review team revisited the preferred site and alternative sites, including a trip to the proposed, offsite location of Make-Up Pond C (northwest of the Lee Nuclear Station site) (NRC 2010c). During both site visits the review team met with Duke staff; Federal, State, and local officials; and the public. In June 2011, the review team conducted a supplemental audit of cooling system and energy alternatives at Duke's corporate headquarters in Charlotte, North Carolina (NRC 2011b). Documents related to the proposed Lee Nuclear Station and alternative sites were reviewed and are listed as references where appropriate.

To guide its assessment of the environmental impacts of a proposed action or alternative actions, the NRC has established a standard of significance for impacts based on guidance developed by the Council on Environmental Quality (40 CFR 1508.27). Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, provides the following definitions of the three significance levels established by the NRC – SMALL, MODERATE, and LARGE:

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

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

This EIS presents the review team's analysis, which considers and weighs the environmental impacts of the proposed action at the Lee Nuclear Station site, including the environmental impacts associated with construction and operation of Units 1 and 2, construction and operation of Make-Up Pond C, the impacts of construction and operation of reactors at alternative sites, the environmental impacts of alternatives to granting the COLs, and the mitigation measures available for reducing or avoiding adverse environmental effects presented by the applicant. This EIS also provides the NRC staff's recommendation to the Commission regarding the issuance of the COLs for proposed Lee Nuclear Station Units 1 and 2.

A 75-day comment period on the draft EIS began on December 23, 2011, when the U.S. Environmental Protection Agency (EPA) issued a Notice of Availability of the filing of the draft EIS (76 FR 80367) to allow the public to comment on the results of the review team's review. Two public meetings were held on January 19, 2012, near the site in Gaffney, South Carolina (NRC 2012b. During these public meetings, the NRC staff described the results of the NRC environmental review, provided the public with information to assist them in formulating comments on the draft EIS, responded to questions, and accepted comments on the draft EIS. Comments on the draft EIS and the staff's responses are provided in Appendix E. This final EIS has change bars in the page margins to denote where information has been updated or added in response to public comment or where changes, other than minor editorial changes, have been made.

1.1.1.2 USACE Permit Application Review

The USACE is part of the review team that makes a determination based on the three significance levels established by the NRC; however, the USACE's independent Record of Decision regarding the aforementioned permit application will reference the analyses in the EIS and present any additional information required by the USACE to support its permit decision. The USACE's role as a cooperating agency in the preparation of this EIS is to ensure that the information presented in the EIS is adequate to fulfill the requirements of USACE regulations and the EPA's 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material found at 40 CFR Part 230 (hereafter the 404(b)(1) Guidelines) to construct the preferred alternative identified in the EIS. The EIS is intended to provide the environmental information the USACE needs to meet its NEPA obligation, complete its review, and draw conclusions regarding the least environmentally damaging practicable alternative (LEDPA), public good, and the Public Interest Review Factors (PIRFs) for its permitting decision.

In this EIS, the USACE evaluates certain construction and maintenance activities proposed in waters of the United States, including wetlands that would be affected by the proposed project. The USACE decision will reflect the national concern for both protection and use of important resources. The benefit that may reasonably be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments.

The decision whether to issue a permit will be based on an evaluation of the probable impacts, including cumulative impacts, of the proposed activity, and its intended effect on the public interest. This evaluation requires a careful weighing of all of the factors that become relevant in each particular case. A decision by the USACE to authorize this proposal, and if so, the conditions under which it will be allowed to occur, are therefore determined by the outcome of this general balancing process. All factors that may be relevant to the proposal must be considered, including the cumulative effects thereof. The USACE PIRFs are listed and described more fully in Appendix I.

For activities involving discharges regulated by Section 404 of the Clean Water Act, a permit will be denied if the discharge would not comply with the EPA's 404(b)(1) Guidelines. Subject to the aforementioned guidelines and any other applicable guidelines and criteria (see 33 CFR 320.2 and 320.3), a permit will be granted unless the USACE district engineer determines that it would be contrary to the public interest. The following general criteria are considered in the evaluation of every application:

- the relative extent of the public and private need for the proposed structure or work
- where there are unresolved conflicts about resource use, the practicability of using practicable and reasonable alternative locations and methods to accomplish the objective of the proposed structure or work
- the extent and permanence of the beneficial and/or detrimental effects that the proposed structure or work is likely to have on the public and private uses to which the area is suited.

1.1.2 Preconstruction Activities

In a final rule dated October 9, 2007, "Limited Work Authorization for Nuclear Power Plants" (72 FR 57416), the Commission limited the definition of "construction" to those activities within its regulatory purview as defined in 10 CFR 51.4. Many of the activities required to construct a nuclear power plant are not part of the NRC's regulatory authority. Activities associated with building the plant that are not within the purview of the NRC action are grouped under the term "preconstruction." Preconstruction activities include clearing and grading, excavating, erecting support buildings and transmission lines, and other associated activities. These preconstruction activities may occur before the application for a COL is submitted, during the review of a COL application, after a COL is granted, or in some cases, concurrently with NRC-regulated construction. Although preconstruction activities are outside the NRC's regulatory authority, many of them are within the regulatory authority of local, State, or other Federal agencies, including certain preconstruction activities that require permits from the USACE.

Because preconstruction activities are not part of the NRC action, their impacts are not reviewed as a direct effect of the NRC action. Rather, the impacts of preconstruction activities are considered in the context of cumulative impacts. In addition, certain preconstruction activities that propose to discharge dredged, excavated, and/or fill material into waters of the United States, including jurisdictional wetlands that require permits from the USACE, are viewed by that agency as direct effects related to its Federal permitting action. Jurisdictional wetlands are wetlands as defined in the Clean Water Act Section 404(b)(1) Guidelines. Chapter 4 of this EIS describes the relative magnitude of impacts related to preconstruction and construction activities.

1.1.3 Cooperating Agencies

NEPA lays the groundwork for coordination between the lead agency preparing an EIS and other Federal agencies that may have jurisdiction by law or special expertise regarding an environmental issue. These other agencies are referred to as "cooperating agencies." Cooperating agencies have the responsibility to assist the lead agency through early participation in the NEPA process, including scoping, by providing technical input to the environmental analysis and making staff support available as needed by the lead agency.

Where impacts are proposed to waters of the United States, proposed nuclear power plants require a permit from the USACE in addition to a license from the NRC. Therefore, the NRC and the USACE concluded that the most effective and efficient use of Federal resources in the review of nuclear power projects would be achieved by a cooperative agreement. On September 12, 2008, the NRC and the USACE signed a Memorandum of Understanding regarding the review of nuclear power plant license applications (USACE and NRC 2008). Therefore, the Charleston District of the USACE is a cooperating agency as defined in 10 CFR 51.14. The USACE request for cooperation on the environmental review for Lee Nuclear Station was received by the NRC on February 16, 2009 (USACE 2009a) and accepted on March 30, 2009 (NRC 2009a).

As described in the Memorandum of Understanding, the NRC is the lead Federal agency, and the USACE is a cooperating agency in the development of the EIS. Under Federal law, each agency has jurisdiction related to portions of the proposed project. The goal of this cooperative agreement is the development of a single EIS that serves the needs of both the NRC license decision process and the USACE permit decision process. While both agencies must comply with NEPA, the NRC and the USACE have additional mission requirements that must be met. The NRC makes license decisions under the Atomic Energy Act (42 U.S.C. 2011 et seq.), and the USACE makes permit decisions under the Clean Water Act. The USACE is cooperating with the NRC to ensure that the information presented in the NEPA documentation is adequate to fulfill the requirements of USACE regulations; the EPA's Clean Water Act Section 404(b)(1) Guidelines (40 CFR Part 230), which contain the substantive environmental criteria used by the USACE in evaluating discharges of dredged or fill material into waters of the United States; and the USACE public interest review process.

As a cooperating agency, the USACE is part of the NRC review team and has been involved in all aspects of the environmental review, including scoping, public meetings, public comment resolution, and EIS preparation. The USACE refers to public meetings as hearings; however, no adjudicatory process is involved as in NRC hearings conducted by the Atomic Safety and Licensing Board. For the purposes of assessing environmental impacts under NEPA, the EIS uses the SMALL/MODERATE/LARGE criteria discussed in Section 1.1.1.1; this approach has been vetted by the Council on Environmental Quality. However, for permit decisions under Section 404 of the Clean Water Act, the USACE can only permit the LEDPA and must address PIRFs. This EIS is intended to provide information about the environmental impacts necessary to allow the USACE to address the public interest in the Record of Decision associated with the permit decision. However, some of the PIRFs not specifically related to environmental impact, such as mineral needs, are not addressed in this EIS.

The timing of the preparation of the EIS compared to the timing of the USACE permit review is such that the USACE will not have completed its assessment of the LEDPA criterion until it receives public feedback in the form of public comments on the draft EIS. The USACE will address whether the LEDPA criterion is met in the Record of Decision. The goal of the process is for the USACE to have all of the information necessary to make a permit decision when the final EIS is issued. However, it is possible that the USACE will still need some information from Duke to complete the permit documentation—information that Duke may not make available by the time of final EIS issuance. In addition, any conditions required by the USACE, such as compensatory mitigation, will be addressed in the permit issued by the USACE. Mitigation is an important aspect of the review and balancing process for many Department of the Army permit applications. Consideration of mitigation will occur throughout the permit application review process and includes avoiding, minimizing, rectifying, reducing, or compensating for resource losses. Losses will be avoided to the extent practicable. Compensation may occur onsite or at an offsite location.

1.1.4 Participating Agencies

The proposed location of the intake and discharge structures, and the source of cooling water and the recipient of effluent, for the proposed Lee Nuclear Station Units 1 and 2 is the Ninety-Nine Islands Reservoir, which is a feature of the Ninety-Nine Islands Hydroelectric Project, operated by Duke and regulated by the Federal Energy Regulatory Commission (FERC). Under the hydroelectric project license issued by the FERC, Duke is required, in part, to request authorization for any water intake or pumping facilities that extract more than one million gallons of water per day from the project reservoir. To protect and enhance the scenic, recreational, fish and wildlife, and other environmental values of the hydroelectric project, upon receipt of an application, the FERC must review Duke's water withdrawal/discharge proposal and accompanying construction activities for the Lee Nuclear Station that occur within the hydroelectric project boundary. Duke expects to apply for necessary FERC permits in 2013.

To enhance interagency coordination and ensure that issues of concern are identified, the FERC requested to be a participating agency in the environmental review of Duke's combined license application for the Lee Nuclear Station (FERC 2011a). As a participating agency, the FERC provided input at key decision points during the NEPA evaluation process, in particular on those environmental areas that also fall under its jurisdiction.

1.1.5 Concurrent NRC Reviews

In reviews separate from, but parallel to, the EIS process, the NRC analyzes the safety characteristics of the proposed site and emergency planning information. These analyses are documented in a Safety Evaluation Report (SER) issued by the NRC. The SER presents conclusions reached by the NRC regarding (1) whether there is reasonable assurance that two Westinghouse AP1000 reactors can be constructed and operated at the Lee Nuclear Station site without being inimical to the common defense and security or to the health and safety of the public; (2) whether the emergency preparedness program meets the applicable requirements in 10 CFR Part 50, 10 CFR Part 52, 10 CFR Part 73, and 10 CFR Part 100; and (3) whether site characteristics are such that adequate security plans and measures can be developed. The final SER for the Duke COL application is expected to be published as a NUREG document in 2015. Part 2 of Duke's COL application is the Final Safety Analysis Report (FSAR), which is updated annually. Revision 7 of the FSAR was published on May 9, 2013 (Duke 2013a).

Since submission of the Lee Nuclear Station COL application, Westinghouse has updated its design certification application with Revisions 18 and 19 (Westinghouse 2010a, 2011) of the AP1000 design control document. The reactor design referenced in Duke's COL application is Revision 19 of the AP1000 certified design (Westinghouse 2011). The final rulemaking for Revision 19 of the AP1000 design was published on December 30, 2011 (76 FR 82079).

1.2 The Proposed Federal Actions

The proposed NRC Federal action is issuance, under the provisions of 10 CFR Part 52, of COLs for authorizing the construction and operation of two new AP1000 reactors at the Lee Nuclear Station site. The proposed USACE Federal action is issuance of a permit pursuant to Section 404 of the Clean Water Act authorizing certain activities potentially affecting waters of the United States based on evaluation of the probable impacts, including cumulative impacts, of the proposed construction activities on the public interest.

This EIS provides the NRC and the USACE analyses of the environmental impacts that could result from building and operating two proposed units at the Lee Nuclear Station or one of the three alternative sites. These impacts are analyzed by the review team to determine whether the preferred site is suitable for the construction and operation of the units and whether any alternative site is considered obviously superior to the proposed site.

1.3 Purpose and Need for the Proposed Actions

The purpose and need for the proposed actions are described below.

1.3.1 The NRC's Proposed Action

In its 2011 and 2012 analyses (Duke 2011g, 2012a), Duke indicated that a combination of additional baseload, intermediate and peaking generation, renewable resources, and energy efficiency and demand-side management programs are required over the next 20 years, specifying a need for approximately 4440 MW(e) of additional capacity by 2027 (Duke 2012a). Accordingly, the purpose and need for the proposed NRC action (i.e., issuance of COLs) is to provide additional baseload electrical generating capacity in 2024 and 26[(a)] within the service territories of Duke (Duke 2013b). The need for additional baseload power is discussed in Chapter 8 of this EIS.

Two COLs from the NRC are needed to construct and operate two proposed AP1000 units at the Lee Nuclear Station site. Preconstruction and certain long lead-time activities, such as ordering and procuring certain components and materials necessary to construct the plant, may begin before the COLs are granted. Duke must obtain and maintain permits or authorizations from other Federal, State, and local agencies and permitting authorities prior to undertaking certain activities. The ultimate decision whether to build the new units and the schedule for building are not within the purview of the NRC nor the USACE and would be determined by the license holder if the authorizations are granted.

1.3.2 The USACE's Permit Action

Duke's November 2011 permit application to the USACE is for work to prepare the site and facilities for two proposed new nuclear units at the Lee Nuclear Station site. Defining the project objectives is critical to the evaluation of any project and to evaluating compliance with the Clean Water Act Section 404(b)(1) Guidelines. In addition to the NEPA-required purpose and need described above, the 404(b)(1) Guidelines and subsequent 404(q) guidance require that the USACE define the "basic project purpose" and the "overall project purpose" to verify appropriate consideration of alternatives.

(a) On October 15, 2013, Duke submitted its 2013 Integrated Resource Plan (IRP) to the North Carolina Utilities Commission. In this document Duke modified the in-service dates for the two units to 2024 and 2026 and adjusted its projections for future generation sources. Because the review team determined that the changes in the updated IRP do not materially change the analysis or its results, the analysis that follows has not been modified to address the 2013 IRP.

The basic purpose is the most simple or irreducible objective of the project and is used to determine whether the applicant's project is "water-dependent" (40 CFR 230.10(a)(3)). The water dependency test contained in the 404(b)(1) Guidelines creates a presumption that activities that do not require access to, proximity to, or siting within special aquatic sites to fulfill their basic project purpose are not water-dependent. Therefore, the 404(b)(1) Guidelines state that practicable alternatives to non-water-dependent activities are presumed to exist, are less damaging, and are environmentally preferable to alternatives that involve discharges into special aquatic sites (e.g., wetlands and riffle and pool stream complexes) (40 CFR 230.10(a)(3)). The basic purpose of this project would be to generate electricity for additional baseload capacity. Constructing facilities to create energy supplies is not a water-dependent activity, and in accordance with the 404(b)(1) Guidelines, practicable alternatives that do not involve discharges into special aquatic sites are presumed to exist unless clearly demonstrated otherwise (40 CFR 230.10(a)(3)).

In addition to defining the basic project purpose, the USACE must also define the overall project purpose. The overall project purpose establishes the scope of the alternatives analysis and is used for evaluating practicable alternatives under the 404(b)(1) Guidelines. In accordance with the 404(b)(1) Guidelines and guidance from USACE Headquarters, the overall project purpose must be specific enough to define the applicant's needs, but not so narrow and restrictive as to preclude a proper evaluation of alternatives. The USACE is responsible for controlling every aspect of the 404(b)(1) Guidelines analysis (HQUSACE 1989). In this regard, defining the overall project purpose for issuance of Department of the Army permits is the sole responsibility of the USACE. While generally focusing on Duke's purpose and need statement, the USACE will, in all cases, exercise independent judgment in defining the purpose and need for the project from both Duke's and the public's perspectives (33 CFR Part 325; 53 FR 3120).

The overall purpose of the project would be to construct a power-generating facility to provide for additional baseload electrical generating capacity to meet the growing demand in the states of South Carolina and North Carolina.

1.4 Alternatives to the Proposed Actions

Section 102(2)(C)(iii) of NEPA states that EISs are to include a detailed statement analyzing alternatives to the proposed action. The NRC regulations for implementing Section 102(2) of NEPA provide for including in an EIS a chapter that discusses the environmental impacts of the proposed action and the alternatives (10 CFR Part 51, Subpart A, Appendix A). This EIS addresses five categories of alternatives: (1) the no-action alternative, (2) energy source alternatives, (3) alternative sites, (4) system design alternatives, and (5) onsite alternatives to reduce impacts on natural and cultural resources.

In the no-action alternative, the proposed action would not go forward. The NRC could deny Duke's request for the COLs. If the request was denied, the construction and operation of two new nuclear generating units at the Lee Nuclear Station site would not occur, nor would any benefits intended by the approved COLs be realized. The USACE could deny Duke's permit request. If the permit were denied, Duke's construction of the two new units would not go forward as proposed. Energy source alternatives include energy-replacement technologies such as oil-fired and gas-fired generation and wind power, focusing on alternatives that could generate baseload power and, therefore, could meet the purpose and need of the project. System design alternatives include heat-dissipation and circulating-water systems, intake and discharge structures, and water-use and water-treatment systems. Finally, onsite alternatives evaluated by the USACE to reduce impacts to waters of the United States, including jurisdictional wetlands and shoreline resources, are described.

In the ER, Duke defines a region of interest for use in identifying and evaluating potential sites for power generation (Duke 2009c). Using the process outlined in the ER, Duke reviewed multiple sites and identified a suite of candidate sites for this power generation project. The alternative sites include the Perkins site in North Carolina and the Keowee and Middleton Shoals sites in South Carolina. Duke owns the Perkins and Keowee sites. All three sites are greenfield sites; however, Keowee is on the eastern border of the existing Oconee Nuclear Power Plant site. In this EIS the review team evaluates the region of interest, the process by which Duke selected alternative sites, and the environmental impacts of construction and operation of two new nuclear reactors at those sites using reconnaissance level information. The objective of the comparison of environmental impacts is to determine if any of the alternative sites are environmentally preferable and, if so, whether any are obviously superior to the preferred Lee Nuclear Station site.

As part of the evaluation of permit applications subject to Section 404 of the Clean Water Act, the USACE is required by regulation to apply the criteria set forth in the 404(b)(1) guidelines (33 U.S.C. 1344; 40 CFR Part 230). These guidelines establish criteria that must be met for the proposed activities to be permitted pursuant to Section 404. Specifically, these guidelines state, in part, that no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge that would have less adverse impacts on the aquatic ecosystem provided the alternative does not have other significant adverse consequences (40 CFR 230.10(a)). An area not presently owned by the applicant that could reasonably be obtained, used, expanded, or managed to fulfill the basic purpose of the proposed activity may be considered if it is otherwise a practicable alternative.

1.5 Compliance and Consultations

Before constructing and operating the two proposed units, Duke is required to obtain certain Federal, State, and local environmental permits, as well as meet applicable statutory and regulatory requirements. In the ER (Duke 2009c), Duke provided a list of environmental approvals and consultations associated with proposed Lee Nuclear Station Units 1 and 2. Duke provided an update to this list in March 2013 (Duke 2013c). Potential authorizations and consultations relevant to the proposed COL are included in Appendix H of this EIS. The information provided in Appendix H is based on ESRP guidance (NRC 2000a). The review team reviewed the list and has contacted the appropriate Federal, State, Tribal, and local agencies to identify any compliance, permit, or significant environmental issues of concern to the reviewing agencies that may affect the acceptability of the Lee Nuclear Station site for building and operating the proposed two Westinghouse AP1000 PWRs. A chronology of all environmental review correspondence is provided as Appendix C. A list of the key Federal, State, and Tribal consultation correspondence is provided as Appendix F.

1.6 Report Contents

Subsequent chapters of this EIS are organized as follows. Chapter 2 describes the proposed site and discusses the environment that would be affected by the proposed nuclear reactor units. Chapter 3 describes the power plant layout, structures, and activities related to building and operation that are used as the basis for evaluating the environmental impacts. Chapters 4 and 5 examine the environmental impacts of building (Chapter 4) and operating (Chapter 5) the proposed nuclear reactor units. Chapter 6 analyzes the environmental impacts of the uranium fuel cycle, transportation of radioactive materials, and decommissioning. Chapter 7 examines the cumulative impacts of the proposed action as defined in 40 CFR Part 1508. Chapter 8 addresses the need for power. Chapter 9 discusses alternatives to the proposed action; analyzes alternative energy sources, sites, and system designs; and compares the proposed action with these alternatives. Chapter 10 summarizes the findings of the preceding chapters, provides a benefit-cost evaluation, and presents the NRC staff’s recommendation with respect to the Commission’s approval of the proposed site for COLs based on the evaluation of environmental impacts.

The appendices to the EIS provide the following additional information:

- Appendix A – Contributors to the Environmental Impact Statement
- Appendix B – Organizations Contacted
- Appendix C – NRC and USACE Environmental Review Correspondence
- Appendix D – Scoping Comments and Responses

- Appendix E – Draft Environmental Impact Statement Comments and Responses
- Appendix F – Key Consultation Correspondence
- Appendix G – Supporting Documentation on Radiological Dose Assessment and Historic and Cultural Resources
- Appendix H – Authorizations, Permits, and Certifications
- Appendix I – U.S. Army Corps of Engineers Public Interest Review Factors
- Appendix J – Carbon Dioxide Footprint Estimates for a 1000-MW(e) Reference Reactor

2.0 Affected Environment

The site proposed by Duke Energy Carolinas, LLC (Duke) for two combined construction permits and operating licenses (combined licenses or COLs) and a Department of the Army permit is located in the eastern portion of Cherokee County in north-central South Carolina. The proposed William States Lee III Nuclear Station (Lee Nuclear Station) site property is owned by Duke and is the site of the former Duke Power Company Cherokee Nuclear Station. Development of the former Cherokee Nuclear Station was halted mid-construction in the early 1980s. The location of the proposed Lee Nuclear Station is described in Section 2.1, with the land use, water use and quality, ecology, socioeconomics, environmental justice, historic and cultural resources, geology, meteorology and air quality, the nonradiological environment, and the radiological environment of the site presented in Sections 2.2 through 2.11, respectively. Section 2.12 examines related Federal projects and consultations.

2.1 Site Location

Figure 2-1 shows Duke's proposed location for Lee Nuclear Station in relationship to the counties and important cities and towns within a 50-mi radius. The nearest population centers with more than 25,000 residents are Charlotte, North Carolina, 40 mi to the northeast; Spartanburg, South Carolina, 25 mi to the southwest; and Greenville, South Carolina, 52 mi to the southwest. The nearest population center is Gastonia, North Carolina, located approximately 24 mi to the northeast of the site. The closest community is Gaffney, South Carolina, the county seat of Cherokee County, located approximately 8.2 mi to the northwest (Duke 2009c). The Universal Transverse Mercator grid coordinates (NAD83) in meters (m) for the center line between the proposed Units 1 and 2 are 453,331 m east and 3,877,239 m north (Duke 2013c).

Figure 2-2 shows the vicinity (within a 6-mi radius) of the Lee Nuclear Station site. The site occupies approximately 1900 ac along the west side of the Broad River (Duke 2009c). At the southeastern edge of the property is Ninety-Nine Islands Dam that impounds the Broad River to create Ninety-Nine Islands Reservoir. The site is generally bounded by Ninety-Nine Islands Reservoir to the north and east, McKowns Mountain Road to the south, and private property to the west and part of the south. McKowns Mountain Road is the primary access route to the site. An abandoned railroad spur enters the northern side of the property and ends near the middle of the site. Figure 2-3 shows the planned footprint of major structures at the Lee Nuclear Station site, along with the site's placement along the Broad River and the location of Ninety-Nine Islands Dam.

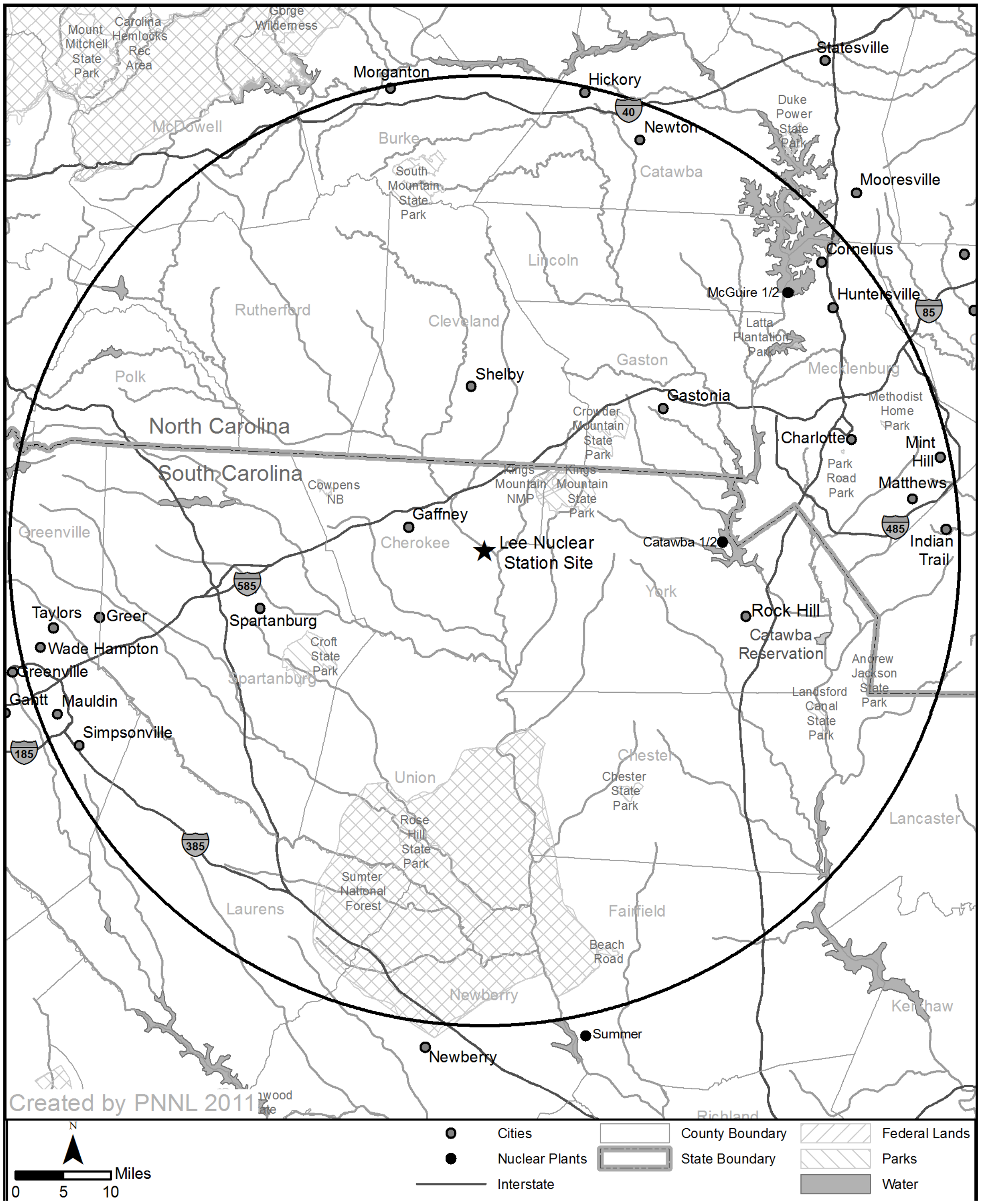

Figure 2-1. Area within a 50-Mi Radius of the Proposed Lee Nuclear Station

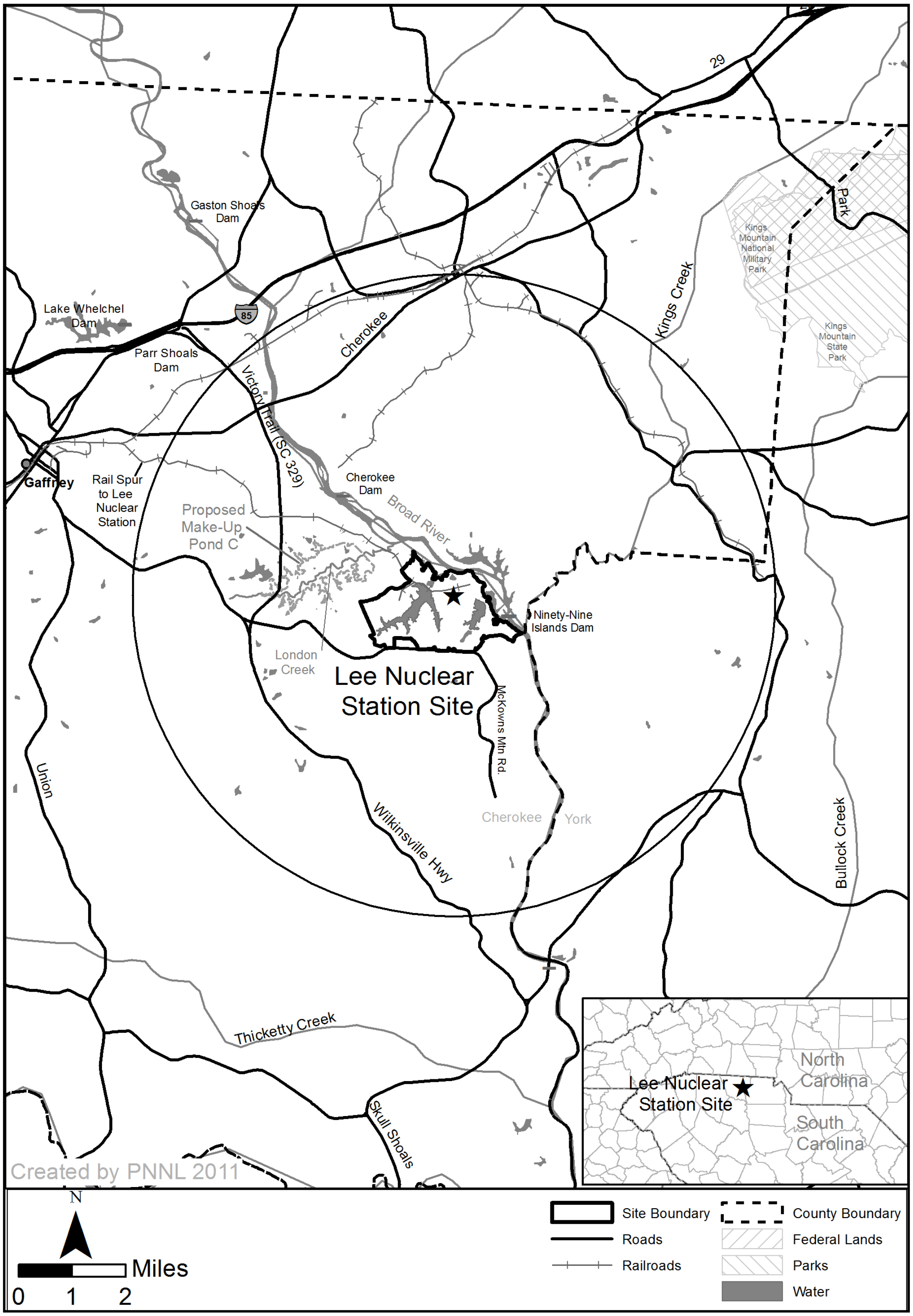

Figure 2-2. 6-Mi Vicinity of the Lee Nuclear Station Site

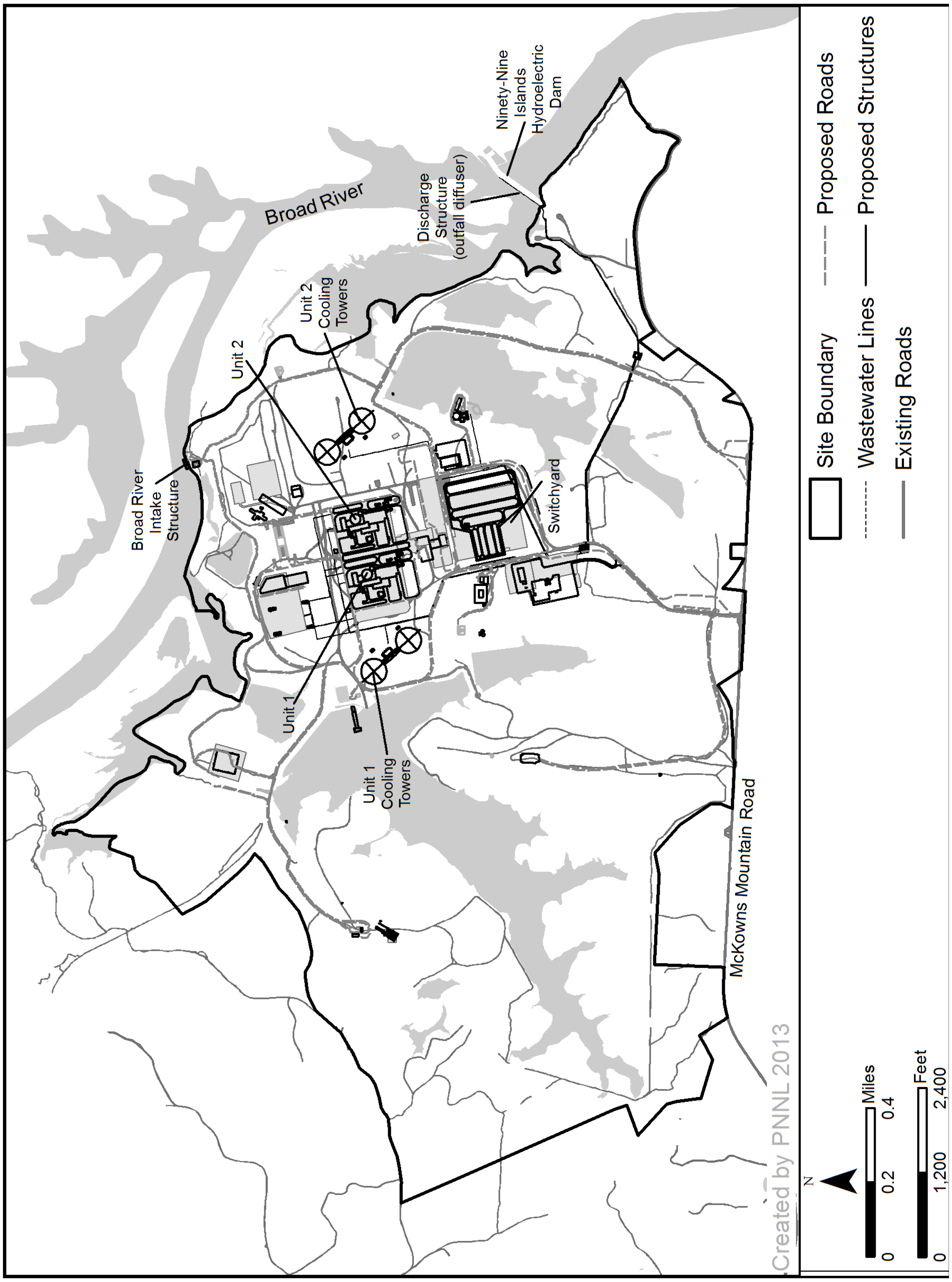

Figure 2-3. Planned Footprint of Major Structures at the Proposed Lee Nuclear Station

2.2 Land Use

This section discusses land use for the proposed Lee Nuclear Station. Section 2.2.1 describes the site and the vicinity within a 6-mi radius of the site (Figure 2-2). Section 2.2.2 describes the proposed Make-Up Pond C site. Section 2.2.3 discusses the proposed transmission corridors and other offsite facilities. Section 2.2.4 discusses the region, defined as the area within 50 mi of the center point of the proposed Lee Nuclear Station power block footprint (Figure 2-1).

2.2.1 The Site and Vicinity

The Lee Nuclear Station site refers to an area of 1928 ac in an unincorporated portion of Cherokee County, South Carolina (Duke 2013d). The 6-mi vicinity also includes a portion of York County, South Carolina. The proposed site lies within the existing boundaries of the unfinished Cherokee Nuclear Station site, and is wholly owned by Duke (Duke 2009c).

The Lee Nuclear Station site is situated on the south bank of the Broad River, immediately to the west of Ninety-Nine Islands Dam. The Broad River from Ninety-Nine Islands Dam south to the confluence with the Pacolet River (15.3 mi) was designated as a State Scenic River in 1991. With that designation, the Broad River became part of the South Carolina Scenic Rivers Act of 1989 (South Carolina Code, Title 49, Chapter 29), the purpose of which is to protect unique and outstanding river resources throughout South Carolina. However, the reach adjoining the Lee Nuclear Station site is upstream of the dam and hence without this designation. The Broad River is not classified as a National Wild and Scenic River as the term is defined in Title 36 of the *Code of Federal Regulations* (CFR) 297.3. There are no additional publically accessible waterbodies within the Lee Nuclear Station site boundary (Duke 2009c). The site and vicinity are not located within the coastal zone.

The proposed location for the Lee Nuclear Station site is an abandoned industrial construction site that was evaluated by the U.S. Nuclear Regulatory Commission (NRC) in the mid-1970s, and where construction permits were issued for three nuclear reactor units (unfinished Cherokee Nuclear Station) (NRC 1975a). Construction activities began in 1977 and were halted in 1982 and 1983 (NRC 2012a), resulting in alterations to the site. During that time, approximately 750 ac of land were disturbed by site-preparation, excavation, and other initial site-development activities (Duke 2009c). In 1986, the site was purchased by Earl Owensby Studios for production of a movie, after which the site sat idle until it was purchased by Cherokee Falls Development Company, LLC in 2005. Duke purchased all outstanding ownership shares in early 2007 (Duke 2009c).

Within the proposed site boundaries, previous construction activities—including excavation and site development—left numerous changes to the land, some of which remain. Several structures present at the site when Duke wrote the initial version of the environmental report (ER) in 2007 have since been removed, including the partially constructed power unit buildings and several large and small buildings that were used in support of previous construction activities. Still present are several large excavated areas, including several small impoundments, material laydown areas, and buildings—including a guardhouse. Concrete pads and vehicle parking areas are present at several locations on the site. A system of paved roads links existing development features on the site, while peripheral areas are served by a related system of unpaved roads (Duke 2009c).

Utilities that originally served the unfinished Cherokee Nuclear Station include buried utility pipelines, overhead electric distribution lines, and communication lines. These utilities are still present at the Lee Nuclear Station site (Duke 2009c).

An abandoned railroad spur enters the Lee Nuclear Station site and extends across the northern half of the site, terminating at the previously excavated area where the new power block would be built. The abandoned spur connects the Lee Nuclear Station site to the main railroad line operated by Norfolk Southern that runs through Gaffney, South Carolina, and connects to Blacksburg, South Carolina (Duke 2009c).

The Lee Nuclear Station site contains three major surface-water impoundments excavated prior to 1982 to provide cooling water to the Cherokee Nuclear Station reactors that were never built. The impoundments are designated Make-Up Pond A on the east side of the site, Make-Up Pond B on the west side of the site, and Hold-Up Pond A on the north end of the site. Make-Up Pond B was originally formed by the impoundment of McKowns Creek (Duke 2009c). Make-Up Ponds A and B and Hold-Up Pond A are jurisdictional waters of the United States (under the jurisdiction of the U.S. Army Corps of Engineers [USACE]) (USACE 2007a). The USACE has also identified 12.52 ac of wetlands and several open water areas and streams onsite that are under jurisdiction of the Clean Water Act (USACE 2013a). In addition, 100-year floodplains occur in low-lying areas of the Lee Nuclear Station site, primarily along the Broad River and around the margins of Make-Up Ponds A and B (USACE 2013a).

The land cover within the Lee Nuclear Station site boundary, as described by Duke (2009c) using the U.S. Geological Survey (USGS) 2001 National Land Cover Dataset, is primarily upland forest (i.e., 64 percent made up of deciduous, evergreen, and mixed forest), with most of the remainder classified as grassland, pasture, and developed land. Previously excavated areas, including water impoundments, are classified as water. Developed land cover within the vicinity is approximately 8 percent (Table 2-1) and limited primarily to areas near East Gaffney and Blacksburg, South Carolina. Table 2-1 provides a summary of land-cover statistics for the site, vicinity, and region.

Table 2-1. Land Cover Near the Lee Nuclear Station Site

USGS Description	Percentage of Site	Area (ac)	Percentage of Vicinity (6-mi)	Area (ac)	Percentage of Region (50-mi)	Area (ac)
Water	14.5	279	1.4	1446	1.5	73,132
Open developed	2.6	49.4	5.6	5891	9.3	461,912
Low-intensity developed	0.4	8.0	2.2	2276	4.5	221,711
Medium-intensity developed	0	0	0.3	346	1.2	62,067
High-intensity developed	0	0	0.2	161	0.6	31,240
Barren land	0.1	2.7	0.04	40	0.6	32,075
Deciduous forest	50.8	979	45.1	47,088	34.7	1,725,013
Evergreen forest	7	135	15.9	16,630	17.8	887,107
Mixed forest	2.9	55.7	2.5	2602	1.5	74,612
Shrub/scrub	2.6	50.4	2.8	2918	1.2	58,241
Grassland	15.5	299.3	7.8	8159	5.9	291,133
Pasture	3.1	59.2	15.3	16,010	19.3	961,495
Cropland	0.3	5.5	0.3	279	0.3	13,607
Woody wetlands	0.2	4.3	0.5	502	1.6	78,191
Emergent herbaceous wetlands	0	0.5	0.01	12	0	301
Total	**100**	**1928**	**100**	**104,360**	**100**	**4,971,837**

Source: Adapted from Duke 2009c. Site data is scaled to a site area of 1928 ac (Duke 2013d)

Even though no zoning laws currently apply to the Lee Nuclear Station site in this unincorporated portion of Cherokee County, South Carolina, Duke maintains a land-management plan for the Lee Nuclear Station site. Since 2005, Duke has maintained pumps to remove seepage water from previously excavated areas (Duke 2009c). As indicated by the U.S. Department of Agriculture (USDA 2002) soil survey database, approximately 2 ac of prime farmland are present in the southeast corner of the proposed site, but these 2 ac are not currently farmed. Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses, or under defined conditions would be available for these uses (7 CFR Part 657). Although Duke owns the mineral rights on the Lee Nuclear Station site, no known mineral resources within or adjacent to the site are being exploited, nor are there any known mineral resources of value. However, an active sand-mining operation adjacent to the Broad River is situated approximately 1 mi upstream (Duke 2009c).

Topography in the vicinity of the Lee Nuclear Station site consists of rolling, forested woodland hills with elevations ranging from approximately 511 ft above mean sea level (MSL) on the shore of Ninety-Nine Islands Reservoir to 816 ft above MSL at the top of McKowns Mountain. There are several homes and small farms within the vicinity of the site; these residences are predominantly south of the McKowns Mountain Road and to the west of the site (Duke 2009c).

The Lee Nuclear Station site is accessible only by the McKowns Mountain Road, which runs along most of the southern boundary of the site. South Carolina Route 105 (SC 105; Wilkinsville Highway) runs from Gaffney and eventually turns into McKowns Mountain Road approximately 4 mi to the west of the site entrance. Victory Trail Road (SC 329) intersects McKowns Mountain Road (state roadway) at this same location, and intersects Federal Highway 29 approximately 4 mi to the north.

The closest communities to the Lee Nuclear Station site include Gaffney, East Gaffney, Blacksburg, Hickory Grove, and Smyrna. Gaffney, with 12,492 residents, has the largest population near the Lee Nuclear Station site (USCB 2010e). The city is located approximately 8.2 mi northwest of the site and has the closest hospital to the site (Duke 2009c). East Gaffney has a population of 2784 and is located approximately 7.5 mi to the northwest of the site. Blacksburg has a population of 2007 and is located approximately 5.8 mi to the north of the site (USCB 2010e). The nearest residences are located immediately to the south of the site boundary, along McKowns Mountain Road. The nearest school is Draytonville Elementary, approximately 4 mi west of the site. The nearest church is McKowns Mountain Baptist Church, near the entrance to the site on McKowns Mountain Road (Duke 2009c).

The vicinity includes all land within a 6-mi radius of the Lee Nuclear Station site and includes local parks and recreational facilities (Figure 2-2). The nearest State park is Kings Mountain State Park located approximately 7.8 mi northeast of the site; this park shares its northern boundary with Kings Mountain National Military Park. Kings Mountain State Park is 6885 ac, and offers fishing, boating, equestrian facilities, camping, and hiking. Kings Mountain National Military Park is nearly 4000 ac, and offers back country hiking, equestrian facilities, camping, and historical references through short-film presentations and a museum. Gaffney has seven local parks and a golf course, all located within 10 mi of the site. Additionally, there are two campgrounds near the Lee Nuclear Station site; one at Kings Mountain, and the other at Pinecone Campground, which is 5 mi west of Gaffney. The State-designated Broad Scenic River offers paddling, bird watching, picnicking, fishing, and other outdoor activities (Duke 2009c).

Cherokee County contains 14 reservoirs and one lake, all of which may be used for recreational purposes (Duke 2009c). Recreational access points for Ninety-Nine Islands Reservoir include the Cherokee Ford Recreation Area near Goat Island; Pick Hill boat access north of Ninety-Nine Islands Dam on the east bank of the Broad River accessible from SC 43; and the area to the immediate south of the dam (also on the east bank) that offers canoe portage, a tailrace fishing area, and a boat ramp. Lake Cherokee is a public waterbody, located approximately 2 mi west of the western site boundary. Figure 2-2 provides a detailed view of the proposed Lee Nuclear Station vicinity, which includes roads and waterways.

2.2.2 The Make-Up Pond C Site

Make-Up Pond C is proposed for the purpose of allowing operation of the proposed Lee Nuclear Station during severe drought conditions. The total proposed Make-Up Pond C site encompasses approximately 2110 ac and is located northwest of the Lee Nuclear Station in the London Creek watershed (Duke 2009b). When acquired by Duke, the proposed Make-Up Pond C site consisted mostly of forest and pasture land interspersed with small areas of grassland, residential and other development, scrub, cropland, water, and wetlands (Table 2-2 and Figure 2-4). The USACE has identified 7.43 ac of wetlands and several open waters and streams on the site that are subject to its jurisdiction under the Clean Water Act (USACE 2013a) (Section 2.4). In addition, 100-year floodplains occur in low-lying areas of the site, primarily in low areas along London Creek (Section 2.4.1). The Make-Up Pond C site contains approximately 260 ac of land designated as prime farmland and farmland of statewide importance (Duke 2009b). The entire Make-Up Pond C site lies within an unincorporated area of Cherokee County and, therefore, is not subject to zoning restrictions. The Make-Up Pond C site lies upstream of the Ninety-Nine Islands Dam and does not abut the portion of the Broad River designated as a State Scenic River.

Table 2-2. Land-Cover Classification for the Make-Up Pond C Site

Land-Cover Classification	Area (ac)	Percentage of Area
Forested (deciduous, evergreen, and mixed forest)	1372	65.0
Pasture land	443	21.0
Residential development	11	0.5
Grassland	114	5.4
Open development	82	3.9
Shrub/scrub	53	2.5
Cropland	27	1.3
Water	6	0.3
Woody wetlands	2	<0.1
Total	**2110**	**100**

Source: Adapted from Duke 2009b

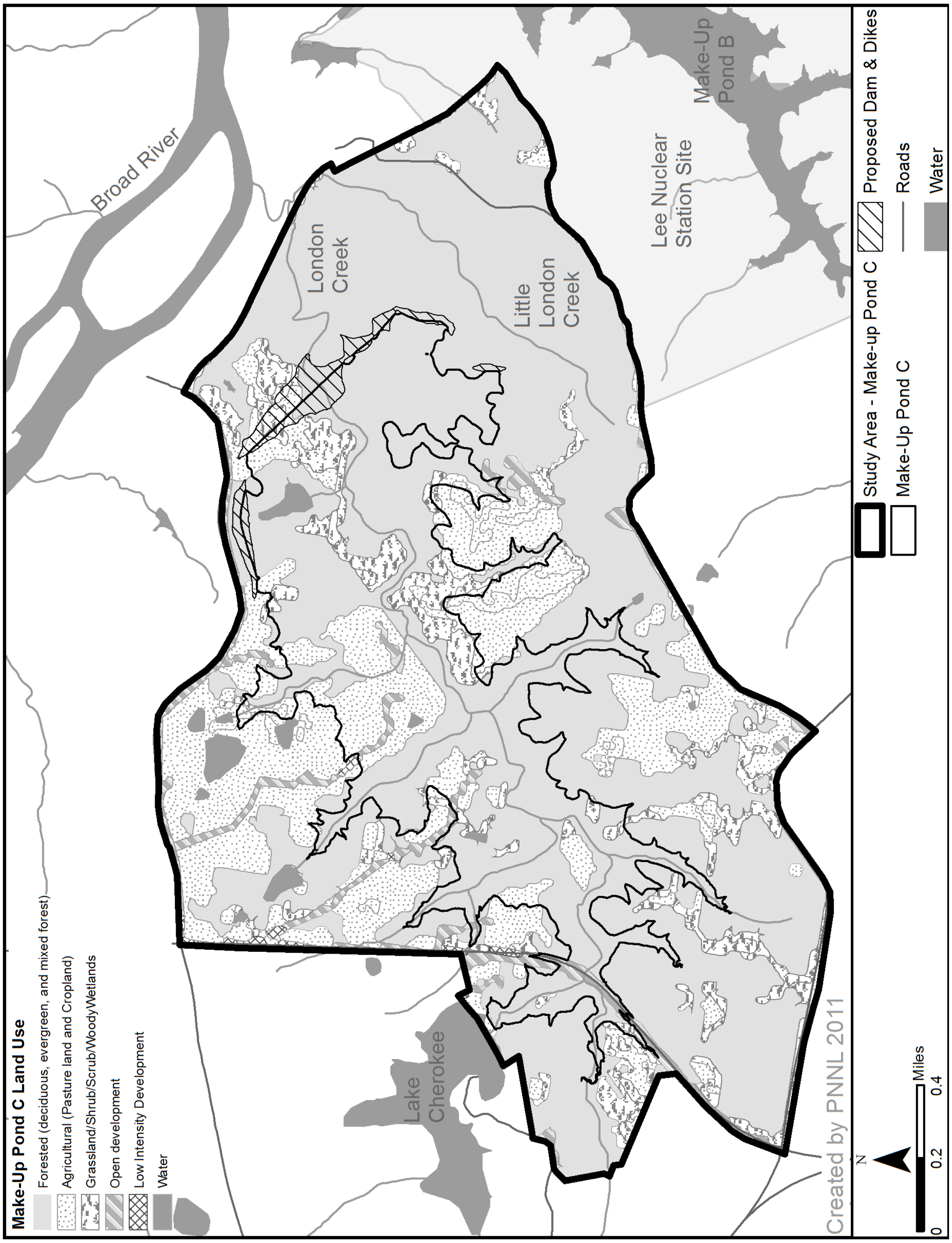

Figure 2-4. Make-Up Pond C Land Cover

According to Duke (2013d), Make-Up Pond C itself, including the impoundment, dam footprint, saddle dikes, and spillway, would occupy approximately 643 ac. The land needed for other elements of Make-Up Pond C, including spoils placement areas, vegetation maintenance areas, and various roads, transmission lines, and ancillary facilities to support the pond, would include an additional area of about 404 ac, for a total footprint of approximately 1047 ac. The remaining acreage on the Make-Up Pond C site would be owned and managed by Duke; however, Duke has not decided how it would use those lands not permanently occupied by Make-Up Pond C or its ancillary facilities. The rural landscape surrounding the Make-Up Pond C site contains scattered areas of residential development. Residences are located east of SC 329 (Victory Trail Road), off of Edward Road, Darby Road, Old Barn Road, Grace Road, Jimmy Road, and Whites Road. Other residential development is located north of Rolling Mill Road off of Deer Ridge Road, Fawn Trail, and Buck Trail (Duke 2009b). Approximately 86 privately owned housing units (single-family houses and mobile units) have been removed from the Make-Up Pond C site since Duke acquired the land (Duke 2012b).

2.2.3 Transmission-Line Corridors and Other Offsite Facilities

Section 2.2.3.1 discusses the proposed offsite transmission-line corridors and Section 2.2.3.2 discusses the proposed offsite railroad-spur route.

2.2.3.1 Transmission-Line Corridors

Duke is proposing to add 2234 MW(e) capacity to the existing transmission systems serving the region. Duke is therefore proposing to establish two additional transmission-line corridors, termed Route K and Route O, that would each contain two transmission lines (one 230 kV and one 525 kV). Duke would reroute existing lines through the proposed new Lee Nuclear Station switchyard. Duke conducted a comprehensive siting and environmental analysis to select routes for the proposed new transmission corridors that minimize effects to land use, environmental resources, cultural resources, and aesthetic quality (Duke 2007c).

At the proposed Lee Nuclear Station and the Make-Up Pond C site, the proposed transmission-line corridors would lie within the Piedmont physiographic region in an area composed of gently rolling hills with limited changes in the overall elevation. The total geographic area evaluated by Duke (2007c) for the new transmission-line corridors was approximately 181,420 ac, of which approximately 121,600 ac are mapped as forest or woodlands. From 21 alternative routes, representing 115 different route combinations, 2 corridors were selected as meeting the criteria that would minimize effects to land use, environmental resources, cultural resources, and aesthetic quality. The two selected corridors encompass approximately 987 ac; almost all of which (i.e., 97 percent) are not subject to zoning restrictions and consist mostly of forest and pasture land. None of the proposed transmission lines would cross the Broad River, which is considered a state scenic waterway from Ninety-Nine Islands Dam to the confluence of the Pacolet River (Duke 2007c). None of the proposed transmission-line routes are located within the coastal zone.

Approximately 163 ac of the proposed transmission-line corridors are considered prime farmland, or farmland of statewide importance (Duke 2007c). In addition to land Federally designated as prime farmland, farmland of statewide importance has been designated by individual State and County agricultural boards as being especially important to food crop production regionally (7 CFR Part 657). Duke permits farming and crop production within transmission-line corridors and expects these uses only to be limited where the new transmission-line structures would be located (Duke 2009c). Approximately 66 ac of transmission-line corridor is within the 100-year floodplain (Duke 2007c). The corridors also encompass streams, open waters, and approximately 11.17 ac of jurisdictional wetlands (USACE 2013a) (Section 2.4). Table 2-3 provides current land-cover characterization within the proposed corridors.

Table 2-3. Proposed Transmission-Line Corridor Land Cover Classification

Land-Cover Classification	Route K (ac)	Route O (ac)	Total Area (ac)
Bottomland/floodplain forest	21.2	6.7	27.9
Closed canopy evergreen forest/woodland	128.9	50.7	179.6
Cultivated land	0	0	0
Dry deciduous forest/woodland	0.4	1.5	1.9
Dry scrub/shrub thicket	48.2	38.8	87.0
Fresh water	10.0	5.2	15.2
Grassland/pasture	90.4	86.3	176.7
Marsh/emergent wetland	0	0	0
Mesic deciduous forest/woodland	60.9	90.0	150.9
Mesic mixed forest/woodland	159.7	154.9	314.6
Needle-leaved evergreen mixed forest/woodland	10.7	4.6	15.3
Open canopy/recently cleared forest	0	0	0
Urban development	12.2	5.0	17.2
Urban residential	0	0	0
Wet scrub/shrub thicket	0.3	0.1	0.4
Total	**543.0**	**443.8**	**986.8**

Source: Duke 2007c

The proposed transmission system supporting Lee Nuclear Station Units 1 and 2 would be tied into the existing Oconee-Newport 525-kV line and the Pacolet-Catawba 230-kV transmission lines in two corridors that would run south and southwest of the Lee Nuclear Station site. From the proposed switchyard at the Lee Nuclear Station site, each transmission-line corridor would carry one 525-kV line and one 230-kV line to their respective tie-in locations with the existing transmission lines (Duke 2007c). By distributing both voltage and tie-in locations, Duke is not anticipating the need for additional transmission lines to provide offsite power to the Lee Nuclear Station site in case of an emergency.

From the Lee Nuclear Station site switchyard, two new transmission-line corridors have been identified. They are labeled Route K, which runs generally south and west of the Lee Nuclear Station site, and Route O, which runs generally south of the Lee Nuclear Station site. Corridors exiting from the Lee Nuclear Station site switchyard have a 325-ft right-of-way (ROW) and would support both a 230-kV line and a 525-kV line to the first tie-in location on the 230-kV Pacolet-Catawba transmission line. Each corridor from the Pacolet-Catawba line to the Oconee-Newport 525-kV tie-in location would have a 200-ft ROW and would support one 525-kV line (Duke 2007c). The proposed new corridors and tie-in locations to the existing transmission-line corridors in the vicinity of the Lee Nuclear Station site are shown in Figure 2-5.

The Route K transmission-line corridor runs generally southwest from the Lee Nuclear Station site switchyard to the Pacolet-Catawba 230-kV tie-in location. It then runs generally south to the Oconee-Newport 525-kV tie-in location. The entire length of the corridor is approximately 17.5 mi. The length from the Lee Nuclear Station site switchyard to the first tie-in location on the Pacolet-Catawba 230-kV transmission line is approximately 8.0 mi. The corridor from the Pacolet-Catawba 230-kV line to the Oconee-Newport 525-kV tie-in location is approximately 9.5 mi (Duke 2007c).

The Route O transmission-line corridor runs generally south from the Lee Nuclear Station site following the boundary between Cherokee and York Counties. The entire length is approximately 13.9 mi. The length from the Lee Nuclear Station site to the first tie-in location on the Pacolet-Catawba 230-kV transmission line is approximately 7.1 mi. The length from the Pacolet-Catawba 230-kV line to the Oconee-Newport 525-kV transmission-line tie-in location is approximately 6.8 mi (Duke 2007c).

With the exception of areas around Smyrna, Hickory Grove, and Sharon, South Carolina, the proposed transmission-line corridors would run through predominantly rural areas.

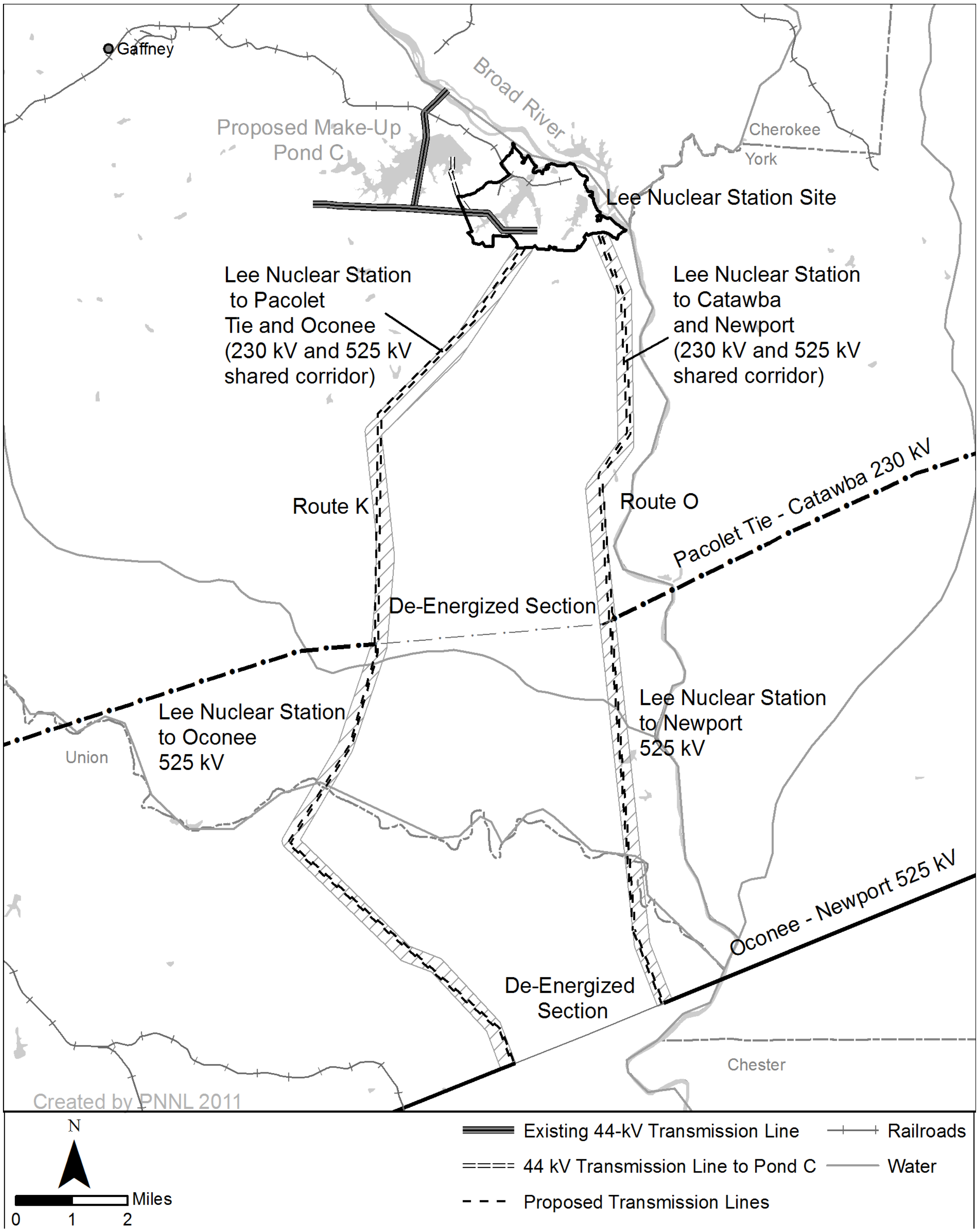

Figure 2-5. Existing and Proposed Electrical Transmission Systems

2.2.3.2 Railroad Corridor

The 6.8-mi-long and 50-ft-wide corridor for the railroad spur from near Gaffney to the Lee Nuclear Station site was abandoned when the Cherokee Nuclear Station project was cancelled in 1982. After the project was terminated, the rails were removed and the ROW reverted to private ownership. Duke is reacquiring the necessary ROW and would reactivate the railroad spur by installing new ballast and track for the construction of Lee Nuclear Station Units 1 and 2. The original study area for the railroad corridor extended 25 ft on both sides of the bottom of the 50-ft-wide berm of the rail embankment, creating a 100-ft-wide study area along the corridor (Enercon 2008). Duke also plans a short detour from the original ROW where it is occupied by Reddy Ice on the southeast edge of East Gaffney (Figure 2-6). The detour involves approximately 1300 ft of track with a 50-ft-wide ROW (Duke 2009c).

2.2.4 The Region

The region, defined as 50 mi beyond the Lee Nuclear Station site, includes all or portions of the following counties in South Carolina: Cherokee, Chester, Fairfield, Greenville, Lancaster, Laurens, Newberry, Spartanburg, Union, and York; and in North Carolina, Burke, Cabarrus, Catawba, Cleveland, Gaston, Henderson, Iredell, Lincoln, McDowell, Mecklenburg, Polk, Rutherford, and Union. Major waterways, highways, parks, and recreational areas in the region are shown in Figure 2-1, which also includes the transmission-line corridors study area.

There are several large cities within the region (Figure 2-1). The Lee Nuclear Station site is approximately 40 mi southwest of Charlotte, North Carolina (population 704,422) and 25 mi northeast of Spartanburg, South Carolina (population 40,387). Interstate-85 (I-85) passes 8 mi to the northwest of the site. South Carolina State Routes SC 5, SC 97, and SC 118 are within 6 mi of the east boundary of the site and SC 18 passes approximately 6 mi from the west boundary of the site.

Land use within the region varies with distance from major population centers and high-use corridors. The metropolitan areas of Charlotte, Gastonia, and Spartanburg contain the highest density of residential, commercial, and light industrial land uses. Land cover in the immediate vicinity of the Lee Nuclear Station site and the areas outside the noted metropolitan areas and transportation corridors are primarily forest (54 percent), pasture (19 percent), and grassland (6 percent) (Table 2-1). Cropland is less than 1 percent within the region (Duke 2009c).

The region surrounding the Lee Nuclear Station site contains Federal lands including Cowpens National Battlefield to the northwest, Sumter National Forest to the south, and the Kings Mountain National Military Park to the east. Tribal lands of Federally recognized Native American Tribes within the region include the Catawba Indian Reservation, situated approximately 31 mi east-southeast of the Lee Nuclear Station site (Duke 2009c).

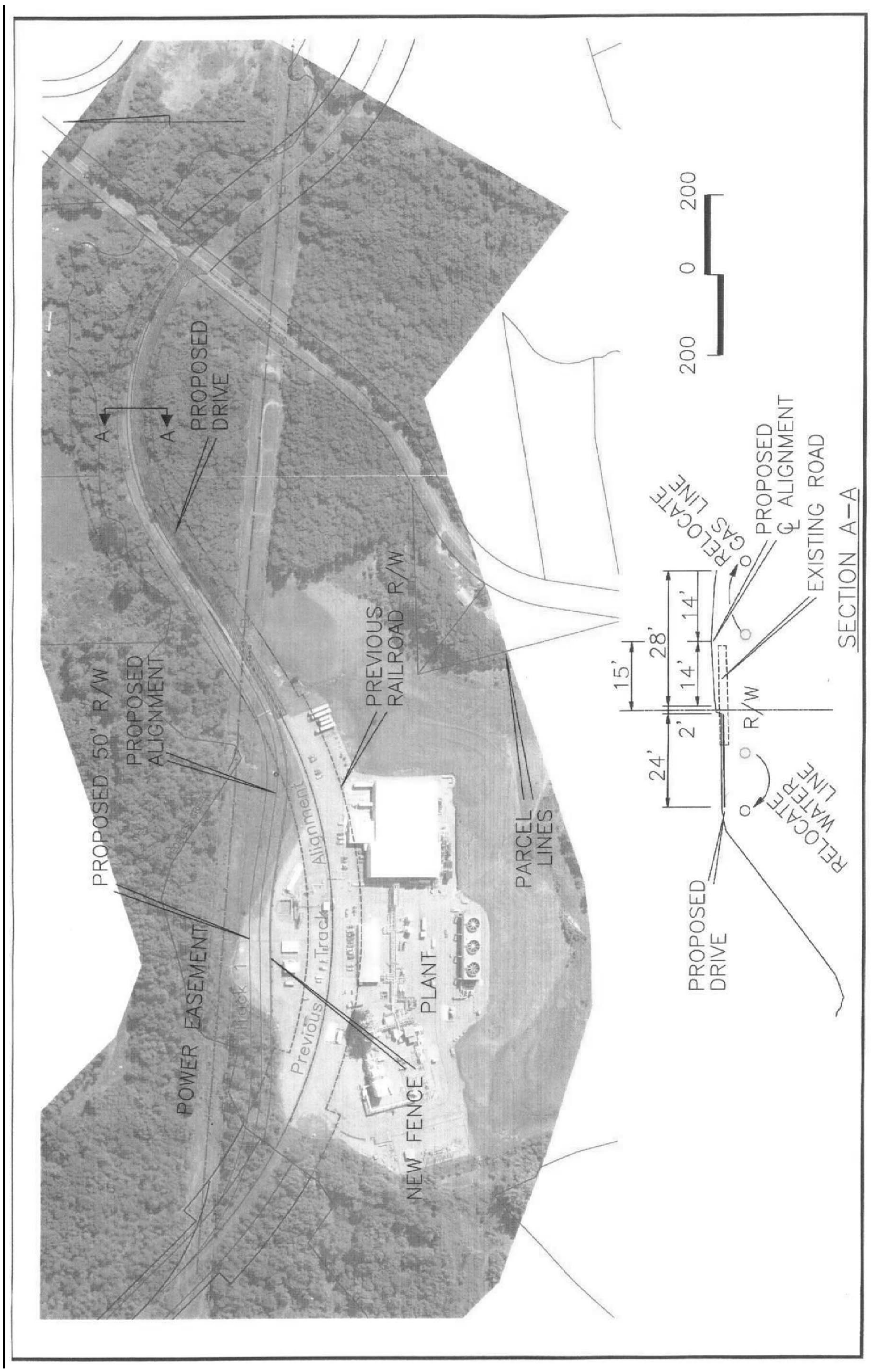

Figure 2-6. Proposed Railroad-Spur Detour

Three airports with regularly scheduled passenger air service reside within the region: Charlotte Douglas International Airport is 34 mi to the northeast, Hickory Regional Airport is 47 mi to the northeast, and Greenville-Spartanburg International Airport is 41 mi to the southwest. There are also several smaller municipal airports, including Spartanburg and Lincoln, and numerous agricultural-use airstrips scattered throughout the region (Duke 2009c).

2.3 Water

This section describes the hydrological processes governing movement and distribution of water in the existing environment at the Lee Nuclear Station site. The surface waterbodies, groundwater resources, existing water uses, and water quality in the vicinity of the site are described.

2.3.1 Hydrology

This section describes the site-specific and regional hydrological features that could be altered by construction and operation of the proposed Lee Nuclear Station Units 1 and 2 and by creating proposed Make-Up Pond C in the London Creek drainage northwest of the site. The hydrological features of the site and vicinity are presented in Section 2.3 of the ER (Revision 1) and the Make-Up Pond C supplement to the ER (Duke 2009b, c). Duke described the hydrological features of the site related to site safety (e.g., probable maximum flood) in the Final Safety Analysis Report (FSAR) portion (Part 2) of its COL application (Duke 2013a). All elevations in this section are given in feet above MSL unless otherwise stated. It is assumed that elevations reported in the ER have adopted the same convention when no vertical datum is otherwise referenced.

The Lee Nuclear Station site lies in the Broad River basin in the Piedmont physiographic region of South Carolina. As described in Section 2.1, the 1900-ac (3-mi^2) site is located southwest of the Broad River, 0.5 mi upstream of Ninety-Nine Islands Dam in Cherokee County, South Carolina (Figure 2-2). Elevations across the site range from approximately 512 ft at the Broad River to 816 ft at the top of McKowns Mountain, with the higher elevations to the west and lower elevations to the east (Duke 2009c). Lee Nuclear Station Units 1 and 2 would have a proposed final site grade of 593 ft (Duke 2013a).

London Creek is a tributary to the Broad River located just upstream and to the northwest of the Lee Nuclear Station site (Figure 2-7). It flows approximately 3.76 mi from the outflow of Lake Cherokee to its confluence with the Broad River (USACE 2013a); its drainage basin has a high elevation of 740 ft and a low elevation of about 520 ft at the Broad River. Duke proposes to dam approximately 3.16 mi of London Creek below Lake Cherokee to form Make-Up Pond C, a 620-ac impoundment designed to provide supplemental water to proposed Lee Nuclear Station Units 1 and 2 during periods of prolonged low flow in the Broad River (USACE 2013a).

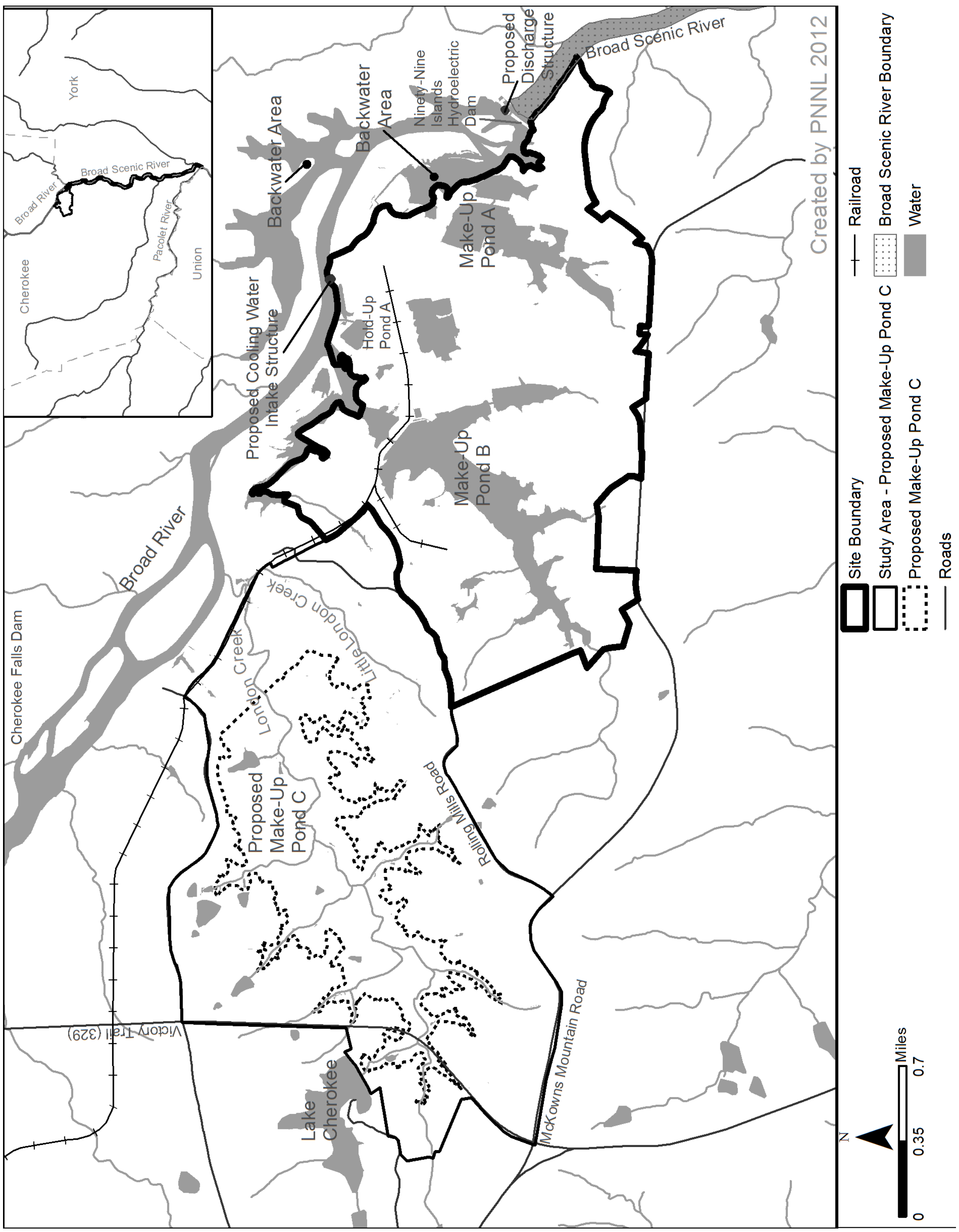

Figure 2-7. Waterbodies On and Near the Lee Nuclear Station Site

2.3.1.1 Surface-Water Hydrology

This section provides physical information needed to support the water-related assessment of surface-water including hydrological alteration, water use, water quality, aquatic ecology, radiological transport, and socioeconomic impacts.

Broad River

Surface-water in the vicinity of the Lee Nuclear Station site is dominated by the Broad River and onsite impoundments formed by damming local tributaries. The Broad River originates in the Blue Ridge Mountains in North Carolina, and flows southeast through the foothills and the Piedmont before its confluence with the Saluda River in Columbia, South Carolina, to form the Congaree River. These rivers are part of the larger Santee River Basin (USGS hydrologic unit code 030501). The upper and lower Broad River basins and other major watersheds within the Santee River Basin are shown in Figure 2-8 (Duke 2009c).

The drainage area of the Broad River above Ninety-Nine Islands Dam is approximately 1550 mi^2, consisting of the Upper Broad River (drainage area 184 mi^2) and four major tributaries: the Green River (137 mi^2), Second Broad River (513 mi^2), First Broad River (426 mi^2), and Buffalo Creek (163 mi^2) (Duke 2009c). Lower Buffalo Creek, Cherokee Creek, and other direct drainages make up another 130 mi^2 of drainage area. These drainage areas are shown in Figure 2-9, as are major dams and bridges in the upper Broad River basin.

Ninety-Nine Islands Reservoir, adjacent to the Lee Nuclear Station site, is a "run-of-the-river" impoundment of the Broad River formed by Ninety-Nine Islands Dam. Ninety-Nine Islands Reservoir and other onsite impoundments are described later in this section. Two other Broad River dams are in the vicinity of Lee Nuclear Station. Cherokee Falls Dam is 4.5 mi upstream of Ninety-Nine Islands Dam, and Gaston Shoals Dam is approximately 6 mi upstream of Cherokee Falls Dam. Like Ninety-Nine Islands Dam, both Cherokee Falls Dam and Gaston Shoals Dam were built for hydroelectric power (not flood control), and have run-of-the river reservoirs with no significant storage capacity. Further upstream in the Broad River basin there are over 100 dams, of which the two largest dams (Kings Mountain Lake and Lake Lure dams) represent approximately 64 percent of the Broad River basin storage capacity (Duke 2009c).

The streamflow in the Broad River has seasonal patterns typical of the southeastern United States. Flows generally mirror the pattern of precipitation, with higher flows in December through May and lower flows June through November. Flow fluctuations in the Broad River at the Lee Nuclear Station site would also be affected by the storage capacity of, and regulated releases from, upstream reservoirs. Streamflow data for the Upper Broad River is compiled by the USGS; gaging stations in the vicinity of the Lee Nuclear Station site and their characteristics are provided in Table 2-4. The nearest stream gaging station to the Lee Nuclear Station site is located on the Broad River just below Ninety-Nine Islands Reservoir (left bank of tailrace, 0.1 mi

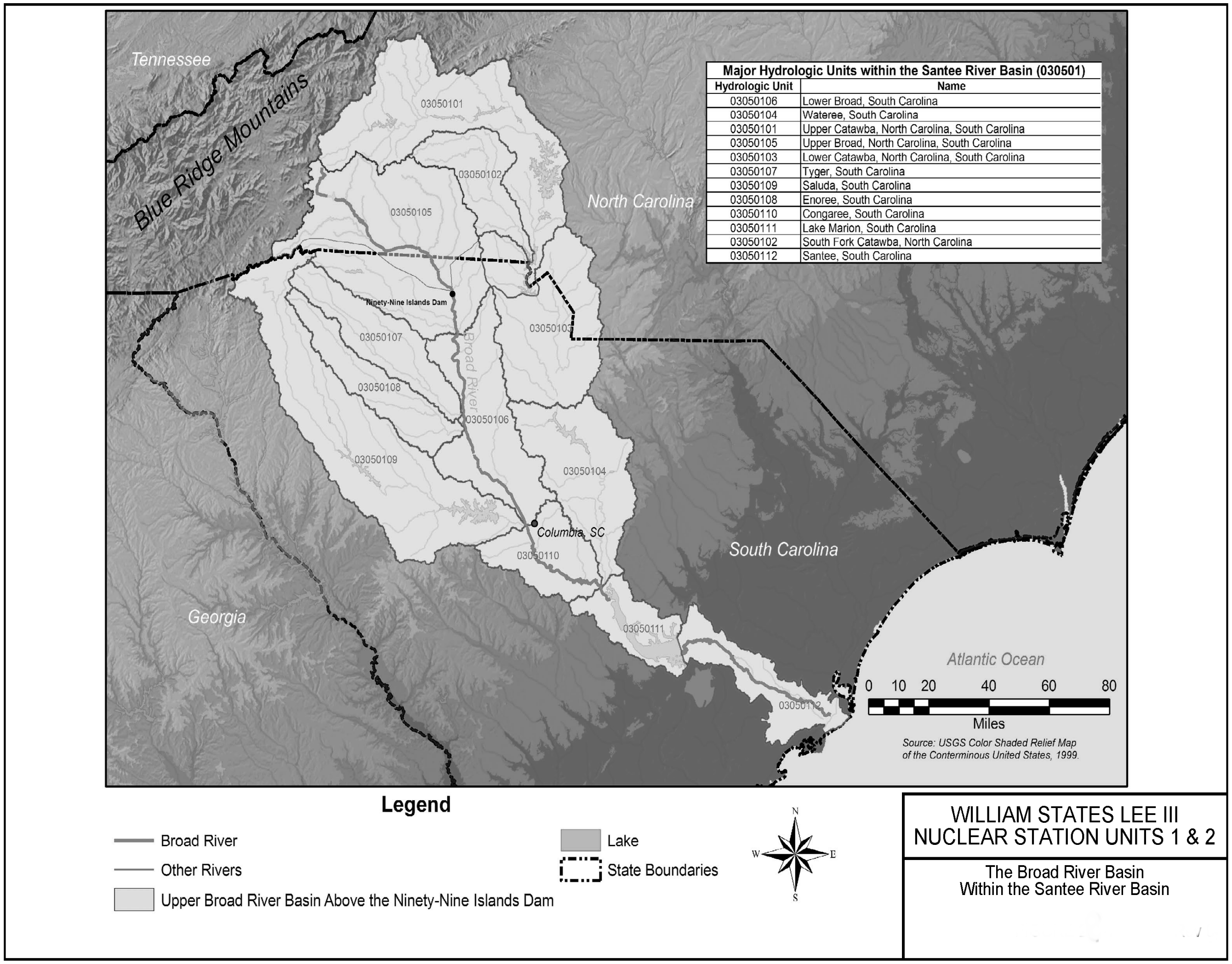

Figure 2-8. Upper and Lower Broad River Basins and Other Major Watersheds of the Santee River Basin (Duke 2009c)

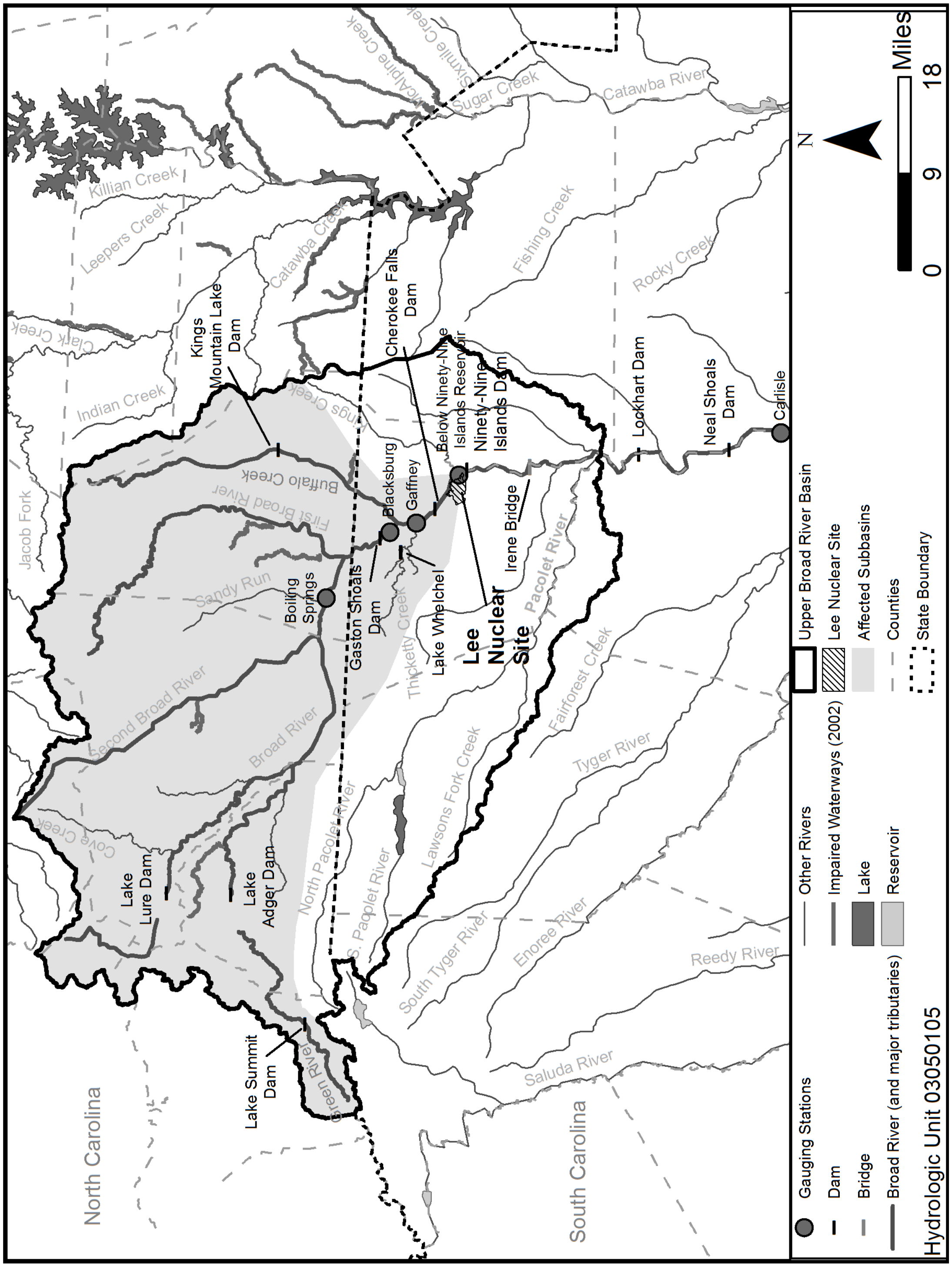

Figure 2-9. Upper Broad River Sub-Basins, Dams, and Gaging Stations

Table 2-4. USGS Monitoring Stations in the Vicinity of Lee Nuclear Station

USGS Gage	Description	Drainage Area (mi^2)	Period of Record for Discharge
02151500	Broad River near Boiling Springs, North Carolina	875	07/01/1925 to present
02153500	Broad River near Gaffney, South Carolina	1490	12/01/1938 to 09/30/1998
02153200	Broad River near Blacksburg, South Carolina	1290	09/24/1994 to present
02153551	Broad River below Ninety-Nine Islands Reservoir, South Carolina	1550	10/30/1998 to present[(a)]
02156500	Broad River near Carlisle, South Carolina	2790	10/01/1938 to present
02161000	Broad River at Alston, South Carolina	4790	10/01/1896 to present

Source: USGS 2010a, 2011b,c
(a) Prior to August 22, 2006, gage elevation was 412 ft NGVD29; present location is 700 ft downstream at elevation of 405 ft NGVD29.

upstream of Kings Creek) (USGS 2011a). The highest and lowest average monthly flows recorded by the USGS at this station were 8733 (April 2003) and 242 cfs (August 2002), respectively (USGS 2010a). During droughts, low flows can show considerable persistence. For instance, in the entire period from April 2007 through March 2009, the median monthly flow was exceeded for only one month (USGS 2010a, 2011a). Water years 2003 and 2008 have the highest and lowest annual mean flows of 4200 and 774 cfs, respectively. Based on the daily data for the same USGS gage for water years 2000 through 2010, the mean annual flow of the Broad River below Ninety-Nine Islands Reservoir is 1858 cfs and exceeds 467 cfs 90 percent of the time (USGS 2010a).

The USGS gage below Ninety-Nine Islands Dam has only operated since October 1998. Duke used data from the USGS gage near Gaffney, located approximately 8 mi upstream of the gage below Ninety-Nine Islands Dam, to construct a long-term flow record covering 85 years (1926-2010). Where gaps existed in the Gaffney record, flow estimates for Gaffney were calculated by pro-rating flows from the next gage upstream with available data (usually the USGS gage at Blacksburg, otherwise the USGS gage at Boiling Springs), based on the drainage area for that gage relative to the Gaffney Station drainage area (see Table 2-4) (Duke 2008a, 2009c). Using protocols consistent with USGS recommendations, Duke estimated a mean annual daily flow of 2495 cfs for the entire 85-year period of record and a mean annual daily flow of 1956 cfs for the most recent 10 years of record (2001 through 2010) at the Gaffney gage. Duke estimated a 7-day, consecutive low flow with a 10-year return frequency (7Q10) of 464 cfs (Duke 2011a).

The review team independently developed a synthetic, gap-filled streamflow record for the Broad River for the period July 1, 1925 to February 8, 2011 at the Lee Nuclear Station site. The review team's synthetic streamflow record was based on the USGS daily streamflow data using a combination of data from three gages and watershed proportionality. The review team's derived average flow was 2485 cfs.

The review team's estimate of mean annual flow (2485 cfs), Duke's estimate of mean annual flow (2495 cfs), and the USGS record of mean annual flow at the gage below Ninety-Nine Islands Dam (1858 cfs) are not inconsistent. The lower value for the USGS gage reflects the bias caused by a short period of record in which several severe droughts occurred. For the period 2001-2010, Duke reported a similar value (1956 cfs) to the USGS gage below Ninety-Nine Islands Dam (1858 cfs).

London Creek

London Creek is not gaged and there are no historical streamflow measurements, but Duke estimated London Creek flows by using a ratio of London Creek drainage area above the proposed dam location to the drainage area of Cove Creek near Lake Lure, North Carolina (USGS gage 02149000). The range of daily flows at the proposed dam location was estimated to be from near zero to a maximum of 213 cfs, with an average daily flow of approximately 7 cfs (Duke 2009b).

Vegetated areas experience evapotranspiration and other areas experience evaporation. These two hydrological processes transfer water from surface-water and groundwater to the atmosphere. The evaporation rate at any time is dependent on a variety of factors (e.g., humidity, air temperature, water temperature, and wind speed). Clemson University has measured and recorded 60 years of pan evaporation (Purvis 2011). The average pan evaporation for Clemson is 55 in./yr. This pan evaporation rate corrected to actual evaporation is 39 in./yr. The average annual evapotranspiration for the period from 1948 to 1990 in the vicinity of the Lee Nuclear Station site is estimated to be 30 in./yr (Cherry et al. 2001).

Impoundments

There are four impoundments on, or adjacent to, the Lee Nuclear Station site (Figure 2-7). Ninety-Nine Islands Reservoir, formed in 1910 by damming the Broad River for Ninety-Nine Islands Hydroelectric Project, is the largest of the impoundments. Ninety-Nine Islands Reservoir is the proposed source of cooling water for proposed Lee Nuclear Station Units 1 and 2. The reservoir characteristics, morphology, circulation, and mixing are described in Sections 2.3.1.3.1.1, 2.3.1.3.1.2, and 2.3.1.3.1.3 of the ER (Duke 2009c). Water flow through Ninety-Nine Islands Reservoir is dominated by the main channel of the Broad River, which separates two backwater areas formed by flooding side channels and small tributaries, one on each side of the river just above the dam (Figure 2-7). Evaporation and seepage are thought to be insignificant losses in terms of the water balance within Ninety-Nine Islands Reservoir because it is a run-of-the-river reservoir with estimated transit times of 3 hours at average flow (2500 cfs) and 16 hours at low flow (440 cfs), assuming a 570 ac-ft storage capacity in the main channel area and ignoring the backwater areas, which exhibit little circulation in nonflood periods (Duke 2009b).

Ninety-Nine Islands Reservoir is fairly shallow, so the impounded area and volume of the reservoir can change significantly with small fluctuations in reservoir level (Duke 2009c). In a September 2006 bathymetry study, Enercon (Duke 2008n) reported a maximum depth of 35.2 ft and a mean depth of 9.2 ft in a survey area that included both the Broad River main channel and backwater areas of Ninety-Nine Islands Reservoir. A more recent bathymetry study of Ninety-Nine Islands Reservoir conducted by Devine Tarbell & Associates (DTA) estimated a 351 ac surface area and 1684 ac-ft storage volume at full pond (DTA 2008a). The DTA study provides a table of projected area and volume changes with changes in water surface elevation (DTA 2008a).

Ninety-Nine Islands Reservoir and Ninety-Nine Islands Dam sustain Ninety-Nine Islands Hydroelectric Project, which is operated by Duke (Duke 2009c). Operations of Ninety-Nine Islands Hydroelectric Project and Ninety-Nine Islands Reservoir are regulated by the Federal Energy Regulatory Commission (FERC). The drawdown of Ninety-Nine Islands Reservoir is limited to 510 ft (1 ft below full impoundment level of 511 ft) from March to May and 509 ft (2 ft below full impoundment) for the remainder of the year, as permitted by the FERC operating license (Duke 2009c). At the 509-ft elevation, Ninety-Nine Islands Reservoir storage volume is estimated to be 1122 ac-ft (DTA 2008a). Article 402 of the FERC license for Ninety-Nine Islands Dam, issued June 17, 1996 and amended November 2011 (FERC 2011c), specifies continuous minimum flows for three periods: 966 cfs for January through April; 725 cfs for May, June, and December; and 483 cfs for July through November. It is unclear from Article 402 whether each of the three minimums or just the lowest minimum is the appropriate criteria to curtail withdrawals. The review team discussed the definition of minimum flows with FERC, (NRC 2012c). Uncertainty remained after these discussions as to the specific nature of the implementation of the low-flow limitations. In order to bracket the residual regulatory uncertainty from FERC, the review team decided to evaluate both seasonal low-flow limitations and a single low-flow limitation.

Ninety-Nine Islands Reservoir velocity distributions and bathymetry in the area affected by the Lee Nuclear Station intake structure are discussed in ER Section 2.3.1.2.1.3. The proposed location of the intake structure is on the shore of Ninety-Nine Islands Reservoir where the main channel of the Broad River is impounded by Ninety-Nine Islands Dam, approximately 1.5 mi upstream of the dam (Figure 2-7). The 2006 bathymetry survey shows a narrow scour channel in the vicinity of the proposed intake structure (Duke 2008n). The DTA (2008) bathymetry survey also shows deeper water at the proposed intake location. At the time of the 2006 bathymetry survey, Enercon (Duke 2008n) also measured river velocity at 5-ft depth intervals to 15 ft at seven stations along a cross-section of the Broad River at the intake structure location. The river is approximately 240 ft wide near the intake structure location. Enercon (Duke 2008n) measured velocities ranging from 0.24 to 0.40 ft/s, with an average of 0.32 ft/s.

The proposed location of the Lee Nuclear Station Units 1 and 2 discharge structure is on the upstream side of Ninety-Nine Islands Dam toward its northeast end, approximately 150 ft south of the intake for the hydroelectric powerhouse (Figure 2-7). Ninety-Nine Islands Reservoir velocity distributions and bathymetry in the area affected by the discharge structures were not characterized for the ER because of restricted access and safety issues related to hydroelectric operations (Duke 2009c). However, the Ninety-Nine Islands Reservoir survey conducted by DTA for Duke included bathymetric and water velocity data for Ninety-Nine Islands Reservoir immediately above the dam, and water elevation and velocity data for the tailrace below the dam (DTA 2008a). Velocities in the lower portion of the reservoir, just above the dam, ranged from zero to 1.72 ft /s when no hydroelectric units were operating and from zero to 2.34 ft/s when one hydroelectric unit was operating (DTA 2008a). In the immediate vicinity of the proposed outfall, velocities were generally in the 0.05 to 0.10 ft/s range when no units were operating and higher and more variable (generally 0.26 to 0.75 ft/s) when one hydroelectric unit was operating. USGS records indicate that Ninety-Nine Islands Reservoir was discharging approximately 500 cfs on the days of the survey (USGS 2011a).

The outfall diffuser for proposed Lee Nuclear Station Units 1 and 2 would release effluent on the upstream side of the dam and most of the effluent would flow into the hydroelectric powerhouse intake. DTA reported that water depth across most of the tailrace was less than 2 ft, with maximum depths of 5 ft when no hydroelectric units were operating and 6 ft when one hydroelectric unit was operating. Water velocities ranged from 0.01 to 3.9 ft/s, and were highest below the powerhouse (northeast end of the dam) and lower below the spillway and the southwest bank. No water was flowing over the spillway at the time of the survey (DTA 2008a).

Three impoundments are located on the Lee Nuclear Station site: Make-Up Pond A, Make-Up Pond B, and Hold-Up Pond A (Figure 2-7). The characteristics of these impoundments are shown in Table 2-5. These impoundments were created in the late 1970s during the initial construction phase of the unfinished Cherokee Nuclear Station.

Table 2-5. Characteristics of Surface-Water Impoundments on the Lee Nuclear Station Site

Impoundment[(b)]	Impounded Stream, (Watershed Area, mi^2)[(a)]	Normal Water Elevation (ft MSL)	Surface Area (ac)[(b)]	Mean Depth (ft)[(b)]	Total Storage (ac-ft)[(b)]
Make-Up Pond B	McKowns Creek (2.55)	570	154	31	3994
Make-Up Pond A	Arm of Ninety-Nine Islands Reservoir (0.6)	547	62	26	1425
Hold-Up Pond A	Site runoff (0.031)	535	4	not found	52

(a) Source: Duke 2008b
(b) Source: Duke 2009c

Wetlands

Wetlands occurring on the Lee Nuclear Station site, in the London Creek drainage adjacent to the site, and in affected offsite areas are described in Section 2.4.1.

2.3.1.2 Groundwater Hydrology

Groundwater aquifers in the region of the Lee Nuclear Station site and Make-Up Pond C site are described in Section 2.3.1.5 of the ER (Duke 2009c, 2009b). The geology of each site is summarized in Section 2.8 of this environmental impact statement (EIS) and detailed in Section 2.5 of the FSAR (Duke 2013a).

The Lee Nuclear Station site and Make-Up Pond C site lie within the Piedmont physiographic province where rolling hills are cut by drainages with steep slopes. In undisturbed areas, the bedrock is overlain by unconsolidated materials. These materials include a soil zone known as residuum, or residual soil; a zone of weathered bedrock known as saprolite; and alluvium (Miller 2000). Alluvium is sediment deposited by flowing water, such as in a riverbed or river delta. During construction of the unfinished Cherokee Nuclear Station, some hills were removed, some drainages were filled, a substantial excavation was created, and a large relatively flat plateau was created for the unfinished units. Between the excavation and Hold-Up Pond A (to the north) approximately 60 ft of fill was placed to create the plateau surface at approximately 588 ft (Duke 2013a). To the east of the excavation, creation of the plateau required up to 40 ft of fill between the excavation and Make-Up Pond A. The site grade for the Lee Nuclear Station will be 593 ft. The long-term water table is expected to fluctuate between 584 and 574 ft (Duke 2013a).

A two-layer aquifer system that is more local than regional exists within the Piedmont physiographic province (Duke 2009c; Miller 2000). The upper aquifer is found in the saprolite strata, while the lower aquifer is found in the partially weathered and unweathered bedrock. Both aquifers are unconfined because there are no low-permeability strata isolating them, and consequently, the saprolite and bedrock materials are viewed as one interconnected aquifer. These aquifers are recharged by infiltration from local precipitation and by infiltration from adjacent natural and constructed surface waterbodies. Within this aquifer system water does not recharge to great depths before being redirected laterally by the low-permeability unweathered bedrock that has a lower fracture density (Duke 2009c). The interconnectedness of the soils and saprolite with the fractures of partially weathered and unweathered bedrock allow the overlying sediments to act as a reservoir with water moving vertically downward into fractures and then laterally to wells completed in the weathered bedrock (Miller 2000).

From a groundwater hydrology perspective, the Lee Nuclear Station site is bounded on the west by Make-Up Pond B with an approximate water surface elevation of 570 ft, on the north and northeast by the Broad River behind Ninety-Nine Islands Dam with an approximate water surface elevation of 511 ft, and on the east-southeast by Make-Up Pond A with an approximate water surface elevation of 547 ft (Duke 2009c). Private wells completed on properties on McKowns Mountain Road near the entrance to the Lee Nuclear Station site are the closest wells to the site. It is these wells that could affect or be affected by building and operating the proposed Lee Nuclear Station.

Prior to construction of the unfinished Cherokee Nuclear Station, water level measurements made on the proposed site and in nearby private wells revealed a water table that conformed to the surface topography and hydraulic gradients that sloped from the proposed reactor location toward the Broad River impounded behind Ninety-Nine Islands Dam (Duke Power Company 1974a, b, c). The original undisturbed Cherokee Nuclear Station site included numerous springs and seeps in locations that have since been cut or filled to create the landscape needed for the site. The changes created during that earlier building effort appear to have altered subsurface flow such that at many locations springs were buried or their flow disrupted (Duke 2009c).

A network of storm drains and buried piping was installed during site preparation for the unfinished Cherokee Nuclear Station. Some of these stormwater control structures remain onsite (Duke 2009c). Such structures located upgradient (i.e., to the south) of the nuclear island could intercept groundwater and allow it to drain toward Make-Up Pond A; however, such structures would not adversely affect groundwater in the vicinity of the power block (Duke 2013a). One such structure was designed to remove stormwater from the Cherokee Station power block. This existing storm drain and its associated materials will be removed by overexcavation when building proposed Lee Nuclear Station Units 1 and 2 (Duke 2013a).

When building proposed Lee Nuclear Station Units 1 and 2, additional excavation will be required to remove softened or loose soil and rock to expose relatively undisturbed materials (Duke 2013a). Additional grooming of the excavation slope will also be required to create the necessary foundation support zone for the nuclear island. Some additional excavation will be required in the vicinity of both proposed units (Duke 2013a).

Groundwater at the Lee Nuclear Station and Make-Up Pond C sites is found in the pore space of the overlying soils and saprolite and in the fractures of the partially weathered and unweathered bedrock (Duke 2009c). Of the natural materials, the partially weathered bedrock provides a consistent and connected fracture permeability and is generally the most hydraulically conductive aquifer media (Duke 2013a). The overlying soils and saprolite with their clay content and the underlying unweathered bedrock with sparse and poorly connected fractures (Duke 2009c, 2013a) provide lower conductivity. The undifferentiated material, which occurs to 100 ft deep, is composed of fill material, soil, saprolite, and partially weathered bedrock. These materials exhibit somewhat higher hydraulic conductivity values than the natural, undisturbed materials (Duke 2013a). However, the Cherokee-era site investigations that provide these results for the entire soil/sediment/rock profile could not be analyzed for properties of individual strata (Duke 2009d). An estimate of hydraulic conductivity in the partially weathered bedrock (i.e., conservative estimate 1.4×10^{-3} cm/s, maximum value 9.89×10^{-3} cm/s) was obtained from aquifer tests in 2006 and best represents the hydraulic conductivity of flow paths from the proposed units to the accessible environment (Duke 2013a). Total and effective porosity values for the partially weathered bedrock were reported as 27 and 8 percent, respectively (Duke 2013a).

Groundwater flows through the overlying soils and saprolite, into the underlying weathered and fractured bedrock, and then into the less conductive deeper unweathered bedrock. Potentiometric diagrams based on water level measurements completed between April 2006 and March 2007 (see Figure 2-10, Duke 2013a) suggest that groundwater flows either (1) toward the dewatered excavation or (2) off the plateau created for the unfinished Cherokee Nuclear Station and toward Hold-Up Pond A, Make-Up Ponds A and B, or the Broad River. A depiction of groundwater hydraulic head and flow consistent with an undisturbed site does not exist. From December 2005 until March 2006, preconstruction dewatering was undertaken to allow subsurface investigation of the pre-existing excavation. That dewatering effort, using a sump pit and sump pump approach, has continued unabated since March 2006 to maintain an essentially dry excavation supporting demolition of the unfinished Cherokee Nuclear Station Unit 1 structures. Duke reported the average maintenance dewatering rate through March 2007 as 0.39 cfs (250,000 gpd) (Duke 2008c). Accordingly, the year-long effort to collect groundwater hydraulic head data to understand the seasonal variations in the groundwater resource was biased by the dewatering stress on the aquifer. Data gathered from April 2006 and March 2007 at one onsite well (i.e., MW 1214) relatively far from the dewatering effort showed that the groundwater level declined during the late spring, summer, and early fall months and recovered during the late fall, winter, and early spring months—consistent with seasonal precipitation and evapotranspiration in the region (Duke 2009c).

Dewatering during the construction of the unfinished Cherokee Nuclear Station was achieved by pumping groundwater wells completed to depths of 200 to 280 ft below ground surface that were located outside the excavation and internal sump pits (Duke 2009c, 2013a). The drawdown that occurred during this first dewatering effort is shown in Figure 2-11; wells monitored by Duke between 1976 and 1985 outside the shadowed region were not affected (Duke 2013a). While groundwater levels and quality have been affected by mining excavations in the region (Castro et al. 1988), South Carolina Department of Health and Environmental Control (SCDHEC) staff did not find any record of problems or investigations associated with groundwater elevation or quality when building the unfinished Cherokee Nuclear Station (SCDHEC 2011a). The nearest residential well is located approximately 5000 ft south of the center of the excavation. Because dewatering effects extended less than 1700 ft to the south of the center of the excavation, the nearest offsite well was not affected. The extent of excavation and fill in the vicinity of the unfinished Cherokee Nuclear Station forms the initial landscape for the Lee Nuclear Station. Accordingly, less excavation and fill will be necessary to build the proposed Lee Nuclear Station Units 1 and 2.

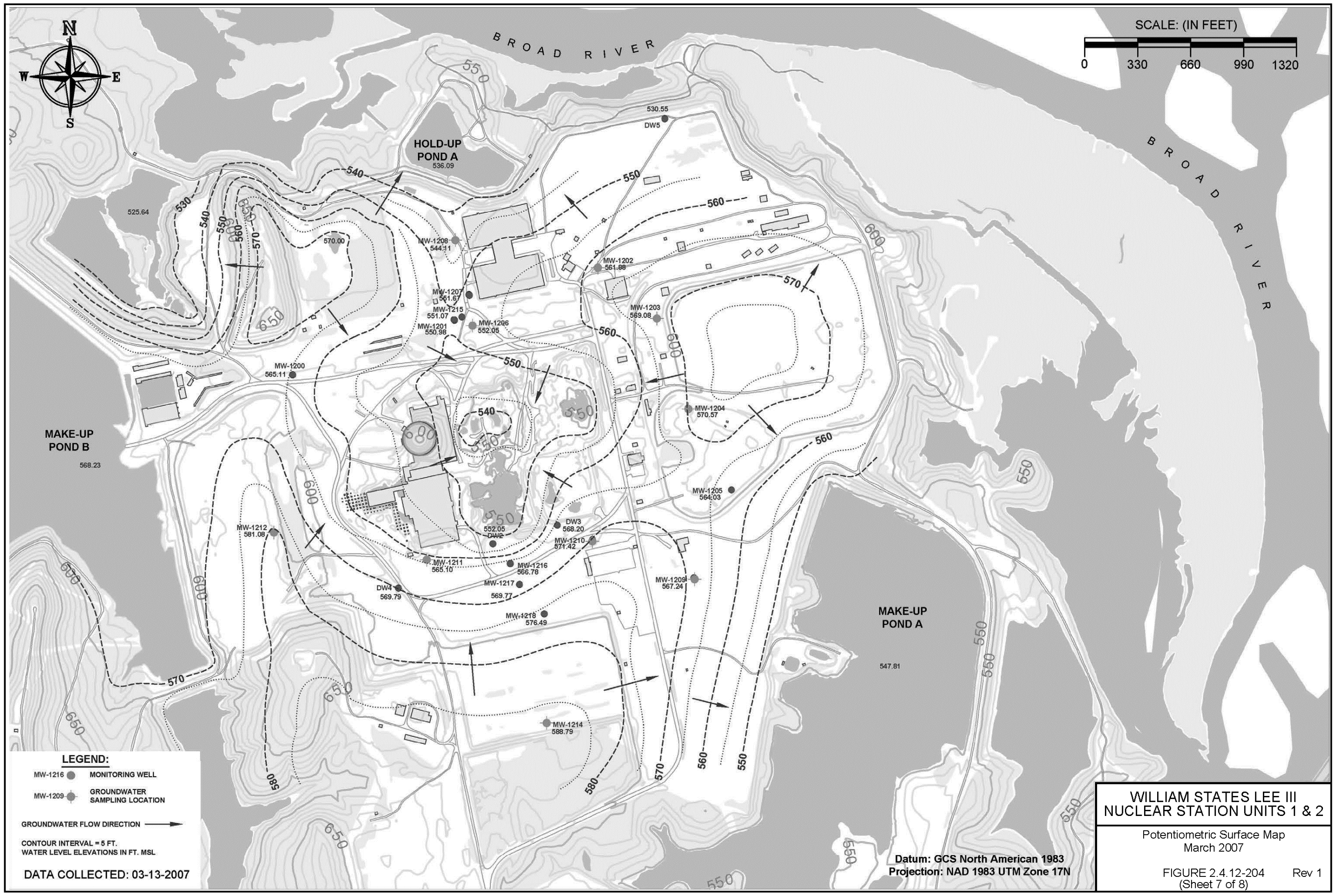

Figure 2-10. Potentiometric Surface Map of the Site of the Proposed Lee Nuclear Station, March 2007 (after Duke 2013a, FSAR Rev 7, Figure 2.4.12-204, sheet 7 of 8)

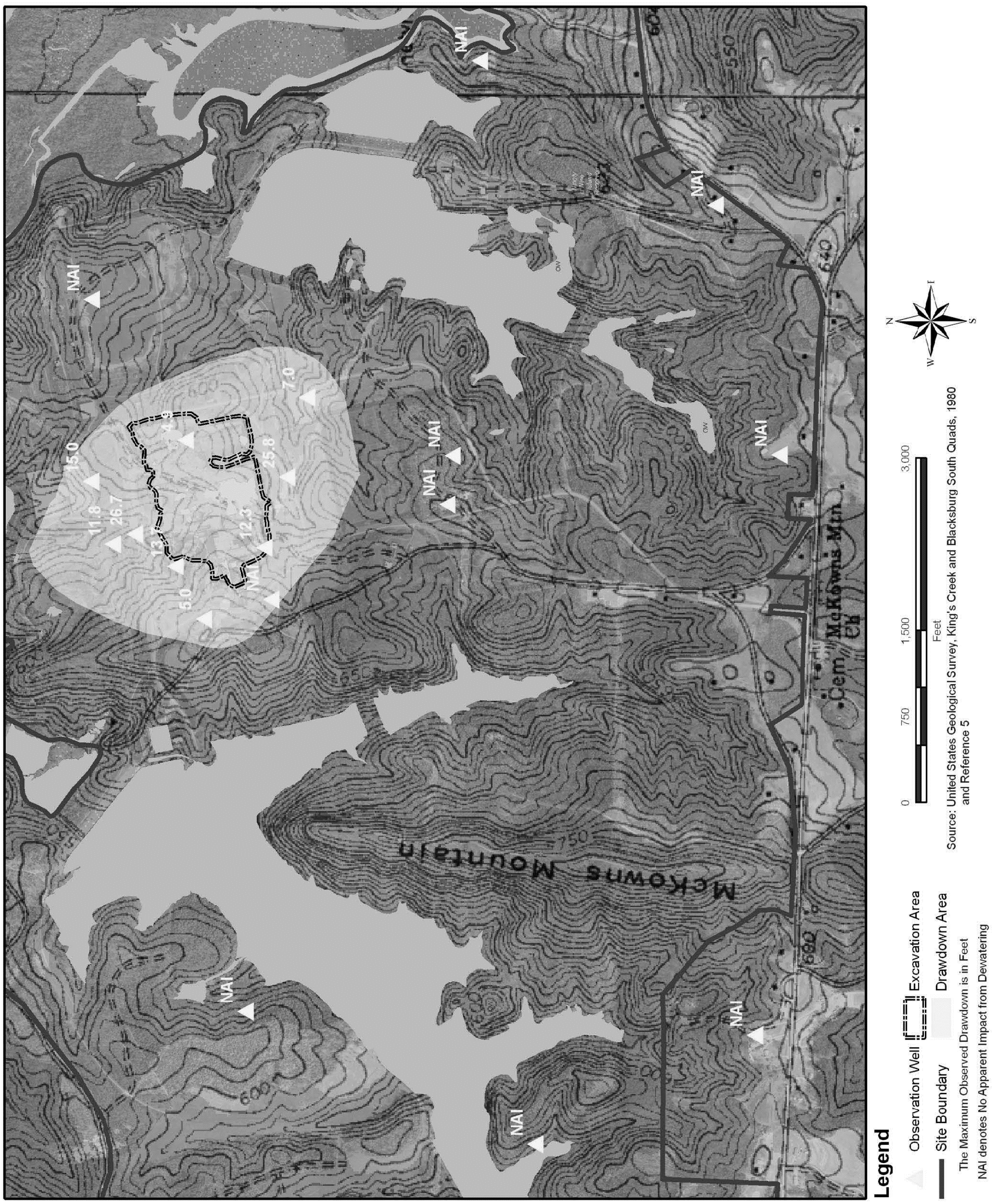

Figure 2-11. Area of Influence of Cherokee Nuclear Station Dewatering (after Duke 2009c, ER Rev 1, Figure 2.3-13)

The review team notes that the hydrologic system, including both surface water and groundwater, that served as a background during the construction at the unfinished Cherokee Nuclear Station has changed. During that earlier construction period, high points in the topography were removed and low points were filled to create the plateau at approximately 588 ft on which the unfinished Cherokee Nuclear Station was, and proposed Lee Nuclear Station Units 1 and 2 are to be constructed. The water table has changed accordingly. In addition, a ravine that was to the west of the nuclear island is now the site of Make-Up Pond B, with water at an approximate elevation of 570 ft. Where the earlier excavation dewatering created a cone of depression within the aquifer without contacting a surface-waterbody, the current dewatering effort and associated cone of depression may be influenced by the presence of Make-Up Pond B, because Make-Up Pond B's water level is above the elevation of the dry excavation (see Figure 2-4). Current hydraulic head data suggest a potential for this hydraulic connection between pond and excavation. However, because the dewatering product is being discharged into Make-Up Pond B during the current preconstruction effort, influence on the pond has been minimal or non-existent.

Duke postulates several alternative conceptual models of the groundwater pathway from the Lee Nuclear Station site to the accessible environment. Possible receptor locations include (1) Hold-Up Pond A, (2) the Broad River, (3) Make-Up Pond A, (4) a wetland located northwest of the nuclear island, and (5) Make-Up Pond B (Duke 2009c). An analysis of alternative groundwater pathways including alternative conceptual models of flow and transport, and evaluation of the potential effects of a postulated accidental release in the vicinity of the power block is in the FSAR Sections 2.4.12 and 2.4.13 (Duke 2013a).

To simplify the analysis of the potential for future contaminant transport in this groundwater environment, Duke has proposed use of the concept of a single, worst-case, straight-line, shortest-distance, highest-conductivity pathway. This results in a straight-line pathway from the proposed power block to the receptor location. All pathways were assumed by Duke to have the partially weathered bedrock values for hydraulic conductivity and effective porosity. The shortest travel time pathway was identified from proposed Unit 2 to Hold-Up Pond A and has an estimated travel time of 1.5 years (Duke 2013a).

The Make-Up Pond C study area is located in the London Creek drainage, to the west and offsite from the Lee Nuclear Station site (Figure 2-4) (Duke 2009b). Elevations within the London Creek watershed range from a topographic high north of London Creek (763 ft), to the proposed Make-Up Pond C water level (650 ft), and to 535 ft at the proposed main dam for the pond. Groundwater levels in the study area vary from approximately 27 to 50 ft below ground surface, and generally mirror the surface topography. Based on measurements of hydraulic properties within the Make-Up Pond C study area and considering estimates based on Lee Nuclear Station site analyses, pore-water velocity is estimated to range from 26 to 37 ft/yr in the saprolite strata, and from 71 to 100 ft/yr in the partially weathered and upper crystalline rock strata.

2.3.2 Water Use

Consideration of water use requires estimating the magnitude and timing of consumptive and non-consumptive water use. Non-consumptive water use does not result in a reduction in the water supply available. For instance, water used to return fish from the water-intake structure to the reservoir would result in no change in the water supply, as the same volume of water pumped from the reservoir would eventually be returned to the reservoir. However, consumptive water-use results in a reduction of the water supply available. For instance, reservoir evaporation results in a transfer of water from the reservoir to the atmosphere, thereby reducing the reservoir volume. The following two sections describe consumptive and non-consumptive uses of surface-water and groundwater.

2.3.2.1 Surface-Water Use

An analysis of water-supply uses and needs for the Broad River basin was documented by Duke Energy (Duke Energy 2007). This study divided the Broad River basin into 40 sub-basins. Existing and projected water withdrawals and returns were estimated for each sub-basin for power, agricultural, public water, and industrial sectors. The net consumptive use for the Broad River basin (withdrawal less return) for 2006 was estimated as 241 cfs. This represents 4.5 percent of the mean annual flow of the basin (5342 cfs) as measured at the Alston gage near Columbia, South Carolina, for the period of record 1981-2010 (USGS 2010b).

2.3.2.2 Groundwater Use

Duke describes groundwater use in the vicinity of the Lee Nuclear Station site in Section 2.3.2.2 of the ER (Duke 2009c). Groundwater use in the immediate vicinity of the Lee Nuclear Station site is limited to individual residences located along McKowns Mountain Road near the entrance to the site (Duke Power Company 1974a, b, c; Duke 2009c). The nearest private well is approximately 5000 ft from the proposed Lee Nuclear Station Unit 1 and 2 power block. The Gaffney Board of Public Works, which withdraws water from the Broad River, provides potable water in the area, including the cities of Gaffney and Draytonville, South Carolina (Duke 2009c). However, some residences in the vicinity of proposed Lee Nuclear Station Units 1 and 2 continue to rely on residential wells for potable water. In 1999, public water supply was not available to residences within 2 mi of the proposed Lee Nuclear Station; however, almost a decade later it was estimated that 83 percent of those residences have the option of public water supply and 59 percent are connected to the public supply (Duke 2008d).

Duke does not plan to use either groundwater or surface water produced at the site while building proposed Lee Nuclear Station Units 1 and 2 (e.g., fire protection, dust control, concrete batch plant operation, potable or sanitary water). All such water requirements will be satisfied by the Draytonville Water District (Duke 2009c). Potable water during operation of the plant will also be provided by the Draytonville Water District.

Duke describes groundwater use in the vicinity of the proposed Make-Up Pond C study area in Section 2.3.2.2.1 of the ER (Duke 2009b). While many residences outside the area to be inundated by the proposed Make-Up Pond C have the option of connecting to the public water supply, residences adjacent to the proposed Make-Up Pond C that currently rely on groundwater wells as a domestic water supply may continue to do so.

2.3.3 Water Quality

The following sections describe the water quality of surface-water and groundwater resources in the vicinity of the Lee Nuclear Station site. Pre-application monitoring programs for thermal and chemical water quality are also described.

2.3.3.1 Surface-Water Quality

The Broad River is both the water-supply source for proposed Lee Nuclear Station Units 1 and 2 and the receiving water for plant discharges. Water quality in the Broad River has been regularly evaluated and compared to State water-quality standards by the SCDHEC watershed water-quality assessment program. Waterbodies that do not meet State standards are identified on a Clean Water Act Section 303(d) list of impaired waters based on levels of metal and organic constituents, dissolved oxygen, fecal coliform, nutrients, pH, the presence of biota, and organism tissue evaluations (SCDHEC 2010a). Several stations in the upper Broad River watershed are listed as impaired for aquatic life use because of macroinvertebrate survey results or copper concentration. In 2008, the two stations nearest the proposed site (i.e., B-062 Thicketty Creek and B-042 Broad River 4 mi northeast of Gaffney) and sites further upstream and downstream were listed as impaired because the copper standard was exceeded. However, these stations were removed from the 303(d) list of impaired waterbodies in 2010, when the copper standard was attained in all but a few stations in the Pacolet River watershed (SCDHEC 2010a). The Pacolet River enters the Broad River downstream of the Lee Nuclear Station site.

In 2006, Duke (2009b, c) conducted pre-application quarterly water-quality sampling at five stations in the main channel and two stations in the backwater areas of the Broad River near the site. Constituent information for the five stations located in the main channel is summarized in Table 2-6. Duke compared water-quality monitoring data from 2006 with historical data from extensive sampling done in 1973 and 1974, in advance of building activities for the unfinished Cherokee Nuclear Station, and in 1989 and 1990 above and below Ninety-Nine Islands Dam in support of Ninety-Nine Islands Hydroelectric Project. Most 2006 water-quality measurements were found to be consistent with historical data (Duke 2009c). The copper concentration in one of the 2006 samples exceeded the water-quality standard (underlined maximum in Table 2-6), but copper was not detected in most samples and the mean copper concentration was below the standard (Duke 2009c). As noted above, the Broad River in the vicinity of the Lee Nuclear Station site is no longer considered to be impaired for aquatic life uses because of copper (SCDHEC 2010a).

Table 2-6. Broad River Water Quality Near the Lee Nuclear Station Site

Constituent	Units	South Carolina CMCs for Freshwater Aquatic Life[a]	Concentration in Broad River Near the Lee Nuclear Station Site[b]	
			Mean	Maximum
Aluminum	mg/L	--	0.163	0.268
Arsenic	µg/L	340	0.36	2.18
Barium	µg/L	--	19.2	22.4
Boron	mg/L	--	<0.1	<0.1
Cadmium	µg/L	0.53	<0.5	<0.5
Chromium	µg/L	--	0.827	1.68
Copper	µg/L	3.8	1.31	4.97[c]
Iron	mg/L	--	0.855	1.11
Lead	µg/L	14	<2	<2
Magnesium	mg/L	--	1.67	1.88
Manganese	µg/L	--	47.7	61.9
Mercury	µg/L	1.6	<0.087	<0.1
Nickel	µg/L	150	0.128	2.95
Selenium	µg/L	--	<2	<2
Silver	µg/L	0.37	<0.5	<0.5
Sulfate	mg/L	--	6.26	9.77
Zinc	µg/L	37	5.44	12.6

Source: Duke 2009b
(a) South Carolina Water Classifications and Standards Regulation 61-68 (June 22, 2012) established maximum concentrations for freshwater (CMCs) (SCDHEC 2012a).
(b) Calculated from quarterly monitoring (February, May, August, November 2006) at five stations within the main channel of the Broad River.
(c) Exceeds CMC value.
CMC = criterion maximum concentration, mg/L = milligrams per liter, µg/L = micrograms per liter.

In Duke's 2006 and earlier (1970s) water-quality studies near the Lee Nuclear Station site, field measurements of water surface temperature were found to be the same as or very close to the ambient air temperature at the time of sampling. To better characterize the water temperature regime in Ninety-Nine Islands Reservoir, Duke monitored temperature hourly from early December 2006 through June 2008 at two locations, one about 1 mi upstream of the proposed intake location, and one at the intake location. In March 2008, Duke added a temperature logger in the dam forebay near the proposed discharge location. Temperature patterns were seasonal, ranging from a low of 38°F in winter to highs of 90°F (2008) and 92°F (2007) in summer, and consistent between all stations in the reservoir (Duke 2009c). In May through August 2007 and between January and early August 2008, Duke also monitored temperature hourly at four locations just below (i.e., within about 0.5 mi of) the dam. The temperature regime below the dam followed the same seasonal pattern as the reservoir, but very low and very high temperatures appeared to fluctuate more below the dam (Duke 2009c).

2.3.3.2 Groundwater Quality

Groundwater characterization during construction of the unfinished Cherokee Nuclear Station Units 1 and 2 (1970s) provided a baseline for groundwater quality discussed in Section 2.3.3.2 of the ER (Duke 2009b, c). While more recent sampling provides a more complete water-quality characterization, the prior and recent work both report results for pH, dissolved solids, alkalinity bicarbonate as $CaCO_3$, total hardness, iron, calcium, magnesium, chloride, sulfate, turbidity, and specific conductance. The results of recent monitoring (i.e., 2006 to 2007) are consistent with the earlier baseline (Duke 2009c) where iron is above its standard in both characterizations (EPA 2008a).

Duke collected samples quarterly from monitoring wells at the Lee Nuclear Station site from May 2006 through February 2007 and reported the results in its ER (Duke 2009c). The recent average concentrations for the metals iron (average, Secondary Maximum Concentration Limits [SMCLs]; 0.41 mg/L, 0.3 mg/L) and manganese (165 μg/L, 50 μg/L) exceeded U.S. Environmental Protection Agency (EPA) Drinking Water Standard SMCLs. The average concentration for the metal aluminum (i.e., average 0.33 mg/L, SMCL range 0.05 to 0.2 mg/L) and the average value for pH (average 6.08 SMCL range 6.5 to 8.5 were also found outside their acceptable SMCL ranges (Duke 2009c). The EPA has established Secondary Drinking Water Standards as guidelines to assist public water systems in managing aesthetic considerations such as the taste, color, and odor of drinking water. Contaminants at the SMCL level are not considered to present a risk to human health, and public water systems test for them on a voluntary basis. If the groundwater were a public water supply using conventional or direct filtration, the recently reported results for turbidity would require filtration to lower its measurement to no greater than 1 nephelometric turbidity unit. The USGS noted that elevated concentrations of iron may arise from groundwater flow through mineralized zones or due to the action of iron-fixing bacteria. However, the USGS also noted that groundwater with elevated levels of iron and manganese can be rendered potable through oxidation and filtration (Miller 2000).

Groundwater samples were also collected and analyzed at wells installed for the hydrogeologic assessment of proposed Make-Up Pond C (Duke 2009b). Analytical results for the offsite Make-Up Pond C study area are similar to the results reported in the preceding paragraph for the Lee Nuclear Station site.

All sanitary service for both building and operation of the Lee Nuclear Station would be provided by the Gaffney Board of Public Works, with treatment of the waste occurring at an offsite location (Duke 2009c).

2.3.4 Water Monitoring

Duke outlines programs for hydrologic and chemical monitoring related to proposed Lee Nuclear Station Units 1 and 2 in ER Sections 6.3 and 6.6 (Duke 2009c).

2.3.4.1 Surface-Water Monitoring

Broad River flows are monitored continuously at several USGS gaging stations near the Lee Nuclear Station site; Table 2-4 lists gaging stations both upstream and downstream of the site along with their periods of record for streamflow measurements. The nearest continuous temperature monitoring site is the gage at Carlisle, approximately 50 mi downstream of Ninety-Nine Islands Dam. Other water-quality parameters (e.g., dissolved oxygen, suspended solids, bacteria, nutrients, and chemical contaminants) have been measured periodically by the SCDHEC to characterize basin-wide water quality. As described in Section 2.3.3.1, Duke conducted site-specific surface-water-quality monitoring studies in the 1970s prior to building the unfinished Cherokee Station and in 1989 and 1990 for Ninety-Nine Islands Hydroelectric Project. More recently, Duke conducted water-quality monitoring (2006) and thermal monitoring (2007 and 2008) in the Broad River, Make-Up Pond A, and Make-Up Pond B in support of the COL application for proposed Lee Nuclear Station Units 1 and 2 (Duke 2009c).

2.3.4.2 Groundwater Monitoring

The pre-application groundwater monitoring program began in March 2006 to evaluate the current hydrogeologic conditions at the Lee Nuclear Station site (Duke 2009c). In addition, Duke collected groundwater-quality samples in February and May 2009 at the proposed Make-Up Pond C study area (Duke 2009b). Duke installed 24 monitoring wells to measure groundwater elevation at the Lee Nuclear Station site. Groundwater elevation data were reported from April 18, 2006 through April 19, 2007, and are shown in seven plots from April 2006 through March 2007 (Duke 2009c). Ten of the monitoring wells were also used in the baseline water-quality study for the site. Eight wells were sampled during the baseline water-quality study for the Make-Up Pond C study area (Duke 2009b). Groundwater samples were collected and analyzed quarterly for the Lee Nuclear Station site (Duke 2009c) and in February and May 2009 for the Make-Up Pond C study area (Duke 2009b). Results of the pre-application groundwater-quality sampling for the Lee Nuclear Station site and the Make-Up Pond C study area are generally consistent with historical sampling results completed for the unfinished Cherokee Nuclear Station (Duke 2009b, c).

2.4 Ecology

This section describes the terrestrial and aquatic ecology of the site and vicinity that might be affected by building, operating, and maintaining the proposed Lee Nuclear Station Units 1 and 2. Sections 2.4.1 and 2.4.2 provide general descriptions of terrestrial and aquatic environments on and near the Lee Nuclear Station site (including proposed Make-Up Pond C), the two proposed new transmission corridors, the railroad corridor for the existing spur that would be renovated and partially rerouted, and offsite road-improvement areas.

Detailed descriptions are provided, as needed, to support the analysis of potential environmental impacts from building, operating, and maintaining new nuclear power generating facilities, new transmission-line corridors, the railroad-spur corridor, and offsite road improvements. These descriptions also support the evaluation of mitigation activities identified during the assessment to avoid, reduce, minimize, rectify, or compensate for potential impacts. Descriptions also are provided to help compare the alternative sites to the Lee Nuclear Station site. Also included are descriptions of monitoring programs for terrestrial and aquatic environments.

The information in this section is based on qualitative data recently gathered to determine the distribution and abundance of fauna and flora and waters of the United States on the Lee Nuclear Station site, within the Make-Up Pond C study area, within the two new transmission-line corridors, along the existing and rerouted portions of the railroad-spur corridor, and at offsite road-improvement areas. Supplementary information was taken from the Cherokee Nuclear Station ER (Duke Power Company 1974a, b, c).

Some fauna and flora species have special status designations that are used throughout the ecology sections of the EIS. Federal listings for animal and plant species are issued by the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS). State species designations include NatureServe, State conservation status ranks (State ranks) and State legal listings. State ranks typically are complementary to State legal listings. However, State legal listings are conversely used to complement State ranks in the EIS based on the following rationale. State ranks are used by State natural resource agencies for both animal and plant species in South Carolina, North Carolina, and Georgia. State legal listings are used by State wildlife agencies for only animal species in South Carolina and for both animal and plant species in North Carolina and Georgia. Because State ranks apply to both animal and plant species in all three states, they are used (in addition to the Federal listing) to compare the proposed Lee Nuclear Station site located in South Carolina, the Keowee and Middleton Shoals alternative sites also located in South Carolina, and the Perkins alternative site located in North Carolina (see Chapter 9). For consistency, State ranks are also used in the ecology sections throughout the other chapters in the EIS. The staff considered species ranked as critically imperiled (S1), imperiled (S2), or vulnerable (S3). Further, State legal listings are provided in the EIS as an indication of the importance a State places on the conservation of a species. In some instances, NatureServe global conservation status ranks are used to provide an indication of the viability of a species across its range when discussing potential impacts (see Chapter 4). Categories of Federal listings, NatureServe State ranks, global conservation status ranks, and State legal listings are defined in the footnotes of applicable tables throughout the EIS. In addition to animal and plant species that fall under the above special status designations, conservation priority species, deemed by the South Carolina Department of Natural Resources (SCDNR) in the *South Carolina Comprehensive Wildlife Conservation Strategy* (SCDNR 2005) to be of conservation concern in the State, are also discussed. Finally, avian species considered of conservation priority to the Atlantic Coast Joint Venture, a consortium of public, private, and conservation groups focused on the conservation of habitat for native birds in the Atlantic Flyway, are discussed. Note that the terminology "State species of concern" is commonly used but is not an official designation in the State of South Carolina, where all species tracked by the SCDNR that are not threatened or endangered under Federal or State law are considered to be of concern. Thus, "State species of concern" was not used in the EIS (SCDNR 2011a).

Duke delineated wetlands, streams, and open water areas for the various project components (e.g., Lee Nuclear Station site, Make-Up Pond C study area) within its established project component boundaries (Duke 2009b, c). In some instances, Duke redefined these boundaries slightly for purposes of its application to the USACE for a Department of the Army permit (Duke 2011h). Wetland acreages, stream lengths, and open water acreages in Chapter 2 of the EIS are based on the USACE boundaries for the jurisdictional determination (USACE 2013a) instead of Duke's permit application boundaries (Duke 2011h) or Duke's original project component boundaries (Duke 2009b, c).

Duke delineated wetlands, streams, and open water areas for the two new transmission-line corridors within boundaries established in the Duke Energy *Siting and Environmental Report for the William States Lee III Nuclear Station 230 kV and 525 kV Fold-In Lines, Cherokee and Union Counties, SC* (Duke 2007c) (HDR/DTA 2009b). The original total area of these two corridors is about 987 ac (Duke 2007c). However, Duke defined the permit area for the two transmission-line corridors in its application to the USACE for a Department of the Army permit to include a total of 5760 ac (Duke 2011h). Quantifications of wetlands, streams, and open water areas in Chapter 2 of the EIS for the two transmission-line corridors are, as indicated above, based on the USACE jurisdictional determination instead of Duke's permit application boundaries. The jurisdictional determination boundaries are consistent with the original boundaries in Duke's transmission-line siting report (Duke 2007c).

2.4.1 Terrestrial and Wetland Ecology

This section identifies terrestrial and wetland ecological resources and describes species composition and other structural and functional attributes of biotic assemblages that could be affected by building, operating, and maintaining the proposed Units 1 and 2, two new transmission-line corridors, each containing both the Lee Nuclear Station 230-kV transmission line and the Lee Nuclear Station 525-kV transmission line, the existing railroad-spur corridor that would be renovated and partially rerouted, and several offsite road improvements. It also identifies "important" terrestrial resources, including habitats and species that might be affected by the proposed action.

2.4.1.1 Terrestrial Resources – Lee Nuclear Station Site

The Lee Nuclear Station site, the Make-Up Pond C site, the proposed two new transmission corridors, the railroad-spur corridor, and offsite road-improvement areas are located in two of five subdivisions of the Piedmont ecoregion of South Carolina. The Piedmont is a northeast-southwest trending ecoregion that is approximately 160 km (100 mi) wide that comprises a transitional area between the mostly mountainous ecoregions of the Appalachians (Blue Ridge) to the northwest and the relatively flat coastal plains ecoregions (Southeastern Plains) to the southeast (EPA 2007a). Major land-cover transformations in the Piedmont over the past 200 years include conversion from hardwood forest to farm and then from farm back to forest. The South Carolina Piedmont was once largely cultivated with crops such as cotton, corn, tobacco, and wheat. Most of this region is now planted in loblolly pine (*Pinus taeda*), which was introduced as a cash crop on monotypic pine plantations during the nineteenth century (Duke 2009c), or has reverted to successional pine and hardwood woodlands with some pasture (Griffith et al. 2002).

The proposed Lee Nuclear Station, proposed Make-Up Pond C, railroad-spur corridor, and offsite road-improvement areas are located in the Kings Mountain subdivision of the Piedmont ecoregion, and the proposed two new transmission-line corridors are located in this and the Southern Outer Piedmont subdivision (EPA 2007a). The Kings Mountain subdivision is a hilly area with northeast to southwest trending ridges that are covered with oak-hickory-pine forest and Virginia pine (*P. virginiana*) (Griffith et al. 2002). The Southern Outer Piedmont subdivision has mostly irregular plains where pine dominates on old field sites and pine plantations and mixed oak forest are found in less heavily altered areas. The northern portion of the subdivision where a portion of the new transmission-line corridors would be located tends to have more pasture and cropland, while the landscape of the southern portion of the region now is dominated by loblolly pine plantations (Griffith et al. 2002).

The remainder of this subsection covers the terrestrial and wetland ecologies of the Lee Nuclear Station site. The terrestrial and wetland ecologies of the Make-Up Pond C site, the two new transmission-line corridors, the railroad-spur corridor, and the offsite road-improvement areas are covered in Sections 2.4.1.2, 2.4.1.3, 2.4.1.4, and 2.4.1.5, respectively.

Existing Cover Types

The areal extent of the existing cover types on the Lee Nuclear Station site is summarized in Table 2-7. The proposed site consisted almost entirely of second-growth forest in various stages of succession prior to building activities for the unfinished Cherokee Nuclear Station (Duke 2009c). In addition to forest, active and abandoned agricultural fields and pasture, wetlands, and alluvial thickets were present. Terrestrial ecological conditions on the proposed site were extensively altered by grading and building and creating water storage reservoirs for the unfinished Cherokee Nuclear Station (Duke 2009c).

Table 2-7. Acreage Occupied by Various Cover Types at the Lee Nuclear Station Site

Cover Type	Description	Acres	Percent of Total
Open/field/ meadow	Non-forested areas dominated by grasses, herbs, or bare soil maintained by cattle grazing and/or mowing	441.17	22.9
Mixed hardwood	Stands dominated by mixed hardwood with little or no pine in the canopy	418.87	21.7
Mixed hardwood-pine	Stands dominated by mixed hardwood with pine in the canopy	312.12	16.2
Pine-mixed hardwood	Stands dominated by pine with mixed hardwood in the canopy and understory	228.51	11.9
Upland scrub	Partially forested early successional, scrubby areas	154.21	8.0
Open pine-mixed hardwood	Selectively cut stands with scattered pine in canopy and mixed hardwood understory	70.24	3.6
Pine	Young to mid-aged pine stands/plantations with no hardwoods in canopy	17.41	0.9
Open water[(a)]	Reservoirs and ponds under regulatory authority of the USACE	260.47	13.5
Wetland[(b)]	Backwater emergent wetland associated with ponds, impoundments, and upland depressions	15.96	0.8
Non-jurisdictional feature	Disturbed, open, man-made wet area not under regulatory authority of the USACE	9.25	0.5
	Total[(c)]	**1928.21**	**100**

Source: Duke 2013d. The delineation of existing ecological cover types was updated to include the current boundaries of waters of the United States based on results of the approved jurisdictional determination received from the USACE (USACE 2013a).

(a) Acreage of open water in this table is smaller than what is provided in the jurisdictional determination (262.54 ac) (USACE 2013a) because the 2008 site boundary does not include areas of Ninety-Nine Islands Reservoir (Duke 2013d).

b) Acreage of wetland in this table is larger than what is provided in the jurisdictional determination (12.52 ac) (USACE 2013a) due to the smaller size of the project area submitted for the jurisdictional determination (Duke 2013d).

(c) After issuance of the draft EIS, the site boundary was updated using survey information (Duke 2013d), thus the revised total.

During that period, Duke Power Company cleared and graded approximately 750 ac of the more than 1900 ac for the unfinished Cherokee Nuclear Station (Duke 2009c), impounded riparian and upland habitat associated with much of the 23,000 linear ft of streams with the creation of Make-Up Pond A and Make-Up Pond B (Duke 2011h), and cleared about 41 ac to create the railroad corridor. Currently, this core building area on the Lee Nuclear Station site is designated primarily as the open/field/meadow cover type shown in Figure 2-12. After cancelling the Cherokee project and selling the site, cleared areas may have been maintained through mowing and cattle grazing and pastures seeded with non-native fescue (*Festuca* spp.). The upland scrub type that commonly occurs around the periphery of the core building area (Figure 2-12) represents early successional encroachment into the area (Duke 2009c). The open/field/ meadow and upland scrub habitat types were not present on the site prior to 1975 when

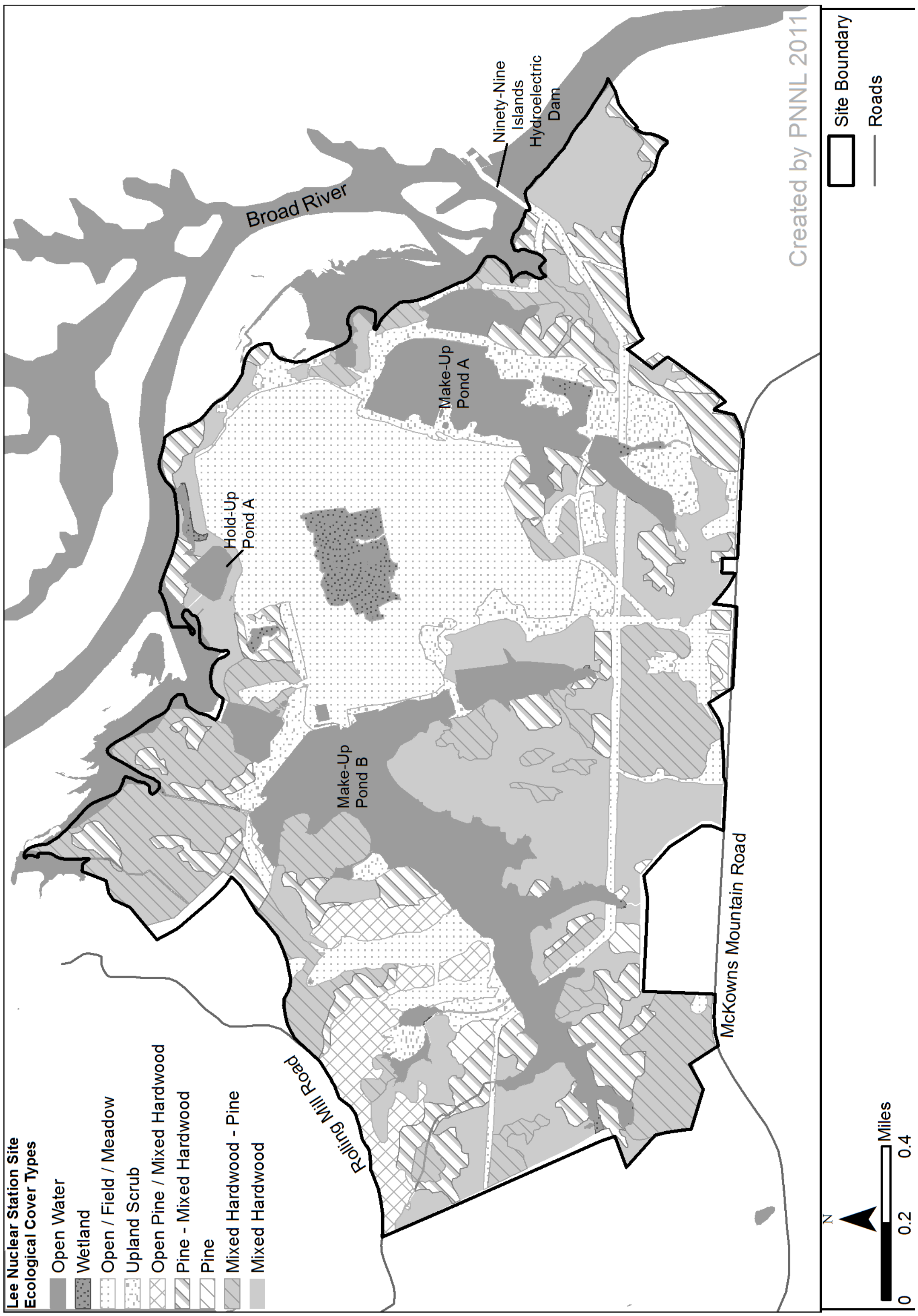

Figure 2-12. Ecological Cover Types on the Lee Nuclear Station Site (based on information provided in Duke 2013c)

construction of the Cherokee Nuclear Station began (Duke Power Company 1974a, Duke 2008a). Also included in the 750 ac are eight non-jurisdictional features, five of which developed in abandoned excavations intended for unfinished Cherokee Nuclear Station facilities (USACE 2013a).

The second-growth forest that remains onsite from prior to construction activities associated with the unfinished Cherokee Nuclear Station, and the open/field/meadow cover type and the upland scrub cover type that resulted from those construction activities would eventually revert to oak-hickory or mesophytic hardwood communities if left undisturbed. Oak-hickory is considered a typical climax forest for dry ridges and well-drained gentle slopes, and mesophytic hardwood communities are considered typical climax forests for more mesic and north-facing slopes, on the Lee Nuclear Station site (Duke Power Company 1974a, b, c; Duke 2011h).

Duke Power Company also dammed what was formerly McKowns Creek, then a perennial stream, to form the nuclear service-water pond, now referred to as Make-Up Pond B. A backwater of the Broad River was dammed to form Make-Up Pond A (Duke 2009c). Make-Up Ponds A and B are now jurisdictional waters of the United States (USACE 2013a). A small stream and a backwater of the Broad River were dammed to create the former stormwater retention pond, now referred to as Hold-Up Pond A (Duke 2009c), which is now a jurisdictional water of the United States (USACE 2013a). These ponds, together with two smaller ponds and two small sections of the Broad River associated with proposed plant-related structures, total approximately 262.5 ac and appear as the jurisdictional open water cover type in Figure 2-13. Jurisdictional wetlands developed in some areas along the margins of Make-Up Ponds A and B, in the forested bottomland along the Broad River floodplain, and in upland areas along streams (Figure 2-13) (USACE 2013a). In addition, about 3.9 mi of jurisdictional streams occur on the Lee Nuclear Station site (USACE 2013a).

In 2006, a map of vegetation cover types at the Lee Nuclear Station site was developed based on false color infrared aerial photographs taken in 1999, which were the most recent photographs available. During April and June 2006, the map was ground-truthed (Duke 2009c, 2008e). The vegetation types (mostly forest) that were present on the Lee Nuclear Station site in 1975 (Duke Power Company 1974a, b, c) continue to exist there but the areal extent is less (Duke 2009c). These vegetation types also are common and widespread elsewhere in the Piedmont ecoregion and are representative of several broader natural community types described by Nelson (1986) and SCDNR (2005) for the State of South Carolina. Duke grouped these vegetation types, as well as wetlands and open water, into cover type in support of the Lee Nuclear Station COL application (Figure 2-12), in part to reflect the effects of building the unfinished Cherokee Nuclear Station (Duke 2009c).

In summary, clearing land, building facilities, and creating impoundments for the unfinished Cherokee Nuclear Station altered a large amount of upland habitat (mostly forest) on the Lee Nuclear Station site; these activities resulted in the creation of new early successional and

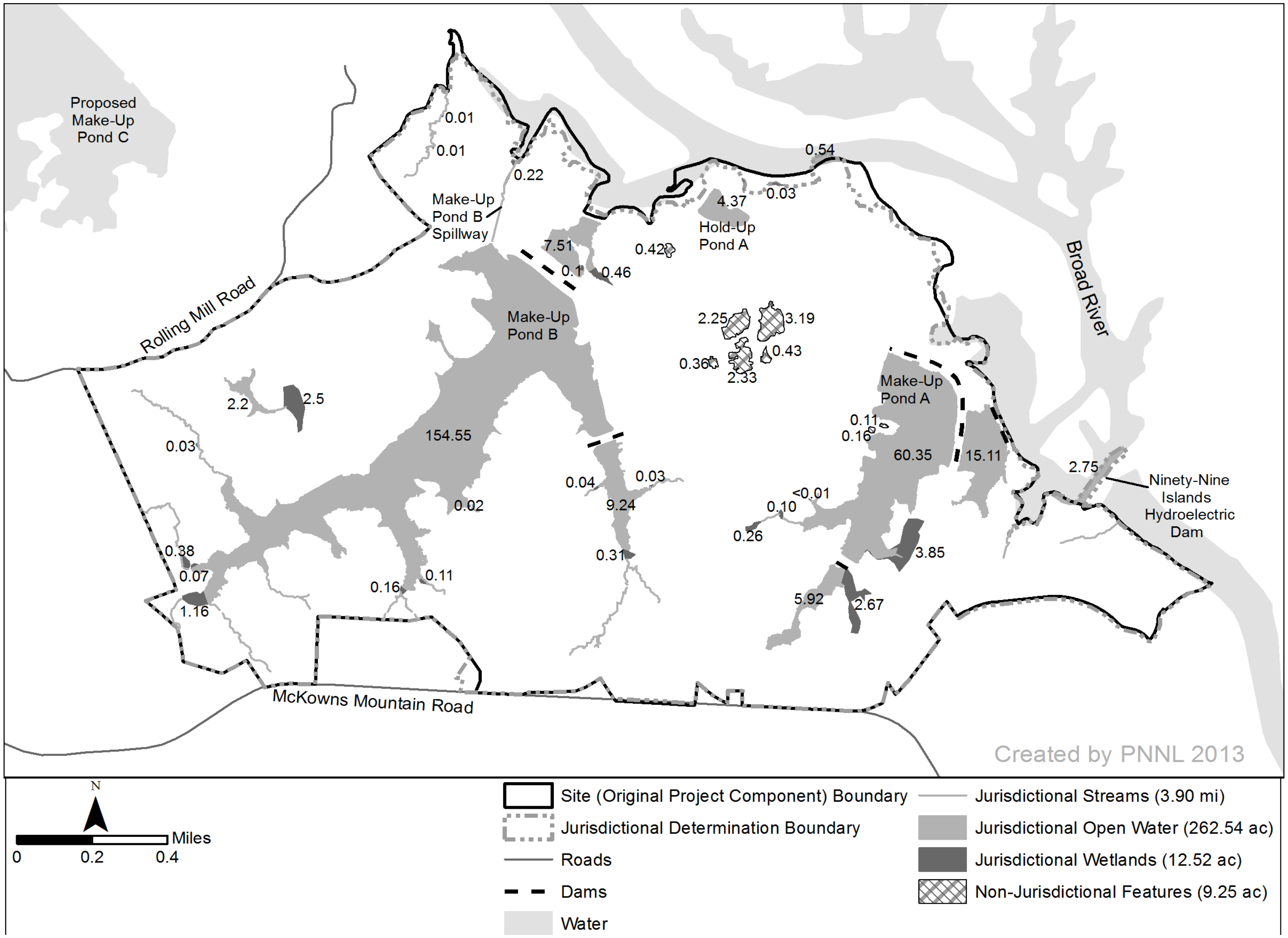

Figure 2-13. Wetlands and Waterbodies within USACE Jurisdictional Boundaries on the Lee Nuclear Station Site (acreages for jurisdictional wetlands, jurisdictional waterbodies, and non-jurisdictional features obtained from the USACE [2013a])

wetland habitats. Thus, current upland and wetland habitats on the Lee Nuclear Station site appear to be more diverse than those that were identified prior to construction of the Cherokee Nuclear Station.

Mixed Hardwood

The mixed hardwood cover type is the most biologically diverse plant community at the Lee Nuclear Station site. It occupies a total of 418.87 ac (21.7 percent) of the site and comprises different species assemblages at different locations (Duke 2009c, 2013d). These communities are included in the oak-hickory, mesic mixed hardwood, chestnut oak (*Quercus montana*), and basic forest types described by Nelson (1986).

On the north side of the Lee Nuclear Station site near the Broad River, dry bluffs support communities dominated by chestnut oak with northern red oak (*Q. rubra*), white oak (*Q. alba*), and tulip poplar (*Liriodendron tulipifera*). Communities on the lower slopes near the river and floodplain are dominated by black oak (*Q. velutina*), shortleaf pine (*P. echinata*), and Shumard oak (*Q. shumardii*), with white ash (*Fraxinus americana*), cottonwood (*Populus* spp.), sweet gum (*Liquidambar styraciflua*), and cucumber magnolia (*Magnolia acuminata*) as subdominants. The mixed hardwood subcanopy is dominated by redbud (*Cercis canadensis*), chalk maple (*Acer leucoderme*), dogwood (*Cornus spp.*), American holly (*Ilex opaca*), and eastern red cedar (*Juniperus virginiana*). The mixed hardwood shrub layer supports pawpaw (*Asimina triloba*) and giant cane (*Arundinaria gigantea*), and in one location, great rhododendron (*Rhododendron maximum*), Piedmont rhododendron (*R. minus*), and mountain laurel (*Kalmia latifolia*) (Duke 2009c; Nelson 1986; SCDNR 2005). The mixed hardwood herbaceous layer is occupied by Japanese honeysuckle (*Lonicera japonica*), an introduced species that is considered invasive and a severe threat (i.e., spreads easily into native plant communities and displaces native vegetation) in much of the southern and eastern United States (Dillenburg et al. 1993, White and Govus 2005), and Piedmont heartleaf (*Hexastylis minor*) (Duke 2009c).

Duke (2009c) described the steep, rocky bluffs on the west side of the Broad River as supporting a mixture of oaks, with white oak dominant, followed by tulip poplar, and shortleaf pine. Dogwood and sourwood (*Oxydendrum arboreum*) occupy the subcanopy, along with dense thickets of great rhododendron, Piedmont rhododendron, wild azalea (*R. nudiflorum*), and mountain laurel. The herbaceous layer consists of pipsissewa (*Chimaphila umbellata*), partridgeberry (*Mitchella repens*), Piedmont heartleaf, and mayapple (*Podophyllum peltatum*), with silverbell (*Halesia carolina*) and cane thickets present at the base of the bluffs along the river.

Mixed forests dominated by young to mid-age chestnut oak occur on the northwestern side of McKowns Mountain on dry, rocky soils. The lower slopes near Make-Up Pond B have tulip poplar, red oak, white oak, and beech (*Fagus spp.*) making up more of the canopy, with dogwood and ironwood (*Carpinus carolianiana*) in the subcanopy layer. Widely scattered

Piedmont heartleaf, American hepatica (*Hepatica americana*), Christmas fern (*Polystichum acrostichoides*), rattlesnake plantain (*Goodyera pubescens*), black-edged sedge (*Carex nigromarginata*) and whip nutrush (*Scleria triglomerata*) occur in the herbaceous layer (Duke 2009c).

The ravines that form the backwaters of Make-Up Pond B were described by Duke (2009c) as being dominated by American beech (*Fagus grandifolia*), tulip poplar, white oak, red oak, and white ash. Mountain laurel occurs in the shrub layer, and pipsissewa, partridgeberry, Piedmont heartleaf, and black-edged sedge are common in the herbaceous layer (Duke 2009c). Similarly, Duke (2009c) describes small ravines in the southwestern corner of the Lee Nuclear Station site as having similar overstories, with the addition of chalk maple in the subcanopy, and an herbaceous layer of Christmas fern, mayapple, violet wood sorrel (*Oxalis violacea*), false Solomon's seal (*Maianthemum racemosum*), Solomon's seal (*Polygonatum biflorum*), rattlesnake fern (*Botrychium virginianum*), and Canada horsebalm (*Collinsonia canadensis*). These areas appear similar to the mesic mixed hardwood forest described by Nelson (1986).

<u>Mixed Hardwood-Pine</u>

The mixed hardwood-pine cover type occupies 312.12 ac (16.2 percent) of the Lee Nuclear Station site (Duke 2013d). These areas may be young second or third growth mixed hardwood forests, such as oak-hickory that now have a significant pine component (NatureServe Explorer 2010). Duke indicated that the northwestern portion of the site is occupied by cutover mixed hardwood-pine dominated by tulip poplar, white ash, and white oak, with mountain laurel and species such as Jack-in-the-pulpit (*Arisaema triphyllum*), Christmas fern, southern lady fern (*Athyrium filix-femina*), Piedmont heartleaf, black cohosh (*Cimicifuga spp.*), mayapple, sessile-leaved bellwort (*Uvularia sessilifolia*), false Solomon's seal, coastal plain sedge (*C. crebriflora*), reflexed sedge (*C. retroflexa*), and white-edged sedge (*C. debilis*) in the herbaceous layer (Duke 2009c) Some of the ravines near Make-Up Pond B are dominated by tulip poplar, sweet gum, red maple (*Acer rubrum*), and white oak growing with shortleaf and loblolly pine (Duke 2009c).

<u>Open/Field/Meadow</u>

Open areas, fields, and meadows occupy 441.17 ac (22.9 percent) of the Lee Nuclear Station site (Duke 2013d). The area partially developed for the unfinished Cherokee Nuclear Station remains a large open habitat because of periodic disturbances from land clearing, mowing, and grazing. This cover type also includes areas with bare soil; paved roadways and parking lots; abandoned building foundations; and patches of early successional annual and perennial grasses, forbs, shrubs, and abandoned agricultural fields and improved fescue pastures (Duke 2009c).

Open Pine-Mixed Hardwood

This cover type represents a successional stage subsequent to the open/field/meadow cover type. These areas are dominated by widely spaced loblolly pine. The shrub and herbaceous layers also are sparse, and consist of a mix of hardwood species including white oak, sweet gum, and red maple (Duke 2009c). The open pine-mixed hardwood cover type occupies 70.24 ac (3.6 percent) of the Lee Nuclear Station site (Duke 2013d).

Pine

The pine cover type occupies 17.41 ac (0.9 percent) of the Lee Nuclear Station site and includes some silvicultural stands that are dominated by loblolly pine with scattered shortleaf or Virginia pine (Duke 2009c, 2013d).

Pine-Mixed Hardwood

Duke describes this cover type as being dominated by loblolly and shortleaf pine with a mixture of hardwood species consisting of white oak, red oak, tulip poplar, sweet gum, and red maple (Duke 2009c). The pine-mixed hardwood cover type occurs as widespread scattered stands and occupies 228.51 ac (11.9 percent) of the Lee Nuclear Station site (Duke 2013d).

Upland Scrub

The upland scrub cover type, as defined by Duke (2009c), includes "… early successional pine-mixed hardwood stands, open, partially forested stands, and dwarfed forest species growing on poor soil." It occupies a total of 154.21 ac (approximately 8.0 percent) of the Lee Nuclear Station site (Duke 2013d), primarily around the edges of the previously disturbed core building area. Dominant species include loblolly pine, Virginia pine, eastern red cedar, sumac (*Rhus spp.*), blackberry (*Rubus spp.*) (Duke 2009c), and exotic lespedeza (*Lespedeza cuneata*), which is planted in disturbed areas as an erosion control measure (Miller 2003).

Wetlands, Streams and Floodplains

This subsection discusses the wetlands, streams, and floodplains on the Lee Nuclear Station site. Streams are discussed further in Section 2.4.2.1.

The USACE has identified 22 jurisdictional wetlands totaling 12.52 ac on the Lee Nuclear Station site (USACE 2013a). One jurisdictional wetland (0.03 ac) on the Lee Nuclear Station site abuts the Broad River (USACE 2013a) (Figure 2-13). This wetland is forested, with cottonwood, sycamore (*Platanus occidentalis*), sugarberry (*Celtis laevigata*), sweet gum, and green ash (*Fraxinus pennsylvanica*) as the dominant canopy species with box elder (*Acer negundo*), black willow (*Salix nigra*), and buttonbush (*Cephalanthus occidentalis*) in the understory. The herbaceous layer includes false nettle (*Boehmeria cylindrica*), river oats (*Chasmanthium latifolium*), and cane (Duke 2009c).

The other 21 jurisdictional wetlands, occupying approximately 12.49 ac, abut or are otherwise closely associated with Make-Up Ponds A and B, small stream channels, springs, and natural depressions on the Lee Nuclear Station site (USACE 2013a) (Figure 2-13). These areas are partially forested, with the canopy dominated by a mix of red maple, tulip poplar, sweet gum, and black willow. Ironwood and tag alder (*Alnus serrulata*) are present in the understory and shrub layer. Other understory species include cottonwood, box elder, buttonbush, swamp dogwood (*Cornus stricta*), and elderberry (*Sambucus canadensis*). The herbaceous layer is characterized by common needlerush (*Juncus roemerianus*), sedges (*Carex* spp.), and false nettle (Duke 2009c).

<u>Wetland Functional Assessment</u>. Duke conducted functional assessments for jurisdictional wetlands within the boundaries of its Department of the Army permit application area (Duke 2011h) according to the USACE Charleston District Guidelines (USACE 2010a) and the North Carolina Wetland Assessment Method (NCWAM 2010). These activities were performed to assess the wetland resource functions lost from proposed unavoidable impacts to waters of the United States that would result from the development of the Lee Nuclear Station and help determine mitigation credits required to offset the net loss of waters (wetlands, open waters, and streams) of the United States and their associated functional benefits. Functional assessments for wetlands are discussed in this section and functional assessments for open waters and streams are discussed in Section 2.4.2.1.

Jurisdictional wetlands were assessed in the field in April and June 2011, based on three major functions and ten subfunctions: hydrology (surface storage and retention and subsurface storage and retention), water quality (pathogen change, particulate change, soluble change, physical change, and pollution change) and habitat (physical structure, landscape patch structure, and vegetation composition) and then compared to a reference wetland (NCWAM 2010). Functions and subfunctions were evaluated using 22 field metrics listed on a field assessment form. Scores for each of the functional descriptors were converted to give one of the four conditions: fully functional (functioning naturally as in an undisturbed condition), partially impaired (partial loss of functionality due to disturbance, but functional recovery is expected to occur through natural processes), impaired (partial loss of functionality due to disturbance which would require restoration activities to facilitate recovery), or very impaired (loss of most functionality due to disturbance and functional recovery would require a significant restoration effort).

Of the 22 wetland assessment areas on the Lee Nuclear Station site, 12 were classified as being fully functional, 6 were partially impaired, 2 were impaired, and 2 were very impaired (Duke 2011h).

Non-Jurisdictional Features

Eight non-jurisdictional features, total approximately 9.25 ac (USACE 2013a) (approximately 0.5 percent) of the Lee Nuclear Station site original project component boundaries (Table 2-7). Five of these developed in depressions surrounding the former locations for the unfinished Cherokee Nuclear Station reactors (Figure 2-13) and accumulate rainwater and runoff. Seasonal rainwater continues to be removed from the depressions. One of the other three features lies in a depression located northwest of the previous Cherokee Unit 1 containment structure (Figure 2-13). It is dominated by cottonwood, black willow, and common needlerush (Duke 2009c). The other two features are located just west of Make-Up Pond A (Figure 2-13).

Streams

About 3.9 mi of jurisdictional perennial and seasonal streams occur on the Lee Nuclear Station site and have hydrologic connections to the Broad River, the wetlands described above, and the open water areas, including Make-Up Ponds A and B (USACE 2013a).

Floodplains

Regulatory 100-year floodplains occur in low-lying areas of the Lee Nuclear Station site, primarily along the Broad River and in jurisdictional wetland areas around the margins of Make-Up Ponds A and B (Duke 2011h).

Wildlife

The wildlife observations noted below are primarily from three types of inventories carried out at the Lee Nuclear Station site. The first inventory involved intensive, quantitative, seasonal sampling of mammals, birds, and herpetofauna (amphibians and reptiles) conducted in each plant community onsite during 1973 and 1974 in support of the Cherokee Nuclear Station ER (Duke Power Company 1974a, b, c). The second inventory involved casual, anecdotal observations of mammals, birds, and herpetofauna made during pedestrian reconnaissance visits conducted in March, April, June, and October 2006 in support of the Lee Nuclear Station ER (Duke 2009c and Duke 2008e), and a cursory herpetological survey in 2007 (Dorcas 2007). The open/field/meadow and upland scrub cover types, and Make-Up Ponds B and A with their associated wetlands, described in the previous subsection did not exist and were thus not surveyed for mammals, birds, and herpetofauna from 1973 to 1974. In addition, it is likely that many wildlife species, particularly those that are more cryptic and/or are subject to time-of-day restrictions in detectability such as birds and herpetofauna, were not encountered during the 2006 reconnaissance visits or during the 2007 cursory herpetological survey. Consequently, a third type of wildlife inventory was conducted that involved collecting qualitative data sitewide on birds in 2009 (HDR/DTA 2009a) and herpetofauna (Dorcas 2009a) to determine their current distribution and abundance in support of the Lee Nuclear Station ER (Duke 2009c). These three types of inventories span the range from most intensive (the 1973 and 1974 quantitative studies) to least intensive (the 2006 anecdotal reconnaissance observations). Finally, when other anecdotal information about wildlife sightings onsite was available, that information also was incorporated.

Mammals

A total of 42 mammal species were considered as possibly occurring on the Cherokee Nuclear Station during 1973 and 1974, 20 (48 percent) of which were observed during field studies (Duke 2009c). Studies consisted of live-trapping and population estimation techniques for small and medium-sized mammals in each plant community onsite in December 1973 and April 1974 (Duke Power Company 1974a, b, c). The most common mammals observed during these studies were opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), eastern gray squirrel (*Sciurus carolinensis*), eastern fox squirrel (*S. niger*), eastern cottontail (*Sylvilagus floridanus*), and white-tailed deer (*Odocoileus virginianus*). All are considered year-long residents of the Lee Nuclear Station site (Duke 2009c). Most of these mammals were also observed during the 2006 surveys, as was beaver (*Castor canadensis*), which was not observed during surveys conducted during the mid-1970s (Duke 2009c).

A single white-tailed deer was observed onsite in the 1970s. Larger groups of two to six deer were observed during the 2006 field reconnaissance, suggesting that the species may be more abundant at the Lee Nuclear Station site than it was in the 1970s (Duke 2009c).

In South Carolina, black bears (*Ursus americanus*) traditionally occur in the mountains of Oconee, Pickens, Greenville, and Spartanburg Counties at the western edge of the state, but they appear to have been expanding their range and increasing in numbers over the past several decades (SCDNR 2005). Because Cherokee County is adjacent to and immediately east of Spartanburg County, black bears may be assumed to occur in the vicinity of the Lee Nuclear Station.

No small mammal trapping was conducted during the 2006 field reconnaissance. However, trapping in 1973 and 1974 (Duke Power Company 1974a, b, c) found numerous small mammal species, including rice rat (*Oryzomys palustris*), white-footed mouse (*Peromyscus leucopus*), short-tailed shrew (*Blarina brevicauda*), meadow vole (*Microtus pennsylvanicus*), and pine vole (*Pitymys pinetorum*) (Duke 2009c).

Birds

The Lee Nuclear Station site is situated along one of the principal inland routes of the Atlantic flyway (Bird and Nature 2009). The proposed site has potentially diverse avifauna, with 241 species considered as possibly occurring year-round based on known distributions in 1973 and 1974 (Duke 2009c). At that time, studies were conducted during all four seasons; these studies consisted of strip censuses to determine relative abundance and intensive plot censuses to determine breeding bird densities in each plant community onsite (Duke Power Company 1974a, b, c). Of the 77 possible water-dependent species, only 14 (18 percent) were observed in 1973 and 1974. Of the 164 possible upland species, 90 (55 percent) were observed in 1973 and 1974.

Since the 1970s, the creation of Make-Up Ponds A and B and Hold-Up Pond A has increased open water and wetland habitat on the Lee Nuclear Station site. Thus, it is likely that water-dependent birds are now more common onsite than in the 1970s (Duke 2009c). In addition, the open/field/meadow and upland scrub cover types did not exist onsite in the early 1970s before construction of the unfinished Cherokee Nuclear Station (Duke Power Company 1974a, b, c), and thus birds that use these habitats may currently occur onsite. Consequently, wetland/open water habitat, as well as open/field/meadow, upland scrub, mixed hardwood forest, and mixed pine/hardwood forest were intensively surveyed in May and June of 2009 using transect and point count censuses for spring migrants and resident breeding birds (HDR/DTA 2009a).

Based on information from field guides, breeding bird surveys in the vicinity (i.e., London Creek in support of proposed Make-Up Pond C and the North American Breeding Bird Survey Results and Analysis from 1966 to 2007, [Chesnee, SC route], regional and State bird lists, and the South Carolina Breeding Bird Atlas, 108 bird species could potentially breed in the vicinity of the Lee Nuclear Station. A total of 102 avian species were observed during the 2009 surveys, 19 of which are water-dependent, which is significantly more than the number of water-dependent species observed in 1973 and 1974 (Duke 2009c) considering that fall migrants and winter residents were not surveyed in 2009. A total of 70 of the 102 species were assumed to be breeding on or in the vicinity of the Lee Nuclear Station because they were present during the June 2009 survey (HDR/DTA 2009a). The most species-rich habitats included riparian, wetland, and bottomland hardwood forest associated with any of the open water areas on, or adjacent to, the Lee Nuclear Station site (HDR/DTA 2009a). The 2009 bird survey locations are provided in HDR/DTA (2009a).

The 2009 spring migrant/summer breeding (HDR/DTA 2009a) and 1973 and 1974 year-long (Duke Power Company 1974a, b, c) survey information is applied below to describe groups of bird species that occur on and in the vicinity of the proposed Lee Nuclear Station.

Waterfowl. The mallard duck (*Anas platyrhynchos*) and wood duck (*Aix sponsa*) were the only waterfowl species observed on or in the vicinity of the site in 1973 and 1974 (Duke 2009c). These species, along with the Canada goose (*Branta canadensis*), were also observed during the migrant/breeding bird surveys of 2009 (HDR/DTA 2009a). These three species are assumed to nest on or in the near vicinity of the Lee Nuclear Station site (HDR/DTA 2009a).

Shorebirds. Only 10 percent of the shorebirds (i.e., 2 of 21) considered as possible year-round residents at the site were observed during the 1973 and 1974 surveys: the killdeer (*Charadrius vociferus*) and the spotted sandpiper (*Actitis macularius*) (Duke 2009c). These two species, plus six additional shorebird species, were observed during the migrant/breeding bird surveys of 2009 (HDR/DTA 2009a). However, only the killdeer is believed to nest on or in the near vicinity of the Lee Nuclear Station site (HDR/DTA 2009a). Cleared and open areas of the Lee Nuclear Station site provide suitable habitat for killdeer, which is typically found in fields and pastures, often far from water (Duke 2009c).

Colonial-Nesting Waterbirds. Only 26 percent of the colonial-nesting waterbirds (i.e., 5 of 19) considered to be possible year-round residents at the site were observed there during 1973 and 1974: herring gull (*Larus argentatus*), ring-billed gull (*Larus delawarensis*), great blue heron (*Ardea herodias*), little blue heron (*Egretta caerulea*), and green heron (*Butorides virescens*). No nesting colonies of any of these species were found at that time on or in the vicinity of the Cherokee Nuclear Station site (Duke 2009c). The great blue heron, green heron, and double-crested cormorant (*Phalacrocorax auritus*) were observed during the migrant/breeding bird surveys of 2009 (HDR/DTA 2009a). However, only the great blue heron and green heron are believed to nest on or in the vicinity of the Lee Nuclear Station (HDR/DTA 2009a).

Upland Game Birds. Four species of upland game birds were considered to be possible onsite residents during 1973 and 1974: wild turkey (*Meleagris gallopavo*), northern bobwhite quail (*Colinus virginianus*), American woodcock (*Scolopax minor*), and common snipe (*Gallinago gallinago*). Wilson's snipe (*G. delicata*), mourning dove (*Zenaida macroura*), rock dove (*Columba livia*), northern bobwhite quail, and wild turkey were observed during the migrant/breeding bird surveys of 2009 (HDR/DTA 2009a). However, only the mourning dove, rock dove, and wild turkey are believed to nest on or in the vicinity of the Lee Nuclear Station (HDR/DTA 2009a). The northern bobwhite quail was absent during the June 2009 survey; however, it could nest on or in the near vicinity of the Lee Nuclear Station, as it is considered a year-round resident throughout the southeastern United States (Kaufman 2000).

Perching Birds. Approximately 52 percent of the perching birds (i.e., 65 of 125) with the potential to occur at the unfinished Cherokee Nuclear Station were observed during the 1973 and 1974 surveys (Duke 2009c). The site still offers a variety of upland habitats; thus, most species observed in 1973 and 1974 probably still occur there. About 70 species of perching birds were observed during the migrant/breeding bird surveys of 2009, and about 50 of those species are believed to nest on or in the vicinity of the Lee Nuclear Station (HDR/DTA 2009a). Perching birds may be resident breeders, stop-over migrants that breed further north, or year-long residents. Year-long residents include eastern phoebe (*Sayornis phoebe*), blue jay (*Cyanocitta cristata*), Carolina chickadee (*Poecile carolinensis*), tufted titmouse (*Baeolophus bicolor*), Carolina wren (*Thryothorus ludovicianus*), mockingbird (*Mimus polyglottos*), American robin (*Turdus migratorius*), eastern bluebird (*Sialia sialis*), and cardinal (*Cardinalis cardinalis*) (Duke 2009c).

Birds of Prey. Approximately 52 percent of the birds of prey (i.e., 11 of 21) potentially occurring at the site were observed during the 1973 and 1974 surveys. Open habitats at the site provide suitable hunting-scavenging areas, and adjacent forest stands offer nesting habitat. Thus, most species observed there during 1973 and 1974 probably still occur there. Seven birds of prey were observed during the migrant/breeding bird surveys of 2009, and five of those species are believed to nest on or in the near vicinity of the Lee Nuclear Station: black vulture (*Coragyps atratus*), osprey (*Pandion haliaetus*), turkey vulture (*Cathartes aura*), red-shouldered hawk (*Buteo lineatus*), and red-tailed hawk (*Buteo jamaicensis*) (HDR/DTA 2009a). All of these species are non-migratory habitat generalists, and most take live prey such as other birds and small mammals. Some (e.g., vultures) are also scavengers. The osprey is a piscivore and nests along the western edge of Make-Up Pond A (Duke 2009c).

Woodpeckers. The prevalence of upland forests at the Lee Nuclear Station site is reflected in the number of woodpecker species inhabiting the site. Six of the eight woodpecker species that possibly occur at the site were observed there during 1973 and 1974 (Duke 2009c). Four woodpecker species were observed during the migrant/breeding bird surveys of 2009, and three of those species are believed to nest on or in the vicinity of the Lee Nuclear Station site (HDR/DTA 2009a). These include the downy woodpecker (*Picoides pubescens*), hairy woodpecker (*Picoides villosus*), and red-bellied woodpecker (*Melanerpes carolinus*). In addition, the pileated woodpecker (*Dryocopus pileatus*), also observed in the migrant/breeding bird surveys of 2009, probably nests on or in the near vicinity of the Lee Nuclear Station site, as it is considered a year-round resident throughout much of the southeastern United States (Kaufman 2000). Woodpeckers are mainly non-migratory in the Carolina Piedmont (Kaufman 2000).

Amphibians and Reptiles

During the periods May 19-21, 1974, and August 12-13, 1974, intensive visual surveys for reptiles and amphibians were conducted in 1-ac plots within forest stands representative of each of seven bottomland and upland plant communities existing on the Cherokee Nuclear Station site at that time. In total, 16 amphibian and 17 reptile species were observed (Duke Power Company 1974a, b, c).

Since the 1970s, the creation of Make-Up Ponds A and B and Hold-Up Pond A has increased open water and wetland habitat on the Lee Nuclear Station site. Thus, anecdotal observations of reptiles and amphibians were made during the 2006 reconnaissance visits (Duke 2009c). In addition, on November 7, 2007, wetland habitats along the margins of Make-Up Ponds B and A were searched for amphibians and reptiles by boat with binoculars, turning over objects on land and in shallow water, and dipnetting streams and small pools. Five amphibian and four reptile species were documented. The low number of amphibian and reptile species identified during the November 7, 2007, survey may have been due to the time of year (i.e., fall as opposed to spring), the drought experienced in the southeastern United States in the summer and fall of 2007, and the short duration of sampling (Dorcas 2007). The 2007 herpetofauna survey locations also are documented by Dorcas (2007).

Consequently, between February and July 2009, extensive trapping and manual sampling (101 person days) was conducted in aquatic habitats, and less intensive sampling was conducted in terrestrial habitats (Dorcas 2009a). Turtle and minnow traps were used in open water and nighttime call surveys were conducted at significant amphibian breeding sites, in addition to the survey methods employed in 2007. The 2009 herpetofauna survey locations were documented by Dorcas (2009a). Based on queries of 47 museums, universities, and other appropriate organizations, and known geographic ranges and available habitat, a total of 66 species potentially could occur on and in the vicinity of the Lee Nuclear Station site (Dorcas 2009a). A total of 35 species of amphibians and reptiles, including 13 frog and toad species, 9 salamander species, 7 turtle species, 3 lizard species, and 3 snake species, were documented in 1974, 2007, and 2009. A high number of amphibians and reptiles were observed, especially those that are semi-aquatic (i.e., amphibians and turtles). This is likely due to the abundance and variety of lentic wetlands and ephemeral pools onsite (Dorcas 2009a).

Information from surveys conducted during 1974, 2007, and 2009 (Duke Power Company 1974a, b, c; Dorcas 2007, 2009a) is used below to describe herpetofauna species on and in the vicinity of the Lee Nuclear Station site.

Frogs and Toads. The frogs and toads of the Lee Nuclear Station site range from fully aquatic (e.g., bullfrog [*Rana catesbeiana*]) to semi-aquatic (e.g., toad species, treefrogs) in their habits. A total of 13 species of frogs and toads were observed during the surveys conducted in 1974, 2007, and 2009: (1) northern cricket frog (*Acris crepitans*), (2) Cope's gray treefrog (*Hyla chrysoscelis*), (3) green treefrog (*H. cinerea*), (4) spring peeper (*Pseudacris crucifer*), (5) upland chorus frog (*P. feriarum*), (6) green frog (*Rana clamitans*), (7) pickerel frog (*Rana palustris*), (8) Southern leopard frog (*R. sphenocephala*), (9) bullfrog, (10) American toad (*Bufo americanus*), (11) Fowler's toad (*B. fowleri*), (12) eastern narrowmouth toad (*Gastrophryne carolinensis*), and (13) eastern spadefoot toad (*Scaphiopus holbrookii*). The 12 species observed in 2009 (all of the above species except the Eastern spadefoot toad [Duke Power Company 1974a, b, c]) range from common (observed three to seven times in the 2007/2009 surveys) to abundant (observed eight or more times in the 2007/2009 surveys) (Dorcas 2009a). All 13 species are closely tied to water habitats (e.g., wetlands, temporary pools, and low-gradient streams and rivers), where they reproduce. All the frog and toad species, except the bullfrog, also make extensive use of adjacent terrestrial habitats, such as forest, grassland, and cropland as juveniles and adults.

Salamanders and Newts. The salamanders and newts range from those that are fully aquatic (e.g., red-spotted newt [*Notophthalmus viridescens*]), to those that are semi-aquatic (e.g., all salamander species observed except the northern slimy salamander [*Plethodon glutinosus*]), to completely terrestrial (e.g., slimy salamander) in their habits. Nine salamander and newt species were observed during surveys conducted in 1974, 2007, and 2009: (1) spotted salamander (*Ambystoma maculatum*), (2) marbled salamander (*A. opacum*), (3) northern dusky salamander (*Desmognathus fuscus*), (4) three-lined salamander (*Eurycea guttolineata*),

(5) Atlantic Coast slimy salamander (*Plethodon chlorobryonis*), (6) northern red salamander (*P. ruber*), (7) southern two-lined salamander (*Eurycea bislineata cirrigera*), (8) the northern slimy salamander, and (9) the red-spotted newt. Of the six salamander/newt species observed in 2009, only the spotted salamander and red-spotted newt were considered common; all others were considered somewhat rare (two observations) to rare (one observation) (Dorcas 2009a). The semi-aquatic salamanders and fully aquatic newt are closely tied to water such as trickling streams and wetlands where they reproduce. The adult semi-aquatic salamanders also utilize adjacent terrestrial habitat such as forests and grasslands, as do both larval and adult life stages of the fully terrestrial northern slimy salamander.

<u>Turtles</u>. The turtle species inhabit aquatic habitats ranging from rivers and streams to still-water habitats such as wetlands. The lifestyles of these turtles range from mostly aquatic (e.g., common snapping turtle [*Chelydra serpentina*]) to semi-aquatic (all the other turtle species). Nine turtle species were observed during surveys conducted in 1974, 2007, and 2009: (1) painted turtle (*Chrysemys picta*), (2) eastern mud turtle (*Kinosternon subrubrum*), (3) eastern river cooter (*Pseudemys concinna*), (4) common musk turtle (*Sternotherus odoratus*), (5) eastern box turtle (*Terrapene carolina*), (6) yellow-bellied slider (*Trachemys scripta*), (7) Gulf Coast spiny softshell (*Apalone spinifera aspera*), and (8) the snapping turtle. The seven species observed in 2009 (all of the species listed above except the Gulf Coast spiny softshell [Duke Power Company 1974a, b, c]) ranged from abundant to rare (Dorcas 2009a). All of the turtle species leave the water to nest and to bask. Nesting (egg deposition) is accomplished in soft substrates near water. Hibernation/burrowing during inactive periods may occur in soft soil or in fallen logs/debris, soft substrates under water, or under rocks or in holes in banks, depending on the species and habitat availability.

<u>Lizards</u>. The lizard species range from mostly arboreal (e.g., green anole [*Anolis carolinensis*]) to terrestrial (e.g., ground skink [*Scincella lateralis*]). Four lizard species were observed during surveys conducted in 1974, 2007, and 2009: (1) fence lizard (*Sceloporus undulatus*), (2) six-lined racerunner (*Aspidoscelis sexlineata*), (3) green anole, and (4) ground skink. The three species observed in 2009 (all of the species listed above except the six-lined racerunner [Duke Power Company 1974a, b, c]) ranged from common to rare (Dorcas 2009a). All the lizard species inhabit upland habitats, but may be found in upland areas near wetland or other aquatic habitats, although they have no particular affinity for aquatic habitats. All the lizard species spend periods of inactivity underground or in crevices, and they deposit eggs in soil, litter, or debris.

<u>Snakes</u>. The snake species range from mostly aquatic (e.g., northern watersnake [*Nerodia sipedon*]), to having an affinity for terrestrial habitats near water (e.g., rough greensnake [*Opheodrys aestivus*]), to having no apparent affinity for water or terrestrial habitats near water (all the other snake species subsequently listed). Seven snake species were observed during surveys conducted in 1974, 2007, and 2009: (1) smooth earthsnake (*Virginia valeriae*), (2) ringneck snake (*Diadophis punctatus*), (3) northern black racer (*Coluber constrictor*),

(4) coachwhip (*Masticophis flagellum*), (5) black rat snake (*Elaphe obsoleta*), (6) northern watersnake, and (7) rough greensnake. The three species observed in 2009 (i.e., black racer, rat snake, and watersnake [Duke Power Company 1974a, b, c]) ranged from common to rare (Dorcas 2009a). All the snake species spend periods of inactivity underground or in crevices or burrows and deposit eggs in soil, litter, debris, or abandoned mammal burrows.

2.4.1.2 Terrestrial Resources − Make-Up Pond C Site

Make-Up Pond C would be located in the London Creek watershed just northwest of the Lee Nuclear Station (Figure 2-14). Make-Up Pond C would have a surface area of approximately 620 ac and a drainage area of approximately 2500 ac (approximately 3.9 mi^2) (Duke 2009b, 2011h).

The Make-Up Pond C study area was delineated to define the boundaries within which related environmental data would be collected. The study area includes the following features (Duke 2009b, 2011h):

- Make-Up Pond C.
- a 300-ft buffer around the perimeter (Figure 2-14).
- Make-Up Pond C intake and refill structures and an associated 225-ft-long bridge extending from the shore, and pipelines that would transport water from the Broad River to Make-Up Pond C and between Make-Up Pond B and Make-Up Pond C.
- a plan to use an overhead 44-kV transmission line to power the Make-Up Pond C intake/refill structure has been eliminated. Instead, the Make-Up Pond C intake/refill structure will be powered with underground cables from the Lee Nuclear Station that will be routed below ground within the area of disturbance for the raw water service (RWS) pipeline (Duke 2013d).
- a realignment area for SC 329.
- an expansion area for the box culvert at the railroad crossing on London Creek.
- a realignment area for an existing 44-kV transmission line (The existing transmission line is currently out of service and is not needed at this time. Thus, only the corridor will be realigned [Duke 2011h].)
- improvements to Lake Cherokee Dam.

Existing cover types in the proposed Make-Up Pond C area are shown in Figure 2-14; jurisdictional open waters, wetlands, and streams, and non-jurisdictional features are shown in Figure 2-15. Acreages for the existing cover types are given in Table 2-8. Existing cover types, wetlands, streams, and floodplains, as well as mammals, birds, amphibians, and reptiles found in the cover types, are described below.

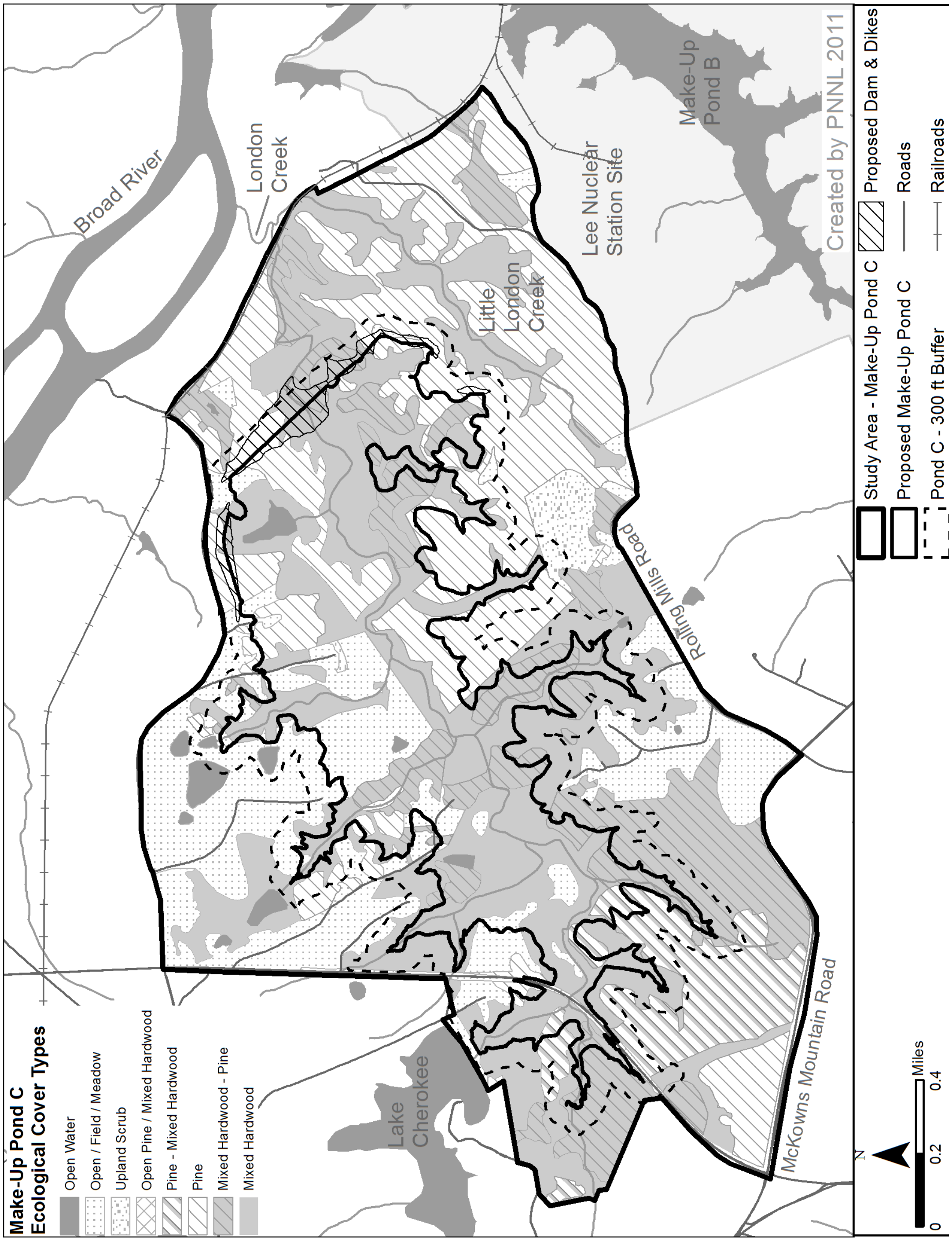

Figure 2-14. Ecological Cover Types in the Proposed Make-Up Pond C Study Area

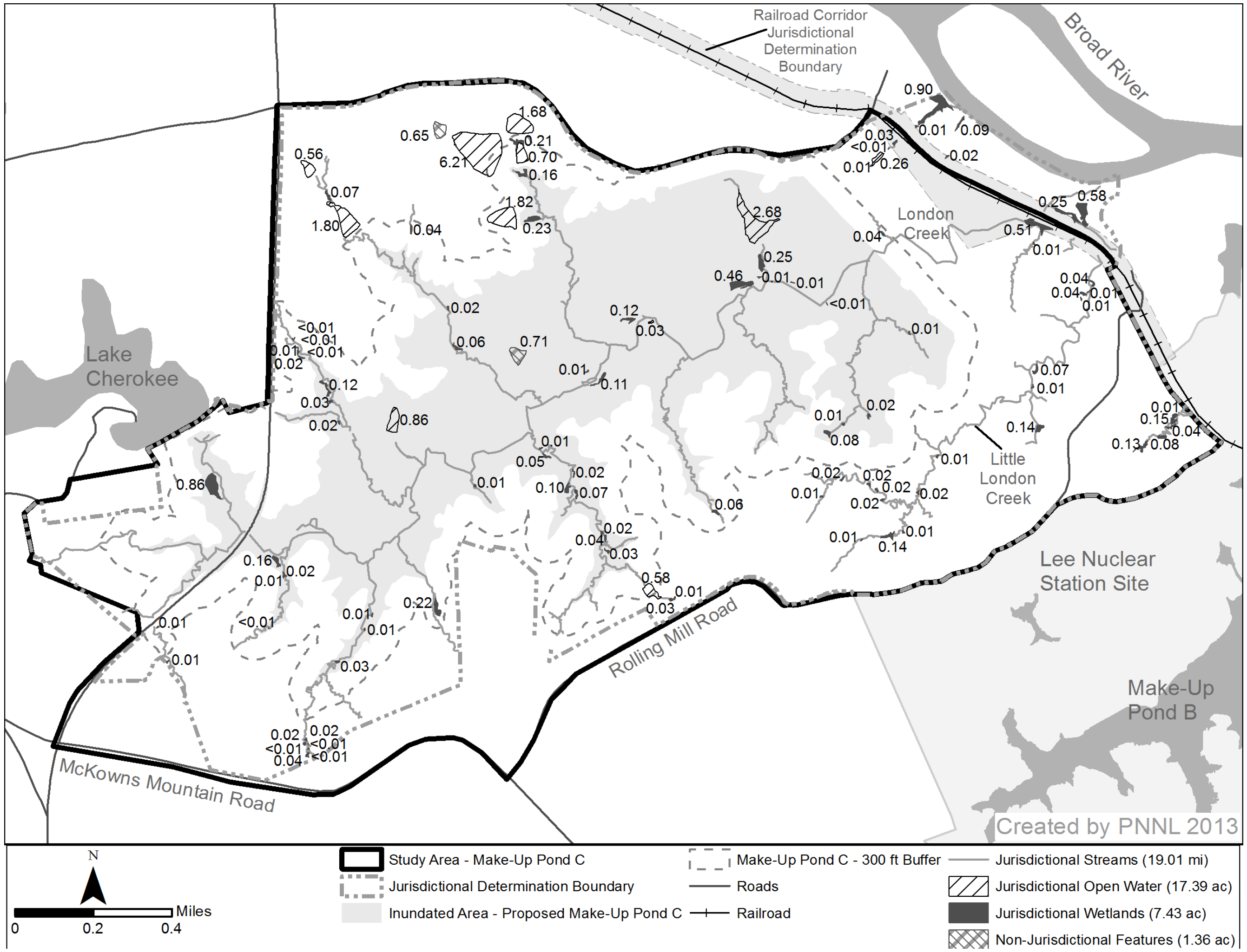

Figure 2-15. Wetlands and Waterbodies within USACE Jurisdictional Boundaries at the Proposed Make-Up Pond C (acreages for jurisdictional wetlands, jurisdictional waterbodies, and non-jurisdictional features obtained from the USACE [2013a])

Table 2-8. Acreages Occupied by Various Cover Types at the Proposed Make-Up Pond C

Coverage Type	Brief Description	Area (ac)	Percent of Total
Mixed hardwood	Stands dominated by mixed hardwood with little or no pine in the canopy	664.8	31.5
Pine	Pine stands/pine plantations with no or limited hardwoods in canopy	515.0	24.4
Open/field/meadow	Non-forested areas dominated by grasses, herbs, etc.; maintained by cattle grazing, mowing, and/or other vegetation management, past or present	426.6	20.2
Mixed hardwood-pine	Stands dominated by mixed hardwood with pine in the canopy	335.9	15.9
Pine-mixed hardwood	Stands dominated by pine with mixed hardwood in the canopy and understory	119.6	5.7
Upland scrub	Partially forested, early successional scrubby areas, including cutover areas lacking forest canopy development	28.0	1.3
Open water[(a)]	Reservoirs and ponds (farm ponds)	20.1	1.0
Open pine/mixed hardwood	Selectively cut stands with scattered pine in canopy and mixed hardwood understory	0.3	<0.1
	Total	**2110.3**	**100**

Source: Duke 2009b

(a) Open water cover type acreages were derived using aerial photo interpretation. Open waters were subsequently surveyed in the field during the jurisdictional determination (USACE 2013a), resulting in a more accurate acreage estimate of 17.39 ac for jurisdictional open waters and 1.36 ac for non-jurisdictional features (farm ponds excavated from uplands (Duke 2013d).

Existing Cover Types

A study of the vegetation of the Make-Up Pond C study area began in January 2008 and continued until October 2009 (Gaddy 2009). The study area was surveyed by vehicle and on foot. Vegetation was quantitatively sampled in 42 plots. Forty of these plots were circular 0.10-ac plots located in forested or mostly forested areas. Two plots were located in a non-forested transmission-line corridor, where each plot consisted of a cluster of five 4-m^2 subplots. A total of 426 species of plants were identified within the study area. Duke developed a vegetation cover map using 2006 false color infrared imagery, which was ground-truthed at the sample plots and at various other points in the study area (Gaddy 2009). Vegetation cover types found in the Make-Up Pond C study area are shown in Figure 2-14. Vegetation cover types are representative of several broader natural community types described by Nelson (1986) and SCDNR (2005) for the State of South Carolina.

Mixed Hardwood

Mixed hardwood communities within the Make-Up Pond C study area are similar to those found within the Lee Nuclear Station site. Duke estimated that this cover type occupies 664.8 ac or 31.5 percent of the Make-Up Pond C study area. Within the mixed hardwood classification, Duke identified four subtypes: upper and mid-slope mixed hardwood, cutover mixed hardwood, bluff mixed hardwood, and lowland mixed hardwood forest (Duke 2009b).

Upper and mid-slope mixed hardwood forest is found on mesic upland slopes and is mostly dominated by white oak, with American beech, tulip poplar, sweet gum, red oak, and red maple as co-dominant species. Sourwood, American holly, and ironwood are common species in the understory (Duke 2009b).

Partial recovery following timber harvesting or other disturbances within upper and mid-slope mixed hardwood forests and the mixed hardwood-pine or pine-mixed hardwood cover types results in the cutover mixed hardwood subtype, which occurs throughout the Make-Up Pond C study area (Duke 2009b). These communities are dominated by a mix of hardwood species such as tulip poplar, red maple, red oak, white oak, sweet gum, and hickories (*Carya* spp.).

Relatively undisturbed hillsides with steep faces along London Creek contain bluff mixed hardwood stands. These plant communities include rocky heath bluffs with thickets of mountain laurel and Piedmont rhododendron with scattered sourwood stands. Also included in this subtype are species-rich, mixed hardwood stands on more gentle slopes that are dominated by American beech, white oak, red oak, tulip poplar, bitternut hickory (*Carya cordiformis*), sourwood, and mountain laurel. Some of the trees in these stands are relatively large (e.g., 30- to 40-in. diameter breast high (DBH) (Duke 2009b; Nelson 1986; SCDNR 2005).

Lowland mixed hardwood forest occurs extensively on lower slopes, in riparian and seepage areas, and in bottomlands along London Creek and its tributaries, and along Little London Creek. These stands include elements of the bottomland hardwood forest and Piedmont seepage forest communities as described by Nelson (1986). Bottomland hardwood forest that occurs in the narrow floodplains of small Piedmont streams is known collectively as Piedmont small stream forest by the SCDNR and is targeted for conservation in South Carolina (SCDNR 2005). Bottomland hardwood forest is also one of several Piedmont floodplain community types targeted for conservation in the Piedmont of North Carolina (NCWRC 2005). A variety of species, such as sweet gum, American beech, tulip poplar, red maple, black walnut (*Juglans nigra*), green ash, American elm (*Ulmus americana*), and white ash are often present with giant cane, pawpaw, and strawberry bush (*Euonymus* spp.) listed as shrub layer dominants. The London Creek floodplain near the Broad River is dominated by cottonwood and sycamore. Large trees (30- to 40-in. DBH) are present. Forbs, such as mayapple and Jack-in-the-pulpit, occur in the herbaceous layer (Duke 2009b).

Mixed Hardwood-Pine

Mixed hardwood-pine forest dominated by white oak, red oak, sweet gum, and tulip poplar occurs on lower slopes and in transitional areas between pine-mixed hardwood and mixed hardwood cover types (Duke 2009b). The mixed hardwood-pine cover type occupies 335.9 ac (15.9 percent) of the Make-Up Pond C study area.

Open/Field/Meadow

This cover type consists of assemblages of herbaceous species that occur in residential areas, fields, pastures, and along roads and in transmission-line corridors (SCDNR 2005). It occupies 426.6 ac (20.2 percent) of the Make-Up Pond C study area. Dominant species in more xeric areas include little bluestem (*Schizachyrium scoparium*), broomsedge (*Andropogon virginicus*), purpletop (*Tridens flavus*), blackberry, fescue, goldenrod (*Solidago* spp.), asters (*Aster* spp.), sunflowers (*Helianthus* spp.), and plantains (*Plantago* spp.). More mesic species, such as skullcap (*Scutellaria integrifolia*), false indigo (*Baptisia alba*), and southern beardtongue (*Penstemon australis*), occur on more clayey soils. Giant cane, chaffseed (*Verbesina occidentalis*), and ironweed (*Vernonia noveboracensis*) are abundant in low-lying areas, while sedges, bulrushes (*Scirpus* spp.), and needlerush are present along streams. Pastures commonly support planted fescues (Duke 2009b).

Open Pine-Mixed Hardwood

Less than 0.1 percent (0.3 ac) of the Make-Up Pond C study area is characterized as open pine-mixed hardwood cover type (Duke 2009b).

Pine

As with the similar stands on the Lee Nuclear Station site, the pine cover type within the Make-Up Pond C study area consists primarily of stands of planted loblolly pine and scattered Virginia pine that are less than 50 years old. This cover type occupies 515.0 ac (24.4 percent) of the Make-Up Pond C study area. Understory vegetation is usually limited (Duke 2009b).

Pine-Mixed Hardwood

The pine-mixed hardwood cover type occupies 119.6 ac (5.7 percent) of the Make-Up Pond C study area. This community is a successional stage following disturbance within oak-hickory or other hardwood forest types. It is usually dominated by loblolly pine and Virginia pine, but early successional trees such as tulip poplar and sweet gum are common in the canopy as well as the understory (Duke 2009b; Nelson 1986).

Upland Scrub

The upland scrub cover type occupies 28.0 ac (1.3 percent) of the Make-Up Pond C study area. This type of community may develop following logging, especially in poor or erosion-prone soils. The trees in the communities that develop following logging may be stunted. Dominant species include eastern red cedar, Virginia pine, blackberry, and sumac (Duke 2009b).

Wetlands, Streams, and Floodplains

Make-Up Pond C would be located immediately downstream of Lake Cherokee, which is a 53-ac waterbody impounded in 1971 by Wildlife Dam on upper London Creek, a second-order stream. Lake Cherokee is the headwater of London Creek. Its drainage area is estimated at approximately 512 ac, which is included in the approximately 2500-ac drainage area upstream of the proposed Make-Up Pond C dam. London Creek flows approximately 3.76 mi from its head at Lake Cherokee to its confluence with the Broad River within the upper reaches of Ninety-Nine Islands Reservoir. Downstream of the proposed Make-Up Pond C dam, Little London Creek joins London Creek and their combined flow enters the Broad River (Duke 2009b, 2011h). London Creek and its tributaries, including Little London Creek, are the water sources for the numerous wetlands that occur in the Make-Up Pond C study area.

Jurisdictional Wetlands

Jurisdictional wetlands within the USACE jurisdictional determination boundary at the Make-Up Pond C site (Figure 2-15) were delineated in the field (Duke 2011h). These wetlands comprise a relatively small portion of the lowland mixed hardwood cover type, with a total area estimated to be 7.43 ac (USACE 2013a), or about 0.4 percent of the Make-Up Pond C study area.

The wetlands range in size from less than 0.01 to 0.90 ac; however, most are less than 0.10 ac (Figure 2-15), and are primarily associated with stream features (e.g., seepage areas, old beaver ponds, oxbow wetlands, and partially impounded streambeds) along London Creek, Little London Creek, and various unnamed tributaries (Figure 2-7) (Duke 2009b, 2011h). Dominant vegetation includes green ash, red maple, black willow, alder, cottonwood, and sycamore in the overstory, and common needlerush, sedges, and chain fern (*Woodwardia* spp.) in the herbaceous layer (Duke 2009b).

Wetland Functional Assessment

Duke performed functional assessments for jurisdictional wetlands in the Make-Up Pond C study area in the same manner as noted above for jurisdictional wetlands on the Lee Nuclear Station site (see Section 2.4.1.1). Of the 95 wetland assessment areas on the Make-Up Pond C site, 73 were classified as being fully functional, 15 were partially impaired, 4 were impaired, and 3 were very impaired (Duke 2011h).

Streams

About 19 mi of jurisdictional perennial and seasonal streams occur within the USACE jurisdictional determination boundary at the Make-Up Pond C site (USACE 2013a) and have hydrologic connections to the wetlands described above and to the Broad River (Duke 2009b, 2011h). These include London Creek and its tributaries (including Little London Creek) below Lake Cherokee (USACE 2013a). Tributary streams on the south side of London Creek generally have significant forested buffers, whereas tributary streams on the north side often lack forested buffers and are located in pasture areas (Duke 2011h).

Floodplains

Regulatory 100-year floodplains occur in low-lying areas of the Make-Up Pond C study area, along most of the mainstem of London Creek (Duke 2011h).

Significant Natural Areas

Ten locations were determined by the applicant to be “significant natural areas” based on the presence of rare plant communities, rare plant species, or mature to old-growth trees. These natural areas are generally small, ranging in size from around 0.5 ac (Chain Fern Bog) to just over 5 ac (London Creek Bottoms) (Gaddy 2009). Note that the numbering system for each sampling area approximates the mileage upstream from the confluence of London Creek with the Broad River.

Cinnamon Fern Bog

This is a seepage bog near the westernmost portion of sampling area 2.6 (Figure 2-16) dominated by green ash and tulip poplar with several dominant sedges (bent sedge [*Carex styloflexa*], thicket sedge [*C. abscondita*], prickly bog sedge [*C. atlantica*]) and a luxuriant fern flora with large cinnamon (*Osmunda cinnamomea*), royal (*O. regalis* var. *spectabilis*), and sensitive ferns (*Onoclea sensibilis*) (Gaddy 2009).

Laurel Ravine

This is a mountain laurel-dominated ravine just east of Cinnamon Fern Bog in sampling area 2.6. Extremely large mountain laurel up to 25 ft in height and with a main stem diameter over 4 in. are present (Gaddy 2009).

West Bluff

Just downstream from Laurel Ravine (in sampling area 2.6), a steep, north-facing bluff harbors a stand of mature red oak, bitternut hickory, and beech with trees up to 30- to 40-in. DBH. Large sourwood up to 11-in. DBH also are present (Gaddy 2009).

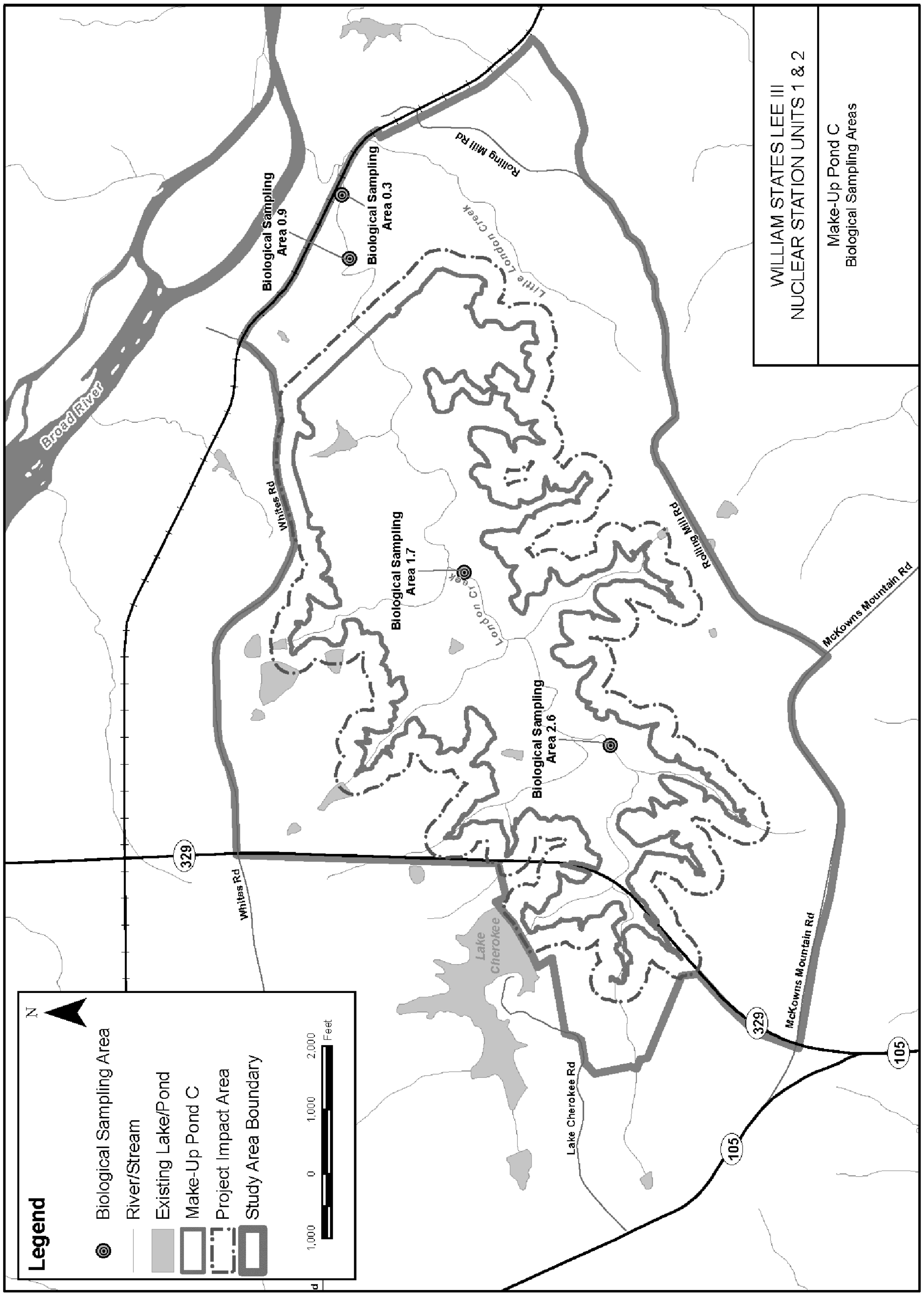

Figure 2-16. Survey Locations within Footprint of Make-Up Pond C (Duke 2009b)

West Bottoms

A rich bottomland with a diverse assemblage of species is found in sampling area 2.6 along London Creek. Black walnut, American elm, eastern red cedar, white ash, winged elm (*Ulmus alata*), tulip poplar, and sweet gum are present in the canopy. In the understory, redbud, pawpaw, and spicebush (*Lindera benzoin*) are common. In the herbaceous layer, two State-ranked species are present (i.e., southern adder's-tongue fern (*Ophioglossum vulgatum*) and drooping sedge [*Carex prasina*]; see Section 2.4.1.6), along with mayapple and Jack-in-the-pulpit (Gaddy 2009).

Sampling Area 1.7 and Adjacent Bluff

Sampling area 1.7 (Figure 2-16) and the adjacent bluff is a species-rich complex of forest and herbaceous species. The bluff is dominated by mature (up to 30-in. DBH) beech, tulip poplar, and bitternut hickory and overlooks a species-rich bottom. The bottom has black walnut, red maple, tulip poplar, American elm, and sweet gum in the canopy with three State-ranked plant species in the herbaceous layer (i.e., southern enchanter's nightshade [*Circaea lutetiana* ssp. *canadensis*], southern adder's-tongue fern, and single-flowered cancer root [*Orobanche uniflora]*) (see Section 2.4.1.6) (Gaddy 2009).

Rhododendron Bluff

Rhododendron Bluff overlooks lower London Creek at sampling area 0.9 (Figure 2-16). It is dominated by Piedmont rhododendron, mountain laurel, beech, sourwood, and American holly. Piedmont rhododendron, which is found in the Piedmont of Virginia and North Carolina, is rarely dominant on bluffs in the Piedmont of South Carolina. In South Carolina, this flowering shrub is usually a Blue Ridge species and is, thus, somewhat outside of its normal range at this location (Gaddy 2009).

London Creek Bottoms

London Creek enters the species-rich floodplain of the Broad River in the downstream portion of sampling area 0.3 (Figure 2-16). Large cottonwood (*Populus deltoides*) and sweet gum over 36-in. DBH dominate a mature forest that is more typical of larger floodplains. Mature sycamore, green ash, and American elm also are found in the canopy. The understory is open with scattered box elder. Yellowish milkweed vine (*Matalea flavidula*), known from only four counties in South Carolina and rare in the Piedmont, was found in the herbaceous layer (Gaddy 2009).

Little London Creek Bottoms

Little London Creek is located in the upper portion of sampling area 0.3. The Little London Creek ravine is rich in mature hardwood species, such as white oak, sweet gum, tulip poplar, water oak (*Quercus nigra*), beech, and black gum (*Nyssa sylvatica*). American holly is common in the understory with southern lady fern, Christmas fern, and partridgeberry common in the herbaceous layer (Gaddy 2009).

Fern Ravine

A ravine with a small rocky stream with waterfalls and slides enters London Creek upstream from sampling area 2.6. This pristine area is dominated by scattered mature beeches (up to 43-in. DBH) and tulip poplars. American holly is the dominant species in the understory, and broad beechfern (*Thelypteris hexagonoptera*) and maidenhair fern (*Adiantum pedatum*) are common along the creek (Gaddy 2009).

Chain Fern Bog

Chain Fern Bog is a small mucky seepage bog found adjacent to a small tributary of London Creek southeast of sampling area 2.6. Netted chain fern (*Woodwardia areolata*) is the dominant species. The canopy consists of scattered red maple and black gum, and highbush blueberry (*Vaccinium corymbosum*) is common in the understory. Other wetland plants include arrow arum (*Peltandra virginica*) and turtlehead (*Chelone obliqua*) (Gaddy 2009).

Noteworthy Ecological Associations

The basic unit for vegetation classification in the U.S. National Vegetation Classification (NVC) is the association. The NVC defines the association as “a vegetation classification unit defined on the basis of a characteristic range of species composition, diagnostic species occurrence, habitat conditions, and physiognomy [structural appearance]” (Jennings et al. 2009). Based on the botanical inventory of the Make-Up Pond C study area (Gaddy 2009) and observations made in the field in July 2010 by the SCDNR (SCDNR 2011b), four noteworthy ecological associations were preliminarily identified—three in the uplands of the Make-Up Pond C study area and one in the lowlands (SCDNR 2011b). Piedmont acidic mesic mixed hardwood forest, Piedmont beech/heath bluff, and Piedmont basic mesic mixed hardwood forest occur in the uplands. Piedmont streamside seepage swamp occurs in the lowlands (SCDNR 2011b).

It is uncertain whether these four ecological associations (SCDNR 2011b) co-occur with the significant natural areas (Gaddy 2009) or occur within the cover types previously described, as none was delineated in the field. It is also uncertain whether the significant natural areas are representative of the four ecological associations because the detailed floristic information that would be necessary to classify such areas as ecological associations per the U.S. National Vegetation Classification System is lacking (Duke 2012c). However, the four ecological associations and the significant natural areas share some prevalent plant species, as indicated in the descriptions presented in this section.

In addition, Gaddy (2009) noted the presence of giant cane in the Make-Up Pond C study area, and the SCDNR (2011b) referred to this as representing the floodplain canebrake ecological association. This discrepancy (Duke 2012c) is discussed in greater detail in the following paragraphs. Further, the SCDNR noted the presence of mountain-like cove habitats (small, well-developed hardwood forests usually on protected bluffs close to stream or river bottoms [SCDNR 2005]) created by steep rock formations (SCDNR 2010a, 2011b). Cove habitats are more typically associated with the higher elevations of the upper Piedmont (SCDNR 2010a) and further increase the biological diversity of the London Creek system, especially for the birds (SCDNR 2005, 2010f) and amphibians (SCDNR 2005) discussed below.

Piedmont acidic mesic mixed hardwood forest (American beech – northern red oak/flowering dogwood [*Cornus florida*]/Christmas fern – Virginia heartleaf [*Hexastylis virginica*] forest) (unique association identifier CEGL008465) is the most typical ecological association along ravines and coves in the Piedmont (SCDNR 2011b). Piedmont acidic mesic mixed hardwood forest communities are fairly common but are considered vulnerable (global conservation status rank of G3). Under natural conditions, these forests are uneven-aged, with old trees present (NatureServe Explorer 2010). Large-stature beech trees (dominant), red oak (prevalent), and flowering dogwood were observed in the West Bluff significant natural area in the Make-Up Pond C study area (Gaddy 2009). However, it is uncertain whether this location of mature beech trees represents or is associated with the Piedmont acidic mesic mixed hardwood forest community type observed by SCDNR (SCDNR 2011b).

The Piedmont beech/heath bluff (American beech – white oak/mountain laurel – common sweetleaf [*Symplocos tinctoria*], Catawba rosebay [*Rhododendron catawbiense*]/beetleweed [*Galax urceolata*] forest) (SCDNR 2011b) association (unique identifier CEGL004539) occurs on steep north-facing slopes in the lower Piedmont, and disjunct examples of this type are found in South Carolina. This association is considered imperiled (global conservation status rank of G2) (NatureServe Explorer 2010). Although Catawba rosebay was not documented in this community in the Make-Up Pond C study area, both Piedmont rhododendron and great rhododendron are present (SCDNR 2011b). Beech, white oak, and Piedmont rhododendron were observed in the Bluff Hardwoods significant natural area in the Make-Up Pond C study area (Gaddy 2009). However, it is uncertain whether this significant natural area represents or is associated with the Piedmont beech/heath bluff community type observed by the SCDNR (SCDNR 2011b).

The Piedmont basic mesic mixed hardwood forest (American beech – northern red oak/Florida maple [*Acer barbatum*] – painted buckeye [*Aesculus sylvatica*]/black baneberry [*Actaea racemosa*] – maidenhair fern forest) (SCDNR 2011b) association (unique identifier CEGL008466) represents intermediate and basic, mesic, mixed hardwood forests of the Piedmont and is considered vulnerable (global conservation status rank of G3) (NatureServe Explorer 2010). Beech and red oak are dominant in some parts of the bluff mixed hardwood forest community subtype (Gaddy 2009) described above. However, it is uncertain whether this community subtype represents or is associated with the Piedmont basic mesic mixed hardwood forest community type observed by the SCDNR (SCDNR 2011b).

Piedmont streamside seepage swamp (red maple [*Acer rubrum var. trilobum*] – tulip poplar/ American holly/cinnamon fern forest) (unique association identifier CEGL004551) vegetation is found in the southeastern Piedmont of North Carolina (NatureServe Explorer 2010), and undisturbed, extensive wetlands of this type are very limited in the Piedmont of South Carolina (SCDNR 2011b). This association is considered imperiled (global conservation status rank of G2) (NatureServe Explorer 2010). Tulip poplar is present in the overstory and cinnamon fern species in the understory of the Cinnamon Fern Bog significant natural area in the Make-Up Pond C study area (Gaddy 2009). However, it is uncertain whether this significant natural area represents or is associated with the Piedmont streamside seepage swamp community type observed by the SCDNR (SCDNR 2011b).

SCDNR (2011b), reporting on a reconnaissance-level survey of the Make-Up Pond C study area, cited the floodplain canebrake (giant cane shrubland) ecological association (unique association identifier CEGL003836 [NatureServe Explorer 2010]) as being present but not extensive. This floodplain canebrake ecological association is considered globally imperiled (global conservation status rank of G2) (NatureServe Explorer 2010). Gaddy (2009), reporting on a detailed botanical inventory of the Make-Up Pond C study area, noted that giant cane was prevalent in the understory at two locations in lowland mixed hardwood forest and mixed hardwood forest, where black walnut and sweet gum are prevalent, respectively, in the overstory; in low-lying areas of open/field/meadow habitat; and in scattered areas of lowland mixed hardwood forest as a shrub layer dominant in association with pawpaw and spicebush.

White (2004) describes the floodplain canebrake ecological association as follows:

> *This floodplain canebrake ecological association is characterized by dense, often monospecific thickets of the giant cane occupying large areas referred to as canebrakes. The canebrake shrubland type was historically widespread, but is now rare and occupies very little of its former acreage. It was best developed in streamside flats and alluvial floodplains on ridges and terraces where it was protected from prolonged inundation. Historically, this community covered large areas of many floodplains and streamsides in the Coastal Plain from North Carolina to Texas, Mississippi River Alluvial Plain, Interior Highlands, Interior Low Plateau, Southern Blue Ridge and possibly the Central Appalachians of the southeastern United States. Stands occur on alluvial and loess soils and are often associated with bottomland hardwood forest vegetation. This association is successional and is thought to be maintained by periodic fires and/or grazing. It may have originated following abandonment of aboriginal agricultural fields or other natural and anthropogenic disturbances such as blow-downs and catastrophic floods.*

The above statement is ambiguous as to whether just extensive monospecific thickets of giant cane, or extensive monospecific thickets of cane and stands of cane associated with bottomland hardwood forest comprise the floodplain canebrake ecological association.

Brantley and Platt (2001), in their discussion of minimum habitat standards for canebrake, raise the need for development of specific criteria to differentiate “canebrakes” (referring to the imperiled ecological association) from smaller areas of cane growing in the understory of other vegetative cover classifications, because the latter may provide the basis for restoration efforts of the former. In distinguishing the imperiled floodplain canebrake ecological association from cane growing in the understory of other vegetative cover, it is illustrative to consider the White (2004) floristic inventory and plant community classification of the Cowpens National Battlefield, located about 18 mi northwest of the Lee Nuclear Station site. Historical accounts from the time of the Revolutionary War describe extensive fields of cane along many of the creeks that today no longer exist within the park boundary. Canebrake is further described as being locally extinct in the area of Cowpens National Battlefield, although small populations of cane still exist in sparse patches throughout the park’s streamside forests (White 2004). Based on the above information, the review team concludes that the cane patches that occur in the understory of forested areas in the Make-Up Pond C study area do not represent the globally imperiled floodplain canebrake ecological association.

Rare Plant Species

Five rare or otherwise noteworthy (not Federally listed or State-ranked) plant species were observed in the Make-Up Pond C study area: (1) mountain holly (*Ilex montana*) and (2) golden ragwort (*Senecio aureus*), both rare outside of the Blue Ridge Mountains; (3) tuberous dwarf-dandelion (*Krigia dandelion*), widely scattered in the Piedmont of South Carolina; (4) yellowish milkweed vine, known from only four counties in South Carolina; and (5) Kral’s sedge (*Carex kraliana*), unreported in the South Carolina Plant Atlas (USC 2013) and possibly the second record for the State (Gaddy 2009).

Invasive Plant Species

Of the 426 plant species that were identified within the study area, 20 (about 5 percent) were exotic or invasive species (Gaddy 2009). However, the more common invasive plant species, such as Chinese privet (*Ligustrum sinense*), autumn olive (*Elaeagnus umbellata*), Japanese honeysuckle, and Vietnam grass (*Microstegium vimineum*), were present but uncommon in the Make-Up Pond C study area (Gaddy 2009). This may be because habitat/ground disturbance in the bottomlands of the Make-Up Pond C study area is relatively low compared to similar sites in the foothills of upstate South Carolina. The ridge tops have been disturbed mostly by silviculture, but the north-facing slopes (and bottomlands) have undergone relatively little disturbance (Duke 2011h, SCDNR 2011b). Chinese privet, Japanese honeysuckle, and

Vietnam grass are considered a severe threat, i.e., spreads easily into native plant communities and displaces native vegetation (White and Govus 2005).

Wildlife

The riparian corridor along London Creek provides habitat suitable for a wide variety of wildlife, including both game and non-game species representative of the Piedmont and foothills regions. Bottomland hardwood habitats and the adjacent areas provide vital travel corridors, feeding areas, and den sites for many of the wildlife species (SCDNR 2011b) discussed in this section.

<u>Mammals</u>

During 2008 and 2009, Duke employed a variety of techniques to survey the mammalian fauna of the Make-Up Pond C study area, including snap traps (1192 trap nights), live traps, and pitfall traps (7450 trap nights) for small mammals and field surveys to record mammal observations and field sign (e.g., tracks, scat, nests, dens) for small, medium, and large mammals. Sampling areas included most of the habitat types within the Make-Up Pond C study area, including mixed hardwood, mixed hardwood-pine, pine-mixed hardwood, open/field/meadow, and pine habitats. Bats were inventoried using mist nets for three nights along London Creek and nearby open habitats. In addition, bat vocalizations were recorded using an ANABAT ultrasonic detector. Other sampling was conducted via pedestrian field surveys to record mammal observations and sign throughout a variety of habitat types within the Make-Up Pond C study area (Duke 2009b; Webster 2009). Locations for mammal surveys undertaken in 2008 and 2009 are shown in Figure 1 in Webster (2009).

In the evaluation of the Make-Up Pond C study area, Webster (2009) identified 34 mammal species (33 native and one introduced) that could potentially occur based on major North American museum collections and a review of literature and other pertinent records for the locality. A total of 22 species were documented during the 2008 and 2009 field surveys (Webster 2009). Common mammal species typical of the region include Virginia opossum, eastern mole (*Scalopus aquaticus*), eastern red bat (*Lasiurus borealis*), eastern cottontail, eastern gray squirrel, coyote (*Canis latrans*), raccoon, white-tailed deer, eastern harvest mouse (*Reithrodontomys humulis*), and hispid cotton rat (*Sigmodon hispidus*) (Duke 2009b; Webster 2009).

Although some of the trapping success rates were relatively low for small mammals in the forested habitats, the small mammal density in early successional old field habitats was relatively high. The population densities of medium and large mammals within the Make-Up Pond C study area were similar to comparable habitats in the Piedmont (Duke 2009b; Webster 2009).

Birds

In 2008, DTA evaluated the breeding and migratory avifauna of the Make-Up Pond C study area by conducting field surveys during spring migration, the summer breeding season, and fall migration near the four main biological sampling areas (Figure 2-16) (DTA 2008b). Bird survey locations are provided in DTA (2008b). Mixed hardwood forest (mainly lowland mixed hardwood forest along London Creek), pine forest (mainly planted pine with some cutover successional forest), and open/field/meadow cover types were surveyed in a similar manner (Duke 2009b; DTA 2008b).

Based on general geographic distributions in the region, obtained by a review of literature and existing data records (i.e., field guides, State bird lists, and the compilation of the North American Breeding Bird Survey records [Chesnee, SC route] and Breeding Bird Atlas data from Cherokee County) a total of over 200 bird species could potentially occur within the Make-Up Pond C study area. Field surveys documented 87 bird species in the Make-Up Pond C study area, including 57 species known to breed in South Carolina and assumed to be breeding locally because of their seasonal occurrence. Of these 87 species, 30 are on either the South Carolina Comprehensive Wildlife Conservation Strategy (SCDNR 2005) or the regional Atlantic Coast Joint Venture (ACJV 2010) priority list (SCDNR 2011b), many of which are neotropical migrant songbirds.

The mixed pine-hardwood and bottomland hardwood habitats exhibited the greatest number of species. Duke (DTA 2008b) indicated that the most common bird species include turkey vulture, wild turkey, mourning dove, pileated woodpecker, red-bellied woodpecker, hairy woodpecker, downy woodpecker, barn swallow (*Hirundo rustica*), blue jay, American crow (*Corvus brachyrhynchos*), Carolina chickadee, tufted titmouse, white-breasted nuthatch (*Sitta carolinensis*), Carolina wren, northern mockingbird, American robin, eastern bluebird, blue-gray gnatcatcher (*Polioptila caerulea*), white-eyed vireo (*Vireo griseus*), red-eyed vireo (*V. olivaceous*), black-and-white warbler (*Mniotilta varia*), northern parula (*Parula americana*), pine warbler (*Dendroica pinus*), Louisiana waterthrush (*Seiurus motacilla*), common yellowthroat (*Geothlypis trichas*), yellow-breasted chat (*Icteria virens*), hooded warbler (*Wilsonia citrina*), eastern meadowlark (*Sturnella magna*), common grackle (*Quiscalus quiscula*), scarlet tanager (*Piranga olivacea*), northern cardinal, American goldfinch (*Carduelis tristis*), eastern towhee (*Pipilo erythrophthalmus*), and brown-headed cowbird (*Molothrus ater*).

Duke compared the Make-Up Pond C bird survey results with the North American Breeding Bird Survey (Chesnee, SC route) and found that the species richness and composition within the Make-Up Pond C study area appears to be typical for the region and habitat types present (Duke 2009b; DTA 2008b). The spring migration surveys had the highest species counts of any of the surveys and the bottomland hardwood forest along London Creek provided the highest quality avian habitat and species diversity. However, the bottomland habitat is narrow, degraded, and fragmented because of past and present land uses. Clearing of hardwood forests for pastureland and planting pine plantations has limited the amount of breeding habitat for birds. Thus, because of the extensive low-quality pine plantations and cultivated lands, lower diversity of avian species, and the reduced size and fragmentation of higher quality habitats (Duke 2009b; DTA 2008b), the London Creek area is considered to be relatively poor avian habitat.

Diversity of shorebirds was low, with only killdeer and American woodcock noted within the Make-Up Pond C study area. Great blue herons were the only colonial-nesting water birds observed, and no suitable heron nesting habitat was observed (DTA 2008b).

A number of upland game birds were observed, including wild turkey, northern bobwhite, American woodcock, mourning dove, and ruffed grouse (*Bonasa umbellus*). Wild turkeys were abundant in both mature woods and open areas. Northern bobwhite and mourning doves were observed in brushy areas, abandoned fields, and open pine forests. The woodcock was observed in lowland mixed hardwoods along London Creek. Ruffed grouse were observed onsite, but were not expected to occur in the Make-Up Pond C study area because the species is usually found in the mountains of South Carolina west of the Lee Nuclear Station (Duke 2009b). Areas near the edges and adjacent to the open land and pastures provide bugging sites and nesting and brood rearing habitat for species such as bobwhite quail and wild turkey (SCDNR 2011b).

Over 60 species of perching birds were observed in the Make-Up Pond C study area, and over 40 of these were assumed to be nesting within the study area. Migratory species that were observed included a number of neotropical migrants (Duke 2009b; DTA 2008b).

Relatively high numbers of migrant songbirds were observed (DTA 2008b). Migrants probably are using the forested stream corridor during migration when the connectivity of forested wetlands and stream systems is critical. Forested areas are used because they provide the highest density of food resources (SCDNR 2011b).

At least five species of woodpeckers were observed in the area, including the northern flicker (*Colaptes auratus*), pileated woodpecker, red-bellied woodpecker, hairy woodpecker, and downy woodpecker. Except for the northern flicker, these species are likely to nest within the Make-Up Pond C study area (Duke 2009b; DTA 2008b).

Several birds of prey species were assumed to be nesting in the Make-Up Pond C study area including turkey vulture, black vulture, red-tailed hawk, red-shouldered hawk, and great horned owl (*Bubo virginianus*) (Duke 2009b; DTA 2008b). Osprey and bald eagle (*Haliaeetus leucocephalus*) were also observed in the study area.

Amphibians and Reptiles

The herpetofauna of the Make-Up Pond C study area was investigated from January through October 2008 and from February through July 2009 via field sampling. Techniques employed included automated recording systems, systematic dip netting, minnow traps, turtle traps, pitfall traps, and visual and auditory (frog/toad call) field searches (Duke 2009b; Dorcas 2009b).

Field surveys were conducted at seven separate locations in the vicinity of the four biological sampling areas depicted in Figure 2-16. Various herpetofauna habitats were surveyed in and along London Creek and several of its tributaries, including stream pool and riffle areas, a beaver pond, wetlands, farm ponds, lowland mixed hardwood habitats, and upland habitats. Additional areas and habitat types were surveyed using visual and call searches (Duke 2009b; Dorcas 2009b). The 2009 herpetofauna sample locations are identified in Dorcas (2009b).

Based on published distributions and specimen records for Cherokee County obtained from museums, universities, and other appropriate organizations, 66 species (25 amphibian and 41 reptile) were determined to potentially occur within the Make-Up Pond C study area. Of these 66 potential species, 37 species, including 19 amphibian (76 percent of the potential species) and 18 reptile (43 percent of the potential species), were documented during the Make-Up Pond C study area field sampling (Dorcas 2009b). The most common species included northern cricket frog, Fowler's toad, Cope's gray treefrog, spring peeper, upland chorus frog, bullfrog, green frog, southern leopard frog, marbled salamander, northern dusky salamander, southern two-lined salamander, red-spotted newt, Atlantic Coast slimy salamander, eastern box turtle, green anole, six-lined racerunner, fence lizard, worm snake (*Carphophis amoenus*), black racer, ringneck snake, rat snake, northern watersnake, and copperhead (*Agkistrodon contortrix*) (Duke 2009b; Dorcas 2009b).

Primary aquatic habitats within the Piedmont are typically stream-based ecosystems often with associated farm ponds, beaver ponds, and floodplain wetlands, similar to London Creek. Based on the field surveys, the herpetofauna of London Creek and its environs is similar to the herpetofauna found throughout the Piedmont of the Carolinas. However, the London Creek herpetofauna is considered to be relatively diverse, likely resulting from diverse aquatic habitats (e.g., wetlands, floodplains, ephemeral pools, stream pools and riffles, man-made ponds) in close proximity to large tracts of intact forest (e.g., bottomland hardwood forest) (Duke 2009b; Dorcas 2009b). Amphibians represent tangible linkages among aquatic, wetland, and terrestrial habitats. The vast majority of amphibian species documented at London Creek require some type of aquatic habitat for reproduction, and as adults, they may occur at some distance or closely adjacent to breeding sites (SCDNR 2011b). For example, the presence of amphibians dependent on ephemeral pools and wetlands (i.e., marbled and spotted salamanders) at multiple sites indicates suitable breeding habitat for these species exists throughout the area (Duke 2009b; Dorcas 2009b).

The substantial diversity and abundance of turtles in the farm ponds within the London Creek watershed is typical of Piedmont habitats (Duke 2009b; Dorcas 2009b). However, these ponds are not indicative of the environmental integrity of the London Creek riparian habitat and adjacent wetland or terrestrial habitats (SCDNR 2011b).

Frogs and Toads. The observed frogs and toads of the Make-Up Pond C study area range from fully aquatic (e.g., bullfrog) to semi-aquatic (e.g., toad species, treefrogs) in their habits. In 2008 and 2009, 11 species of frogs and toads (i.e., northern cricket frog, Cope's gray treefrog, spring peeper, upland chorus frog, green frog, pickerel frog, Southern leopard frog, bullfrog, American toad, Fowler's toad, and eastern narrowmouth toad) were observed. These 11 species range from common (observed three to seven times) to abundant (observed eight or more times), except for the eastern narrowmouth toad, which was somewhat rare (observed two times) (Dorcas 2009b). All 11 species are closely tied to water (e.g., wetlands, temporary pools, and low-gradient streams and rivers), which is where they reproduce. Further, as juveniles and adults, all the frog and toad species, except the bullfrog, may make extensive use of adjacent terrestrial habitats (e.g., forest, grassland, and cropland).

Salamanders and Newts. Salamanders and newts range from fully aquatic (e.g., red-spotted newt) to semi-aquatic (e.g., all salamander species observed) in their habitats. A total of 8 of 11 potential salamander and newt species were observed in 2008 and 2009: spotted salamander, marbled salamander, northern dusky salamander, Atlantic Coast slimy salamander, northern red salamander, southern two-lined salamander, spring salamander [*Gyrinophilus porphyriticus*]), and red-spotted newt. All eight salamander/newt species were considered common to abundant, except for the spring salamander (somewhat rare) and red salamander (rare [one observation]) (Dorcas 2009b). The semi-aquatic salamanders and fully aquatic newt are closely tied to water, such as trickling streams and wetlands where they reproduce. Adult semi-aquatic salamanders also use adjacent terrestrial habitat such as forests and grasslands. The mud salamander (*Pseudotriton montanus*), four-toed salamander (*Hemidactylium scutatum*), and three-lined salamander (*Eurycea guttolineata*) were not observed in the Make-Up Pond C study area, likely due to their fossorial behavior (NatureServe Explorer 2012a, b, c). However, these species are likely present due to habitat integrity and the fact that the other 8 (more readily detected) of the 11 potentially occurring salamander species in the area were observed.

Turtles. The turtle species use aquatic habitats ranging from rivers and streams to still-water habitats such as wetlands. The lifestyles of these turtles range from mostly aquatic (e.g., common snapping turtle) to semi-aquatic (all the other turtle species). A total of four turtle species were observed in 2008 and 2009: eastern mud turtle, eastern river cooter, eastern box turtle, and snapping turtle. The four species ranged from common to rare (Dorcas 2009b). All the turtle species leave the water to nest and to bask. Nesting (egg deposition) is accomplished in soft substrates near water. Hibernation/burrowing during inactive periods may occur in soft soil or in fallen logs/debris, soft substrates underwater, or under rocks or in holes in banks, depending on the species and habitat availability.

Lizards. The lizard species range from mostly arboreal (e.g., green anole and broadhead skink [*Eumeces laticeps*]) to terrestrial (e.g., ground skink). A total of five lizard and skink species were observed in 2008 and 2009: fence lizard, six-lined racerunner, green anole, broadhead skink, and ground skink. These five species ranged from abundant to rare (Dorcas 2009b). All of these species inhabit upland habitats, but may be found in upland areas near wetland or other aquatic habitats, although they have no particular affinity for them, and all spend periods of inactivity underground or in crevices, and deposit eggs in soil, litter, or debris.

Snakes. The snake species range from mostly aquatic (e.g., northern watersnake), to having an affinity for terrestrial habitats near water (e.g., garter snake [*Thamnophis sirtalis*]), to having no apparent affinity for water or terrestrial habitats near water (all the other snake species subsequently listed). A total of nine snake species were observed in 2008 and 2009: copperhead, worm snake, ringneck snake, northern black racer, black rat snake, eastern kingsnake (*Lampropeltis getula*), brown snake [*Storeria dekayi*]), northern watersnake, and garter snake. The nine species ranged from common to rare (Dorcas 2009b). All the snake species spend periods of inactivity underground or in crevices or burrows, and deposit eggs in soil, litter, debris, or abandoned mammal burrows.

2.4.1.3 Terrestrial Resources – Transmission-Line Corridors

As described in Section 2.2.3.1, Duke proposes to construct new transmission lines in two corridors, Route K and Route O, to connect the existing 230-kV and 525-kV transmission lines with the proposed Lee Nuclear Station Units 1 and 2 switchyards. Both the existing and proposed transmission lines are shown in Figure 2-5. From the switchyards, the corridors for Routes K and O would each be 325 ft wide to the tie in with the existing Pacolet-Catawba line. South of the Pacolet-Catawba line, the corridors for Routes K and O would each be 200 ft wide to the point where they would tie in to the existing Oconee-Newport line (Figure 2-5).

Existing Cover Types

An inventory of land cover within the two proposed transmission-line corridors and in the whole siting study area (283.47 mi^2) was made through analysis and classification of aerial photography, satellite imagery, and limited field investigations (Duke 2007c). Land-cover types and acreages within the two proposed transmission-line corridors are provided in Table 2-3. The most prevalent habitat, and the one with the greatest overall value to wildlife, is forest. The various types of forest cover a total of approximately 690 of the 987 ac within the two transmission-line corridors (HDR/DTA 2009b).

The following descriptions of the natural vegetation communities that occur in the transmission-line siting study area largely follow that provided by Nelson (1986) for the State of South Carolina as referenced in HDR/DTA (2009b). Because the descriptions are drawn from a much broader geographic area, they do not correlate exactly with the forest and shrub/scrub cover types within the two transmission-line corridors, but are provided for contextual reference.

Vegetation communities in the transmission-line siting study area include bottomland hardwoods, oak-hickory forests, active and fallow pastures, small stream forests, planted pine plantations, and shallow freshwater swamps. Dominant vegetation in bottomland hardwood forests includes black willow, box elder, buttonbush, elderberry, sensitive fern, and spotted lady's thumb (*Polygonum persicaria*). Dominant vegetation typical of oak-hickory forest includes southern red oak (*Quercus falcata*), white oak, hickory, tulip poplar, flowering dogwood, basswood (*Tilia americana*), and poison ivy (*Toxicodendron radicans*). Dominant vegetation in active and fallow pastures includes redtop (*Agrostis alba*), various other grasses, and bull thistle (*Cirsium vulgare*). Planted pine areas consist of moderate to high-density stands of commercial species, such as loblolly pine, and recently cutover areas that now are in early successional growth. Dominant species in these areas include pioneer species such as sweet gum, black locust (*Robinia pseudoacacia*), tulip poplar, sourwood, sawtooth blackberry (*Rubus argutus*), asters, and American pokeweed (*Phytolacca americana*). Dominant vegetation within the small stream forests is similar to that of the bottomland hardwood forests, except that upland elements also are present in the small stream forests. Vegetation within shallow freshwater swamps is dominated by black willow and other obligate species; however, it may be distinguished from bottomland hardwood forest by the presence of standing water and the large number of standing snags (Nelson [1986] as referenced in HDR/DTA [2009b]).

Wetlands, Streams, and Floodplains

Wetlands were not identified in the inventory of land cover within the two proposed transmission-line corridors (see Table 2-3) at the scale at which the inventory was conducted. Thus, potentially jurisdictional wetlands and streams found within 25 ft of either side of the two transmission-line corridors (i.e., total of 250 ft wide for both corridors from the Oconee-Newport line to the Pacolet-Catawba line; total of 375 ft wide for both corridors from the Pacolet-Catawba line to the switchyard) were identified in the field (HDR/DTA 2009b). Wetlands include forested wetlands, scrub-shrub wetlands, and emergent wetlands. Wetlands are similar in composition to those on the Lee Nuclear Station site and within the Make-Up Pond C study area (Duke 2011h).

<u>Jurisdictional Wetlands</u>

Jurisdictional wetlands located within the jurisdictional determination boundary for the two new transmission lines total approximately 11.17 ac: 0.52 ac in the east corridor (Route O) and 10.65 ac in the west corridor (Route K) (USACE 2013a), or about 1 percent of the approximately

987 ac within the corridors for the two new transmission lines (Table 2-3). The four jurisdictional wetlands in the east corridor (Route O) range in size from 0.01 to 0.38 ac (USACE 2013a). The small wetlands are associated with small streams while the larger wetlands are located in active floodplains (HDR/DTA 2009b). The 12 jurisdictional wetlands in the west corridor (Route K) range in size from less than 0.01 ac to 7.66 ac (USACE 2013a), and include small fringe wetlands associated with small streams to large wetland/stream complexes (HDR/DTA 2009b).

<u>Wetland Functional Assessment</u>

Duke conducted functional assessments for jurisdictional wetlands within the two transmission-line corridors in the same manner as noted above for jurisdictional wetlands on the Lee Nuclear Station site (see Section 2.4.1.1). A total of 8 of the 12 wetland assessment areas in the Route K (western) corridor were classified as fully functional (functioning naturally as in an undisturbed condition), 3 assessment areas were classified as partially impaired (partial loss of functionality due to disturbance, but functional recovery is expected to occur through natural processes), and one assessment area was classified as impaired (partial loss of functionality due to disturbance which would require restoration activities to facilitate recovery) (Duke 2011h). Three of the four wetland assessment areas in the Route O (eastern) corridor were classified as being fully functional and the fourth was classified as partially impaired (Duke 2011h).

<u>Streams</u>

In their jurisdictional determination, the USACE identified a total of 70 stream crossings, extending 4.84 mi, in the Route O (eastern) corridor and 46 stream crossings extending 2.76 mi in the Route K (western) corridor (USACE 2013a). The streams range in size from small, first-order headwater channels to the Pacolet River (HDR/DTA 2009b). Streams are also discussed in Section 2.4.2.2.

<u>Floodplains</u>

Regulatory 100-year floodplains in the Route K (western) corridor occur in low-lying areas of Abingdon Creek, Gilkey Creek, Thicketty Creek, Mill Creek, Gault Creek, Fanning Creek, and the Pacolet River (Duke 2011h). Regulatory 100-year floodplains in the Route O (eastern) corridor occur in low-lying areas of the Quinton Branch, Abingdon Creek, Thicketty Creek, and the Pacolet River. Floodplains along the Pacolet River are wider than along these tributary streams (Duke 2011h).

Significant Natural Areas

During surveys for Federally and State-ranked plant species in selected areas of the transmission-line corridors in August and October 2009 and March and April 2010 (see

Section 2.4.1.6), a species-rich, mixed hardwood bluff was found on Abingdon Creek along the Route O corridor. It is dominated by beech and Florida maple, and supports a rich herbaceous layer of piedmontane and montane cove plant species, including the State-listed southern adder's-tongue fern (see Section 2.4.1.6 and Table 2-9) and nerveless sedge (*Carex leptonervia*) (Gaddy 2010).

Rare Plant Species

Nerveless sedge, a rare mesic-site species not reported in South Carolina by the South Carolina Plant Atlas (USC 2013) was found to be common in the noteworthy Abingdon Creek mixed hardwood bluff habitat (described above) (Gaddy 2010).

Wildlife

Wildlife within the two proposed transmission-line corridors has not been surveyed in the field. Further, outside of the jurisdictional wetlands and streams noted above, plant communities and habitat types have not been delineated in the field. The transmission-line corridors intersect more than 7 mi of jurisdictional streams, 11 ac of jurisdictional wetlands, and many floodplains. Bottomland hardwood forest in these areas likely supports a wide variety of wildlife due to relatively abundant habitat resources. For example, hardwood tree species (e.g., oaks [*Quercus* spp.] and hickories) provide mast, mature hardwood trees provide nest and den sites, and snags and downed woody debris provide sources of food and cover for mammals, birds, amphibians, and reptiles. Bottomland hardwood forests also provide travel corridors for mammals and migration, nesting, foraging, and winter habitat for birds (e.g., neotropical and nearctic migrants, and resident and migratory waterfowl). Riparian wildlife in the transmission-line corridors may be similar to that of the Make-Up Pond C study area, which also harbors substantial stream/wetland/floodplain complexes along London Creek and its tributaries.

In addition to intersecting many wetland areas and streams, the transmission-line corridors intersect upland plant community and habitat types, which are likely similar to those present in the Make-Up Pond C study area and on the Lee Nuclear Station site. The upland wildlife assemblages (which are similar to bottomland wildlife communities except for species closely tied to streams, wetlands, and floodplains) in the proposed transmission-line corridors are likely similar to those documented for the Lee Nuclear Station site and the Make-Up Pond C study area.

2.4.1.4 Terrestrial Resources – Railroad Corridor

As described in Section 2.2.3.2, Duke Power Company laid a 6.8-mi-long and 50-ft-wide (41.2 ac) railroad spur to support construction of the Cherokee Nuclear Station. The railroad spur was abandoned when construction of the Cherokee Nuclear Station was discontinued. Duke plans to upgrade the spur to support building the Lee Nuclear Station, altering the course slightly where the original ROW is occupied by the Reddy Ice facility. The detour involves approximately 1300 ft of track (Figure 2-6) in a 50-ft-wide corridor.

The western one-third of the realigned section is forested (0.5 ac), and the eastern two-thirds is in paved or maintained yard areas for the ice plant (Duke 2009c). The area of potential impact for the renovated (non-realigned) portion of the railroad spur is primarily the existing railroad bed and the parallel margins along each side that were disturbed during the earlier railroad construction for the unfinished Cherokee Nuclear Station (Duke 2009c).

The study area for the railroad-spur corridor extended 25 ft on both sides of the bottom of the 50-ft-wide berm of the rail embankment, creating a 100-ft-wide study area along the corridor (Enercon 2008). The information presented below on the various biota of the railroad-spur corridor is summarized from the results of surveys conducted within this study area.

Existing Cover Types

Vegetation along the existing railroad-spur corridor was not inventoried in support of the ER for the unfinished Cherokee Nuclear Station (Duke Power Company 1974a, b, c). However, upland vegetation and streams and wetlands and associated vegetation along the existing railroad-spur corridor were inventoried in support of the COL application for Lee Nuclear Station Units 1 and 2 (Enercon 2008). Excerpted information from this report is provided in this subsection.

Vegetation communities along the railroad-spur corridor include grass-forb (railroad line surface and road crossings), early successional forests (young pine and mixed hardwoods less than 30 ft tall), pine forests (planted and natural pines on ridges and upper slopes), pine-mixed hardwood forests (mesic upper slopes and previously disturbed lower slopes), and mixed hardwood forests (lower slopes, north-facing slopes, along streams and deep ravines) (Enercon 2008).

Wetlands, Streams, and Floodplains

<u>Jurisdictional Wetlands</u>

A total of three jurisdictional wetlands, comprising 0.066 ac were identified in the railroad corridor. The individual wetlands within the railroad corridor vary in size from 0.006 to 0.04 ac (USACE 2013a). Wetlands are similar in composition to those within the Make-Up Pond C study area.

<u>Wetland Functional Assessment</u>

Duke conducted field-based functional assessments for jurisdictional wetland areas within the railroad-spur corridor in the same manner as noted above for jurisdictional wetland areas on the Lee Nuclear Station site (see Section 2.4.1.1). All four of the wetland assessment areas in the railroad-spur corridor were classified as being fully functional (functioning naturally as in an undisturbed condition) (Duke 2011h).

Streams

All waterbodies associated with the existing railroad spur were previously channelized with culverts (Duke 2009c). The USACE identified a total of 21 stream crossings extending 1.13 mi within the railroad corridor (USACE 2013a). Riparian habitat associated with the streams includes typical bottomland species (Enercon 2008) described in Sections 2.4.1.1 through 2.4.1.3.

Floodplains

Regulatory 100-year floodplains in the railroad corridor occur in low-lying areas of Peoples Creek, Furnace Creek, London Creek, and Little London Creek (Duke 2011h).

Wildlife

Wildlife along the existing railroad-spur corridor was not inventoried in support of the ER for the unfinished Cherokee Nuclear Station (Duke Power Company 1974a, b, c). However, the avian and herpetofauna communities along the existing railroad-spur corridor were inventoried in support of the COL application for Lee Nuclear Station Units 1 and 2. Excerpted information from the respective reports on these two taxa is provided below.

Birds

The majority (4.9 mi) of the 6.8-mi-long railroad-spur corridor was intensively surveyed from April 7 through July 1, 2009 for migratory and breeding birds and raptor nests. Surveyed portions included the following vegetation types: bottomland hardwood forest, mesic mixed pine-hardwood forest, planted pine plantation (15 to 20 years old), cove forest (diverse hardwood species with a very dense canopy cover), cutover/open land, mesic mixed pine-hardwood forest with intersecting utility ROWs and residential properties, and various combinations of these vegetation types (HDR/DTA 2009c). Survey locations are noted in HDR/DTA (2009c). However, the 1300-ft portion of the railroad to be realigned (west of the Reddy Ice Plant (Figure 2-6) was not surveyed (HDR/DTA 2009c) because one part is highly disturbed and provides little vegetative habitat; another part would require cutting very few trees for railroad refurbishment; and another part lies in an existing Duke transmission-line corridor where trees and shrubs are cut or sprayed every 5 years (Duke 2010c).

Based on field guides, breeding bird surveys in the vicinity (i.e., London Creek in support of Make-Up Pond C and the North American Breeding Bird Survey [Chesnee, SC route], regional and State bird lists, and the South Carolina Breeding Bird Atlas, there are 108 breeding bird species that could potentially occur in the vicinity of the Lee Nuclear Station site. A total of 80 avian species were observed during the 2009 surveys, 50 of which were assumed to be breeding in the vicinity of the railroad-spur corridor. A total of 42 of the species were perching birds, 3 were birds of prey (i.e., barred owl [*Strix varia*], red-shouldered hawk, red-tailed hawk), 2 were woodpeckers (i.e., downy woodpecker and red-bellied woodpecker), 3 were upland game birds (i.e., mourning dove and wild turkey), and 1 was the chimney swift (*Chaetura pelagica*). The only raptor species that appeared to actually be nesting in the area of the railroad-spur corridor was the barred owl; however, no raptor nests were observed along the margin of the railroad-spur corridor (HDR/DTA 2009c).

The most species-rich habitat along the railroad-spur corridor was the planted pine plantation, which accounts for about 27 percent of the surveyed portion of the railroad-spur corridor. The high species diversity in this cover type is presumably due to the presence of young hardwoods that stems from the lack of canopy closure of the young pines. Avian species diversity in this habitat type is projected to decrease as the young pines age and canopy closure occurs, thus reducing the prevalence of the shade-intolerant hardwoods (HDR/DTA 2009c). The noteworthy lack of waterfowl, shorebirds, and colonial-nesting waterbirds is due to the lack of open water and wetland habitats along the railroad-spur corridor (Enercon 2008; HDR/DTA 2009c).

Amphibians and Reptiles

The majority of the 6.8-mi-long railroad-spur corridor was surveyed from February through July 2009 for amphibians and reptiles in aquatic and terrestrial habitats (Dorcas 2009c). Survey locations are noted in Dorcas (2009c). One location, where London Creek intersects the railroad-spur corridor, was sampled in 2008 as part of the amphibian and reptile investigation of the Make-Up Pond C study area (Dorcas 2009b) and was not sampled again during 2009 (Dorcas 2009c). In addition, the forested one-third of the 1300-ft portion of the railroad-spur corridor to be realigned (west of the Reddy Ice Plant) (Figure 2-6) was not surveyed (Dorcas 2009c). Surveyed habitats adjacent to and within the railroad-spur corridor included ponds, seeps, puddles, and forest (Dorcas 2009c).

According to geographic distribution maps, species records for Cherokee County obtained from 47 museums and universities, and available suitable habitat, 25 amphibian and 41 reptile species potentially occur along the railroad-spur corridor. A total of 33 species of amphibians and reptiles were observed during the 2009 and 2008 surveys, 11 frog and toad species, 6 salamander species, 5 turtle species, 3 lizard species, and 8 snake species. This high diversity is in part likely due to the large number of habitat types through which the railroad-spur corridor passes and the high species diversity in that portion of Cherokee County (Dorcas 2009c).

Commonly found abundant amphibians included the pickerel frog, cricket frog, Fowler's toad, bullfrog, green frog, spring peeper, southern leopard frog, and northern dusky salamander. Commonly found abundant reptiles included the eastern box turtle, green anole, six-lined racerunner, worm snake, black racer, and rat snake. The herpetofauna of the railroad-spur corridor is similar to the herpetofauna found throughout the Piedmont of the Carolinas (Dorcas 2009c).

Important habitats include the wetlands where London Creek crosses the railroad-spur corridor and the large puddles within the corridor, which support a number of amphibians including pickerel frogs and cricket frogs. These habitats were also frequented by box turtles. The railroad-spur corridor itself provides ideal habitat for box turtles (Dorcas 2009c).

2.4.1.5 Offsite Road Improvements

Improvements to existing offsite roads will occur at nine locations in six areas covering about 85 ac along SC 18 and SC 329 and McKowns Mountain Road. No jurisdictional wetlands or streams occur at these locations. However, a regulatory 100-year floodplain associated with the Broad River occurs in a road-improvement area along SC 329 (Duke 2011h).

2.4.1.6 Important Terrestrial Species and Habitats

The NRC has defined important species as any that are rare, ecologically sensitive, play an ecological role, or are relied on by a valuable species, and/or have economic or recreational value (NUREG-1555 [NRC 2000a]). The FWS identifies Federally threatened or endangered species in 50 CFR 17.11 and 50 CFR 17.12. Important species include those that are proposed or candidates for listing as Federally threatened or endangered. Important species also include species ranked as critically imperiled (S1), imperiled (S2), or vulnerable (S3) by the State of South Carolina, some of which may also be designated as threatened or endangered by the State. Biological indicator species that respond to and indicate environmental change are also classed as important species.

In a letter dated April 9, 2008, the NRC requested that the FWS Field Office in Atlanta, Georgia, provide information regarding Federally listed, proposed, and candidate species and critical habitat that may occur in the vicinity of the Lee Nuclear Station (NRC 2008e). On May 13, 2008, the FWS provided a response letter indicating three listed and one candidate species and no critical habitat in Cherokee, Union, and York Counties (FWS 2008a), which encompass the Lee Nuclear Station site, the Make-Up Pond C site, the two proposed transmission-line corridors, the railroad-spur corridor, and the six offsite road-improvement areas. These species include the pool sprite (*Amphianthus pusillus*), Georgia aster (*Symphyotrichum georgianum* [formerly *Aster georgianus*]), dwarf-flowered heartleaf (*Hexastylis naniflora*), and Schweinitz's sunflower (*Helianthus schweinitzii*). An additional listed species identified that may occur in the project area is the smooth coneflower (*Echinacea laevigata*) (Cantrell 2008). Life-history attributes and habitat affinities of these species that are relevant to the review of Duke's application are summarized in this section. In addition, the potential occurrence of these species on, and in the vicinity of, the project area is summarized in this section.

Important Terrestrial Species

Federally listed, proposed, or candidate species and State-ranked species were surveyed for studies commissioned by Duke for the major components of the Lee Nuclear Station Units 1 and 2 COL and formerly for the Cherokee Nuclear Station ER, including mammals (Duke Power

Company 1974a, b, c), birds (HDR/DTA 2009a), amphibians and reptiles (Dorcas 2007, 2009a), Federally and State-listed plant species (Gaddy 2009); Make-Up Pond C (mammals [Webster 2009], birds [DTA 2008b], amphibians and reptiles [Dorcas 2009b], Federally listed and State-ranked plant species and significant natural areas [Gaddy 2010]); the two proposed transmission-line corridors (habitat for Federally listed and State-ranked wildlife and plant species [HDR/DTA 2009b], Federally listed and State-ranked plant species [Gaddy 2010]); and the railroad-spur corridor (birds [HDR/DTA 2009c], amphibians and reptiles [Dorcas 2009c], habitat for Federally and State-listed wildlife and plant species [Enercon 2008], and Federally and State-listed plant species (Duke 2009e, 2010c).

The specific locations of all survey routes, transects, sampling points, etc., are provided in the individual study reports referenced above. Federally listed and State-ranked species that potentially could occur and those observed on and in the vicinity of the Lee Nuclear Station site, the Make-Up Pond C site, the two proposed transmission-line corridors, and the railroad-spur corridor are listed in Table 2-9. The general level of effort, temporal coverage, and results of these surveys with regard to general biota are discussed above in Sections 2.4.1.1 through 2.4.1.4. The results of these surveys with regard to Federally listed and State-ranked species are discussed below.

Lee Nuclear Station Site

During field reconnaissance on the Lee Nuclear Station site in 2006, the interiors of several abandoned buildings onsite were examined for bats and guano before their removal. However, no bats or guano were found (Duke 2009c, 2008e). Given the isolated occurrences of southeastern myotis (*Myotis austroriparius*) (Table 2-9) in the Piedmont (see below), it is unlikely that the species would have maternity roosts or winter hibernacula on the Lee Nuclear Station site.

During the avian migration and breeding surveys on the Lee Nuclear Station site in 2009, suitable habitat for Federally listed and State-ranked species (Table 2-9), such as the bald eagle and loggerhead shrike (*Lanius ludovicianus*), was searched visually and via responses to call back recordings. No Federally listed or State-ranked avian species were recorded. However, the loggerhead shrike (Table 2-9) was observed on the Cherokee Nuclear Station site during the fall, winter, spring, and summer avian survey periods in 1973 and 1974 (Duke Power Company 1974a, b, c; Duke 2009c). The site offers much more suitable habitat now than it did during the 1970s (i.e., large expanses of open/field/meadow and upland scrub habitats created by construction of the Cherokee Nuclear Station). The shrike may be sufficiently rare that it was not observed during the 2009 surveys (HDR/DTA 2009a) but likely occurs year-round at the Lee Nuclear Station site, as it was observed during the breeding season outside of the Make-Up Pond C study area.

Table 2-9. Important Species that Potentially Occur in the Project Area for the Proposed Lee Nuclear Station Units 1 and 2, Including an Indication of Their Presence within the Project Footprint Based on Field Surveys

Scientific Name	Common Name	Federal/ State Status[a]	Nearest County(ies) of Known Occurrence	Lee Nuclear Station[b]	Make-Up Pond C[b]	Railroad Corridor[b]	Transmission-Line Corridors[b]
Mammals							
Myotis austroriparius	southeastern myotis bat[c]	S1	Cherokee[d,e,f,g]				
Myotis lucifugus	little brown bat	S3?	Greenville[f,h]				
Neotoma floridana	eastern woodrat	S3S4	Greenville[g,h]/York[k]				
Peromyscus polionotus	oldfield mouse	S1 (North Carolina)[i]	Cleveland[i]/Rutherford[i]				
Birds							
Haliaeetus leucocephalus	bald eagle	BGEPA/S2 (SE)	Chester[g,j]/York[g,k]				
Lanius ludovicianus	loggerhead shrike	S3	Florence[l]		X[m]		
Reptiles							
Lampropeltis triangulum	scarlet kingsnake (milksnake)	S2	Statewide[n]				
Pituophis melanoleucus	pine snake	S3S4	Statewide[n]				
Sistrurus miliarius	pigmy rattlesnake	S3 (North Carolina)[i]	Statewide except Blue Ridge Mountains[n]				
Plants							
Agalinis auriculata	ear-leaved foxglove	S1	York[k]				
Agrimonia pubescens	soft grooveburr[c]	S1	York[k]				
Allium cernuum	nodding onion[c]	S2	Cherokee[d]				
Amorpha schwerinii	Schwerin's indigobush	S1	Union[o]				
Amphianthus pusillus	pool sprite	FT/S1	York[g,k,p]				
Asplenium bradleyi	Bradley's spleenwort[c]	S1	York[k]				

Table 2-9. (contd)

Scientific Name	Common Name	Federal/ State Status[a]	Nearest County(ies) of Known Occurrence	Lee Nuclear Station[b]	Make-Up Pond C[b]	Railroad Corridor[b]	Transmission-Line Corridors[b]
Carex gracillima	graceful sedge	S2	Union[o]				
Carex prasina	drooping sedge	S2	Union[o]		X		
Carex scabrata	rough sedge[c]	S2	Cherokee[d]				
Circaea lutetiana ssp. *canadensis*	southern enchanter's nightshade	S3	Spartanburg[q]		X		
Cyperus granitophilus	granite-loving flatsedge	S1?	York[k]				
Dasistoma macrophylla	mullein foxglove	S1	York[k]				
Echinacea laevigata	smooth coneflower	FE/S3	Pickens[p,r]/Lancaster[p,s]				
Eleocharis palustris	spike-rush[c]	S1?	York[k]				
Hackelia virginiana	Virginia stickseed	S1	Union[o]				
Helianthus laevigatus	smooth sunflower[c]	S2	Cherokee[d]/Union[o]/York[k]				
Helianthus schweinitzii	Schweinitz's sunflower	FE/S3	York[g,k,p]				
Hexastylis naniflora	dwarf-flowered heartleaf[c]	FT/S3	Cherokee[d,g,p]/York[g,p]				
Hydrangea cinerea	ashy hydrangea[c]	S1	Cherokee[d]				
Hymenocallis coronaria	shoals spider-lily	S2	Chester[j]/Union[o]/York[k]				
Isoetes piedmontana	Piedmont quillwort[c]	S2	York[k]				
Juglans cinerea	butternut (white walnut)	S3	York[k]				
Juncus georgianus	Georgia rush	S2	York[k]				
Lilium canadense	Canada lily	S1	York[k]				
Lipocarpha micrantha	dwarf bulrush	S2	York[k]				
Melanthium virginicum	Virginia bunchflower	S2	York[k]				
Menispermum canadense	Canada moonseed[c]	S2S3	Cherokee[d]/Chester[j]/York[k]		X		

Table 2-9. (contd)

Scientific Name	Common Name	Federal/ State Status[a]	Nearest County(ies) of Known Occurrence	Lee Nuclear Station[b]	Make-Up Pond C[b]	Railroad Corridor[b]	Transmission-Line Corridors[b]
Minuartia uniflora	one-flowered stitchwort[c]	S3	Union[o]/York[k]				
Monotropsis odorata	sweet pinesap	S2	Union[o]				
Najas flexilis	slender naiad[c]	S1	York[k]				
Ophioglossum vulgatum	southern adder's-tongue fern[c]	S2	Cherokee[d]/Chester[j]/Union[o]	X	X		X
Orobanche uniflora	single-flowered cancer root	S2	Charleston[t]		X		
Poa alsodes	blue grass[c]	S1?	York[k]				
Quercus bicolor	swamp white oak	S1	York[k]				
Quercus oglethorpensis	Oglethorpe's oak	S3	York[k]				
Ranunculus fascicularis	early buttercup	S1	Chester[j]/York[k]				
Ratibida pinnata	gray-headed prairie coneflower	S1	Chester[j]/York[k]				
Rhododendron eastmanii	Creel's azalea (May white)	S2	Union[o]/York[k]				
Rudbeckia heliopsidis	sun-facing coneflower[c]	S1S2	York[k]				
Scutellaria parvula	dwarf skullcap	S2S3	Chester[j]/York[k]				
Sedum pusillum	granite rock stonecrop	S2	Union[o]				
Silphium terebinthinaceum	prairie rosinweed	S1	Union[o]/York[k]				
Solidago rigida	rigid prairie goldenrod	S1	Union[o]/York[k]				
Symphyotrichum georgianum	Georgia aster[c]	FC/SNR	Cherokee[d,g,p]/York[g,k,p]/ Union[g,o,p]		X		
Thermopsis mollis	soft-haired thermopsis[c]	S1	York[k]				
Tiarella cordifolia var. cordifolia	heart-leaved foamflower	S2	York[k]				
Torreyochloa pallida	pale manna grass[c]	S1	York[k]				
Trillium rugelii	southern nodding trillium	S2	York[k]				

Table 2-9. (contd)

Scientific Name	Common Name	Federal/ State Status[a]	Nearest County(ies) of Known Occurrence	Lee Nuclear Station[b]	Make-Up Pond C[b]	Railroad Corridor[b]	Transmission-Line Corridors[b]
Verbena simplex	narrow-leaved vervain	S1	Union[o]/York[k]				
Veronicastrum virginicum	Culver's root	S1	York[k]				
Xerophyllum asphodeloides	turkey-beard[c]	S2	Cherokee[d]				

(a) Federal status (FE = Federal endangered; FT = Federal threatened; FC = Federal candidate, BGEPA= Federally protected under the Bald and Golden Eagle Protection Act) taken from the FWS (2008a,c) unless otherwise indicated. State status (S1 = critically imperiled; S2 = imperiled; S3 = vulnerable; S4= apparently secure; ? or two ranks listed together for the same species= inexact numeric rank; SE = endangered; SNR = unranked (conservation status not yet assessed) taken from the SCDNR (2012a) unless otherwise indicated.
(b) Based on direct observation within the project footprint unless otherwise noted.
(c) These species also occur within a 15-mi radius of the Lee Nuclear Station site (SCDNR 2012b).
(d) SCDNR (2012c)
(e) Webster (2009)
(f) Menzel et al. (2003)
(g) FWS (2008a,c)
(h) SCDNR (2012d)
(i) NCNHP (2013)
(j) SCDNR (2012e)
(k) SCDNR (2012f)
(l) SCDNR (2012g)
(m) Based on observations made along roadways near Make-Up Pond C
(n) Savannah River Ecology Laboratory Herpetology Program (2011)
(o) SCDNR (2012h)
(p) FWS (2012a)
(q) SCDNR (2012i)
(r) SCDNR (2012j)
(s) SCDNR (2012k)
(t) SCDNR (2012l)

The reptile surveys on the Lee Nuclear Station site in 2007, 2008, and 2009, targeted the three State-ranked snake species listed in Table 2-9); however, none were observed (Dorcas 2007, 2009a).

In March and April 2008, suitable habitat on the Lee Nuclear Station site was searched for the dwarf-flowered heartleaf. The dwarf-flowered heartleaf was not observed (Duke 2008e). In October 2008, much of the open/field/meadow cover type on the Lee Nuclear Station site (the unfinished Cherokee Nuclear Station site) (see Section 2.4.1.1), including that which overlays Iredell and Mecklenberg soils, was searched for four Federally listed and State-ranked plant species (Table 2-9) known to occupy primarily open, non-forested habitats. None of the four species (smooth coneflower, Schweinitz's sunflower, Georgia aster, and smooth sunflower [*Helianthus laevigatus*]) were found (Duke 2010c).

A population of southern adder's-tongue fern was observed during pedestrian field reconnaissance of the Lee Nuclear Station site in 2006. The population consisted of 25 individuals located in a ravine above an old, man-made stock pond in cutover beech/mixed hardwood forest in the southwestern portion of the site. This observation represents a range expansion for the species, as it was not previously recorded in Cherokee or York Counties (Duke 2008e, 2009c).

<u>Make-Up Pond C Site</u>

In the Make-Up Pond C study area in 2008 and 2009, four Federally listed and State-ranked mammal species (Table 2-9) were surveyed during small mammal trapping and pedestrian searches. None of these species was observed (Webster 2009).

During the avian migration and breeding surveys in the Make-Up Pond C study area in 2008, no particular methods were employed to survey Federally listed and State-ranked species (as was done at the Lee Nuclear Station site and along the railroad-spur corridor). Federally listed and State-ranked species surveyed at the Lee Nuclear Station site and along the railroad-spur corridor were not recorded in the Make-Up Pond C study area (DTA 2008b). However, miscellaneous sightings of the loggerhead shrike were made along roadways near Make-Up Pond C (Duke 2010d).

During the reptile surveys in the Make-Up Pond C study area in 2008 and 2009, searches for the three State-ranked snake species noted above for the adjacent Lee Nuclear Station site were conducted. These three species were not observed (Table 2-9) (Dorcas 2009b).

During vegetation surveys in the Make-Up Pond C study area in 2008 and 2009, one Federally listed candidate species and five State-ranked plant species (Table 2-9) were found. Five Georgia aster plants with 10 flowering stems were found in 2008 in a transmission-line corridor. In an October 2009 revisit to the site, 14 flowering stems were present. About 20 drooping sedge plants were found along a tributary of London Creek. Approximately 25 southern enchanter's nightshade plants were found in lowland mixed hardwood forest. Two stems of single-flowered cancer root were found along London Creek in lowland hardwood forest. Six stems of Canada moonseed (*Menispermum canadense*) were found growing in an opening along a tributary of London Creek (Duke 2011h, Gaddy 2009). The drooping sedge, southern enchanter's nightshade, single-flowered cancer root, and Canada moonseed occurrences were each in a single location, each in association with southern adder's-tongue fern (Duke 2011h). Hundreds of southern adder's-tongue fern plants, many of them fertile, were found in 2008 at two locations in lowland hardwood forest. In 2009, numerous subpopulations of the fern also were found in the floodplain of London Creek (Gaddy 2009).

Transmission-Line Corridors

Suitable habitat for Federally listed and State-ranked birds and amphibian species, as well as the presence of the species, was noted during general wetland and stream surveys of the two proposed transmission-line corridors conducted in April and May of 2009 (HDR/DTA 2009b; Duke 2010d).

No caves or cave-like environments (e.g., mine shafts), which may serve as potential hibernacula/maternity roosts for southeastern myotis bats, were observed in the two transmission-line corridors. However, several abandoned buildings, which may serve as potential maternity roosts, were observed within the corridors but not investigated (Duke 2010d).

No bald eagles were observed during visual surveys for eagles and their habitat. The only potential habitat for the bald eagle was observed along the Broad River, but no potential nest trees (i.e., trees with large canopies with sufficiently large branches to support a nest) close to the Broad River were observed. Suitable habitat for the loggerhead shrike (i.e., clearings, pastureland and scrubby areas) exists in the transmission-line corridors. Although the shrike was not observed, the miscellaneous sightings along roadways near the proposed Make-Up Pond C site, as mentioned earlier in this section, indicate that it likely uses suitable corridor habitat (Duke 2010d).

Surveys for Federally listed and State-ranked plant species were conducted in ten selected areas of the transmission-line corridors in August and October 2009 and March and April 2010. The survey areas were selected based on comparison of false color infrared imagery of the habitats within the proposed transmission-line corridors and the habitat affinities of the Federally listed and State-ranked plant species. No Federally listed plant species were found, and only one State-ranked plant species was observed, southern adder's-tongue fern. The fern was found at three locations, two along the east transmission-line corridor (Route O) and one along the west transmission-line corridor (Route K) (Duke 2011h; Gaddy 2010).

Railroad Corridor

During the avian migration and breeding surveys in the railroad-spur corridor in 2009, the same survey methods employed at the Lee Nuclear Station site for the same Federally listed and State-ranked species (see related subsection above) were used along the railroad-spur corridor. None of the Federally listed and State-ranked species surveyed were recorded along the railroad-spur corridor (HDR/DTA 2009c).

During the reptile surveys along the railroad-spur corridor in 2009, searches were made for the three State-ranked snake species noted above for the adjacent Lee Nuclear Station site. None of the species were observed (Dorcas 2009c).

In October 2008, most of the railroad-spur corridor (i.e., the non-realignment portion) was searched for four Federally listed and State-ranked plant species (Table 2-9) known to occupy primarily non-forested habitats (i.e., smooth coneflower, Schweinitz's sunflower, Georgia aster, and smooth sunflower). The railroad-spur corridor was mostly searched on foot and none of the four species were found. However, three populations of Georgia aster were found nearby, one within 500 ft of the railroad-spur corridor, on roadsides, and transmission-line corridors. Also, one population of smooth sunflower was found within 0.5 mi of the railroad-spur corridor on a transmission-line corridor that crosses the railroad line (Duke 2010c). In September 2008, a separate botanical survey was conducted of the 1300-ft realignment portion of the railroad-spur corridor. Suitable habitat for three State-ranked species (nodding onion [*Allium cernuum*], Canada moonseed, and southern adder's-tongue fern) was present, but none of these species were observed (Duke 2009e).

Offsite Road Improvements

No Federally listed, proposed, or candidate species or State-ranked species have been documented by the FWS or the SCDNR as occurring within the six offsite road-improvement areas (Duke 2011h).

Federally Listed Species

The Federally listed, proposed, or candidate species known to occur (detected in surveys of the Lee Nuclear Station Units 1 and 2 COL project area [Table 2-9]) or that potentially could occur in the project area (although not detected in species-specific surveys) are described below. The NRC staff's correspondence to the FWS regarding these species is listed in Appendix F. Information about the occurrence of these species in the project area, as well as life-history attributes of these species that are pertinent to the review of Duke's application, are summarized in this subsection.

Dwarf-flowered Heartleaf (*Hexastylis naniflora*)—Federally Threatened and State Vulnerable (S3). Dwarf-flowered heartleaf is an evergreen herb. Soil type is the most important habitat requirement of the species (54 FR 14964). It needs acidic Pacolet, Madison gravelly sand loam, or Musella fine sandy loam to grow (Duke 2009c). Given these soil types, the plant occupies bluffs and nearby slopes, boggy areas adjacent to the headwaters of creeks and streams, and hillsides and ravines (NatureServe Explorer 2010). The dwarf-flowered heartleaf is found only in the upper Piedmont regions of North and South Carolina, where approximately 108 populations occur in a 12-county area, with one relatively large population (Cowpens National Battlefield) that numbers over 10,000 plants and several smaller populations located in Cherokee County (FWS 2011b).

Georgia Aster (*Symphyotrichum georgianum* [formerly *Aster georgianus*])—Federal Candidate and State Unranked – Conservation Status Not Yet Assessed (SNR). Georgia aster is a perennial, colonial herb that is a relict species of the post oak (*Quercus stellata*) savannah-prairie communities that existed in the Carolina Piedmont prior to widespread fire suppression and extirpation of large grazing animals. It now occupies a variety of dry habitats in areas adjacent to roads; along woodland borders; in dry, rocky woods; and within utility ROWs on low acidic or highly alkaline soil where current land management mimics natural disturbance. The primary controlling factor in its location is the availability of light, as it tends to decline when shaded by woody species. It reproduces mostly vegetatively (Duke 2009c; FWS 2010a).

Pool Sprite (*Amphianthus pusillus*)—Federally Threatened and State Critically Imperiled (S1). Pool sprite is endemic to granite outcrops in the Piedmont physiographic region of the southeastern United States. The species is known from Alabama, Georgia, and South Carolina, including an estimated four sites in York County, South Carolina (FWS 2008b). Optimal habitat for the species has been consistently described as pools surrounded by a rock rim several centimeters in height and sandy-silty soils with low organic matter content (53 FR 3560; FWS 2008b).

Schweinitz's Sunflower (*Helianthus schweinitzii*)—Federally Endangered and State Vulnerable (S3). Schweinitz's sunflower is a rhizomatous perennial herb that is found in clayey soils on the edges of woodlands and on roadsides, formerly in areas with post oak-blackjack oak (*Quercus marilandica*) savannahs, xeric oak-pine woodlands, or "Piedmont prairies," now primarily on mowed road or transmission-line corridors, with the populations nearest to the Lee Nuclear Station site located in eastern York County (56 FR 21087; FWS 2010b).

Smooth Coneflower (*Echinacea laevigata*)—Federally Endangered and State Vulnerable (S3). Smooth coneflower is a rhizomatous perennial herb that grows in open woods, cedar barrens, roadsides, clearcuts, dry limestone bluffs, and transmission-line corridors, usually on magnesium- and calcium-rich soils associated with diabase and marble soils in South Carolina (57 FR 46340). Although not known to occur in Cherokee or York Counties (FWS 2011d), suitable habitat is present in the vicinity of the Lee Nuclear Station site.

State-Ranked Species

State-ranked species detected in surveys of the project area (Table 2-9) or likely to occur within the project footprint, regardless of not being detected during surveys, are described below. Although it was not detected in surveys, the bald eagle is discussed because of its recent former listing as a Federally threatened species.

Bald eagle (*Haliaeetus leucocephalus*)—State Imperiled (S2) and Endangered (SE). The bald eagle is a bird of aquatic ecosystems, frequenting major rivers, large lakes, reservoirs, estuaries, and some seacoast habitats. Fish are the major component of its diet, but waterfowl, seagulls, and carrion are eaten also. Bald eagles usually nest in large trees along shorelines in relatively remote areas that are free of disturbance (64 FR 36454).

The bald eagle was listed as Federally threatened but is now considered by the FWS to be recovered in the conterminous United States and was thus removed from the Federal list of endangered and threatened wildlife in 2007 (72 FR 37346). However, the bald eagle is listed as a threatened species (SC Code Ann. Regs. 123-150), receives protection as a non-game species (SC Code Ann. 50-15-10) in South Carolina, and is still afforded Federal protection under the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d) and the Migratory Bird Treaty Act (16 U.S.C. 703-712). The bald eagle is not known from Cherokee County, but is known to reside in York County located just to the east across the Broad River (FWS 2008a).

Canada Moonseed (*Menispermum canadense*)—State Imperiled (S2). Canada moonseed is a perennial woody vine that is typically found in moist, nutrient-rich forests, and along streams and bluffs (HDR/DTA 2009b). It is considered imperiled in South Carolina (NatureServe Explorer 2010).

Drooping Sedge (*Carex prasina*)—State Imperiled (S2). Drooping sedge occurs on wooded seepage slopes and stream banks, lowland woods, glades, and spring heads (HDR/DTA 2009b; NatureServe Explorer 2010). It is considered imperiled in South Carolina (NatureServe Explorer 2010).

Eastern Woodrat (*Neotoma floridana*)—State Vulnerable (S3). Woodrat habitat in the southern United States includes wooded areas, ravines, floodplain forest, and swamps, where the species builds large stick nests (NatureServe Explorer 2010). In North and South Carolina, the species occurs along the Blue Ridge Mountains (Webster 2009), which are located in the extreme northwestern corner of South Carolina. It is considered vulnerable in South Carolina (NatureServe Explorer 2010).

Loggerhead Shrike (*Lanius ludovicianus*)—State Vulnerable (S3). The loggerhead shrike is a year-round resident in the southeastern United States (Kaufman 2000). Suitable habitat for the shrike consists of grassland or other open habitat with scattered trees and thorny shrubs for foraging, nesting, and perching. The species feeds on small prey such as insects, arthropods, small mammals, birds, reptiles, amphibians, and occasionally carrion (Dechant et al. 1998). The shrike is one of South Carolina's highest priority bird species for conservation (SCDNR 2005).

The SCDNR Breeding Bird Atlas Project indicates the shrike is a probable breeder in Cherokee County (SCDNR 2010a). The species was recorded as recently as 1994 along the North American Breeding Bird Survey Chesnee, SC route located about 20 mi northwest of the Lee Nuclear Station, but was not recorded from 1995 through 2003 (Sauer et al. 2007).

<u>Single-flowered Cancer Root (*Orobanche uniflora*)—State Imperiled (S2)</u>. Cancer root is a perennial, parasitic herb that occurs in lowland woods (Gaddy 2009). It is considered imperiled in South Carolina (NatureServe Explorer 2010).

<u>Southeastern Myotis (*Myotis austroriparius*)—State Critically Imperiled (S1)</u>. The southeastern myotis is restricted to riverine habitats in the southeastern United States. The species is generally restricted to the coastal plain of North and South Carolina (Webster 2009), with isolated occurrences in the Piedmont of South Carolina (Menzel et al. 2003). For example, a single specimen was taken from an abandoned gold mine near Smyrna in Cherokee County (Menzel et al. 2003), and there is an unpublished record from Cherokee County in the Kings Mountain National Military Park database (Webster 2009).

In the Coastal Plain, the species may use basal cavities (for maternity roosts) and chimney cavities (winter hibernacula) that develop in mature hardwood trees of large stature due to heart rot. Cavities used by these species are best known from cypress (*Taxodium distichum*) and tupelo gum (*Nyssa* spp.) in bottomland hardwood swamps (WES 2008). There are no cypress-gum swamps in the project footprint. Cavities in other hardwood species, such as white oak and sugarberry, are also known to be used by the species (WES 2008). Although these trees are prevalent in the project footprint, there are apparently few large enough to develop cavities. The species also may establish maternity roosts in abandoned buildings near permanent sources of water (Kentucky Bat Working Group 2011; Webster 2009), but there are no abandoned buildings in the project footprint, except for those in the two proposed transmission-line corridors noted above. The species typically hibernate in caves (Kentucky Bat Working Group 2011), but there are no caves or cave-like structures on the Lee Nuclear Station site. Thus, although the southeastern myotis might forage over the slow-moving reaches of the Broad River in southern Cherokee County, it is very unlikely that it occurs in the unfavorable roosting and foraging habitats that characterize the London Creek area (Webster 2009).

<u>Southern Adder's-tongue Fern (*Ophioglossum vulgatum*)—State Imperiled (S2)</u>. This small fern, often less than 2 in. tall, is found in shady, circumneutral ravines and creek floodplains in the Piedmont of South Carolina (Duke 2009c). It is considered imperiled in South Carolina (NatureServe Explorer 2010).

Southern Enchanter's Nightshade (*Circaea lutetiana* ssp. *canadensis*)—State Vulnerable (S3). This species grows in mesic, nutrient-rich forests (Weakley 2008). It is considered vulnerable in South Carolina (NatureServe Explorer 2010).

Other Important Species

This subsection discusses commercially and recreationally valuable species, species that are essential to the maintenance and survival of commercially or recreationally valuable species that are rare, species critical to the structure and function of the local terrestrial ecosystem, biological indicator species, pest and nuisance species, and invasive species. Noted are occurrences of such species on and in the vicinity of the Lee Nuclear Station site, the Make-Up Pond C site, the two proposed transmission-line corridors, and the railroad-spur corridor.

Commercially and Recreationally Valuable Species. Forests on the Lee Nuclear Station, the Make-Up Pond C site, the two proposed transmission-line corridors, and the railroad-spur corridor contain harvestable timber. Some stands were harvested previously. Commercial timber harvest will likely be prohibited following construction of the proposed Units 1 and 2 (Duke 2009c).

Recreationally hunted game potentially occurring in the project area include black bear, beaver, bobcat (*Lynx rufus*), coyote, deer, feral hog (*Sus scrofa*), gray fox (*Urocyon cinereoargenteus*) and red fox (*Vulpes vulpes*), mink (*Mustela vison*), muskrat (*Ondatra zibethicus*), nine-banded armadillo (*Dasypus novemcinctus*), opossum, river otter (*Lutra canadensis*), rabbit, raccoon, striped and spotted skunks (*Mephitis mephitis* and *Spilogale putorius*), squirrel, and weasel (*Mustela* spp.). Recreationally hunted birds potentially occurring on or in the vicinity of the Lee Nuclear Station site include waterfowl (ducks and geese), bobwhite quail, mourning dove, rails (members of the family Rallidae), American coot (*Fulica americana*), gallinule (*Porphyrula martinica*), ruffed grouse, American crow, wild turkey, common snipe, and American woodcock (Duke 2009c).

Based on the availability of suitable habitat, all of these species are likely to inhabit the project area but are also common elsewhere. After Duke sold the Cherokee Nuclear Station site, subsequent owners apparently hunted upland birds and other game as evidenced by spent shotgun shells observed at numerous locations during field reconnaissance conducted in 2006. However, recreational hunting and trapping will likely be prohibited on the Lee Nuclear Station site in the future (Duke 2009c).

Essential Species. There are no species that are considered to be essential to the maintenance and survival (e.g., through a trophic relationship) of the Federally listed or State-ranked species known to occur in the project footprint (Table 2-9). There are no commercially or recreationally valuable species in the vicinity (Duke 2009c).

Critical Species. There are no species that are considered to be critical to the structure and function of the local terrestrial ecosystem in the project area (Duke 2009c).

Biological Indicator Species. Biological indicators are usually species or groups of species that can be used to assess environmental conditions. These may be relatively common species that are sensitive to environmental changes, or they could be Federally listed or State-ranked species and other rare species. Examples of potential bioindicator groups include the rare plant species within the Make-Up Pond C study area. These species, which are described in Sections 2.4.1.2 and 2.4.1.6, are primarily indicative of relatively undisturbed mixed hardwood forests that occur in significant natural areas (Gaddy 2009). The salamanders observed in the Make-Up Pond C study area are another example of an indicator species because they are wetland dependent (Duke 2009b).

Nuisance Species. Numerous vertebrate species can become pests, including raccoons, deer, bears, moles, voles, beavers, feral hogs, gophers, snakes, crows, pigeons, starlings, and nutria. At least some of these species inhabit the project area (Duke 2009c).

After the Lee Nuclear Station is fenced, mammals (e.g., deer, feral hogs, and beavers) may become trapped within the fenced area, potentially leading to habitat damage and nuisance issues. If this occurs, Duke will attempt to remove the animals using either lethal or non-lethal methods (Duke 2009c).

Other pests include insects such as mosquitoes, ticks, wasps, bees, termites, bark beetles, and fire ants. Some of these pests (e.g., mosquitoes and wasps) present a nuisance as well as a health and safety risk to humans. Others (e.g., the southern pine beetle) can be devastating to native and planted pines. Although there are many pine forest areas on the Lee Nuclear Station site, no evidence of pine beetles was observed during field reconnaissance. Primary disease vectors onsite appear to be mosquitoes, which can transmit the West Nile virus and ticks, which can carry Lyme disease (Duke 2009c).

Important Terrestrial Habitats

Important habitats are defined as sanctuaries, refuges, and/or preserves that have been set aside and protected by State and/or Federal agencies or organizations. Critical habitats are those designated to support Federally listed threatened or endangered species (NRC 2000a).

Wildlife Sanctuaries, Refuges, and Preserves

There are no national or state wildlife refuges, management areas, or other designated wildlife sanctuaries or preserves in the project area (Duke 2009c).

Unique and Rare Habitats or Habitats with Priority for Protection

Kings Mountain National Military Park is located in Cherokee and York Counties about 10 mi northeast of the Lee Nuclear Station site. According to White and Govus (2005), the park covers 3946 ac and is composed primarily of forest and woodland. Elevations range from 650 to 1045 ft. Kings Mountain National Military Park is surrounded on two sides by Kings Mountain State Park. All creeks in the park flow into the Broad River or one of its tributaries (White and Govus 2005).

Kings Mountain National Military Park, created by an act of Congress in 1931, is known for its importance in the Revolutionary War. Between the time of the war and the establishment of the park, the area served as pastureland, cropland, timberland, and sites for homes. However, much of the park has been recovering from human disturbance for at least 50 years, and thus contains significant natural resources. For example, it harbors 508 plant species, among them the Georgia aster, a Federal candidate plant species also found in the Make-Up Pond C study area and 12 State-ranked (S3 [vulnerable] or above) plant species, some of which are also found in the Make-Up Pond C study area (e.g., southern enchanter's nightshade, Canada moonseed, southern adder's-tongue fern, single-flowered cancer root). In addition, Kings Mountain National Military Park harbors four highly ranked ecological associations (global conservation status rank G3 [vulnerable] and above), one of which also occurs in the Make-Up Pond C study area (Piedmont beech/heath bluff [unique identifier CEGL004539]), which is considered imperiled (global conservation status rank of G2) (White and Govus 2005). The fact that Kings Mountain National Military Park (3946 ac) is almost twice the size of the Make-Up Pond C study area (2110 ac) and harbors a comparable number of plant species (i.e., 508 in Kings Mountain National Military Park, 426 in the Make-Up Pond C study area), highly ranked ecological associations (i.e., 4 in Kings Mountain National Military Park, 4 in the Make-Up Pond C study area), and State-ranked plant species (i.e., 12 in Kings Mountain National Military Park, 5 in the Make-Up Pond C study area) supports the SCDNR's description of the London Creek watershed as having relatively high habitat integrity (SCDNR 2011b).

Significant natural areas and several noteworthy plant communities of interest to the State of South Carolina in the Make-Up Pond C study area, are described in Section 2.4.1.2.

Critical Habitat

No areas designated by the FWS as critical habitat exist at the Lee Nuclear Station site, the Make-Up Pond C site, the two proposed transmission-line corridors, or the railroad-spur corridor (FWS 2008a).

Travel Corridors

The relatively continuous, undisturbed bottomland mixed hardwood and mixed hardwood-pine forest habitats along London Creek and its tributaries provide vital travel corridors for many wildlife species between Lake Cherokee and the Broad River. This corridor functions as part of the greater Broad River travel corridor. Most notable among the wildlife that use this corridor are neotropical and other migratory birds. For example, the bottomland hardwood forest and mixed pine-hardwood forest had the highest avian species diversity of any habitats sampled in the Make-Up Pond C study area. Further, the highest avian diversity in the Make-Up Pond C study area was observed during spring migration (DTA 2008b). These data support use of London Creek habitats as a travel corridor for neotropical and other migratory birds.

Recreation Areas

There are 19 ecologically oriented recreational areas in the vicinity of the Lee Nuclear Station, including outdoor recreation areas, hiking trails, campgrounds, public fishing sites and piers, heritage preserves, boat ramps, and wildlife viewing areas (Duke 2009c). However, only two of these areas that are potentially important for habitat and wildlife occur within 10 mi of the Lee Nuclear Station site: Lake Cherokee (discussed in Section 4.3.1.2 in relation to Make-Up Pond C), and the Broad Scenic River (discussed in Section 7.3.1 in relation to cumulative impacts).

2.4.1.7 Terrestrial Monitoring

As indicated in the first paragraph of Section 2.4.1.6, many terrestrial ecology studies were conducted recently for the Lee Nuclear Station Units 1 and 2 COL ER and previously for the Cherokee Nuclear Station ER. The specific locations of survey routes, transects, points, etc., are provided in the individual study reports referenced in Important Terrestrial Species in Section 2.4.1.6, and in the study reports referenced in relation to wetland delineation and vegetation cover type mapping in Sections 2.4.1.1 through 2.4.1.4. The general level of effort expended, temporal coverage, and results of these surveys with regard to general biota, wetland delineation, and vegetation cover type mapping are discussed in Sections 2.4.1.1 through 2.4.1.4. The results of these surveys with regard to Federally listed and State-ranked species are discussed in Section 2.4.1.6. Federally listed and State-ranked species that potentially could occur and those which were observed on and in the vicinity of the Lee Nuclear Station, the Make-Up Pond C site, the two proposed transmission-line corridors, and the railroad-spur corridor are provided in Table 2-9.

The NRC staff reviewed the available information relative to the terrestrial ecological monitoring program and the data collected by the program. The NRC staff concludes that the program provides adequate data to characterize and track impacts on the terrestrial ecological environment for the Lee Nuclear Station, the Make-Up Pond C site, the two proposed transmission-line corridors, and the railroad-spur corridor in support of the acceptance criteria outlined in the NRC's Environmental Standard Review Plan (NRC 2000a) and recent updates (hereinafter referred to as the ESRP).

2.4.2 Aquatic Ecology

This section describes the aquatic environment and biota in the vicinity of the Lee Nuclear Station site and other areas likely to be affected by the building, operating, or maintaining of the proposed Units 1 and 2. This section describes the spatial and temporal distribution, abundance, and other structural and functional attributes of biotic assemblages on which the proposed action could have an impact. Further, this section identifies "important" or irreplaceable aquatic natural resources and the location of natural preserves that might be affected by the proposed action.

The major aquatic environments within the vicinity of the Lee Nuclear Station site include the Broad River; Ninety-Nine Islands Reservoir; onsite impoundments (i.e., Make-Up Pond A, Make-Up Pond B, and Hold-Up Pond A); the proposed Make-Up Pond C study area on London Creek; and various other waterbodies, including wetlands surrounding the onsite impoundments, farm ponds, and tributaries to the Broad River and London Creek (Duke 2009c). Figure 2-7 provides an overview of the waterbodies discussed in this section. The Broad River is the largest waterbody near the site and is a State navigable water, subject to permitting requirements pursuant to South Carolina R.19-450 under the State Navigable Waters Act (SCDNR 2008a). London Creek and several of its tributaries would be dammed and inundated to create the new supplemental water reservoir (Make-Up Pond C).

2.4.2.1 Aquatic Resources – Site and Vicinity

Aquatic resources associated with the Lee Nuclear Station site, Make-Up Pond C area, railroad-spur corridor, and two offsite transmission-line corridors include a total of 31.184 ac of Federally defined jurisdictional freshwater wetlands, 284.4 ac of open waters, and 167,071.01 linear ft of streams or other waters of the United States subject to the jurisdiction of the USACE as well as 10.61 ac of non-jurisdictional features (i.e., open water ponds not subject to jurisdiction by the USACE) (USACE 2013a). No aquatic resources in areas would be affected by the offsite road improvements.

As part of its Joint Permit Application, Duke conducted functional assessments for jurisdictional streams within the boundaries of its Department of the Army permit application (Duke 2011h) according to the USACE Charleston District Guidelines (USACE 2010a). These activities were performed to assess the stream resource functions lost from proposed unavoidable impacts to waters of the United States that would result from the development of the Lee Nuclear Station and help determine mitigation credits required to offset the net loss of waters of the United States and their associated functional benefits.

A total of 250 stream reaches were assessed in the field (i.e., the Lee Nuclear Station site, Make-Up Pond C area, railroad-spur corridor, and the two offsite transmission-line corridors) during April and June 2011, based on a number of functional descriptors, including stream width and depth, epifaunal substrate, embeddedness, velocity/depth, sediment, channel flow, channel alteration, frequency of riffles, bank stability, vegetation, and riparian zone. Scores for each of the functional descriptors were converted to give one of the four existing conditions: fully functional (functioning naturally as in an undisturbed condition), partially impaired (partial loss of functionality due to disturbance, but functional recovery is expected to occur through natural processes), impaired (partial loss of functionality due to disturbance which would require restoration activities to facilitate recovery), or very impaired (loss of most functionality due to disturbance and functional recovery would require a significant restoration effort) (USACE 2010a).

On the Lee Nuclear Station site, most stream reaches were partially impaired, followed by reaches that were fully functional. A small number of stream reaches (less than 10 percent) were impaired. No stream reaches were very impaired. Within the Make-Up Pond C permit area, nearly half the stream reaches were partially impaired and over one-quarter of the reaches fully functional. The remainder of the stream reaches in the Make-Up Pond C permit area were impaired; none were very impaired. Within the railroad-spur corridor permit area, slightly over half the stream reaches were fully functional and slightly under half were partially impaired. Only one stream reach was impaired and none were very impaired. Finally, along the proposed west and east transmission-line corridors, most stream reaches were classified as partially impaired (roughly 60 percent). The number of reaches that were fully functional slightly outweighed the number of stream reaches that were considered impaired. None were very impaired.

Functional assessments of open waters were not performed. Instead, Duke assumed that all open water areas present within the permit area were fully functional (Duke 2011h).

Since 1991, the 15.3-mi section of the Broad River between Ninety-Nine Islands Dam and the downstream confluence with the Pacolet River has been designated as a State Scenic River (SCDNR 2006a). The Broad Scenic River is a stretch of undeveloped riverfront with diverse riparian habitat that is crossed by only one highway bridge. A voluntary, cooperative community-based process is used by the SCDNR, landowners, and other community stakeholders to accomplish river conservation goals (SCDNR 2006a). According to Duke's ER, the current uses of this river section include fishing, boating, rafting, tubing, swimming, nature study, photography, and bird watching (Duke 2009c). According to *The South Carolina Rivers Assessment* (South Carolina Water Resources Commission 1988) and summarized in the *Broad River Management Plan, 2003 Update* (Broad Scenic River Advisory Council 2003), "the Broad River is an outstanding river of regional significance in seven categories: 1) Historic and Cultural, 2) Industrial, 3) Inland Fisheries, 4) Recreational Fishing, 5) Timber Management, 6) Water Supply, and 7) Wildlife Habitat."

Other than the 15.3-mi stretch of the Broad Scenic River below Ninety-Nine Islands Dam, none of the abovementioned waterbodies are designated by the State of South Carolina as unique or critical aquatic habitat. The nearest preserve is the SCDNR's Pacolet River Heritage Preserve, which is located approximately 17 mi southwest of the Lee Nuclear Station site (Duke 2009c). The Pacolet River joins the Broad River approximately 15.3 mi downstream of Ninety-Nine Islands Dam, at the lower end of the Broad Scenic River. The preserve is located approximately 20 mi upstream on the banks of the Pacolet River. It covers 278 ac in Spartanburg County and provides opportunities for recreational fishing, plant and wildlife viewing, and exploring two historical Native American soapstone quarries (SCDNR 2008b). Direct impacts to the Pacolet River Heritage Preserve are unlikely because of its distance from the Lee Nuclear Station site.

Other heritage preserves listed in the Duke ER include Peters Creek (approximately 20 mi southwest of the Lee Nuclear Station site) and Rock Hill Blackjacks (approximately 30 mi southeast) (Duke 2009c). Peters Creek, a tributary of the Pacolet River, is not expected to be affected by the proposed action because of its distance from the proposed site. Rock Hill Blackjacks is outside the Upper Broad River basin and is unlikely to be affected by the Lee Nuclear Station site (Duke 2009c).

In 2008, several sites near the Lee Nuclear Station site were listed as impaired for use by aquatic life by South Carolina under Section 303(d) of the Clean Water Act (SCDHEC 2008b). Three sites were listed because levels of copper exceeded State standards more than once in 5 years (Cherokee Creek, a tributary above Cherokee Falls Dam; Thicketty Creek, a tributary below Ninety-Nine Islands Dam; and the mainstem Broad River above Cherokee Falls Dam, 4 mi northeast of Gaffney). Two sites on tributaries to the Broad River (Cherokee Creek, above Cherokee Falls Dam, and Gilkey Creek, below Ninety-Nine Islands Dam) were listed because the composition and functional integrity of macroinvertebrate populations was compromised.

No critical habitat has been designated by the FWS or NMFS in the vicinity of the Lee Nuclear Station site (FWS 2008a; Duke 2009b).

Broad River and Ninety-Nine Islands Reservoir

The Broad River originates in North Carolina and flows for approximately 110 mi through South Carolina's Piedmont Watershed until it merges with the Saluda River to form the Congaree River (Bettinger et al. 2003). The Lee Nuclear Station site would be located on the Broad River immediately upstream from Ninety-Nine Islands Dam along the part of the river known as Ninety-Nine Islands Reservoir. This reservoir, which would provide source water and serve as the receiving waterbody, is the largest and most important aquatic resource in the vicinity of the site.

Ninety-Nine Islands Reservoir is a 4-mi-long hydroelectric reservoir above Ninety-Nine Islands Dam. The reservoir has limited storage capacity, estimated between 1691 ac-ft (Duke 2009c) and 2300 ac-ft (Wachob et al. 2009). The smaller estimate is based on the loss of storage capacity caused by significant sedimentation since the dam was completed in 1910 (Taylor and Braymer 1917; Duke 2009c).

Ninety-Nine Islands Reservoir is a dynamic system undergoing change through the process of floods, scouring, low flow, and sedimentation. Currently, the reservoir consists of the main river and two backwater regions to either side of the river channel (Duke 2009c).

The main channel is broad (approximately 180 to 360 ft wide) and characterized as "often turbid" (Cloutman and Harrell 1987). Substrate composition is primarily sand with some gravel beds or rubble outcrops (Duke 2009b; Cloutman and Harrell 1987). A bathymetric survey of the impoundment conducted in September 2006 documented a mean reservoir depth of just 9.2 ft (Duke 2013a). The maximum recorded depth was 35.2 ft at the site of the proposed raw water (Broad River)-intake structure. Because most of the reservoir is so shallow, even minor fluctuations in water levels from human activities (e.g., water use and release) or natural events (e.g., drought or significant rainfall) can result in significant changes to the surface area of the reservoir (Duke 2013a).

The two backwater areas are separated from the main channel by areas of sediment deposition. Large areas of streambed have been filled by sediment deposits and stabilized with vegetation. The shallow backwater areas parallel to the main channel contain large deposits of river-borne sediments deposited during flood conditions (Duke 2009c). Little emergent vegetation is present in the mainstem or backwater areas; fallen trees and riparian vegetation are present along the shore.

Seven hydroelectric projects are located on the South Carolina portion of the Broad River. Only Columbia Dam (furthest downstream) currently has fish-passage facilities (Figure 2-17) (NCWRC 2008a). Under the *Santee River Basin Accord for Diadromous Fish Protection, Restoration, and Enhancement*, biological triggers for initiating the development of new fish-passage projects at upstream dams have been determined (SRBA 2008). Ninety-Nine Islands Dam would be the fourth dam to include fish-passage facilities, should downstream fish-passage projects prove successful at restoring anadromous fish, such as American Shad (*Alosa sapidissima*) and Blueback Herring (*A. aestivalis*). Because of "no sooner than" dates linked to the *Santee River Basin Accord* (SRBA 2008), fish-passage facilities at Ninety-Nine Islands Dam are unlikely to be installed before 2020; however, it is possible that a fishway could be installed during the operational period of the proposed Lee Nuclear Station Units 1 and 2, should the NRC grant the requested COLs. Currently, the operating license for Ninety-Nine Islands Dam includes a requirement for continuous minimum flows of 966 cfs (January through April), 725 cfs (May, June, and December), and 483 cfs (July through November) or the inflow amount, whichever is less (Duke 2008m). Minimum flows help stabilize instream water temperatures,

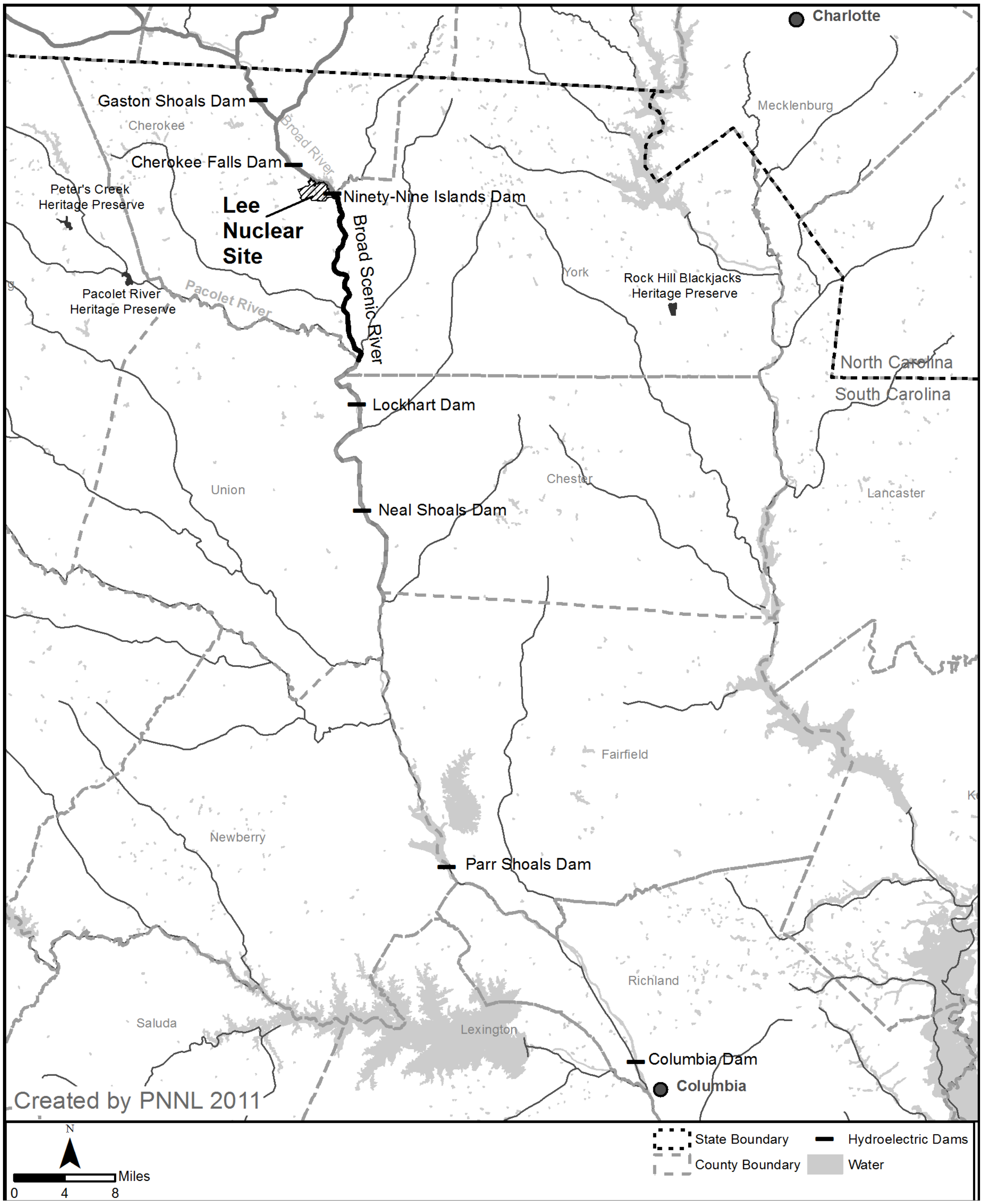

Figure 2-17. Hydroelectric Projects on the Broad River, the Broad Scenic River, and Heritage Preserves in South Carolina

provide reliable habitat for aquatic life, and guarantee some predictable water levels for recreational purposes. An Order Amending License Article 402 (which pertains to these minimum flows) was issued to Duke on November 15, 2011 (FERC 2011c) (see Section 2.3.1.1). Section 5.2.1, Hydrological Alterations (during nuclear station operations), provides more detail.

Attached Algae and Phytoplankton

Duke Power Company sampled the Broad River for algae, plankton, and aquatic macrophytes in the 1970s before construction of the unfinished Cherokee Nuclear Station (Duke Power Company 1974a, b, c; Duke 2008a). In the mid-1970s, researchers studying grab samples and artificial substrates (glass slides) found that attached algae (periphyton) in the Broad River were largely composed of diatoms, with some blue-green algae species also present (NRC 1975a).

Sampling for drifting algae (phytoplankton) by Duke Power Company in the 1970s indicated that diatoms were numerically dominant (NRC 1975a). Phytoplankton was most abundant in spring and summer and least abundant in fall and winter. Blue-green and green algae were also present. The highest densities were in the backwater areas of the reservoir, while lower densities were recorded in the main river channel. These records from the 1970s are the most recent sampling data available.

Zooplankton

In the 1970s, net tow surveys indicated that rotifers dominated the zooplankton population in the main channel of the Broad River except during the coldest parts of the year when copepods and cladocerans predominated (NRC 1975a). In Ninety-Nine Islands Reservoir, zooplankton densities were much higher, and while rotifers were still dominant, copepods and cladocerans made up a larger proportion of the reservoir community. In the lentic environment of the backwater areas, zooplankton is the primary link between primary production and higher trophic levels. These records from the 1970s are the most recent sampling data available.

Aquatic Macrophytes

During the 1970s, marsh areas associated with the backwater areas of Ninety-Nine Islands Reservoir also supported substantial populations of native emergent aquatic macrophytes, such as broadleaf cattail (*Typha latifolia*) and broadleaf arrowhead (*Sagittaria latifolia*) (NRC 1975a). However, Cloutman and Harrell (1987) observed that emergent macrophytes were not present along the Broad River within 4 km of the Lee Nuclear Station site (Cloutman and Harrell 1987). Likewise, the NRC staff did not observe emergent vegetation during a site visit conducted in April and May 2008.

Benthic Invertebrates

In the main channel of the Broad River, it is the benthic community that is the predominant link between primary production, detritus, and higher trophic levels, such as fish. During surveys conducted in the 1970s with Surber samplers, Ekman grabs, and Ponar grabs, chironomids (non-biting midges), phantom midges (*Chaoborus punctipennis*), oligochaetes (worms), and Gomphidae (clubtail dragonflies) were present in sandy areas of the Broad River above and below Ninety-Nine Islands Reservoir while Trichoptera (caddisflies) and Ephemeroptera (mayflies) were more abundant in rocky substrate (NRC 1975a). Densities of benthos from the rocky substrates were greater than the densities sampled from the sandy substrate. There were no seasonal changes in benthic species composition. Species composition in the reservoir was similar to that of the sandy portions of the river; however, densities of benthic invertebrates in the reservoir were higher than densities in the river above and below the reservoir.

Duke conducted macroinvertebrate sampling at five stations in April, August, and October 2006 (Duke 2008a). One station was above Ninety-Nine Islands Reservoir just below Cherokee Falls Dam (Station 465), two stations were in Ninety-Nine Islands Reservoir just above and below the location of the proposed Lee Nuclear Station cooling-water intake (Stations 463 and 460), one station was near the proposed cooling-water discharge (Station 459), and the last station was downstream of Ninety-Nine Islands Dam in the vicinity of the Broad River's confluence with Kings Creek (Station 453) (Figure 2-18) (Duke 2009c). The *Standard Operating Procedures for Benthic Macroinvertebrates* (NCDENR 2006) were used, with the appropriate seasonal corrections. This method is accepted by the SCDNR and provides an indication of the biological integrity of rivers and streams. Benthic macroinvertebrates are useful indicators of water quality because they are sensitive to a wide variety of potential pollutants, and their sedentary nature allows researchers to monitor spatial and temporal changes in water quality. In clean water, species that tolerate poor water quality are present, along with species that do not tolerate pollution. As the water quality degrades, the pollution intolerant species decrease in number or die off. Thus, a greater number of species collected (i.e., total taxa) generally indicates better water quality. Another metric, total Ephemeroptera-Plecoptera-Trichoptera (EPT) taxa, measures the number of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) collected. The EPT species are generally those most intolerant of pollution or of poor water quality. A biotic index uses a region-specific sorting system to rank benthic species according to their pollution tolerance. The final ranking using the NCDENR (2006) method results in a bioclassification rating of the sample location's overall water quality as "excellent," "good," "good-fair," "fair," or "poor." Criteria have been developed to translate macroinvertebrate bioclassifications to use support ratings. Rankings in the excellent to good-fair range equate to supporting ratings. Fair ratings translate to impaired ratings when a second sample within 12 to 24 months is rated fair or poor, but translates to supporting when the second sample is rated good-fair to excellent. Between the first and second sampling, the location is considered not rated. A poor sample automatically translates to an impaired rating (NCDENR 2003).

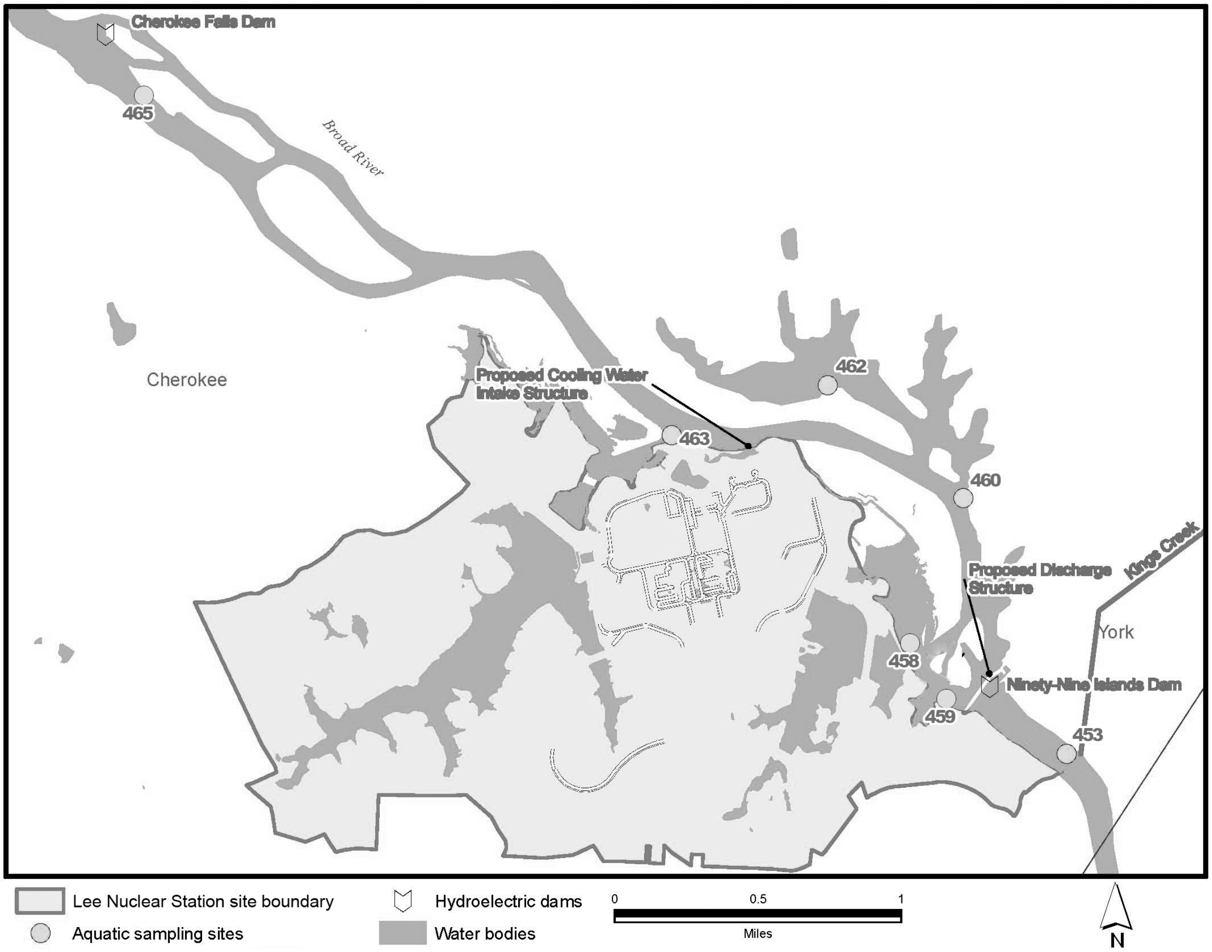

Figure 2-18. Duke Aquatic Sampling Sites, 2006 (adapted from Duke 2009c)

Total taxa per sampling trip ranged from a low of 18 in August 2006 at the site just upstream from the proposed cooling-water intake (Station 463) to a high of 86 in April 2006 at a site just downstream from Cherokee Falls Dam (Station 465). The maximum number of EPT taxa found during any one sampling period was 26, in April 2006 at a site just below Cherokee Falls Dam (Station 465), approximately 3 mi from the river water intake. Overall, the total number of taxa found was highest at the two sites outside Ninety-Nine Islands Reservoir, with 86 taxa found just below Cherokee Falls Dam (Station 465) and 67 taxa found just below Ninety-Nine Islands Dam (Station 453) (Table 2-10). Bioclassification scores were good and good/fair at the sites outside the reservoir, and either fair or poor in the reservoir, including those areas near the proposed cooling-water intake (Station 463) and proposed discharge structure (Station 459). Substrate composition is the most likely reason for the low bioclassification scores within the reservoir. As indicated in the 1975 surveys (NRC 1975a), the EPT taxa generally prefer rockier substrate, which is not common within the reservoir.

Table 2-10. 2006 Macroinvertebrate Surveys of Total Taxa in the Broad River, South Carolina

	Station 465 (just below Cherokee Falls Dam)	Station 463 (just upstream of proposed cooling-water intake)	Station 460 (downstream of proposed cooling-water intake)	Station 459 (near proposed cooling-water discharge)	Station 453 (below Ninety-Nine Islands Dam)
April	86	40	47	42	67
August	48	18	21	33	51
October	68	35	26	36	58

Source: Duke 2008a

Apparently, no surveys for mussels were conducted in the 1970s as part of the original licensing activities for the Cherokee Nuclear Station. In 2002, the SCDNR surveyed six sites for mussels on the Broad River between Gaston Shoals (RM 91) and the Columbia Dam (RM 2) (Bettinger et al. 2003). No sample sites were located between Cherokee Dam and Ninety-Nine Islands Dam (Figure 2-18). Only two identifiable live species, the eastern elliptio (*Elliptio complanata*) and eastern creekshell (*Villosa delumbis*), and one live group of mussels from the yellow lance mussel complex (*E. lanceolata*) were collected. Relic shells from seven species were found, but the *Elliptio* spp. in the South Carolina portion of the Broad River are apparently not well known and could not be verified (Bettinger et al. 2003). Overall, mussels were found to be more abundant and diverse in the lower river than in the upper river (Bettinger et al. 2003).

In 2006, Duke conducted a search for mussels in the vicinity of the Lee Nuclear Station site using a combination of diving with self-contained underwater breathing apparatus, snorkeling, and bathyscope (Duke 2009c). A total of 14 hours were spent searching 11 sites in the mainstream Broad River (upstream and downstream of Ninety-Nine Islands Dam) and in the onsite ponds. Only one Carolina lance (*E. angustata*) and one eastern elliptio were found, both in the Ninety-Nine Islands Dam tailrace (Duke 2009c). Some potential mussel habitat was observed in the faster flowing sections of the river just below Cherokee Falls Dam and just below Ninety-Nine Islands Dam.

Fish

<u>1970s</u>

In the 1970s, fish were first sampled with backpack and boat electrofishing gear, seines, fyke nets, and trammel nets (Duke Power Company 1974a, b, c). In follow-on studies, experimental gill nets with three mesh sizes also were used to sample adult fish (Duke 2008a). Twenty-four fish species were collected in the mainstem Broad River outside the impounded area by Duke Power Company in the early 1970s (NRC 1975a). Cyprinids (minnows), which are important forage fish for game species, numerically dominated the catch at approximately 75 percent of the total fish captured. Centrarchids (sunfish) and clupeids (shad) accounted for a smaller proportion of the catch. Few ictalurids (catfish) were captured in the river.

Sampling in the backwater areas of Ninety-Nine Islands Reservoir in the 1970s produced 15 fish species typical of a lake-type fish community (NRC 1975a). Centrarchids, including Largemouth Bass (*Micropterus salmoides*), Bluegill (*Lepomis macrochirus*), and crappie (*Pomoxis* spp.) were numerically dominant. Catfish, another target of recreational fishers, were also present. Forage species collected from the reservoir included Threadfin Shad (*Dorosoma petenense*), Gizzard Shad (*D. cepedianum*) and Golden Shiner (*Notemigonus crysoleucas*). The Common Carp (*Cyprinus carpio*) and Quillback (*Carpiodes cyprinus*) (a catostomid or sucker) accounted for the greatest biomass.

Ichthyoplankton were sampled in the 1970s by towing circular nitex nets or by allowing larval fish to drift into the nets where water was too shallow for towing (Duke 2008a). Duke Power Company sampled for fish larvae in the mainstream of the Broad River above and below Ninety-Nine Islands Dam and in one backwater area of Ninety-Nine Islands Reservoir in 1975 and 1976 (Duke 2008a). No more recent ichthyoplankton surveys have been conducted. Overall, fish larvae were much more common in the backwater area (approximately 1106/1000 yd^3) than in the mainstream river (approximately 53/1000 yd^3). The uneven distribution is a result of the spawning and rearing habitat preferences of the fish species in this river system.

The most common fish larvae taxa observed in the mainstream portion of the Broad River were shad, minnow, and catfish, with minor occurrences of sunfish, catostomids (suckers), Common Carp, Largemouth Bass, and Piedmont Darters (*Percina crassa*) (Duke 2008a). In 1975, Common Carp were most abundant in the mainstream at approximately 4.2/1000 yd^3, followed by suckers at approximately 3.9/1000 yd^3. In 1976, shad were most abundant in the mainstream at approximately 40.4/1000 yd^3.

The backwater areas of the reservoir had much higher densities of ichthyoplankton (Duke 2008a). Shad (*Dorosoma* spp.), sunfish, and crappie were the most common taxa. Shad, including Gizzard Shad and Threadfin Shad, were the most abundant larvae in the backwater area both years, averaging approximately 459/1000 yd^3 in 1975 and approximately 1063/1000 yd^3 in 1976.

<u>2000s</u>

In February, April, July, and October 2006, Duke sampled fish from four stations in Ninety-Nine Islands Reservoir (Stations 460 and 463 in the mainstem river; Stations 458 and 462 in backwater areas), and from one station downstream of the reservoir just below Ninety-Nine Islands Dam (Station 453) (Figure 2-18) (Duke 2009c). A boat-mounted electroshocker was used to perform the sampling except when water levels were too low for the boat below Ninety-Nine Islands Dam in July and October. A tote-mounted barge carrying the same electroshocker was used to complete those two surveys at Station 453. Sampling was standardized by shocking for 1000 seconds (16.7 minutes) per segment of shoreline. Two 328-ft (100-m) segments were sampled at each of these stations.

In April 2006, one site upstream of the reservoir near Cherokee Falls Dam, was sampled to target suckers utilizing the rocky shoals and riffles for spawning. The same boat-mounted electroshocker was used, but one 2000-second (33.4-minute) shock period was used. Only suckers were retained for identification, enumeration, and measurement at this station.

All fish collected in 2006 were identified to species, enumerated, and measured for total length. In all, 38 species and 1 hybrid were captured, comprising 6 fish families. In 2006, Duke collected 21 fish species in the impounded area of the Broad River, not including the backwater areas (Duke 2009c). Centrarchids dominated the catch at 87 percent of the total fish captured. Bluegill dominated the sunfish species, but other centrarchids captured included several Largemouth and Smallmouth Bass (*Micropterus dolomieu*). The remainder of the catch was composed of 6 percent cyprinids (minnows), nearly 3 percent each of clupeids (shad) and ictalurids (catfish), and less than 2 percent each of catostomids (suckers) and percids (darters). A Fantail Darter (*Etheostoma flabellare*), synonomous with the Carolina Fantail Darter (*Etheostoma brevispinum*) due to a recent name change, was also collected at Location 463 (just upstream from the proposed river intake structure). The V-lip Redhorse (*Moxostoma pappillosum*), a rare species in the Broad River, was captured by the SCDNR between Cherokee Falls and Ninety-Nine Islands Dam. The V-lip Redhorse fish was also captured just below Ninety-Nine Islands Dam by both the SCDNR and Duke (Bettinger et al. 2003; Duke 2009c). This species is not listed as threatened or endangered by the State, but is on the State's Priority Species List for consideration for protection (SCDNR 2005).

The Smallmouth Bass in the Broad River is a unique fishery in the Piedmont rivers in South Carolina. The SCDNR introduced the species in 1984 to increase and diversify sport fishing in the State (Bettinger et al. 2003). SCDNR surveys of the Broad River in 2006 documented natural reproduction in the Smallmouth Bass population at three sites, including just below Cherokee Falls Dam (Bettinger et al. 2003).

Sampling in 2006 produced 18 species in the backwater areas of Ninety-Nine Islands Reservoir (Duke 2009c). Bluegill and other centrarchid species were still dominant, and all other species common in the 1970s were still present. Two catostomid species, the Notchlip Redhorse (*Moxostoma collapsum*) and Quillback, were captured in the backwater areas.

In the Broad River below Ninety-Nine Islands Dam during 2006, 27 fish species were identified. Cyprinids (minnows) and centrarchids (sunfish) were numerically dominant with 31 and 32 percent of the total fish captured, respectively. Catostomids (suckers) made up 20 percent of the catch while ictalurids (catfish) made up 16 percent. Percids (darters) and clupeids (shad) made up just over 2 percent of the fish captured below Ninety-Nine Islands Dam, combined.

Between 2000 and 2002, SCDNR's backpack electrofishing sampling station, located below Ninety-Nine Islands Dam, had the greatest mean species richness and second highest mean species diversity (Bettinger et al. 2003). Further, it was the only location where SCDNR captured Carolina Fantail Darters in the South Carolina section of the Broad River.

Overall, the number of fish species present in the vicinity of the proposed Lee Nuclear Station has not changed much over the past 30 years (Table 2-11). Species composition in the impounded area may have shifted from a cyprinid-dominated population to one that is more balanced between cyprinid and centrarchid species. However, the difference in sampling gear, locations, and seasons make direct comparisons impossible. According to the SCDNR, fish species composition appears to be comparable to what was previously known from the Broad River and that of similar-sized southern Piedmont rivers, such as the Catawba and Edisto Rivers (Bettinger et al. 2003).

Table 2-11. Species Richness[a]: Broad River Basin, South Carolina

	Collection Years:	**1974-1976[b]**	**2000-2002[c]**	**2003-2004[d]**	**2006[e]**
Number of Species (Number of Families)		43 (8)	50 (9)	45 (8)	40 (7)
Family Esocidae					
Esox americanus	Redfin Pickerel			X	
Esox niger	Chain Pickerel			X	
Family Lepisosteidae					
Lepisosteus osseus	Longnose Gar		X		
Family Clupeidae					
Dorosoma cepedianum	Gizzard Shad	X	X		X
Dorosoma petenense	Threadfin Shad	X	X		X
Family Cyprinidae					
Clinostomus funduloides	Rosyside Dace	X	X	X	
Ctenopharyngodon idella	Grass Carp		X		
Cyprinella pyrrhomelas	Fieryblack Shiner		X	X	X
Cyprinus carpio	Common Carp	X	X		X
Hybognathus regius	Eastern Silvery Minnow	X	X	X	
Hybopsis hypsinotus	Highback Chub	X		X	
Cyprinella labrosa[f]	Thicklip Chub	X	X		X
Cyprinella zanema[g]	Santee Chub	X	X	X	
Nocomis leptocephalus	Bluehead Chub	X	X	X	X
Notemigonus crysoleucas	Golden Shiner	X	X	X	X
Cyprinella chloristia[h]	Greenfin Shiner	X	X	X	X
Notropis cummingsae	Dusky Shiner			X	
Notropis hudsonius	Spottail Shiner	X	X	X	X

Table 2-11. (contd)

	Collection Years:	1974-1976[b]	2000-2002[c]	2003-2004[d]	2006[e]
Notropis lutipinnis	Yellowfin Shiner	X	X	X	
Cyprinella nivea[i]	Whitefin Shiner	X	X	X	X
Notropis petersoni	Coastal Shiner			X	
Notropis procne	Swallowtail Shiner	X		X	
Notropis scepticus	Sandbar Shiner	X	X	X	X
Semotilus atromaculatus	Creek Chub	X		X	X
Family Catostomidae					
Carpiodes cyprinus	Quillback	X	X		X
Carpiodes sp. cf. *velifer*	Highfin Carpsucker		X		
Catostomus commersonii	White Sucker	X	X	X	X
Erimyzon oblongus	Creek Chubsucker			X	
Hypentelium nigricans	Northern Hogsucker		X	X	X
Ictiobus bubalus	Smallmouth Buffalo		X		X
Moxostoma collapsum[j]	Notchlip Redhorse	X	X	X	X
Moxostoma macrolepidotum	Shorthead Redhorse	X	X		X
Moxostoma pappillosum	V-lip Redhorse		X		X
Moxostoma robustum[k]	Smallfin Redhorse	X			
Moxostoma rupiscartes[l]	Striped Jumprock	X	X	X	X
Moxostoma sp[m]	Brassy Jumprock		X	X	X
Family Ictaluridae					
Ameiurus brunneus[n]	Snail Bullhead	X	X	X	X
Ameiurus catus[o]	White Catfish	X	X		X
Ameiurus natalis	Yellow Bullhead			X	
Ameiurus platycephalus	Flat Bullhead	X	X	X	X
Ameiurus nebulosus[p]	Brown Bullhead	X			X
Ictalurus punctatus	Channel Catfish	X	X		X
Noturus insignis	Margined Madtom	X	X	X	X
Family Aphredoderidae					
Aphredoderus sayanus	Pirate Perch			X	
Family Poeciliidae					
Gambusia affinis	Mosquitofish	X			
Gambusia holbrooki	Eastern Mosquitofish		X	X	
Family Moronidae[q]					
Morone americana	White Perch		X		
Morone chrysops	White Bass	X	X		X
Family Centrarchidae					
Centrarchus macropterus	Flier		X	X	
Lepomis auritus	Redbreast Sunfish	X	X	X	X
Lepomis cyanellus	Green Sunfish		X	X	
Lepomis gibbosus	Pumpkinseed	X	X	X	X
Lepomis gulosus	Warmouth	X	X	X	X

Table 2-11. (contd)

	Collection Years:	1974-1976[b]	2000-2002[c]	2003-2004[d]	2006[e]
Lepomis macrochirus	Bluegill	X	X	X	X
Lepomis microlophus	Redear Sunfish	X	X	X	X
Micropterus dolomieu	Smallmouth Bass		X	X	X
Micropterus salmoides	Largemouth Bass	X	X	X	X
Pomoxis annularis	White Crappie	X			X
Pomoxis nigromaculatus	Black Crappie	X	X	X	X
Family Percidae					
Etheostoma brevispinum[r]	Carolina Fantail Darter	X	X	X	X
Etheostoma olmstedi	Tessellated Darter	X	X	X	
Etheostoma saludae	Saluda Darter			X	
Etheostoma thalassinum	Seagreen Darter	X	X	X	
Perca flavescens	Yellow Perch		X		X
Percina crassa	Piedmont Darter	X	X	X	X

(a) Hybrid species are not included in the table.
(b) Duke (2008a) including the Ninety-Nine Islands backwaters, the Broad River mainstem, and Broad River tributaries.
(c) Bettinger et al. (2003) including the SCDNR's entire sampling area of the Broad River in South Carolina.
(d) Bettinger et al. (2006) including the SCDNR's entire sampling area of the Broad River basin.
(e) Duke (2008a) in the vicinity of the proposed Lee Nuclear Station.
(f) Formerly *Hybopsis labrosa*
(g) Formerly *Hybopsis zanema*
(h) Formerly *Notropis chloristius*
(i) Formerly *Notropis niveus*
(j) The Notchlip Redhorse was formerly subsumed under the Silver Redhorse, *Moxostoma anisurum.* All previous accounts of southeastern Atlantic slope populations of Silver Redhorse actually describe the Notchlip Redhorse.
(k) Use of *Moxostoma robustum* in the Cherokee ER was a result of misidentification due to incomplete understanding of taxonomy of the species at that time.
(l) Formerly *Scartomyzon rupiscartes*
(m) Formerly *Scartomyzon* sp.
(n) Formerly *Ictalurus brunneus*
(o) Formerly *Ictalurus catus*
(p) Formerly *Ictalurus nebulosus,* Brown Catfish
(q) Sometimes attributed to Family Percichthyidae
(r) Formerly Fantail Darter (*Etheostoma flabellare*); the *E. flabellare brevispinum* subspecies was elevated to species level and is now known as *E. brevispinum* (Blanton and Schuster 2008).

Onsite Impoundments

There are three large man-made ponds located on the Lee Nuclear Station site (Figure 2-7). Make-Up Ponds A and B and Hold-Up Pond A were sampled for fish in April 2006 using a boat-mounted electroshocker. Segments of shoreline at all three ponds were sampled for 1000 seconds (16.7 minutes). Mussels were also sampled in 2006 (Duke 2009c).

Make-Up Pond A was built by Duke in the late 1970s by damming a backwater arm of Ninety-Nine Islands Reservoir. The pond is located east of the Lee Nuclear Station site and covers approximately 62 ac (Duke 2009c). The mean depth of the pond is approximately 26 ft, with a maximum depth near 57 ft. The cooling-water intake system would pump water from the Broad River into Make-Up Pond A to be used by the circulating-water system, replacing water lost from the cooling towers because of evaporation, drift, and blowdown. There is no commercial or recreational fishing in Make-Up Pond A. Fish captured by Duke in 2006 included Pumpkinseed (*Lepomis gibbosus*), Warmouth (*L. gulosus*), Bluegill, Largemouth Bass, Black Crappie (*Pomoxis nigromaculatus*), and White Catfish (*Ameiurus catus*) (Table 2-11). Bluegill was the heavily dominant species (Duke 2009c). Two mussel species were found in Make-Up Pond A, the eastern floater (*Pyganodon cataracta*) and the paper pondshell (*Utterbackia imbecillis*) (Duke 2009c). Both mussel species occur throughout South Carolina (Bogan and Alderman 2008) and have a global conservation status of G5, secure; neither has a State conservation status rank (SCDNR 2012a).

Make-Up Pond B was formed in the late 1970s by damming McKowns Creek, then a perennial stream. Make-Up Pond B is located west of proposed Lee Nuclear Station Units 1 and 2 and covers approximately 150 ac (Duke 2011h). The mean depth is approximately 31 ft, with a maximum depth near 60 ft. During the 2006 site evaluation, water was pumped into Make-Up Pond B to dewater the original excavation site for the unfinished Cherokee Nuclear Station (Duke 2009c). Under conditions of low flow in the Broad River (less than 538 cfs), water from Make-Up Pond B would be used as a backup water source to augment flow for the circulating-water system. Water would be pumped from Make-Up Pond B into Make-Up Pond A and then into the circulating-water system. Water also could be pumped from Make-Up Pond A or from the Broad River to Make-Up Pond B to refill the pond following any drawdown associated with low river flows. Fish captured in Make-Up Pond B by Duke in 2006 included Redbreast Sunfish (*Lepomis auritus*), Warmouth, Bluegill, Redear Sunfish (*L. microlophus*), Largemouth Bass, Black Crappie, Gizzard Shad, Common Carp, Snail Bullhead (*Ameiurus brunneus*), White Catfish, and Flat Bullhead (*A. platycephalus*) (Table 2-12) (Duke 2009c). Bluegill was the heavily dominant species (Duke 2009c). One mussel species, the eastern floater, was sampled from Make-Up Pond B (Duke 2009c).

Hold-Up Pond A was developed in the late 1970s by the construction of two dams within the backwaters of Ninety-Nine Islands Reservoir. It is located immediately north of the proposed Lee Nuclear Station and covers a surface area of approximately 4 ac (Duke 2009c) and is located immediately north of the proposed Unit 1 and 2 locations, between the reactors and the Broad River. Only Largemouth Bass, Redbreast Sunfish, Bluegill, and sunfish hybrids were captured by Duke in 2006, with Largemouth Bass being the dominant species (Table 2-12) (Duke 2009c). No mussels were collected from Hold-Up Pond A (Duke 2009c).

Several additional ponds are located at the Lee Nuclear Station site. These ponds were developed by previous landowners and cover a total surface area of approximately 32 ac (Duke 2009c). These small waterbodies were not sampled to inventory aquatic organisms.

Table 2-12. Fish Species Found in the Onsite Impoundments and London Creek

Scientific Name	Common Name	Make-Up Pond A[(a)]	Make-Up Pond B[(a)]	Hold-Up Pond A[(a)]	London Creek 2008-2009[(b)]	London Creek 2010[(c)]
Family Centrarchidae						
Lepomis auritus	Redbreast Sunfish		X	X	X	X
Lepomis cyanellus	Green Sunfish				X	X
Lepomis gibbosus	Pumpkinseed	X			X	X
Lepomis gulosus	Warmouth	X	X		X	X
Lepomis macrochirus	Bluegill	X	X	X	X	X
Lepomis microlophus	Redear Sunfish		X		X	
Micropterus salmoides	Largemouth Bass	X	X	X	X	X
Pomoxis nigromaculatus	Black Crappie	X	X			
Family Cyprinidae						
Clinostomus funduloides	Rosyside Dace				X	X
Cyprinella chloristia	Greenfin Shiner					X
Cyprinella nivea	Whitefin Shiner				X	X
Cyprinus carpio	Common Carp		X			
Hybopsis hypsinotus	Highback Chub				X	X
Nocomis leptocephalus	Bluehead Chub				X	X
Notropis chlorocephalus	Greenhead Shiner				X	X
Notropis scepticus	Sandbar Shiner				X	X
Semotilus atromaculatus	Creek Chub				X	X
Family Catostomidae						
Catostomus commersonii	White Sucker				X	X
Hypentelium nigricans	Northern Hogsucker				X	X
Moxostoma rupiscartes	Striped Jumprock				X	
Moxostoma sp.	Brassy Jumprock				X	
Family Ictaluridae						
Ameiurus brunneus	Snail Bullhead		X			
Ameiurus catus	White Catfish	X	X			
Ameiurus platycephalus	Flat Bullhead		X		X	X
Family Percidae						
Etheostoma olmstedi	Tessellated Darter				X	X
Family Poeciliidae						
Gambusia holbrooki	Eastern Mosquitofish				X	
Family Clupeidae						
Dorosoma cepedianum	Gizzard Shad		X			

(a) Duke (2009c)
(b) Coughlan (2009)
(c) SCDNR (2011b)

London Creek

London Creek is a tributary to the Broad River located offsite (Figure 2-7). It joins the Broad River within the upper reaches of Ninety-Nine Islands Reservoir. The proposed offsite Make-Up Pond C would be formed by impounding London Creek and some of its tributaries (Figure 2-7). If Make-Up Pond C receives the necessary authorizations from Federal and State regulatory agencies, it would inundate a portion of the approximately 3.76-mi-long London Creek to create an approximately 620-ac reservoir (Duke 2009b, 2011h). Its maximum depth would be approximately 116 ft, and the reservoir would have a total storage volume of approximately 22,000 ac-ft (Duke 2009b).

London Creek currently originates at the Lake Cherokee outfall, which is a drop-inlet spillway with a discharge pipe. Thus, Lake Cherokee provides flow to London Creek only when the lake is full. There is no minimum flow requirement for this outlet, and in times of severe or extreme drought, London Creek may cease to flow (Duke 2009b). Under normal conditions, London Creek is a shallow Piedmont stream with alternating pools and riffles that meanders through wooded bottomland. Duke (2009b) describes London Creek's instream habitat as including "shallow riffles with cobbles, pools, root masses, leaf packs, woody debris, smaller amounts of sand and silt substrate, and minor amounts of trash in places." A few small sections contain bedrock. Based on a survey it conducted May 2010 (SCDNR 2011b), the SCDNR characterized the London Creek physical conditions "as consistent with a reasonably high quality Piedmont stream, including a forested riparian corridor, good channel sinuosity and habitat (riffle/pool) diversity, and coarse, clean substrate composition."

Duke surveyed three stream segments of London Creek for fish using backpack electrofishing techniques in March and September of 2008 and 2009 (Coughlan 2009). Each segment was approximately 328-ft (100-m) long. Twenty-one species of fish were captured and identified (excluding hybrids) (Table 2-12). The most numerous species were cyprinids (minnows), followed by centrarchids (sunfish), and four other family groups. The species captured are typical of other Piedmont streams in the vicinity (Duke 2010f, g).

SCDNR used the South Carolina Stream Assessment protocol (Thomason et al. 2002) to sample 561 ft of London Creek in May 2010 (SCDNR 2011b). The SCDNR collected 18 fish species, including 1 species not collected by Duke in 2008 (Table 2-12). Thus, a total of 22 fish species were collected in London Creek surveys. Of these 22 species, 1 species, the Greenhead Shiner (*Notropis chlorocephalus*), is a South Carolina State conservation species of high priority and 3 are species of moderate priority: Greenfin Shiner (*Cyprinella chloristia*), Highback Chub (*Hybopsis hypsinotus*), and Flat Bullhead.

Macroinvertebrate species were surveyed by Duke in March and September of 2008 and 2009 and in June 2009 (Derwort and Hall 2009). Two mussel species were identified: native swamp fingernail clam (*Musculium partumeium*) and non-native Asiatic clam (*Corbicula fluminea*). The swamp fingernail clam, which is not a State species of conservation concern in South Carolina, was rare (1 to 2 individuals collected) to abundant (10 or more individuals collected) depending on the time of year and the individual sampling site. The Asiatic clam was also rare to abundant depending on time of year and sampling site. Duke collected crayfish during surveys in 2008 and 2009 (Derwort and Hall 2009). In 2010, the SCDNR borrowed and examined Duke's archived crayfish collections and, on three occasions, performed joint collections with Duke (SCDNR 2010b). Two stream-dwelling and one burrowing species of crayfish were collected (Derwort and Hall 2009; SCDNR 2010b). None of the three crayfish species collected from the London Creek area are of conservation concern in South Carolina (SCDNR 2006b). The Broad River spiny crayfish (*Cambarus spicatus*), which is of high conservation concern and is present in the Broad River drainage, was not collected in London Creek.

All macroinvertebrate samples collected by Duke in London Creek resulted in fair bioclassification scores in 2008 and mostly good-fair scores in 2009. The scores take into consideration species diversity, abundance, and pollution sensitivity. The sampling and scores were calculated using the North Carolina Department of Environment and Natural Resources' *Standard Operating Procedures for Benthic Macroinvertebrates*, which is accepted by the State of South Carolina (NCDENR 2006). Higher bioclassification scores and numbers of taxa in 2009 compared to 2008 were likely due to drought conditions that persisted during the 2008 sampling period followed by more normal rainfall in 2009 (Derwort and Hall 2009).

Other Waterbodies

There are 100,398.07 linear ft of jurisdictional stream reaches located within the Make-Up Pond C area, including London Creek and Little London Creek (USACE 2013a). Because Little London Creek joins London Creek downstream of the proposed impoundment site, it would remain intact.

There are 21 stream crossings and 5942.14 linear ft of stream reaches within the railroad corridor jurisdictional determination boundary. Two small areas of jurisdictional open water ponds, totaling 0.41 ac, are also located within the railroad corridor (USACE 2013a). The existing railroad-spur corridor that would be upgraded and used for the proposed Lee Nuclear Station crosses London Creek and seven other tributaries (Figure 2-7).

Thirteen small farm ponds covering 18.54 ac also occur in the vicinity of the proposed Make-Up Pond C. Eleven of these ponds, encompassing 17.18 ac, are considered jurisdictional waters of the United States (USACE 2013a). It is assumed that the ponds were used to water livestock and provide recreational fishing opportunities for the private landowners. Most of the ponds would be inundated by the impoundment; all would be breached and drained (Duke 2009b).

Duke sampled seven of the farm ponds in the vicinity of the proposed Make-Up Pond C using boat-mounted electrofishing equipment during April 2010 (Duke 2010d). Two ponds contained no fish. Two ponds contained only Largemouth Bass, and two ponds contained Largemouth Bass and hybrid sunfish. One pond contained Bluegill, Redear Sunfish, hybrid sunfish, and Largemouth Bass. This pond was isolated from pasture land and was the only pond with a wooded shoreline. Length-frequency distributions indicated that the Largemouth Bass were small and of marginal fishing value. Several large sunfish were sampled from the wooded pond, but collection rates were very low. Duke anticipates the small size of the bass and limited number of sunfish will preclude relocation of fish, but it will consult with SCDNR before draining the ponds (Duke 2010d).

As discussed in Section 2.4.1.1, the Lee Nuclear Station site contains 12.52 ac of jurisdictional wetlands (USACE 2013a). In addition, the Make-Up Pond C area contains 7.43 ac of jurisdictional wetlands, including small wetlands associated with stream features along London Creek, Little London Creek, and several unnamed tributaries (USACE 2013a).

2.4.2.2 Aquatic Resources – Transmission-Line Corridors

As described in Section 2.2.3.1, Duke proposes to establish two additional offsite transmission-line corridors that would each contain two transmission lines: one 230-kV line and one 525-kV line. Each proposed transmission-line corridor from the Lee Nuclear Station site switchyard has a 325-ft-wide corridor to the first tie-in location on the Pacolet-Catawba transmission line. Each corridor from the Pacolet-Catawba line to the Oconee-Newport tie-in location would have a 200-ft-wide corridor. Both routes would be located in Cherokee and Union Counties, and both routes would cross Thicketty Creek and the Pacolet River (Duke 2009c). Approximately 15.1 mi of corridors would be 325-ft wide, and approximately 16 mi of corridors would be 200-ft wide. There are 46 stream crossings (extending 14,596 linear ft) within the Route K (western) offsite transmission-line ROW and 70 stream crossings (extending 25,530 linear ft) and a 4.06-ac open-water impoundment within the Route O (eastern) offsite transmission-line ROW (USACE 2013a).

Habitat along the proposed transmission-line corridors was surveyed specifically for the Carolina heelsplitter (*Lasmigona decorata*), which is a Federally and State-listed endangered and State-ranked S1 (critically imperiled) aquatic mussel species known to occur in York and Chester Counties (Duke 2009g). The Carolina heelsplitter was not found within streams that will be crossed by the transmission lines. No other Federally or State-protected aquatic species were found during the survey effort.

2.4.2.3 Important Aquatic Species

The NRC has defined important species as species that are rare, ecologically sensitive, play an ecological role, are relied on by a valuable species, and/or have commercial or recreational value (NUREG-1555 [NRC 2000a]). The FWS identifies Federally threatened or endangered species in 50 CFR 17.11 and 50 CFR 17.12. Important species also include those proposed or candidates for listing as Federally threatened or endangered and those ranked as critically imperiled, imperiled, or vulnerable by the State of South Carolina, some of which may also be designated as threatened or endangered by the State. Biological indicator species that respond to and indicate environmental change also are classed as important species.

The following section includes commercially important species, recreationally important species, invasive species, important species, protected species, and State-ranked species that have been documented at the Lee Nuclear Station site, or are thought to occur in the vicinity of the site or counties where proposed transmission-line corridors will be located. The *Comprehensive Wildlife Conservation Strategy* developed by the SCDNR identifies conservation priority species (SCDNR 2005), some of which are known to occur at the Lee Nuclear Station site and vicinity.

Commercially Important Species

There are no commercially important fisheries associated with the portion of the Broad River near the Lee Nuclear Station site.

Recreationally Important Species

Recreational fishers pursue Bluegill, Redbreast Sunfish, Redear Sunfish, Largemouth Bass, Black Crappie, White Catfish, Channel Catfish (*Ictalurus punctatus*), and suckers in Ninety-Nine Islands Reservoir (Duke 2009c). The Broad River also supports a Smallmouth Bass fishery that began with the SCDNR's introduction of the species to the Broad River in 1984 (Bettinger et al. 2003).

<u>Bluegill (*Lepomis macrochirus*)</u>

Native Bluegill are found in pools and backwater areas of low-to-moderate gradient creeks, streams, and rivers (Jenkins and Burkhead 1993). Bluegill inhabit clear and turbid waters with both hard and silted substrates. These fish are generally a prolific species and are popular for sport fishing. Because of their small mouths, the young and juveniles are planktivores and adults generally eat small aquatic and terrestrial insects. Spawning may occur during most of the growing season. Males will construct nests in shallows on sand or gravel, frequently as part of a colony. Females will spawn multiple times during the season and have been reported to produce approximately 80,000 eggs per year. The adhesive eggs are laid in a nest where they cling to the substrate. Larvae are guarded by the male on the nest for several days after hatching. Larger larvae may become limnetic (Duke 2008a).

Bluegill were captured in the vicinity of the Lee Nuclear Station site during all four documented fish surveys (Duke 2009c). In 2006, large numbers of Bluegill were captured at all five sampling stations during each sampling event throughout the year (Duke 2009c).

Redbreast Sunfish (*Lepomis auritus*)

Native Redbreast Sunfish are found in pools and backwaters of warm creeks, streams, and rivers of low-to-moderate gradient, as well as ponds and reservoirs (Jenkins and Burkhead 1993). They most often are found in clear water, but will sometimes inhabit turbid waters. This fish has a high thermal tolerance, having been found in elevated water temperatures (to 102°F) below a power plant outfall in Virginia (Jenkins and Burkhead 1993). These fish are generalists, eating mostly aquatic insects; however, they also prey on crayfish, other arthropods, mollusks, and occasionally fish. Redbreast Sunfish usually breed in waters that are 61 to 82°F, with peak spawning observed within the 68 to 82°F range. Males construct nests over silt-free or lightly silted sand and gravel, often in association with cover. The nests are usually spaced closely in calm, shallow water (less than 3.3 ft deep), though some have been found in the lee of large rocks near swift currents. Females contain approximately 1000 to 8000 ova, with older fish producing larger numbers of eggs. The adhesive eggs are laid in a nest where they cling to the substrate. Larvae are guarded by the male on the nest for several days after hatching. Larger larvae may become limnetic (Duke 2008a).

Redbreast Sunfish were captured in the vicinity of the Lee Nuclear Station site during all four documented fish surveys (Duke 2009c). In 2006, this species was captured in very low numbers at three of five sampling stations during each sampling event throughout the year (Duke 2009c). The greatest numbers were captured below Ninety-Nine Islands Dam. No Redbreast Sunfish were captured in the backwater arms of Ninety-Nine Islands Reservoir (Duke 2009c).

Redear Sunfish (*Lepomis microlophus*)

Native Redear Sunfish are found more often in clear lakes and ponds than in streams or rivers, although the species may also be found in backwater areas of streams and rivers exhibiting lacustrine characteristics (Jenkins and Burkhead 1993). Some tolerance to turbidity has been noted by researchers. Redear Sunfish have large teeth suitable for crushing snails and small mussels for consumption. They also eat aquatic insects and the occasional fish. Spawning generally begins when the water approaches 68 to 70°F and ends by mid-summer or early fall. Nests are built in colonies near vegetation and in shallow (less than 6.6 ft deep) water. Females may produce approximately 15,000 to 30,000 adhesive eggs that cling to the substrate. Larvae are guarded by the male on the nest for several days after hatching. Larger larvae may become limnetic (Duke 2008a).

Redear Sunfish were captured in the vicinity of the Lee Nuclear Station during three of four documented fish surveys (Duke 2009c). In 1973 and 1974, this species was not recorded as being present in the vicinity of the site. In 2006, this species was captured in very low numbers at all five sampling stations during nearly every sampling event throughout the year (Duke 2009c).

Largemouth Bass (*Micropterus salmoides*)

Largemouth Bass are an important game fish and the most widespread of the *Micropterus* genus (Jenkins and Burkhead 1993). Largemouth Bass are stocked in many parts of the United States to provide sport fishing opportunities. These fish inhabit many waters including marshes, ponds, lakes, reservoirs, and small streams to large rivers. In general, they prefer warm, clear water. Juvenile bass eat plankton, small insects, and fish; adults generally feed on larger insects, fish, and crayfish. Spawning occurs in spring when the water reaches temperatures in the 61 to 64°F range, and has been reported to continue until the water reaches 75°F. Several distinct spawning peaks may occur during the season. Males create a nest on a variety of substrates in backwater areas, pools in streams, or along the shores of ponds and reservoirs in water that is usually 1 to 2 ft deep, although nest sites have been documented as deep as 27 ft. These nests may be in the open or associated with aquatic macrophytes or other structure. Adult females average approximately 20,000 ova. After the eggs hatch, the males typically guard their young on the nest for 4 to 8 days (Duke 2008a).

Largemouth Bass were captured in the vicinity of the Lee Nuclear Station site during all four documented fish surveys (Duke 2009c). In 2006, small numbers of this species were captured at all five sampling stations during nearly every sampling event throughout the year (Duke 2009c).

Smallmouth Bass (*Micropterus dolomieu*)

Smallmouth Bass were introduced to the Broad River in 1984, making it a unique fishery in the Piedmont region of South Carolina (Bettinger et al. 2003). These fish live in both cool and warm waters, but generally prefer clear, large lakes, streams, or rivers with gravelly and rocky substrates (Jenkins and Burkhead 1993). Juvenile Smallmouth Bass feed on microcrustaceans, insects, and small fish; adults primarily consume crayfish and fish. Spawning has been observed at water temperatures between 61 and 72°F. Males construct nests in streams near shorelines in 1- to 2-ft-deep water on firm bottoms in slow currents, often adjacent to structure. Estimated numbers of mature ova in adult females range from approximately 2500 to 28,000. The males guard the nests until after the eggs hatch.

Smallmouth Bass have been captured in the vicinity of the Lee Nuclear Station site during three documented fish surveys between 1987 and 2006 (Duke 2009c). In 2006, small numbers of this species were captured by Duke personnel below Ninety-Nine Islands Dam and also at a sampling station located just upstream from the proposed cooling-water intake (Duke 2009c). Between 2000 and 2002, the SCDNR found Smallmouth Bass in at least nine Broad River sampling locations between Parr Shoals and Gaston Shoals (Bettinger et al. 2003). There is evidence that the population is reproducing naturally in some parts of the river, including the area between Ninety-Nine Islands Dam and Cherokee Falls Dam (Bettinger et al. 2003).

Black Crappie (*Pomoxis nigromaculatus*)

Native Black Crappie can live in swamps, ponds, lakes, reservoirs, and slack water areas of low-to-moderate gradient creeks to rivers (Jenkins and Burkhead 1993). These fish are often associated with structures, such as aquatic vegetation, logs, or fallen trees. The young fish prey on microcrustaceans, insects, and larval fish. Adults are largely piscivorous, but will eat a variety of aquatic organisms and terrestrial insects. Black Crappie are early spawners, actively congregating and constructing nests when water temperatures are between 59 and 68°F. Nests are built in shallow-to-moderately deep water (to 20 ft), are often associated with vegetation, and may be crowded. Females can bear 11,000 to 188,000 small eggs, making them a highly fecund species. Eggs adhere to the nest or surrounding objects; after hatching, the larvae remain in the nest for 2 to 4 days before moving to open water (Duke 2008a).

Black Crappie were captured in the vicinity of the Lee Nuclear Station site during all four documented fish surveys (Duke 2009c). In 2006, small numbers of this species were captured at four of the five sampling stations, but observations at each station were sporadic throughout the year (Duke 2009c). No Black Crappie were collected at the sampling station located just upstream from the proposed location for the Lee Nuclear Station's cooling-water-intake structure.

White Catfish (*Ameiurus catus*)

Native White Catfish live mainly in the warm waters of ponds, reservoirs, and medium-to-large rivers (Jenkins and Burkhead 1993). Juveniles typically eat aquatic insects; adults consume a variety of aquatic invertebrates, fish, and plants. The minimum spawning temperature for White Catfish is reported to be 70°F. Both males and females prepare the nest, which is typically in 1- to 1.6-ft-deep water, and guard and fan the nest, which may contain approximately 1500 to 3000 eggs.

White Catfish were captured in the vicinity of the Lee Nuclear Station site during all four documented fish surveys (Duke 2009c). In 2006, small numbers of this species were captured at three of the five sampling stations. Most of the fish were found in one of the two backwater arms of Ninety-Nine Islands Reservoir, but observations at each station were sporadic throughout the year (Duke 2009c). Only two White Catfish were captured at the sampling station located just upstream from the proposed location for the Lee Nuclear Station cooling-water-intake structure. This species has the potential to be negatively affected as a result of predation and competition with exotic catfish species, such as Blue Catfish (*Ictalurus furcatus*) and Flathead Catfish (*Pylodictis olivaris*) (SCDNR 2005).

Channel Catfish (*Ictalurus punctatus*)

Channel Catfish are an introduced species that inhabit both clear and turbid large warm streams, big rivers, ponds, lakes, and reservoirs (Jenkins and Burkhead 1993). In lotic systems, this species is typically associated with pools, but can be found in moderate current. Channel Catfish are considered a prized game fish. Very young catfish eat plankton and insect larvae; juveniles and adults eat a wide variety of aquatic invertebrates, vertebrates (including other fish), and plants. Spawning occurs at water temperatures between 70 and 86°F. Both males and females may construct the nest, but males care for the eggs. Females may produce approximately 4000 to 10,000 eggs per year. The larvae are typically guarded by the male for up to a week after hatching.

Channel Catfish were captured in the vicinity of the Lee Nuclear Station site during three of four documented fish surveys (Duke 2009c). No Channel Catfish were recorded in 1973 or 1974. In 2006, very low numbers were captured at all five sampling stations. None were captured in February 2006, and 12 were captured sporadically, mainly as singles or pairs, throughout the remainder of the year (Duke 2009c).

Sucker Species

Suckers, which are native to the Broad River, are strongly adapted for bottom feeding with mouths that angle downward (Jenkins and Burkhead 1993). Although some anglers target suckers directly, the juvenile fish are often used by anglers as bait. Suckers belong to the family Catostomidae and generally move to shallower, fast-moving water to spawn in early spring. The eggs are deposited in gravel and afforded no protection by the adults. Larval catostomids may swim out of the gravel and enter flowing water where high mortality may occur as they become part of the plankton.

Catostomids captured during all four sampling periods associated with the Lee Nuclear Station site (i.e., 1973 to 1974, 1987, 2000 to 2002, and 2006) include Quillback, White Sucker (*Catostomus commersonii*), Northern Hogsucker (*Hypentelium nigricans*), Notchlip Redhorse, and Striped Jumprock (*Moxostoma rupiscartes*) (Duke 2009c). In addition to these sucker species, the FWS indicated in its letter to Duke (dated May 23, 2006) that a rare, but extant, population of Robust Redhorse (*M. robustum*) was found in the Broad River downstream of the Lee Nuclear Station site (Duke 2010f).

A total of 312 Quillback were captured during Duke's fish surveys in 2006. One fish was taken by electrofishing in October from one of the two backwater arms of the Ninety-Nine Islands Reservoir and 262 were captured in the Ninety-Nine Islands Reservoir during four gillnetting sampling trips conducted in February, April, July, and October 2006 (Duke 2009b; Barwick et al. 2006). Another 49 Quillback were captured by electrofishing downstream of Cherokee Falls in April 2006 (Barwick et al. 2006). The SCDNR captured several Quillback above and below the

Ninety-Nine Islands Dam during its survey of the Broad River between 2000 and 2002 (Bettinger et al. 2003). This species is on the State's Priority Conservation Species List in the high conservation category (SCDNR 2005).

White Suckers, which are often used for bait by fishers, have very generalized habitat requirements (Jenkins and Burkhead 1993). Most of their native range is north and west of South Carolina. Very few were found by the SCDNR during its 2000 to 2002 surveys, but at least one was taken just below Ninety-Nine Islands Dam (Bettinger et al. 2003). In 2006, only two White Suckers were captured by Duke. Both fish were captured in February from the Broad River just below Ninety-Nine Islands Dam (Duke 2009c).

Northern Hogsuckers are not considered game fish; they are associated primarily with lotic systems and prefer hard substrates (Jenkins and Burkhead 1993). Though present in South Carolina, most of their native range is northward. Northern Hogsuckers are sometimes migratory, ascending streams to reproduce, but may spawn where it resides. Their spawning habitat is reported to be the gravelly tails of pools or in medium gravel in shallow moving water (0.3 to 1.5 ft deep).

SCDNR found small numbers of Northern Hogsuckers throughout the Broad River (Bettinger et al. 2003). During the surveys conducted by Duke in 2006 in the Ninety-Nine Islands Reservoir and Broad River, 152 Northern Hogsuckers were captured (Duke 2009c). Higher numbers were observed in July and October than during February and April. A separate survey conducted in April 2006 to target rare catostomid species just below Cherokee Falls Dam in the free-flowing section of the river located five additional Northern Hogsuckers (Barwick et al. 2006).

Notchlip Redhorse are considered a moderate priority species by South Carolina (SCDNR 2005). In 2006, Notchlip Redhorse were observed in very low numbers from all five of Duke's sampling stations. Half of the fish were observed below Ninety-Nine Islands Dam (Duke 2009c). The SCDNR did not capture any of this species during its 2000 to 2002 surveys (Bettinger et al. 2003).

Jumprocks (*Moxostoma* spp.) are generally small and inhabit fast water (Jenkins and Burkhead 1993). In 2006, moderate numbers of Striped Jumprocks and Brassy Jumprocks were captured by Duke below Ninety-Nine Islands Dam throughout the year (Duke 2009c). One Brassy Jumprock specimen was captured during February in the main channel of Ninety-Nine Islands Reservoir, just above the proposed location for the Lee Nuclear Station cooling-water-intake structure. The targeted catostomid electrofishing surveys conducted just downstream of Cherokee Falls Dam in April 2006 located 39 Brassy Jumprocks (Barwick et al. 2006). The SCDNR also captured small numbers of Striped and Brassy Jumprocks above and below Ninety-Nine Islands Dam (Bettinger et al. 2003).

Robust Redhorse are large suckers that can reach lengths over 17 in. (SCDNR 2005). They have large teeth specialized for crushing their food, which includes native mussels. Robust Redhorse have no legal conservation status in South Carolina, but are on the State's priority conservation list in the highest conservation category (SCDNR 2005). In South Carolina, wild populations of Robust Redhorse are known to exist in the Savannah and Pee Dee Rivers. The SCDNR has also been stocking the Broad River with Robust Redhorse every year since 2004, with over 50,000 fingerlings released to date. In 2006 the FWS stated that Robust Redhorse were found in the Broad River downstream of Ninety-Nine Islands Dam (FWS 2006). Over 15,000 Robust Redhorse have been introduced to the Wateree River since 2005 (Georgia Power 2011). It is unclear whether the introduced populations will be able to sustain themselves over time (Georgia Power 2011).

Nuisance Species

No invasive aquatic plant species have been noted in the Broad River aquatic environment near the proposed Lee Nuclear Station. However, one nuisance fish species, the Smallmouth Buffalo (*Ictiobus bubalus*), and the invasive Asiatic clam have been observed (Duke 2009c).

<u>Smallmouth Buffalo (*Ictiobus bubalus*)</u>

Smallmouth Buffalo are an introduced fish species. The method of its introduction to North Carolina and South Carolina is unknown (Fuller 2009). This species was collected by the SCDNR near the site in 2001 (Bettinger et al. 2003), but was previously undocumented in the Broad River (Duke 2009c). The impact of Smallmouth Buffalo on other Broad River species is unknown (Fuller 2009); however, they may compete with some of the local redhorse fish species (SCDNR 2005).

<u>Asiatic Clam (*Corbicula fluminea*)</u>

Asiatic clams are a nonindigenous species of mussel introduced on the West Coast of the United States in the 1930s that migrated east to South Carolina by the 1970s. Asiatic clams are generally considered a nuisance species because of their ability to reproduce rapidly and because of their tendency to foul raw water-intake pipes at power and water-supply facilities (Foster et al. 2012). Unlike most native mussels, Asiatic clams do not require a fish host during their larval period. In addition, Asiatic clams are highly resistant to desiccation and may be better adapted than most native species to survive dry periods (Bogan and Alderman 2008). Asiatic clams are often found in sandy substrate in slow-flowing rivers and are present throughout the Broad River basin (Duke 2009c; Bogan and Alderman 2008). Asiatic clams were found in Make-Up Pond B in 2006 (Duke 2009c).

Diadromous Fish Species Potentially Available in Future

Although fish-passage facilities are unlikely to be located at Ninety-Nine Islands Dam before 2020, if the COLs are granted and the new units constructed, a fishway could be installed during the operational period of the Lee Nuclear Station. Therefore, while the fish species identified below are not currently found in the vicinity of the Lee Nuclear Station site, plans to provide fish-passage at dams on the Broad River could lead to their presence in the site vicinity in the future. Diadromous species addressed in the *Santee River Basin Accord for Diadromous Fish Protection*, *Restoration*, *and Enhancement* include the American Eel (*Anguilla rostrata*), American Shad, Blueback Herring, Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*), and Shortnose Sturgeon (*A. brevirostrum*) (SRBA 2008). American Eel and American Shad, which are the only species with historical presence in the vicinity of the Lee Nuclear Station site, are discussed below (FWS 2001). The NRC staff's correspondence to NMFS regarding diadromous fish species is listed in Appendix F.

American Eel (*Anguilla rostrata*)

American Eel are catadromous (i.e., they spawn in the ocean, but otherwise inhabit fresh, brackish, or estuarine water). South Carolina has placed the American Eel in the highest priority category on its Priority Conservation Species List (SCDNR 2005), but the species has no legal protection status. The following description is based on a species description prepared by the SCDNR (SCDNR 2005). In South Carolina, historical records indicate the fish were present in the Santee River Basin, well inland of the fall line and into North Carolina. Juvenile eels, called elvers, may migrate far into inland habitats. Small eels can climb wet, textured vertical walls, but are unable to scale large structures such as the existing dams on the Broad River. When juvenile eels exceed 4 in. in length, they are called yellow eels. Primarily during spring and fall, yellow eels may migrate upstream, gradually migrating farther and farther inland over the years. The fish mature between 3 and 24 years, with females growing larger, living longer, and migrating much farther inland than males, which generally are restricted to estuarine and brackish water habitats. American eels can be found in all habitats with sufficient food resources and well-oxygenated water.

American Shad (*Alosa sapidissima*)

The American Shad are anadromous and spawn in large river basins. Although South Carolina has placed the American Shad in the highest priority category on its Priority Conservation Species List (SCDNR 2005), the species has no legal protection status. The following description is based on a species description prepared by the SCDNR (SCDNR 2005). Historic data show American Shad once ascended the Santee River Basin, well inland of the fall line and into North Carolina. Upstream migration and spawning is temperature-dependent, but generally occurs between mid-January and mid-May in South Carolina. Peak spawning occurs during March and April. American Shad release groups of eggs in batches as they move upstream. These eggs are semi-buoyant and can drift in the water column. Juveniles may spend a year or more maturing in freshwater before reaching the ocean.

Although populations are probably depressed from levels predating dams, American Shad have responded well to existing fish-passage protocols and increased flows at hydropower projects. In fact, the American Shad population in the Santee-Cooper River Basin is currently among the largest on the Atlantic coast.

Threatened and Endangered Aquatic Species

State-Ranked Species

As described in Section 2.4, the State ranking provides the only common basis for comparison of numbers of important animal and plant species at the Lee Nuclear Station site located in South Carolina, the Keowee and Middleton Shoals alternative sites (also located in South Carolina), and the Perkins alternative site in North Carolina (see Chapter 9.3, Alternative Sites). This section describes the Carolina Fantail Darter, a South Carolina State-ranked aquatic species known to occur near the Lee Nuclear Station site (Table 2-13), and the Carolina Darter (*Etheostoma collis*). Although not State-ranked, the Carolina Darters are assigned a State-protection status of threatened. Carolina Darter occur in York County (SCDNR 2012f), but not within 15 mi of the Lee Nuclear Station (SCDNR 2012a).

Table 2-13. Federally Listed and State-Ranked Aquatic Species that May Occur in the Vicinity of the Lee Nuclear Station Site or Transmission-Line Corridors

Scientific Name	Common Name	Federal Status[(a)]	State Status/ Rank[(b)]
Fish			
Etheostoma brevispinum	Carolina Fantail Darter	-	-/S1
Etheostoma collis	Carolina Darter	-	SNR/T
Mussels[(c)]			

(a) Federal status rankings determined by the FWS under the Endangered Species Act of 1973 (FWS 2012a).
(b) State rank: S1 = critically imperiled, SNR = not ranked; State status: T = threatened (SCDNR 2012a).
(c) The Carolina heelsplitter (*Lasmigona decorata*) is listed by the FWS as endangered in York County, South Carolina (FWS 2012a), but occurs only within the Catawba River drainage (SCDNR 2005).

Carolina Fantail Darter (*Etheostoma brevispinum*). Formerly known as the Fantail Darter (*Etheostoma flabellare*), the *E. flabellare brevispinum* subspecies was elevated to species level and is now known as *E. brevispinum* (Blanton and Schuster 2008). The Carolina Fantail Darter is ranked in South Carolina as an "S1" species (i.e., critically imperiled statewide because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation) (SCDNR 2012a). South Carolina has placed this species in the high priority category on its Priority Conservation Species List (SCDNR 2005). The Carolina form of the Fantail Darter is endemic to the Piedmont and Blue Ridge sections of the Upper Pee Dee and Santee River drainages in the State (SCDNR 2005). These fish inhabit gravel riffles in small-to-medium-sized rivers in strong currents and rely on rocky substrates for feeding and spawning. The geographic isolation of the Carolina Fantail Darter makes the species vulnerable to pollution, development, and habitat alterations. Carolina Fantail Darter are considered secure in North Carolina, but relatively little is known of their population size or trends in South Carolina (SCDNR 2005). The global conservation status rank for the species is G4, apparently secure (NatureServe Explorer 2013).

Carolina Fantail Darter spawn in water between 59 and 75°F (Jenkins and Burkhead 1993). Their spawning habitat includes runs and slow riffles where the fish lay adhesive eggs on the underside of stones. The females may spawn approximately five times per year, with single egg counts reported to range between approximately 50 and 550 (Jenkins and Burkhead 1993).

Duke captured Carolina Fantail Darter during all four surveys conducted in the vicinity of the site (Duke 2009c). In 2006, one specimen was captured just upstream from the proposed location for the Lee Nuclear Station cooling-water intake (Duke 2009c). A total of 51 specimens were collected in 2003 and 2004 from four Broad River tributary sites, including Kings Creek, which joins the Broad River immediately below Ninety-Nine Islands Dam (Bettinger et al. 2006).

Carolina Darter (*Etheostoma collis*). Carolina Darter have a South Carolina State-protection status of threatened and are designated as a species of high conservation priority by the SCDNR (SCDNR 2005). This species is not ranked in South Carolina, but does have a global conservation status rank of G3, vulnerable (NatureServe Explorer 2013). These small (up to 6-cm long) fish are typically found in small upland creeks and rivulets in both wooded and pasture areas in pools or slow-moving runs and often among vegetation that includes brush and fallen tree limbs (NatureServe Explorer 2010). They are difficult to sample in such habitat. Carolina Darter exist only in the Piedmont region from south-central Virginia through North Carolina and into north-central South Carolina (SCDNR 2005). However, watershed distribution maps indicate the species are likely extirpated in the Broad River drainage (NatureServe Explorer 2010). No Carolina Darter have been sampled by Duke or the SCDNR in the vicinity of the Lee Nuclear Station site (Bettinger et al. 2006; Duke 2009b).

Federally Listed Species

In a letter dated April 9, 2008, the NRC requested that the FWS Field Office in Atlanta, Georgia, provide information regarding Federally listed, proposed, and candidate species and critical habitat that may occur in the vicinity of the Lee Nuclear Station site (NRC 2008e). On May 13, 2008, the FWS provided a response letter that included a list of Federally listed species in Cherokee, Union, and York Counties (FWS 2008a), which encompass the Lee Nuclear Station site, the Make-Up Pond C site, the railroad-spur corridor, the two proposed transmission-line corridors, and the six offsite road-improvement areas. The FWS indicated that one listed mussel species, the Carolina heelsplitter, was known to be present in York County (Table 2-13). However, the review team reviewed the literature and species summaries for these areas and found no evidence that any Federally listed aquatic species is likely to be found in the vicinity of the Lee Nuclear Station site (FWS 2010c). The NRC staff's correspondence to the FWS regarding Federally protected species is listed in Appendix F.

Carolina heelsplitter (*Lasmigona decorata*). Carolina heelsplitter is a Federally endangered aquatic species that may reside in rivers, creeks, or streams (FWS 2010c, d). South Carolina lists it as an endangered species, ranks it S1 (i.e., critically imperiled statewide because of extreme rarity or because of some risk factor(s) making it especially vulnerable to extirpation), and classifies it as a species of highest conservation priority (SCDNR 2012a). The global conservation status rank for the Carolina heelsplitter is G1, critically imperiled (NatureServe Explorer 2013). It is listed by the FWS as present in York County, South Carolina, which bounds the Broad River downstream of Ninety-Nine Islands Dam (FWS 2010c). The Carolina heelsplitter has not been located in the Broad River or its tributaries, but does occur within the Catawba River drainage (SCDNR 2005). Critical habitat has been designated only in Chesterfield, Edgefield, Greenwood, Kershaw, Lancaster, and McCormick Counties in South Carolina, none of which are associated with the proposed Lee Nuclear Station preconstruction or construction activities (67 FR 44501).

Additional Species of Ecological Importance

In addition to the species listed by the State as threatened or endangered, or ranked S1 to S3, additional species have been given priority for conservation in South Carolina by the SCDNR (SCDNR 2005). These species are considered ecologically important aquatic species. A list of ecologically important aquatic species associated with the Lee Nuclear Station site and transmission-line corridors is provided in Table 2-14.

Table 2-14. Ecologically Important Aquatic Species

Scientific Name	Common Name	Status
Fish		
Ameiurus brunneus	Snail Bullhead	Biological indicator ("moderate" conservation priority in South Carolina, SNR).[(a)] Captured by the SCDNR in 2000, 2001, and 2002 at all 11 of its Broad River sampling sites, including sites in the vicinity of the Lee Nuclear Station site.[(b)] One specimen was captured by Duke in 2006 near the proposed cooling-water-intake structure location, and 194 were captured just below Ninety-Nine Islands Dam.[(c)] Also found by the SCDNR in 2003 and 2004 in Thicketty Creek, a tributary to the Broad River that would be crossed by new transmission lines associated with Lee Nuclear Station.[(d)]

Table 2-14. (contd)

Scientific Name	Common Name	Status
Ameiurus platycephalus	Flat Bullhead	Biological indicator ("moderate" conservation priority in South Carolina, SNR).[a] Captured by the SCDNR in 2000, 2001, and 2002 at eight sites on the Broad River, including sites in the vicinity of the proposed new nuclear station.[b] Found by Duke in 2006 in one of the two backwater areas, near the proposed intake structure location, and just below Ninety-Nine Islands Dam.[c] Also found by the SCDNR in 2003 and 2004 in Thicketty Creek, a tributary to the Broad River that would be crossed by new transmission lines associated with Lee Nuclear Station.[d] Also captured by the SCDNR in 2010 in London Creek.[e]
Carpiodes velifer	Highfin Carpsucker	Biological indicator ("highest" conservation priority in South Carolina).[a] Possibly captured by the SCDNR in 2002 just below Cherokee Falls Dam and below Ninety-Nine Islands Dam.[b]
Cyprinella chloristia	Greenfin Shiner	Biological indicator ("moderate" conservation priority in South Carolina, S4).[a] Captured by the SCDNR in 2000, 2001, and 2002 at all 11 of its Broad River sampling sites, including sites in the vicinity of the Lee Nuclear Station site.[b] Three specimens were captured by Duke in 2006, below Ninety-Nine Islands Dam.[c] Also found by the SCDNR in 2003 and 2004 in Thicketty Creek, a tributary to the Broad River that would be crossed by new transmission lines associated with the Lee Nuclear Station.[d] Also captured in 2010 by the SCDNR in London Creek.[e]
Cyprinella labrosa	Thicklip Chub	Biological indicator ("moderate" conservation priority in South Carolina, SNR).[a] Captured by the SCDNR in 2000, 2001, and 2002 at all 11 of its Broad River sampling sites, including sites in the vicinity of the Lee Nuclear Station site.[b] Four specimens were captured by Duke in 2006 below Ninety-Nine Islands Dam.[c]
Cyprinella pyrrhomelas	Fieryblack Shiner	Biological indicator ("moderate" conservation priority in South Carolina, S4).[a] Six specimens were captured by Duke in 2006, below Ninety-Nine Islands Dam.[c]
Cyprinella zanema	Santee Chub	Biological indicator ("high" conservation priority in South Carolina, SNR).[a] Reported as captured in the Broad River in the vicinity of Cherokee Nuclear Station between 1974 and 1976.[f] Captured by the SCDNR in 2002, but only at one site on the Broad River between the Lockhart and Neal Shoals Dams.[b]
Etheostoma thalassinum	Seagreen Darter	Biological indicator ("high" conservation priority in South Carolina, SNR).[a] Captured by the SCDNR in 2000, 2001, and 2002 at six sites on the Broad River.[b] Species was never observed between the Cherokee Falls and Lockhart Dams. However, it was found by the SCDNR in 2003 and 2004 in Thicketty Creek, a tributary to the Broad River that would be crossed by new transmission lines associated with the Lee Nuclear Station.[d]
Hybopsis hypsinotus	Highback Chub	Biological indicator ("moderate" conservation priority in South Carolina, SNR).[a] Captured by the SCDNR in 2003 and 2004 in Thicketty Creek, a tributary to the Broad River that would be crossed by new transmission lines associated with the Lee Nuclear Station.[d] Also captured in 2010 by the SCDNR in London Creek.[e]

Table 2-14. (contd)

Scientific Name	Common Name	Status
Moxostoma pappillosum	V-lip Redhorse	Biological indicator ("moderate" conservation priority in South Carolina).[a] Captured by the SCDNR in 2001, at six sites on the Broad River, including sites in the vicinity of the Lee Nuclear Station site.[b] Two specimens were captured by Duke in 2006, just below Ninety-Nine Islands Dam.[c]
Notropis chlorocephalus	Greenhead Shiner	Biological indicator ("high" conservation priority in South Carolina).[a] Captured in 2010 by the SCDNR in London Creek.[e]
Percina crassa	Piedmont Darter	Biological indicator ("high conservation priority in South Carolina, SNR).[a] Captured by the SCDNR in 2000, 2001, and 2002 at 10 sites on the Broad River, including sites in the vicinity of the Lee Nuclear Station site.[b] Captured by Duke in 2006 only below Ninety-Nine Islands Dam.[c]
Mussels		
Elliptio angustata	Carolina lance	Biological indicator ("moderate" conservation priority in South Carolina).[a] A single live specimen was found by Duke in 2006, just below Ninety-Nine Islands Dam.[c]
Elliptio complanata complex	Eastern elliptio	Biological indicator ("moderate" conservation priority in South Carolina).[a] Found by the SCDNR in 2002, but only above Cherokee Falls Dam and below Parr Shoals Dam.[b] A single live specimen was found by Duke in 2006, just below Ninety-Nine Islands Dam.[c]

(a) Source: SCDNR 2005
(b) Source: Bettinger et al. 2003
(c) Source: Duke 2009c
(d) Source: Bettinger et al. 2006
(e) Source: SCDNR 2011b
(f) Source: Duke 2008a

2.4.2.4 Aquatic Ecology Monitoring

The NRC does not impose conditions of operation, including monitoring requirements, in the area of water quality. Regulation of water quality is implemented by a National Pollutant Discharge Elimination System (NPDES) permit issued by the EPA or the states (i.e., South Carolina). The NRC's role in water quality is limited to assessing aquatic impacts as part of its National Environmental Policy Act of 1969, as amended (NEPA) evaluation.

On August 15, 2011, Duke submitted its NPDES application to the SCDHEC. SCDHEC issued Duke an NPDES Permit (Permit No. SC0049140) on July 17, 2013, effective September 1, 2013 (SCDHEC 2013a). This permit outlines requirements for monitoring of aquatic ecological resources during operation of the proposed units.

Duke conducted several surveys of the aquatic resources that might be affected by building the proposed new nuclear units and a new supplemental water-supply reservoir. Early monitoring was completed in the 1970s, when Duke Power Company began building Cherokee Nuclear

Station Units 1, 2, and 3 (Duke Power Company 1974a; Duke 2008a; NRC 1975a). Initial sampling was performed between October 1973 and September 1974. Further ecological surveys were performed between September 1974 and December 1976 as a continuation of the initial 1-year baseline study.

As part of its program, Duke Power Company studied the Broad River, Ninety-Nine Islands Reservoir, two onsite creeks that were later impounded to form Make-Up Ponds A and B, respectively, and several tributaries to the Broad River. Biological communities studied included phytoplankton, periphyton, zooplankton, benthos, and fish.

Since the 1970s, phytoplankton, periphyton, and zooplankton populations have not been reassessed. The SCDNR has performed several recent relevant surveys of fish, mussels, and benthic macroinvertebrates in the Broad River basin (Bettinger et al. 2003, 2006; Bulak et al. 2000, 2001). The results of these surveys are included in the description of aquatic biota in Section 2.4.2.1, "Aquatic Communities of the Proposed Site."

In March, April, June, and October 2006, Duke made reconnaissance visits to the site (Duke 2009c). In June 2006, a meeting was held onsite with Duke and representatives from the USACE to tour the property and view wetlands and streams potentially within the USACE's regulatory jurisdiction. Also in 2006, Duke conducted a literature review and field study designed to characterize current populations of fish, macrobenthic biota, and mussels in the vicinity of the Lee Nuclear Station site (Duke 2008a). Standard operating procedures for benthic macroinvertebrates, as published by the North Carolina Department of Environment and Natural Resources, were used, including making seasonal corrections and using the Piedmont Criteria when appropriate (NCDENR 2006).

During March and September of 2008 and 2009, Duke surveyed London Creek for macroinvertebrates and fish (Derwort and Hall 2009; Coughlan 2009). An additional London Creek macroinvertebrate survey was conducted by Duke in a previously unsampled location in June 2009 (Derwort and Hall 2009), and an additional fish survey was completed by the SCDNR in May 2010 (SCDNR 2011b). The farm ponds in the vicinity of Make-Up Pond C also were surveyed by Duke in 2010 (Duke 2010d). No aquatic ecology monitoring is proposed during preconstruction and construction of the proposed Lee Nuclear Station Units 1 and 2 (Duke 2010e). The proposed new units will be designed to meet the Phase I, New Facility requirements in 40 CFR 125.80 to 89, under Track I. The EPA requirements meet the Clean Water Act 316(b) rules to verify there will be minimal increases in fish and benthic community impingement and entrainment for the new cooling-water intake structures. Monitoring required for proposed Units 1 and 2 to comply with Track I include biological monitoring for impingement and entrainment of commercial, recreational, and forage base fish and shellfish species as required by 40 CFR 125.87.

2.5 Socioeconomics

This section describes the socioeconomic baseline of the Lee Nuclear Station site. It describes the characteristics of the region surrounding the proposed site, including population demographics and density, and uses that data to form the basis for assessing the potential social and economic impacts from the building and operation of proposed Lee Nuclear Station Units 1 and 2. Unless otherwise specified, the information presented in this section is based on the Duke ER (Duke 2009c) and has been confirmed by the review team.

These impacts are for the region[(a)] surrounding the proposed site. This discussion emphasizes the socioeconomic characteristics of Cherokee and York Counties, although it considers the entire region within a 50-mi radius of the proposed site. These two counties constitute the economic impact area where the review team expects all noticeable economic impacts (e.g., employment, income effects, tax impacts) would occur. The scope of the socioeconomics review is guided by the magnitude and nature of the expected impacts of construction, maintenance, and operation of the proposed project and by those site-specific community characteristics that can be expected to be affected by these impacts. The review team concluded, after discussions with local officials in counties surrounding the proposed Lee Nuclear Station, that both construction and operations workers are likely to settle in several different counties in the region. However, due to the size of counties such as Spartanburg County, South Carolina and Gaston County, North Carolina, local officials presumed in-migrating construction workers for proposed Lee Nuclear Station Units 1 and 2 would not significantly impact them, and could easily be absorbed by, the community (Niemeyer 2008). Officials from Cleveland County, North Carolina, also stated they have excess capacity within their services, education, and housing to absorb in-migration (NRC and PNNL 2008).

The population data for the region are based on the 2010 U.S. Census Bureau (USCB) American Community Survey (ACS) 5-year data for 2006 through 2010 (USCB 2010a, b, c, d). In addition, the review team analyzed the economic, employment, and population trends for the region using additional USCB data sets and population projections from the North Carolina Office of State Budget and Management and the South Carolina State Budget and Control Board.

(a) For the purposes of the EIS, the relevant region is limited to that area necessary to include social and economic base data for (1) the county in which the proposed plant would be located, and (2) those specific portions of surrounding counties and urbanized areas (generally up to 50 mi from the Lee Nuclear Station site) from which the construction/operations workforce would be principally drawn, or that would receive stresses to community services by a change in the residence of construction/operations workers.

The analytical area is a 50-mi circle centered on the proposed power block and includes all or a portion of 23 counties in South and North Carolina. Table 2-15 identifies the counties and provides some summary geographic and demographic information for each county. Figure 2-19 shows a map of the analytical area.

Table 2-15. Population of Counties Within 50 mi of the Proposed Lee Nuclear Station

County	State	Population (2006–2010 ACS 5-Year Data)	Population Density per mi^2 (2010)
Burke	NC	90,912	179.3
Cabarrus	NC	178,011	492.1
Catawba	NC	154,358	387.1
Cleveland	NC	98,078	211.3
Gaston	NC	206,086	578.8
Henderson	NC	106,740	286.1
Iredell	NC	159,437	277.8
Lincoln	NC	78,265	262.7
McDowell	NC	44,996	102.1
Mecklenburg	NC	919,628	1755.5
Polk	NC	20,510	86.3
Rutherford	NC	67,810	120.2
Union	NC	201,292	318.7
Cherokee	SC	55,342	140.9
Chester	SC	33,140	57.1
Fairfield	SC	23,956	34.9
Greenville	SC	451,225	574.7
Lancaster	SC	76,652	139.6
Laurens	SC	66,537	93.2
Newberry	SC	37,508	59.5
Spartanburg	SC	284,307	351.9
Union	SC	28,961	56.3
York	SC	226,073	332.2

Source: 2006-2010 USCB ACS 5-Year Summary (USCB 2010e)

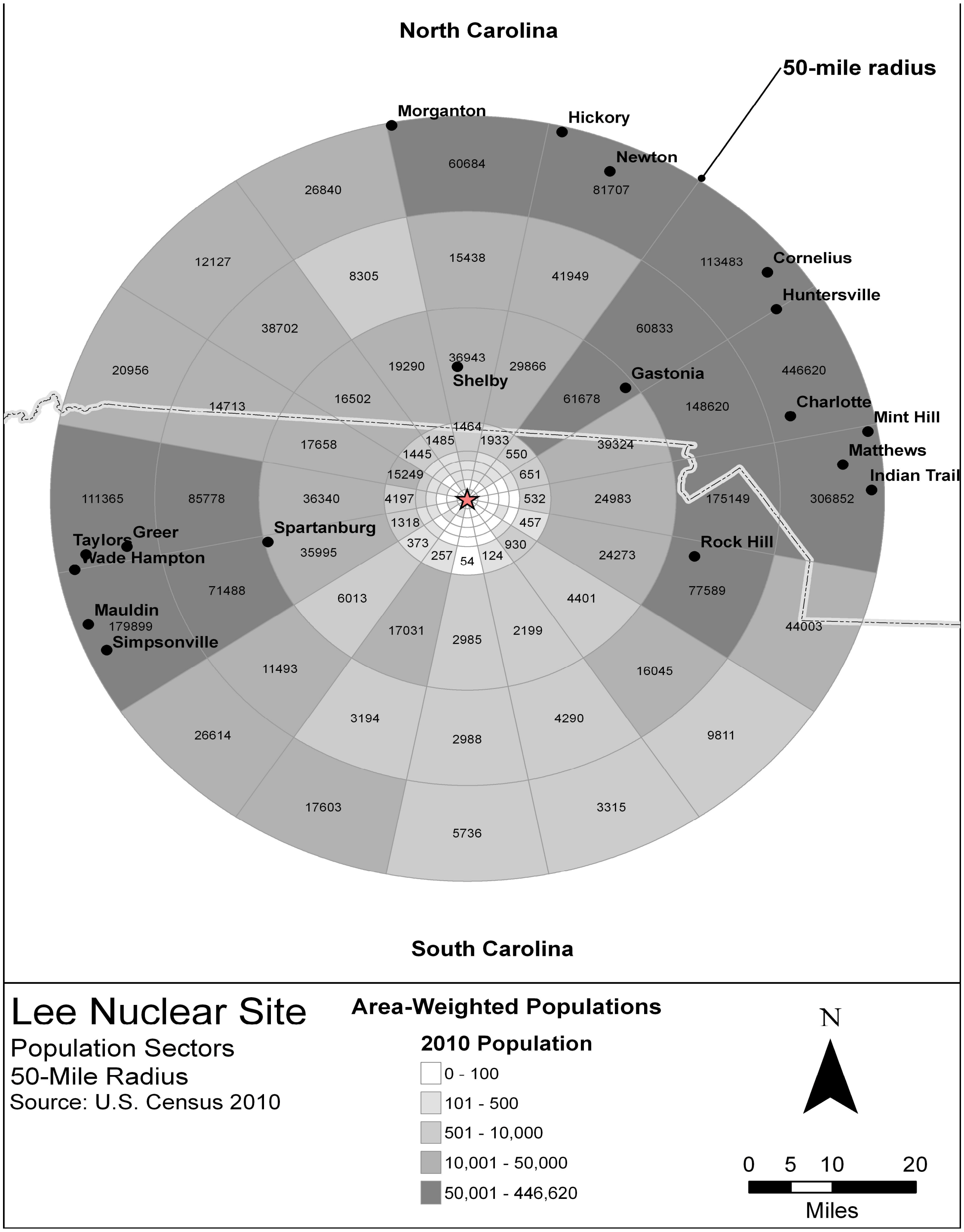

Figure 2-19. Estimated 2010 Population Within 50 mi of the Lee Nuclear Station Site (USCB 2011a)

2.5.1 Demographics

For the purposes of this analysis, the review team divided the total population within the analytical area into three major groups: residents, who live permanently in the area; transients, who may temporarily live in the area but have a permanent residence elsewhere; and migrant workers, who travel into the area to work and then leave after their job is done. Transients and migrant workers are not fully characterized by the U.S. Census, which generally captures only resident populations.

2.5.1.1 Resident Population

Figure 2-19 shows the area-weighted 2010 population estimates derived from county estimates that were based on the cohort-component method within 50 mi of the center point between proposed Lee Nuclear Station Units 1 and 2. The center of the circle in Figure 2-19 is the power block for the proposed Lee Nuclear Station, with concentric circles at 2, 4, 6, 8, 10, 16, 40, 60, and 80 km (1.24, 2.5, 3.7, 5, 6.2, 10, 25, 37, and 50 mi) from the center point between proposed Lee Nuclear Station Units 1 and 2. Population distribution is highest east-northeast and southwest of the Lee Nuclear Station site. Resident population data for the area surrounding the Lee Nuclear Station site indicate low population densities and a rural setting outside the cities and towns.

Based on USCB ACS 2010 Summary data, approximately 40,823 people live within 10 mi of proposed Lee Nuclear Station Units 1 and 2, resulting in a population density of 130 persons/mi^2. The closest residential cities to the proposed site are East Gaffney, South Carolina (7.5 mi northwest) and Blacksburg, South Carolina (5.8 mi north) (Duke 2009c, USCB 2011a). Their population estimates for the year 2009 were 2784 and 2007, respectively (USCB 2010e). The closest residence and business to the proposed Lee Nuclear Station are both on McKowns Mountain Road, approximately 0.99 and 0.80 mi away, respectively (Duke 2009c, 2013d).

The most populated city in the 50-mi region is Charlotte, North Carolina (population 705,896), located 40 mi northeast of proposed Lee Nuclear Station Units 1 and 2. Other large North Carolina cities in the 50-mi region include Gastonia (population 70,709), which is 24 mi northeast and Hickory (population 39,932), which is 49 mi north-northeast. The largest cities in South Carolina in or near the 50-mi region are Rock Hill (population 63,108), which is 29 mi east-southeast; Greenville (population 57,821), which is 52 mi west-southwest; and Spartanburg (population 37,488), which is 25 mi west-southwest (USCB 2010e). These towns provide shopping and services to the local region.

Table 2-16 describes population information for Cherokee and York Counties and South Carolina from 1970 through 2010. The table also provides estimated population projections through 2035 based on estimates developed by the South Carolina's Office of Research & Statistics. Although the review team has updated its demographic data to more recent information, the projections in Table 2-16 display future projections of population from the

South Carolina Budget and Control Board (SCBCB), which performs its own independent estimates. These estimates provide the basis for a number of analyses in this EIS that evaluate future impacts. The review team determined that the estimates in Table 2-16 are consistent with the demographic data in the 2006-2010 ACS 5-Year Summary data. Therefore, the data in Table 2-16 are still valid and no update is required for the purposes of this EIS. Data in Table 2-16 indicate that Cherokee and York Counties have been growing and are projected to continue growing for the foreseeable future.

Table 2-16. Population Growth in Cherokee and York Counties

	Cherokee County	York County	South Carolina
1970	36,669	85,216	2,590,516
1980	40,983	106,720	3,122,814
1990	44,506	131,497	3,486,703
2000	52,537	164,614	4,012,012
2005	53,545	189,398	4,254,989
2010	55,800	218,990	4,549,150
Projections			
2015	58,780	235,930	4,784,700
2020	61,760	252,860	5,020,400
2025	64,760	269,790	5,256,080
2030	67,350	287,970	5,488,460
2035	70,170	305,440	5,722,720

Source: SCBCB 2006a, b and SCBCB 2010

2.5.1.2 Transient Population

Transients include people who work in or visit large workplaces, schools, hospitals and nursing homes, correctional facilities, hotels and motels, and at recreational areas or special events where there may be seasonal and workday variations in population. The 50-mi region includes a number of facilities, venues, and recreational areas that attract transient populations in substantial numbers. Outdoor recreation opportunities in the 50-mi region include a number of parks and water-based and forest-based recreational opportunities. These locations provide a range of activities, including fishing, camping, biking, picnicking, and hiking.

Shopping and natural attractions in the area attract thousands of visitors each year. Most of the transient population near the Lee Nuclear Station site is attributed to shoppers at the Gaffney Premium Outlets in Gaffney, South Carolina. Gaffney Premium Outlets has an average of 7671 visitors a day, for a total of 2.8 million visitors per year. Natural attractions are the second largest transient population contributor within the 50-mi region of the Lee Nuclear Station. The closest park is Kings Mountain State Park (7.8 mi northeast), which averages 548 daily visitors. Kings Mountain State Park is adjoined at its northwest border with Kings Mountain National

Military Park (12 mi northwest), which averages 1452 daily visitors and Cowpens National Battlefield (18 mi northwest), which averages 573 daily visitors. A portion of Francis Marion and Sumter National Forests are within the Lee Nuclear Station 50-mi region and accounts for approximately 3000 daily visitors. Other attractions include Christmastown, USA, with over 600,000 visitors per year and the City of Charlotte, North Carolina, where visitors travel for vacation and business purposes. Table 2-17 lists the major contributors to the transient population and Figure 2-20 shows their location relative to the Lee Nuclear Station site (Duke 2009c).

2.5.1.3 Migrant Labor

The USCB defines a migrant laborer as someone who is working seasonally or temporarily and moves one or more times from one place to another for seasonal or temporary employment. The 2007 Census of Agriculture indicates the migrant population within 50 mi of the proposed Lee Nuclear Station is low.[a] As a part of the census, farm operators were asked whether any hired or contract workers were migrant workers, defined as a farm worker whose employment required travel that prevented the worker from returning to a permanent residence the same day. Migrant laborers tend to work short-duration (usually less than 150 days), labor-intensive jobs harvesting fruits and vegetables. Only 8 of 416 total farms in Cherokee County and 13 of 1036 farms in York County employ migrant workers (USDA 2009a).

2.5.2 Community Characteristics

The Lee Nuclear Station site is in a quiet, rural area with two small cities located within 16 km (10 mi) of the site. The Lee Nuclear Station site is located in an unincorporated part of Cherokee County. As stated earlier, most impacts are expected to occur within Cherokee and York Counties. The review team realizes some workers may choose to live outside of Cherokee and York Counties. However, the review team expects any impacts occurring outside of these two counties would be negligible due to the large population of those outside counties relative to the size of the workforce.

Approximately 25 percent of the population in the 50-mi region around the Lee Nuclear Station site is minority, primarily black. In 2010, approximately 14 percent of the households in counties within the region had incomes below the poverty level (USCB 2010e). In 2000, Cherokee and York Counties had 13.9 and 10 percent of individuals living under the poverty level, respectively (USCB 2000a, b). However, 2006-2010 ACS estimates indicated that the number of individuals living below the poverty level in Cherokee and York Counties has increased to 19.5 and 12.5 percent, respectively (USCB 2010e). Racial characteristics and income levels for Cherokee and York Counties are described in Table 2-18.

(a) During the preparation of this final EIS, the latest U.S. Department of Agriculture Census of Agriculture was still the 2007 study referenced in the draft EIS.

Table 2-17. Major Contributors to Transient Population

Name	Average Daily Transients[(a)]	Peak Daily
Christmastown USA	23,077	
Charlotte Knights Baseball Club		10,000
Gaffney Premium Outlets	7671	
Sumter National Forest	7268	
Daniel Stowe Botanical Garden	6000	
South Carolina Peach Festival		2500
Christmas on Limestone		2000
Kings Mountain National Military Park	1452	
Spartanburg Museum of Art	1000	
Crowders Mountain State Park	930	
Mint Museum of Art	750	
Chimney Rock Park	684	
Cowpens National Battlefield	573	
Kings Mountain State Park	548	
South Mountain State Park	527	
Roper Mountain Science Center	515	
Schiele Museum of Natural History	500	
Hollywild Animal Park	411	
Croft State Natural Area	345	
Hatcher Garden and Woodland Preserve	305	
Charlotte Museum of History	113	
Landsford Canal State Park	82	
Chester State Park	64	
Paris Mountain State Park	52	
Charlotte Steeplechase	41	
Gaffney Visitor's Center	35	
Musgrove Mill State Historic Site	28	
Spartanburg County Historical Museum	15	
Rose Hill Plantation State Historic Site	15	

Source: Duke 2009c

(a) Daily transients are peak numbers, when available. Otherwise, a daily average derived from the annual total is used.

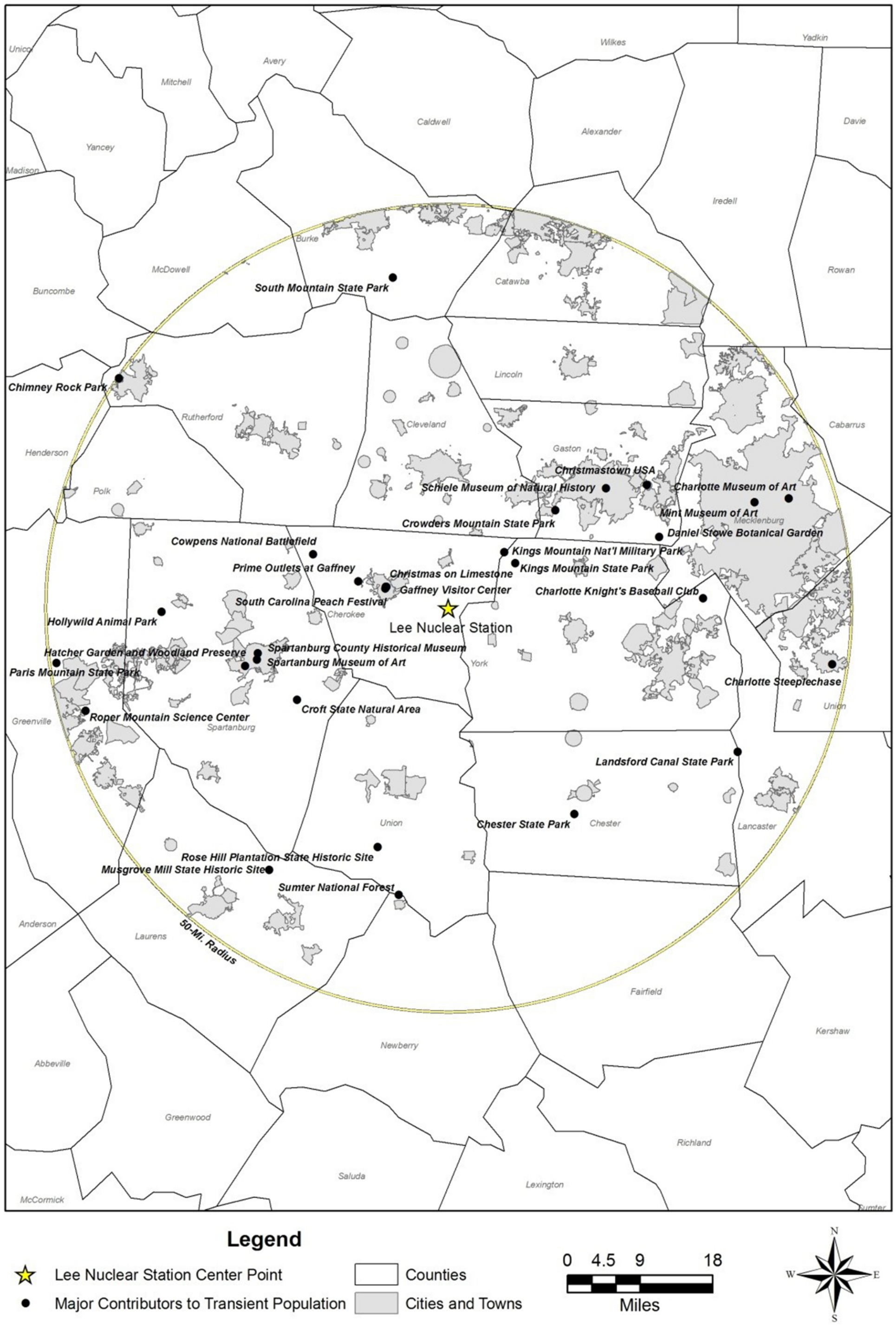

Figure 2-20. Location of Major Contributors to Transient Population (Duke 2009c)

Table 2-18. Minority and Low-Income Populations

	2000 Census		2010 ACS 5-Year Estimate	
	Percent Minority	**Percent Below Poverty**	**Percent Minority**	**Percent Below Poverty**
United States	24.9	12.4	35.3	13.8
South Carolina	32.8	14.1	35.5	16.4
Cherokee County	23.1	13.9	25.4	19.5
York County	22.8	10	26.7	12.5

Sources: USCB 2000a, b, c and USCB 2010e

Further discussion of the demographic composition of the analytical area is provided in Section 2.6. The remainder of this section focuses primarily on Cherokee and York Counties and addresses community characteristics, including the regional economy, transportation networks and infrastructure, taxes, aesthetics and recreation, housing, community infrastructure and public services, and education.

2.5.2.1 Economy

The principal economic centers in Cherokee and York Counties are Gaffney, South Carolina (Cherokee County); Blacksburg, South Carolina (Cherokee County); York, South Carolina (York County); Hickory Grove, South Carolina (York County); and Rock Hill (York County). In addition, because Charlotte, North Carolina (Mecklenburg County) is the largest economic center within the Lee Nuclear Station site 50-mi region, it is included in this section. Table 2-19 details employment by industry for Cherokee, York, and Mecklenburg Counties.

Local officials in Cherokee County, South Carolina, described the local economy as diverse and stable, despite the recent closure of textile mills, and believe the county's location off of I-85 near Charlotte positions it fairly well for industrial growth (NRC and PNNL 2008). Cherokee County has a diverse industrial base. Though manufacturing jobs declined 29.5 percent between 1994 and 2004, they remained the largest employment base in Cherokee County. Services, government, retail, and construction are the other major significant employment sectors in Cherokee County. Wholesale trade increased 72.9 percent between 1994 and 2004. In addition, the finance, insurance, real estate, transportation, and utilities sectors made considerable gains. Although no single employer dominates the county, the largest employers in Cherokee County are Nestlé USA (food production), Sander Brothers (construction), and Timken Company (machining), each with more than 1000 employees (Duke 2009c).

Table 2-19. Employment by Industry in the Economic Impact Area 2008

Year	Cherokee County 2008	York County 2008	Mecklenburg County 2008	Total 2008
Total employment	25,603	102,924	723,770	852,297
Wage and salary employment	21,219	81,488	605,422	708,129
Proprietors employment	4384	21,436	118,348	144,168
Farm	408	1339	481	2228
Agricultural services, forestry, fishing, and other	(D)	262	304	(NA)
Mining	(D)	91	651	(NA)
Construction	1895	6356	45,781	54,032
Manufacturing	6351	10,289	36,458	53,098
Transportation and utilities	1411	4085	(D)	(NA)
Wholesale trade	729	4696	42,612	48,037
Retail trade	2691	10,686	65,885	79,262
Finance, insurance, and real estate	1161	10,100	105,495	116,756
Services	7579	42,245	324,106	373,930
Government	2658	12,775	69,063	84,496

Source: BEA 2010
(D) = did not disclose
(NA) = not applicable

Currently, only 4 percent of the York County population works in the textile industry, compared to about 40 percent in the 1960s. York County has increased its manufacturing employment through industries such as plastics and machinery, mainly on the east side of the county. Most of the population in York County lives on the east side of the county around Rock Hill, which serves as a bedroom community to Charlotte, and along the North Carolina border near the I-77 and I-85 corridors (NRC and PNNL 2008).

Table 2-20 shows the size of the workforce, the number of workers employed, and the unemployment rates for Cherokee and York Counties for the 2007–2009 period. Recently, unemployment in the economic impact area has risen significantly because of economic conditions similar to those seen throughout the country associated with the economic downturn.

Table 2-20. Employment Trends for Cherokee and York Counties

	Cherokee County			York County		
	2007	2008	2009	2007	2008	2009
Labor force	25,220	25,567	26,063	104,215	107,789	112,094
Employed	23,521	23,228	21,782	98,652	100,159	96,185
Unemployed	1699	2339	4281	5563	7630	15,909
Unemployment rate (%)	6.7	9.1	16.4	5.3	7.1	14.2

Source: BLS 2011a

Table 2-21 shows median family income information covering the economic impact area based on the 2000 census and 2010 Housing and Urban Development estimates. Family incomes in Cherokee County grew at the same rate as the state average. However, family incomes in York County grew at a slower rate and appear to be noticeably lower than South Carolina as a whole. Family income in the economic impact area and in South Carolina as a whole grew at a slower rate than the rest of the country.

Table 2-21. Annual Median Family Income (Current Dollars) by County for the Economic Impact Area

County	2000 Median Family Income	2010 Median Family Income	2000 to 2010 Percent Change	2010 Index Versus South Carolina	2010 Index Versus United States
Cherokee County	39,393	49,600	25.9	0.890	0.770
York County	55,178	67,200	21.8	1.206	1.043
South Carolina	44,227	55,700	25.9	1.000	0.865
United States	50,046	64,400	28.7	1.156	1.000

Source: HUD 2011a, b, c

2.5.2.2 Taxes

South Carolina imposes a 6 percent sales and use tax on goods and certain services. Counties may impose an additional 1 percent local sales tax if voters within the county approve the tax. Both Cherokee and York Counties have a 1 percent local sales tax for a total tax of 7 percent (SCDOR 2008). Property tax is assessed on all real and personal property in South Carolina. A millage rate is applied to the assessed value of the property (4 percent for residences) to determine the tax. The average millage rate for South Carolina is 289 mills (0.289). The recently passed South Carolina Property Tax Relief law means homeowners are exempt from school property taxes for the first $100,000 of the value of their home (Carolina Living 2008).

Duke will pay all property taxes to Cherokee County. In 2007, Duke paid Cherokee County approximately $69,000 in property taxes (0.16 percent of Cherokee County 2007 property tax and fee-in-lieu revenue) for the Lee Nuclear Station site (Duke 2008f).

Table 2-22 identifies taxes collected by Cherokee County from 2002 to 2006. Based on ordinance 2005-20, passed by County Council of Cherokee County, South Carolina, Duke is entitled to make fee-in-lieu of tax payments, provided that the overall investment in the project is at least $2 billion (Duke 2008f). As part of this agreement, Duke would make fee-in-lieu payments at a rate of 2 percent of the taxable property value for the first 30 years of operation (Duke 2009c).

Table 2-22. Cherokee County Tax Collections by Category

	Fee Transfers From Other Counties - 1% Money, $	Fee-in-Lieu of Tax Collected, $	Penalties, Interest, and Costs on Collected Property Taxes, $	Delinquent Collections - Without Penalties or Interest, $	Motor Vehicle Collections, $	Current Collections - Without Penalties or Reimbursements, $
2002						
County	0.00	1,231,128.52	169,738.65	664,143.04	1,995,220.67	7,083,993.16
School	0.00	2,607,388.24	183,883.25	1,311,420.37	3,931,516.77	13,672,756.77
Special	0.00	207,768.94	9,524.74	55,571.29	142,851.41	498,875.48
Total	0.00	4,046,285.70	363,146.64	2,031,134.70	6,069,588.85	21,255,625.41
2003						
County	4,243.33	1,417,908.25	240,205.44	929,926.36	1,785,532.02	7,780,398.55
School	0.00	3,235,888.12	328,257.17	1,888,421.47	3,893,978.85	16,854,809.33
Special	0.00	254,056.93	12,918.13	68,364.02	141,620.58	567,064.33
Total	4,243.33	4,907,853.30	581,380.74	2,886,711.85	5,821,131.45	25,202,272.21
2004						
County	19,166.01	1,376,188.06	216,813.68	867,955.81	1,661,358.30	7,544,611.08
School	40,377.37	3,111,527.02	206,252.97	1,705,804.32	3,739,884.99	15,736,809.56
Special	0.00	259,953.57	8,193.25	65,020.01	136,704.07	602,590.14
Total	59,543.38	4,747,668.65	431,259.90	2,638,780.14	5,537,947.36	23,884,010.78
2005						
County	10,193.98	1,427,082.79	196,324.28	547,498.98	1,632,465.75	7,579,880.76
School	20,633.50	3,227,452.40	195,265.89	1,071,827.43	3,687,255.20	15,808,717.33
Special	0.00	257,221.12	7,487.12	37,348.59	137,299.68	622,320.12
Total	30,827.48	4,911,756.31	399,077.29	1,656,675.00	5,457,020.63	24,010,918.21
2006						
County	12,591.67	1,379,273.00	182,978.03	731,775.07	1,652,862.01	7,946,774.90
School	24,881.52	2,924,662.06	170,362.44	1,546,035.73	3,618,979.73	15,094,772.93
Special	0.00	253,820.21	7,058.43	57,968.47	140,397.01	610,775.90
Total	37,473.19	4,557,755.27	360,398.90	2,335,779.27	5,412,238.75	23,652,323.73

Source: Duke 2009c

Total 2009 taxes for Make-Up Pond C land were $68,869. Cherokee County will likely reassess the property as part of the Lee Nuclear Station site; however, this has not occurred so the reassessed value is unknown (Duke 2010c). In addition, it has not been decided if the Make-Up Pond C land will be included in the fee-in-lieu agreement.

2.5.2.3 Transportation

The transportation network for the Lee Nuclear Station site includes Federal and State highways, one primary freight rail service, and two primary commercial passenger airports. The Lee Nuclear Station site cannot be accessed by barge due to downstream dams.

Roads

Figure 2-21 illustrates the road network in Cherokee and York Counties and the surrounding region. I-85 is the closest highway to the Lee Nuclear Station site and runs from Spartanburg, South Carolina, through Cherokee County up to Gastonia, North Carolina. I-77 runs north to south through eastern York County from Rock Hill, South Carolina, and up to Charlotte, North Carolina. Workers in York County could use one of four South Carolina State Highways (i.e., SC 5, SC 55, SC 97, or SC 211) to gain access to the Lee Nuclear Station site. Currently, SC 5 is undergoing improvements that will allow for better access to the site from York County. Those commuting from Cherokee County could use one of three South Carolina State Highways (i.e., SC 5, SC 105, or SC 329). Access to the site is only available on McKowns Mountain Road (also known as County Road 13) on the southern side of the proposed site. Currently, about 950 vehicles travel McKowns Mountain Road between SC 105 and the end of the road everyday (Duke 2009c). According to Duke, there are approximately 74 property addresses for McKowns Mountain Road.

Air

Charlotte Douglas International Airport is located 34 mi northeast of the Lee Nuclear Station site. As of June 2006, 146 aircraft were based at Charlotte Douglas International Airport with an average of 1372 operations a day (47 percent commercial). Twenty-three aircraft are based at the Greenville-Spartanburg International Airport, approximately 41 mi west-southwest of the Lee Nuclear Station site. As of June 2006, Greenville-Spartanburg International Airport conducted 182 operations a day (11 percent commercial). Approximately 6 mi north of the Lee Nuclear Station site is a 25-ft square helipad at the Milliken and Company Heliport. No aircraft are based at the heliport (Duke 2009c).

Rail

The Southern Railroad Company owns and operates a small railroad spur that passes within a 5-mi radius of the proposed site and averages two freight trains per day. Southern Railroad Company also runs a major railroad line approximately 5.5 mi from the site that runs from Atlanta, Georgia to Charlotte, North Carolina and eventually to New York City, New York and New Orleans, Louisiana. This is primarily a freight line, with the exception of one passenger Amtrak Crescent train, and runs through downtown Gaffney and Blacksburg with an average of 22 trains per day. An abandoned railroad spur connects the main line running through Gaffney to the site. Duke plans to reactivate this railroad spur (Duke 2009c).

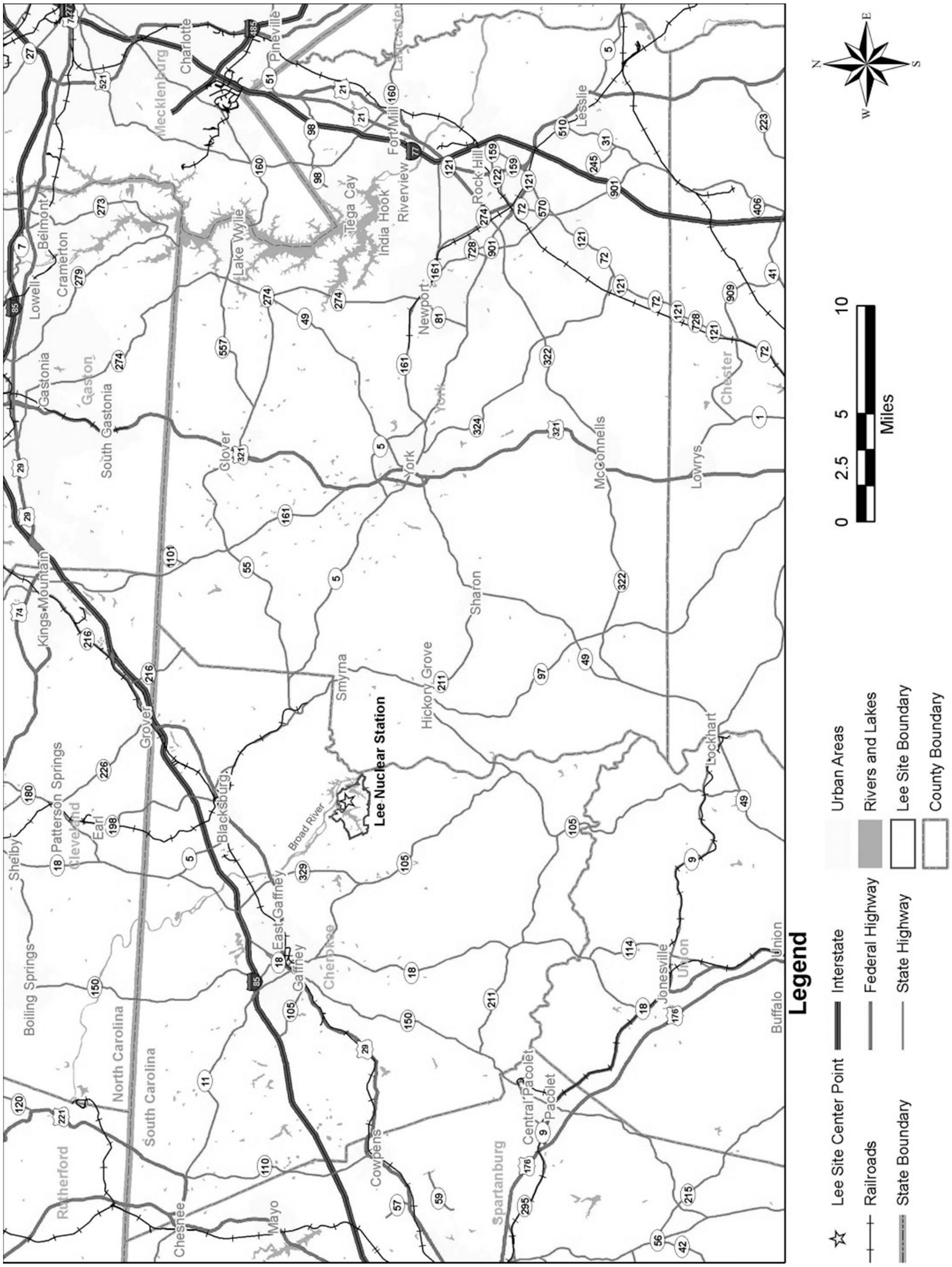

Figure 2-21. Transportation Network in Cherokee and York Counties (Duke 2009c)

The Southeast High-Speed Rail Corridor is proposed to run through this area on the existing tracks from Atlanta, Georgia, to Charlotte, North Carolina. This line would carry more than 1.6 million passengers annually (Duke 2009c).

Waterways

Proposed Lee Nuclear Station Units 1 and 2 are located near the Broad River, approximately 1 mi north of Ninety-Nine Islands Dam. According to the SCDNR, north of the site, the river is considered a State navigable water and is subject to permitting requirements pursuant to South Carolina R.19-450 under the State Navigable Waters Act (SCDNR 2008a). The section between the dam and the confluence with the Pacolet River is considered a State Scenic River.

2.5.2.4 Aesthetics and Recreation

Cherokee County is considered a Piedmont region, characterized by rolling hills, numerous tributaries, and, especially in the southeast, iron-rich red clay once hidden by ample deposits of topsoil. The county is entirely drained by the Broad River and its basin. Elevations at the Lee Nuclear Station site range from 437 to 816 ft above MSL. Original construction is not visible from surrounding areas.

Cherokee County contains 14 reservoirs and 1 lake, all with the potential to be used for various recreational activities, including hiking, fishing, and recreational swimming. Ninety-Nine Islands Reservoir is the closest to the Lee Nuclear Station site, directly adjacent to the eastern site boundary. Three recreational areas are identified on Ninety-Nine Islands Reservoir: Cherokee Ford Recreation Area; Pick Hill boat access; and an area on the east bank just south of the dam that has a canoe portage, tailrace fishing area, and boat ramp. Another public body of water near the Lee Nuclear Station site is Lake Cherokee, which is approximately 2 mi from the western site boundary (Duke 2009c).

Hunting, fishing, and wildlife watching in the region are recreational activities enjoyed by the public. These activities attract approximately 705,000 outdoor enthusiasts per year (Duke 2009c). Other recreational activities in the Lee Nuclear Station 50-mi region include local, State, and national park visitation, shopping, and community events. A list of recreational places and events are listed in Table 2-17, shown in Figure 2-20 and discussed in Section 2.5.1.2.

The closest park is Kings Mountain State Park (7.8 mi northeast) and Kings Mountain National Military Park, which adjoins the Kings Mountain State Park along its northwest border. Other nearby tourist attractions are Cowpens National Battlefield in Chesney, South Carolina; Gaffney Premium Outlets in Gaffney, South Carolina; and Sumter National Forest, located south of the Lee Nuclear Station site (Duke 2009c).

2.5.2.5 Housing

Many of the proposed Lee Nuclear Station Units 1 and 2 construction and operations workers are projected to live in Cherokee and York Counties in South Carolina, due to their proximity to the site. Cherokee County does not have any zoning or growth restrictions; however, York County has implemented a "smart growth" policy to prevent urban sprawl. There are boundaries for urban areas; however, it is still fairly easy to develop land for other uses, such as residential use. The proposed Lee Nuclear Station 50-mi region encompasses residential areas in and near cities and towns, smaller communities, and farms. Rental property is scarce in rural areas, but available in larger areas (e.g., Gaffney, East Gaffney, and Blacksburg, South Carolina). The majority of residents in the vicinity of the Lee Nuclear Station site are clustered in residential neighborhoods in the aforementioned cities. Outside the city limits, residents live in isolated, single-family homes or mobile homes (Duke 2009c). The median value for owner-occupied housing units in 2010 in Cherokee County was $82,700 and in York County was $158,900. The value for South Carolina was $134,100 (USCB 2010e).

Table 2-23 provides the number of housing units and vacancies for Cherokee and York Counties, the two counties where the review team expects Lee Nuclear Station site employees to reside. According to 2010 ACS, a total of 113,850 housing units are in the two counties. The average vacancy rate was 9.7 percent, with Cherokee County having the higher vacancy rate of the two counties and York County having the larger absolute number of vacant units (USCB 2010e).

Table 2-23. Regional Housing Information by County

County	Total Housing Unit	Occupied	Owner Occupied	Renter Occupied	Vacant Housing	Percent Vacancy
Cherokee	23,825	20,975	14,360	6615	2850	12.0
York	90,025	81,826	58,939	22,887	8199	9.1
Total	**113,850**	**102,801**	**73,299**	**29,502**	**11,049**	**9.7**

Source: USCB 2010e

2.5.2.6 Public Services

Water Supply and Waste Treatment

Duke is expected to obtain potable water for the Lee Nuclear Station site from the Draytonville Water System, which purchases its water from the City of Gaffney (Duke 2009c). Wastewater treatment will be handled by the Broad River Waste Water Treatment Plant (Duke 2010h). Groundwater use in this vicinity is limited to mainly individual residences and is not expected to be used at the Lee Nuclear Station (Duke 2009c).

There are two drinking-water-treatment plants in Cherokee County: the Victor Gaffney Plant and the Cherokee Plant, both of which are operated by the City of Gaffney. Victor Gaffney is the largest, with a maximum capacity of 12 Mgd. The Cherokee Plant, which completed upgrades in May 2007, has a capacity of 6 Mgd. The county currently draws approximately 8 Mgd. This water is used for local consumption and is sold to municipalities like Blacksburg, South Carolina, for resale and to water districts like Draytonville Water District. According to officials, water systems in Cherokee County are generally not operating at or near capacity (Duke 2009c).

Table 2-24 provides information on both drinking-water-treatment plants and the wastewater-treatment facilities in Cherokee County. The City of Gaffney operates both wastewater plants in Cherokee County. The Clary Plant is the largest with a maximum capacity of 5 Mgd and operates at a 60 percent capacity. The second plant is the Broad River Plant with a maximum capacity of 4 Mgd and is operating at a 40 percent capacity. The rural areas of Cherokee County use septic systems (Duke 2009c).

The largest provider of water in York County is the City of Rock Hill with a capacity of 26 Mgd and a current usage of approximately 22 Mgd. Most of York County receives its water from the City of Rock Hill, with a small portion from Charlotte, North Carolina; however, a majority of the western part of the county is on well or septic systems (NRC and PNNL 2008). York County has three wastewater-treatment plants with a combined capacity of 26 Mgd and current usage of 20.7 Mgd (EPA 2008b).

Table 2-24. Public Wastewater-Treatment and Water-Supply Facilities in Cherokee County

	Max Capacity (Mgd)	Utilization (Mgd)
Wastewater treatment		
Clary Plant	5	3
Broad River	4	1.6
Drinking water treatment		
Victor Gaffney Plant	12	5.28
Cherokee Plant	6	2.72

Source: Duke 2009c

Police, Fire, and Medical

The Cherokee County Sheriff's Department employs 42 officers and has police jurisdiction for all of Cherokee County, including the area immediately around the proposed Lee Nuclear Station. The Draytonville Volunteer Fire Department has firefighting jurisdiction for all of Cherokee County, including the area immediately around the proposed Lee Nuclear Station site. Gaffney and Blacksburg have the only other police departments in the county and employ approximately 40 and 14 full-time officers, respectively (FBI 2006). According to the U.S. Fire Administration's National Fire Department Census Database, Cherokee County has 12 fire departments with more than 350 volunteer and paid firefighters, but only Gaffney Fire Department employees are fully paid (USFA 2009). Cherokee County officials consider police and fire protection adequate, but expansion and facility upgrades may be needed to accommodate future population growth. Funding does exist in the county budget, however, to quickly increase staffing if needed (NRC and PNNL 2008). The York County Sheriff's Department employs 125 officers and has jurisdiction throughout York County. Rock Hill, York, Fort Mill, Tega Cay, and Clover all have city police departments (FBI 2006). York County also has 14 voluntary fire departments with approximately 1000 firefighters (both volunteer and career) (USFA 2009). Table 2-25 and Table 2-26 present police and fire statistics for Cherokee and York Counties.

Table 2-25. Police Departments in Cherokee and York Counties, 2005

	Total Law Enforcement Employees	Total Officers	Total Civilians
Cherokee County	90	42	48
Gaffney	44	40	4
Blacksburg	15	14	1
York County	262	125	137
Rock Hill	150	107	43
York	33	26	7
Fort Mill	31	25	6
Tega Cay	17	13	4
Clover	15	11	4

Source: FBI 2006

Table 2-26. Fire Statistics for Cherokee and York Counties

	Number of Fire Departments	Number of Stations	Career Firefighters	Volunteer Firefighters
Cherokee County	12	16	45	309
York County	14	24	110	973

Source: USFA 2009

Cherokee County's only hospital, Upstate Carolina Medical Center in Gaffney, has 125 beds and nearly 100 medical staff members. The current occupancy rate is 38 percent (Duke 2009c). Two nursing home facilities operate in Gaffney: Brookview Healthcare Center, which has 132 beds and 150 employees; and Peachtree Healthcare Center, which has 145 beds and 165 employees (Duke 2009c). The Cherokee County Health Department, also located in Gaffney, provides general medical services to between approximately 17,000 and

20,000 individuals per year. York County's primary hospital, Piedmont Medical Center in Rock Hill, has 288 beds. Rock Hill is also home to the York County Health Department (AHD 2013). Social services (e.g., adoptions, child protective services, family nutrition programs, foster care services, foster home and group home licensing, and food stamps) are overseen by the South Carolina Department of Social Services (Duke 2009c). Local officials stated the current level of health services is adequate, but funding is available in the budget to increase services if needed (NRC and PNNL 2008).

2.5.2.7 Education

Within the Lee Nuclear Station 50-mi region, 57 school districts with 799 schools supported a 2004 to 2005 student enrollment of 526,675 students (Duke 2009c). Five school districts in Cherokee and York Counties supported a 2008 to 2009 student enrollment of 48,200 students. One school district is in Cherokee County (Cherokee County Schools) and four are in York County (York County District 1, Clover School District, York County District 3, and Fort Mill School District). Two private schools in Cherokee County serve 150 students and eight private schools in York County serve approximately 1500 students (NCES 2008). The two school districts most likely to be affected by construction and operation of proposed Lee Nuclear Station Units 1 and 2 are Cherokee County and York County District 1. Table 2-27 provides school enrollment numbers for York and Cherokee Counties for the 2008 to 2009 school year.

For the 2008 to 2009 school year, Cherokee County Schools had 9360 enrolled students in 19 schools. A new primary school in Blacksburg was completed in 2006, and additions and renovations were completed at two other schools. Cherokee County passed a $45 million bond issue to fund stadium upgrades at two high schools and classroom additions and renovations at other schools (Duke 2009c). School officials reported $100 million worth of building construction and renovations in the past 10 years. In addition, 185 teachers have been hired, but only 100 additional students have enrolled (NRC and PNNL 2008).

Table 2-27. Number of Public Schools, Students, and Student/Teacher Ratios in Cherokee and York Counties for 2008-2009

	Number of Schools	Student Population	Student/ Teacher Ratio
Cherokee County			
Cherokee Independent School District	19	9360	14.8
York County			
York County District 1	8	5286	15.3
Clover School District	9	6445	16.2
York County District 3	28	17,664	16.5
Fort Mill School District	10	9445	14.5

Source: NCES 2010a, b

York County District 1, which covers most of the western portion of York County, is the largest district in the county based on geography but the smallest based on population. York County District 1 has a total enrollment of 5286 students in eight schools, three of which are over capacity; however, the district is undergoing construction and renovations, after which capacities should not be a problem for approximately 15 years (NRC and PNNL 2008). Local school officials estimated that Hickory Grove-Sharon Elementary would be impacted the most by construction of the proposed Lee Nuclear Station. Currently, Hickory Grove has an enrollment of 400 students but a capacity for 600 (NRC and PNNL 2008).

The Lee Nuclear Station 50-mi region is home to 33 two-year and four-year colleges and universities with a total student enrollment of more than 98,145. Limestone College in Gaffney, which has an enrollment of 700 students, is the closest college to the proposed site (Duke 2009c).

2.6 Environmental Justice

Environmental justice refers to a Federal policy established under Executive Order 12898 (59 FR 7629), which requires each Federal agency to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority or low-income populations.[a] The Council on Environmental Quality has provided guidance for addressing environmental justice (CEQ 1997). Although it is not subject to the Executive Order, the Commission has voluntarily committed to undertake environmental justice reviews. On August 24, 2004, the Commission issued its policy statement on the treatment of environmental justice matters in licensing actions (69 FR 52040). The review team's environmental justice analysis is guided by the NRC's ESRP and the additional guidance document, Revision 1 of *Addressing Construction and Preconstruction Activities*, *Greenhouse Gas Issues*, *General Conformity Determinations*, *Environmental Justice*, *Need For Power*, *Cumulative Impact Analysis*, *and Cultural/Historical Resources Analysis Issues in Environmental Impact Statements* (NRC 2011a).

This section describes the existing demographic and geographic characteristics of the proposed site and its surrounding communities. It offers a general description of minority and low-income populations within the region surrounding the Lee Nuclear Station site. The characterization in this section forms the analytical baseline from which potential environmental justice effects would be made. The characterization of populations of interest includes an assessment of "populations of particular interest or unusual circumstances" (NRC 2000a), such as minority

(a) Minority categories are defined as the following: American Indian or Alaskan Native; Asian; Native Hawaiian or other Pacific Islander; Black races; or Hispanic ethnicity; "other" may be considered a separate minority category. Low income refers to individuals living in households meeting the official poverty measure. To see the U.S. Census definition and values for 2000, visit the U.S. Census website at http://ask.census.gov/.

communities exceptionally dependent on subsistence resources or identifiable in compact locations, such as Native American settlements.

The racial population is expressed in terms of the number and/or percentage of people that are minorities in an area, and, in this discussion, the sum of the racial minority populations is referred to as the aggregate racial minority population. Persons of Hispanic/Latino origin are considered an ethnic minority and may be of any race. The review team did not include Hispanics in its aggregate race estimate because the Federal government considers race and Hispanic origin to be two separate and distinct concepts (USCB 2011b). Table 2-28 shows the overall representation of the populations of interest in the Lee Nuclear Station 50-mi region and South Carolina as a whole.

Table 2-28. Regional Minority and Low-Income Populations by Census Blocks Meeting Environmental Justice Criteria

Category	Number of Blocks (out of 1766 Total)	Percent of Total
African American	301	17
Aggregate Minority	419	24
Hispanic	87	5
American Indian or Alaskan Native	1	0
Asian	20	1
Native Hawaiian or Other Pacific Islander	0	0
Persons Reporting Some Other Race	27	2
Low-Income Population	147	8

Source: Review team U.S. Census data analysis

2.6.1 Methodology

The review team first examined the geographic distribution of minority and low-income populations within 50 mi of the Lee Nuclear Station site, employing a geographic information system (GIS) and the 2006-2010 ACS 5-Year Summary data to identify minority and low-income populations. The location of minority and low-income populations within 50-mi of the proposed Lee Nuclear Station was analyzed using the ArcView® GIS software and 2006-2010 ACS 5-Year Summary data at the census block level (USCB 2011a, c).[a] The review team verified its analysis by conducting field inquiries with numerous agencies and groups (see Appendix B for contact lists). The first step in the review team's environmental justice methodology was to examine each census block group fully or partially included within the 50-mi region to determine

(a) A census block is the smallest geographic area that the U.S. Census Bureau collects and tabulates decennial census data. A block group is the next level above census blocks in the geographic hierarchy and is a subdivision of a census tract or block numbering area.

for each block group whether the percentage of any minority or low-income population was great enough to identify that block group as a minority or low-income population of interest. If either of the two criteria discussed below is met for a census block group, that census block group is considered either a minority or low-income population of interest warranting further investigation. The two criteria are described below:

- the population of interest that resides in the census block group exceeds 50 percent of the total population of the census block group, or
- the percentage of the population of interest in the census block group is significantly greater (at least 20 percentage points) than the minority or low-income population percentage in the respective state.

The identification of census block groups that meet either of the above two-part criteria is not sufficient for the review team to conclude that disproportionately high and adverse impacts exist. Likewise, the lack of census block groups meeting the above criteria cannot be construed as evidence of no disproportionate and adverse impacts. Accordingly, the review team conducts an active public outreach and on-the-ground investigation in the region of the proposed site to determine whether minority and low-income populations may exist in the region that are not identified in the census mapping exercise. To reach an environmental justice conclusion, starting with the identified populations of interest, the review team must examine impact pathways and investigate all populations in greater detail to determine whether disproportionately high and adverse effects may be present. To do this, the review team addresses the following considerations:

1. Health Considerations
   - Are the radiological or other health effects significant or above generally accepted norms?
   - Is the risk or rate of hazard significant and appreciably in excess of the general population?
   - Do the radiological or other health effects occur in groups affected by cumulative or multiple adverse exposures from environmental hazards?
2. Environmental Considerations
   - Is there an impact on the natural or physical environment that significantly and adversely affects a particular group?
   - Are there any significant adverse impacts on a group that appreciably exceed or [are] likely to appreciably exceed those on the general population?
   - Do the environmental effects occur in groups affected by cumulative or multiple adverse exposures from environmental hazards? (NRC 2007a).

If this investigation in greater detail does not yield any potentially high and adverse impacts on populations of interest, the review team may conclude that there are no disproportionately high and adverse effects. If, however, the review team finds any potentially disproportionate and adverse effects, the review team would fully characterize the nature and extent of that impact and consider possible mitigation measures that may be used to lessen that impact. The remainder of this section discusses the results of the search for potentially affected populations of interest.

2.6.1.1 Minority Populations

The racial population is expressed in terms of the number and/or percentage of people that are minorities in an area, and, in this discussion, the sum of the racial minority populations is referred to as the aggregate racial minority population. Persons of Hispanic/Latino origin are considered an ethnic minority and may be of any race; therefore, they are not included in the aggregate racial minority population. The review team did not include Hispanics in its aggregate race estimate because the Federal government considers race and Hispanic origin to be two separate and distinct concepts (USCB 2011b).

The review team estimated that in 2010, 1766 census block groups were wholly or partially within the Lee Nuclear Station 50-mi region. Using the individual comparison criteria (i.e., comparing the block group to the state in which it is located), GIS analysis found the following census block groups with populations of interest: 301 block groups have African American populations, 87 have Hispanic ethnicity populations, 1 has an American Indian or Alaskan Native population, 20 have Asian populations, and 27 have "some other race" populations. The review team identified 419 block groups with aggregate minority plus Hispanic populations. No blocks were identified with minority populations of interest for Hawaiians or other Pacific Islanders (USCB 2011a, c). The closest aggregate minority population to Lee Nuclear Station Units 1 and 2 is about 7 mi west, in the town of Gaffney. Figure 2-22 shows the geographic location of aggregate minority block groups.

2.6.1.2 Low-Income Populations

South Carolina's statewide low-income population measured 16.4 percent in 2010. Within the Lee Nuclear Station 50-mi region, 147 out of 1766 census block groups have low-income populations of interest (USCB 2011a, c). This represents 8.3 percent of the census block groups. The closest low-income block group to Lee Nuclear Station Units 1 and 2 is approximately 7 mi west, in the town of Gaffney. Figure 2-23 shows the geographic location of low-income block groups.

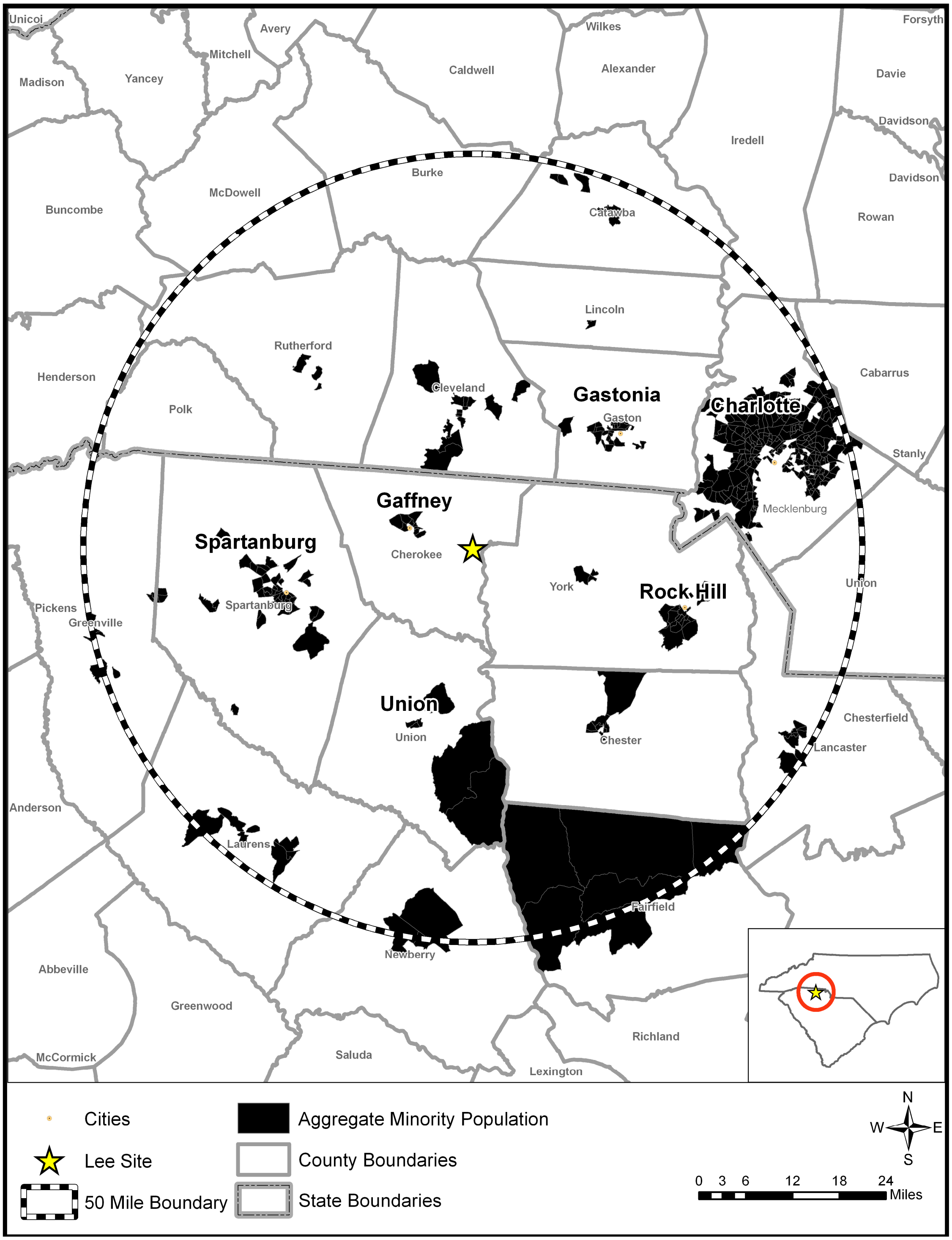

Figure 2-22. Aggregate Minority Populations (USCB 2011a, c)

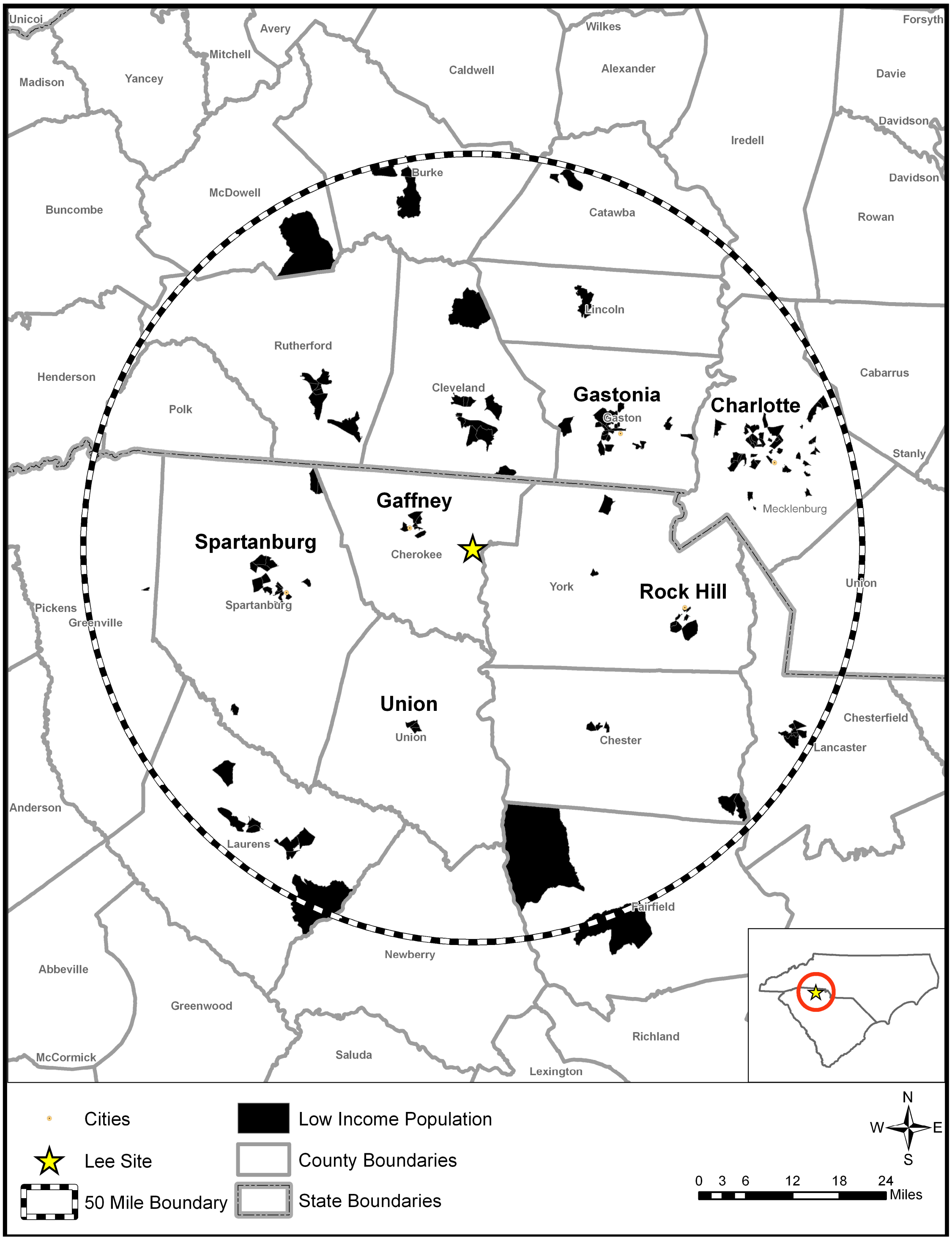

Figure 2-23. Low-Income Populations (USCB 2011a, c)

2.6.2 Scoping and Outreach

During the development of its ER, Duke interviewed community leaders of the minority populations within the analytical area. The review team built upon this base and performed additional interviews in the analytical area with the potential for the greatest environmental and socioeconomic effects. The review team interviewed local and county officials, business leaders, and key members of minority communities in Cherokee and York Counties to assess the potential for disproportionate environmental and socioeconomic effects that may be experienced by minority and low-income communities impacted by building and operating proposed Lee Nuclear Station Units 1 and 2. In accordance with NRC guidance, the review team provided advance notice of public hearings for EIS scoping purposes (see Appendix D). These activities did not identify any additional groups of minority or low-income persons not already identified in the GIS analysis of census data.

2.6.3 Subsistence and Communities with Unique Characteristics

For each of the identified low-income and minority groups, the staff must determine if any of the identified populations of interest, or any other populations, appears to have a unique characteristic that would cause it to be subject to disproportionately high and adverse effects. Examples of unique characteristics might include lack of vehicles, sensitivity to noise, close proximity to the plant, or subsistence activities. Such unique characteristics need to be demonstrably present in the population and relevant to the potential environmental impacts of the plant. If the impacts from the proposed action would appear to affect an identified minority or low-income population more than the general population because of one of these or other unique characteristics, then a determination is made whether the impact is disproportionate when compared to the general population.

Subsistence uses of natural resources often supplement income by providing food or other resources that free up actual earnings for additional store-bought foodstuffs, medications, or other needs. Further, subsistence is sometimes undertaken for ceremonial and traditional cultural purposes. Subsistence is generally considered to be the use of publicly held resources such as rivers (subsistence fishing) or forests (hunting or gathering of vegetation); however, subsistence use of privately owned resources, such as home vegetable gardens, is also applicable. Typical categories of subsistence uses include gathering plants, fishing, and hunting. Subsistence information is often site-specific and difficult to differentiate from the recreational uses of natural resources. Therefore, the review team presents subsistence information in a more qualitative manner based on diverse sources of published and anecdotal information.

The general public is not allowed uncontrolled access to the site for safety and security reasons; thus, no ceremonial, culturally significant, or subsistence gathering of vegetation occurs on the site. No information for plant gathering could be found in the vicinity of the Lee Nuclear Station site. Therefore, the review team assumes that if collection of plants for ceremonial, cultural, or subsistence purposes is occurring, that collection is taking place at a de minimis level. During its community outreach, the review team interviewed several individuals with knowledge of low-income and minority communities in the region. The review team only found one person who witnessed subsistence fishing activities, and those activities were confined to ponds, creeks, streams, and Lake Wiley in York County (Niemeyer 2008). Through its review of the applicant's ER, its own outreach and research (NRC and PNNL 2008), and through scoping meeting comments, the review did not identify any potentially unique communities with characteristics that warranted further consideration.

2.6.4 Migrant Populations

The U.S. Census Bureau defines a migrant worker as an individual employed in the agricultural industry in a seasonal or temporary nature, and who is required to be absent overnight from their permanent place of residence. Migrant workers can 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.

From an environmental justice perspective, potential exists for such groups in some circumstances to be disproportionately affected by emissions in the environment. Eight of the 416 farms in Cherokee County and 13 of the 1036 farms in York County employ migrant workers (USDA 2009a). Additionally, interviews with local officials indicated a small pocket of migrant workers in Cherokee and York Counties were employed at peach orchards and construction sites (NRC and PNNL 2008).

2.6.5 Environmental Justice Summary

The review team found low-income, Black, Hispanic, American Indian or Alaska Native, Asian, and aggregated minority populations within the 50-mi radius that exceed the percentage criteria established for environmental justice analyses. Consequently, the staff performed additional analyses before making a final environmental justice determination. Sections 4.5 and 5.5 of this EIS present the environmental justice impacts of construction and operation, respectively, of Lee Nuclear Station Units 1 and 2.

2.7 Historic and Cultural Resources

In accordance with 36 CFR 800.8(c), the NRC and the USACE have elected to use the NEPA process to comply with the obligations found under Section 106 of the National Historic Preservation Act, as amended (NHPA). As a cooperating agency, the USACE is part of the review team, and is involved in all aspects of the historic and cultural resources portion of the COL review for proposed Lee Nuclear Station Units 1 and 2.

The review team has identified direct (physical) and indirect (visual) areas of potential effect (APEs) at the Lee Nuclear Station site, in the 6-mi vicinity of the proposed plant, and in offsite areas for the environmental review. The NRC has determined that the direct, physical APE for this COL review is the area at the Lee Nuclear Station site and its immediate environs that may be impacted by proposed ground-disturbing activities associated with building and operating proposed Lee Nuclear Station Units 1 and 2. The onsite indirect APE that encompasses potential visual impacts for this COL review is located within the Lee Nuclear Station site vicinity and is defined as a zone within 1 mi of the tallest structures associated with the proposed new units. For the USACE, additional direct and indirect APEs are defined for other plant components in the Lee Nuclear Station site and vicinity including proposed onsite utilities, grading areas, spoil piles, laydown areas, and a railroad turnaround, Make-Up Pond C and associated developments, reactivation and modification of an offsite railroad spur, new offsite transmission lines, and new offsite transportation improvements. Indirect, visual APEs associated with these proposed plant components include a zone within 1 mi of the onsite utilities, within 1.25 mi of the shoreline of Make-Up Pond C, within 300 ft of the railroad line, and within 0.5 mi of the transmission lines. For the purposes of NHPA Section 106 review, the USACE will conduct ongoing and future consultation with the South Carolina State Historic Preservation Officer (SHPO), appropriate Tribal Historic Preservation Officers (THPOs), and Duke for onsite and offsite preconstruction activities as well as any future APEs or inadvertent discoveries according to the Lee Nuclear Station site cultural resources management plan and Memorandum of Agreement (MOA) (USACE et al. 2013).

This section provides an overview of the historic and cultural background of the Lee Nuclear Station site and region. Onsite and offsite direct (physical) and indirect (visual) APEs are also discussed, including the efforts that have been taken to identify historic properties and cultural resources within them. Historic properties (resources eligible or potentially eligible for nomination to the National Register of Historic Places [National Register]) and other cultural resources identified as a result of these efforts are included in the discussion and additional detail on these resources is included in Appendix G. The discussion also includes a description of the coordination and consultation efforts accomplished to date, with references to Appendices C and F for additional information. Assessments of effects relative to construction of proposed Lee Nuclear Station Units 1 and 2 and preconstruction of various onsite developments, Make-Up Pond C, and offsite plant components such as the railroad line, proposed new transmission lines, and transportation improvements are provided in Section 4.6; associated assessments relative to operations are provided in Section 5.6. Cumulative effects of construction and preconstruction are discussed in Section 7.5.

2.7.1 Cultural Background

This section provides an overview and summary of the cultural history of the Lee Nuclear Station site and surrounding region based on documentation provided in cultural resources survey reports completed by Duke's primary cultural resources contractor, Brockington and Associates, Inc. (Brockington 2007a). The area in and around the Lee Nuclear Station site has a rich cultural history and a substantial record of significant prehistoric and historic resources, with evidence of continuous settlement for at least the past 12,000 years. Prehistoric occupation is traditionally divided into four periods:

- Paleo-Indian (12,000 to 8000 BC)—This period is typically characterized by the presence of small mobile bands dependent upon large game, and to some extent upon smaller aquatic and terrestrial game and flora. Archaeological evidence of Paleo-Indian settlement is rare in Cherokee County and in the general vicinity of the Lee Nuclear Station site.
- Archaic (8000 to 1500 BC)—The Archaic period is divided into early, middle, and late sub periods defined on the basis of changing diagnostic projectile point typologies and evolving resource procurement strategies. During this period, people appear to have become increasingly sedentary and adept at exploiting resources found within their environment, resulting in an overall increase in population. The late Archaic period is characterized by the presence of sand-tempered pottery, which arrived at the Piedmont region via the coastal plain. The majority of prehistoric archaeological sites recorded on and in proximity to the Lee Nuclear Station site have components associated with the middle and late Archaic sub periods.
- Woodland (1500 BC to 900 AD)—The Woodland period is also divided into early, middle, and late sub periods characterized by changing pottery types. During this time in the Piedmont region, bow and arrow technology is employed and evidence exists of extensive use of pottery, reliance upon freshwater shellfish, and development of larger settlements located along major river terraces, where horticulture was practiced. Evidence of food preservation and storage is also found, indicating population growth. Archaeological evidence of this period is found at the Lee Nuclear Station site and in the Make-Up Pond C area.
- Mississippian (900 AD to 1550 AD)—This period is characterized by ceremonial mounds, distinctive mortuary practices, and large agriculture-based settlements generally considered to have been controlled by chiefdoms. Very few archaeological sites associated with this period have been found on the Lee Nuclear Station site or in the immediate vicinity.

The Historic period in the vicinity of the Lee Nuclear Station site begins with the arrival of Hernando de Soto, a Spanish explorer who traveled the interior of the Southeast during the mid-sixteenth century. The Cherokee County area was a buffer zone between the warring Catawba and Cherokee Tribes during the sixteenth and seventeenth centuries. During the late seventeenth century, colonial settlers of European descent traded with Cherokee Tribes and lived in relative peace with them. However, by the middle-to-late eighteenth century and during the American Revolutionary War (1775 to 1783), Euro-American settlements had encroached upon Cherokee lands, resulting in numerous battles and conflicts between the two groups that ultimately devastated the American Indian population.

In the late eighteenth and early nineteenth centuries, Euro-Americans began settling on small farms in the region with cotton being the dominant crop. National Register-eligible farmsteads identified along proposed Lee Nuclear Station Units 1 and 2 offsite transmission-line corridors (Smiths Ford Farm and Reid-Walker-Johnson Farm) are associated with these efforts. Iron smelting also played a significant role in the area's economy during the nineteenth century, with several furnaces located near the Lee Nuclear Station site, including the National Register-eligible Ellen Furnace located along the Lee Nuclear Station railroad line. After the Civil War (1861 to 1865), railroad expansion and the growth of textile manufacturing in the region prompted considerable growth, including the establishment of the Town of Gaffney in 1875 and the creation of Cherokee County in 1897. Introduction of hydropower in the late nineteenth and early twentieth centuries provided additional support for the expanding textile industry in the region. The National Register-eligible Ninety-Nine Islands Dam and Ninety-Nine Islands Hydroelectric Project, located on the Broad River adjacent to the Lee Nuclear Station site, are associated with this era.

2.7.2 Historic and Cultural Resources at the Site and Vicinity

The following sections describe historic properties and cultural resources located within the direct (physical) and indirect (visual) APEs at the Lee Nuclear Station site, at Make-Up Pond C, and at offsite plant developments (railroad line, new transmission lines, transportation improvements). To gain a general understanding of all resources in the vicinity of the Lee Nuclear Station site, Duke initially assembled information on National Register-eligible archaeological sites, structures, buildings, and districts located within 10 mi of the Lee Nuclear Station site (Duke 2009c). There are 118 previously recorded archaeological sites in this large area and aboveground architectural resources include 69 individual properties and another 184 properties contained within the boundaries of National Register-listed historic districts (Gaffney Commercial Historic District, Limestone Springs Historic District, Hill Complex Historic District, and Sharon Downtown Historic District), and one National Register-listed national military park (Kings Mountain National Military Park) (Duke 2009c).

Cultural resources investigations of the Lee Nuclear Station site began in the early 1970s for the unfinished Cherokee Nuclear Station and continue now as additional project components needed to support the building and operation of the proposed Lee Nuclear Station are identified. Figure 2-24 illustrates the main APEs that have been identified to date.

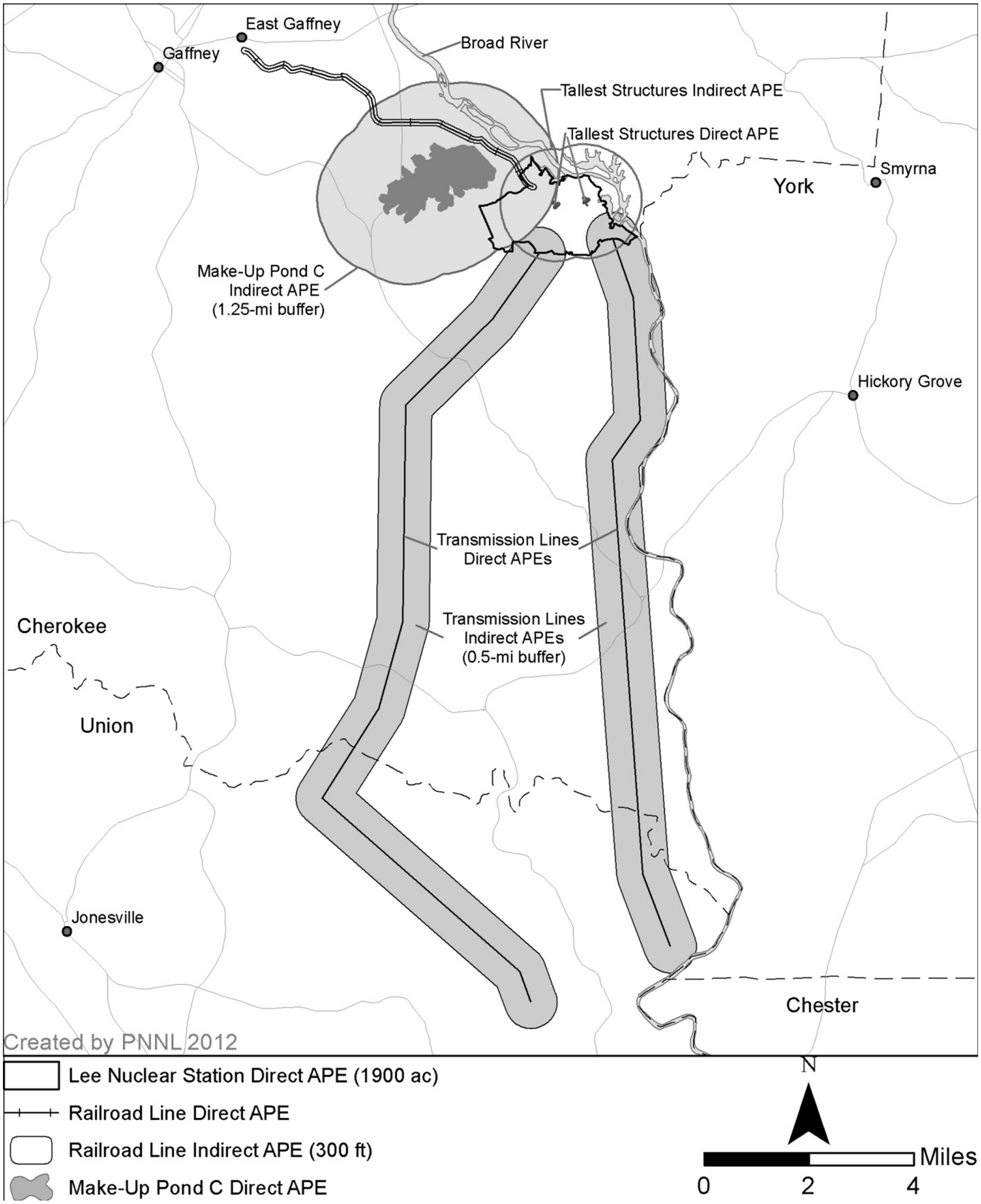

Figure 2-24. Main Areas of Potential Effect for the Lee Nuclear Station Site and Offsite Developments

Duke has engaged the South Carolina SHPO in discussions to define all APEs, and interested American Indian Tribes and organizations have also been provided with information (primarily the Catawba Indian Nation, Eastern Band of Cherokee Indians, and Seminole Tribe of Florida) and opportunities to comment. A substantial record of correspondence between Duke and these interested parties documents these efforts; the overall SHPO and Tribal interest in the projects; and their concurrence with the approach to identifying, evaluating, and assessing potential impacts to historic properties and cultural resources. The record of Duke's coordination with these parties is available in Appendix B of the ER (Duke 2009c), in various cultural resources reports (Brockington 2009a), or has been provided separately to the review team by Duke (Duke 2008f; 2009h, i; 2010i, j; 2012d). The NRC has also initiated consultation with these and other groups, as discussed in Section 2.7.4 and Appendix F.

The discussions to follow are based on the cultural resources reports prepared for the APEs that have been defined and investigated to date, including the following primary references:

- Lee Nuclear Station Units 1 and 2 COL ER (Duke 2009c) and the supplement to the ER specific to Make-Up Pond C (Duke 2009c)
- Cultural resources investigations completed by the South Carolina Institute of Archaeology and Anthropology (SCIAA) of developments associated with the unfinished 750 ac Cherokee Nuclear Station (SCIAA 1974), the Gaffney By-Pass (SCIAA 1977), and the proposed Cherokee Transmission Lines (SCIAA 1981)
- 2007, 2009, and 2013 cultural resources surveys of proposed developments in the 1900 ac Lee Nuclear Station site by Duke's primary cultural resources contractor, Brockington and Associates, Inc. (Brockington 2007a, b, 2009a, 2013)
- 2009, 2010, 2011, and 2013 cultural resources surveys of Make-Up Pond C and associated developments (Brockington 2009b, 2010, 2011, 2013)
- 2007 cultural resources survey of the offsite railroad line (Brockington 2007c)
- Duke's 2007 siting study for offsite transmission lines (Duke 2007c), a 2009 cultural resources survey of the preferred routes completed by Archaeological Consultants of the Carolinas, Inc. (ACC 2009), and a 2010 visual impact assessment along the preferred routes (Pike Electric 2010)
- 2012 cultural resources record search and field review of offsite transportation improvements (Duke 2012d)

Onsite Direct Areas of Potential Effect

The first cultural resources surveys completed at the Lee Nuclear Station site were initiated in the 1970s as part of environmental evaluations of the proposed Cherokee Nuclear Station (Duke Power Company 1974a). At this time, investigators from the SCIAA at the University of

South Carolina documented 11 archaeological sites and a historic cemetery within what is now the Lee Nuclear Station site and a few additional sites nearby (Duke 2009c; SCIAA 1974). This included five prehistoric archaeological resources (38CK8, 38CK9, 38CK10, 38CK11, 38CK13), four historic archaeological sites (38CK16, 38CK17, 38CK18), three archaeological sites with both prehistoric and historic components (38CK12, 38CK14, 38CK15), and one historic cemetery (38CK19/Stroup Cemetery). Investigators concluded that most of these resources were not significant archaeological sites (SCIAA 1974); only one prehistoric archaeological site (38CK8) and the historic Borden's Ferry (38CK16) were recommended for further investigations (SCIAA 1974), indicating that they exhibited some potential for further research and National Register eligibility. Investigators also recommended additional documentation and protection of the historic Stroup Cemetery (38CK19). In 1975, the South Carolina SHPO concluded that no National Register properties would be affected by the proposed Cherokee Nuclear Station (Duke 2009c). No architectural resources or potential indirect visual effects were investigated during these surveys.

Between 1977 and 1982, a 750-ac area within the onsite direct APE was extensively disturbed to a depth of at least 30 ft during onsite preparations for the Cherokee Nuclear Station (Duke 2009c). It is likely that half of the archaeological sites recorded during the 1974 survey (SCIAA 1974) were destroyed by these activities (38CK10, 38CK11, 38CK12, 38CK13, 38CK17, 38CK18) (Duke 2009c; Brockington 2007a). This was at least partially confirmed during a subsequent archaeological survey for proposed transmission lines (SCIAA 1981). Given the original evaluations for no further investigations at all of these resources, it is unlikely that any were eligible for nomination to the National Register. The six remaining archaeological resources originally recorded in the 1970s were probably not disturbed by site preparations made for the Cherokee Nuclear Station (38CK8, 38CK9, 38CK14, 38CK15, 38CK16, and 38CK19/Stroup Cemetery) (Duke 2009c).

Beginning in 2007, Duke contracted with Secretary of Interior-qualified cultural resources contractor Brockington and Associates, Inc., to conduct archaeological surveys, including shovel testing of onsite direct physical APEs, and architectural surveys within onsite indirect visual APEs, to support the COL review for Lee Nuclear Station Units 1 and 2. Field methods, background research, and project reporting were completed for all of these investigations in accordance with Federal and South Carolina guidelines (48 FR 44716; CSCPA 2005; SCDAH 2007a).

In 2007, Brockington and Associates, Inc. completed archaeological investigations within onsite direct, physical APEs, including a proposed water-intake structure, road-improvement corridor, and a meteorological tower location (Brockington 2007a, b). During these investigations, disturbance of the original 750-ac area associated with preparations for the Cherokee Nuclear Station in the 1970s was confirmed (Brockington 2007a). One of the six archaeological sites that was not disturbed by previous preparations for the Cherokee Nuclear Station (38CK14) was reportedly located in proximity to the overlook road surveyed at this time; however, no evidence of this site could be found despite intensive survey and test excavations (Brockington 2007a). Additionally, no new archaeological sites were identified (Brockington 2007a, b). The South Carolina SHPO accepted the 2007 survey report and addendum without specifically commenting on the eligibility of archaeological sites or the probable destruction of resources originally recorded in the 1970s and requested negotiation of an agreement to cover future cultural resources assessments associated with the building and operation of the Lee Nuclear Station (SCDAH 2007b).

In 2009, Brockington and Associates, Inc. returned to the Lee Nuclear Station site to complete investigations of additional direct, physical APEs for proposed onsite utilities and developments (Brockington 2009a). Two archaeological sites previously recorded in 1974 were included in these APEs; site 38CK14 in a proposed site-preparation spoils APE and 38CK15 in a rebar laydown APE. In spite of shovel tests and careful ground inspections, no evidence of these sites remained (Brockington 2009a). Surveys and shovel testing in 2009 also resulted in the documentation of one new archaeological isolate (two fragments of aqua window glass) and three new archaeological sites: 38CK138 (prehistoric lithic scatter and nineteenth-century artifacts) in the proposed wastewater line APE; 38CK139 (late nineteenth-century artifact scatter) in the onsite transmission corridor APE; and 38CK143 (prehistoric lithic scatter and nineteenth- and twentieth-century artifacts) in the site-preparation spoils APE. All of these resources exhibited low artifact frequencies, lack of potential for intact subsurface features, lack of integrity due to erosion and previous ground disturbance, and no potential for generating additional important information concerning past settlement patterns or land-use practices (Brockington 2009a). As a result, the South Carolina SHPO concurred with the investigators evaluation that all are ineligible for nomination to the National Register (SCDAH 2009a).

In 2012 and 2013, Duke updated plans for the design and placement of site-specific structures, system, and components at the Lee Nuclear Station site (Duke 2013c), making minor changes to the locations of Units 1 and 2 and associated components; refining plans for spoils, laydown, and grading areas; and designing a new railroad turnaround. Under the guidance of the Lee Nuclear Station cultural resources management plan and associated MOA (USACE et al. 2013), cultural resources investigations were completed of these new proposed developments (Brockington 2013). Surveys and shovel testing resulted in the documentation of four new archaeological sites in direct, physical APEs within the Lee Nuclear Station site: 38CK185 (late nineteenth- and early twentieth-century homesite), 38CK186 (nineteenth-century artifact scatter), and 38CK187 and 38 CK188 (prehistoric lithic scatters). Seven isolated prehistoric artifact finds were also documented, including one Middle Archaic projectile point. All of the identified resources were evaluated by investigators as ineligible for nomination to the National Register (Brockington 2013) and the South Carolina SHPO concurred with these findings (SCDAH 2013).

During each of the 2007, 2009, and 2013 investigations of onsite direct APEs, historic cemeteries known to be located within the 1900 ac Lee Nuclear Station site were revisited and confirmed to be outside all direct, physical APEs (Brockington 2007b). All four of the historic cemeteries located within the 1900-ac Lee Nuclear Station site, including the Stroup Cemetery (38CK19), an unnamed cemetery, Moss Cemetery (38CK141), and the McKown Family Cemetery, are protected by several South Carolina statutes (SC Code Ann 16-17-600, and SC Code Ann 27-43, summary also found in CSCPA 2005). Although historic cemeteries are generally not eligible for nomination to the National Register, they are often culturally important to local members of the community. Periodic requests for access to the identified historic cemeteries continue to be received and Duke has recognized the importance of continued public access, avoidance of ground disturbance, and maintenance of the fences that currently define these sensitive areas (Duke 2010d). These protections are also integral to the Lee Nuclear Station site cultural resources management plan and MOA (USACE et al. 2013). Following the guidance of the cultural resources management plan and MOA, 50-ft protective buffers will be established around the Stroup Cemetery (38CK19) and the McKown Family Cemetery during onsite land-disturbance activities associated with grading and spoil disposal to ensure they are not impacted by work activities nearby (Brockington 2013; Duke 2013c).

A summary of the archaeological resources and historic cemeteries identified within onsite direct, physical APEs at the 1900-ac Lee Nuclear Station site is provided in Appendix G.

Onsite Indirect Areas of Potential Effect

Architectural surveys to assess indirect, visual effects resulting from onsite developments were also completed by Brockington and Associates, Inc. in 2007 and 2009 (Brockington 2007a, b, 2009a). The indirect, visual APE for these surveys was defined in coordination with the South Carolina SHPO as a 1-mi radius around the tallest proposed structures, including the proposed nuclear units, associated shield buildings, and the meteorological tower. Field and archival investigations documented 12 architectural resources in this APE, including several twentieth-century houses, a twentieth-century church and associated cemetery and outbuildings, and a previously recorded National Register-eligible industrial property—the twentieth-century Ninety-Nine Islands Dam and Power Plant (Brockington 2007a, b; 2009a). The 1-mi radius indirect, visual APE also accommodates proposed 2012 plant configuration changes and updated 2013 plans for associated developments such as spoil, laydown, and grading areas and a new railroad turnaround (Duke 2013c) and no additional architectural surveys were completed for these changes (Brockington 2013).

All of the identified architectural resources were evaluated against a broad historic overview and context highlighting important themes in the history of the region developed by Brockington and Associates, Inc. (Duke 2008g). Based on this context, the newly recorded architectural resources were not associated with any significant historical development in the region and were therefore evaluated as ineligible for nomination to the National Register (Brockington

2007a, b; 2009a). However, the previously recorded Ninety-Nine Islands Dam and Ninety-Nine Islands Hydroelectric Project property also located within the onsite indirect, visual APE was evaluated as eligible for nomination based on the unique design and association with early twentieth-century hydropower development in the Piedmont region of South Carolina (Brockington 2009a). The South Carolina SHPO concurred with these evaluations (SCDAH 2007b, 2009a).

A summary of the architectural resources identified within the onsite indirect, visual APE associated with the Lee Nuclear Station site is provided in Appendix G.

Make-Up Pond C

In 2009, Duke recognized the need for supplemental water to support operation of the proposed new units during drought conditions and initiated investigations for a proposed new 620-ac reservoir (Make-Up Pond C) in the Lee Nuclear Station site vicinity, within 6 mi of proposed Units 1 and 2. Cultural resources investigations of Make-Up Pond C and associated developments were completed in 2009, 2010, 2011, and 2013 (Brockington 2009b, 2010, 2011, 2013). All methods employed during these investigations were in accordance with Federal and South Carolina guidelines (48 FR 44716; CSCPA 2005; SCDAH 2007a). Scopes of work for the archaeological and architectural surveys and the direct (physical) and indirect (visual) APEs were also reviewed and accepted by the South Carolina SHPO and provided to American Indian Tribes that had previously expressed interest (Duke 2010j).

During the phased investigations of Make-Up Pond C and associated developments (Brockington 2009b, 2010, 2011, 2013), archaeological surveys and test excavations, geomorphological testing, archival investigations, and architectural surveys, were completed for direct (physical) and indirect (visual) APEs by Duke's primary cultural resources contractor, Brockington and Associates, Inc. A summary of the archaeological sites investigated in direct, physical APEs for Make-Up Pond C is provided in Appendix G.

Surveyors identified ten previously unknown archaeological sites and one historic cemetery in the direct, physical APEs; eight new isolated finds consisting of less than three contemporaneous artifacts were also identified; and one previously recorded historic cemetery was revisited. Historic sites from the late nineteenth to early twentieth centuries dominate the archaeological inventory, including the Service Family Cemetery (38CK142), McKown Family Cemetery, four possible homesites (38CK144, 38CK182, 38CK183, 38CK184), two stills (38CK152, 38CK153), and one road and bridge foundation (38CK148). Two of the identified archaeological sites represented prehistoric occupation during the Middle Archaic period (38CK145, 38CK147) and one resource contained both prehistoric and historic materials (38CK146). Investigators also searched and tested for three previously recorded archaeological sites (38CK31, 38CK32, 38CK58), but they were unable to locate these resources because of significant erosion, modern disturbances since their original recordings, or possibly because the original investigators removed all of the artifacts (Brockington 2010; SCIAA 1981).

In order to assess the potential for buried soils and cultural horizons in the alluvial deposits along the London Creek drainage, which will be inundated by Make-Up Pond C, a program of deep backhoe test excavation was implemented (Brockington 2010). No evidence of buried cultural deposits was recorded in the 39 trenches excavated. The lack of evidence for human occupation along London Creek was attributed to a combination of factors including rugged terrain, frequent flooding, and periodic drought conditions (Brockington 2010).

All of the archaeological resources recorded in direct, physical APEs for Make-Up Pond C were recommended as ineligible for nomination to the National Register and all but two were evaluated as unlikely to warrant additional management consideration (Brockington 2009b, 2010). The historic Service Family Cemetery (38CK142) and McKown Family Cemetery are the exceptions, and while not eligible for nomination to the National Register, these cultural resources are protected from disturbance and desecration under South Carolina State law (SC Code Ann 16-17-600, and SC Code Ann 27-43, summary also found in CSCPA 2005).

The South Carolina SHPO concurred with the eligibility assessments for the archaeological resources located in the Make-Up Pond C direct, physical APEs as well as plans to relocate the Service Family Cemetery (SCDAH 2009b, 2010a, 2011, 2012a). Responses were also received from interested American Indian Tribes. The Eastern Band of Cherokee Indians concurred with the eligibility assessments for archaeological sites (EBCI 2010a, b) and the Seminole Tribe of Florida indicated no objections to the findings (STF 2010).

An architectural survey and background research within the indirect, visual APE of Make-Up Pond C in 2009 and 2010 focused on a zone within 1.25 mi of the proposed reservoir (Brockington 2009b, 2010). Resources identified within this area included 28 individual architectural resources and one possible historic district associated with the Cherokee Falls Mill and Village. Nearly all of the individual resources identified in the area are early twentieth-century residences and associated outbuildings, including 15 houses, 4 barns, and 3 outbuildings. Also near these structures were a middle twentieth-century elementary school, a church and associated cemetery, and one additional cemetery. Only one late nineteenth-century residence and outbuilding were identified. The background research and field investigations completed by Brockington and Associates, Inc. (Brockington 2009b, 2010) demonstrated that all of the individual resources are ineligible for nomination to the National Register, although the two identified cemeteries would merit protection under South Carolina State law. A determination of eligibility was not submitted for the Cherokee Falls Mill and Village pending review of the survey results by the South Carolina SHPO. The South Carolina SHPO concurred with the individual assessments (SCDAH 2009b) and reviewed the Cherokee Mill and Village information to conclude that these resources are also ineligible for National Register nomination (SCDAH 2010a).

Appendix G provides a summary of the historic and cultural resources identified within the direct (physical) and indirect (visual) APEs for Make-Up Pond C.

2.7.3 Historic and Cultural Resources in Transmission Corridors and Offsite Areas

Duke has initiated specific cultural resources investigations of offsite direct (physical) and indirect (visual) APEs over the course of several years, including a 2007 investigation of the railroad corridor (Brockington 2007c), a 2009 investigation of two proposed routes (Routes K and O) for 230-kV and 525-kV transmission lines (ACC 2009), and a 2012 review of proposed transportation improvements (Duke 2012d). All cultural resources survey methods employed during these offsite investigations were in accordance with Federal and South Carolina guidelines (48 FR 44716; CSCPA 2005; SCDAH 2007a). Scopes of work for the archaeological and architectural surveys and the direct and indirect APEs were also reviewed and accepted by the South Carolina SHPO and provided to American Indian Tribes that had previously expressed interest (Duke 2010j).

2.7.3.1 Railroad Corridor

In 2007, Duke contracted with Brockington and Associates, Inc. to conduct cultural resources investigations of the offsite direct, physical APE for reuse of an existing railroad line originally built in the 1970s to support the proposed Cherokee Nuclear Station. Investigators in 2007 did not record any new archaeological sites within the new alignment and did not re-identify any evidence of a previously recorded small prehistoric lithic scatter (38CK38, the “Eroded Site”), reportedly located nearby. This resource was originally recorded in the 1970s during investigations in support of the Cherokee Nuclear Station and evaluated as unlikely to reveal any additional information of importance (SCIAA 1977). Similarly, no new architectural resources were identified within 300-ft-wide corridors on either side of the railroad line defined as the indirect, visual APE.

Background research and surveys confirmed that the existing railroad bed passes directly through a portion of a property listed on the National Register, archaeological site 38CK68 (Ellen Furnace Works), which is significant for its association with early nineteenth-century ironworks that thrived in Cherokee County and were integral to the earliest phases of industrialization in the region (Brockington 2007c). Based on field inspection, the investigators concluded that the portions of 38CK68 located within the railroad line direct, physical APE had been disturbed by previous grading activities associated with the original railroad bed, but observed that this previous disturbance had not altered significant aspects of the site still preserved in the indirect, visual APE (Brockington 2007c). Since the proposed reuse of the existing line through the Ellen Furnace Works property would not require any major alterations to the line or the area through which it passes, no adverse effects were anticipated. The South Carolina SHPO concurred with these findings (SCDAH 2008, 2012a).

Appendix G provides a summary of the resources identified within the direct (physical) and indirect (visual) railroad corridor APEs.

2.7.3.2 Transmission Lines

In 2007, Duke completed a siting study for proposed new offsite transmission lines to connect the Lee Nuclear Station to existing transmission infrastructure in the region (Duke 2007c). This study compared 21 alternative routes within a 283.47 mi^2 study area and selected two preferred routes (Routes K and O) that analyses suggested would pose the least impact to the environment. As part of this siting study, Duke sought input from the interested public, many of whom expressed a general concern about impacts to historic homes, churches, and cemeteries (Duke 2007c: Appendix C). Brockington and Associates, Inc. conducted preliminary records searches with the SCIAA and the South Carolina Department of Archives and History and a "windshield reconnaissance" level survey, traveling existing roads throughout the study area to confirm the continued existence of previously documented historic properties and cultural resources and obtain a general idea of the range of undocumented historic properties and cultural resources in the area (Duke 2007c, 2010q).

One prehistoric archaeological site (38CK52) that had not been evaluated for National Register eligibility was identified within proposed Route K during this initial records search. Results also included six historic buildings within the viewshed of proposed Route O: National Register-eligible Ninety-Nine Islands Dam and Power Plant; the Smith's Ford Farm; and three buildings associated with a farmstead that had not been evaluated for National Register eligibility at that time. Later surveys would confirm this latter property as the National Register-eligible Reid-Walker-Johnson Farm. Preliminary conclusions in the siting study indicated that the historic architectural properties would not be visually affected by the proposed transmission-line route (Duke 2007c).

In 2009, Duke contracted with Archaeological Consultants of the Carolinas, Inc. to conduct intensive archaeological survey and shovel testing within the direct, physical APEs associated with the two preferred routes for the proposed transmission lines (Route K extending 7.94 mi at 325 ft wide and 9.46 mi at 200 ft wide and Route O extending 7.09 mi at 325 ft wide and 6.78 mi at 200 ft wide) and identify previously recorded archaeological sites in the indirect, visual APEs, defined as 0.5-mi-wide corridors on either side of the proposed centerlines of the two transmission lines. Inventory and assessment of architectural properties within these larger indirect, visual APEs were also completed (ACC 2009). Both the South Carolina SHPO and Eastern Band of Cherokee Indians were involved in the development of study plans and APEs and reviewed copies of the resulting reports for this work (Duke 2010j). Archaeological investigations resulted in the identification of 37 new archaeological sites in the direct, physical APEs of the two proposed transmission lines.

Within the direct, physical APE of proposed Route K, 12 new archaeological sites were found (ACC 2009). Prehistoric lithic scatters dominated the inventory (38CK175, 38CK176, 38CK178, 38UN1443, 38UN1445, 38UN1446), followed by historic late nineteenth-, early twentieth-century house sites (38CK174, 38CK177, 38CK181, 38UN1444), and two sites included both prehistoric and historic components (38CK179, 38CK180). Eight new isolated finds, including three prehistoric lithics, four historic ceramic sherds, and two historic glass sherds were also documented (ACC 2009). One previously recorded archaeological site, 38CK52, could not be re-identified in the direct, physical APE, in spite of shovel testing at its reported location (ACC 2009).

Proposed transmission-line Route O passes near the Broad River and archaeological investigations of the direct, physical APE resulted in the documentation of 25 new archaeological sites (ACC 2009). The inventory is dominated by prehistoric lithic scatters (38CK150, 38CK151, 38CK156, 38CK159, 38CK164, 38CK167, 38CK168, 38CK171, 38CK173, 38UN1441), including four with Archaic components (38CK155, 38CK157, 38CK160, 38UN1442), and one with a Mississippian component (38CK149). Seven identified prehistoric lithic scatters also contained late nineteenth-, early twentieth-century historic components (38CK161, 38CK162, 38CK163, 38CK165, 38CK166, 38CK169, 38CK170). Resources from the Historic period included one late nineteenth-, early twentieth-century house site (38CK154) and a possible prospector’s pit (38CK158) associated with late nineteenth-, early twentieth-century mining in the area. Finally, one possible grave site (38CK172) was identified (ACC 2009). The seven isolated finds identified in the Route O direct, physical APE included prehistoric flakes and historic domestic artifacts generally thought to be associated with nearby archaeological sites.

The possible grave site (38CK172) identified in the direct, physical APE of Route O is protected by several South Carolina statutes (SC Code Ann 16-17-600, and SC Code Ann 27-43-310, summary also found in CSCPA 2005), and the requirements of the regulations implementing the Native American Graves Protection and Repatriation Act (NAGPRA) may apply if remains are Native American. Investigators evaluated this site as ineligible for nomination to the National Register, but recommended that further investigation or protection may be warranted (ACC 2009). All of the remaining archaeological resources newly identified within the direct, physical APEs for the proposed transmission lines exhibited no preserved cultural features or important deposits and very low potential for future research. As a result, all were recommended as ineligible for nomination to the National Register (ACC 2009). The South Carolina SHPO concurred with these assessments (SCDAH 2009c, 2012a). The Eastern Band of Cherokee Indians also concurred that none of the identified archaeological sites are National Register-eligible, but stressed that the possible burial site (38CK172) is protected under Federal and State burial law (EBCI 2009).

Architectural survey and background research within the indirect, visual APEs of the proposed transmission lines (0.5 mi-wide corridor on either side of the centerlines of Routes K and O) resulted in the identification of 39 resources (ACC 2009). Nine of these are previously recorded resources also located within the indirect APE for onsite activities at the Lee Nuclear Station site: three twentieth-century residences and Ninety-Nine Islands Dam and Power Plant in Route K and four twentieth-century residences and the McKowns Mountain Baptist Church in Route O. Aside from the National Register-eligible Ninety-Nine Islands Dam and Ninety-Nine Island Hydroelectric Project, all of the previously recorded resources collocated in the Lee Nuclear Station site and transmission-line indirect, visual APEs have been assessed by investigators and the South Carolina SHPO as ineligible to the National Register (Brockington 2007a, b; SCDAH 2007b, 2009a, 2012a).

Archival investigations of the indirect, visual APEs for Routes K and O in 2009 (ACC 2009) revealed 7 additional early twentieth-century residences and 1 National Register-eligible middle eighteenth-century farmstead complex (Smith's Ford Farm) and subsequent field investigations resulted in the recording of 20 additional early twentieth-century buildings and one early twentieth-century farmstead complex (Reid-Walker-Johnson Farm). With the exception of Ninety-Nine Islands Dam and Power Plant and the two historic farm complexes, all of the architectural resources identified in Routes K and O have been heavily modified by modern activities and were evaluated as ineligible for the National Register due to lack of research potential and compromised integrity (ACC 2009). The South Carolina SHPO concurred with these recommendations (SCDAH 2009c, 2012a).

Three architectural properties identified in the indirect, visual APE for transmission-line Route O are eligible for National Register nomination: Ninety-Nine Islands Dam and Power Plant; Reid-Walker-Johnson Farm, including the Pleasant Grove Cemetery; and Smith's Ford Farm (ACC 2009). The South Carolina SHPO concurred with these evaluations and requested additional investigation of the viewsheds associated with the two historic farms (SCDAH 2009c). In response, Duke contracted with Pike Electric to complete a visual effects analysis for the transmission line on these properties (Pike Electric 2010). The South Carolina SHPO concurred that these analyses demonstrated that distance, topography, and vegetation will screen both of the National Register-eligible properties from adverse visual impacts (SCDAH 2010b).

Appendix G provides a summary of the historic and cultural resources identified within the direct (physical) and indirect (visual) APEs of the proposed transmission-line routes.

2.7.3.3 Transportation Improvements

In 2012, Duke contracted with Kimley-Horn and Associates, Inc. to complete a cultural resources archive review and limited field inspection of proposed offsite transportation improvements at six key intersections from I-85 east to the Lee Nuclear Station site (Duke 2012d). From west to east, the intersections are as follows:

- I-85 and Shelby Highway
- SC 329 and U.S. Highway 29 (US-29)
- SC 329 and McKowns Mountain Road
- McKowns Mountain Road and Rolling Mill Road
- McKowns Mountain Road and Patrick Road
- McKowns Mountain Road, Sardis Road and Owensby Street.

The archive search revealed five previously recorded archaeological sites evaluated as ineligible for the National Register within the direct APEs for road improvements (38CK29, 28CK48, 38CK49, 38CK132, 38CK133), but no evidence of these resources was observed during field investigations in 2012. The South Carolina SHPO concurred with the assessment that no properties listed in or eligible for listing in the National Register are located in the direct APEs for the transportation improvements (SCDAH 2012b). Documentation of the cultural review has also been provided to Federally recognized American Indian Tribes, including the Catawba Indian Nation, the Eastern Band of Cherokee Indians, and others (Duke 2012d).

Appendix G provides a summary of archaeological sites investigated in proposed offsite transportation improvement APEs.

2.7.4 Consultation

In April 2008, the NRC initiated consultation on the proposed COL by writing to the South Carolina SHPO and the Advisory Council on Historic Preservation. Also in April 2008, the NRC initiated consultations with three Federally recognized American Indian Tribes and four State-recognized Tribal organizations (see Appendix C for a complete list). The Seminole Tribe of Florida was identified by the South Carolina SHPO during the site audit as another Federally recognized tribe with historical ties to Cherokee and York Counties and in June 2008, the NRC also initiated consultation with them. In May 2010, the NRC sent additional invitations to participate in a supplemental scoping process regarding the addition of Make-Up Pond C to the COL application for Lee Nuclear Station Units 1 and 2. At this time, the South Carolina SHPO, Advisory Council on Historic Preservation, and the previously contacted American Indian Tribes and organizations were invited to participate in the expanded environmental review. In 2012, the NRC invited all of these parties to review the draft EIS and the USACE initiated consultation with Duke, the South Carolina SHPO, the Catawba Indian Nation, and the Eastern Band of Cherokee Indians to develop the Lee Nuclear Station site cultural resources management plan and associated MOA. This effort was finalized in 2013, with the USACE, Duke, the South Carolina SHPO, and the Catawba Indian Nation as signatories to the MOA (USACE et al. 2013).

In all of these scoping letters, the NRC provided information about the proposed action; indicated that review under the NHPA would be integrated with the NEPA process in accordance with 36 CFR 800.8; invited participation in identification of and possible decisions regarding historic properties; invited participation in the scoping process; and defined the APE for the new units as the area at the Lee Nuclear Station and its immediate environs that may be impacted by ground-disturbing activities associated with constructing and operating Units 1 and 2. As documented in Appendices C and F, responses to the initial and supplemental scoping letters were received from the South Carolina SHPO, the Catawba Indian Nation, and the Eastern Band of Cherokee Indians indicating a willingness to continue to work with the NRC and Duke in the ongoing environmental review. The NRC followed up on requests from the Catawba Indian Nation with transmittal of all cultural resources information and survey reports completed to date (see Appendix F) and Duke established an ongoing relationship and exchange of information with the South Carolina SHPO, the Eastern Band of Cherokee Indians, and the Seminole Tribe of Florida. All of these groups continue to express interest in reviewing project information through communications with the NRC, the USACE, or Duke (Duke 2010j) and all were invited by the NRC to review the draft EIS in 2012 (Appendix F).

Throughout the cultural resources investigations and consultation process, the South Carolina SHPO has repeatedly requested that an agreement be developed to "…govern future cultural resources identification and address future work to be done at the plant through the life of the license" (SCDAH 2010c). As an initial step to comply with this request, Duke Energy developed a corporate policy for the protection of cultural resources that provides guidance to minimize impacts to cultural resources during activities at all facilities owned and operated by Duke Energy Corporation and general procedures for handling any inadvertent cultural resources discoveries (Duke 2009j). In 2012, Duke, the USACE, the South Carolina SHPO, and THPOs from the Catawba Indian Nation and the Eastern Band of Cherokee Indians worked together to develop a cultural resources management plan and MOA specifically tailored to proposed Lee Nuclear Station Units 1 and 2 and associated developments. Early in 2013, the plan and associated MOA were finalized with the USACE, Duke, the South Carolina SHPO, and the Catawba Indian Nation as final signatories (USACE et al. 2013).

The NRC has conducted two public scoping meetings associated with the COL application for proposed Lee Nuclear Station Units 1 and 2: one related to the initial application and a second for the later addition of Make-Up Pond C. The initial scoping meeting was held on May 1, 2008, in Gaffney, South Carolina and one commenter expressed some concerns about protection of Cherokee Indian sites along the Broad River (NRC 2008f). On June 17, 2010, the NRC conducted a second scoping meeting to seek comment on the addition of Make-Up Pond C to the environmental review. One individual expressed concerns through the supplemental scoping process regarding the flooding of archaeological sites (Breckheimer 2010). Public feedback obtained through the siting study for new transmission corridors also indicated some local concern for preservation of historic cemeteries and other local cultural resource locations (Duke 2007c). Additional coordination between Duke, Duke's cultural resource contractors, and these interested parties are described and referenced in the following sections.

Traditional Cultural Properties and Historic Cemeteries

Ongoing communications between Duke and American Indian Tribes and Tribal groups with historical, cultural, and/or traditional ties to the Cherokee and York Counties area are summarized in the ER (Duke 2009c), the Make-Up Pond C supplement to the ER (Duke 2009b), and in correspondence records provided by Duke for the review team (Duke 2008f, 2010j). Duke sent letters requesting input on cultural resources of concern to American Indian THPOs and chiefs of Federally recognized Tribes, including the Catawba Indian Nation, Eastern Band of Cherokee Indians, the Eastern Shawnee Tribe of Oklahoma, and the Seminole Tribe of Florida. Duke also sent letters requesting input on cultural resources of concern to four American Indian organizations: the Piedmont American Indian Association/Lower Eastern Cherokee Nation, United South and Eastern Federation of Tribes, Carolina Indian Heritage Association, and Pine Hill Indian Community (Duke 2009c). Responses were received from the Catawba Indian Nation, the Eastern Band of Cherokee Indians, the Eastern Shawnee Tribe of Oklahoma, and the Seminole Tribe of Florida (Duke 2009c, 2010j). THPOs from the Catawba Indian Nation and the Eastern Band of Cherokee Indians have also been involved in the development of the Lee Nuclear Station cultural resources management plan and MOA and the Catawba Indian Nation is a signatory to the final MOA (USACE et al. 2013).

No traditional cultural properties have been identified within any of the defined onsite or offsite direct or indirect APEs during coordination and consultation with interested parties, but several specific requests have been received. The Catawba Indian Nation requested archaeological assessment of future project APEs, notification if human remains or sensitive cultural items were located during project activities (Duke 2009c), and ongoing consultation on any proposed ground-disturbing activities (Catawba 2010). The NRC followed through on this request, providing information and survey reports (Appendix F). The Catawba Indian Nation also participated in consultation on the final cultural resources management plan for the Lee Nuclear Station site and associated MOA along with Duke, the USACE, and the South Carolina SHPO (USACE et al. 2013). The Eastern Shawnee Tribe of Oklahoma declined to participate in any further project coordination or consultation, but requested work stoppage and notification if human remains or sensitive cultural items were uncovered (Duke 2009c). The Eastern Band of Cherokee Indians requested continued participation in the project through review of cultural resources investigations completed for current and future APEs (Duke 2009c) and participated in initial consultation on the cultural resources management plan and associated MOA for the

Lee Nuclear Station site and offsite developments. In 2008, the South Carolina SHPO recommended initiation of coordination with the Seminole Tribe of Florida and in response to the resulting invitation from Duke, they requested continued involvement through review of cultural resources survey reports (STF 2009).

Throughout their interactions with Duke, the interested American Indian Tribes have consistently focused their comments on resource identification and protection as well as stop work and notification requirements in the event of inadvertent cultural resources discoveries. The Eastern Band of Cherokee Indians has specifically identified Federal and State requirements regarding the protection of the possible human burial (38CK172) located within the direct APE of transmission-line Route O (EBCI 2009). However, no specific American traditional cultural properties have been identified and in 2011, the Eastern Band of Cherokee Indians confirmed that no culturally important resources are located within any onsite or offsite direct or indirect APEs associated with the Lee Nuclear Station site (EBCI 2011). The Catawba Indian Nation also confirmed support of Duke's intent to protect important cultural resources by participating in consultation on the cultural resources management plan for the Lee Nuclear Station site and associated developments and signing the associated MOA with Duke, the USACE, and the South Carolina SHPO (USACE et al. 2013).

The results of scoping meetings for proposed Lee Nuclear Station Units 1 and 2 and Make-Up Pond C and questionnaires and public meetings associated with the offsite transmission lines indicate local community concerns regarding impacts to historic buildings and cemeteries, as well as protection of scenic, recreational, American Indian, and archaeological resources in the area (Breckheimer 2010; Duke 2007c; NRC 2008f). Several individuals have formally requested access to historic cemeteries within the Lee Nuclear Station site and have communicated with Duke's cultural resources contractor regarding the Service Family Cemetery in the Make-Up Pond C site (Duke 2010d). However, the local community has shared no specific information regarding specific resources of traditional cultural concern located within the Lee Nuclear Station site and vicinity or any of the offsite APEs (Duke 2007c).

Both direct and indirect APEs associated with the Lee Nuclear Station site, Make-Up Pond C, and offsite transmission lines include historic cemeteries. A possible human burial site is located in the offsite direct APE for transmission-line Route O. These resources are protected by South Carolina statutes (SC Code Ann 16-17-600 and SC Code Ann 27-43, summary also found in CSCPA 2005) and the requirements of the implementing regulations of the NAGPRA (25 U.S.C. 3001) may apply if remains are Native American. Although historic cemeteries are generally not eligible for nomination to the National Register, the historic cemeteries identified at the Lee Nuclear Station site are culturally important to local members of the community and the South Carolina SHPO. Duke and Lee Nuclear Station site cultural resources contractors continue to receive periodic requests for access and information on these resources and the importance of continued public access, careful maintenance, and avoidance or mitigation of direct impacts are emphasized in the Lee Nuclear Station site cultural resources management plan and associated MOA (USACE et al. 2013). Avoidance of direct impacts at the possible human burial site is also addressed in the Lee Nuclear Station cultural resources management plan and associated MOA (USACE et al. 2013), in response to concerns expressed by the Eastern Band of Cherokee Indians (EBCI 2009).

2.8 Geology

A detailed description of the geological, seismological, and geotechnical conditions at the Lee Nuclear Station site is provided in Section 2.5 of the Lee Nuclear Station FSAR (Duke 2013a) as part of the COL application. A summary of the geology at the site is presented in Section 2.6 of the ER (Duke 2009c). A description of the geology at the proposed Make-Up Pond C area is presented in the supplement to the ER (Duke 2009b). The regional and site-specific geologic descriptions provided in Duke's FSAR (Duke 2013a) are based on the results of field and subsurface investigations conducted in the 1970s for the unfinished Cherokee Nuclear Station (Duke Power Company 1974a, b, c) and more recently at the site and proposed location of Make-Up Pond C.

The NRC staff's Safety Evaluation Report (SER), which will be published in the future as a NUREG document, will provide a detailed description of the geologic features of the Lee Nuclear Station site and vicinity and document the NRC staff's independent assessment of the applicant's detailed evaluation and analysis of geological, seismological, and geotechnical data. Groundwater hydrological data are analyzed and discussed in detail in Section 2.3 of this report.

The Lee Nuclear Station and Make-Up Pond C sites lie within the Piedmont physiographic province, which is characterized by gently rolling hills cut by drainages with steeper slopes. Site elevations range from 512 ft above MSL at the edge of the Broad River to about 816 ft above MSL on McKowns Mountain, and the design site grade at the proposed locations for Units 1 and 2 is 593 ft above MSL (Duke 2013a). Previous cut and fill activities for the unfinished Cherokee Nuclear Station removed some hills and filled some drainages.

Topography in the vicinity of the Lee Nuclear Station site is controlled by the variations in the resistance of the bedrock to weathering. Bedrock beneath the site consists of igneous, volcaniclastic, and minor sedimentary rocks of the Battleground Formation that were folded, faulted and metamorphosed into felsic and mafic shists, gneisses, and metasediments (Duke 2009b). Quartzite and metaconglomerate rocks are more resistant to weathering and locally create ridges such as McKowns Mountain. The area has undergone extensive erosion and weathering, creating a surficial zone of residual soil and saprolite (chemically weathered in place rock) consisting of sand, silt, and clay typically 40 to 80 ft thick that grades down through partially weathered rock into solid bedrock (Duke 2013a). At one Make-Up Pond C study borehole near London Creek, residual soil and partially weathered rock was more than 190 ft below ground (Duke 2009b). In undisturbed areas, 2 to 8 ft of soil has developed at the surface, while alluvium occurs along the Broad River and smaller drainages onsite. Two aquifers generally occur in the area; the upper aquifer in the saprolite and the lower aquifer in the fractured, partially weathered and unweathered bedrock. According to the U.S. Environmental Protection Agency Sole Source Aquifer Protection Program, no aquifers have been designated as sole source aquifers in the vicinity of the Lee Nuclear Station site (EPA 2011a).

No evidence of previous subsurface mining activity was found at the Lee Nuclear Station site and Duke owns the mineral rights on the site (Duke 2009c). A number of rock and construction material mines exist in the area around the Lee Nuclear Station site (EPA 2011b). The closest to the site is a dredge mining operation for sand in the Broad River located between the mouth of London Creek and the upstream boundary of the Lee Nuclear Station site. None of the mines are designated as major NPDES facilities (EPA 2011b). Duke has indicated material for Make-Up Pond C's earthen dam will be excavated from the footprint of the pond in areas below the pond's future maximum water level (Duke 2009c).

2.9 Meteorology and Air Quality

The following sections describe the climate and air quality of the Lee Nuclear Station site. Section 2.9.1 describes the climate of the region and the immediate vicinity of the site, Section 2.9.2 describes the air quality of the region, Section 2.9.3 describes atmospheric dispersion at the site and in the surrounding area, and Section 2.9.4 describes the meteorological monitoring program at the site.

2.9.1 Climate

The climatological statistics presented in this section are derived from weather stations located near the Lee Nuclear Station site. An onsite meteorological tower (Tower 2) was also constructed specifically to support the COL application. The closest first-order National Weather Service (NWS) stations to the site are Greenville-Spartanburg, South Carolina (34° 54' N, 82° 13' W; located near Greer, South Carolina) (NCDC 2010a), about 42 mi west-southwest of the site and Charlotte, North Carolina (35° 13' N, 80° 57' W) (NCDC 2010b), about 35 mi east-northeast of the site. In addition, Ninety-Nine Islands NWS cooperative station (35° 03' N, 81° 30' W) is located approximately 1.75 mi north of the site (NCDC 2010c). These stations provide a good indication of the general climate at the site because of their proximity and similarities in topography and vegetation. The Lee Nuclear Station site is located near Ninety-Nine Islands Reservoir and the Broad River. Most of the site is approximately 500 to 660 ft above MSL. The dominant terrain feature at the site is McKowns Mountain, the top of which is 816 ft above MSL. Silver Mine Ridge is located approximately 3 mi to the northwest of the site. This ridge is approximately 800 ft above MSL. In other directions, the terrain consists of rolling wooded hills.

The Lee Nuclear Station site is located in the Piedmont region of the Carolinas, which is characterized by a humid, subtropical climate with short, cool winters and long, humid summers. Air masses may approach the region from any direction, but the Appalachian Mountains protect most of the region from cold wintertime air masses (NCDC 2010a, b). Average maximum temperatures at Ninety-Nine Islands NWS cooperative station range from about 88°F in July to 51°F in January, while average minimum temperatures range from about 66°F in July to 27°F in January (SERCC 2010a). Monthly average wind speeds at Greenville-Spartanburg are nearly constant throughout the year, ranging from about 6 mph in the summer to about 8 mph in the winter and early spring (NCDC 2010a, b). Precipitation occurs throughout the year, but slightly more precipitation tends to occur during the spring and summer. Annual average precipitation amounts at Greenville-Spartanburg, Ninety-Nine Islands, and Charlotte are 50.24, 48.37, and 43.51 in., respectively (NCDC 2010a, SERCC 2010a, NCDC 2010b). Snow generally occurs in the period from December through March, but is usually limited to two or three small snowstorms. The annual mean snowfall for the region is approximately 5 to 6 in. (NCDC 2010a, b).

While the regional climate is generally humid, there is a diurnal cycle to relative humidity; the relative humidity is highest during the early morning hours and lowest in the afternoon. For example, during the month of August in Greenville-Spartanburg, the average relative humidity ranges from 90 percent in the morning to 58 percent in the afternoon (NCDC 2010a). The relative humidity is also higher during the summer than the winter. For example, the average daily relative humidity at Greenville-Spartanburg ranges from a maximum of 76 percent in August to a minimum of 62 percent in April (NCDC 2010a). Fog is most common during the winter months, occurring on approximately 4 days in both December and January (NCDC 2010a, b).

On a larger scale, climate change is a subject of national and international interest. The recent compilation of the state of knowledge in this area (GCRP 2009) has been considered in preparation of this EIS. Projected changes in the climate for the region during the life of the proposed Lee Nuclear Station Units 1 and 2 site include an increase in average temperature of 2 to 4°F, a decrease in precipitation in the spring and summer, and an increase in the frequency of heavy precipitation (GCRP 2009).

Based on the assessments of the Global Climate Research Program and the National Academy of Sciences' National Research Council, the EPA determined that potential changes in climate caused by greenhouse gas (GHG) emissions endanger public health and welfare (74 FR 66496). The EPA indicated that, while ambient concentrations of GHGs do not cause direct adverse health effects (such as respiratory or toxic effects), public health risks and impacts can result indirectly from changes in climate. As a result of the determination by the EPA and the recognition that mitigative actions are necessary to reduce impacts, the review team concludes that the effect of GHG on climate and the environment is already noticeable, but not yet destabilizing. In CLI-09-21, the Commission provided guidance to the NRC staff to consider carbon dioxide and other GHG emissions in its NEPA reviews and directed that it should encompass emissions from constructing and operating a facility as well as from the fuel cycle (NRC 2009b). NRC staff memoranda (NRC 2010d, 2011a) provide additional guidance to NRC staff on consideration of GHGs and carbon dioxide in its environmental reviews. The review team characterized the affected environment and the potential GHG impacts of the proposed action and alternatives in this EIS. Consideration of GHG emissions was treated as an element of the existing air-quality assessment, which is essential in a NEPA analysis. In addition, where it was important to do so, the review team considered the effects of the changing environment during the period of the proposed action on other resource assessments.

2.9.1.1 Wind

This section includes a description of the average winds observed in the region as well as the winds measured at the Lee Nuclear Station site meteorological tower. The regional winds are strongly influenced by local effects, such as ridges and valleys, which act to channel the low-level winds. At Greenville-Spartanburg, the average wind direction is generally from the southwest, except during late summer through fall, when the wind comes from the northeast (NCDC 2010a). At Charlotte, the winds are predominately from the south-southwesterly direction, except during late summer through fall, when wind comes from the north-northeast (NCDC 2010b). In both locations, the average wind speeds range from 6 to 8 mph throughout the year (NCDC 2010a, b).

In contrast, the average wind direction measured at the 10-m level on the Lee Nuclear Station site meteorological tower, from December 2005 through November 2006, was from the northwest at approximately 5 mph (Duke 2009c). The predominant northwesterly wind direction at the Lee Nuclear Station site is further supported by consideration of an additional year (December 2006 to November 2007) of onsite meteorological data (Duke 2011b). Differences in wind direction at the various stations are likely due to the channeling of the winds along the Broad River valley at the Lee Nuclear Station site as well as differences in the local topography. These effects are most pronounced when large-scale weather patterns are weak and the wind speed is relatively low. When only cases with wind speeds greater than 5 mph are considered, the predominant wind directions at the Lee Nuclear Station site are from the southwest and northeast, similar to those at Greenville-Spartanburg (Duke 2008h).

2.9.1.2 Atmospheric Stability

Atmospheric stability is a meteorological parameter that describes the dispersion characteristics of the atmosphere. It can be determined by the difference in temperature between two heights. A seven-category atmospheric stability classification scheme, based on temperature differences over a 100-m vertical interval, is established in Regulatory Guide 1.23, Revision 1 (NRC 2007b). When the temperature decreases rapidly with height, the atmosphere is unstable and atmospheric dispersion is greater. Conversely, when temperature increases with height, the atmosphere is stable and dispersion is more limited.

Measurements taken for 1 year (December 2005 through November 2006) at the 60- and 10-m levels at the Lee Nuclear Station site meteorological tower were used to determine atmospheric stability for the site. On an annual basis, the atmosphere at the Lee Nuclear Station site is stable about 50 percent of the time, neutral about 25 percent of the time, and unstable about 25 percent of the time (Duke 2009c). Consideration of an additional year of data (December 2006 through November 2007) results in a similar atmospheric stability distribution (Duke 2011b) for the composite 2-year period of record. Atmospheric stability varies with season and time of day, with stable conditions occurring more frequently at night and unstable conditions occurring more frequently during the day. Seasonally, spring and summer tend to have more extremely unstable conditions because of increased solar heating occurring at the surface. Autumn and winter months exhibit more extremely stable conditions because of reduced solar heating resulting in greater radiational cooling at the surface at night.

2.9.1.3 Temperature

The temperature measured at 10 m above ground at the Lee Nuclear Station site meteorological tower is considered to be reasonably representative of mean temperature conditions in the area around the site. Temperature data from the tower for December 2005 through the November 2006 time period show the daily average temperature ranged from a low of 32°F in December to 84°F in August. During this 1-year period, the absolute minimum temperature was 20°F, and the absolute maximum temperature was 96°F. Consideration of an additional year (December 2006 through November 2007) of onsite meteorological data results in similar temperature trends (Duke 2011b). Longer-term daily average temperatures range from a low of 39°F in January to a high of 77°F in July at the nearby Ninety-Nine Islands NWS cooperative observing station (SERCC 2010a); extreme temperatures have ranged from a minimum of −4°F in December 1962 and January 1985 to a maximum of 106°F in August 1983 (SERCC 2010b).

2.9.1.4 Atmospheric Moisture

The moisture content of the atmosphere can be represented in various ways. The most common are reports of relative humidity, precipitation, and fog. At the Lee Nuclear Station site, the atmospheric humidity is represented using the relative humidity measured 10 m above the ground.

In general, the Piedmont region of the Carolinas experiences high relative humidity throughout much of the year. At Greenville-Spartanburg and Charlotte, the 6-hour average relative humidity is always greater than 50 percent. The highest humidity measurements occur in the early morning hours and are above 80 percent during the months of May through November (NCDC 2010a, b). Humidity at the Lee Nuclear Station site tends to be higher due to the proximity of the Broad River and Ninety-Nine Islands Reservoir. On a diurnal basis, relative humidity levels at the Lee Nuclear Station site (based on measurements between December

2005 and November 2006) appear to be highest during the early morning hours of the summer months (Duke 2009c). This is similar to long-term conditions observed at the two closest first-order NWS stations.

Annual average precipitation amounts at Greenville-Spartanburg, Ninety-Nine Islands, and Charlotte are 50.24, 48.37, and 43.51, respectively (NCDC 2010a, SERCC 2010a, NCDC 2010b). In general, precipitation amounts are fairly evenly distributed throughout the year; however, autumn months tend to be slightly drier. South Carolina has been subject to a number of recent droughts, most notably the periods of 1998 through 2002 (SERCC 2010c) and 2007 through 2008. The precipitation recorded at the Lee Nuclear Station site from December 2005 through November 2006 was 39.72 in. (Duke 2009c) and is comparable to 42.28 in. at Greenville-Spartanburg (NCDC 2010a) over the same period. The 2-year average from December 2005 through November 2007 is 32.70 in. (Duke 2011b) and reflects the more recent dry period.

2.9.1.5 Severe Weather

The Lee Nuclear Station site can experience severe weather in the form of hurricanes, tropical storms, thunderstorms, tornadoes, hail, snow, and ice. Tropical cyclones (e.g., hurricanes, tropical storms, tropical depressions) weaken quickly after they pass over the coast, so regional flooding from excessive rainfall is a larger concern than damaging winds at the Lee Nuclear Station site. The heaviest 1-day rainfall recorded at the nearby Ninety-Nine Islands NWS cooperative station for the period of 1949 to 2005 was 7.16 in. on August 17, 1985 (SERCC 2010b). This rain was associated with Hurricane Danny, which was classified as a tropical depression when it passed through the area (NOAA 2010).

Tornadoes are rare in Cherokee County. A total of 15 tornadoes have been reported within Cherokee County during the period of 1950 to 2010 (NCDC 2010d). Approximately 50 percent of the tornadoes occurred in the months of March through May. Of all the tornadoes observed in Cherokee County, only the May 5, 1989, tornado had a magnitude of F4 (wind speeds ranging from 207 to 260 mph) on the original Fujita scale. Statistical methods (Thom 1963) can be used to compute the probability of the occurrence of a tornado. Given a total path area of 3.57 mi^2 for the 15 tornadoes recorded in Cherokee County, an average of 0.26 tornadoes per year, and that Cherokee County has an area of 392.7 mi^2, the probability of a tornado striking any point in the county is 1.6×10^{-4}/yr. This value is consistent with results obtained from NUREG/CR-4461 (Ramsdell and Rishel 2007), which yields a probability of 3.7×10^{-4}/year.

Thunderstorms are common throughout the Piedmont region of North and South Carolina and occur on approximately 40 days per year. The majority of reported thunderstorms occur during May through July (NCDC 2010a, b). Hail occurred, on average, about four times per year in Cherokee County during the period 1993 to 2010. Damaging hail is less frequent, and damage from hail was reported in only 3 of the last 17 years (NCDC 2010e). The average annual snowfall for the region is approximately 5 to 6 in. Instances of large snowfall amounts are not common; the greatest 24-hour snowfall total was around 12 in. (NCDC 2010a, b).

South Carolina is subject to hurricanes, which have sustained wind speeds greater than 74 mph (119 km/hr); tropical storms, which have wind speeds between 39 and 73 mph (63 and 118 km/hr), respectively; and tropical depressions, which have wind speeds less than 39 mph (63 km/hr). A total of 19 tropical storms and tropical depressions have passed within 50 statute miles of the Lee Nuclear Station site during the period of 1859 to 2009. Hurricane Hugo was the only hurricane to pass within 50 statute miles during the period of record. At the time it passed the site, Hurricane Hugo was a category 2 hurricane on the Saffir-Simpson Hurricane Scale, with a sustained wind speed between 96 and 110 mph (NOAA 2010).

2.9.2 Air Quality

The Lee Nuclear Station site is in Cherokee County, South Carolina, which is located within the Greenville-Spartanburg Intrastate Air Quality Control Region (AQCR); this AQCR also includes the counties of Anderson, Greenville, Oconee, Pickens, and Spartanburg (40 CFR 81.106). Within this AQCR, the counties of Anderson, Greenville, and Spartanburg are classified as maintenance areas for the 8-hour ozone National Ambient Air Quality Standard (NAAQS). All other counties, including Cherokee County, are designated as being in attainment or unclassified for NAAQS criteria pollutants (40 CFR 81.341).

Prior to 1992, Cherokee County had been designated as a marginal ozone nonattainment area for the 1-hour ozone standard; however, this standard was revoked on June 15, 2005 (40 CFR 81.341). As part of the anti-backsliding provisions in the final rule to implement the 8-hour ozone standard, a 40 CFR 52 (Clean Air Act) Section 110(a)(1) maintenance plan was prepared for Cherokee County and submitted to the EPA in 2007 (SCDHEC 2007a); it was finalized in 2010 (75 FR 3870). The purpose of the plan is to ensure that Cherokee County remains in compliance with ozone standards. However, this maintenance plan does not carry any conformity obligations (EPA 2010a).

SCDHEC operates a statewide air-monitoring network composed of 34 sites that monitor various criteria pollutants (SCDHEC 2012b). The closest monitoring stations to the Lee Nuclear Station are the Cowpens National Battlefield in Cherokee County and York in York County. Additional nearby stations are located in the Spartanburg and Greenville areas, and include the North Spartanburg Fire Station site. Monitoring results at all locations indicate that as of 2012, there were no days on which the NAAQS criteria for sulfur dioxide, nitrogen dioxide, carbon monoxide, or particulate matter were exceeded (SCDHEC 2012b). In 2008, the NAAQS 8-hour ozone standard was reduced from 0.080 to 0.075 parts per million (ppm) (73 FR 16436). Monitoring results from 2011 and 2012 indicate that all locations were within the standard (SCDHEC 2012c).

Six areas in North and South Carolina are designated in 40 CFR 81.422 and 40 CFR 81.426, respectively, as mandatory Class I Federal areas in which visibility is an important value. The nearest Class I area is the Linville Gorge Wilderness Area, which is more than 50 mi north-northwest of the Lee Nuclear Station site.

2.9.3 Atmospheric Dispersion

Atmospheric dispersion factors, referred to as χ/Q values, are used to evaluate the potential consequences of routine and accidental releases at the Lee Nuclear Station site. Duke used 2 years (December 2005 through November 2007) of onsite meteorological data to calculate χ/Q values (Duke 2013c). The meteorological data were provided to the NRC staff so that independent, confirmatory estimates could be made. Because accurate meteorological measurements are necessary for calculating site-specific χ/Qs, the NRC staff viewed the Lee Nuclear Station site meteorological tower and instrumentation, reviewed the meteorological monitoring program information, and evaluated the program's data. Based on this information, the NRC staff concludes that the meteorological program provides data that represent the affected environment as required by 10 CFR 100.20. The data therefore provide an acceptable basis for making estimates of atmospheric dispersion for the evaluation of the consequences of long-term routine and short-term accidental releases required by 10 CFR 50.34; 10 CFR Part 50, Appendix I; and 10 CFR 52.79. These estimates are provided in the following sections.

2.9.3.1 Long-Term Dispersion Estimates

Long-term, routine release atmospheric dispersion (χ/Q) and atmospheric deposition (D/Q) factors for the Lee Nuclear Station site were calculated using the XOQDOQ dispersion program (Sagendorf et al. 1982). XOQDOQ, which implements Regulatory Guide 1.111 (NRC 1977a), is a straight-line Gaussian plume model that calculates annual average values for the 16 cardinal directions at the exclusion area boundary (EAB), the low population zone (LPZ), discrete distances and ranges of distances extending out to 50 mi, and other receptor locations (e.g., the site boundary, nearest milk cow, milk goat, garden, meat animal, and residence). Two years of onsite meteorological data (December 2005 through November 2007), which include estimates of atmospheric stability and measurements at the 10-m level for wind speed and wind direction, were used in the calculation. In addition, the XOQDOQ model analysis was performed assuming a ground-level release and accounted for enhanced dispersion due to building wake effects.

The maximum annual average relative atmospheric dispersion and deposition factors are reported in Table 2-29. The relative atmospheric dispersion factors, accounting for deposition (i.e., depleted) are also provided. Values listed in Table 2-29 are used in Section 5.9 of this EIS to estimate radiological health impacts of normal operations.

Table 2-29. Maximum Annual Average Atmospheric Dispersion and Deposition Factors for Evaluation of Normal Effluent Releases for Receptors of Interest (Duke 2013a, 2013g)

Receptor	Downwind Sector	Distance (mi)	No Decay Undepleted χ/Q (s/m^3)	No Decay Depleted χ/Q (s/m^3)	D/Q (1/m^2)
Site boundary[(a)]	NW, Unit 1	0.27	1.5×10^{-5}	1.3×10^{-5}	2.9×10^{-8}
EAB	SE, Unit 2	0.81	6.3×10^{-6}	5.6×10^{-6}	1.3×10^{-8}
Residence	SE	0.99	4.6×10^{-6}	4.0×10^{-6}	9.4×10^{-9}
Meat animal	SE	1.65	2.2×10^{-6}	1.8×10^{-6}	3.9×10^{-9}
Vegetable garden	SSE	1.00	2.4×10^{-6}	2.1×10^{-6}	4.3×10^{-9}
Milk cow	SE	1.65	2.2×10^{-6}	1.8×10^{-6}	3.9×10^{-9}
Milk goat	SSW	1.05	1.6×10^{-6}	1.4×10^{-6}	3.6×10^{-9}

(a) In response to an NRC staff request for additional information (RAI), Duke reevaluated its air dispersion modeling and revised their calculations (Duke 2013g). At the time of publication of this final EIS, the NRC staff review of the applicant's RAI response to assure that the applicant meets all applicable regulatory requirements is ongoing. NRC's evaluation of Duke's response will be addressed in the NRC's Final Safety Evaluation Report and any changes to the COL application that are deemed necessary will be incorporated into the applicant's FSAR.

2.9.3.2 Short-Term Dispersion Estimates

Short-term, accidental release atmospheric dispersion (χ/Q) factors for the Lee Nuclear Station site were calculated using the PAVAN dispersion program (Bander 1982). PAVAN, which implements Regulatory Guide 1.145 (NRC 1983), is a straight-line Gaussian plume model that calculates short-term average χ/Q values at the EAB and LPZ as a function of 16 cardinal directions for various time periods. A joint frequency distribution of wind speed and wind direction by atmospheric stability classes was created from 2 years (December 2005 through November 2007) of onsite hourly data. For the purpose of estimating dose to the environment, 50th percentile χ/Q values are used and represent typical meteorological conditions that can be expected in the site vicinity (NRC 1976a). Based on the AP1000 reactor design, the release point is considered to be near ground level.

Table 2-30 provides a summary of the Lee Nuclear Station site χ/Q values for the 0- to 2-hour period at the EAB and the 0- to 8-hour, 8- to 24-hour, 1- to 4-day, and 4- to 30-day periods at the LPZ (Duke 2013c). Values listed in Table 2-30 are used in Section 5.11 of this EIS to estimate dose for design-basis accidents (DBAs).

Table 2-30. Short-Term Atmospheric Dispersion Factors for Lee Nuclear Station Site DBA Calculations

Time Period	Boundary	χ/Q (s/m^3)
0 to 2 hours	EAB	8.30×10^{-5}
0 to 8 hours	LPZ	8.80×10^{-6}
8 to 24 hours	LPZ	7.51×10^{-6}
1 to 4 days	LPZ	5.33×10^{-6}
4 to 30 days	LPZ	3.25×10^{-6}

Source: Duke 2013c

2.9.4 Meteorological Monitoring

Meteorological monitoring at the Lee Nuclear Station site originally began in the 1970s, when the site was first considered for nuclear reactors. Lee Nuclear Station site Tower 2 was constructed and commenced operation on December 1, 2005 for the purpose of meeting current licensing activities; this tower is discussed in the applicant's ER and in more detail below. In addition, a third meteorological tower has been installed to meet the operational needs of a licensed plant (Duke 2009c).

Tower 2 is a 60-m meteorological tower, instrumented with wind and temperature sensors at the 10- and 60-m levels. Dewpoint temperature is also measured at the 10-m level. In addition, temperature, pressure, incoming solar radiation, and precipitation are measured near ground level (Duke 2009c). Tower 2 became operational on December 1, 2005, to provide meteorological information needed for siting purposes. The instrumentation on this tower meets the recommendations described in Revision 1 of Regulatory Guide 1.23 for meteorological monitoring programs for nuclear power plants (NRC 2007b).

Data acquired by the meteorological monitoring system are stored by the local data logger and are available for remote access. Each sensor is sampled at least once every second; these data are used to compute 1-minute, 15-minute, and 1-hour averages (Duke 2013c). Data are collected by Duke's Ambient Monitoring Group on a daily basis for preliminary analysis. Onsite checks are performed monthly to verify proper operation of the system. Site technicians also complete a review of all data collected during the previous month. Additional review is conducted by Duke's Ambient Monitoring Group (Duke 2009c).

The meteorological equipment is kept properly calibrated and in good working order by trained staff members. All equipment is calibrated or replaced at least every 6 months. The methods for maintaining a calibrated set of instruments and data-collection system include field checks, field calibration, and/or replacement by laboratory-calibrated components. More frequent calibration can be conducted if required (Duke 2009c).

2.10 Nonradiological Environment

This section describes aspects of the environment at the Lee Nuclear Station site and within the vicinity of the site associated with nonradiological human health impacts. It provides the basis for evaluation of impacts on human health from building and operation of the proposed Lee Nuclear Station Units 1 and 2. Building activities have the potential to affect public and occupational health, create impacts from noise, and affect the health of the public and workers by transportation of construction materials and personnel to the Lee Nuclear Station site. Operation of the proposed Lee Nuclear Station Units 1 and 2 has the potential to affect the public and workers at the Lee Nuclear Station site from operation of the cooling system, noise generated by operations, electromagnetic fields (EMFs) generated by transmission systems, and transportation of operations and outage workers to and from the Lee Nuclear Station site.

2.10.1 Public and Occupational Health

This section describes public and occupational health at the Lee Nuclear Station site and vicinity associated with air quality, occupational injuries, and etiological (i.e., disease-causing) agents.

2.10.1.1 Air Quality

Public and occupational health can be affected by changes in air quality from activities that contribute to fugitive dust, vehicle and equipment exhaust emissions, and automobile exhaust from commuter traffic (NRC 2013a). Air quality for Cherokee County is discussed in Section 2.9.2. Fugitive dust and other particulate matter (including particulate matter smaller than 10 μm and particulate matter smaller than 2.5 μm) can be released into the atmosphere during any site excavations and while grading is being conducted. Most activities that generate fugitive dust are short in duration, cover a small area, and can be controlled by watering unpaved roads, stabilizing construction roads and spoil piles, and other best management practices described in Section 4.4.1.6 (Duke 2009c). Mitigation measures to minimize and control fugitive dust are required for compliance with all Federal, State, and local regulations that govern such activities (NRC 2013a; Duke 2009c).

Exhaust emissions during normal plant operations associated with onsite vehicles and equipment as well as from commuter traffic can affect air quality and human health. Supporting equipment (e.g., diesel generators, fire-prevention pump engines), and other nonradiological emission-generating sources (e.g., storage tanks) or activities are not expected to be a significant source of criteria pollutant emissions. Diesel generators and supporting equipment would be in place for emergency use only but would be started regularly to confirm that the systems are operational. Emissions from nonradiological sources of air pollution are permitted by the SCDHEC.

2.10.1.2 Occupational Injuries

In general, occupational health risks to workers and onsite personnel engaged in activities such as building, maintenance, testing, excavation, and modifications are dominated by occupational injuries (e.g., falls, electric shock, asphyxiation) or occupational illnesses. Historically, actual injury and illness rates for building and operating utility systems have been lower than the average U.S. industrial rates (BLS 2011b). The U.S. Bureau of Labor Statistics (BLS) provides reports that account for occupational injuries and illnesses as total recordable cases, including cases that result in loss of consciousness, days away from work, restricted work activity or job transfer, or medical treatment beyond first aid. The State of South Carolina also tracks the annual incidence rates of injuries and illnesses for utility system construction. These records of statistics are used to estimate the likely number of occupational injuries and illnesses for building and operating the proposed units. According to the BLS, rates for occupational injuries and illnesses in years 2001 to 2009 ranged from 3.8 to 7.8 for the United States and 2.8 to 5.7 for South Carolina for heavy and civil engineering construction and utility system construction, respectively (BLS 2011b, c). For the same years, rates for utilities and electric power generation, transmission, and distribution ranged from 3.3 to 5.7 for the United States and 1.3 to 3.2 for South Carolina (BLS 2011b, c).

2.10.1.3 Etiological Agents

Public and occupational health can be compromised by activities at the Lee Nuclear Station site that encourage the growth of etiological agents. Thermal discharges from proposed Lee Nuclear Station Units 1 and 2 into the circulating-water system and the Broad River (Duke 2009c) have the potential to increase the growth of thermophilic microorganisms. The types of organisms of concern for public and occupational health include enteric pathogens (e.g., *Legionella* spp.) and free-living amoeba (e.g., *Naegleria fowleri* and *Acanthamoeba* spp.). These microorganisms could result in potentially serious human health concerns, particularly at high exposure levels.

A review of the outbreaks of human waterborne diseases in South Carolina indicates that the incidence of most of these diseases is not common. Available data assembled by the U.S. Centers for Disease Control and Prevention (CDC) for the years 1996 to 2007 (CDC 1997, 1998, 1999, 2001, 2002, 2003, 2004, 2005, 2006, 2007) report only two occurrences of waterborne outbreaks of disease from recreational water in South Carolina. From 1989 to 2000, the CDC surveillance system for waterborne-disease outbreaks documented 24 fatal cases of primary amebic meningoencephalitis (a disease caused by *Naegleria fowleri*) in the United States, most occurring in southern states during July and September (CDC 2008). Outbreaks of Legionellosis, Salmonellosis, or Shigellosis that occurred in South Carolina were within the range of national trends in terms of cases per 100,000 population or total cases per year, and the outbreaks were associated with pools, spas, or lakes (CDC 1997, 1998, 1999, 2001, 2002, 2003, 2004, 2005, 2006, 2007).

Epidemiological reports from South Carolina indicate a very low risk of outbreaks from thermophilic microorganisms associated with recreational water (CDC 2006). In the *South Carolina Annual Report on Reportable Conditions* for the years 2007 and 2008, the SCDHEC reported 28 cases of Legionellosis, 11 cases of Salmonellosis, and 1 case of Shigellosis in Cherokee County (SCDHEC 2010b).

No SCDHEC water-quality monitoring stations are located in the vicinity of the proposed discharge for the Lee Nuclear Station. The closest USGS water-quality monitoring station to Lee Nuclear Station is USGS 02153551, which is located on the Broad River just below Ninety-Nine Islands Reservoir. A discussion of water quality in the Broad River is included in Section 2.3.3.1. The main recreational activities associated with the Broad River are fishing, boating, and occasional swimming (Duke 2009c). The closest recreation area to the proposed site is Ninety-Nine Islands Reservoir, directly east-adjacent to the site and where the proposed Lee Nuclear Station will discharge thermal effluent, upstream of the dam (Duke 2009c). Ninety-Nine Islands Reservoir features the Cherokee Ford Recreation Area, upstream of the Lee Nuclear Station site on the west bank of the reservoir near Goat Island; Pick Hill boat access, just north of the dam on the east bank of reservoir; and another access area just south of the dam on the east bank that has a canoe portage, a tailrace fishing area, and a boat ramp (Duke 2009c).

2.10.2 Noise

Existing sources of noise at the Lee Nuclear Station site, other than natural sources, are limited to the occasional use of maintenance equipment, traffic entering and exiting the site, and security activities (Duke 2011b). In the summer of 2006, an ambient noise survey was conducted on the Lee Nuclear Station site that identified offsite noise levels at several sensitive receptor locations in the ranges of 28 and 83 dBA for daytime levels and between 36 and 75 dBA for nighttime levels (Duke 2011b). For context, the sound intensity of a quiet office is 50 dBA, normal conversation is 60 dBA, busy traffic is 70 dBA, and a noisy office with machines or an average factory is 80 dBA (Tipler 1982).

Regulations governing noise associated with the activities at the Lee Nuclear Station site are generally limited to worker health. Federal regulations governing construction noise are found in 29 CFR Part 1910, *Occupational Health and Safety Standards*, and 40 CFR Part 204, *Noise Emission Standards from Construction Equipment*. The regulations in 29 CFR Part 1910 deal with noise exposure in the construction environment, and the regulations in 40 CFR Part 204 generally govern the noise levels of compressors.

2.10.3 Transportation

According to the ER (Duke 2009c), the Lee Nuclear Station site is served by a transportation network of Federal and State highways, one primary freight rail service, and two primary commercial passenger airports. Because of downstream dams, the Lee Nuclear Station site cannot be accessed by barge. Within Cherokee and York Counties, there are two interstate highways and four Federal highways. I-85 runs northeast through northern Cherokee County, entering the county north of Cowpens, South Carolina, passing on the northern boundaries of Gaffney and Blacksburg, South Carolina, then crossing into North Carolina east of Grover, North Carolina. I-77 runs north to south through eastern York County, entering the county south of Rock Hill, South Carolina, passing through eastern portions of Rock Hill, South Carolina, and western portions of Fort Mill, South Carolina, and then crossing into North Carolina on the south side of Charlotte, North Carolina. US-221 passes through the extreme northwest corner of Cherokee County, South Carolina. US-29 parallels I-85 through Cherokee County, passing through downtown Gaffney and Blacksburg, South Carolina. US-321 runs north to south through central York County, passing through McConnells, York, and Clover, South Carolina. US-21 runs north to south through eastern York County, passing through Lesslie, Rock Hill, and Fort Mill, South Carolina. Numerous state routes pass through the counties, providing rural areas access to the urban areas. Access to the site is only available on McKowns Mountain Road on the south side of the site. The majority of proposed Lee Nuclear Station Units 1 and 2 construction and operations workers are expected to reside in Cherokee and York Counties.

Cherokee and York Counties consist of both urban and rural roadways. Vehicle volume on roads, obtained from estimated Annual Average Daily Traffic (AADT) data from the South Carolina Department of Transportation, reflects the urban and rural character of the counties. AADT counts for 2006 indicate that approximately 7000 vehicles traveled on US-29 between SC 329 and SC 5 and a maximum of approximately 5600 vehicles travel on SC 5 between US-29 and SC 55. Approximately 5000 vehicles also travel along SC 105 between SC 211 and SC 18. Approximately 1600 vehicles travel on SC 329 between SC 105 and US-29, and approximately 425 vehicles travel on SC 97 between SC 5 and the York County line. Approximately 950 vehicles travel McKowns Mountain Road between SC 105 and the end of the road (near the Broad River). McKowns Mountain Road is also known as Cherokee County Highway 13 and County Road 13.

According to the South Carolina Department of Transportation, no road modifications near the Lee Nuclear Station site are planned; however, several road construction projects are planned in Cherokee County between 2011 and 2016. Planned projects include installation of a bridge over Furnace Creek on S-41, an emergency bridge replacement on SC 150 at I-85, and replacement of a bridge 2 mi east of Gaffney on US-29. SC 329 and McKowns Mountain Road were upgraded in the 1970s to handle anticipated truck traffic for construction of the Cherokee Nuclear Station.

2.10.4 Electromagnetic Fields

Transmission lines generate both electric and magnetic fields, referred to collectively as EMFs. Public and worker health can be compromised by acute and chronic exposure to EMFs from power transmission systems, including switching stations (or substations) onsite and transmission lines connecting the plant to the regional electrical distribution grid. Transmission lines operate at a frequency of 60 Hz (60 cycles per second), which is considered to be extremely low frequency (ELF). In comparison, television transmitters have frequencies of 55 to 890 MHz and microwaves have frequencies of 1000 MHz and greater (NRC 1996).

Electric shock resulting from direct access to energized conductors or from induced charges in metallic structures is an example of an acute effect from EMFs associated with transmission lines (NRC 1996). Objects near transmission lines can become electrically charged by close proximity to the electric field of the line. An induced current can be generated in such cases, where the current can flow from the line through the object into the ground. Capacitive charges can occur in objects that are in the electric field of a line, storing the electric charge, but isolated from the ground. A person standing on the ground can receive an electric shock from coming into contact with such an object because of the sudden discharge of the capacitive charge through the person's body to the ground. Such acute effects are controlled and minimized by conformance with National Electrical Safety Code (IEEE 2011) criteria that limit the induced current from electrostatic effects to 5 mA.

Long-term or chronic exposure to power transmission lines has been studied for a number of years. These health effects were evaluated in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, *Main Report* (GEIS) (NRC 1996) for nuclear power in the United States and are discussed in the ER (Duke 2009c). The GEIS (NRC 1996) reviewed human health and EMF and concluded:

> The chronic effects of electromagnetic fields (EMFs) associated with nuclear plants and associated transmission lines are uncertain. Studies of 60-Hz EMFs have not uncovered consistent evidence linking harmful effects with field exposures. EMFs are unlike other agents that have a toxic effect (e.g., toxic chemicals and ionizing radiation) in that dramatic acute effects cannot be forced and longer-term effects, if real, are subtle. Because the state of the science is currently inadequate, no generic conclusion on human health impacts is possible.

2.11 Radiological Environment

No operations involving radioactive materials have occurred at the Lee Nuclear Station site; the Cherokee Nuclear Station reactors were left unfinished. Two main sources of natural background radiation exist: cosmic radiation, produced by collisions of high-energy particles in the upper atmosphere, and naturally occurring terrestrial radionuclides in rocks and soils. The cosmic ray background varies with geomagnetic latitude and elevation; the cosmic ray dose rate in North and South Carolina is about 25 mrem/yr. The dose rate from uranium, thorium, potassium, and related natural radionuclides depends on the underlying geology. Two main regions with differing natural terrestrial radionuclide dose rates are found in North and South Carolina: the Atlantic Coastal Plain and the Piedmont (National Academy of Sciences 1980). The Atlantic Coastal Plain rises from the sandy beaches of the Atlantic coast to about 300 ft elevation (called the fall line), and the Piedmont rises from about 300 ft to a high of about 1500 ft where it meets the Blue Ridge. Terrestrial dose rates in the Atlantic Coastal Plain average between 15 and 35 mrem/yr, and terrestrial dose rates in the Piedmont average between 35 and 75 mrem/yr. When combined with the cosmic ray contribution, direct natural radiation in North and South Carolina ranges between 40 to 60 mrem/yr in the coastal plain and 60 to 100 mrem/yr in the Piedmont. Therefore, the naturally occurring background radiation dose rates at the Lee Nuclear Station site should be in the anticipated range of 60 to 100 mrem/yr, which is consistent with the United States average of about 100 mrem/yr from direct radiation (NCRP 2009).

Two years prior to the operation of Lee Nuclear Station Unit 1, preoperational radiological monitoring would be used to establish the baseline for local radiological environmental conditions along the pathways of exposure discussed in Section 5.9.1 (Duke 2009c).

2.12 Related Federal Projects and Consultation

The staff reviewed the possibility that activities of other Federal agencies might impact the issuance of COLs to Duke. Any such activities could result in cumulative environmental impacts and the possible need for another Federal agency to become a cooperating agency for preparation of the EIS (10 CFR 51.10(b)(2)). As discussed in Chapter 1, the USACE is a cooperating agency and the FERC is a participating agency in the preparation of this EIS.

Ninety-Nine Islands Dam and Ninety-Nine Islands Hydroelectric Project are located on the Broad River just downstream of the Lee Nuclear Station site. The 18-MW hydroelectric project is licensed to operate by the FERC (FERC 2011c). The Ninety-Nine Islands Reservoir is part of the hydroelectric project (FERC No. 2331) and is under the jurisdiction of the FERC. In the summer of 2013, Duke intends to submit to the FERC an application for Non-Project Use of Project Lands and Water. This application would cover four actions in the Ninety-Nine Islands Reservoir related to the proposed Lee Nuclear Station: (1) construction of the river intake structure in the reservoir, (2) construction of the discharge pipe in the reservoir, (3) withdrawal of water from the reservoir, and (4) discharge of water to the reservoir. Duke has initiated early consultation with the FERC regarding the proposed actions.

Federal lands within a 50-mi radius of the Lee Nuclear Station site include Kings Mountain National Military Park, Cowpens National Battlefield, and Sumter National Forest. The Sumter National Forest is managed by the U.S. Department of Agriculture. Several state parks exist within the 50-mi radius, including Kings Mountain State Park in South Carolina and Crowders Mountain State Park in North Carolina. The SCDNR has classified the Broad River south of

Ninety-Nine Islands Dam to the confluence with the Pacolet River as a State Scenic River. The Tribal reservation for the Federally recognized Catawba Indian Nation is approximately 31 mi east-southeast of the Lee Nuclear Station site. Under Section 102(2)(C) of NEPA, the NRC is required to “consult with and obtain the comments of any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved.” During the course of preparing this EIS, the NRC consulted with various Federal, State, and local agencies and Tribal contacts. Appendix F provides a list of consultation correspondence.

3.0 Site Layout and Plant Description

This chapter describes the key plant characteristics that are used in the assessment of the environmental impacts of building and operating the proposed William States Lee III Nuclear Station (Lee Nuclear Station) Units 1 and 2. Units 1 and 2 and supporting buildings would be situated wholly within the 1900-ac Lee Nuclear Station site. Make-Up Pond C, a proposed impoundment to provide supplemental water in case of low flow in the Broad River, would be located northwest of the Lee Nuclear Station site (Figure 3-1). The information for this chapter is drawn from Revision 1 of the environmental report (ER) prepared by Duke Energy Carolinas, LLC (Duke) (Duke 2009c), the Make-Up Pond C supplement to the ER (Duke 2009b), the Final Safety Analysis Report (FSAR) (Duke 2013a), and supplemental documentation provided by Duke (2007c, 2008i, o, 2009k, l, 2010c, d, f, h, k-m, 2011a, e-f, h-i, 2012b, e-k, 2013c, d).

Whereas Chapter 2 of this environmental impact statement (EIS) describes the existing environment of the proposed site and its vicinity, this chapter describes the physical layout of the proposed plant. This chapter also describes the physical activities involved in building and operating the plant. The environmental impacts of building and operating the plant are discussed in Chapters 4 and 5, respectively. This chapter is divided into four sections. Section 3.1 describes the external appearance and layout of the proposed plant. Section 3.2 describes the major plant structures and distinguishes structures that routinely interface with the environment from those that minimally or temporarily interface with the environment. Section 3.3 describes the activities involved in building or installing each of the plant structures. Section 3.4 describes the operational activities of the plant that interface with the environment.

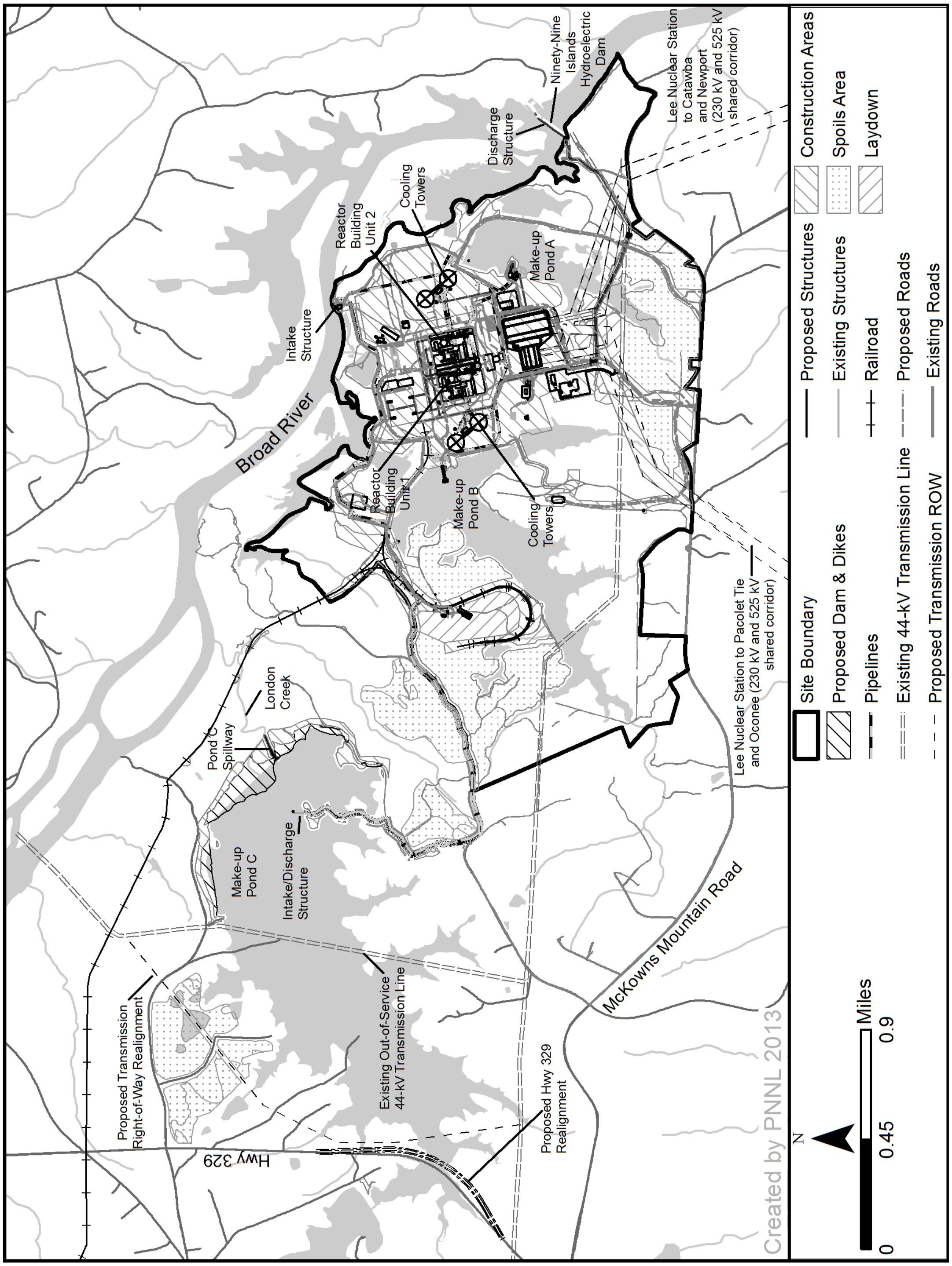

Figure 3-1. Lee Nuclear Station Site and Proposed Make-Up Pond C

3.1 External Appearance and Plant Layout

The proposed Lee Nuclear Station would be located on the site of the unfinished Cherokee Nuclear Station, for which a construction permit was granted to Duke Power Company by the U.S. Nuclear Regulatory Commission (NRC) in 1975 (NRC 1975a). The containment structure of Cherokee Nuclear Station Unit 1 (of three proposed units) was partially complete when construction was halted in 1982; it was demolished in 2007. The proposed Lee Nuclear Station site development is shown in Figure 3-1. The proposed Units 1 and 2 would be located on the 750-ac portion of the site that was previously disturbed by site preparation and building of the unfinished Cherokee Nuclear Station (Duke 2009c). Some of the existing warehouses built before 1982 will be used to support Lee Nuclear Station building activities. An existing basemat[a] installed for the unfinished Cherokee Nuclear Station Unit 1 will be used as fill for Lee Nuclear Station Unit 1, which will be installed at a higher elevation (Duke 2009c). All other previously constructed buildings were demolished in 2007 and 2008; other than reuse of some warehouses, all support buildings and facilities for Lee Nuclear Station will be new.

The proposed location of Lee Nuclear Station Units 1 and 2, would have a design site grade of 593 ft above mean sea level (MSL) (Duke 2013a). The containment vessel, shield building, and auxiliary building make up the "nuclear island," which is one of five principal structures of the standard Westinghouse Electric Company, LLC (Westinghouse) Advanced Passive 1000 (AP1000) pressurized water nuclear power reactor proposed for Lee Nuclear Station Units 1 and 2. The other four principal structures of an AP1000 unit are the turbine building, diesel generator building, radwaste building, and annex building. In a letter dated December 20, 2012, Duke notified the NRC that a slight shift in the location of the proposed Units 1 and 2 was required to manage project construction risks and that the plant grade elevation was being increased by 3 ft (Duke 2012l). The remainder of Chapter 3 Site Layout and Plant Description incorporates the 3-ft increase in site grade and slight shift in the location of Units 1 and 2 (Unit 1 shifts 50 ft east and both units shift 66 ft south).

The footprint areas of the new units are adjacent to each other, with the center of Unit 2 situated 800 ft east and slightly north of the center of Unit 1. Each new reactor unit would be supported by two mechanical draft cooling towers for the circulating-water system (CWS), each 85 ft high and 360 ft in diameter. The proposed location for the Unit 1 cooling towers is approximately 1000 ft west of Unit 1; the proposed location for the Unit 2 cooling towers is approximately 1000 ft east of Unit 2. The CWS cooling-tower bases would be at an elevation 588 ft above MSL (Duke 2012g, 2013a). Each unit also has one mechanical draft cooling tower for the

(a) Basemat is a commonly used type of foundation for five principal building structures at nuclear power plants: reactor building, turbine building, annex building, diesel generator foundation, and radwaste building. In general, a basemat is a flat, thick slab that supports the specific building. During construction, special consideration is given to the structural integrity of junctions with sidewalls and sumps.

service-water system (SWS). The total area required for the proposed two power-generating units, four CWS cooling towers, and associated structures for the CWS would be approximately 100 ac (Duke 2013c). Figure 3-2 is a rendering of how the proposed Units 1 and 2 and CWS cooling towers would appear on the site.

Figure 3-2. Artist Rendering of Proposed Units 1 and 2 Superimposed on the Lee Nuclear Station Site (Duke 2012g)

3.2 Proposed Plant Structures

This section describes each of the major plant structures: the reactor power system, structures that would have a significant interface with the environment during operation, and the balance of plant structures. All of these structures are relevant in the Chapter 4 discussion of the impacts of building proposed Units 1 and 2. Only the structures that interface with the environment are relevant to the operational impacts discussed in Chapter 5.

3.2.1 Reactor Power-Conversion System

Duke has proposed building and operating two Westinghouse AP1000 nuclear power reactors at the Lee Nuclear Station site. On January 27, 2006, the NRC issued the final design certification rule for the AP1000 in the *Federal Register* (71 FR 4464) based on Revision 15 of the AP1000 Design Control Document (DCD). Westinghouse requested to amend the AP1000 DCD with Revision 19 (Westinghouse 2011). Based on a review of Revision 19, NRC issued the AP1000 design certification amendment final rule in the *Federal Register* on December 30, 2011 (76 FR 82079). DCD amendment review documents are available at http://www.nrc.gov/reactors/new-reactors/design-cert/amended-ap1000.html. Each applicant or licensee intending to construct and operate a plant based on the AP1000 design may do so by referencing its design certification rule, as set forth in Appendix D to Title 10 of the *Code of Federal Regulations* (CFR) Part 52. The reactor design referenced in Duke's application is Revision 19 of the certified design (Westinghouse 2011). Figure 3-3 is an illustration of the reactor power-conversion system. Each AP1000 reactor is connected to two steam generators, which transfer heat from the reactor core, converting feed water to steam that drives the turbines that turn the generator, thereby creating electricity. Steam that has passed through the turbines is condensed back to water that is heated and pumped back to the steam generators, repeating the cycle. The AP1000 design has a thermal power rating of 3400 MW(t), with a design gross electrical output of approximately 1200 MW(e). The expected net electrical output for each unit would be 1117 MW(e) (Duke 2009c).

3.2.2 Structures with a Major Environmental Interface

The review team divided plant structures into two primary groups: (1) those that interface with the environment and (2) those that are internal to the reactor and associated facilities but without direct interaction with the environment. Examples of interfaces with the environment are withdrawal of water from the environment at the intake structures, release of water to the environment at the discharge structure, and release of excess heat to the atmosphere. The structures or locations with environmental interfaces are considered in the review team's assessment of the environmental impacts of facility construction and preconstruction in Chapter 4 and of facility operation in Chapter 5. The power-production processes that would occur within the plant itself and that do not affect the environment are not relevant to a National Environmental Policy Act of 1969, as amended (NEPA) review and are not discussed further in this EIS. However, such internal processes are considered by the NRC staff in the Westinghouse AP1000 DCD and in NRC safety reviews of the Lee Nuclear Station Units 1 and 2 combined construction permit and operating license (COL) application. This section (3.2.2) describes the structures with significant plant-environment interfaces. The remaining structures are discussed in Section 3.2.3, inasmuch as they may be relevant in the review team's consideration of impacts discussed in Chapter 4 of this EIS.

Figure 3-4 illustrates the Lee Nuclear Station site layout with a grid overlay to reference the locations of various plant structures and activity areas as they are described in the following sections. Structures for the proposed Units 1 and 2 are located primarily in grid reference area C2.

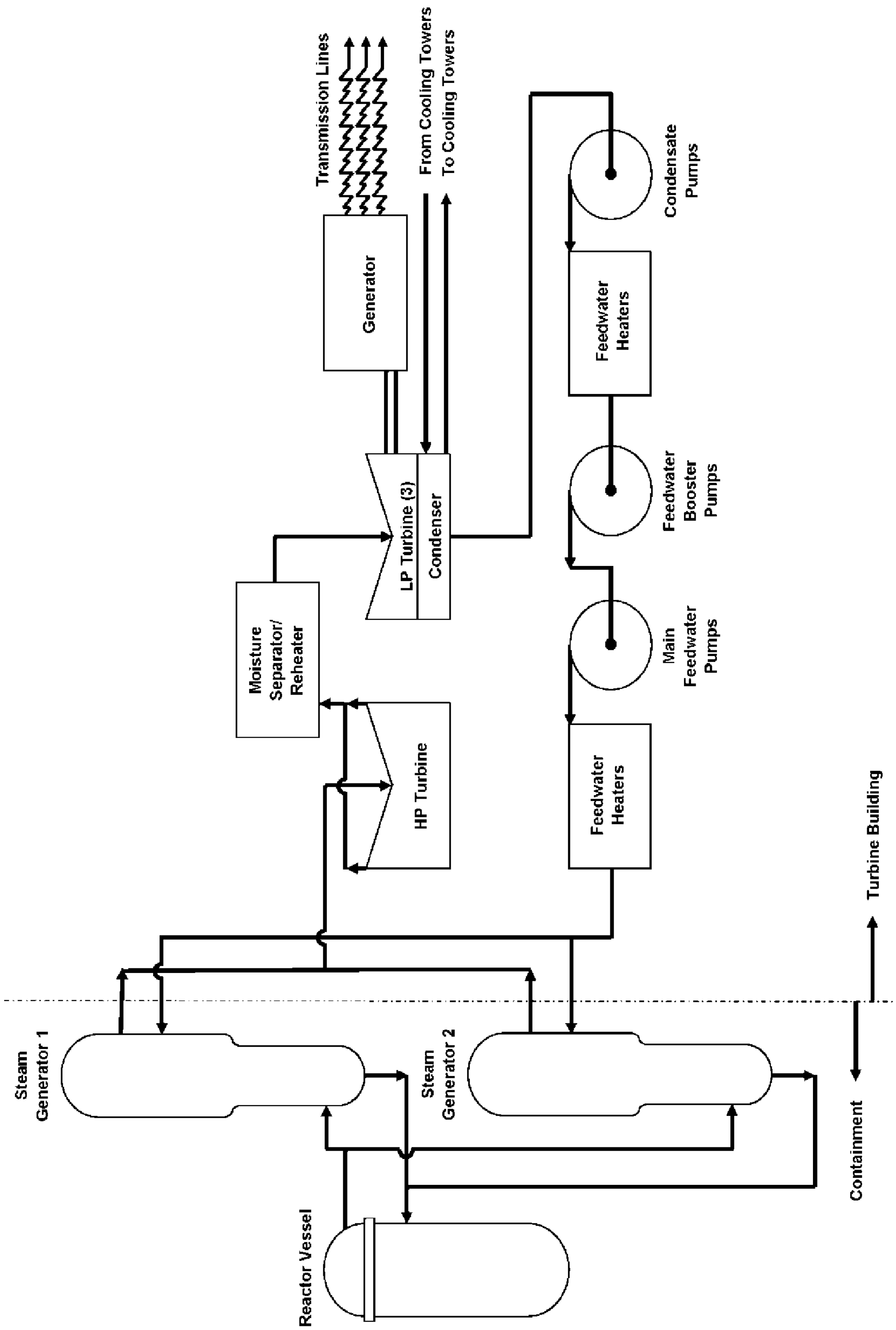

Figure 3-3. AP1000 Power-Conversion Diagram (Duke 2009c)

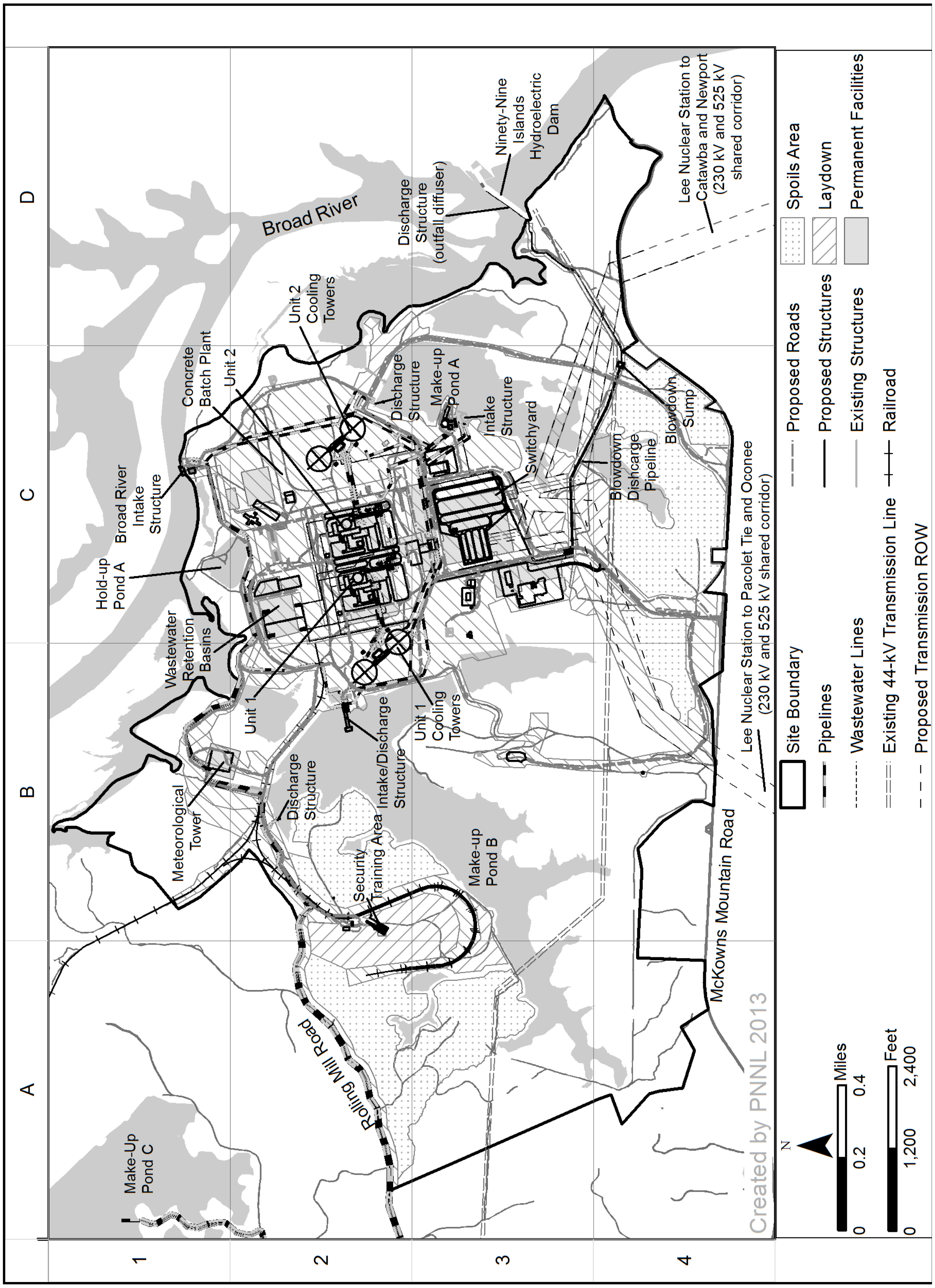

Figure 3-4. Lee Nuclear Station Site Layout Showing Major Structure and Activity Areas for Proposed Units 1 and 2

3.2.2.1 Landscape and Stormwater Drainage

Landscaping and the stormwater-drainage system affect both the recharge to the subsurface and the rate and location at which precipitation drains into adjacent creeks and streams. Impervious areas eliminate recharge to aquifers beneath the site. Pervious areas managed to reduce runoff and kept free of vegetation would experience considerably higher recharge rates than adjacent areas with vegetation. The stormwater management system, including site grading, drainage ditches, swales, retention ponds, and Make-Up Ponds A and B, has safety and environmental functions, keeping locally intense precipitation from flooding safety-related structures and preventing runoff from adversely affecting the environment.

The proposed site would be graded so that stormwater is diverted from Units 1 and 2 to Make-Up Pond A, Make-Up Pond B, or the Broad River (Duke 2009c, 2013a).

3.2.2.2 Cooling System

The cooling system represents the largest interface between the plant and the environment. Makeup water from the Broad River would be provided to the plant via Make-Up Pond A. During periods of low flow when withdrawals from the Broad River are limited, makeup water would be provided from Make-Up Ponds B and C to Make-Up Pond A (Duke 2010f). A portion of the makeup water would be returned to the environment via a discharge structure, also in the Broad River on the upstream side of Ninety-Nine Islands Dam (Figure 3-4). The remaining portion of the water would be released to the atmosphere via evaporative cooling through mechanical draft cooling towers. These components represent interfaces between the plant and the environment. This section describes the components of the proposed cooling system based on the information provided by Duke in its ER, in its supplemental ER regarding Make-Up Pond C (Duke 2009b, c), FSAR (Duke 2013a), and in other supplemental documentation (Duke2010c, f, k-m, 2011e-f, h, 2012e, g-i, 2013c).

Make-Up Ponds A, B, and C

The cooling system for the proposed Units 1 and 2 includes three constructed impoundments: Make-Up Pond A and Make-Up Pond B, which presently exist on the Lee Nuclear Station site, and Make-Up Pond C, which would be built on the London Creek watershed to the northwest of the Lee Nuclear Station site (Figure 3-1). Duke's initial COL application for Units 1 and 2 relied on the existing Make-Up Ponds A and B and the Broad River to supply cooling water; a supplemental water source was not proposed (Duke 2007b). However, low flows in the Broad River during the summer and fall of 2007 resulted in an increased awareness that a severe long-term drought could affect the reliability of baseload generation at the Lee Nuclear Station site, and Duke determined that it was prudent to propose auxiliary water storage for periods of prolonged drought. In addition, the South Carolina Department of Natural Resources expressed concerns that water supply was insufficient to ensure future uninterrupted operation of Lee

Nuclear Station when Broad River water availability was limited by minimum flow requirements (SCDNR 2008b). Therefore, Duke proposed Make-Up Pond C in its 2009 supplement to the ER (Duke 2009b).

Key characteristics of each impoundment are provided in Table 3-1. Duke's estimates of average daily evaporation rates by month are provided in Table 3-2 (Duke 2011e). Evaporation in each pond is a function of surface area, which varies with pond elevation. For example, during June if Make-Up Pond C was at full pool elevation with a surface area of 618 ac, Duke estimated that evaporation would result in a loss of 8.34 ac-ft/d or 4.21 cfs (Table 3-2).

Table 3-1. Elevation, Area, Depth, and Storage Volume of Make-Up Ponds A, B, and C

Impoundment	Normal (full pool) Elevation (ft MSL)	Surface Area at Normal Elevation (ac)	Maximum Depth (ft)	Total Storage Volume (ac-ft)	Maximum Drawdown (ft)	Usable Storage Volume (ac-ft)
Make-Up Pond A	547[(a)]	62[(a)]	57[(a)]	1425[(a)]	29[(a)]	1200[(b)]
Make-Up Pond B	570[(a)]	152[(c)]	59[(a)]	3994[(c)]	30[(c)]	3156[(c)]
Proposed Make-Up Pond C	650[(c)]	618[(c)]	116[(c)]	22,023[(c)]	45[(c)]	17,493[(c,d)]

(a) Source: Duke 2009c
(b) Source: Duke 2013a
(c) Source: Duke 2009b.
(d) Duke estimated that 12,374 ac-ft would be needed to sustain plant operation during an extended drought; the remaining "usable storage" volume would stay in Make-Up Pond C to provide a zone of aquatic refuge (Duke 2011h).

Table 3-2. Duke Estimates of Daily Average Evaporation Rates

Month	Daily Evaporation Rate (ft/d)[(a)]	Daily Evaporation Rate for Make-Up Ponds (cfs)[(a)]		
		Make-Up Pond A	Make-Up Pond B	Make-Up Pond C
January	0.00351	0.11	0.27	1.09
February	0.00512	0.16	0.39	1.59
March	0.00777	0.24	0.60	2.42
April	0.01081	0.34	0.83	3.37
May	0.01217	0.38	0.93	3.79
June	0.01350	0.42	1.03	4.21
July	0.01361	0.43	1.04	4.24
August	0.01245	0.39	0.95	3.88
September	0.00965	0.30	0.74	3.01
October	0.00708	0.22	0.54	2.21
November	0.00478	0.15	0.37	1.49
December	0.00337	0.11	0.26	1.05

Source: Duke 2011e
(a) Daily evaporation rate incorporating pan evaporation values for Clemson, South Carolina, during period July 1948 through 2010 (Duke 2011e).

Make-Up Pond A

Make-Up Pond A, located southeast of proposed Units 1 and 2, is an arm of Ninety-Nine Islands Reservoir impounded by an earthen dam built in the late 1970s (Duke 2009c). Make-Up Pond A serves as the source of water for the plant CWS and treatment system for other plant uses. Water from the Broad River would be delivered to Make-Up Pond A through a discharge structure in the northwest corner of the pond (Figure 3-4, grid reference C2). During periods of low flow in the Broad River, Make-Up Pond A would receive water from Make-Up Pond B through the same discharge structure.

Make-Up Pond B

The primary function of Make-Up Pond B would be to maintain normal water levels in Make-Up Pond A when withdrawals from the Broad River are reduced or terminated due to low flow (Duke 2010f). Make-Up Pond B, located west of proposed Units 1 and 2, receives water from McKowns Creek and surface runoff. This natural recharge from McKowns Creek and surface runoff can be supplemented by pumping from Make-Up Pond A during normal operations, and pumping from Make-Up Pond C when withdrawal from the Broad River is restricted due to low flow. If needed, and if flow in the Broad River is sufficient, Make-Up Pond B also can be filled by pumping directly from the Broad River intake. Water transfers between makeup ponds during plant operation are described in Section 3.4.2.1. Water sent to Make-Up Pond B from the Broad River or from Make-Up Pond C enters the pond through a discharge structure in the northwest corner of the pond (Figure 3-4; water from Make-Up Pond A would enter Make-Up Pond B through a pipe in the Make-Up Pond B intake structure (Figure 3-4, grid reference B2).

Make-Up Pond C

Make-Up Pond C would be created by damming the London Creek drainage upstream of the confluence of Little London Creek, located northwest of proposed Units 1 and 2. The inundated area, impounding structures, intake/discharge structure, pipeline, and other features associated with Make-Up Pond C are shown in Figure 3-5. Duke considered three water-storage components when sizing Make-Up Pond C (Duke 2010l). The primary component was the volume required to support station operations through a drought period, which was based on the number of days of drought on record, the maximum consumptive use rate of 63 cfs, and a 25 percent margin of safety. Duke estimated this volume to be 11,743 ac-ft. The other two components were specific to the topography of the inundated area: (1) the volume needed to avoid disruption of the thermal stratification (assumed to occur in the upper 20 ft of the reservoir, based on observed stratification depths in Make-Up Ponds A and B and Monticello Reservoir), and (2) the volume needed to keep the intakes clear of debris and sediment. Duke estimated these volumes to be 10,133 ac-ft and 147 ac-ft, respectively (Duke 2010l). In its CWA § 316(b) compliance demonstration prepared for the National Pollutant Discharge Elimination System (NPDES) permit application, Duke showed that, at the proposed Make-Up Pond C elevation of

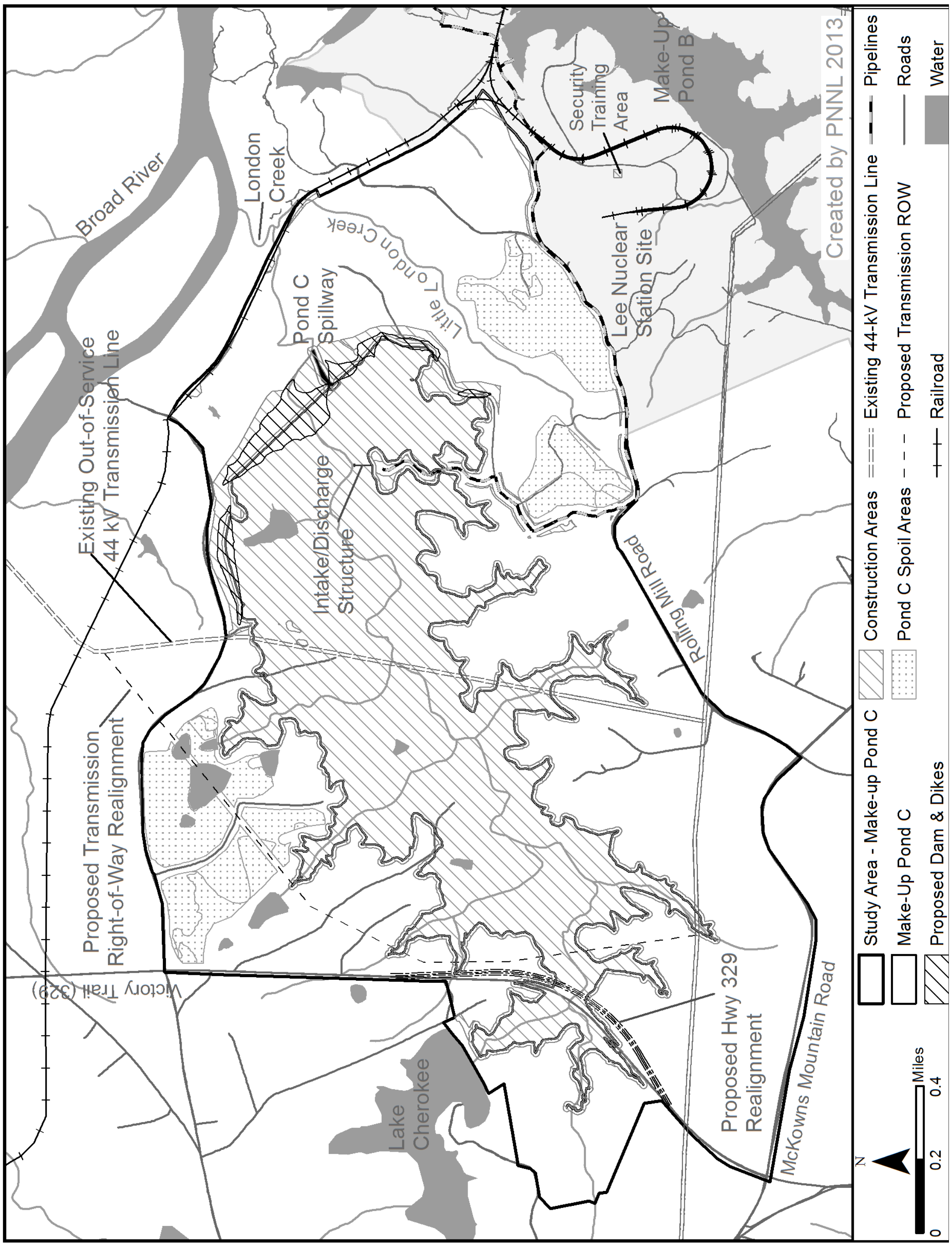

Figure 3-5. Study Area, Inundated Area, Structures, and Activity Areas Associated with Proposed Make-Up Pond C

650 ft above MSL, the proposed new units could be operated 20 days longer than the longest recorded drought within the watershed and that disruption of thermal stratification in the proposed reservoir could be avoided (Duke 2011h, i).

Make-Up Pond C would have a surface area of approximately 620 ac and a maximum depth of 116 ft at its normal pool elevation of 650 ft above MSL (Table 3-1). During normal operations, the level of Make-Up Pond C would be maintained by pumping water from Make-Up Pond B through the combined intake/discharge structure in the southeast corner of Make-Up Pond C (Figure 3-5). Natural precipitation and runoff is expected to contribute an average of 236 gpm to Make-Up Pond C (Duke 2009b). During periods when withdrawal from the Broad River is restricted due to low flows, water can be pumped from Make-Up Pond C to Make-Up Pond B. Following periods when Make-Up Pond C has been drawn down to support plant operations, and flow in the Broad River is sufficient to allow it, Make-Up Pond C can be refilled by pumping water directly from the Broad River intake (Duke 2010f). Operational drawdowns and water transfers between Make-Up Ponds A, B, and C during low-flow conditions in the Broad River are discussed further in Section 3.4.2.1.

Cooling-Water Intake Structures

Broad River Intake Structure

The Broad River intake structure would house two subsystems. The river water (plant raw-water supply) subsystem would supply water to Make-Up Pond A for all plant cooling and non-cooling needs except for potable water. The refill subsystem also would supply water to refill Make-Up Ponds B and C during normal and high flows, if those ponds were drawn down during low flows. The Broad River intake structure would be located on the north side of the Lee Nuclear Station site where the riverbank slope is relatively steep (Figure 3-4, grid reference C1). The Broad River intake would be a concrete structure approximately 142 ft long and approximately 64 ft wide at its base, placed parallel to river flow and flush with the riverbank (Duke 2010f). The proposed design is for eight pumps, four for each subsystem. Four of the pumps (two operating and two on standby) would pump water to Make-Up Pond A for the plant raw-water supply. The other four pumps would be used to directly fill Make-Up Ponds B and C if needed and if permitted by Broad River flow conditions (Duke 2010f). Each pump would be located in a separate pump bay approximately 13 ft wide with a bar rack to trap large debris and a traveling screen system to keep fish and finer debris from entering the plant water system. The traveling screens would be a modified Ristroph design with 0.375-in. mesh and a design through-screen velocity of less than 0.5 fps (Duke 2012i). A system of Fletcher buckets on each screen basket and a low-pressure wash to separate fish from debris would move fish to a trough that would return them to the river downstream of the intake structure. A separate high-pressure wash system would wash debris to a separate trough (Duke 2008i, 2009b). The location of the Broad River intake structure on the riverbank is shown in Figure 3-6. A plan view of the Broad River intake structure is shown in Figure 3-7, and a cross-section view through a pump bay of the Broad River intake structure is shown in Figure 3-8.

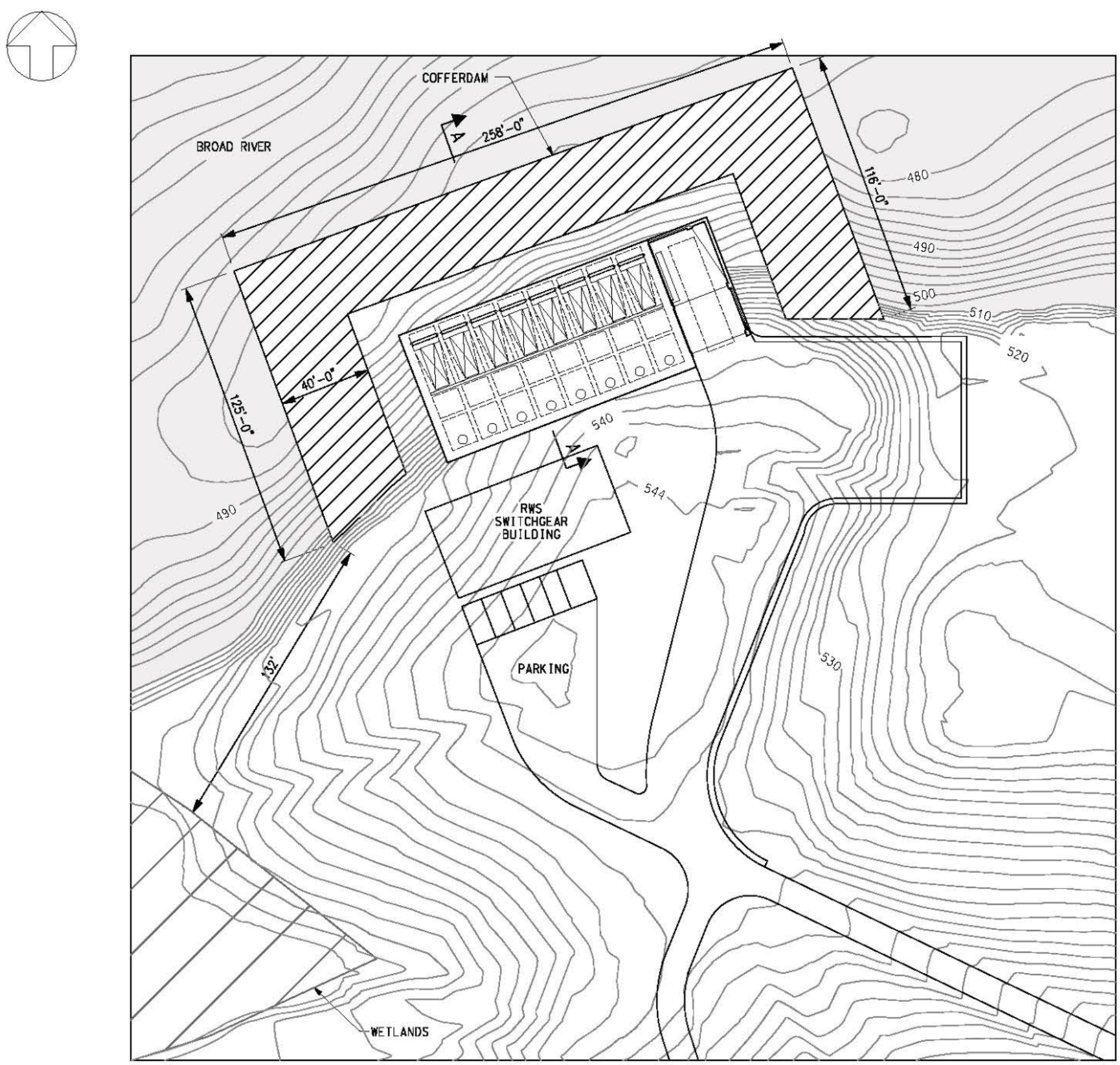

Figure 3-6. Planned Configuration of the Broad River Intake (Duke 2012h)

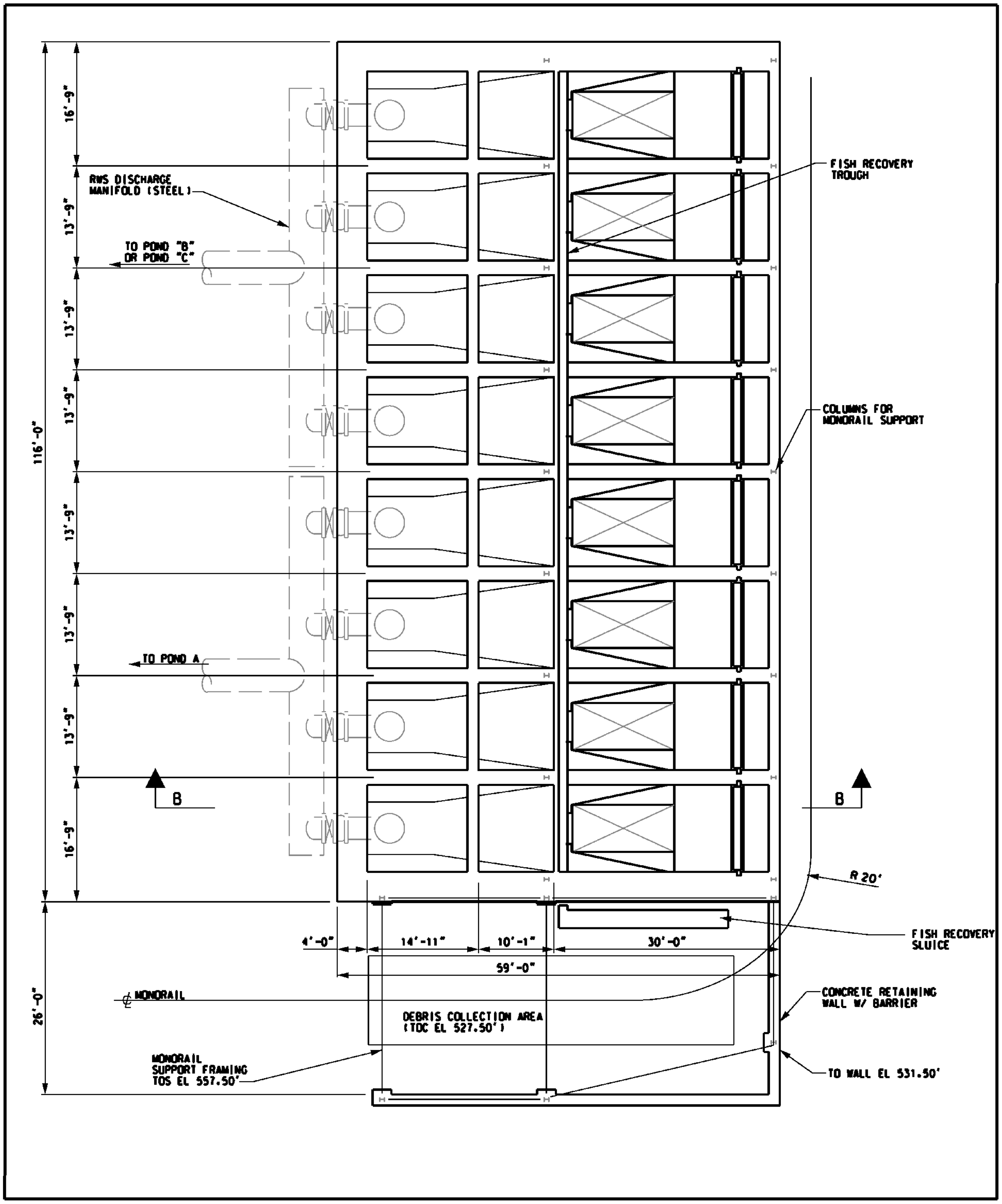

Figure 3-7. Plan View of the Broad River Intake Structure (Duke 2012h)

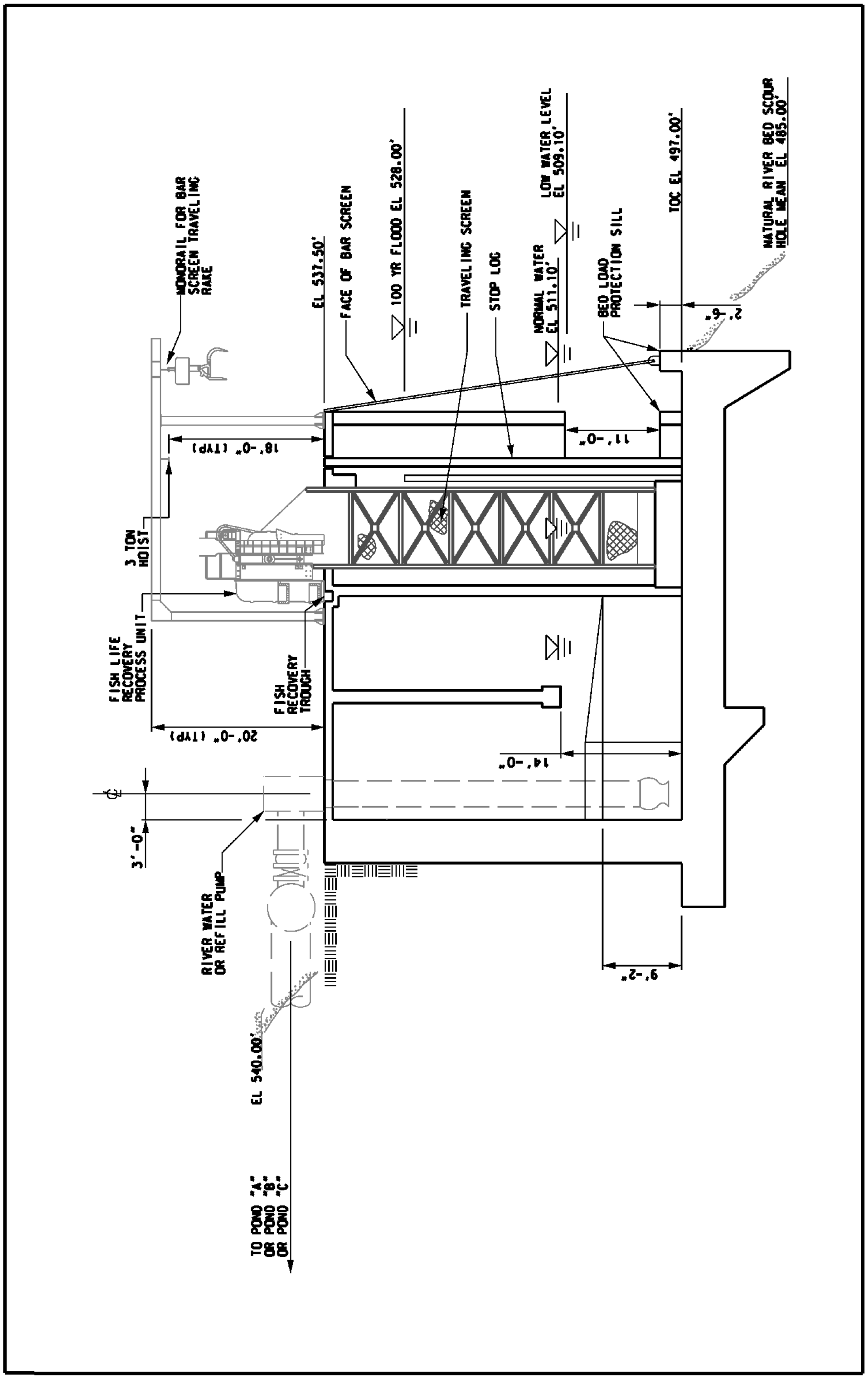

Figure 3-8. Cross-Sectional View of the Broad River Intake Structure (Duke 2012h)

Make-Up Pond A Intake Structure

The intake structure in Make-Up Pond A would pump water to the CWS and the water-treatment system that feeds the SWS and demineralized-water system. The Make-Up Pond A intake structure would be located on the west bank of Make-Up Pond A, approximately 2000 ft southeast of proposed Unit 2 (Figure 3-4, grid reference C3). The intake would be constructed of concrete; would be approximately 70 ft long and 61 ft wide at its base, and would house four raw-water pumps (two pumps per AP1000 unit), each in an individual pump bay (Duke 2012h). The planned layout of the intake structure on the shoreline of Make-Up Pond A is shown in Figure 3-9. Three pumps would operate full time to maintain the supply to the cooling towers; the fourth pump would be on standby (Duke 2012g). Each pump bay would have bar racks to exclude large debris and dual-flow traveling screens to exclude fish and smaller debris (Duke 2010l, m; Duke 2012g). The design through-screen velocity would be less than 0.5 fps. A plan view of the Make-Up Pond A intake system's four pump bays is shown in Figure 3-10, and a cross-sectional view of one pump bay is shown in Figure 3-11.

Make-Up Pond B Intake Structure

The Make-Up Pond B intake structure would be located on the northeast shore of the pond, about 2000 ft west of the proposed Unit 1 (Figure 3-4, grid reference B2). The intake structure would be located at the end of a 40-ft-wide causeway that would extend approximately 375 ft from the existing shoreline to a point where the pond is approximately 50 ft deep at normal pool elevation. The structure itself would be a concrete wet well approximately 44 ft by 88 ft, and 60 ft in height from its base at about 520 ft above MSL to the pump station platform at an elevation of about 580 ft above MSL (Duke 2010m). A pump station platform at the end of the causeway would house five pumps: two pumps per unit to transfer water to Make-Up Pond A and one pump to transfer water to Make-Up Pond C (Duke 2009c, 2010f). Water would enter the intake structure through inlet pipes at the bottom of the structure. Each inlet would be fitted with a passive wedge wire cylindrical drum screen that can be raised to the surface for cleaning (Duke 2010l, m). The Make-Up Pond B intake structure would also house a pipe to refill Make-Up Pond B with water pumped from Make-Up Pond A.

The causeway would consist of crushed stone fill for approximately 200 ft from the existing shoreline, and then would extend over the water on concrete piers to the intake structure and pumphouse. It would be designed to support a 20-ft-wide roadway and 54-in.-diameter water pipe (Duke 2010m). A plan view of the Make-Up Pond B intake structure is shown in Figure 3-12 and a side-profile view of the causeway, piers, and intake structure is shown in Figure 3-13. A cross-sectional view through the concrete wet well of the Make-Up Pond B intake structure is shown in Figure 3-14.

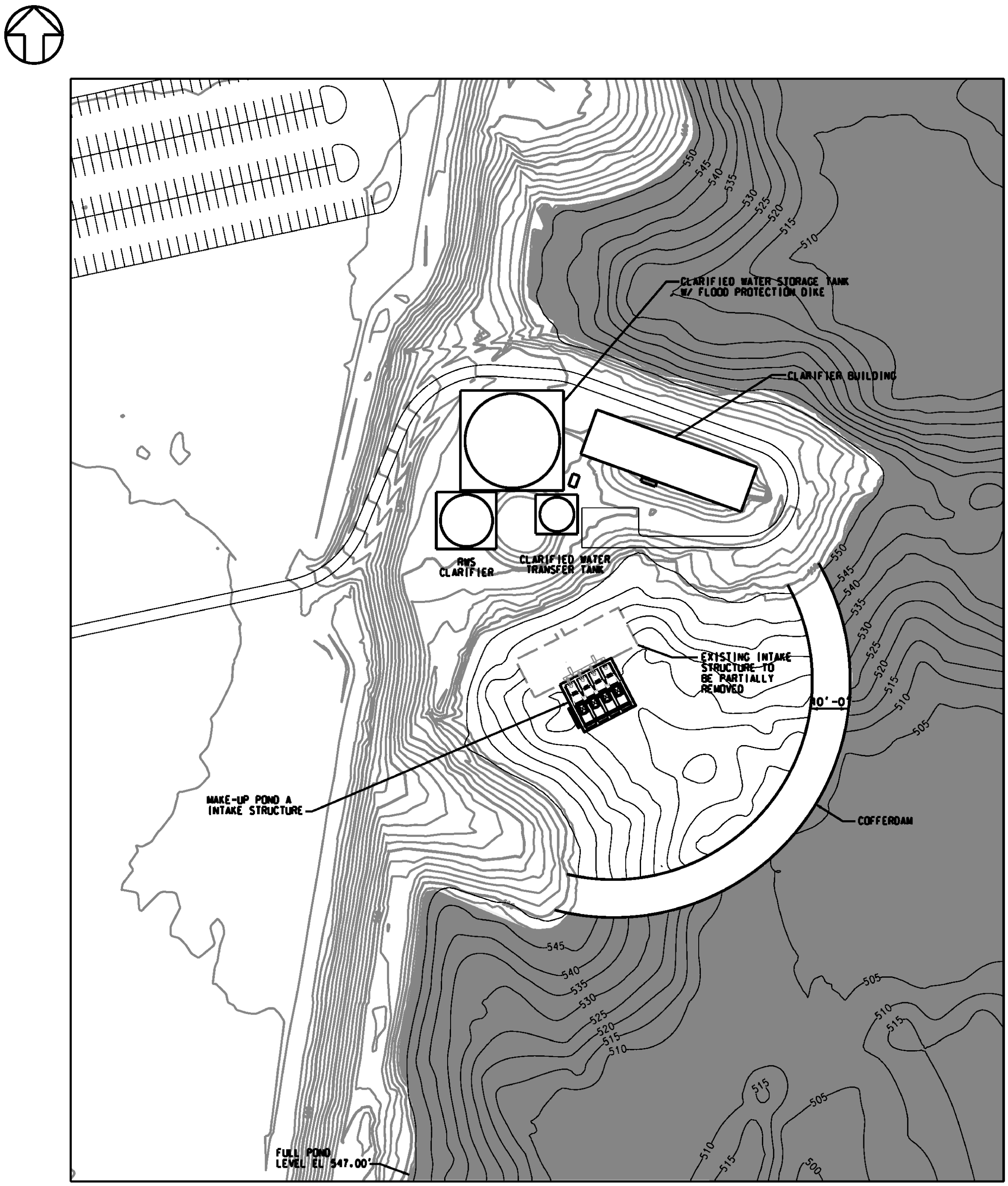

Figure 3-9. Planned Configuration of the Make-Up Pond A Intake Structure (Duke 2012h)

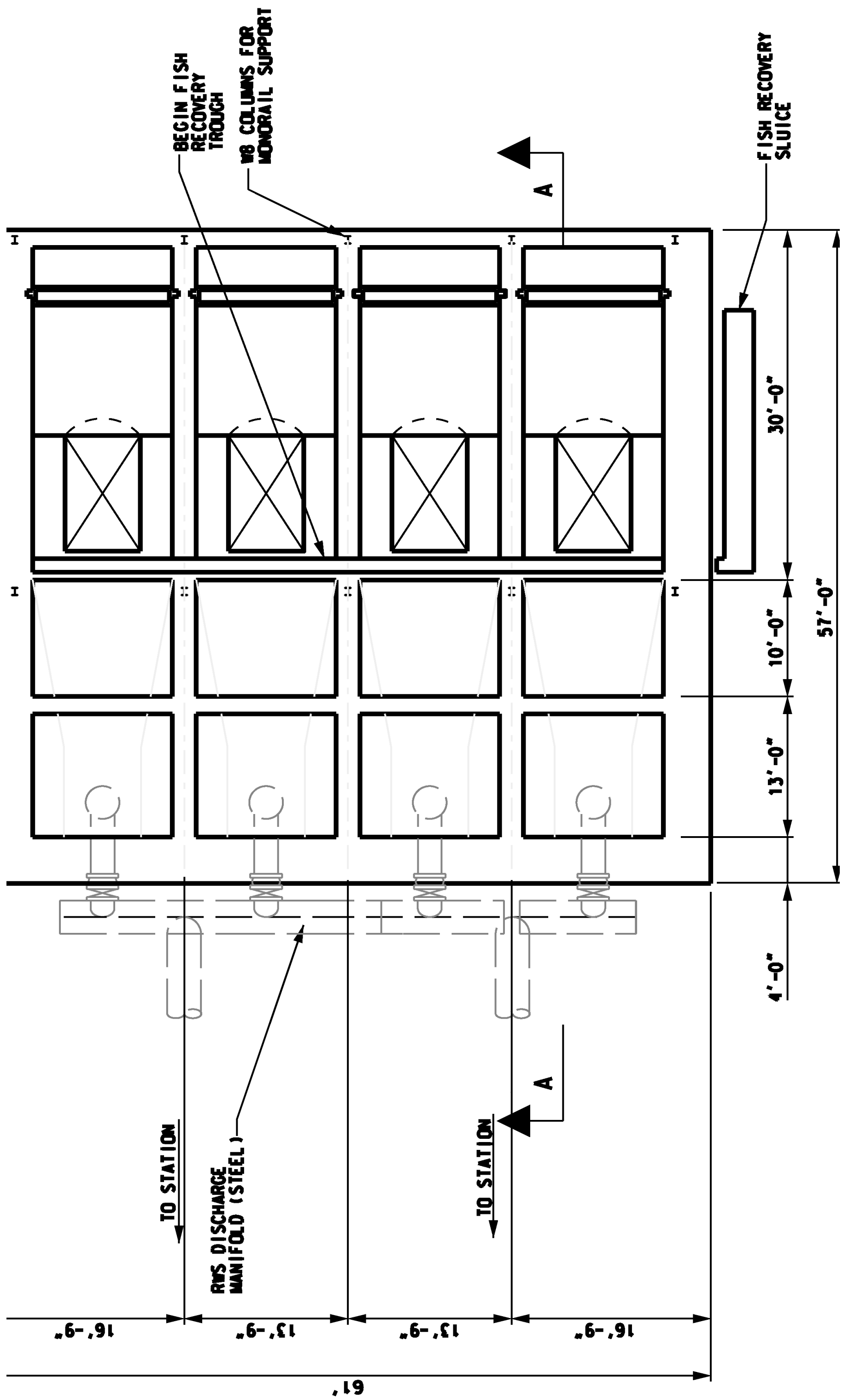

Figure 3-10. Plan View of the Make-Up Pond A Intake Structure (Duke 2012h)

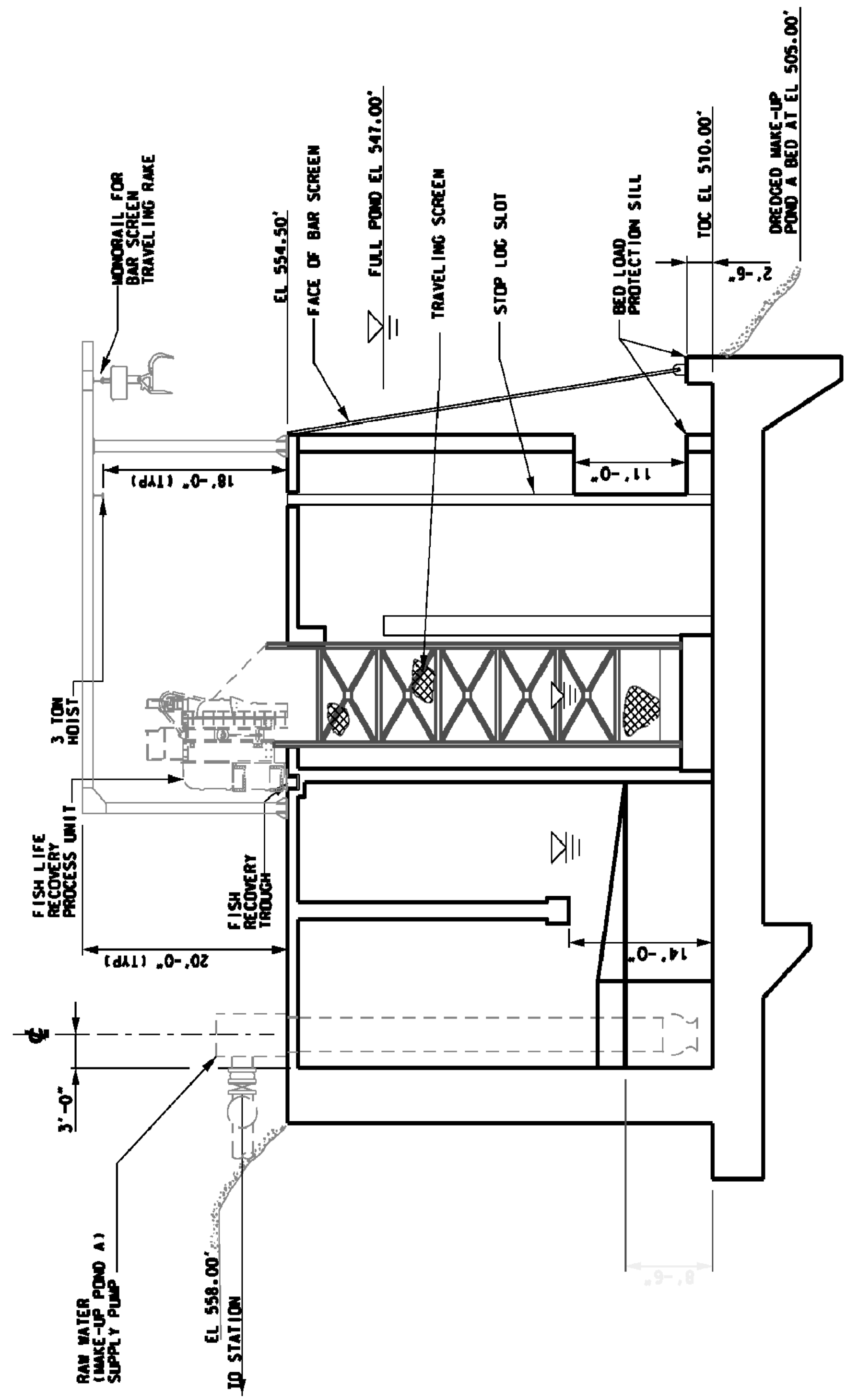

Figure 3-11. Cross-Section View of the Make-Up Pond A Intake Structure (Duke 2012h)

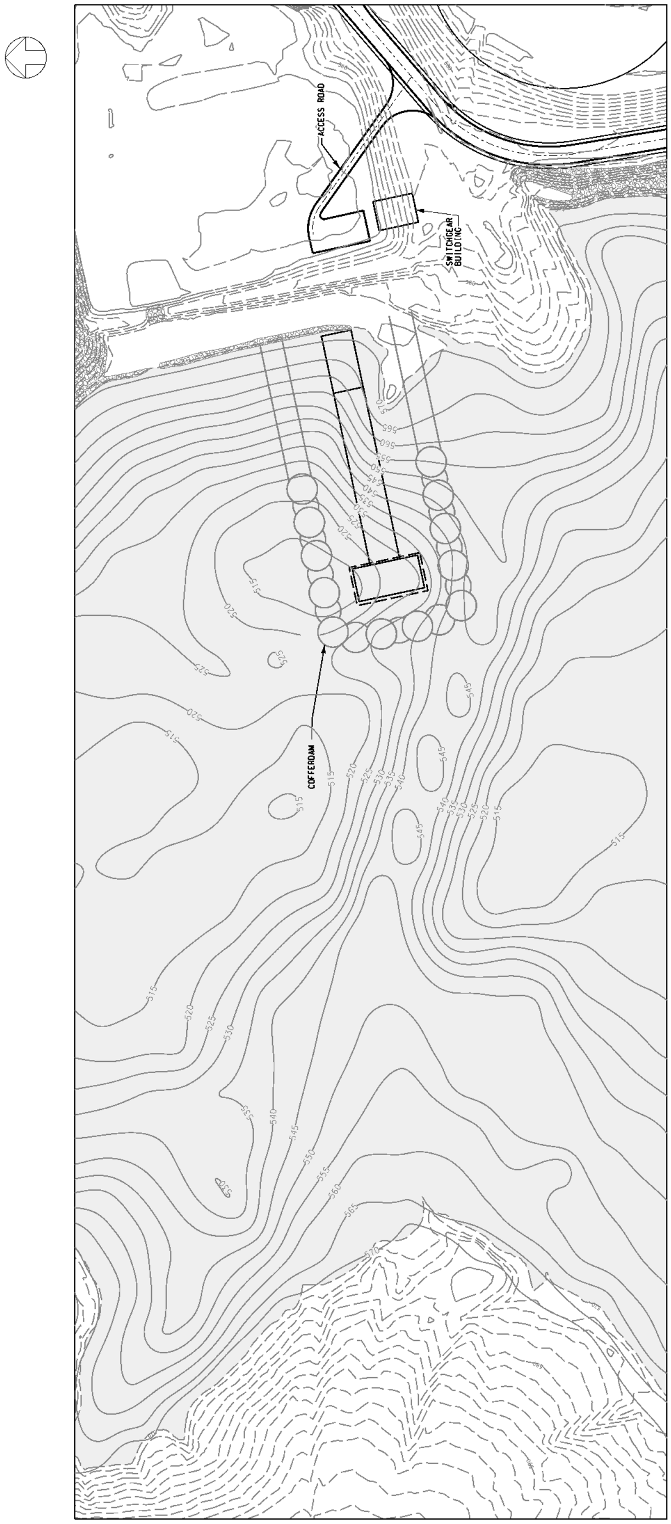

Figure 3-12. Planned Configuration of the Make-Up Pond B Intake Structure and Access Pier (Duke 2012h)

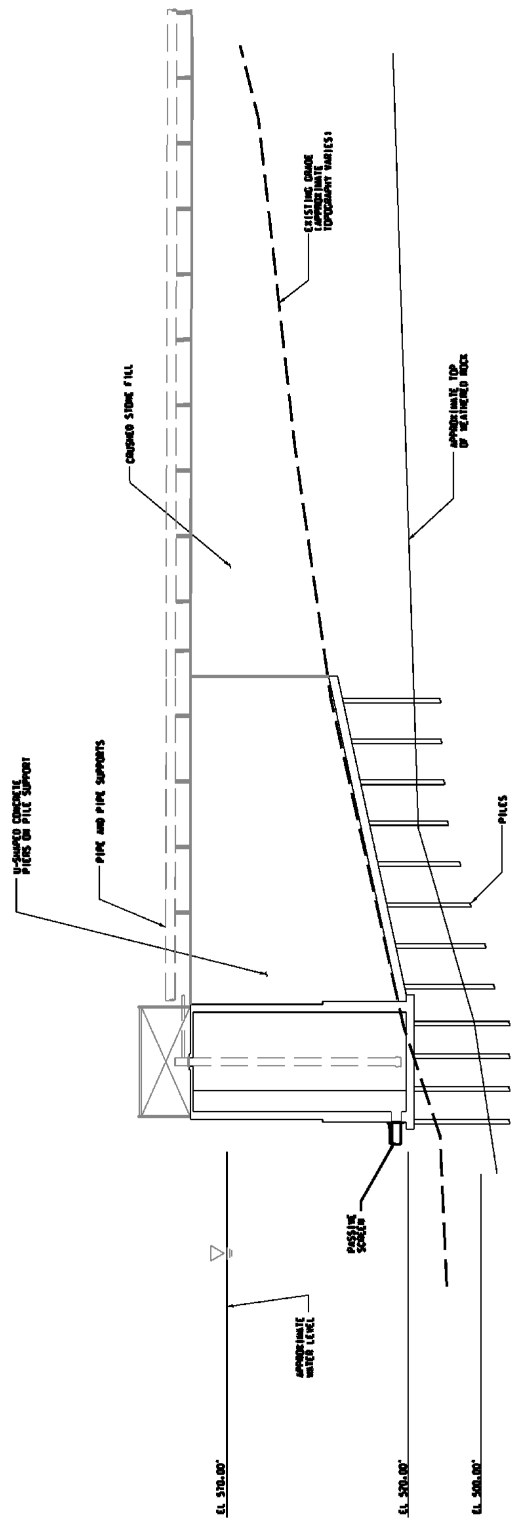

Figure 3-13. Side-Profile View of the Make-Up Pond B Intake Structure and Access Pier (Duke 2012h)

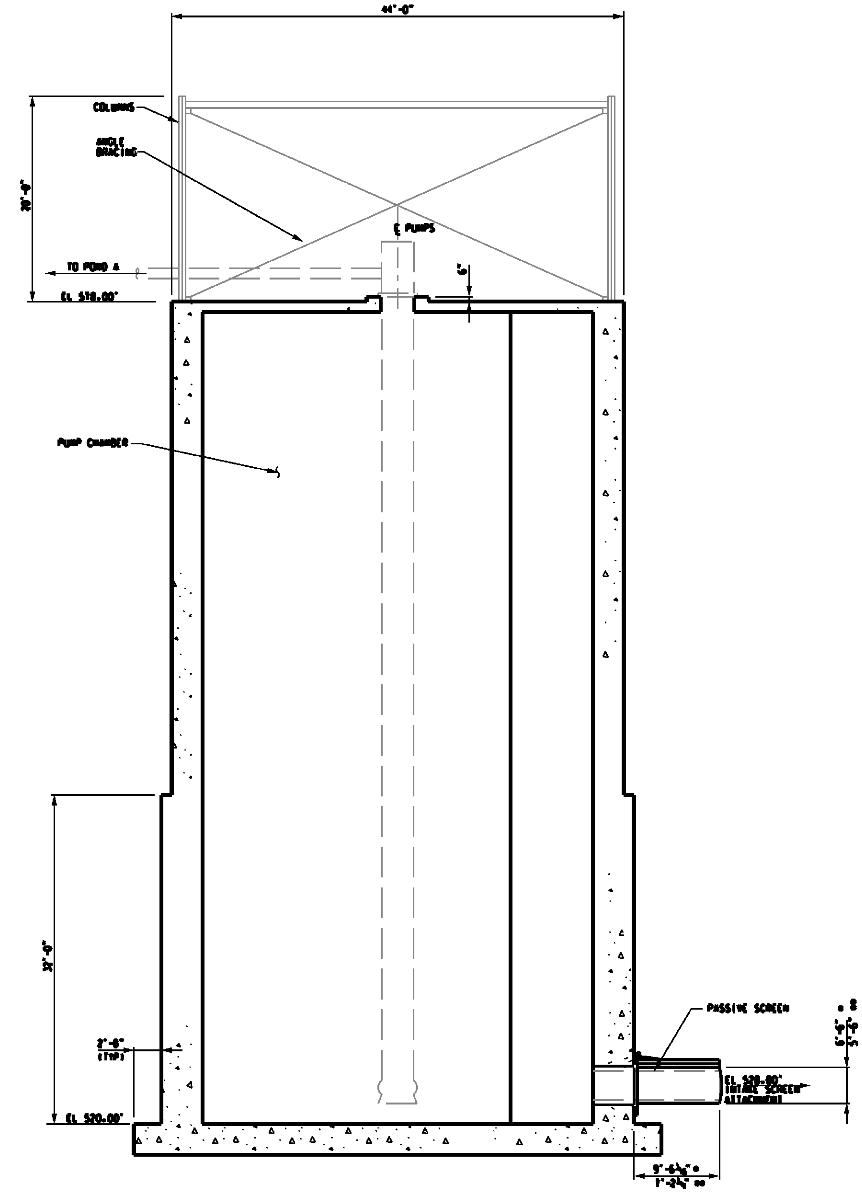

Figure 3-14. Cross-Section View of the Make-up Pond B Intake Structure (Duke 2012h)

Make-Up Pond C Intake/Discharge Structure

A combined intake and discharge structure is proposed for Make-Up Pond C. It would be located approximately 225 ft off the southeast shore in the deeper part of the pond (Figure 3-1, Figure 3-5). The structure would be a concrete wet well approximately 36 ft long, 42 ft wide, and 115 ft in height from its base at about 545 ft above MSL to the pump station platform at about 660 ft above MSL. Water would enter the intake structure through inlet pipes at the bottom of the structure. Each inlet would be fitted with a passive wedge wire cylindrical drum screen that could be raised to the surface for cleaning. The pump station would house three pumps that would only be used to transfer water to Make-Up Pond B if its storage capacity was depleted during very low-flow conditions (Duke 2009b, 2010f, m).

Access to the Make-Up Pond C intake/discharge structure would be provided by a bridge to the shore. The 225-ft-long, 32-ft-wide bridge deck would be supported by concrete piles and would be about 10 ft above the water surface at normal pool elevation (Duke 2010m). The bridge would support a 12-ft-wide access road and two 54-in.-diameter pipelines to carry water to and from the intake/discharge. A plan view of the Make-Up Pond C access bridge and intake structure is shown in Figure 3-15 and a side-profile view of the bridge and intake structure is shown in Figure 3-16. A cross-section view through the concrete wet well of the Make-Up Pond C intake structure is shown in Figure 3-17.

Discharge Structures

Blowdown and Wastewater Discharge Structure

Proposed Units 1 and 2 blowdown and wastewater discharges would flow through a 36-in.-inside-diameter high-density polyethylene (HDPE) pipeline to a discharge structure (outfall diffuser) on the upstream side of Ninety-Nine Islands Dam (Figure 3-4, grid reference D3). Between the blowdown sump and Ninety-Nine Islands Dam, the pipeline would be buried in a trench. Once the pipeline reaches the dam, the pipe would be fastened to the dam using steel braces. The pipe would extend approximately 925 ft along the upstream face of the dam and would end just before the intake structure for Ninety-Nine Islands Hydroelectric Station. The centerline of the pipe would be at an elevation of about 500 ft above MSL, so that the top of the pipe would be 10 ft below the water surface at normal full pond elevation. The section of the pipe closest to the hydroelectric station intakes would be perforated with holes so that the discharge would be diffused into the forebay of the dam. The diffuser configuration was designed to achieve an exit velocity of approximately 3.2 ft/s at an 18 cfs discharge rate (Duke 2012e). The water at the diffuser is approximately 12 to 15 ft deep, but Duke proposes to dredge the area to enhance mixing (DTA 2008a; Duke 2011f).

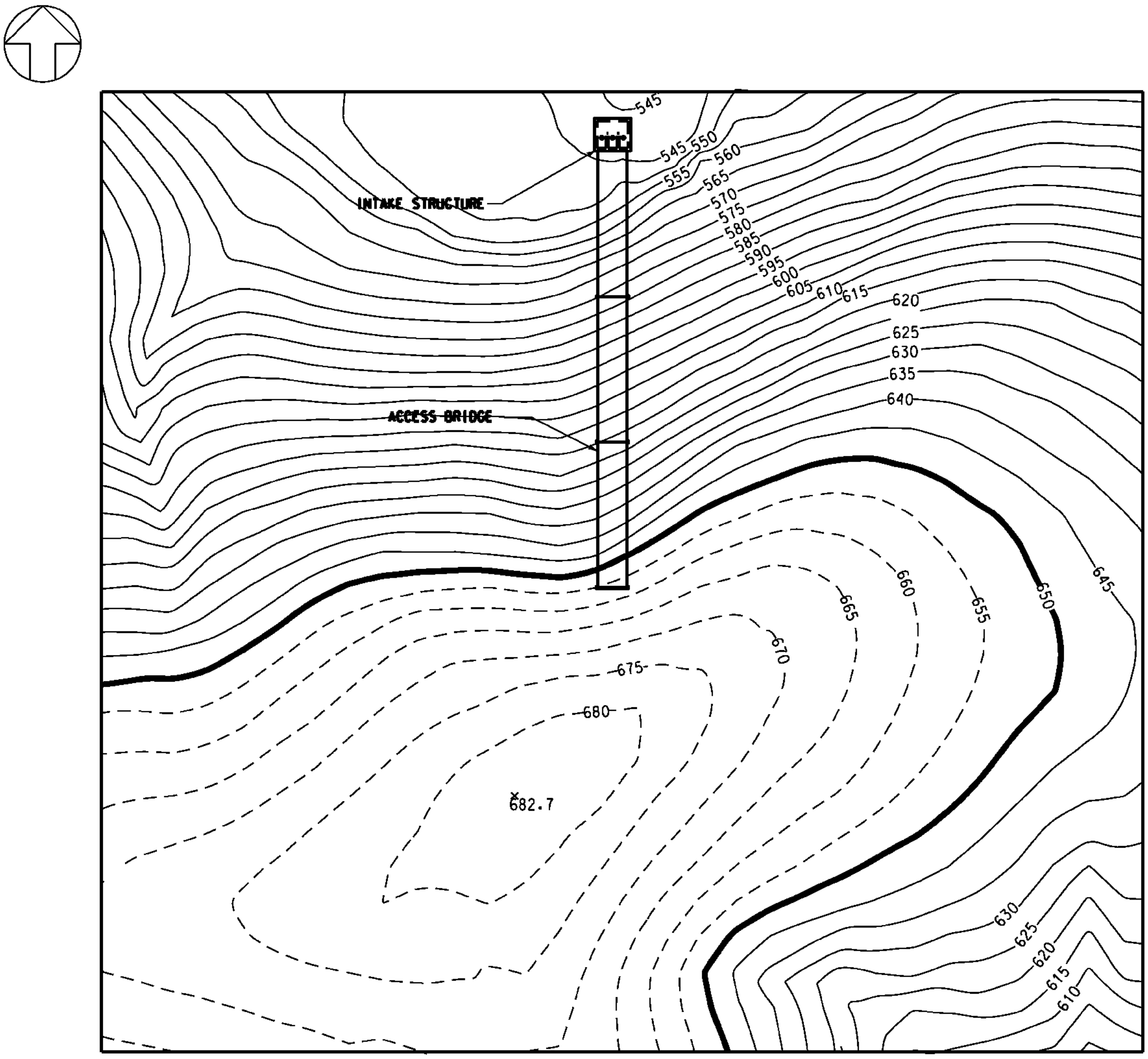

Figure 3-15. Planned Configuration of the Make-Up Pond C Intake Structure and Access Bridge (Duke 2012h)

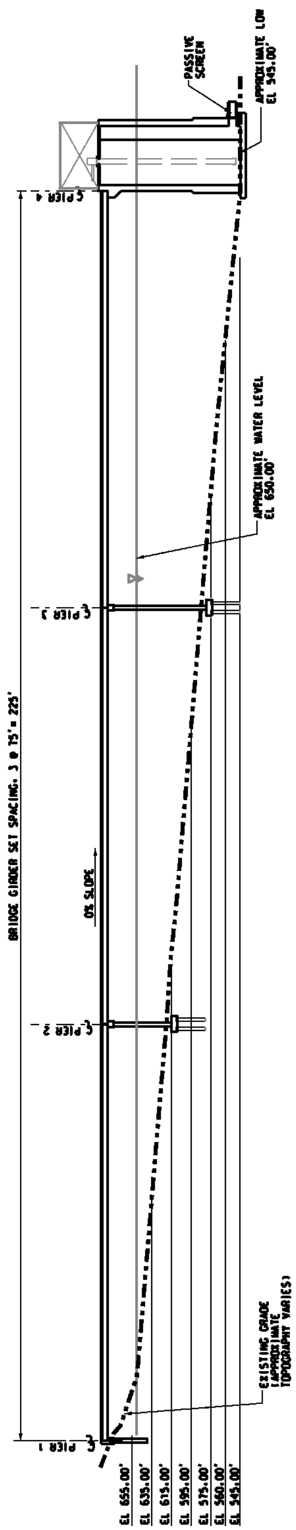

Figure 3-16. Side-Profile View of the Make-Up Pond C Intake Structure and Access Bridge (Duke 2012h)

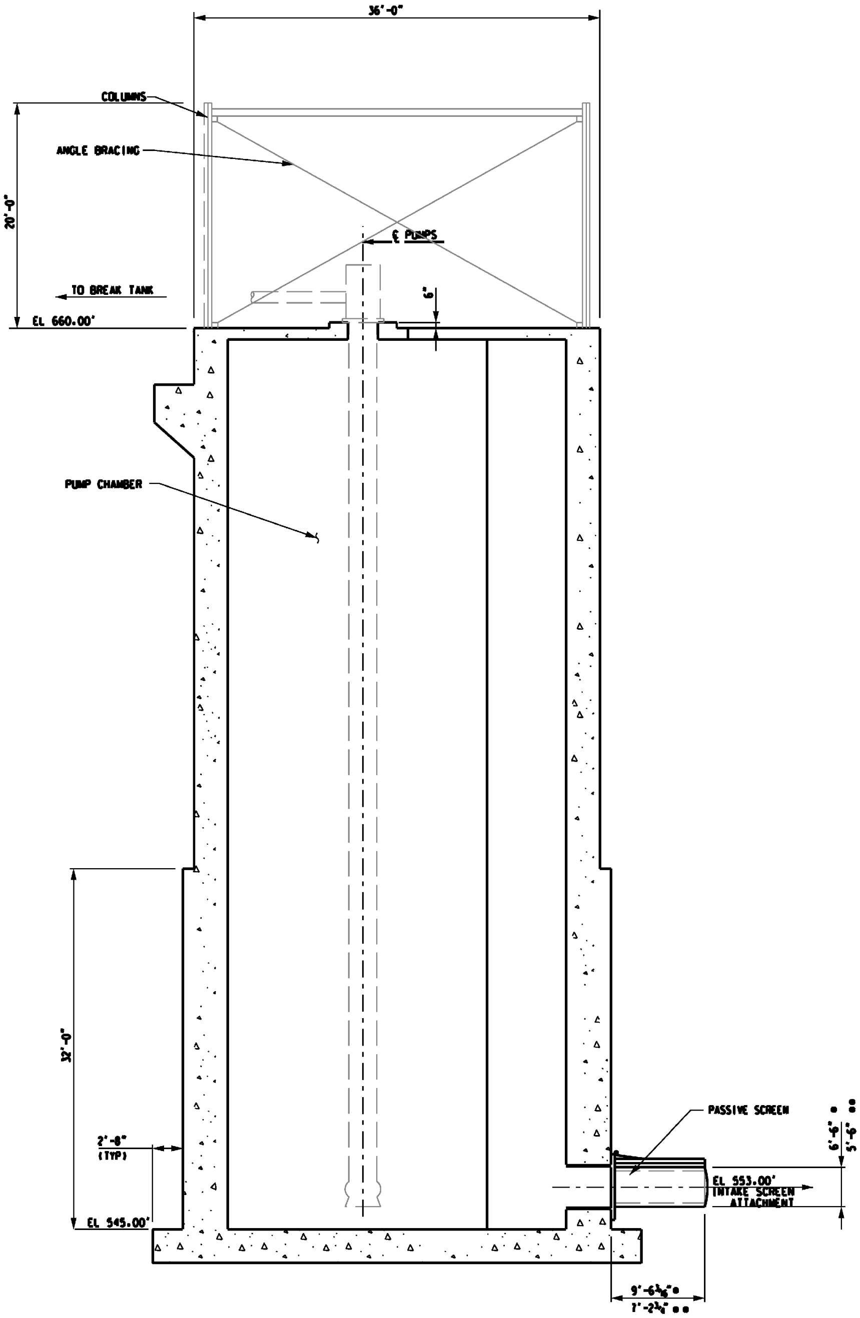

Figure 3-17. Cross-Section View of the Make-Up Pond C Intake Structure (Duke 2012h)

Make-Up Pond A Discharge Structure

Water from the Broad River (normal operations) or from Make-Up Pond B (low-flow operations) would enter Make-Up Pond A at a discharge structure located near the northwest corner of the pond (Figure 3-4, grid reference C2). HDPE piping would deliver water to a concrete retaining structure that is reinforced with riprap to protect its foundation and prevent scour (Duke 2010f).

Make-Up Pond B Discharge Structure

Water from the Broad River (during refill operations) or from Make-Up Pond C (low-flow operations) would enter Make-Up Pond B at a discharge structure located along the shoreline west of the Make-Up Pond B spillway (Figure 3-4, grid reference B2). A 54-in.-diameter pipe would deliver water to a 12 ft by 17 ft concrete box. Riprap would be placed adjacent to the discharge side of the concrete box to prevent scour and erosion (Duke 2009c).

Make-Up Pond C Discharge Structure

The Make-Up Pond C discharge structure is combined with the intake structure as described above (Figure 3-5). One of the 54-in.-diameter pipelines would carry water from the Broad River intake to the concrete wet well that is the combined Make-Up Pond C intake/discharge structure.

Cooling Towers

The proposed Units 1 and 2 would use closed-cycle cooling towers to dissipate heat from both the CWS and the SWS. As described in Section 3.1, each unit requires two cooling towers for the CWS; these are mechanical draft towers with circular concrete shells, approximately 360 ft in diameter at the base and 85 ft high. In each tower, fans blow air across water sprayed through fine nozzles to enhance evaporation, thereby removing heat. Two towers require approximately 10.6 ac (Figure 3-4, grid reference B2, C2). Each new unit also would have one cooling tower for the SWS located within the power block area, adjacent to the AP1000 turbine building. The SWS cooling towers are rectangular, two-cell mechanical draft cooling towers (Duke 2009c; Duke 2012g, 2013c).

3.2.2.3 Other Structures with a Permanent Environmental Interface

Roads, railroad lines, the power transmission system, and support buildings are additional structures with a permanent operational environmental interface that would be built on the proposed site.

Roads

The existing road network on the Lee Nuclear Station site would provide access to and between the proposed units and support facilities, although some of the existing roads would be improved to support construction equipment traffic, and some new roads are proposed (Figure 3-4). A heavy-haul road would be built between the east end of the railroad spur and the proposed Units 1 and 2 construction areas. Other roads between I-85 and the Lee Nuclear Station site would be improved to accommodate traffic during the construction period. Improvements would include widening and adding traffic signals and turn lanes at intersections, particularly those intersections providing site access along South Carolina Highway 329 (SC 329) and McKowns Mountain Road. Building Make-Up Pond C would involve realigning approximately 5000 ft of SC 329 to the east, adding a bridge over the area that would be inundated by Make-Up Pond C, and adding three culverts to facilitate drainage in the new alignment (Figure 3-5) (Duke 2009b,c; 2011h, 2012k).

Railroad Lines

Duke plans to re-establish a 6.8-mi-long railroad line connecting the Lee Nuclear Station site to the Norfolk Southern line in Gaffney, South Carolina (Figure 2-2). The railroad line would occupy the original cleared and graded right-of-way (ROW) except for approximately 1300 ft of track that would be routed to detour around the Reddy Ice Plant, which occupies part of the original ROW east of Gaffney (Duke 2009c). The proposed detour is shown in Figure 2-6. A larger 4-cell box culvert would be placed where the railroad line crosses London Creek below the proposed Make-Up Pond C impoundment and above its confluence with the Broad River (Figure 3-5). London Creek would typically flow through one of the culvert cells; the other culvert cells would carry water if the creek were more than 1 ft deep (about 36 cfs) or if high flow in the Broad River created backwater conditions (Duke 2009b, 2012j). On the Lee Nuclear Station site, a rail spur would continue east to the plant construction area, and another spur located north of Make-Up Pond B would provide a rail turnaround and railcar storage (Figure 3-4) (Duke 2013c).

Power Transmission System

In its COL application, Duke proposes to construct and operate two nuclear reactor units, with a total rated net electrical output capacity of 2234 MW(e), at the Lee Nuclear Station site. This section describes the transmission system needed to connect the proposed Units 1 and 2 to the existing power grid. Two new switchyards, a 230-kV switchyard connected by overhead lines to Unit 1 and a 525-kV switchyard connected by overhead lines to Unit 2, would be built adjacent to each other just south of the new units (Figure 3-4, grid reference area C3). The switchyards would be connected to each other through autotransformers, and would share support facilities.

Duke proposes to “fold in,” or incorporate by rerouting and connecting, the new switchyards to existing transmission lines that run east-west approximately 7 mi (the 230-kV Pacolet-Catawba line) and 14 mi (the 525-kV Oconee-Newport line) south of Lee Nuclear Station site. The new configuration will functionally reroute the existing lines to run through the Lee Nuclear Station switchyards (Figure 2-5). Physically, “folding-in” would break each existing line at two points several miles apart, turn the lines north from one break point and route them in a new ROW to the Lee Nuclear Station switchyards, and then would turn the lines back south from the switchyards in a separate new ROW to tie in at the other break point on the existing line. By using this approach, the section between the line breaks (tie-in locations) on each line would be de-energized, but not removed (Figure 2-5).

For grid stability reasons, two lines of the same voltage should be separated by at least 1 mi for the greatest possible distance, but a 230-kV line and a 525-kV line can run parallel to each other in a shared 325-ft-wide ROW (Duke 2009c). Therefore, the proposed fold-in configuration requires two new transmission-line ROWs between the Lee Nuclear Station and the break points on each line (Table 3-3, Figure 2-5). The proposed new ROWs, Routes K and O, were the result of a detailed transmission siting study in which more than 20 alternative routes were evaluated based on a range of land use and land cover, cultural and natural resource, water quality, property ownership and occupancy, and public and residential visibility factors (Duke 2007c). From the Lee Nuclear Station switchyards, one 230-kV line and one 525-kV line would run parallel to each other in a 325-ft-wide ROW along Route K to the tie-in point with the 230-kV line that continues west to Pacolet. From that point, the 525-kV line would run south in a 200-ft-wide ROW along Route K to the tie-in point with the 525-kV line that continues west to Oconee. The other new ROW, Route O, connects the switchyards to the existing lines to the east in a similar manner. One 230-kV line and one 525-kV line share a 325-ft-wide ROW to the tie-in point with the 230-kV line that continues east to Catawba Nuclear Station. From the 230-kV tie-in point, the 525-kV line runs south in a 200-ft-wide ROW along Route O to the tie-in point with the 525-kV line that continues east to Newport, South Carolina.

Structures associated with the transmission-line corridors are support towers and access roads. All tower structures would be designed so that span clearances would meet or exceed National Electrical Safety Code standards. The 525-kV lines would be supported on lattice steel towers 120 to 150 ft tall, with an average ruling span of 1300 ft. The 230-kV lines would be supported on double-circuit lattice steel towers ranging from 120 to 190 ft tall, with an average ruling span of 1000 ft. To meet standards for line sag and ground clearance, actual tower spacing depends on topography and land cover (Duke 2009c).

Table 3-3. Summary of New Transmission Lines for Proposed Lee Nuclear Station Units 1 and 2

Route	Size (kV)	Total Length (mi)	Length within Existing Corridor[a] (mi)	Existing Corridor Width (ft)	Length of New Corridor Needed[b] (mi)	New Corridor Segment (mi)	Segment Size (kV) and Corridor Width (ft)
Route O (Lee Nuclear Station to Catawba)	230 kV	32	25	150	14	7 mi (north)	230 kV and 525 kV share 325-ft corridor
Route O (Lee Nuclear Station to Newport)	525 kV	34	20	200		7 mi (south)	525 kV in 200-ft corridor
Route K (Lee Nuclear Station to Pacolet)	230 kV	25	17	150	17	8 mi (north)	230 kV and 525 kV share 325-ft corridor
Route K (Lee Nuclear Station to Oconee)	525 kV	103	86	200		9 mi (south)	525 kV in 200-ft corridor
Make-Up Pond C to Existing 44-kV Line	6.9 kV	3	0	NA[c]	3	NA	6.9 kV cable buried in access road and pipeline corridor

Sources: Duke 2007c, 2009b, k, 2010c, 2013d
(a) Length within existing corridor calculated as difference between total length and length of new corridor needed.
(b) Length of new corridor includes the 230-kV line for part of the distance (north segment only) and the 525-kV line for the full distance (north and south segments).
(c) NA = Not applicable.

In addition to the new 230-kV and 525-kV transmission lines needed to connect the proposed Lee Nuclear Station Units 1 and 2 to the existing grid, Duke proposes to install two new underground 6.9-kV, three-phase cables to provide power to the Make-Up Pond C intake/discharge facility. These cables would be approximately 3 mi long and would occupy the same corridor as the road and pipeline to the Make-Up Pond C intake structure (Figure 3-1, Figure 3-5) (Duke 2009b, 2010c, 2013d).

Finally, the proposed clearing and inundation of the London Creek drainage to form Make-Up Pond C would require removal of a portion of an existing 44-kV transmission line that once served residences in the Make-Up Pond C inundation area. The transmission-line corridor would be rerouted to skirt the west side of the pond, but no line would be installed as part of the project because no line is needed (Figure 3-1) (Duke 2011h).

3.2.2.4 Other Structures with a Temporary Environmental Interface

Some temporary (building-related) plant-environment interfacing structures would be removed before operation commences. These include a concrete batch plant and excavation dewatering systems. The impacts from the operation and installation of these structures are discussed in Chapter 4.

Concrete Batch Plant

A concrete batch plant would occupy approximately 3 ac located north of Make-Up Pond A (Figure 3-4, grid reference C2). This area would house the equipment and facilities needed for delivery, materials handling and storage, and preparation of concrete throughout the construction period for Units 1 and 2. Water for the concrete batch plant and other construction uses would be supplied by the Draytonville Water District (Duke 2009c, 2012b, e, g).

Dewatering Systems

Dewatering is expected to be a localized activity associated with deep excavation onsite, excavation for the proposed Make-Up Pond C dam footings, and work inside of cofferdams (Duke 2013a). An existing dewatering system in the excavation for the unfinished Cherokee Nuclear Station is in use currently and would continue to be used as Lee Nuclear Station Unit 1 was built; a similar system would be used in the Unit 2 excavation. The onsite deep excavation dewatering systems discharge to Make-Up Pond B. Dewatering is expected to be discontinued during operations (Duke 2009c, 2013a).

3.2.3 Structures with a Minor Environmental Interface

The structures described in the following sections would have minimal environmental interface during plant operation.

Nuclear Island and Other Reactor Buildings

Each AP1000 nuclear island would consist of a containment building, a shield building, and an auxiliary building. The foundation for the nuclear island would be an integral basemat that supports these buildings. The steel containment vessel would be completely surrounded by the reinforced concrete shield building and the auxiliary building. The containment foundations would be approximately 40 ft below grade. The construction materials would be reinforced concrete and steel. The shield buildings would be the tallest structures on the site at 229.5 ft above grade (Duke 2012f).

Annex Building

The annex building would be a concrete and steel structure that would rise to a height of approximately 81 ft above grade and provide personnel access to the plant and house plant-support systems and equipment.

Turbine Building

The AP1000 turbine building would be a rectangular, metal-sided, steel column and beam structure oriented with its long axis radiating from the containment structure. It would rise 146 ft above grade. Each turbine building would have a drain system that discharges to a wastewater retention basin connected to the blowdown sump, and a vent system for the condenser and turbine. The wastewater retention basins would be located north of Unit 1 (Figure 3-4, grid reference C2).

Radwaste Building

The AP1000 radwaste facility would be a steel-framed structure that would house the holding and processing systems for low-level liquid radioactive waste and solid radioactive waste. It also would house the collection and processing system for gaseous radioactive waste. Radioactive waste management is described in more detail in Section 3.4.3. Packaged solid wastes and liquid mixed wastes would be stored in the radwaste building until shipment offsite for further processing or disposal. The environmental interfaces for the radwaste treatment facility would be liquid effluent discharges to the blowdown discharge line, gaseous effluent venting, and solid waste handling for offsite shipment.

Diesel Generator Building

Diesel generators would be installed onsite to provide a backup source of power when the normal power source is disrupted. Combustion emissions would be released to the atmosphere from the generators only during emergency operations and periodic testing. Two diesel generators would be located in the AP1000 diesel generator building; ancillary diesel generators would be located in the AP1000 annex building.

Pipelines

A number of pipelines would be installed to convey water and wastewater on the site and to or from offsite municipal facilities. A potable water pipeline from the Draytonville Water Works distribution system would be brought onsite. Draytonville Water Works indicated that 4000 ft of 6-in. water main would be installed offsite to provide a redundant supply path to the Lee Nuclear Station site. This waterline would be installed within the shoulder of SC 329 just north of its intersection with McKowns Mountain Road (Duke 2010h). A sanitary wastewater pipeline would connect site sanitary waste facilities to the Gaffney Board of Public Works wastewater-treatment plant sewer system.

New HDPE pipelines would be constructed to convey raw water from the Broad River to various plant structures and to convey wastewater from the various plant water systems to the discharge structure (Duke 2012b, e). Raw-water pipelines would interconnect the intake structure on the Broad River and all three makeup ponds. Pipelines would also run between Make-Up Pond A and Make-Up Pond B, and between Make-Up Pond B and Make-Up Pond C. Pipelines would run from the cooling towers and from the wastewater retention basins to the blowdown sump, and from the blowdown sump to the discharge structure on Ninety-Nine Islands Reservoir. The locations of these structures and the raw-water pipeline routes are shown in Figure 3-4 and Figure 3-5. The pipeline easements between the site (Broad River and Make-Up Pond B intakes) and Make-Up Pond C would be 150 ft wide, most other pipeline easements would be 75 ft wide, and all would generally be routed adjacent to existing or planned access roads (Duke 2009b, c).

Support, Laydown, and Spoils Areas

Multiple construction support and laydown areas would be established to support fabrication and building activities and might be maintained as laydown areas for future maintenance and refurbishment of the plant. A spoils disposal and stockpile area is located on the south side of the site (Figure 3-4, grid reference B4). Approximately 186 ac north of Rolling Mill Road and south of Little London Creek would be used for offsite spoils disposal and stockpile during Make-Up Pond C construction (Figure 3-5) (Duke 2009b, c).

Parking

Parking areas would be created to support the construction workforce and some parking would be retained for the operating workforce once plant operations begin. Temporary parking areas would be in the vicinity of the plant, support, and laydown areas identified in Figure 3-4. The permanent parking area for the operating workforce would be located immediately south of Units 1 and 2, between the reactor buildings and the switchyard (Figure 3-4, grid reference C2).

Cranes and Footings

A large crane on a concrete footing would be used to erect proposed Units 1 and 2. Other cranes may be used for materials handling and erection of structures.

Miscellaneous Buildings

A variety of small buildings would exist throughout the site to support worker, fabrication, building, and operational needs (e.g., shop buildings, support offices, warehouses, and guardhouses). Some buildings may be temporary and would be removed after the plant begins operation.

3.3 Construction and Preconstruction Activities

The NRC's authority is limited to construction activities that have "… a reasonable nexus to radiological health and safety or common defense and security" (72 FR 57416), and the NRC has defined "construction" within the context of its regulatory authority. Examples of construction (defined at 10 CFR 50.10(a)) activities for safety-related structures, systems, or components include driving of piles; subsurface preparation; placement of backfill, concrete, or permanent retaining walls within an excavation; installation of foundations; or in-place assembly, erection, fabrication, or testing.

Other activities related to building the plant that do not require NRC approval (but may require a Department of the Army permit) may occur before, during, or after NRC-authorized construction activities. These activities are considered to be “preconstruction” activities in 10 CFR 51.45(c) and may be regulated by other local, State, Tribal, or Federal agencies. Preconstruction includes activities such as site preparation (e.g., clearing, grading, erosion control, and other environmental mitigation measures); erection of fences; excavation; erection of support buildings or facilities; building service facilities (e.g., roads, parking lots, railroad lines, etc.); and procurement or fabrication of components occurring somewhere other than the final, in-place location at the proposed site. Further information about the delineation of construction and preconstruction activities is presented in Chapter 4 of this EIS.

This section describes the structures and activities associated with building proposed Units 1 and 2. Table 3-4 provides general definitions and examples of activities that would be performed when building the new units. This section characterizes the activities for the principal structures to provide the requisite background for the assessment of environmental impacts; it is not intended to be a complete discussion of every activity or a detailed engineering plan.

Table 3-4. Descriptions and Examples of Activities Associated with Building the Proposed Lee Nuclear Station Units 1 and 2

Activity	Description	Examples
Clearing	Removing vegetation or existing structures from the land surface	Clearing vegetation from new pipeline corridors, demolishing and removing old buildings from the unfinished Cherokee Nuclear Station
Grubbing	Removing roots and stumps by digging	Removing stumps and roots of vegetation cleared from new pipeline corridor
Grading	Reforming the elevation of the land surface to facilitate operation of the plant and drainage of precipitation	Leveling the site of the reactors and cooling towers
Hauling	Transporting of material and workforce along established roadways	Driving on new access road by construction workers
Paving	Laying impervious surfaces, such as asphalt and concrete, to provide roadways, walkways, parking areas, and site drainage	Paving a parking area
Shallow excavation	Digging a hole or trench to a depth reachable with a backhoe. Shallow excavation may not require dewatering.	Placing pipelines; setting foundations for small buildings
Deep excavation	Digging an open hole in the ground. Deep excavation requires equipment with greater vertical reach than a backhoe. Deep excavation generally requires dewatering systems to keep the hole from flooding.	Excavating to support fabrication of the basemat for the reactor

Table 3-4. (contd)

Activity	Description	Examples
Excavation dewatering	Pumping water from wells or pumping water directly to keep excavations from flooding with groundwater or surface runoff	Pumping water from excavation of base for reactor building
Grouting	Installing low-permeability material in the subsurface around deep excavation to minimize movement of groundwater	Installing a slurry wall around the excavation for the reactor building
Dredging	Removing substrates and sediment in waters or wetlands regulated under the Clean Water Act	Removing sediment from an intake location
Spoils placement	Placement of construction (earthwork) or dredged material in an upland location	Relocating rock and soil excavated from Make-Up Pond B intake area to the onsite upland spoils disposal area near McKowns Mountain Road
Filling of wetland or waterbody	Discharging dredge and/or fill material into waters of the United States, including wetlands	Placing fill material into a wetland to bring it to grade with adjacent land surface
Dredge placement	Placing fill material in areas not designated as wetlands. These materials can come from dredging wetlands or waterbodies.	Placing sediments removed from the river intake area in a U.S. Army Corps of Engineers-approved placement area
Erection	Assembling all modules into their final positions including all connection between modules	Using a crane to assemble reactor modules
Fabrication	Creating an engineered material from the assembly of a variety of standardized parts. Fabrication can include conforming native soils to some engineered specification (e.g., compacting soil to meet some engineered fill specification).	Preparing and pouring concrete; laying rebar for basemat
Vegetation management	Thinning, planting, trimming, and clearing vegetation	Maintaining the switchyard free of vegetation

3.3.1 Major Activity Areas

3.3.1.1 Landscape and Stormwater Drainage

Preparing to build and operate proposed Units 1 and 2 would require land to be cleared and graded for the main reactor buildings and support facilities and additional space for material and equipment laydown areas. The details of the alterations are discussed in the following sections. After the site is graded, a stormwater-drainage system would be created around the facilities to direct stormwater away from the operational areas to existing or new settling basins. Drainage ditches and pipes would route surface water to monitored discharge locations at Make-Up Ponds A and B and the Broad River. Retention ponds would be designed, constructed, and operated as needed to manage runoff in compliance with Clean Water Act provisions relative to stormwater management. Stormwater discharges to waters of the United States would require an NPDES permit from the South Carolina Department of Health and Environmental Control (SCDHEC) (Duke 2009c, 2013a, 2013c).

3.3.1.2 Reactor Buildings and Cooling Towers

Preparing the locations for the power block and cooling towers would be the largest and most complex activity on the site (Figure 3-4, grid reference C2). Deep excavation and extensive fill placement and large-scale fabrication and erection activities would be involved in building the AP1000 units. The cooling towers would require extensive grading, filling, shallow excavation, and fabrication and erection activities. Building the diesel generator facility would involve limited fabrication and erection. Various components would be hauled to the site by railroad and road. Railroads and roads would be built or upgraded on the Lee Nuclear Station site, particularly in the immediate vicinity of Units 1 and 2 and their cooling towers.

3.3.1.3 Excavation Dewatering

A dewatering system already in place from the unfinished Cherokee Nuclear Station Unit 1 excavation has been used for maintenance dewatering. The existing system would be used to continue dewatering deep excavations as needed during construction. Dewatering pumps would be used during construction of the dam foundation for Make-Up Pond C. Shallow excavation for foundations for other buildings and trenching for pipelines are not expected to require dewatering.

3.3.1.4 Broad River Intake Structure

Building the Broad River intake structure would involve some dredging, and isolating the nearshore work area by installing a temporary cofferdam and dewatering the area behind the cofferdam so that excavation and other site preparation could occur in dry conditions. The cofferdam at the Broad River raw-water intake would be constructed using two banks of Z-shaped sheet piles tied together and filled with stone ballast. The cofferdam would be approximately 258 ft long and would extend approximately 75 ft into the river at the narrowest width of the river. Approximately 47,000 yd^3 of soil and partially weathered rock are expected to be removed. Fabrication of the main concrete pump bay structure would occur after excavation to the level needed to construct a base at 497 ft above MSL. Pumps, piping, debris exclusion and screen wash systems, and necessary electrical systems would be installed to create an operational intake structure.

Duration of the river intake construction would be about 20 months. It would take about five months to complete the cofferdam. Following construction, the cofferdam would be removed behind a weighted silt curtain to protect the river from excess silt load during removal. The removal of the cofferdam would take approximately three months (Duke 2010f).

3.3.1.5 Blowdown and Wastewater Discharge Structure

Underground placement of the blowdown and wastewater discharge pipeline would involve some clearing along the easement, shallow excavation, fill, and grading. Dredging at the shoreline behind the cofferdam (approximately 1400 yd^3) and in the Ninety-Nine Islands Dam forebay near the end of the diffuser (approximately 14,400 yd^3) would be required. Placement of the discharge structure would primarily involve installation of prefabricated components: attaching steel braces to Ninety-Nine Islands Dam, and attaching the diffuser pipe to the braces (Duke 2011f, h).

3.3.1.6 Make-Up Pond A

The remains of the existing water-treatment plant would be removed from Make-Up Pond A. The former Cherokee Nuclear Station intake structure in Make-Up Pond A would be partially removed, but part of it would be left in place to provide access to the proposed new Make-Up Pond A intake structure located further offshore (Figure 3-9) (Duke 2012h). To improve flow near the proposed intake structure, existing underwater dikes would be removed and areas of the pond would be dredged. Approximately 53,000 yd^3 of materials would be removed from the pond (Duke 2011h). Construction activities for the Make-Up Pond A intake structure would be similar to those for the Broad River intake structure. A cofferdam would be placed around the site of the proposed intake structure to allow dewatering of the work area, the site would be excavated to the appropriate depth for structure placement, and the concrete structure would be installed. Pumps, piping, screens, and other equipment would complete the system, and the cofferdam would be removed (Duke 2009c). Construction activities for the Make-Up Pond A discharge structure would include cofferdam installation, dewatering, and fill around the discharge structure after it is installed.

3.3.1.7 Make-Up Pond B

Several modifications are planned to Make-Up Pond B to improve water movement between regions of the pond. Approximately 100 ft of an existing cofferdam in the forebay of the pond would be removed and the area on either side of the cofferdam may be dredged, removing approximately 43,300 yd^3 of material. These changes are proposed to enhance water movement at low water levels. Installing the Make-Up Pond B intake structure and its access causeway would involve dredging or excavation of 86,900 yd^3 of material, temporary cofferdam placement and dewatering, and installation of the concrete wet well (Duke 2011h). Building the causeway would require pile driving and placement of rock fill and riprap (Duke 2009c, 2010l). Installation of the discharge structure on the northwest shore would involve cofferdam installation and dewatering, some excavation, placement of piping and concrete, and placement of riprap to protect the concrete box structure from erosion and scour.

3.3.1.8 Make-Up Pond C

Building Make-Up Pond C would require clearing and grubbing approximately 700 ac and building a dam and other water-retaining structures to impound London Creek. The area around the dam foundation would require dewatering (Duke 2009b). Building the dam and associated structures would require approximately 1.6 million yd^3 of fill material that would come from three borrow areas north of London Creek within the footprint of the proposed pond (Duke 2010f). Existing structures in the area to be impounded would be demolished and removed. In addition, existing ponds within the footprint of the proposed pond would be drained and the existing dams removed. The footprint of the existing ponds would be contoured so that the areas would drain as water levels drop in Make-Up Pond C (Duke 2010d). The downstream side of the existing Lake Cherokee Dam would be protected with filter fabric and riprap where its base would be inundated with about 10 ft of water, and the dam's emergency spillway would be improved (Duke 2012j).

Outside the area that would be inundated, clearing, grubbing, grading, and shallow excavation would be the primary construction activities associated with Make-Up Pond C. These activities would occur as access roads and temporary haul roads were built, as borrow and spoils areas were established, and as support structures were built. London Creek would be temporarily diverted while the Make-Up Pond C dam and spillway were built. Once the pond was filled, a log boom would be installed to prevent debris from blocking the spillway (Duke 2012m).

Approximately 2 mi of an existing out-of-service 44-kV transmission line would have to be removed and a new transmission-line ROW would be rerouted around the west side of the impoundment. In addition, about 3 mi of new 6.9-kV power cable would be buried in the same ROW as the water pipelines and access road for the Make-Up Pond C combined intake/discharge structure.

Approximately 0.8 mi of SC 329 near the southwest end of the impoundment would be realigned, and a new bridge would be built over Make-Up Pond C. At the east end of the impoundment, below the proposed outlet, the railroad crossings of London Creek, Little London Creek, and their tributaries would be improved. Both of these transportation system improvements involve clearing, placement of cofferdams and temporary diversion of streams, shallow excavation, grading, and filling. At the rail crossing, two existing 10-ft-diameter culverts would be removed and replaced with a large box culvert. Some fill and ballast placement would likely be used to restore the rail bed. Once the realigned SC 329 roadway and bridge were completed, the old roadway would be removed.

Installing the Make-Up Pond C combined intake/discharge structure would involve clearing, grading, shallow excavation, pile driving, placement of piers for the access bridge to the wet well structure, and placement of the wet well structure itself. The intake/discharge structure would be installed prior to filling, so no in-water work would be required (Duke 2009b).

3.3.1.9 Roadways

Improving or building roads on the Lee Nuclear Station site and associated offsite areas would involve clearing, grading, and paving. Temporary access and haul roads in the Make-Up Pond C area would be cleared and graded.

3.3.1.10 Railroad Lines

Restoring the abandoned railroad spur between the Lee Nuclear Station site and the main Norfolk Southern railroad in East Gaffney would require limited clearing of vegetation and replacement of ballast, ties, and track. Some clearing and grading would be required for the detour of approximately 1300 ft of track around the Reddy Ice Plant east of Gaffney. Below the proposed impoundment for Make-Up Pond C, Duke estimates that 4.7 ac of land would be cleared to improve the railroad crossing of London Creek. London Creek would be diverted temporarily during replacement of the two existing culverts with a larger four-cell box culvert. Engineered streambed material (a mix of rocks, gravel, and sand) would be placed in the bottom of the culvert cell carrying the normal flow of London Creek to create a more natural stream channel bottom (Duke 2009b, 2012j). Clearing, grading, and placement of ballast and track would be required on the Lee Nuclear Station site to extend the railroad spur toward the proposed plant area and to create the rail turnaround north of Make-Up Pond B.

3.3.1.11 Pipelines

Laying pipelines and installing break tanks would occur in several areas on the site and between the Broad River and Make-Up Ponds A, B, and C intakes/discharges (see Figure 3-4 and Figure 3-5). Pipeline and break-tank installation would require the clearing land along the pipeline corridor, shallow excavation (trenching), and backfilling. Supports would need to be installed where the pipelines emerge from the ground to extend over or into the water. As described in Section 3.2.3, most of the pipeline corridors are located adjacent to existing or proposed roadways.

3.3.1.12 Concrete Batch Plant

Erecting the temporary concrete batch plant would occur on a cleared, graded area.

3.3.1.13 Construction Support and Laydown Areas

Establishing and preparing laydown areas would be necessary to stage activities. Prior to and during construction and preconstruction, materials would be brought to the site and stored in laydown areas. Duke expects to clear and grade laydown areas in various locations near the Lee Nuclear Station site and other construction activity areas shown on Figure 3-4 and Figure 3-5. Clearing, grading, and surface preparation of construction support and laydown areas also would be needed offsite near the proposed Make-Up Pond C. Support and laydown areas would be graded relatively level and covered with crushed stone or gravel. Normally only limited vegetation is allowed in laydown areas.

3.3.1.14 Parking

Parking areas would be graded and paved, or surfaced with gravel.

3.3.1.15 Miscellaneous Buildings

Excavating for shallow foundations would be required prior to fabrication and erection of miscellaneous buildings.

3.3.1.16 Switchyard

Grading 21 ac of open land would be required for the proposed 230-kV and 525-kV switchyards, which would be adjacent to each other and located south of proposed Units 1 and 2 (Figure 3-4, grid reference C3) (Duke 2009c). Structures housing electrical switching equipment would be erected, and the switchyard would be fenced.

3.3.1.17 Transmission Lines

Installation of transmission lines would require the removal of trees and shrubs along portions of the transmission-line ROW, movement of construction equipment, shallow excavation for the foundations of the transmission-line towers, erection of towers, and stringing of conductors.

3.3.1.18 Cranes and Crane Footings

Fabrication of footings and erection of cranes would be necessary to erect the larger plant structures.

3.3.2 Summary of Resource Commitments During Construction and Preconstruction

Table 3-5 provides a list of the significant resource commitments of construction and preconstruction. The values in the table combined with the affected environment described in Chapter 2 provide the basis for the impacts assessed in Chapter 4. These values were stated in the ER, and the review team has confirmed that the values are reasonable.

Table 3-5. Summary of Resource Commitments Associated with Proposed Lee Nuclear Station Units 1 and 2 Construction and Preconstruction

Resource Areas	Value	Parameter Description	Reference
All Resource Areas	93 mo (7.75 yr)	Duration of construction and preconstruction activities for two AP1000 units	Duke 2009c
	63 mo (5.25 yr)	Duration of Make-Up Pond C activities	Duke 2010l
Land Use, Terrestrial Ecology, Historic and Cultural Resources (Site and Vicinity)	946 ac	Disturbed area footprint, on site: 619 ac permanently disturbed 327 ac temporarily disturbed	Duke 2013d
	1100 ac	Disturbed area footprint related to Make-Up Pond C. 1050 ac permanently disturbed: 643 ac inundated area and impounding structures 407 ac outside inundated area 50 ac temporarily disturbed outside inundated area	Duke 2013d
Land Use, Terrestrial Ecology, Historic and Cultural Resources (Offsite, Transmission Lines)	32 mi	Total length of new transmission-line corridor	Duke 2007c; 2009c, 2010c
	325 ft	Maximum final corridor width	
Hydrology – Groundwater	522 ft MSL (60 to 70 ft below site grade)	Elevation (excavation depth) to which dewatering of onsite deep excavation would be required	Duke 2013a
Hydrology – Surface Water, Aquatic Ecology	250,000 gpd (174 gpm) (0.39 cfs)	Water supply (maximum) obtained from Draytonville Water District	Duke 2009c
Socioeconomics, Transportation, Air Quality	4510 workers	Peak Units 1 and 2 workforce: peak workforce of more than 4400 workers occurs for approximately 1 yr	Duke 2010l
	4613 workers	Peak project workforce including Make-Up Pond C	Duke 2010l
	114 workers	Peak operations workers during construction and preconstruction period	Duke 2009c, l
Terrestrial Ecology, Nonradiological Health, Socioeconomics	90 dBA	Peak noise level 100 ft from activity or 50 ft from road assuming trucks traveling 55 mph	Duke 2009c
	75 dBA	Worker traffic at shift change, traveling at 55 mph	

3.4 Operational Activities

The operational activities considered in the review team's environmental review are those associated with structures that interface with the environment, as described in Section 3.2.2. Examples of operational activities are withdrawing water for the cooling system, discharging blowdown water and sanitary effluent, and discharging waste heat to the atmosphere. Safety activities within the plant are discussed by Duke in the FSAR portion of its application. The results of NRC's safety review will be documented in its Safety Evaluation Report.

The following sections describe the operational activities, including operational modes (Section 3.4.1), plant-environment interfaces during operations (Section 3.4.2), and the radioactive and nonradioactive waste-management systems (Sections 3.4.3 and 3.4.4, respectively), and summarize the values of resource parameters likely to be experienced during operations in Section 3.4.5.

3.4.1 Description of Operational Modes

The operational modes for the proposed Units 1 and 2 considered in the assessment of operational impacts on the environment (Chapter 5 of this EIS) are normal operating conditions and emergency shutdown conditions. These are considered the conditions under which maximum plant-related water withdrawal, heat dissipation, and effluent discharges occur. Cool down, refueling, and accidents are alternate modes to normal plant operation during which water intake, cooling-tower evaporation, water discharge, and radioactive releases may change from normal conditions. Maximum water withdrawal from the Broad River would occur with both proposed units operating at full power and when the Broad River intake refill subsystem is activated to send water to Make-Up Ponds B or C. Refill operations would be independent of the operational mode of proposed Units 1 and 2, but would be limited by flow in the Broad River and permit conditions.

3.4.2 Plant-Environment Interfaces during Operation

This section describes the activities related to structures with an interface to the environment during operation of the proposed Units 1 and 2.

3.4.2.1 Water Withdrawals and Transfers

Duke has developed and proposed a plan for managing water withdrawal from the Broad River and water transfers between makeup ponds that "… will support operation of Lee Nuclear Station, yet maintain appropriate instream flows in the Broad River during drought conditions."

Duke has requested that the following water-management plan, excerpted verbatim from its NPDES permit application, be incorporated into its NPDES permit conditions (Duke 2011a):

“• To minimize withdrawal of water during low-flow periods, a drought contingency pond (Pond C) will be built to complement existing drought contingency Pond B.

- During normal flow periods on the Broad River (>538 cfs), Duke Energy will withdraw all of its operational water requirements from Ninety-Nine Islands Reservoir through the primary section of the river intake into existing sedimentation Pond A. The primary section of the river intake will have a design intake flow of 98 cfs. Pond A will provide water for plant processes and cooling tower makeup. Based on the historical Broad River flow conditions, Duke Energy anticipates this will be the normal withdrawal scheme employed greater than 95 percent of the time.
- As the Broad River flow drops below 538 cfs and begins to approach 483 cfs, Duke Energy will proportionally withdraw its consumptive water requirements (≤63 cfs) from Ninety-Nine Islands Reservoir and drought contingency Ponds B and C. Pond B will be drawn down first. If Pond B drawdown reaches 30 feet, drawdown from Pond B will cease and water will be withdrawn from Pond C to a nominal drawdown ≤30 feet.
- When Broad River flow is at or below 483 cfs, only non-consumptive cooling water (approximately 23 cfs) will be withdrawn from the Ninety-Nine Islands Reservoir. That water will be returned to the reservoir immediately after use in order to maintain adequate flows in the Broad River. The remaining water needed to operate Lee Nuclear Station (≤63 cfs) will be drawn from drought contingency Ponds B and C. Pond B will be drawn down first. If Pond B drawdown reaches 30 feet, drawdown from Pond B will cease and water will be withdrawn from Pond C to a nominal drawdown ≤30 feet. Based on modeling using worst case droughts over the 85-year period of record, Duke Energy does not anticipate that any additional drawdown will be needed. However, should it be warranted to support station operations during emergency drought conditions, any additional drawdown or other water-management protocols will be performed pursuant to a drought contingency plan to be developed in accordance with the South Carolina Water Withdrawal Law after consultation with appropriate regulatory agencies.
- During the period of July through February, and only when the Broad River flows are above 483 cfs, Ponds B and/or C will be refilled, as needed, by withdrawing water from Ninety-Nine Islands Reservoir through the drought contingency section of the river intake. During this period, the water necessary

to operate the station will also be withdrawn from the Ninety-Nine Islands Reservoir via the primary section of the river intake.

- The drought contingency section of the river intake will have a maximum design intake flow of 206 cfs. However, the actual refill rate will be determined using a flow-sensitive approach to ensure Broad River flows do not fall below 483 cfs due to refill of the drought contingency ponds. Further, regardless of river flows, refilling of Ponds B and C will not occur from March through June, in order to minimize entrainment."

The U.S. Environmental Protection Agency (EPA), in comments on the draft EIS, requested that the following language be incorporated regarding Duke's water-management plan: "Note that the operational conditions in Duke's water-management plan are less stringent than requirements cited at 40 CFR Section 125.84(a) through (e) in EPA's Cooling-Water Intake Structure rule for New Facilities. EPA's approval of an NPDES permit containing any conditions less stringent than those allowed in the rule at Section 125.84 is contingent upon a demonstration that the requested alternative requirements comply with 40 CFR Section 125.85." Actual water withdrawals and discharges would need to meet the conditions of withdrawal and discharge permits issued by SCDHEC as authorized by the EPA.

The remainder of this section describes the water withdrawals and transfers based on Duke's proposed water-management plan, which is the basis for the assessment of impacts of the project as proposed. After issuance of the draft EIS, SCDHEC issued a public notice and Draft NPDES Permit in March 2013 (SCDHEC 2013b), and then issued NPDES Permit No. SC0049140 in July 2013 (SCDHEC 2013a). The NPDES permit includes requirements that the location, design, construction, and capacity of the cooling-water intake structure must comply with 40 CFR Part 125.80 through 125.89 and Section 316(b) of the Clean Water Act. The review team determined that the requirements in the NPDES permit were consistent with the assessment performed by Duke and the independent assessment performed by the review team for the draft EIS.

Broad River Intake Structure

The Broad River would be the primary source of water for cooling and other plant water systems. As described in Section 3.2.2.2, the Broad River intake structure comprises two subsystems: (1) the river water subsystem and (2) the makeup pond refill subsystem (see Figure 3-18). The river water subsystem would supply raw water to Units 1 and 2. It would operate continuously as long as flow in the Broad River meets the consumptive water-use needs and the Federal Energy Regulatory Commission (FERC) minimum continuous flow requirement from Ninety-Nine Islands Reservoir. Under normal operating conditions for both units, two of the four river water subsystem pumps would be running, and the withdrawal rate would be 35,030 gpm (78 cfs). About 2000 gpm (4.5 cfs) would be used for the screen wash system and thus return to the river at the intake location; the remaining 33,030 gpm would be pumped to Make-Up Pond A to serve as the source of water for the CWS and other station

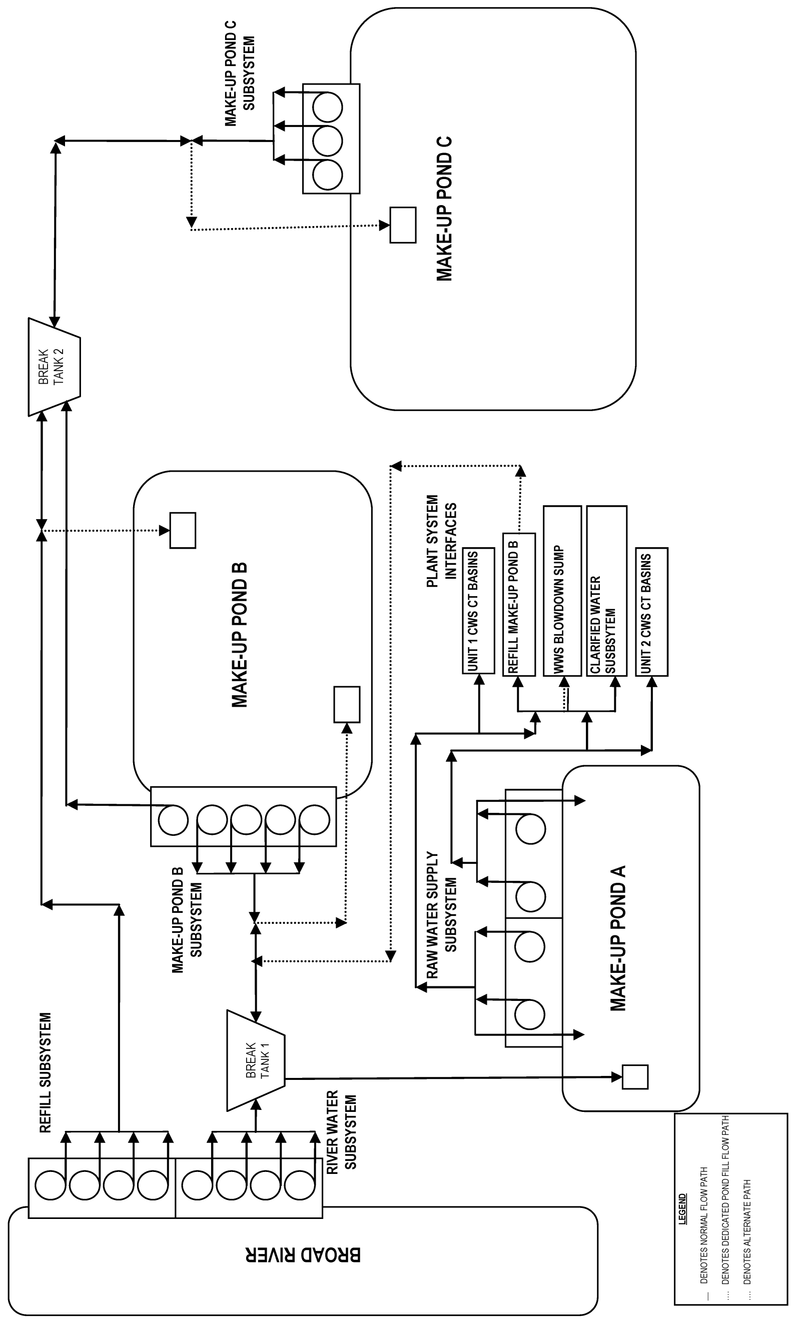

Figure 3-18. Diagram of Water-Supply and Water-Transfer System (Duke 2012h)

water systems (Duke 2009b). Occasionally, one or both standby pumps would be used to maintain the water level in Make-Up Pond A if additional water was being withdrawn to recover the level of Make-Up Pond B, to fill the cooling-tower basins, or for other CWS system maintenance. If all four river water subsystem pumps were operating, the maximum withdrawal rate would be 60,000 gpm (134 cfs).

When flow in the Broad River is unable to meet the consumptive use and the FERC minimum flow requirement, water would be transferred from Make-Up Pond B to Make-Up Pond A, and proportionally less water would be withdrawn from the Broad River, so that Lee Nuclear Station operations would not cause flow in the Broad River to drop below the required minimum release. When flow in the Broad River is at or below the FERC minimum flow requirement, the river water subsystem withdrawal would be limited to the blowdown and screen wash volumes, or about 23 cfs (Duke 2009b, 2010k).

The makeup pond refill subsystem would operate infrequently and intermittently, primarily to refill Make-Up Pond C when its level is low and when river flow and water withdrawal permit conditions allow the additional water to be withdrawn from the Broad River. The refill subsystem also could be used to transfer water directly to Make-Up Pond B. Withdrawal from the Broad River via the refill subsystem (up to four pumps operating) could range up to 92,200 gpm (205 cfs) with 2500 gpm (5 cfs) returning to the river as screen wash water. The remaining 87,900 gpm (200 cfs) would be routed to Make-Up Pond C or Make-Up Pond B as needed to restore the ponds to normal operating levels (Figure 3-18) (Duke 2009b). Refill subsystem withdrawal rates would be variable and intermittent because of the dependence on river flow conditions and consideration of fish spawning periods or seasonal minimum flows.

During operation, the riverbed near the intake structure would need to be dredged periodically; the dredged material would be disposed of at an offsite landfill or reused as beneficial material. Duke estimated the dredged material volume to be approximately 150 yd^3 per year, but also stated that it did not anticipate dredging annually (Duke 2008o, 2012b, j).

Make-Up Pond Intakes, Discharges, and Water Transfers

<u>Make-Up Pond A</u>

Under normal plant operating conditions, three of the four pumps in the Make-Up Pond A intake structure would operate continuously to supply the CWS, SWS, demineralized treatment system, and fire protection systems at a rate of about 33,030 gpm. Occasionally, the standby pump would be used during system maintenance or to refill Make-Up Pond B after Make-Up Pond B had been drawn down to refill Make-Up Pond A during periods when there were limitations on water withdrawal from the Broad River. The maximum withdrawal rate from Make-Up Pond A would be about 57,500 gpm (Duke 2009b, 2012g, h). Duke does not plan to draw down Make-Up Pond A; the water level in Make-Up Pond A would be maintained by transferring water from Make-Up Pond B during low-flow periods when withdrawal from the Broad River is limited. During normal operation, continuous discharge would occur at the Make-Up Pond A discharge structure because Make-Up Pond A is continuously providing water to the station cooling system.

Make-Up Pond B

The intake pumps at Make-Up Pond B would operate only when low-flow conditions limit withdrawal of Broad River water for plant use. As noted above, once Broad River flows drop below the minimum flow requirement, proportionally less water would be withdrawn from the Broad River and proportionally more water would be transferred from Make-Up Pond B to Make-Up Pond A, up to 24,814 gpm (Duke 2009b). Table 3-1 shows that Make-Up Pond B can be drawn down a maximum of 30 ft.

Duke estimated the frequency, magnitude, and duration of Make-Up Pond B drawdown events by applying proposed operational withdrawals for Units 1 and 2 to daily flows in the Broad River over an 85-yr period (January 1926 through December 2010). Duke assumed a minimum continuous flow requirement of 483 cfs plus a 60 cfs allowance for future water demands in the Broad River. In that 85-yr period of record, Duke calculated that Make-Up Pond B would have been drawn down 191 times, and that five of those events would have reached the maximum drawdown of 30 ft (Figure 3-19,Table 3-6) (Duke 2009b, 2011e).

During periods when withdrawal from the Broad River is reduced, the Make-Up Pond B intake pumps would operate continuously to pump water to Make-Up Pond A. Figure 3-20 shows the change in surface area and storage volume as the water level in Pond B is drawn down. Historically, more than 90 percent of Make-Up Pond B drawdown events would have been 5 ft or less and lasted 10 days or less (duration includes time to refill) (Table 3-6).

Duke’s longest modeled drawdown event within the capacity of Make-Up Pond B (meaning the event would not have required pumping from Make-Up Pond C) was 22 days, followed by 17 days to refill to its normal elevation of 570 ft above MSL, for a total duration of 39 days (Duke 2009b, 2010k). Maximum drawdown events (more than 30 ft) would have occurred infrequently in Make-Up Pond B, but their duration would have been prolonged, at least 25 days plus time to refill (Table 3-6, Figure 3-20). Maximum drawdown events would require pumping water from Make-Up Pond C to maintain the minimum elevation in Make-Up Pond B. The water level of Make-Up Pond B would be restored as soon as flow and permit conditions allowed withdrawal from the Broad River.

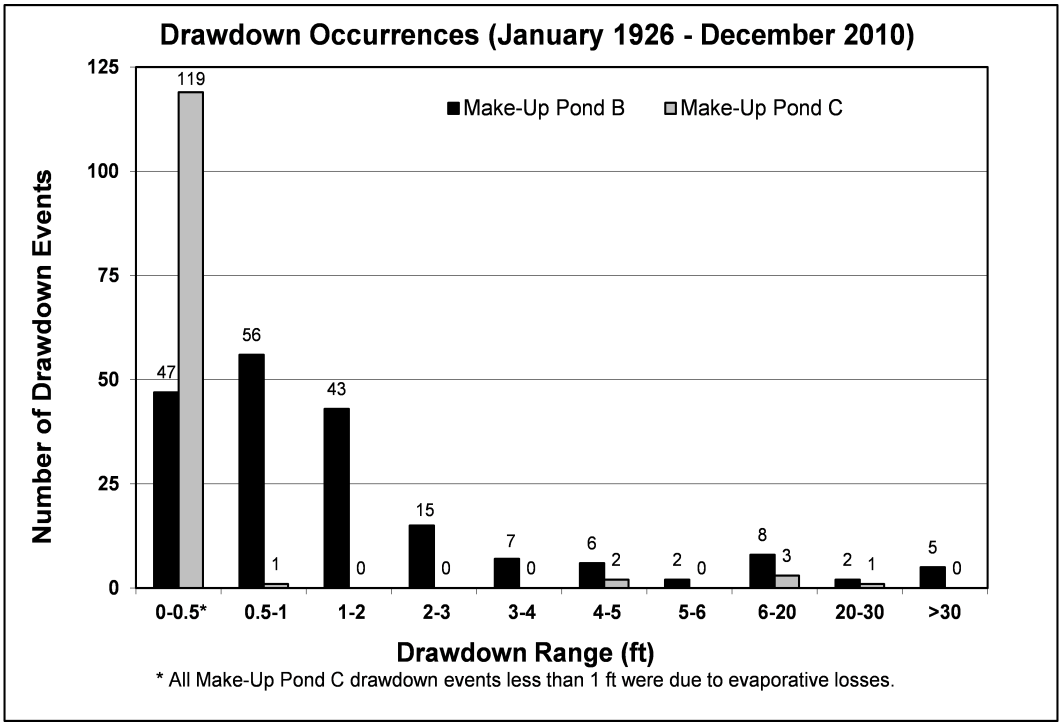

Figure 3-19. Estimated Number of Make-Up Pond Drawdown Events Based on 85-Year Historical Flow Record for Broad River (adapted from Duke 2011a)

Table 3-6. Estimated Frequency, Magnitude, and Duration of Make-Up Pond B Drawdown Events Based on 85-Year Historical Flow Record for the Broad River

Drawdown Range (ft)	Estimated Number of Events	Highest Magnitude Event (ft)[(a)]	Longest Duration Event (days)[(b)]
0–0.5	47	0.5	2
0.5–1	56	1.0	3
1–2	43	2.0	4
2–3	15	3.0	6
3–4	7	3.5	10
4–5	6	4.8	9
5–6	2	5.3	27
6–20	8	17.3	62
20–30	2	21.4	39
>30	5	30.8	139

Sources: Duke 2009b, 2010k, 2011a.

(a) Only the largest drawdown event in Figure 3-19 is shown for each range of drawdown. Magnitudes of drawdown greater than 30 ft are due to evaporation loss when pond has no usable storage.

(b) Duration is sum of days to reach lowest elevation, days at lowest elevation, and days to refill to full pond elevation of 570 ft above MSL, assuming refill begins on the first day that water can be pumped from the Broad River into Make-Up Pond B.

The Make-Up Pond B discharge structure would be used whenever water was pumped in from Make-Up Pond C, and whenever Make-Up Pond B was refilled. Refill events would be associated with each drawdown event, but would be intermittent and variable because of their dependence on Broad River flow conditions. Based on the historical flow record, the duration of refill would typically be up to 2 days for drawdowns of 5 ft or less (91 percent of events), but could be more than 30 days during extended periods of Broad River water limitations (Duke 2009b).

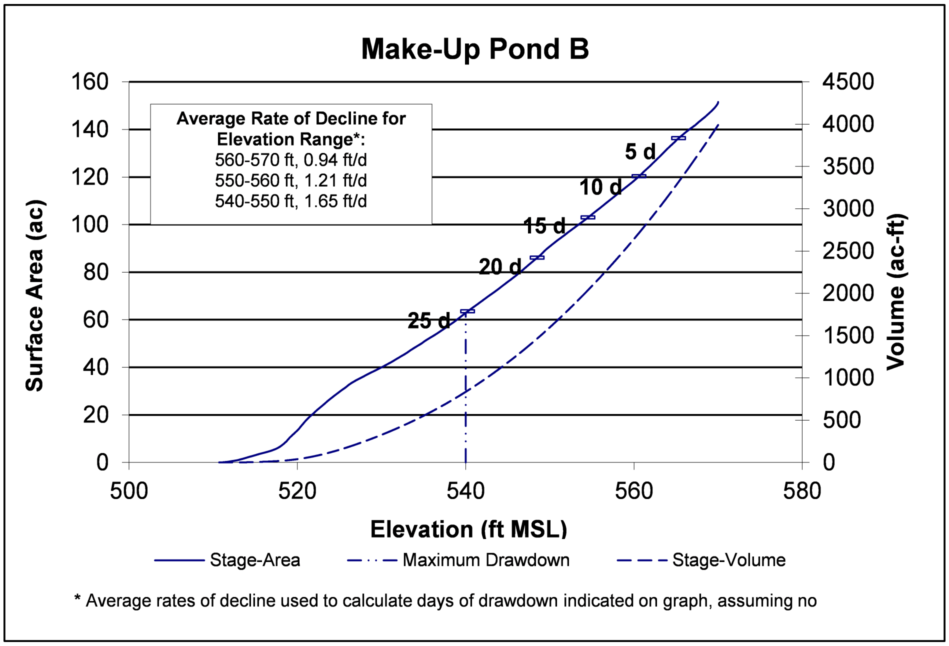

Figure 3-20. Stage-Area and Stage-Volume for Make-Up Pond B, Showing Area at 5, 10, 15, 20, and 25 Days of Transfer to Make-Up Pond A (data sources: Duke 2009b, 2010k)

Make-Up Pond C

The intake pumps at Make-Up Pond C would operate even less frequently than those in Make-Up Pond B. Water would be withdrawn from Make-Up Pond C when low-flow conditions in the Broad River are prolonged to the point that the usable storage in Make-Up Pond B is depleted (Table 3-6). Water would be pumped from Make-Up Pond C to Make-Up Pond B at up to 24,814 gpm (55 cfs) (Duke 2009b). Based on the 85-yr historical record, Duke estimated that water would have been transferred from Make-Up Pond C to Make-Up Pond B five times (Figure 3-19), and that the Make-Up Pond C drawdown would not have exceeded 20 ft during any of those events. Figure 3-21 shows the change in surface area and storage volume as the water level in Make-Up Pond C is drawn down. The discharge portion of the Make-Up Pond C combined intake/discharge structure would only be used during refill operations.

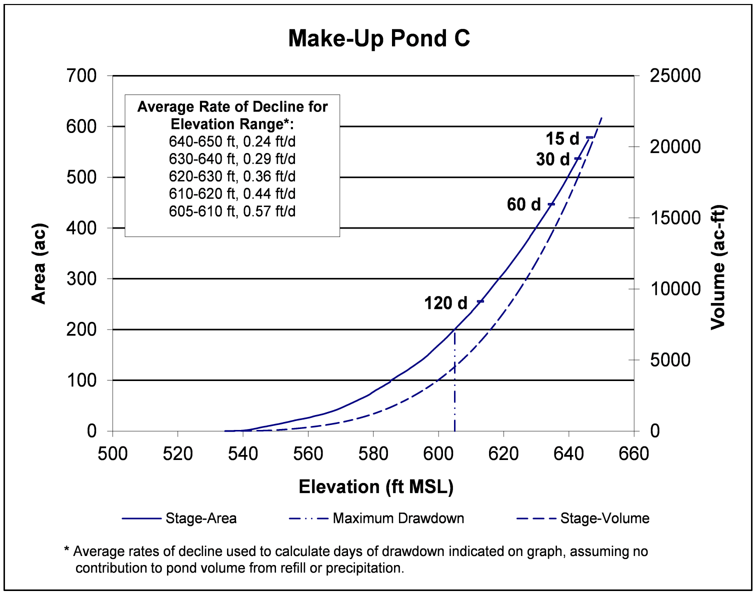

Figure 3-21. Stage-Area and Stage-Volume for Make-Up Pond C, Showing Area at 15, 30, 60, and 120 Days of Transfer to Make-Up Pond B (data sources: Duke 2009b, 2010k)

3.4.2.2 Other Plant-Environment Interfaces During Operation

Cooling Towers

Waste heat is a byproduct of normal power generation at a nuclear power plant. Excess heat in the cooling water would be transferred to the atmosphere by evaporative and conductive cooling in the cooling tower. In addition to evaporative losses, a small percentage of water would be lost in the form of droplets (drift) from the cooling towers, potentially causing visible plumes. Water lost to evaporation and drift is considered consumptive use because the water is not available for reuse. As with water withdrawal, the normal case assumes the cooling towers are operating at four cycles of concentration. The cycles of concentration refers to the number of times that water circulates through the closed-cycle cooling-water system before some of it is discharged as blowdown. This is done to limit the amount of dissolved solids in the water; the number of cycles of concentration is used to calculate the concentration of dissolved solids in the effluent. Duke provided the following typical consumptive use rates (Duke 2009c): CWS normal and maximum evaporation rates would be 24,270 and 28,026 gpm (54 and 62 cfs), respectively; SWS normal and maximum evaporation rates would be 368 and 1248 gpm (0.8 and 2.8 cfs), respectively; and drift rates of 3 gpm for the CWS and 1 gpm for the SWS would not change with the number of cycles of concentration (Duke 2009c). Actual cooling-tower consumptive use rates would vary with atmospheric conditions (temperature and relative humidity). In its analysis of plant water use and pond drawdown, Duke used the monthly consumptive use rates shown in Table 3-7 (Duke 2010k).

Table 3-7. Consumptive Water Use Rates by Month for Proposed Lee Nuclear Station Units 1 and 2

Month	Total Plant Consumptive Use for Two Units (gpm)	Total Plant Consumptive Use for Two Units (cfs)
January	22,846	50.9
February	23,384	52.1
March	24,775	55.2
April	26,122	58.2
May	26,975	60.1
June	27,783	61.9
July	28,276	63.0
August	27,962	62.3
September	27,109	60.4
October	25,763	57.4
November	24,506	54.6
December	23,294	51.9

Source: Duke 2010k.

Discharge Structure

The cooling water that does not evaporate or drift from the towers would be routed back to the cooling-tower basin at the base of each tower. The closed-cycle cooling-water loop is completed when cooled water is pumped from the cooling-tower basins back to the condenser and heat exchangers. Evaporation of water from the cooling tower increases the concentration of dissolved solids in the cooling-water system. To limit the concentration of dissolved solids, a portion of the cooling water would be removed as blowdown and replaced with makeup water. Some waste heat would be removed from the cooling system with the blowdown water. Blowdown water represents 98 percent of effluent discharged to Ninety-Nine Islands Reservoir via the diffuser on the upstream side of the dam. The average blowdown temperature is expected to be 91°F and the maximum blowdown temperature was estimated to be 95°F. Duke estimated the normal CWS blowdown flow rate to be 8087 gpm for both units (maximum 28,023 gpm) and the normal SWS blowdown flow rate to be 121 gpm for both units (maximum 410 gpm). Blowdown from the SWS serves as makeup water for the CWS so it does not contribute to the total volume of water discharged to the reservoir. Discharge from other plant systems including the demineralized water-treatment system, fire protection system, and others would be collected in the wastewater retention basins and discharged with the blowdown yielding discharge to the reservoir of 8216 gpm (18 cfs) under normal operating conditions and maximum discharge to the reservoir of 28,778 gpm (64 cfs) (Duke 2009b).

Power Transmission System

During plant operation, there are potential continuing impacts from electric fields, noise, and corridor maintenance. Duke has established procedures for transmission system inspection and maintenance that include aerial inspections two times per year. Transmission corridors would be maintained to control vegetation using herbicides or mechanical cutting and removal methods where herbicides cannot be applied (Duke 2009c). Routine maintenance activities such as ROW clearing, structure repair and replacement, and other activities are also expected to be consistent with all applicable local, State, and Federal guidelines.

Emergency Diesel Generators

The proposed Lee Nuclear Station Units 1 and 2 would each have two 4000-kW standby generators located in the AP1000 diesel generator building and two 35-kW ancillary diesel generators located in the AP1000 annex building. The backup fire pumps for each unit also are diesel powered. One 750-kW diesel generator would provide backup power to the Lee Nuclear Station technical support center. Combustion emissions from these diesel generators and secondary fire pumps would be released to the atmosphere only during emergency operations and periodic testing. Emissions include particulates, sulfur oxides, carbon monoxide, hydrocarbons, nitrogen oxides, and carbon dioxide (Duke 2009c). Gaseous releases would need to comply with levels permitted by SCDHEC.

3.4.3 Radioactive Waste-Management System

Liquid, gaseous, and solid radioactive waste-management systems would be used to collect and treat radioactive materials produced as byproducts of operating the proposed Lee Nuclear Station Units 1 and 2. These systems would process radioactive liquid, gaseous, and solid effluents to maintain releases within regulatory limits and to levels as low as reasonably achievable (ALARA) before releasing them to the environment. Waste-processing systems would be designed to meet the design objectives of 10 CFR Part 50, Appendix I. Radioactive material in the reactor coolant is the primary source of gaseous, liquid, and solid radioactive wastes in light water reactors such as the AP1000 reactors. Radioactive fission products build up within the fuel as a consequence of the fission process. These fission products would be contained in the sealed fuel rods, but small quantities could escape the fuel rods and contaminate the reactor coolant. Neutron activation of the primary coolant system also would add radionuclides to the coolant.

Prior to fuel load, Duke would develop an Offsite Dose Calculation Manual (ODCM) describing the methods and parameters used for calculating offsite radiological doses from liquid and gaseous effluents. The ODCM also would describe the methodology for calculating gaseous and liquid monitoring alarm/trip set points for release of effluents from Lee Nuclear Station, and would specify the operational limits for releasing liquid and gaseous effluents to ensure compliance with NRC regulations.

The systems used to process liquid, gaseous, and solid wastes are described in the following sections. A more detailed description of these systems for the proposed Lee Nuclear Station Units 1 and 2 is provided in Chapter 11 of the AP1000 DCD (Westinghouse 2011). The liquid and gaseous radioactive effluent source terms for the AP1000 design are provided in Tables 11.2-7 and 11.3-3 of the DCD (Westinghouse 2011).

3.4.3.1 Liquid Radioactive Waste-Management System

The liquid radioactive waste-management system would control, collect, segregate, process, handle, store, and dispose of liquids containing radioactive material such that any discharged liquid effluents are below concentration levels specified in 10 CFR Part 20, Appendix B, Table 2 (Westinghouse 2011). The system would use several process trains consisting of tanks, pumps, ion-exchange systems, and filters, and is designed to handle both normal operations and anticipated operational occurrences. Normal operations would include processing (1) borated reactor-grade wastewater, (2) wastewater from floor drains and other wastes with potentially high-suspended solid content, (3) detergent wastes, and (4) chemical wastes. In addition, the radioactive waste-management system could handle effluent streams that typically do not contain radioactive material but that may, on occasion, become radioactive (e.g., steam generator blowdown as a result of steam generator tube leakage). With two exceptions, liquid effluents processed through the liquid radioactive waste-management system would be discharged to the environment. The exceptions are steam generator blowdown that would normally be returned to the condensate system after processing, and reactor coolant that could be degassed prior to reactor shutdown and returned to the reactor coolant system.

Liquid waste would be discharged in batches with flow rates during discharge controlled to maintain acceptable concentrations when diluted by other nonradioactive liquid effluents, primarily cooling-tower blowdown (Duke 2009c). The diluted liquid radioactive waste would be discharged into the Broad River in accordance with applicable discharge permits. The rate of discharge into the blowdown discharge pipeline would be controlled and monitored to make sure the average annual effluent concentration limits from 10 CFR Part 20 are not exceeded. The calculated dose to the maximally exposed individual (MEI) from liquid effluents is evaluated in Section 5.9.2 of this EIS.

3.4.3.2 Gaseous Radioactive Waste-Management System

The gaseous radioactive waste-management system would collect, process, and discharge radioactive or hydrogen-bearing gaseous wastes. It would be a once-through, ambient-temperature, activated-carbon delay system (Westinghouse 2011). Radioactive isotopes of iodine and the noble gases xenon and krypton are created as fission products within fuel rods during operation. Some of these gases could escape to the reactor coolant system through cladding defects and subsequently decay to stable isotopes, and could be released to the environment via plant ventilation, or captured and then released by the gaseous radioactive waste-management system. In addition, various gaseous activation products, such as argon-41, are formed directly in the reactor containment during operation. The gaseous radioactive waste-management system typically would be active only when gaseous concentrations are measured above a given threshold. Waste gas would flow through a guard bed that removes iodine, oxidizing chemicals, and moisture. From the guard bed, waste gas would flow through two delay beds containing activated carbon that dynamically adsorbs and desorbs the gases, delaying them long enough for significant radioactive decay to occur. The gaseous system would only delay noble gases, not collect them, so if noble gases are measured above a threshold value, the reactor coolant system would be diverted to the liquid radioactive waste-management system that could collect noble gases using the degasifier.

Radioactive gaseous effluents from the gaseous radioactive waste-management system would be discharged through the reactor vent, which would be on the side of the containment building about 183 ft above grade elevation (Westinghouse 2011). Minor discharges and some discharges during accidents could occur through the turbine building vents, such as the condenser air removal stack. At the Lee Nuclear Station, the reactor vent would be at approximately 776-ft elevation, and the turbine building vents would be at approximately 738-ft elevation (Duke 2009c, 2013a). The rate of discharge into the atmosphere would be controlled and monitored to verify that the average annual effluent concentration limits from 10 CFR Part 20 are not exceeded (Duke 2009c). The calculated dose to the MEI from gaseous effluents is evaluated in Section 5.9.2 of this EIS.

3.4.3.3 Solid Radioactive Waste-Management System

The solid radioactive waste-management system would treat, temporarily store, package, and dispose of dry or wet solids. The solid radioactive wastes would include spent ion-exchange resins, deep bed filtration media, spent filter cartridges, dry active wastes, and mixed wastes. The system would be designed to handle both normal operations and anticipated operational occurrences. There would be no onsite facilities for long-term storage or permanent disposal of solid wastes, so the packaged wastes would be temporarily stored in the auxiliary and radwaste buildings prior to being shipped to a licensed disposal facility. The AP1000 solid waste-management system releases no gaseous or liquid effluent directly to the environment. This system discharges effluent through the liquid and gaseous waste-management systems. The expected total annual volume of solid radioactive waste treated and shipped would be 1964 ft^3/yr from each unit (Duke 2009c).

The storage and transportation of used reactor fuel is described in Chapter 6.

3.4.4 Nonradioactive Waste-Management Systems

The following sections provide descriptions of the nonradioactive waste systems proposed for Lee Nuclear Station Units 1 and 2, including systems for chemical (including biocide), sanitary, and other effluents. All discharges to surface waters would be regulated by an NPDES permit that would limit the volume and constituent concentrations. The NPDES permit would be administered by SCDHEC; SCDHEC issued NPDES Permit No. SC0049140 in July 2013 (SCDHEC 2013a).

3.4.4.1 Liquid Waste Management

The expected nonradioactive liquid waste streams include sanitary waste, stormwater runoff, cooling-tower blowdown, water-treatment system effluents, and discharges from floor and equipment drains. At the Lee Nuclear Station site, sanitary waste would not discharge into an onsite effluent stream. Wastewater treatment for discharges from the sanitary and potable water systems will be provided offsite by the Gaffney Board of Public Works. Stormwater runoff would be managed by site grading and paving to direct runoff to Make-Up Pond A, Make-Up Pond B, Hold-Up Pond A, or the Broad River (via retention ponds if necessary to meet NPDES permit water-quality requirements) (Duke 2009c, 2012b, 2013a).

The Lee Nuclear Station plant design consolidates the plant-related nonradioactive liquid effluent streams (other than potable/sanitary waste and stormwater) into a single combined discharge. Nearly all of the liquid effluent volume is blowdown from the CWS cooling towers that is collected in the blowdown sump before being discharged via pipeline into Ninety-Nine Islands Reservoir. The average blowdown discharge rate would be 8087 gpm and the maximum blowdown discharge rate would be 28,023 gpm for both units. The average blowdown water temperature is expected to be 91°F, with a maximum temperature of 95°F (Duke 2009c). About 2 percent of the liquid effluent volume comes from the plant wastewater system (Duke 2009c). The plant wastewater system is designed to manage liquid effluent streams that would contain pollutants from system flushing wastes during startup; oil, grease, and suspended solids from floor drains; corrosion and wear of plant piping and equipment; and liquid waste generated during maintenance or inspection activities. These waste streams, along with discharges from the demineralized-water-treatment system and the fire protection water system, are collected in the turbine building sumps for each unit. Wastewater is pumped from the sumps to an oil separator. Waste oil from the separator is collected in storage tanks and disposed of offsite; the wastewater would be routed to retention basins for settling of solids. As described in Section 3.2.3, the retention basins would be located north of proposed Unit 1 (Figure 3-4). Liquid from the retention basins (125 gpm normal, 990 gpm maximum) would be pumped to the blowdown sump for discharge to the Broad River at the Ninety-Nine Islands Reservoir discharge structure. The total liquid effluent discharge rate at the discharge structure is 8216 gpm or 18 cfs during normal operations.

Chemical constituents naturally occurring in Broad River water would be present in the liquid discharge, concentrated by cooling-water recirculation and losses to evaporation. Mean and maximum constituent concentrations at five routine monitoring stations in the Broad River, using quarterly data collected in 2006, are shown in Table 3-8, along with the concentrations of those constituents that would be projected to occur in blowdown discharge during normal operation assuming four cycles of concentration. The point-of-discharge concentrations as well as diluted concentrations based on low flow and annual mean flow conditions in the Broad River are compared to South Carolina water-quality criteria concentrations in Table 3-8. The effluent could also contain residual concentrations of the chemicals used to treat plant cooling water to maintain optimum operating conditions. These chemicals are injected into the CWS and SWS using a chemical feed system, or added to the clarification system that supplies water to the SWS, demineralized water-treatment system, and fire protection water system. Water-treatment chemicals include biocides, anti-scalants, anti-corrosives, pH adjusters, and silt dispersants. Duke estimates of the amount, frequency of use, and concentrations of chemicals and biocides for the proposed Lee Nuclear Station Units 1 and 2 are provided in Table 3-9 (Duke 2009c). While some variation occurs in chemical treatment to meet particular water-use needs, plant effluents are required to be within NPDES-regulated discharge limits (i.e., 40 CFR Part 423).

3.4.4.2 Gaseous Waste Management

Nonradioactive gaseous emissions would result from testing and operating each nuclear unit's two standby diesel generators, two ancillary diesel generators, and one secondary diesel-driven fire pump. Emissions from the generators and pumps would include particulates, sulfur oxides, carbon monoxide, hydrocarbons, nitrogen oxides, and carbon dioxide (Duke 2009c). These would be discharged through exhaust systems vented to the atmosphere between about 600 and 630 ft elevation. Gaseous emissions from the diesel generators and secondary pumps would not be treated, as operation of the equipment would be infrequent and typically of short duration (for testing). No other sources of nonradioactive gaseous emissions are foreseen at the Lee Nuclear Station site (Duke 2009c, 2013a).

3.4.4.3 Solid Waste Management

Debris from the intake structure trash racks and traveling screens would be collected and disposed of offsite by a contractor at a permitted facility. Other nonradioactive solid wastes, including typical solid waste (e.g., metal, wood, paper), and nonradioactive resins, filters, and sludge would also be disposed offsite by contract in a licensed permitted landfill (Duke 2009c).

Table 3-8. Constituent Concentrations in Liquid Effluent for Proposed Lee Nuclear Station Units 1 and 2

Constituent	Concentration Units	South Carolina CMCs for Freshwater Aquatic Life[(a,b)]	Concentration in Broad River Near Lee Nuclear Station[(c)]		Concentration at Point of Discharge[(d)]	
			Mean	Maximum	Mean	Maximum
Aluminum	mg/L	--	0.163	0.268	0.654	1.07
Arsenic	µg/L	340	0.36	2.18	1.43	8.72
Barium	µg/L	--	19.2	22.4	76.8	89.4
Boron	mg/L	--	<0.1	<0.1	NA	NA
Cadmium	µg/L	0.53	<0.5	<0.5	NA	NA
Chromium	µg/L	--	0.827	1.68	3.31	6.72
Copper	µg/L	3.8	1.31	<u>4.97</u>	<u>5.24</u>	<u>19.9</u>
Iron	mg/L	--	0.855	1.11	3.42	4.42
Lead	µg/L	14	<2	<2	NA	NA
Magnesium	mg/L	--	1.67	1.88	6.68	7.5
Manganese	µg/L	--	47.7	61.9	191	247
Mercury	µg/L	1.6	<0.087	<0.1	NA	NA
Nickel	µg/L	150	0.128	2.95	0.513	11.8
Selenium	µg/L	--	<2	<2	NA	NA
Silver	µg/L	0.37	<0.5	<0.5	NA	NA
Sulfate	mg/L	--	6.26	9.77	25	39.1
Zinc	µg/L	37	5.44	12.6	21.8	<u>50.2</u>

Source: Duke 2009b

(a) CMC=criterion maximum concentration, mg/L = milligrams per liter, µg/L = micrograms per liter, NA = no effluent concentration.
(b) South Carolina Water Classifications and Standards Regulation 61-68 (April 25, 2008) established maximum concentrations for freshwater (CMCs) (SCDHEC 2008a). State water-quality standard maximum concentrations did not change in the 2012 update of Regulation 61-68 (SCDHEC 2012a).
(c) Calculated from quarterly monitoring (February, May, August, November 2006) at five stations within the main channel of the Broad River.
(d) Assumes normal operation at four cycles of concentration, so the mean or maximum analyte concentration in the Broad River is increased by a factor of four. Concentrations were not calculated if the constituent was not detected in the river.

<u>Underlined</u> values exceed CMC value.

Table 3-9. Waste Stream Concentration of Water-Treatment Chemicals from the Proposed Lee Nuclear Station Units 1 and 2

Chemical-Type/Specific	System	Frequency of Use	Concentration in Waste Stream
Biocide/sodium hypochlorite	CWS, SWS	2-4 times per week	Undetectable
Biocide/sodium hypochlorite	Clarifier	Continuous	0.2 ppm
Biocide/sodium bromide	CWS, SWS	2-4 times per week	Undetectable
pH adjustment/sulfuric acid	CWS, SWS, Clarifier	Intermittent	Undetectable
pH adjustment/sulfuric acid	Demineralized Treatment	Intermittent	2.3 to 6.8 ppm
Silt dispersant/polyacrylate	CWS, SWS	Continuous	<10 ppm
Anti-scalant/polyacrylate	Demineralized Treatment	Intermittent	150 to 450 ppm
Dechlorination/sodium bisulfite	Demineralized Treatment	Continuous	Undetectable
pH adjustment/ methoxy-propylamine	Steam Generator Blowdown	Continuous	<9 ppm
pH adjustment/dimethylamine	Steam Generator Blowdown	Continuous	<100 ppb
Oxygen scavenging/hydrazine	Steam Generator Blowdown	Continuous	<100 ppb
Oxygen scavenging/carbohydrazide	Steam Generator Blowdown	Intermittent	<100 ppb

Source: Duke 2009c
ppm = parts per million.
ppb = parts per billion.

3.4.4.4 Hazardous and Mixed Waste Management

Lee Nuclear Station would be classified as a small-quantity generator of hazardous waste, and as such, hazardous waste generated at the Lee Nuclear Station would be temporarily stored onsite and then disposed offsite by a contractor at a licensed permitted facility (Duke 2009c). Hazardous wastes would be managed in compliance with the Resource Conservation and Recovery Act and the South Carolina Hazardous Waste Management Act (SC Code Ann 44-56) requirements. Duke's waste-management practices include separation of wastes to avoid creating mixed waste (i.e., waste containing both radioactive and nonradioactive material); however, any mixed waste would be managed as radioactive waste as described in Section 3.4.3 (Duke 2009c).

3.4.5 Summary of Resource Commitments During Operation

Table 3-10 provides a list of the significant resource commitments that would be involved in operating Units 1 and 2. The values in the table, combined with the affected environment described in Chapter 2 of this EIS, provide a part of the basis for the operational impacts assessed in Chapter 5. These values were stated in the ER, and the review team has determined that the values are reasonable.

Table 3-10. Resource Commitments Associated with Operation of the Proposed Lee Nuclear Station Units 1 and 2

Resource(s)	Value	Parameter Description	Reference
Hydrology-Surface Water, Aquatic Ecology	35,030 gpm (78 cfs)	Normal water withdrawal, plant operations	Duke 2009b
	60,001 gpm (134 cfs)	Maximum water withdrawal, plant operations (not including pond refill)	
	92,200 gpm (205 cfs)	Maximum water withdrawal for periodic pond refill operations	
Hydrology-Surface Water, Meteorology-Air Quality	24,270 gpm 368 gpm	Normal CWS evaporation rate Normal SWS evaporation rate	Duke 2009b
	28,026 gpm 1248 gpm	Maximum CWS evaporation rate Maximum SWS evaporation rate	
Meteorology-Air Quality, Terrestrial Ecology	3 gpm 1 gpm	Normal CWS drift rate Normal SWS drift rate	Duke 2009b
	3 gpm 2 gpm	Maximum CWS drift rate Maximum SWS drift rate	
Hydrology-Surface Water	24,813 gpm (55 cfs)	Normal consumptive water use (all plant systems combined)	Duke 2009b
	29,614 gpm (66 cfs)	Maximum consumptive water use (all plant systems combined)	
Hydrology-Surface Water	8216 gpm (18 cfs)	Normal discharge flow rate to Ninety-Nine Islands Reservoir	Duke 2009b
	28,603 gpm (64 cfs)	Maximum discharge flow rate to Ninety-Nine Islands Reservoir	
Hydrology-Surface Water, Aquatic Ecology	91°F	Average blowdown temperature	Duke 2009k
	95°F	Maximum blowdown temperature	
Terrestrial Ecology, Meteorology-Air Quality	85 ft	CWS cooling-tower height (ground elevation at towers would be 588 ft MSL)	Duke 2012g, 2013a
Terrestrial Ecology	229.5 ft above ground level	Tallest building height (containment)	Duke 2012f
Socioeconomics	957 workers	Normal operating workforce for two units	Duke 2009c
	1757 workers	Maximum workforce during refueling outages lasting 30 days each year (800 temporary workers in addition to the normal workforce)	
Terrestrial Ecology, Nonradiological Health, Socioeconomics	85 dBA	CWS cooling-tower sound level at close proximity	Duke 2009c, 2012g
	55 dBA	CWS cooling-tower sound level at 1000 ft	

Table 3-10. (contd)

Resource(s)	Value	Parameter Description	Reference
Uranium Fuel Cycle, Transportation, Need for Power	3400 MW(t) 3415 MW(t)	Thermal power rating per unit Nuclear steam supply system thermal output per unit	Duke 2009c
	1200 MW(e)	Gross electrical output per unit	
	1117 MW(e)	Net electrical output per unit	
Uranium Fuel cycle, Transportation	93 percent	Expected AP1000 annual capacity factor	Duke 2009c

4.0 Construction Impacts at the Lee Nuclear Station Site

This chapter examines the environmental issues associated with building proposed Units 1 and 2 at the William States Lee III Nuclear Station (Lee Nuclear Station) site as described in the application for combined licenses (COLs) submitted to the U.S. Nuclear Regulatory Commission (NRC) by Duke Energy Carolinas, LLC (Duke). As part of its application, Duke submitted an environmental report (ER) (Duke 2009c), which discusses the environmental impacts of building, operating, and decommissioning proposed Lee Nuclear Station Units 1 and 2, and a Final Safety Analysis Report (Duke 2013a), which addresses safety aspects of construction and operation. Duke subsequently submitted a supplement to the ER that describes impacts related to Make-Up Pond C, which would be an offsite supplemental cooling-water reservoir for the proposed Units 1 and 2 (Duke 2009b).

As discussed in Section 3.3 of this environmental impact statement (EIS), the NRC's authority related to building new nuclear generating units is limited to "… activities that have a reasonable nexus to radiological health and safety and/or common defense and security" (72 FR 57416). Many of the activities required to build a nuclear power plant do not fall within the NRC's regulatory authority and, therefore, are not "construction" as defined by the NRC. Such activities are referred to as "preconstruction" activities in Title 10 of the *Code of Federal Regulations* (CFR) 51.45(c). The NRC staff evaluates the direct, indirect, and cumulative impacts of the construction activities that would be authorized with the issuance of a COL. The environmental effects of preconstruction activities (e.g., clearing and grading, excavation, and erection of support buildings) are included as part of this EIS in the evaluation of cumulative impacts.

As described in Section 1.1.3, the U.S. Army Corps of Engineers (USACE) is working as a cooperating agency on this EIS consistent with the Memorandum of Understanding (MOU) (USACE and NRC 2008). The NRC and the USACE concluded that entering into a cooperative agreement on preparation of this EIS is the most effective and efficient use of Federal resources in the environmental review of impacts associated with building proposed Lee Nuclear Station Units 1 and 2. The goal of this cooperative agreement is to develop one EIS that provides all of the environmental information and analyses needed by the NRC to make a license decision and all of the information needed by the USACE to perform analyses, draw conclusions, and make a permit decision in its Record of Decision documentation. To accomplish this goal, the environmental review described in this EIS was conducted by a joint NRC/USACE review team. The review team was composed of NRC staff, its contractor's staff, and USACE staff.

The information needed by the USACE includes information to perform (1) analyses to determine that the proposed action is the least environmentally damaging practicable alternative

(LEDPA), and (2) its public interest assessment. To perform the public interest assessment, the USACE considered the following public interest factors: conservation, economics, aesthetics, general environmental concerns, wetlands, historic and cultural resources, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, water supply, water quality, energy needs, safety, food and fiber production, and mineral needs. The USACE's public interest assessment is included in Section 9.5.3.

Many of the impacts the USACE must address in its LEDPA analysis are the result of preconstruction activities. Also, most of the activities conducted by a COL applicant that would require a Department of the Army permit would be related to preconstruction. In November 2011, Duke submitted an application to the USACE for a permit to conduct the following activities that may affect waters of the United States, including wetlands: filling, dredging, excavating, grading, removing or destroying vegetation, and building structures (Duke 2011h).

While both the NRC and USACE must meet the requirements of the National Environmental Policy Act of 1969, as amended (NEPA), both agencies also have mission requirements that must be met in addition to their NEPA requirements. The NRC‘s regulatory authority is based on the Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.). The USACE's regulatory authority related to the proposed action is based on Section 404 of the Clean Water Act (CWA) (33 U.S.C. 1251 et seq.), which prohibits the discharge of dredged or fill material into waters of the United States without a permit from the USACE. Therefore, an applicant may not commence preconstruction or construction activities in jurisdictional waters, including wetlands, without a Department of the Army permit. The permit would typically be issued after the USACE's evaluation and public feedback in the form of public comments on its environmental review. Because the USACE is a cooperating agency under the MOU for this EIS, its Record of Decision of whether to issue a permit will not be made until after the final EIS has been issued.

The collaborative effort of the NRC and USACE in presenting their discussion of the environmental effects of building the proposed project, in this chapter and elsewhere, must serve the needs of both agencies. Consistent with the MOU, the NRC and USACE staffs collaborated in (1) the review of the COL application and information provided in response to requests for additional information (RAIs; developed by the NRC and USACE) and (2) the development of the EIS. NRC regulations (10 CFR 51.45(c)) require that the impacts of preconstruction activities be addressed by the applicant as cumulative impacts in its ER. Similarly, the NRC's analysis of the environmental effects of preconstruction activities on each resource area would be addressed as cumulative impacts, normally presented in Chapter 7. However, because of the collaborative effort between the NRC and USACE in this environmental review, the combined impacts of construction activities that would be authorized by the NRC with its issuance of a COL and the preconstruction activities are presented in this chapter. For each resource area, the NRC also provides an impact characterization solely for construction activities that meet the NRC's definition of construction at 10 CFR 50.10(a).

Thereafter, both the assessment of the impacts of 10 CFR 50.10(a) construction activities and the assessment of the combined impacts of construction and preconstruction activities are used in the description and assessment of cumulative impacts in Chapter 7 of this EIS.

For most environmental resource areas (e.g., aquatic ecology), the impacts are not the result of either solely preconstruction or solely construction activities. Rather, the impacts are attributable to a combination of preconstruction and construction activities. However, for most resource areas, the majority of the impacts would occur as a result of preconstruction activities (i.e., development of Make-Up Pond C).

This chapter is divided into 12 sections. In Sections 4.1 through 4.10, the review team evaluates the potential impacts on land use, water use and quality, terrestrial and aquatic ecosystems, socioeconomics, environmental justice, historic and cultural resources, meteorology and air quality, nonradiological health effects, radiological health effects, and nonradioactive waste. An impact category level – SMALL, MODERATE, or LARGE – of potential adverse impacts has been assigned by the review team for each resource area using the definitions for these terms established in Chapter 1. In some resource areas the impacts may be considered beneficial (e.g., in the socioeconomic area where the impacts of taxes are analyzed), and would be stated as such. The review team's determination of the impact category levels is based on the assumption that the mitigation measures identified in the ER or activities planned by various State and county governments, such as infrastructure upgrades (discussed throughout this chapter), are implemented. Failure to implement these upgrades might result in a change in the impact category level. Possible mitigation of adverse impacts, where appropriate, is presented in Section 4.11. A summary of the construction impacts is presented in Section 4.12. The technical analyses provided in this chapter support the results, conclusions, and recommendations presented in Chapters 7, 9, and 10 of this EIS.

The review team's evaluation of the impacts of building proposed Lee Nuclear Station Units 1 and 2 draws on information presented in Duke's ER, supplemental documents, the USACE's permitting documentation, and other government and independent sources.

4.1 Land-Use Impacts

This section provides information regarding land-use impacts associated with site-preparation activities and building the proposed Lee Nuclear Station Units 1 and 2. Topics discussed include land-use impacts at the Lee Nuclear Station site and vicinity, at the proposed Make-Up Pond C site, in the proposed transmission-line corridors, and in other offsite areas. No portion of the Lee Nuclear Station project would be located in areas designated as part of the coastal zone. The Broad River Scenic Corridor runs from Ninety-Nine Islands Dam to the confluence of the Pacolet River and is classified as a State Scenic River. Development of the Lee Nuclear Station project is not expected to have any adverse impacts on this 15-mi section of the

Broad River. The Broad River Scenic Corridor is not Federally designated as a National Wild or Scenic River. No part of the project would conflict with zoning laws or with any applicable land-use plans, policies, or controls.

4.1.1 The Site and Vicinity

With the exception of the new transmission lines, the railroad spur, a few offsite road improvements, and the offsite Make-Up Pond C, proposed Lee Nuclear Station Units 1 and 2 and auxiliary facilities would be developed within a 1928-ac site along the Broad River. Additionally, indirect land-use changes in the surrounding landscape, such as new or expanded hotels, could be induced as a result of the need to support construction workers. No zoning laws or regional land-use plans (e.g., comprehensive plans) are in place at the State or County level for unincorporated areas of Cherokee County, including the proposed site (Duke 2009c).

Land-use needs for assessing building impacts at the Lee Nuclear Station site include transportation, grading and cut/fill, spoils and borrow management, laydown areas, utilities, and debris disposal. Figure 3-4 shows the proposed detailed plot plan for the site, including minor design changes subsequent to the draft EIS.

The total area on the Lee Nuclear Station site that would be affected on a long-term basis as a result of permanent facilities at the site is approximately 619 ac, including land to be occupied by the power block, cooling towers, switchyard, wastewater-treatment facilities, pipelines, onsite transmission lines, and general grading and transportation (Duke 2013d). An additional area of approximately 327 ac would be disturbed for temporary construction facilities, including laydown areas and spoils areas (Duke 2013d). The total permanent and temporary footprint on the site would be approximately 946 ac, accounting for only about 49 percent of the total site area. The site therefore appears to be large enough to readily accommodate the proposed footprint with only minimal encroachment on environmentally sensitive land such as wetlands and floodplains.

Approximately 585 ac of the estimated 946 ac of total permanent and temporary land disturbance lies within the 750 ac of land previously disturbed (prior to 1982) for the unfinished Cherokee Nuclear Station project (Duke 2013d). The proposed construction footprint would therefore encompass only about 361 ac of previously undisturbed land on the site. The Lee Nuclear Station would also use existing Make-Up Pond A, Hold-Up Pond A, and Make-Up Pond B, which were all built on the site prior to 1982 for the unfinished Cherokee Nuclear Station project. These ponds presently serve no use.

Additional disturbances at the Lee Nuclear Station site while building the proposed new facilities would include modification and improvement of existing roadways, building a heavy-haul road from the railroad-spur terminal end to the power block, and building of several outbuildings, including administration, security, and process-related facilities. The land-use demands for these activities are accounted for in the estimated land-use acreage data presented earlier in this section. The heavy-haul road would be built within previously disturbed areas.

The existing site entry and proposed primary construction access road would be on the south-central site boundary, off McKowns Mountain Road. Established roadways on the site would be maintained or refurbished for building activities. Building new roadways onsite to support material deliveries and buildings, either temporary or permanent, would largely be confined to previously disturbed areas. The land-use demands for these activities are accounted for in the estimated land-use acreage data presented earlier in this section. Temporary roadways and temporarily altered acreage would be reclaimed to natural vegetative grassland, native shrub, or native forestland as site conditions permit.

Clearing and removal of shrubs, trees, and other vegetation growing in the area of proposed disturbance would be required. The approximately 2 ac of prime farmland in the southeast corner of the site, off of Ninety-Nine Ferry Road, would not be physically disturbed by building the proposed facilities. Finish grading would be used to enhance stormwater movement away from buildings and other facilities. The area excavated for the power block would require dewatering, excavation, and backfilling of material. Existing cooling-water ponds would be dredged to restore depth and to minimize future dredging activity. Spoils material would be taken from the cooling-water ponds and excavations for the power block and switchyard, and be disposed of in designated spoils areas onsite (Duke 2013d). Figure 3-4 shows areas for borrow and spoils storage. The land-use demands for these activities are accounted for in the estimated land-use acreage data presented above.

Other than cutting woody vegetation from approximately 0.21 ac of forested wetlands to accommodate overhead transmission lines, no project activities would take place within jurisdictional wetlands on the Lee Nuclear Station site. However, work performed within Make-Up Ponds A and B, which are designated as waters of the United States, would require approval under the CWA (see Sections 4.3.1 and 4.3.2). Any work that has the potential to affect wetlands or waters of the United States would be performed in accordance with applicable State and Federal regulatory requirements. Ground disturbance to build the cooling-water intake structure and discharge structure would extend into the Broad River floodplain and channel and would comply with all applicable regulatory requirements under the CWA (see additional discussion in Section 4.3.2.1). Other building activities would take place outside the 100-year and 500-year floodplain. No building-related impacts are expected to affect current land uses within the floodplains aside from intake and discharge structures. Additional information regarding hydrological alterations to the Lee Nuclear Station site is in Section 4.2.

Several existing pipelines are maintained in the 6-mi radius vicinity, including one for fiber-optic cable, four natural-gas pipelines, and four liquid-petroleum pipelines. The existing pipeline closest to the Lee Nuclear Station site is approximately 4 mi away and not expected to be affected by building activities.

Based on information provided by Duke and the review team's independent review, the review team concludes that because the land-use demands of the project can be accommodated in only about 49 percent of the site area, because of the ability to minimize encroachment into sensitive environmental lands, because of the past site-development impacts associated with the former Cherokee Nuclear Station project, and because of the absence of zoning restrictions and other land-use conflicts, land-use impacts on the site would be minimal.

4.1.2 The Make-Up Pond C Site

The proposed Make-Up Pond C site encompasses approximately 2110 ac (Duke 2013d) and is located northwest of the Lee Nuclear Station site in the London Creek watershed (Duke 2009b). According to Duke (Duke 2013d), Make-Up Pond C, including the impoundment, dam footprint, saddle dikes, and spillway, would occupy approximately 643 ac of the 2110-ac Make-Up Pond C site. An additional area of approximately 404 ac would be occupied by other permanent features necessitated by Make-Up Pond C, such as spoils disposal, a pump house, realignment of South Carolina Highway 329 (SC 329) and various onsite roadways and other utilities (Duke 2013d). These permanent land commitments total approximately 1047 ac. In addition, Duke has stated that re-routing a transmission line as part of building the new pond would require a permanent commitment of approximately 3 ac of land outside of the 2110-ac Make-Up Pond C site (Duke 2013d). The total permanent land commitment needed to build Make-Up Pond C is therefore approximately 1050 ac.

Besides these permanent land uses, approximately 50 ac of additional land on the roughly 2110-ac Make-Up Pond C site would have to be temporarily disturbed to build the pond (Duke 2013d). The proposed permanent and temporary land uses associated with building Make-Up Pond C would therefore total approximately 1100 ac. Duke has not indicated what it proposes to do with the remainder of the 2110-ac Make-Up Pond C site.

Approximately 86 privately owned housing units have been removed from the Make-Up Pond C site since the acquisition of the land by Duke (Duke 2012b). After Duke purchased the property, it allowed home owners to remain in their homes from 1 to 18 months rent-free and provided relocation services, as needed, for displaced property owners and renters. For homes that were being rented at the time of purchase, Duke usually gave renters between 30 and 90 days' notice to vacate the property (Duke 2009b).

Approximately 260 ac of land designated as prime farmland and farmland of statewide importance occur within the Make-Up Pond C site (Duke 2009b). Even though not all of these lands would be physically disturbed by building Make-Up Pond C and associated facilities, Duke has stated that none of this land would be available for use as farmland over the 40-year operating license period, because access would be restricted (Duke 2009b). The review team's interpretation is that all 260 ac of prime or other special status farmland would be unavailable to agriculture for the foreseeable future.

Based on information provided by Duke and the review team's independent evaluation, the review team concludes that because Duke had to purchase approximately 2110 ac of privately owned land, restrict most uses of that land, and demolish 86 privately owned residences, the land-use impacts related to building Make-Up Pond C would be noticeable. However, because of the abundance of similar agricultural and undeveloped forestland in the vicinity and region, and because displaced occupants of the demolished residences are not likely to have experienced housing shortages in the region, the review team concludes that the impacts would not be destabilizing to regional land-use patterns.

4.1.3 Transmission-Line Corridors and Other Offsite Areas

Other offsite land-use changes in the vicinity of the Lee Nuclear Station site would be expected from installation of the proposed transmission lines and reconstruction of the railroad spur from East Gaffney to the site.

4.1.3.1 Transmission-Line Corridors

In proposing the new transmission-line corridors and associated rights-of-way (ROWs), Duke conducted a discrete and comprehensive transmission-line siting and environmental analysis (Duke 2007c). The fundamental goal of the siting analysis was to enable the selection of two transmission-line corridors that minimized the impacts on land use, environmental resources, cultural resources, and aesthetic quality. In delineating the siting study area, Duke considered the topical influence of several key criteria, including physical geography and topography, the Broad River Scenic Corridor, land-use and development patterns, transportation and infrastructure corridors, and requiring linear segments of the existing Pacolet-Catawba 230-kV line and the Oconee-Newport 525-kV line. Duke clearly indicated a number of areas to be avoided when possible, including agricultural land, residences, historic and cultural landmarks, buildings, parks, and wetlands.

Duke used both internal and external sources of data to characterize the siting area, including local, State, and Federal resources. Additionally, extensive field investigations were conducted to confirm or refute data regarding existing land use, aesthetic, natural, and cultural resources, identifiable development patterns, and infrastructure. Field-specific activity also included community and public workshops conducted in April 2007. Data and attributes were combined into 12 Geographic Information System layers and weighted to assign sensitivity related to transmission-line routing. Weighted data were then combined to form a multilayer map or suitability composite. This allowed for analysis of the cumulative effect of the combined data points and enabled ranking of the siting area from the lowest constraint to the highest constraint in routing, including all points in between.

The geographic area under consideration was approximately 181,420 ac. Within that area, 21 routes were established as meeting criteria for the lowest constraint and impact. The routes, composed of 115 different combinations of potential routes, were verified in field investigations.

In June 2007, the verified alternative routes were presented in follow-up public meetings. The 21 alternative routes were then individually evaluated against eight criteria, including cultural and natural resources, land cover, land use, property ownership, occupied buildings and facilities, public viewshed/visibility, residential viewshed/visibility, and water-quality factors. The two routes that represented the best combination of technical and environmental considerations were determined to be Routes K and O (Figure 2-5).

As a result of the transmission-line study (Duke 2007c) and public meetings, Duke proposes to build four new transmission lines to serve Lee Nuclear Station. As shown in Figure 2-5, this would require building two transmission-line corridors along Routes K and O running south and southwest from the site to their respective tie-in locations on the existing 230-kV Pacolet Tie–Catawba line, located approximately 7 mi south of the site and the existing 525-kV Oconee–Newport line, located approximately 15 mi south of the site.

From the Lee Nuclear Station to the Pacolet Tie–Catawba 230-kV line, both routes would contain one double-circuit 230-kV line and one single-circuit 525-kV line. The transmission-line corridor width would be approximately 325 ft where both the 230-kV and 525-kV lines run in the same corridor. The 230-kV line from the Lee Nuclear Station site stops at the existing Pacolet Tie–Catawba line. The 525-kV line would continue along both routes in a 200-ft-wide corridor approximately 9.47 mi south, where it would tie in to the Oconee–Newport 525-kV line.

The design of the Lee Nuclear Station fold-in lines would meet or exceed all requirements of the National Electrical Safety Code in effect at the time project activities are under way. Towers for the 230-kV and 525-kV lines would be lattice framework, steel structures consisting of direct-embedded foundations at a depth of approximately 12 ft below the ground surface and they would be nominally spaced at 1000 ft.

The most significant land-use impact from building the transmission lines would be the permanent restriction on structures and timber production within the corridors. The estimated acreage affected by the transmission-line corridors is approximately 987 ac; 97 percent of that acreage is not subject to zoning restrictions and is predominantly forest and pasture land. Based on the information available, the review team does not foresee any zoning change or conflict on the remaining 3 percent of land. Section 2.2 described the existing land-use classifications and acreage that would be affected. Approximately 690 ac of forestland would be converted to cleared corridors. Additionally, approximately 163 ac of the proposed corridors are considered prime farmland, or farmland of statewide importance. Duke allows farming and crop production within transmission-line corridors and expects limitations to these conditions related only to where transmission structures are located. Continued permitted uses in the transmission-line corridors would include pastures, crop production, road construction, parking lots, and other uses that do not interfere with the safe, reliable operation of the transmission lines. It is expected that routine or seasonal maintenance would take place outside crop production time frames, which would limit the impact on existing crops (Duke 2007c, 2009c). Approximately 66 ac of transmission-line corridor is within the 100-year floodplain (Duke 2007c). The corridors also encompass streams and 11.17 ac of jurisdictional wetlands (i.e., wetlands regulated under Section 404 of the CWA) (USACE 2013a) (Section 2.4).

Based on information provided by Duke and the review team's independent evaluation, the review team concludes that because approximately 987 ac of land would be affected by transmission-line installation, including the clearing of approximately 690 ac of forested land, the transmission-line-corridor-related impacts would be noticeable. But considering the mostly rural setting for the new transmission lines, the abundance of forestland in that setting, and the ability to build the lines without interfering with most agricultural land use, the review team believes that the effects would not be destabilizing.

4.1.3.2 Railroad Corridor and Offsite Road Improvements

Reconstruction of a railroad spur is planned to support project activities for the proposed Lee Nuclear Station. The spur enters the site on the northern boundary, extends across the northern quarter of the site, and terminates at the project building site. The railroad spur originates in East Gaffney, southeast of the city center. Reconstruction would include placement of new ballast and track and would take place within the existing corridor and previously disturbed areas. Reconstruction of the railroad spur outside the Lee Nuclear Station site boundary would make use of the existing ROW that already has been heavily disturbed due to previous site building activities (Duke 2009c).

A portion of the existing railroad-spur corridor requires routing around an existing industrial facility, Reddy Ice, in East Gaffney. At this location, the ROW passes through the Reddy Ice driveway. The rerouting would extend the railroad spur a maximum of 125 ft to the north of the current ROW and would involve approximately 1300 ft of track. Building the railway at this location and elsewhere would be in accordance with all local, State, and Federal guidelines regarding good engineering and construction practices to minimize the irreversible commitment of land and the impact on the affected environment.

Based on information provided by Duke and the review team's independent review, the review team concludes that land-use impacts related to building the railroad spur would be minimal. The offsite road improvements, which would be limited widening and adding traffic signals to existing roads, likewise involve no more than minimal land-use impacts.

4.1.4 Summary of Land-Use Impacts During Construction and Preconstruction

The review team evaluated the construction and preconstruction activities related to building proposed Lee Nuclear Station Units 1 and 2 and the potential land-use impacts at the site and vicinity, the Make-Up Pond C site, the proposed transmission-line corridors, and the rail corridor. Based on information provided by Duke in its ER (Duke 2009c), the supplement to the ER regarding Make-Up Pond C (Duke 2009b), the *Duke Energy Carolinas Siting and Environmental Report for the William States Lee III Nuclear Station 230 kV and 525 kV Fold-in Lines, Cherokee and Union Counties, SC* (Duke 2007c), Duke's RAI responses updating design information subsequent to the draft EIS (especially a letter dated July 1, 2013 [Duke 2013d]), and the review team's independent evaluation, the review team concludes land-use impacts attributed to construction and preconstruction activities for the proposed Lee Nuclear Station Units 1 and 2 would be MODERATE, but that no mitigation beyond the actions stated would be required. The primary contributors to the impacts involve acquisition and use of a roughly 2110-ac previously undeveloped land parcel for Make-Up Pond C and ROWs for the transmission lines. Preparing the Make-Up Pond C site for future development of the pond and related facilities required purchasing and demolishing 86 privately owned residences, purchasing approximately 2110 ac of privately owned land, and permanently inundating or otherwise altering approximately 1050 ac of previously undisturbed rural land. Developing the transmission lines would require clearing approximately 690 ac of mostly forested land.

NRC-authorized construction activities represent only a portion of the analyzed activities (and do not include development of the transmission lines or Make-Up Pond C). The NRC staff concludes that the land-use impacts of NRC-authorized construction activities, which would be confined to the Lee Nuclear Station site, would be SMALL. The NRC staff concludes that no further mitigation, beyond Duke's commitments, would be warranted.

4.2 Water-Related Impacts

Water-related impacts involved in building a nuclear power plant are similar to impacts that would be associated with the development of any large industrial site. Prior to initiating onsite activities, including any site-preparation work, Duke would be required to obtain the appropriate authorizations regulating alterations to the hydrological environment. Below is a list of the water-related authorizations, permits, and certifications potentially required from Federal, State, regional, and local agencies; additional detail is provided in Appendix H.

- <u>CWA Section 401 Water Quality Certification</u>. This certification would be issued by the South Carolina Department of Health and Environmental Control (SCDHEC). This certification is required before the NRC can issue a COL to Duke.
- <u>CWA Section 402(p) National Pollutant Discharge Elimination System (NPDES) Permit</u>. This permit would regulate limits of pollutants in liquid discharges to surface water. The

U.S. Environmental Protection Agency (EPA) has delegated the authority for administering the NPDES program in South Carolina to the SCDHEC, which issued the permit (SC0049140) on July 17, 2013, effective September 1, 2013. A stormwater pollution prevention plan (SWPPP) would also be required.

Hydrologic alterations are discussed in Section 4.2.1; water-use impacts are discussed in Section 4.2.2; water-quality impacts are discussed in Section 4.2.3; and water monitoring is discussed in Section 4.2.4. The section draws from material presented in Duke's Revision 1 and Supplement to Revision 1 of the ER (Duke 2009c).

4.2.1 Hydrological Alterations

Activities associated with building the proposed Lee Nuclear Station Units 1 and 2 are described in detail in Section 3.3. Many of these activities would affect surface water and underlying aquifers on and near the site. Affected surface waterbodies include the Broad River and Ninety-Nine Islands Reservoir, London Creek and its tributaries, small streams that flow across the site, and the existing onsite storage ponds (i.e., Make-Up Pond A, Make-Up Pond B, and Hold-Up Pond A). The Lee Nuclear Station site is located on the unfinished Cherokee Nuclear Station site. Significant hydrological alterations that occurred while building Cherokee Nuclear Station would reduce the magnitude of additional alterations when building the Lee Nuclear Station. The additional hydrological alterations would result from removal of Cherokee Unit 1 infrastructure, removal of bedrock for proposed Lee Nuclear Station Units 1 and 2, temporary excavation dewatering, removal of surface soil to expand the switchyard area, and finish grading to develop stormwater drainage paths.

Building the intake and discharge structures would include dredging in the Broad River and Ninety-Nine Islands Reservoir, with anticipated short-term localized degradation in water quality. Dredged material disposal would be in an onsite spoils area (Duke 2013d). Dredging and dredged material disposal activities would comply with USACE permit requirements. Some dredging for removal of sediment would be required for placing the Broad River intake structure and the Make-Up Pond A intake structure. Cofferdam installation, excavation, and filling would be required at the Make-Up Pond B intake structure. The intake structure would be built in compliance with the Department of the Army permit and should not have long-term impacts on water quality.

Building the discharge system would include laying underground pipeline from the blowdown sump and wastewater-treatment system to Ninety-Nine Islands Dam. The ground cover disturbance and excavation activities would include erosion-control measures. The discharge pipe would be attached to the upstream side of Ninety-Nine Islands Dam. Steel braces would be used to attach the discharge pipe to the dam 10 ft below the minimum pool water level (Duke 2009c, Duke 2012e). Sediment in the dam forebay near the diffuser would be dredged to enhance mixing later during operation (Duke 2011f).

Construction Impacts at the Lee Nuclear Station Site

The existing Make-Up Pond A would be dredged to improve flow near the proposed intake structure. Dredging activities would comply with the Department of the Army permit; dredged material disposal would be in an onsite spoils area (Duke 2013d).

Building Make-Up Pond C would alter London Creek. While building of Make-Up Pond C is under way, the London Creek flow would be allowed to pass through sediment settling structures and pipes to downstream of the Make-Up Pond C dam. During the transition period between construction and pond filling, when the pipes would be sealed, pumps would be used to meet the proposed minimum flow releases downstream of the dam (Duke's December 3, 2012 letter). With the filling of the Make-Up Pond C, Duke would release minimum seasonal flows from Make-Up Pond C to London Creek downstream of Make-Up Pond C dam that would be protective of downstream aquatic resources. The minimum seasonal flow rates for January through April would be 1.50 cfs, for May, June, and December 1.0 cfs; and for July through November 0.75 cfs (Duke 2012m). In addition, once the pond was filled, some flow in London Creek downstream of the dam would be expected to resume, fed by dam seepage, groundwater, and runoff from the dam face (Duke 2009b). Groundwater levels in the vicinity of Make-Up Pond C would rise due to leakage from the pond.

Upgrading of the railroad spur to the Lee Nuclear Station site includes improvement of the London Creek and Little London Creek crossings, which involves temporary placement of cofferdams and diversion of streams (Duke 2009b). Erection of transmission-line towers near water or wetlands would be conducted in accordance with SCDHEC erosion-control requirements and NPDES permits.

Onsite groundwater would not be used during building activities for proposed Lee Nuclear Station Units 1 and 2, but it would be affected as a result of those activities. Conditions and activities that could affect groundwater levels and alter groundwater flow at the Lee Nuclear Station site include final site grading, changes to recharge due to impervious surfaces and stormwater basins, and dewatering during excavation (Duke 2009c).

In summary, the hydrological alterations associated with building activities on and in the vicinity of the Lee Nuclear Station site would be due to dredging for the intake and discharge structures in the Broad River and to improve circulation in Make-Up Pond A, building Make-Up Pond C, upgrading railroad-spur crossings over creeks, site grading, changes to runoff and infiltration characteristics, and dewatering in construction areas. Offsite hydrological alterations would be associated with the proposed new or expanded transmission-line corridors where they cross wetlands or surface waters. The impacts of hydrological alterations resulting from both onsite and offsite activities would be localized and temporary. Compliance with the requirements of the permits, certifications, and SWPPP, including implementation of best management practices (BMPs) would minimize impacts.

4.2.2 Water-Use Impacts

This section includes identification of the activities associated with building proposed Lee Nuclear Station Units 1 and 2 that could affect water use, and analysis and evaluation of proposed practices to minimize adverse impacts on water use by these activities. The impacts on the use of surface water and groundwater are discussed in Sections 4.2.2.1 and 4.2.2.2, respectively. Information in this section is drawn from the ER and supplemental information provided by Duke (Duke 2009b, c, Duke 2010f, h, 2011a, e).

4.2.2.1 Surface-Water-Use Impacts

Water needs for building activities at the site would be similar to typical uses of water for large industrial projects. These uses include dust abatement, concrete mixing, and potable water needs. Peak water needs during building activities are estimated to be 250,000 gpd (174 gpm) (Table 3-5). Water would be obtained from Draytonville Water District. The water district obtains its water from the City of Gaffney, South Carolina, which obtains its water from Lake Whelchel and the Broad River. Lake Whelchel is fed by Cherokee and Allison Creeks and water is occasionally pumped into Lake Whelchel from the Broad River (GBPW 2009).

The impacts of construction and preconstruction activities on surface water would be of limited duration. Peak water demands would represent a small portion of the available water from the Draytonville Water District (GBPW 2009; Duke 2010h). Based on the information provided by Duke and the review team's independent evaluation, the review team concludes that the impacts on surface-water use during construction and preconstruction activities for the proposed Lee Nuclear Station Units 1 and 2 would be SMALL, and no mitigation would be warranted. NRC-authorized construction activities represent only a portion of the analyzed activities, therefore the NRC staff concludes that the impacts of NRC-authorized construction activities would be SMALL, and no mitigation measures would be warranted.

4.2.2.2 Groundwater-Use Impacts

Duke has indicated that groundwater would not be used as a water-supply source during building at the Lee Nuclear Station site (Duke 2009c) or Make-Up Pond C site (Duke 2009b). As such, the review team determined that the influences on groundwater while building Lee Nuclear Station and Make-Up Pond C would be from dewatering of excavations at both the site and the pond, and from filling Make-Up Pond C prior to beginning operation of the proposed units.

Building at the Lee Nuclear Station site would involve maintaining a dewatered excavation, removing some additional bedrock within the nuclear island footprint (i.e., deepening the existing excavation), and backfilling the excavated area between proposed Units 1 and 2 (Duke 2009c). Because backfilling would continue, the water table drawdown would decrease, the dewatering product would decrease, and the water table would reach a state of equilibrium with its surrounding aquifer. Building at the site of proposed Make-Up Pond C would require dewatering of the dam foundation and abutment areas (Duke 2009b). Building the intake/discharge structure at Make-Up Pond C and the pipeline from the Broad River to Make-Up Pond C would involve conventional trenching.

Dewatering activities at the Lee Nuclear Station site would continue at the excavation created during the unfinished Cherokee Nuclear Station construction. As discussed in Section 2.3.1.2, the recent excavation dewatering effort produced an average of 0.39 cfs (250,000 gpd) through March 2007. Dewatering of the proposed site would use a combination of dewatering wells located outside of the excavation and sumps with submersible pumps within the excavation. Water from excavation dewatering would be discharged to Hold-Up Pond A before discharging to the Broad River. A similar system was used when building the unfinished Cherokee Nuclear Station units.

Duke assessed the areal extent of dewatering impacts using historical groundwater measurements (see Figure 2-11) and a dewatering analysis. The region affected by drawdown was roughly circular (approximately 1700-ft radius of influence) but irregular in shape. As noted in Section 2.3.1.2, it is possible that along the northeast shore of Make-Up Pond B and in the vicinity of well MW-1200 (see Figure 2-10), groundwater originating from Make-Up Pond B is being drawn to the excavation dewatering sump. A groundwater divide may exist at this location between Make-Up Pond B and well MW-1200; however, the review team interprets the groundwater monitoring data to be inconclusive. Elsewhere, groundwater flow directions appear unchanged away from the excavation; that is, groundwater flows off the high ground to the south of the excavation toward the excavation and from the perimeter of the locally affected region surrounding the excavation toward Hold-Up Pond A and Make-Up Ponds A and B. The review team concludes that Make-Up Pond B drawdown, if caused by excavation dewatering while building the proposed Lee Nuclear Station, would be temporary and influenced by the seasonal water balance within its surrounding watershed. Such a drawdown would not affect offsite water resources.

Duke also evaluated the potential effect of groundwater well drawdown at the Lee Nuclear Station site using a methodology for estimating the radius of influence of dewatering wells. Duke estimated the radius of influence as being well within the site boundaries and relatively far from offsite wells (Duke 2009c). The review team performed an independent check of this calculation and confirmed Duke’s analysis. As described in Section 2.3.1.2, from a groundwater hydrology perspective, the Lee Nuclear Station site is bounded on the west by Make-Up Pond B, on the north by the Broad River, and on the east by the floodplain of the Broad River and Make-Up Pond A. The nearest offsite residential groundwater supply well is located approximately 5000 ft south of the nuclear island and the influence of dewatering drawdown is estimated to extend approximately 1700 ft. Because the original excavation dewatering (i.e., circa 1977 to 1985) required a similar dewatering depth and methodology compared to the proposed excavation dewatering, the review team concludes that the original dewatering activity provides field data indicative of the response of the aquifer to dewatering for the proposed structures. The review team concludes that any impact on the Lee Nuclear Station site groundwater resource as a result of dewatering would be of limited magnitude, localized, and temporary, and therefore minor. Impact on offsite groundwater resources from dewatering would be virtually undetectable.

As described early in this section, building at the proposed Make-Up Pond C site would require dewatering of the dam foundation and abutments area and building the intake/discharge structure. Installation of the onsite/offsite pipeline from the Broad River to Make-Up Pond C would involve conventional trenching. Sediment and rock permeability in the vicinity of the proposed Make-Up Pond C dam and abutments is assumed to be similar to values found at the Lee Nuclear Station site. Accordingly, once the dam foundation area is dewatered, it is anticipated that dewatering flow will reduce to the rainfall that collects in the excavation combined with groundwater inflow (Duke 2009b). Because of the relatively low permeability of the materials, dewatering drawdown is expected to be localized to the immediate vicinity of the excavation.

Upon completion of Make-Up Pond C, groundwater levels would rise in the vicinity of the impoundment area and come into equilibrium with the full-pond level of the pond (Duke 2010f). Within the London Creek watershed, but above the full-pond level of Make-Up Pond C, the groundwater would remain substantially unaffected by the pond. The region that will exhibit the greatest change is the dam, its abutments, and the surrounding region. Groundwater in and around these earthen structures would establish a phreatic surface in equilibrium with the full-pond pool behind the dam, the low-permeability earthen embankments and underlying rock foundation, and the permeability of the natural environment below the dam. Groundwater flow through the earthen structures and surrounding natural materials would feed the stream below the dam.

During site characterization, Duke (2009b) identified one residential potable groundwater well within the Make-Up Pond C inundation area. It, and any other wells discovered within the inundation area during the building of Make-Up Pond C, will be decommissioned and closed in accordance with SCDHEC regulations. Duke acknowledged that potable water groundwater wells located near proposed Make-Up Pond C may exhibit increased water levels due to the filling of Make-Up Pond C.

Based on the absence of groundwater use and the factors discussed above, the review team concludes the overall groundwater impacts from construction and preconstruction activities for the proposed Lee Nuclear Station Units 1 and 2 and Make-Up Pond C would be of limited magnitude, localized, and temporary, and therefore SMALL and no mitigation would be warranted. Based on the above analysis, and because NRC-authorized construction activities represent only a part of the analyzed activities; the NRC staff concludes that impacts on groundwater use from NRC-authorized construction activities would also be SMALL and no mitigation would be warranted.

4.2.3 Water-Quality Impacts

The water-quality impacts of building a nuclear power plant are similar to those associated with the development of any large industrial site. This section includes identification of the activities associated with building the proposed Lee Nuclear Station Units 1 and 2 that could affect surface and groundwater quality, and analysis and evaluation of proposed practices to minimize adverse impacts on water quality by these activities. The impacts on surface water and groundwater are discussed in Section 4.2.3.1 and Section 4.2.3.2, respectively.

4.2.3.1 Surface-Water-Quality Impacts

The activities associated with building proposed Lee Nuclear Station Units 1 and 2 would occur close enough to Ninety-Nine Islands Reservoir their impacts on the quality of surface water need to be considered. The hydrological alterations associated with building the proposed units, including intakes and discharges, as described in Sections 3.3 and 4.2.1, would generally affect surface-water quality by dredging and erosion. Building Make-Up Pond C involves clearing and grubbing, excavation for the dam and abutments, and other activities as described in Section 3.3.1. These activities could result in erosion and sediment and dissolved solids entering the Broad River from the London Creek drainage. The above activities would be regulated by a combination of NPDES and Department of the Army permitting, adoption of a SWPPP, and use of BMPs (for example using cofferdams and silt fences). Installation of the discharge structure within the Federal Energy Regulatory Commission (FERC) Project Boundary Line also requires FERC approval. All necessary mitigation measures required to prevent and/or minimize erosion, sediment and dissolved solids from entering the Broad River will be under the jurisdiction of the FERC.

Activities related to road and railroad-spur improvement could potentially affect water quality in London Creek or other small creeks as land clearing and grading increase the potential for runoff and erosion. Stormwater runoff and water from excavation dewatering in the immediate vicinity of proposed Units 1 and 2 would be managed to drain into Make-Up Pond A, Make-Up Pond B, and the Broad River at permitted outfalls. Duke would use BMPs for soil erosion controls and comply with applicable regulations designed to prevent stormwater runoff from affecting the water quality in the Broad River and small streams in the vicinity of the site (Duke 2009b, c).

New transmission lines would need to be installed. Tower and line installation activities would comply with State and Federal guidelines and BMPs would be used to minimize impacts on water quality from erosion and sedimentation.

Because the impacts of hydrological alterations resulting from activities associated with building the proposed units would be localized and temporary, and because the required permits, certifications, and the SWPPP call for the implementation of BMPs to minimize impacts, the review team concludes that the impacts on surface-water quality from activities related to construction and preconstruction of proposed Lee Nuclear Station Units 1 and 2 would be SMALL, and no further mitigation beyond the actions stated would be warranted. NRC-authorized construction activities represent only a portion of the analyzed activities, therefore the NRC staff concludes that the impacts of NRC-authorized construction would be SMALL, and no further mitigation measures beyond the BMPs discussed above, would be warranted.

4.2.3.2 Groundwater-Quality Impacts

Based on a review of activities that would take place during the building of proposed Lee Nuclear Station Units 1 and 2 and Make-Up Pond C, the review team determined that the impacts on groundwater quality would arise from (1) filling proposed Make-Up Pond C, (2) discharge of groundwater dewatering product, (3) the stormwater management system, and (4) spills. As discussed in Section 4.2.2.2, groundwater would not be used as a water-supply source when building at the Lee Nuclear Station site or Make-Up Pond C site (Duke 2009b, c) and there would be no discharges to the groundwater environment during the building period.

Saturation of the sediment profile during initial filling of Make-Up Pond C can be expected to result in some dissolution of minerals/metals; however, groundwater quality in wells located near the site of proposed Make-Up Pond C is expected to be similar to that observed at the Lee Nuclear Station site and in the region (see Section 2.3.3.2). During the filling process, water will be pumped from the Broad River and discharged into Make-Up Pond C, which could result in elevated levels of turbidity and suspended solids, both from the water source and erosion and suspension of surface soils at the Make-Up Pond C site. Turbidity and suspended solids levels are expected to improve as inorganic particles settle and organic matter is broken down by microbial activity. Based on the filtering provided by the subsurface environment, the review team determined that any changes to the groundwater quality of wells adjacent to Make-Up Pond C would be minor and temporary.

Dewatering of excavations would occur at both sites, (i.e., Lee Nuclear Station and Make-Up Pond C). Ultimately, the dewatering product would discharge to the Broad River at both locations. As discussed above and in Section 2.3.3.2, groundwater in the region includes concentrations of naturally occurring metals as well as pH outside acceptable secondary EPA Drinking Water Standards (40 CFR Part 143). Groundwater of this quality naturally discharges to the Broad River and its tributary streams. The estimated volume of dewatering product from the Lee Nuclear Station site is relatively low compared to the flow of the Broad River (see Section 2.3.1.2). Discharge of dewatering product at both sites would be monitored in accordance with an approved SWPPP prepared by Duke in compliance with an NPDES permit issued by the SCDHEC. The review team concludes that the dewatering product has a naturally occurring quality, is of small volume, is monitored in accordance with an NPDES permit, and would quickly dilute in the Broad River. The review team also concludes that alteration of groundwater quality from other stormwater management system discharges (e.g., to Make-Up Ponds A or Make-Up Pond B) would be undetectable.

BMPs would be applied to prevent spills and minimize their effects. The Spill Prevention, Control, and Countermeasure Plan (SPCCP) required by the SCDHEC pursuant to 40 CFR Part 112 would mitigate impacts on local groundwater because spills would be quickly attended to and not allowed to reach groundwater. Examples of materials that may spill during the building of proposed Lee Nuclear Station Units 1 and 2 are diesel fuel, hydraulic fluid, and lubricants.

Because the impacts of filling proposed Make-Up Pond C, and because spills would be localized, temporary, and of limited magnitude, the review team concludes the construction and preconstruction impacts of the proposed action on groundwater quality would be of limited magnitude, localized, and temporary, and therefore SMALL and no further mitigation other than BMPs would be warranted. Because NRC-authorized construction activities represent only a part of the analyzed activities, the NRC staff concludes that impacts on groundwater-quality from NRC-authorized construction activities would be SMALL and no mitigation other than BMPs would be warranted.

4.2.4 Water Monitoring

Duke outlines monitoring programs for hydrological and chemical monitoring in Sections 6.3 and 6.6 of its ER for proposed Lee Nuclear Station Units 1 and 2 (Duke 2009c).

4.2.4.1 Surface-Water Monitoring

The SCDHEC requires NPDES permitting for projects that disturb more than 1 ac of land. The NPDES permit for construction activities covers the monitoring of stormwater discharges from the areas associated with building the proposed units. To obtain an NPDES permit a SWPPP would be required. The SWPPP would include a description of visual inspection actions to detect erosion and provide effective sediment control, especially after rains. The SWPPP also would include a description of sediment-control BMPs. The approval of the SWPPP precedes the issuance of the NPDES permit, which would typically describe the monitoring locations and frequency. Duke also anticipates monitoring turbidity in the Broad River downstream of dredging activity.

4.2.4.2 Groundwater Monitoring

Some existing groundwater monitoring wells completed during site characterization would likely be abandoned when building at the Lee Nuclear Station site and Make-Up Pond C site because of their location within the proposed action footprint. However, these wells would be replaced with wells at new locations, and all wells would be monitored monthly during site clearing and building activities. The monitoring well network would be used to (1) monitor dewatering and other site clearing and building activities for drawdown during construction; (2) verify design assumptions related to the future hydrostatic loading of the completed structures; (3) document the stabilization of the water table following completion of site clearing and building activities and discontinuance of dewatering; and (4) provide the basis for design of the operational groundwater monitoring program (Duke 2009c).

4.3 Ecological Impacts

This section describes the potential impacts on terrestrial and aquatic ecological resources from construction and preconstruction activities at the Lee Nuclear Station site, creation of a new cooling-water reservoir (Make-Up Pond C), installation of transmission-line and water-pipeline corridors, renovation and partial rerouting of an existing railroad-spur corridor, and improvements to six offsite road areas. The section is divided into two subsections: terrestrial and wetland impacts and aquatic impacts.

4.3.1 Terrestrial and Wetland Impacts

This section provides information about the site-preparation and development activities of the proposed Lee Nuclear Station, Make-Up Pond C, two new transmission-line corridors, renovation and partial rerouting of the railroad-spur corridor, improvements to six offsite road areas, and related impacts on the terrestrial ecosystem. Topics discussed include habitat and associated wildlife impacts, important species and habitats, erosion and sedimentation control, building-related noise, and spill prevention and response.

4.3.1.1 Terrestrial Resources – Site and Vicinity

Site-Preparation and Plant-Building Activities

As described in the ER submitted by Duke (Duke 2009c) and a design update (Duke 2013d), site-preparation and plant-building activities in terrestrial habitats at the Lee Nuclear Station site include the following:

- installing erosion and sediment-control devices, and establishing related practices
- clearing vegetation by cutting or grubbing, and disposing of or recycling the resulting vegetative debris
- leveling the land by grading or filling
- creating spoil areas, laydown areas, and rail turnaround
- excavating to install building and other structural foundations
- excavating, installing, and backfilling new water intake and blowdown discharge pipelines and other station piping and utility connections
- disposing of dredged materials and spoils onsite

- pouring concrete foundations and erecting buildings
- leveling new parking lots and internal roadways by grading or filling
- creating stone (gravel) or paved roads and parking lots
- performing final grading and landscaping to permanently control erosion and runoff.

The majority of terrestrial ecology impacts result from site-preparation activities. Site-preparation activities for Units 1 and 2 are currently scheduled to begin in 2015 and to be completed in 2018 (Duke 2013a).

Upland Vegetation

Ecological cover types on the Lee Nuclear Station site are depicted in Figure 2-12 and described in Section 2.4.1.1. The structures and affected areas associated with proposed Units 1 and 2 are shown in Figure 3-4, and described in Sections 3.2 and 3.3. An analysis of the effects of the site-development footprint on vegetative cover suggests a total impact area of approximately 946 ac, including temporary habitat alteration (327 ac) and permanent habitat loss (619 ac). Table 4-1 summarizes the areas of cover types that would be affected by the temporary and permanent facilities associated with building Units 1 and 2 (Duke 2013d).

About 514 ac or 54 percent of the site-preparation and site-development footprint occurs in the open/field/meadow and upland scrub cover types (Table 4-1). This would affect about 86 percent of the collective open/field/meadow and upland scrub habitat that is available onsite. These cover types developed following cessation of building activities at the unfinished Cherokee Nuclear Station. The open/field/meadow and upland scrub cover types are considered to be of relatively low value to wildlife compared to the five forest cover types onsite (Duke 2012g), and are common in the region where abandoned agricultural and other previously disturbed sites are in the process of reverting back to forest.

Upland forests, including the mixed hardwood, mixed hardwood-pine, pine-mixed hardwood, open pine-mixed hardwood, and pine cover types that would be affected, are higher quality wildlife habitat due largely to relatively high plant species diversity and varied vertical structure (Duke 2008e). However, of these five forest habitat types, mixed hardwood and mixed hardwood-pine provide the greatest value to wildlife (Duke 2010c). Only about 423 ac, or 45 percent of the site-preparation and site-development footprint, occur in five forest cover types. This would affect about 40 percent of the total available area of these five habitat types onsite (Duke 2013d).

Merchantable timber may be harvested prior to site clearing. Non-marketable trees and other woody material would be grubbed and disposed of by burning, chipping, landfill disposal, or it may be recycled or reused elsewhere onsite for firewood, landscape mulch, wildlife habitat, and erosion or siltation control (Duke 2009c).

Table 4-1. Cover Types to be Cleared on the Lee Nuclear Station Site[a]

	Estimated Total Acreage	Estimated Area of Clearing by Cover Type (ac)[b]								
		MH	MHP	PMH	OPMH	P	NJF	OFM	USC	W
Building period[c]										
					8.11					
Laydown area	72.45	8.88	9.35	6.73				27.34	12.04	
Spoils area	254.31	63.50	41.36	51.47	39.75	7.34		12.48	38.41	
Subtotal	326.76	72.38	50.71	58.20	47.86	7.34	0	39.82	50.45	0
Permanent facilities[d]										
Power block	65.55						8.56	56.99		
Cooling towers	10.59							10.59		
Switchyard	19.80							19.80		
Meteorological tower	7.25		4.36	1.87					1.02	
Transmission	64.06	3.79	19.88	13.91				15.08	11.19	0.21[e]
Wastewater treatment	10.13		0.13	4.42			0.42	3.76	1.4	
PWS and WWS pipelines	23.47	3.23	3.67	1.82		0.12		10.83	3.80	
RWS pipeline	41.74	3.22	18.82	5.29	6.61			7.80		
General grading and transportation	376.58	38.02	25.67	16.40	12.68	2.42	0.27	245.97	35.15	
Subtotal	619.17	48.26	72.53	43.71	19.29	2.54	9.25	370.82	52.56	0.21
Total	**945.93**	**120.64**	**123.24**	**101.91**	**67.15**	**9.88**	**9.25**	**410.64**	**103.01**	**0.21**
Percentage of total	**100**	**12.75**	**13.03**	**10.77**	**7.10**	**1.04**	**0.98**	**43.41**	**10.89**	**0.02**

(a) Source for table and footnotes: Duke 2013d.
(b) Cover Type Key: mixed hardwood (MH), mixed hardwood-pine (MHP), pine-mixed hardwood (PMH), open pine-mixed hardwood (OPMH), pine (Pine), non-jurisdictional feature (NJF), open/field/meadow (OFM), upland scrub (USC), wetland (W).
(c) "Building period" activities correspond to temporary impacts. The "borrow area" category was eliminated, because the area for borrow material is no longer needed. "heavy-haul road and path," "parking," and "batch plant" categories will have permanent grading or other facilities located in the same area after completion of plant building and are therefore now included as permanent facilities under "general grading and transportation" to avoid double counting.
(d) "Permanent facilities" correspond to permanent impacts. The "transmission," "potable water service (PWS) and wastewater service (WWS) pipelines," and "raw water service (RWS) pipeline" categories were added. "warehouses," "parking," "vehicle maintenance," "simulator training," "clarifier area," "support and administration," "security training area," and "intake/discharge structures" categories are now included as permanent facilities under "General grading and transportation." Also, the disturbance associated with the railroad turnaround is included under "General grading and transportation."
(e) The onsite 230-kV transmission-line corridor crosses a total of 1.24 ac of wetlands; however, only 0.21 ac is forested. Only the 0.21-ac forested area will have vegetation altered (converted from forested to scrub-shrub wetland), whereas herbaceous wetlands will not be disturbed.

Construction Impacts at the Lee Nuclear Station Site

Site-preparation and clearing would be performed in accordance with Federal and State regulations and permit requirements and established BMPs (Duke 2008j). BMPs employ site preparation, surface stabilization, runoff control and conveyance, sediment traps and barriers, and stream protection measures that can be used effectively depending on site-specific conditions. Prior to initiating site development, Duke will prepare a SWPPP for Lee Nuclear Station using appropriate State or local specifications, such as those provided by the SCDHEC Storm Water Management Program (SCDHEC 2003). General measures to be considered for inclusion in the SWPPP as required by the NPDES permit for construction activities are identified below (Duke 2013d):

- Establish perimeter controls around the area to be disturbed and along the Limits of Disturbance boundaries by placing and maintaining appropriate sediment-control BMPs (e.g., silt fence, fiber rolls, vegetated buffer strips).
- Phase building activities (e.g., initial land-disturbance phase, construction phase, and stabilization phase) to minimize the duration of soil exposure. Exposed soil should be stabilized and covered with appropriate erosion-control BMPs (e.g., seeding, mulching, erosion-control blankets) within the time frame required by the SCDHEC.
- Use diversion ditches or berms to direct sediment-laden stormwater away from unprotected slopes and toward sediment-control devices (e.g., sediment basins, sediment traps, rock check dams).
- Schedule periodic and regular inspection and maintenance of all installed BMPs.

Additional practices to be included in the SWPPP are spill control and prevention measures for construction equipment, waste disposal requirements, dust-control measures, procedures for fertilizer/pesticide use, and non-stormwater discharge requirements. Following site-development activities, all areas cleared as temporary work areas (e.g., laydown areas, temporary parking lots, etc.) would first be re-vegetated in accordance with the Duke's BMPs for erosion control in compliance with the NPDES permit for construction activities issued by the SCDHEC. The site security staff would review long-term landscaping plans for the site to ensure an appropriately cleared security buffer. Duke's landscape architects would make landscape decisions for areas outside the security buffer. Past practices have been to mechanically disturb the soil to facilitate seed germination, amend soil where necessary, re-vegetate with native vascular plants, and allow natural succession to occur (Duke 2013d).

Approximately 411 ac of open/field/meadow, 103 ac of upland scrub, and 423 ac of the forest cover types onsite would be affected by building Lee Nuclear Station (Duke 2013d). Temporary work areas would be re-vegetated. Building activities would be conducted according to Federal and State regulations, permit conditions, existing procedures, and established BMPs. Therefore, building impacts on habitat on the Lee Nuclear Station site would be spatially extensive. However, Duke sited about half of the building impacts in previously disturbed open/field/meadow and upland scrub habitats. In addition, the forest cover types to be disturbed are largely fragmented.

Wetlands, Streams, and Floodplains

This subsection discusses the wetlands, streams, and floodplains on the Lee Nuclear Station site. Impacts on streams are discussed further in Section 4.3.2.1.

Jurisdictional Wetlands

Wetlands and waterways would be avoided by site-development activities to the greatest extent possible. For example, the river intake structure would be located just northeast of the 0.03-ac jurisdictional wetland that abuts the Broad River (USACE 2013a) (see Figure 2-13). This forested wetland falls outside of the footprint of the river intake structure; thus, no direct building impacts are anticipated. Installation of the river intake would be behind a cofferdam, preventing the release of sediment during installation activities, and there are no anticipated impediments to downstream flow in the Broad River except for behind the cofferdam (Duke 2008f). However, a slight increase in turbidity and settling of some sediment may occur when the cofferdam is installed (Duke 2009c). Soil and sediment cut from within the cofferdam would be deposited in an area designated for spoils disposal in the uplands of the Lee Nuclear Station (Duke 2008c). Thus, there would be no substantive sedimentation of the 0.03 ac forested wetland from installation of the river intake, and minimal effects on wetland vegetation are anticipated.

The river intake pipeline and access road would pass by but not through the 0.03-ac forested jurisdictional wetland (Duke 2008f, 2013h). Thus, no direct impacts on this wetland are anticipated from installation of the intake pipeline and access road. In addition, Duke's existing construction practices and BMPs (Duke 2008j) would be implemented, such as installing sediment filter devices (e.g., sediment tubes or silt fences) as necessary to prevent the flow of spoils from the pipeline corridor and restrict sediment flow into the wetland. Following pipeline emplacement, the pipeline corridor would be seeded with annual grasses or other species to stabilize the soil. The seeded species would not require fertilizer or other amendments. Following seeding, the disturbed area would be allowed to revegetate naturally with native herbaceous and small shrub species, largely approximating the open/field/meadow cover type that now occupies the site proposed for the pipeline. Thus, no sedimentation of the forested wetland is anticipated from building the river intake pipeline and access road. Large shrubs and trees would be precluded to establish a permanent corridor that would be maintained to facilitate visual survey of the pipeline ROW (Duke 2009c).

Hand-cutting of trees would be necessary within 0.21 ac of a 0.26-ac forested wetland located in uplands just west of the southwest corner of Make-Up Pond A (Figure 2-13) within the 230-kV onsite transmission-line corridor. These wetlands would be permanently converted to scrub-shrub wetlands. This vegetation conversion would be the only permanent impact on jurisdictional wetlands on the Lee Nuclear Station site (Duke 2011h).

The remaining jurisdictional wetlands that abut or are otherwise closely associated with Make-Up Ponds B and A (Duke 2012n) fall outside the site-development footprint and would not be permanently affected by building Units 1 and 2 (Duke 2009c); however, there may be temporary secondary impacts on certain jurisdictional wetlands that abut portions of Make-Up Ponds A and B. Temporary partial drawdown of the water level within Make-Up Ponds A and B would be required to relieve pressure on the cofferdams while building the associated intake/refill structures. Duke expects the water level would be drawn down 20 ft for approximately 32 months at Make-Up Pond A and for approximately 34 months at Make-Up Pond B (Duke 2012o).

Duke evaluated landscape position (wetland elevation relative to Make-Up Pond A or B, other wetlands, and streams), topographic location (depressions, floodplains, slopes), presence/ absence of vegetation, vegetation type, soil type, and hydrology to identify the wetlands that may be affected (Duke 2013h). Because both Make-Up Ponds A and B are man-made impoundments in steep terrain, little littoral habitat is present, but some emergent vegetation is present in shallow coves and fringe wetlands (Duke 2012o). The temporary drawdown of Make-Up Pond A may affect a 3.85-ac freshwater marsh located in the southeast portion of the pond (Figure 2-13). Three wetlands comprising a total of approximately 1.61 ac and located in the uppermost reach (southwestern end) of Make-Up Pond B (Figure 2-13) may also be temporarily affected by the drawdown. Duke does not expect the drawdown to completely dewater the potentially affected wetland areas and expects them to continue to function as wetlands (Duke 2012o, 2013h).

In addition to implementing interim shoreline stabilization and erosion control in accordance with SCDHEC erosion-control procedures (Duke 2012o), Duke plans to install temporary dikes downstream of the potentially affected wetlands to maintain the hydrology of the existing wetlands (Duke 2012o). Duke intends to monitor the wetlands throughout the construction drawdown period and has proposed a pre-drawdown baseline qualitative floristic and hydrological survey, semi-annual (spring/fall) hydrology monitoring, and a floristic and hydrological survey one growing season after the ponds are refilled to the original full-pond elevation. Duke expects the shoreline/riparian vegetation affected during the drawdown would recover naturally via the existing seedbank. Nevertheless, if the results of the floristic survey after pond refill do not contain a prevalence of hydrophytic plant species identified in the baseline survey, Duke would provide supplemental seeding or planting (Duke 2012o). The South Carolina Department of Natural Resources (SCDNR) has concurred with the proposed work plan for drawdown of Make-Up Ponds A and B (SCDNR 2012m). All ecological monitoring and adaptive management would be performed in accordance with the terms and conditions of the Department of the Army permit and the SCDHEC 401 Water Quality Certification (Duke 2012o).

In addition, indirect impacts on jurisdictional wetlands just below the Make-Up Pond B dam and along the eastern shoreline of the southeastern arm of Make-Up Pond B (Figure 2-13) could result from dewatering the excavation of the unfinished Cherokee Nuclear Station during construction of Lee Nuclear Station. Groundwater may flow from the northeast side of Make-Up Pond B (Figure 2-10) toward the dewatered excavation (groundwater would not flow toward the excavation from anywhere else around the periphery of Make-Up Pond B) (see Section 2.3.1.2). The excavation has been dewatered almost continuously since 2005, and the water pumped to Make-Up Pond B (see Section 2.3.1.2). Thus, any possible dewatering of the four wetlands would not have been noticeable. However, during construction of proposed Lee Nuclear Station Units 1 and 2 (see Section 4.3.2.2), water from dewatering during excavation would instead be pumped to Hold-Up Pond A and could potentially draw down the wetlands. The vertical drawdown, if any, of the jurisdictional wetlands around the periphery of Make-Up Pond B, and the duration of drawdown, are uncertain. Nevertheless, drawdown, if any, and recharge would be consistent with seasonal precipitation patterns for Make-Up Pond B (i.e., drawdown likely during late spring, summer, and early fall months, and recharge likely during late fall, winter, and early spring months). Similar impacts on the jurisdictional wetlands around the periphery of Make-Up Pond A (Figure 2-13) are not anticipated because groundwater flow from Make-Up Pond A is not toward the dewatered excavation (Duke 2009c). Similar impacts on the wetlands located along the periphery of Make-Up Pond B outside its northeast corner, and/or upgradient of Make-Up Pond B (Figure 2-13), are also not anticipated.

Appropriate erosion and sediment-control measures, as described in the *Duke Energy BMPs for Stormwater Management and Erosion Control Policy and Procedures Manual* and the SCDHEC BMP Manual, would be employed for all activities occurring in proximity to jurisdictional waters of the United States to minimize potential indirect impacts on wetlands and streams (Duke Energy 1999; Duke 2008j, 2011h) and to comply with any conditions included in the Department of the Army permit issued by the USACE and the SCDHEC State 401 water-quality certification. The conditions for each authorization are site-specific, and usually require applicable BMPs, and typically include the following practices (Duke 2009c):

- Keep disturbance of vegetation and the substrate to a minimum.
- Grade and reseed disturbed areas (using native vegetation) to minimize erosion and preclude sedimentation.
- Avoid environmentally sensitive areas.
- Install waterway crossings only if no reasonable alternate exists, and minimize placing of fill material in the waterway or adjacent wetlands.

- Use temporary board roads or removable mats in wetlands and stream crossings.
- Totally remove any temporary fill material and restore the site to its original elevation.

In addition, to further protect adjacent waterbodies from indirect impacts during onsite construction activities, Duke intends to maintain a 50-ft undisturbed buffer zone around all existing protected areas, including wetlands, open waterbodies, and streams. Located between the surface waters and the outermost sediment and erosion-control BMPs, this 50-ft buffer zone is a 20-ft increase of the 30-ft buffer zone requirement by the NPDES permit for construction activities as set forth by the SCDHEC. The SWPPP would include a narrative addressing buffer zone maintenance and velocity dissipation measures for concentrated flows entering the buffer zone (Duke 2013d).

Installation of the river intake also would comply with the Department of the Army permit and the SCDHEC State 401 water quality certification. Use of erosion-control measures should also prevent the introduction of sediment into the nearby forested wetland. The river bank would be stabilized and re-vegetated after construction to minimize erosion by river currents (Duke 2011h). The Department of the Army permit would specify any needed mitigation or further restoration (Duke 2009c).

There would be no permanent or temporary impacts on jurisdictional wetlands along the Broad River on the Lee Nuclear Station site (Duke 2012n).

<u>Non-Jurisdictional Features</u>

The site-preparation and building footprint includes impacts on eight non-jurisdictional features encompassing 9.25 ac (Figure 2-13) (Duke 2013d) (Table 4-1). Five of these areas (8.56 ac, Figure 2-13) developed in depressions within the central portion of the unfinished Cherokee Nuclear Station and would be disturbed for installation of the Lee Nuclear Station power block. These non-jurisdictional features developed from rainwater that accumulated in the excavation for the unfinished Cherokee Nuclear Station and support primarily shrubby and herbaceous vegetation. They were dewatered prior to and during the removal of Cherokee Nuclear Station power-block structures in 2007 and seasonal rainwater continues to be removed from the depressions. These areas provide relatively little ecological function or value, and impacts on them would thus be considered negligible (Duke 2009c).

A 0.42-ac non-jurisdictional feature would be disturbed during building of the proposed Lee Nuclear Station wastewater-treatment facility and the two remaining non-jurisdictional features (0.11 and 0.16 ac, respectively) just west of Make-Up Pond A would be disturbed by general grading activities (Figure 2-13) (Duke 2013d). The soils in these areas are more typical of upland soil than hydric soil (see Section 2.4.1.1). Their ecological function and value are limited by this fact (Duke 2009c). Thus, impacts on them would be expected to be negligible.

Streams

Onsite 230-and 525-kV transmission-line structures would be located outside of jurisdictional streams in surrounding upland buffer areas. Hand-cutting of canopy trees would occur within stream buffers, but other buffer vegetation would remain intact. Duke has not quantified these impacts within stream buffers (see Aquatic Ecology Section 4.3.2) (Duke 2011h).

Floodplains

The power block as well as support buildings for Lee Nuclear Station would be sited outside the 100-year floodplain on the Lee Nuclear Station site (Duke 2011h). The intake structure would however cross the 100-year floodplain to reach the Broad River.

Wildlife

Impacts on wildlife would result from the permanent and temporary habitat losses described above. Wildlife may suffer mortality, disturbance, and displacement as a result of ground clearing and building activities. Less mobile animals, such as reptiles, amphibians, small burrowing mammals, and unfledged birds, would incur greater mortality than more mobile animals, such as adult birds and large mammals. Sublethal disturbance may adversely affect movements, feeding, sheltering, and reproductive behaviors. Mobile animals may be displaced into undisturbed habitat where increased competition for resources during building activities may result in increased predation and decreased fecundity, ultimately leading to temporary reductions in populations. Relatively large portions of the available upland cover types onsite would be affected by site preparation, as indicated in the above discussion, and similar habitats are available in adjacent areas onsite (e.g., south and west of Make-Up Pond B) and offsite. Thus, these undisturbed habitats would be available to animals displaced during ground clearing and building. In addition, site preparation would create early successional habitats from forest habitats that could be colonized by early successional species.

Species adapted to early successional habitat may be lost from the open/field/meadow and upland scrub habitats present on the proposed Lee Nuclear Station site. Such species may disperse into open/field/meadow and upland scrub habitats remaining onsite and in adjacent areas, and colonize early successional habitats created by site-preparation activities, such as re-vegetated laydown and spoil-disposal areas. Similarly, species adapted to forest/clearing interface environments may be lost from edge habitats that are destroyed by site preparation, but may disperse into edge habitats remaining onsite and present in adjacent areas, and colonize new edge habitats created by forest fragmentation. However, species dependent on interior forests could only disperse into forest habitats remaining onsite and present in adjacent areas. Thus, forest-interior wildlife may be affected to a greater extent than wildlife adapted to early successional or forest-edge habitats. However, because forest habitat remains onsite (e.g., south of Make-Up Pond B) and additional forest habitat is offsite, resource availability is not expected to be a factor limiting populations of affected forest-interior wildlife, although population levels and hence competition could increase in these adjoining habitats. Further, as forest succession takes place in temporary use areas (e.g., laydown and spoil-disposal areas) forest-interior wildlife would likely recolonize these areas; however, this would not occur for several decades.

Migratory bird collisions with tall construction equipment are possible. Studies of avian collisions with elevated construction equipment are lacking in the literature. The structures that are most similar to elevated construction equipment (e.g., cranes) and that pose the greatest threat of collision mortality are communication towers. The towers that appear to cause the most problems are tall, especially those that exceed 305 m (1000 ft), are illuminated at night with solid or pulsating incandescent red lights, are guyed, are located near wetlands and in major songbird migration pathways or corridors, and have a history of inclement weather during spring and fall migrations (Kerlinger 2004; Manville 2005). Published accounts of kills at short towers and other short structures are limited, and are usually associated with bad weather and lighting (Manville 2005). Although the Lee Nuclear Station site lies near a principal inland route of the Atlantic Flyway that extends through northern South Carolina (Bird and Nature 2009), substantial migratory bird collisions with construction equipment is unlikely because the anticipated equipment is of relatively low stature, is not guyed, is unlit, and would not be located near any major wetlands. Thus, migratory bird collision is not likely to be a substantial source of mortality.

Typical building activity noise is generated by internal combustion engines (e.g., front-end loaders, tractors, scrapers/graders, heavy trucks, cranes, concrete pumps, generators), impact equipment (e.g., pneumatic equipment, jackhammers, pile drivers, etc.), and other equipment such as vibrators and saws (Duke 2009c). Noise from building activities can affect wildlife by inducing physiological changes, nest or habitat abandonment, or behavioral modifications, or it may disrupt communications required for breeding or defense. However, it is not unusual for wildlife to habituate to such noise (AMEC Americas Limited 2005; Larkin 1996). Attenuated noise levels from various types of construction equipment would range from about 80 to 95 dBA (A-weighted decibels) at 50 ft from the source and would be reduced to a range of about 48 to 63 dBA at 2000 ft (Duke 2011b). It would be anticipated that some wildlife would avoid using areas within 400 ft of operating construction equipment (Bayne et al. 2008), where noise levels are expected to range from 62 to 76 dBA, below the 80- to 85-dBA threshold at which birds and small mammals are startled or frightened (Golden et al. 1980). Thus building activity noise is not likely to have noticeable effects on local wildlife.

Building-related increases in traffic would likely be most obvious on the rural roads of Cherokee County, specifically McKowns Mountain Road, a two-lane county road that will provide the only access to the proposed Lee Nuclear Station. Currently, it is estimated that approximately 950 vehicles a day travel on McKowns Mountain Road between SC 105 and the end of the road near the Broad River (Duke 2013a). During construction and preconstruction, up to

4510 vehicles would travel McKowns Mountain Road in each direction twice per day. Also, an estimated 100 truck deliveries will be made daily to the proposed site (see Section 4.4.4.1). This would likely increase traffic-related wildlife mortalities. Local wildlife populations could decline if roadkill rates were to be substantial. However, while roadkill is an obvious source of wildlife mortality and would likely increase during building activities, except for special situations not applicable to the Lee Nuclear Station (e.g., ponds and wetlands crossed by roads where large numbers of migrating amphibians and reptiles would be susceptible), traffic mortality rates rarely limit population size (Forman and Alexander 1998). Consequently, the overall impact on local wildlife populations from increased vehicular traffic on McKowns Mountain Road during construction and preconstruction would be expected to be negligible.

Vegetation clearing (including timber harvest) and grubbing would be scheduled, to the extent practicable, to avoid the migratory bird-nesting season (generally March through June). However, if avoidance is infeasible, Duke would amend its existing U.S. Fish and Wildlife Service (FWS) and SCDNR depredation permits (MB000257-0 and MD-19-10, respectively) (Duke 2010d).

Summary

The review team has determined that the site-preparation and development-related impacts of habitat loss and associated wildlife mortality, disturbance, and displacement would be spatially extensive, but allayed somewhat because a substantial portion of the impacts would occur in previously disturbed, low-quality habitat. In addition, collisions with elevated structures; noise; and increased traffic may adversely affect onsite wildlife. Construction and preconstruction of the proposed Lee Nuclear Station would be conducted according to Federal and State regulations, permit conditions, and established BMPs. Wetlands and waterways would be avoided to the extent possible. The review team concludes that construction and preconstruction impacts on habitat and associated wildlife on the proposed Lee Nuclear Station would be considerable, although not regionally destabilizing.

4.3.1.2 Terrestrial Resources – The Make-Up Pond C Site

Existing Cover Types

The ecological cover types in the Make-Up Pond C study area are shown in Figure 2-14. The infrastructure and affected areas associated with creating Make-Up Pond C are shown in Figure 3-5. The types of vegetation cover and acreages that would be permanently and temporarily affected within the Make-Up Pond C reservoir features, outside the inundation zone but within the Make-Up Pond C study area, and outside the Make-Up Pond C study area (transmission line-reroute) are provided in Table 4-2.

Table 4-2. Cover Types Affected During Construction of Make-Up Pond C[a]

	Estimated Disturbed Acreage	Cover Type[b]										
		OFM	P	PMH	USC	MH	MHP	OPMH				OW[c]
					Permanent Impacts							
Reservoir features												
Impoundment	618.83	88.13	104.45	9.91	1.06	308.77	101.11	-		-		5.4
Dam footprint	14.52	0.62	6.63	-	-	4.43	2.84	-	-	-	-	-
Saddle dikes	6.96	0.95	5.27	-	-	0.74	-	-	-	-	-	-
Make-Up Pond C spillway	2.38	-	0.01	-	-	1.74	0.63	-	-	-	-	-
Impacts outside inundation zone but within Make-Up Pond C study area												
Buck Mill Road	4.89	0.82	3.96	-	-	0.07	0.04	-	-	-	-	-
Grace Road	2.07	1.69	0.13	-	-	0.14	0.11	-	-	-	-	-
Heavy-haul roads and haul paths	0.9	-	-	-	-	-	-	-	-	-	-	0.9
Lake Cherokee spillway	0.43	0.43	-	-	-	-	-	-	-	-	-	-
Newly built road	3.40	-	0.16	-	2.14	-	1.10	-	-	-	-	-
Old Barn Road	8.03	8.03	-	-	-	-	-	-	-	-	-	-
Peeler Ridge Road	1.48	0.03	1.45	-	-	-	-	-	-	-	-	-
RWS pipeline	8.39	0.78	5.44	-	1.72	0.09	0.36	-	-	-	-	-
RWS pipeline break tank	0.16	-	-	-	0.16	-	-	-	-	-	-	-
Rip rap	0.29	0.23	-	-	-	0.06	-	-	-	-	-	-
Road to Make-Up Pond C	6.49	0.61	1.60	-	-	1.37	2.91	-	-	-	-	-
Rolling Mill Road	15.10	7.15	5.54	-	-	1.22	0.93	0.26	-	-	-	-
SC 329--new alignment	31.11	15.96	2.43	4.36	-	7.45	0.91	-		-		-
Transmission line--reroute	18.41	7.17	1.66	2.36	-	5.19	0.23	-	-	-	-	1.8
Railroad-line crossings	8.09	-	3.55	0.02	-	2.48	2.04	-	-	-	-	-
Spoils area	186.21	73.61	67.99	-	8.76	26.76	1.29	-		-		7.8
Vegetation clearing	102.47	10.77	31.05	4.71	-	34.39	21.55	-	-	-	-	-
White Road	6.33	5.64	0.64	-	-	0.05	-	-	-	-	-	-

Table 4-2. (contd)

	Estimated Disturbed Acreage	Cover Type[(a)]										
		OFM	**P**	**PMH**	**USC**	**MH**	**MHP**	**OPMH**				**OW**
Impacts outside Make-Up Pond C study area												
Transmission line--reroute	3.05	-	-	-	-	-	3.05	-	-	-	-	-
Total permanent impacts	**1049.99**	**222.62**	**241.96**	**21.36**	**13.84**	**394.95**	**139.10**	**0.26**				**15.9**
Temporary Impacts												
Impacts outside inundation zone but within Make-Up Pond C study area												
Borrow area	7.67	4.15	0.65	-	-	1.70	1.17	-	-	-	-	-
Dewatering pipe	0.03	-	-	-	-	0.03	-	-		-		-
Diversion pipe	0.36	-	-	-	-	0.34	0.02	-	-	-	-	-
Field office	0.11	0.11	-	-	-	-	-	-	-	-	-	-
Heavy-haul roads and haul paths	10.68	6.92	0.01	-	-	3.75	-	-	-	-	-	-
Laydown	4.78	3.21	-	-	1.04	-	0.53	-	-	-	-	-
Logging roads	12.80	0.25	3.36	6.98	1.19	1.02	-	-	-	-	-	-
Mechanics shop	0.17	0.17	-	-	-	-	-	-	-	-	-	-
Parking	13.03	9.37	1.95	-	-	0.61	1.10	-	-	-	-	-
Upstream cofferdam	0.18	-	-	-	-	0.12	0.06	-	-	-	-	-
Total temporary impacts	**49.81**	**24.18**	**5.97**	**6.98**	**2.23**	**7.57**	**2.88**	**-**				**-**
Total Impacts												
Permanent impacts	1049.99	222.62	241.96	21.36	13.84	394.95	139.10	0.26				15.9
Temporary impacts	49.81	24.18	5.97	6.98	2.23	7.57	2.88	-				-
Total impacts	**1099.80**	**246.80**	**247.93**	**28.34**	**16.07**	**402.52**	**141.98**	**0.26**	**-**	**-**	**-**	**15.9**

(a) Source for table and footnotes: Duke 2013d. The purpose of this table is to summarize impacts on terrestrial land cover types from construction at the Make-Up Pond C study area. Impacts on aquatic resources under the jurisdiction of the USACE (wetlands, streams, and open waters) are provided in Sections 4.3 and 9.5 and Table 9-19).

(b) Cover Type Key: Open/Field/Meadow (OFM), Pine (P), (Pine-Mixed Hardwood (PMH), Upland Scrub (USC), Mixed Hardwood (MH), Mixed Hardwood-Pine (MHP), Open Pine-Mixed Hardwood (OPMH), Open Water (OW).

(c) Open-water (OW) cover type acreages (15.9 ac) were derived using aerial photo interpretation. Open waters were subsequently surveyed in the field during the Jurisdictional Determination resulting in a more accurate acreage estimate (17.58 ac) for impacts on open waters (part of the combined total open water impacts of 29.63 ac noted for the Lee Nuclear Station site and Make-Up Pond C in Tables 9-19 and 9-20).

Construction Impacts at the Lee Nuclear Station Site

All impact areas within the reservoir footprint (Table 4-2) are considered permanent because of inundation (Duke 2010c). Facilities where the possibility of both temporary and permanent impacts exists (e.g., temporary workspace necessary for the spillway installation) are conservatively considered to be permanent in Table 4-2.

Some noteworthy linear building features span the Make-Up Pond C study area outside the inundation zone. For example, an approximately 2-mi-long portion of an existing out-of-service 44-kV transmission line with a 100-ft-wide ROW would need to be removed and a new transmission ROW rerouted (Figure 3-5). A new transmission line is not currently needed and would not be installed in the new ROW until a need is identified (Duke 2011h).

The plan to use an overhead transmission line to power the Make-Up Pond C intake/refill structure has been eliminated. Instead, the Make-Up Pond C intake/refill structure would be powered with underground cables from the Lee Nuclear Station that would be routed below ground within the area of disturbance for the raw water service (RWS) pipeline (see Figure 3-5). The RWS pipeline that would connect Make-Up Pond C to the existing Make-Up Pond B (Figure 3-4 and Figure 3-5), would have a 200-ft-wide corridor, and would require vegetation clearing both within the Make-Up Pond C study area (Table 4-2) and within the Lee Nuclear Station site (Table 4-2) (Duke 2013d). Finally, SC 329 would need to be realigned and would require vegetation clearing outside the inundation zone but within the Make-Up Pond C study area (Figure 3-5 and Table 4-2).

The heavy-haul road and paths appear twice in Table 4-2, once under permanent and once under temporary impacts outside the inundation zone but within the Make-Up Pond C study area. The heavy-haul road and paths outside the inundation zone would be restored after building Make-Up Pond C (temporary impact), except where they cross areas of farm ponds, which would not be restored to open water (permanent impact) (Duke 2010c).

A total of approximately 1100 ac of various habitat types would incur permanent (approximately 1050 ac) and temporary loss and alteration (approximately 50 ac), resulting from impacts such as flooding and clearing (Table 4-2). The mixed hardwood and mixed hardwood-pine cover types are of higher value to wildlife than the other cover types depicted in Figure 2-14. Cumulatively, these two cover types account for 47.4 percent (approximately 1000 ac) of the total cover (approximately 2110 ac) in the Make-Up Pond C study area (Table 2-8) (Duke 2013d). Approximately 545 ac of these two cover types within the Make-Up Pond C study area would be permanently (approximately 534 ac) or temporarily disturbed (approximately 11 ac) during reservoir development (Table 4-2).

Other cover types of lesser habitat quality include pine, open/field/meadow, pine-mixed hardwood, upland scrub, and open pine/mixed hardwood. Habitat quality in these five cover types is relatively low due to intensive management from past silvicultural and agricultural activities (Duke 2010c). These five cover types account for 51.6 percent (approximately

1090 ac) of the total cover in the Make-Up Pond C study area (approximately 2110 ac) (Table 2-8) (Duke 2013d). Approximately 539 ac of these five cover types within the Make-Up Pond C study area would be permanently (approximately 500 ac) and temporarily disturbed (approximately 39 ac) during reservoir development (Table 4-2).

Aerial photographs (USGS 2004) and satellite imagery (USDA 2009b) indicate that the cover types (but not subtypes) identified above for the Make-Up Pond C study area also are common in adjacent watersheds (Duke 2010n). However, while these cover types are common outside the Make-Up Pond C study area, examination of aerial photos from the 2009 National Agriculture Imagery Program overlaid on the U.S. Geological Survey (USGS) National Hydrography Data set (at an approximate scale of 1:10,000 and in natural color) indicates that lowland hardwood forest along London Creek (3.76 mi long) is wider and more continuous than the lowland hardwood forest of nearby streams of similar length (3.1 to 4.3 mi) (i.e., Doolittle Creek, Cherokee Creek, Bells Branch, Nells Branch, Kings Creek, and Abingdon Creek). Lowland hardwood forest along these other streams appears to be narrower and more fragmented, mostly by agriculture (i.e., pasture, hay fields) and silviculture (i.e., clearcut areas, shrub/scrub early successional areas, planted pine forests). To provide an objective assessment of the vegetation cover types in the riparian zone of the stream courses, each stream in the USGS 2006 National Landcover Data Map was buffered at 100 m (328 ft) (believed to encompass most or all of the associated stream valley) and the percentages of vegetation cover types (as defined in the USGS National Landcover Data map) within the buffer area were summarized for each creek (Table 4-3). This analysis shows that, compared to the other six stream courses, the London Creek riparian zone has the highest amount of deciduous forest and woody wetlands (approximately 79.2 percent of the buffered area) and the lowest amount of development and agriculture (6.6 percent). This relatively high amount of forest versus maintained land is consistent with the SCDNR's description of the London Creek watershed as having relatively high habitat integrity (SCDNR 2011b).

The mixed hardwood and mixed hardwood-pine cover types are virtually contiguous in the lowlands of London Creek, Little London Creek, and their tributaries in the Make-Up Pond C study area (Figure 2-14). Virtually all of this high-quality habitat would be permanently lost by building and inundating Make-Up Pond C. The affected forest habitat consists primarily of the bluff hardwood forest and lowland hardwood forest subtypes (of mixed hardwood forest). The bluff hardwood and lowland hardwood forest subtypes are the most undisturbed of the mixed hardwood forest habitat subtypes in the Make-Up Pond C study area (see descriptions in Section 2.4.1.2).

Table 4-3. Vegetation Cover Type Percentages Within 100 m (328 ft) of London Creek and Six Similar Nearby Creeks

Creek Name	Developed	Deciduous Forest	Evergreen Forest	Mixed Forest	Scrub/Shrub	Herbaceous	Agriculture	Woody Wetlands	Total
Abingdon Creek	1.3	53.3	30.2	2.4	3.6	2.7	6.2	1.6	**100.0**
Bells Branch	2.4	72.4	4.4	6.0	1.3	5.3	8.1	0.0	**100.0**
Cherokee Creek	7.3	61.4	2.3	1.0	0.9	2.8	21.7	0.7	**100.0**
Doolittle Creek	6.4	55.0	13.7	3.6	2.2	3.5	13.8	1.2	**100.0**
Kings Creek	1.9	67.5	10.6	8.1	0.6	2.5	5.7	3.1	**100.0**
London Creek	1.9	78.9	5.9	1.8	4.1	1.9	4.7	0.3	**100.0**
Nells Branch	2.3	75.4	4.9	3.1	1.9	5.1	7.4	0.0	**100.0**

Source: data created in 2012 by Pacific Northwest National Laboratory from USGS 2006 National Land Cover Data Map (USGS 2012).

Drastic declines of critical lowland hardwood habitats have occurred statewide over the years, but particularly in the upstate (SCDNR 2011b), and development of Make-Up Pond C would destroy more of this valuable habitat type (see Section 2.4.1.2) and the transitional areas adjacent to it. In addition, based on the above analysis, the London Creek forested riparian corridor is relatively wide, compared to other nearby streams. In the Piedmont ecoregion of South Carolina, plantation pine or pasture is often within only a few feet of the stream (SCDNR 2011b). For neotropical migrant songbirds, many of which are of conservation priority (see Section 2.4.1.2), the intact lowland hardwood forest they need may already be limited in South Carolina (SCDNR 2011b). Kilgo et al. (1998) have positively associated the species richness of neotropical migrant birds with the width of bottomland hardwood forest (considered part of the London Creek lowland hardwood forest complex described in Section 2.4.1.2) in South Carolina. Conservation of wide riparian zones is necessary to maintain the complete avian community characteristic of bottomland hardwood forests in South Carolina (Kilgo et al. 1998). These habitats may permit the maintenance of regional avian diversity in the highly fragmented landscape of the Piedmont. Further, the high amphibian and reptile diversity of the London Creek system is due to habitat diversity (e.g., microhabitat types including stream channel, small tributaries, seepage wetlands, isolated wetlands, floodplain, bluffs, etc.) and integrity. Because of their susceptibility to habitat and water-quality degradation, the amphibian assemblage, in particular the high salamander diversity (see Section 2.4.1.2), is an excellent indicator of the relatively high environmental integrity of the London Creek site (SCDNR 2011b). The abundance of lowland hardwood forest habitat of this quality elsewhere in the upstate Piedmont is unclear.

Following inundation of Make-Up Pond C, the remaining mixed hardwood forest would consist primarily of the upper and mid-slope mixed hardwood forest and cutover mixed hardwood forest subtypes, which are the most disturbed of the mixed hardwood forest subtypes in the Make-Up Pond C study area. The upper and mid-slope mixed hardwood forest and cutover mixed hardwood forest subtypes, together with the remaining mixed hardwood-pine cover type, would be highly fragmented and interspersed with the pine, open/field/meadow, pine-mixed hardwood, upland scrub, and open pine/mixed hardwood cover types in the uplands around the periphery of Make-Up Pond C (Figure 2-14).

All land clearing would be conducted according to Federal and State regulations, permit requirements, Duke's existing construction practices, and established BMPs (Duke 2008j). BMPs seek primarily to keep soil in place (erosion control) and secondarily to capture any sediment that is moved by stormwater before it leaves the site (sediment control). Areas cleared of vegetation and access roads would be watered to attenuate fugitive dust. Equipment and maintenance would be located away from wetlands and open water. Environmentally sensitive areas would be avoided where feasible (Duke 2010c). As previously discussed in Section 4.3.1.1, Duke would prepare a SWPPP for the Lee Nuclear Station using appropriate State or local specifications, such as those provided by the SCDHEC Storm Water Management Program (SCDHEC 2003). General measures to be considered for inclusion in the SWPPP, as required by the NPDES permit for construction activities, are also identified in Section 4.3.1.1.

Temporary roads and buildings would be removed upon completion of Make-Up Pond C. All areas cleared as temporary building areas would be re-vegetated in accordance with Duke BMPs for erosion control in compliance with South Carolina stormwater permits. The site security staff would review long-term landscaping plans for the site to ensure an appropriately cleared security buffer. Duke's landscape architects would make landscape decisions for areas outside the security buffer. Practices for restoration of terrestrial habitat performed by Duke include mechanical disturbance of the upper several inches of soil to facilitate seed germination, application of soil amendments where necessary, revegetation using native vascular plants, and allowing natural succession to take place (Duke 2013d).

Wetlands, Streams, and Floodplains

This subsection discusses the wetlands, streams, and floodplains on the Lee Nuclear Station site. Impacts on streams are discussed further in Section 4.3.2.1. Permanent, clearing, and temporary impacts would occur in wetlands, and clearing impacts would occur along streams. Most impacts would be associated with building the Make-Up Pond C impoundment. Other permanent impacts would include placement of excess spoil material, excavation for onsite fill material, construction of temporary haul roads, and the realignment of SC 329. Locations of these activities within the Make-Up Pond C footprint would also ultimately be inundated when the pond is filled (Duke 2011h).

Construction Impacts at the Lee Nuclear Station Site

Jurisdictional Wetlands

All wetlands within the proposed inundation area for Make-Up Pond C would be mechanically cleared of vegetation prior to inundation (Section 9.5.3). The largest permanent impact on wetlands within the Make-Up Pond C study area would result from inundation (3.22 ac). The inundation area would include areas previously altered by the construction of haul roads and subsequently flooded. As much as about 0.3 ac of permanent wetland impacts outside the Make-Up Pond C inundation footprint would result, including filling from construction of the Make-Up Pond C dam (0.04 ac), filling with spoil material from grading activities (0.24 ac), and filling resulting from the realignment of SC 329 (0.01 ac). Other permanent wetland impacts that would occur outside the Make-Up Pond C inundation footprint would result from mechanized clearing of vegetation within the 50-ft buffer (i.e., a 50-ft wide area around the full-pond elevation of Make-Up Pond C) and conversion of this area (less than 0.01 ac) to emergent wetland. Temporary wetland impacts outside the Make-Up Pond C inundation footprint would result from temporarily filling 0.04 ac of wetland within the 50-ft buffer. Temporary riparian impacts outside the Make-Up Pond C inundation footprint would also result from cutting 884 ft of stream shoreline vegetation within the 50-ft buffer area (Duke 2012n).

Additional indirect impacts on wetlands may occur because of stream diversion (e.g., around construction sites at the Make-Up Pond C dam, the London Creek railroad culvert, the new SC 329 bridge, and the installation of cofferdams). Stream diversion may drain wetlands downstream; and wetlands may remain drained for extended periods. For example, London Creek flow would be diverted (i.e., blocked by cofferdams and pumped) around the dam footprint during construction of Make-Up Pond C. However, because few wetlands downstream of the proposed dam derive their hydrology from overbank flooding from London Creek, stream diversion, dewatering pumps, and flow interruption may have only minor effects on wetlands downstream of Make-Up Pond C.

Transmission-line structures would be located outside of stream buffers, and BMPs for installation of transmission lines in riparian areas (Duke 2008j) would be implemented. BMPs for transmission-line corridor and structure installation consist of considerations for site preparation, sediment traps and barriers, access road placement, stream crossings, runoff-control measures, structure placement, and surface-stabilization measures. Thus, because a majority of the riparian buffers would remain intact (Duke 2010n), little impact is expected on the several unnamed tributaries that would be crossed by rerouting the existing 44-kV transmission line. Duke BMPs (Duke 2008j) would be implemented when building activities occur proximate to wetlands or streams. Typical BMP requirements are listed in Section 4.3.1.1 for jurisdictional wetlands on the Lee Nuclear Station site. In addition, as previously discussed in Section 4.3.1.1, to further protect adjacent waterbodies from indirect impacts during onsite construction activities, Duke intends to implement a 50-ft undisturbed buffer zone around existing protected areas, such as wetlands, open waterbodies, and streams (Duke 2013d).

A mitigation action plan, including compensatory mitigation incorporating restoration and preservation, for permanently or temporarily affected waters of the United States (e.g., wetlands and streams) within the jurisdiction of the USACE would be developed and implemented by Duke according to conditions to be set forth in an individual Department of the Army permit issued by the USACE and the associated CWA Section 401 water-quality certification issued by the SCDHEC (Duke 2010n). Duke has discussed an approach to compensatory mitigation with the USACE, which is described in Section 4.3.1.7. Site-specific BMPs also would be stipulated by the Department of the Army permit.

Make-Up Pond C, when developed, would provide approximately 620 ac of open-water habitat and could potentially develop some littoral wetlands in areas of shallow bathymetry around its margins and in tributary areas (Duke 2010n, 2011h, 2012j). However, according to USACE operating procedures (USACE 2010a), the subsequent provision of open-water habitat and the possible eventual provision of some littoral wetlands following inundation of a stream system does not offset or reduce impacts on the existing (open-water or wetland) resources and would not count toward meeting wetland mitigation requirements.

The main dam of Make-Up Pond C would be sited in a 100-year floodplain (Duke 2011h). Most of the narrow floodplain associated with London Creek would be permanently inundated. Any potential floodplain impacts would be avoided as indicated below for offsite road improvements in Section 4.3.1.5.

Significant Natural Areas, Noteworthy Ecological Associations, and Rare Plants

Duke identified 10 significant natural areas within the Make-Up Pond C study area (see Section 2.4.1.2) (Gaddy 2009). They contain rare plant communities, rare plant species, or mature to old-growth trees, and range in size from around 0.5 ac to just over 5 ac. Seven areas lie within the inundation zone: the Cinnamon Fern Bog, Laurel Ravine, West Bluff, West Bottoms, Sampling Location 1.7 and Adjacent Bluff, Fern Ravine, and Chain Fern Bog. Two areas lie outside the inundation zone in the Make-Up Pond C study area downstream of the proposed dam and saddle dike on London Creek: Rhododendron Bluff and London Creek Bottoms. London Creek Bottoms may be temporarily and minimally affected (0.03 ac) by clearing mixed hardwood, mixed hardwood-pine, and pine forest types (Figure 2-14) for replacement of the existing railroad-spur culvert with an expanded culvert where London Creek crosses the spur (Figure 3-5) (Duke 2009b, 2012j). Rhododendron Bluff is located far enough below the impact area of the proposed dam upstream and above the impact area of railroad-spur culvert replacement downstream that no impacts on this significant natural area are anticipated. The tenth significant natural area, Little London Creek Bottoms, lies outside the inundation zone in the Make-Up Pond C study area. The lowland hardwood forest along Little London Creek (Figure 2-14) would not be directly affected by building activities; however, a spoil area would be established adjacent to it (Figure 3-5). Consequently, 7 of these 10 significant natural areas would be permanently lost, and an eighth significant natural area likely would be disturbed. The abundance of such significant natural areas, either individually or collectively, in watersheds of similar size elsewhere in the upstate Piedmont is unclear.

Four noteworthy ecological associations with State ranks that range in susceptibility from vulnerable (S3) to imperiled (S2)—Piedmont acidic mesic mixed hardwood forest, Piedmont beech/heath bluff, Piedmont basic mesic mixed hardwood forest, and Piedmont streamside seepage swamp—also are of concern to the State of South Carolina (SCDNR 2011b) and also would be affected by the creation of Make-Up Pond C. None of these ecological associations were previously documented in Cherokee County, and only mesic mixed hardwood forest is known to occur in York and Union Counties (SCDNR 2012a), indicating their possible scarcity in that part of the Piedmont.

Occurrences of five plant species (i.e., mountain holly [*Ilex montana*], golden ragwort [*Senecio aureus*], tuberous dwarf-dandelion [*Krigia dandelion*], yellowish milkweed vine [*Matelea flavidula*], and Kral's sedge [*Carex kraliana*]) considered uncommon would also be affected by the creation of Make-Up Pond C (Gaddy 2009). These plant species are not designated as Federally threatened or endangered or as State-ranked species. Such species are discussed in Section 4.3.1.6. Tuberous dwarf-dandelion was also observed in Kings Mountain National Military Park, located about 10 mi northeast of the Make-Up Pond C study area (White and Govus 2005). The prevalence of the tuberous dwarf-dandelion and the other species listed above, either individually or collectively, in watersheds of similar size elsewhere in the upstate Piedmont is unclear. However, loss of occurrences of these species in the Make-Up Pond C study area would have only minor adverse effects on the species range-wide because they are considered apparently secure globally (global conservation status rank G4 [yellowish milkweed vine]) or secure globally (global conservation status rank G5 [other four species]) (NatureServe Explorer 2013).

The significant natural areas, noteworthy ecological associations of concern to the State of South Carolina, and uncommon plant species attest to the integrity and diversity of the London Creek lowland hardwood forest. The number of these resources, either individually or collectively, in watersheds of similar size elsewhere in the upstate Piedmont is unclear.

Lake Cherokee

The creation of Make-Up Pond C would inundate approximately 2.4 ac of mixed hardwood forest within the Lake Cherokee property owned by the SCDNR. Another 1 ac of mixed hardwood forest within the Lake Cherokee property would be cleared within the 50-ft buffer for the pond, but would be allowed to revegetate naturally upon completion of building activities. Approximately 1 ac of open/field/meadow cover type at the Lake Cherokee Dam would be affected by the inundation of Make-Up Pond C and associated improvements to the downstream toe of Lake Cherokee Dam and the Lake Cherokee emergency spillway (Duke 2010h; 2012j, n). The impact acreages of these communities within the Lake Cherokee property are included in Table 4-2. No other effects on terrestrial communities within the Lake Cherokee property are anticipated (Duke 2010h).

Wildlife

Wildlife present in the reservoir footprint, outside the inundation zone but within the Make-Up Pond C study area, and outside the Make-Up Pond C study area (transmission-line reroute) would suffer mortality, disturbance, and displacement as a result of inundation and the other building activities identified in Table 4-2. In general, animals that are less mobile, such as amphibians, reptiles, small burrowing mammals, and unfledged birds, would incur greater mortality than animals that are more mobile, such as adult birds and large mammals.

Vegetation clearing (including timber harvest) and grubbing would be scheduled for the summer, fall, and winter periods. Thus, if vegetation clearing began at the end of June, after most migratory bird young have fledged, only minor impacts on unfledged birds would be expected. However, if vegetation clearing began at the beginning of June, more substantive impacts on unfledged migratory birds would be expected. If avoidance is not feasible, Duke would amend its existing FWS and SCDNR depredation permits (MB000257-0 and MD-19-10, respectively) (Duke 2010d). Regardless of the timing of vegetation clearing, inundation would likely result in declines in avian numbers and possibly species diversity in the watershed (Ransom and Slack 2004).

Disturbances below lethal levels may adversely affect wildlife behaviors, such as movement, feeding, sheltering, and reproduction. Mobile animals may be displaced into nearby undisturbed habitat where increased competition for resources during building activities may result in increased predation and decreased fecundity, ultimately leading to temporary population reductions.

Riparian and wetland species would be lost from the relatively undisturbed lowland mixed hardwood and mixed hardwood-pine habitat along London Creek and many of its tributaries. Except for the adjacent Little London Creek riparian zone, there would be little nearby habitat of similar type and quality (Figure 2-14) to accommodate riparian and wetland species displaced from the London Creek system. Forest-interior-dwelling species, those requiring habitat conditions in the interior of large forests (e.g., lowland hardwood forest along London Creek) to breed successfully and maintain viable populations (e.g., scarlet tanager [*Piranga olivacea*], hooded warbler [*Wilsonia citrina*]) (DTA 2008b; MDDNR 2011), would be similarly affected, because mostly fragmented disturbed forest would remain in the London Creek watershed around the periphery of Make-Up Pond C following inundation. Species adapted to early successional habitat would be lost from the open/field/meadow and upland scrub habitats but could disperse into similar habitats in adjacent areas (Figure 2-14) that would not be used as spoil or parking areas (Figure 3-5). Similarly, species adapted to forest/clearing interface environments may be lost from and disperse into edge habitats that are destroyed and subsequently re-created by inundation or forest clearing, respectively. Thus, creation of Make-Up Pond C would pose temporary adverse effects for some species that inhabit early successional habitat or use edge environments. However, it is expected that long-term mortality, disturbance, and displacement would be incurred to a much greater extent for riparian, wetland, or forest-interior-dwelling species than for species dwelling in open habitats or forest edges.

Noise levels associated with creating Make-Up Pond C and its associated infrastructure are anticipated to be comparable to or less than noise levels associated with building activities at the Lee Nuclear Station site. Thus, the impact on wildlife from site-development noise is expected to be temporary and minor. The potential for traffic-related wildlife mortality is expected to be low because construction crews would be small (103 persons; see Section 4.4.2) and dispersed over very large geographic areas. Avian mortality resulting from collisions with structures and equipment during Make-Up Pond C creation would represent a small hazard for bird populations, particularly when compared to impacts resulting from habitat loss.

Several farms ponds within the Make-Up Pond C study area (Figure 2-15) would be drained and filled with spoil material when the 44-kV transmission line is rerouted (Figure 3-5, Table 4-2) (Duke 2009b, 2010c, n). Duke will discuss the disposition of turtles present in the ponds with the SCDNR before dewatering takes place (Duke 2010d).

The farm ponds are situated within a large field, with no buffering shrubs or trees or other nearby cover. Although no waterfowl have been observed at these ponds, they may provide feeding or loafing habitat for Canada geese (*Branta canadensis*), which may graze on the surrounding grass and available aquatic plants. Canada geese are the only waterfowl species that has been observed within the Make-Up Pond C study area (DTA 2008b). The lack of cover and level of disturbance at these ponds likely preclude the presence of other waterfowl. Other open waterbodies in the vicinity, including Ninety-Nine Islands Reservoir, Lake Cherokee, and Make-Up Ponds A and B, provide habitat if any geese or other waterfowl are displaced by rerouting of the transmission line (Duke 2010h).

A 300-ft buffer would be designated largely in relatively disturbed, degraded forested habitats and open/field/meadow habitat (Figure 2-14). The largely disturbed/degraded nature of the forest and open habitat in the surrounding 300-ft buffer would at least temporarily reduce the functionality of the Make-Up Pond C periphery as a wildlife travel corridor compared with the relatively undisturbed existing forest cover along London Creek and its tributaries. However, vegetation within the 300-ft buffer would be left in its natural state (Duke 2009b) and would be expected to somewhat improve the functionality of the Make-Up Pond C periphery as a wildlife travel corridor over the long term as succession toward hardwood forest occurs. In summary, a lesser degree and quality of connectivity would remain among the Lake Cherokee area, London Creek, and the Broad River floodplain. This may particularly be the case for birds that use forested riparian corridors during migration.

Summary

Make-Up Pond C would be the largest reservoir to be permitted in the State of South Carolina since the creation of Lake Russell in 1984 (SCDNR 2010b and USACE 2011b). The creation of Make-Up Pond C would permanently alter the nature of the terrestrial habitat and wildlife resources in the London Creek watershed. Most notably, Make-Up Pond C would destroy about 534 ac of relatively undisturbed mixed hardwood and mixed hardwood-pine forest along most of the length of London Creek and its tributaries. Make-Up Pond C would inundate seven significant natural areas and the related railroad-spur culvert replacement would minimally disturb one additional significant natural area. Four noteworthy ecological associations of concern to the State of South Carolina, occurrences of five uncommon plant species, 3.55 ac of jurisdictional wetlands, and vegetation along 884 linear ft of jurisdictional stream would also be affected by the creation of Make-Up Pond C. The creation of Make-Up Pond C would destroy diverse amphibian and reptile assemblages that are indicative of the variety and integrity of terrestrial habitats in and adjacent to the lowland hardwood forest along London Creek and its tributaries. Creation of Make-Up Pond C also would alter the functionality of the London Creek corridor as a wildlife travel corridor, particularly for neotropical migrant songbirds, many of which are of conservation priority. The abundance of watersheds of similar size in the upstate Piedmont that support similar high-value resources, either individually or collectively, is uncertain.

Make-Up Pond C would be created in accordance with Federal and State regulations, permit conditions, and established BMPs. Unavoidable impacts on jurisdictional wetlands and streams would be mitigated (see Section 4.3.1.7). Nevertheless, the review team has determined that the related impacts of habitat loss and wildlife mortality, disturbance, and displacement would be substantial and mostly permanent in nature, largely due to the effects of inundation. In addition, some important attributes of these resources would be permanently lost. The SCDNR has indicated that the London Creek watershed and the habitat and wildlife resources found there represent intact examples of other watersheds with similar resources in the upstate Piedmont (SCDNR 2011b). Therefore, the review team concludes that site-preparation and development-related impacts on habitat and associated wildlife from the creation of Make-Up Pond C would be noticeable but not destabilizing to such resources across the Piedmont ecoregion.

4.3.1.3 Terrestrial Resources – Transmission-Line Corridors

The power generated by the proposed Lee Nuclear Station would be transmitted via overhead transmission lines to a 230-kV switchyard and a 525-kV switchyard located on the Lee Nuclear Station site (Figure 3-4). Two double-circuit 230-kV and two single-circuit 525-kV lines would exit the switchyards. The four transmission lines would require development of two transmission-line corridors—Route K (western corridor) and Route O (eastern corridor). The routing and distances of these corridors and their 230-kV and 525-kV lines are shown in Figure 2-5 and described in Sections 2.2.3.1 and 3.2.2.3.

Existing Cover Types

The area within the two proposed transmission-line corridors is approximately 987 ac (see Table 2-3) in Cherokee and Union Counties. Vegetative cover types and acreages are noted in Table 2-3 (Duke 2007c). The greatest impact on land cover would result from clearing the corridors for the transmission lines and the resulting effects on wildlife habitat (Duke 2007c). Clearing would affect approximately 690 ac of various forest and woodland cover types (see Table 2-3) (Duke 2007c). About 87 ac of dry scrub/shrub thicket and 0.4 ac of wet scrub/shrub thicket also would be lost (see Table 2-3) (Duke 2007c). The upland scrub cover type is considered to be of relatively low value to wildlife compared to the forest cover types (Duke 2009c) and is common in the region.

Wetlands, Streams, and Floodplains

<u>Jurisdictional Wetlands</u>

Transmission-line structures would be located outside of jurisdictional waters of the United States (wetlands and streams) in surrounding upland buffer areas. A total of 1.15 ac of forested wetlands would be hand-cleared within the new transmission-line corridors. Hand-clearing of canopy trees would occur on 0.66 ac of the 10.64 ac of jurisdictional wetlands within the western corridor (Route K) and on 0.49 ac of the 0.52 ac of jurisdictional wetlands in the eastern corridor (Route O) (see Section 2.4.1.3) (Duke 2011h). Clearing would be limited to that required for conductor clearance, and understory buffer vegetation would remain intact. A naturally vegetated buffer zone that is at least 25 ft wide would be maintained adjacent to wetlands and streams.

In other upland areas within the corridors, all vegetation would be cleared by mechanized equipment. Topsoil would not be graded and root systems would be left intact to the greatest extent possible for regeneration. The width of clearing would be 200 ft when the corridor contains only a 525-kV line, and 325 ft when the corridor contains 525 and 230-kV lines. Vegetation would be removed and disposed of according to local, State, and Federal regulations (Duke 2011h).

The location and extent of roads to access the corridor and facilitate construction of the transmission-line structures have not been identified at this time. All construction roads would be located and designed to minimize ground disturbance, avoid excessive cutting and filling, and avoid impacts on jurisdictional wetlands and streams. Temporary roads would be seeded with permanent vegetation upon completion of construction activities (Duke 2011h).

Appropriate erosion and sediment-control measures, as described in the *Duke Energy BMPs for Stormwater Management and Erosion Control Policy and Procedures Manual* and the SCDHEC BMP Manual would be employed for all transmission-line construction activities occurring in proximity to jurisdictional waters of the United States in order to minimize potential indirect impacts on wetlands and streams (Duke 2011h, 2012m). BMPs for transmission-line-corridor and structure installation consist of considerations for site preparation, sediment traps and barriers, access road placement, stream crossings, runoff-control measures, structure placement, and surface-stabilization measures.

Because Duke's BMPs would be implemented, transmission-line structures would be located in uplands, and the extent of forested wetlands affected would be limited, only minor wetland impacts (e.g., permanent conversion from forested wetlands to scrub-shrub and emergent wetlands) are expected within the transmission-line corridors. There would be no other permanent or temporary impacts in the transmission-line corridors (Duke 2011h).

A mitigation action plan, including compensatory mitigation and/or restoration, for permanently or temporarily affected waters of the United States (e.g., wetlands and streams) under the jurisdiction of the USACE would be developed and implemented according to conditions set forth in the Department of the Army permit and the associated SCDHEC 401 water-quality certification (Duke 2010c, n). Duke has discussed a preliminary approach to compensatory mitigation with the USACE, as described in Section 4.3.1.7.

Transmission lines would be sited outside 100-year floodplains to the greatest extent possible (Duke 2011h), and any potential floodplain impacts would be avoided as indicated below for offsite road improvements in Section 4.3.1.5.

Significant Natural Areas and Rare Plants

A mixed hardwood bluff that is reportedly species-rich (Gaddy 2010) was found on Abingdon Creek along the eastern transmission-line corridor (Route O) (see Section 2.4.1.3). Nerveless sedge (*Carex leptonervia*), an uncommon mesic-site species not reported to occur in South Carolina by the *South Carolina Plant Atlas* (University of South Carolina 2010), is common on the bluff in the Abingdon Creek community. Only a small portion of this community is located within the transmission-line corridor (Gaddy 2010). Nerveless sedge ranges over much of eastern North America and its global conservation status rank is G4, apparently secure (NatureServe Explorer 2010). Thus, any impacts from installation of the transmission line would have a negligible effect on the species.

Wildlife

Wildlife present in the proposed two new transmission-line corridors during installation of the corridors and transmission-line structures would be subjected to many of the same types of impacts described for the Lee Nuclear Station site. Wildlife may suffer mortality, disturbance, and displacement as a result of forest clearing and building activities. Less mobile animals, such as reptiles, amphibians, small burrowing mammals, and unfledged birds, would incur greater mortality than more mobile animals, such as adult birds and large mammals. Disturbances at sublethal levels may adversely affect behaviors, such as movement, feeding, sheltering, and reproduction. Mobile animals may be displaced into nearby undisturbed forest habitat where increased competition for resources during transmission-line installation may result in increased predation and decreased fecundity, ultimately leading to temporary reductions in populations. Although a large area of forest (about 690 ac) would be affected, a relatively small portion of wetlands and stream riparian corridor would likely be affected because of the existing construction practices and BMPs noted above for these habitats. Thus, overall, it is anticipated that mortality, disturbance, and displacement would be incurred to a much greater extent for upland-forest species than for wetland or riparian species.

Species adapted to early successional habitat would be lost from the upland shrub/scrub habitats during corridor installation. Such species may disperse into shrub/scrub habitats in adjacent areas, and colonize new shrub/scrub habitats created by installation of the corridor. Similarly, species adapted to forest/clearing interface environments may be lost from edge habitats that are destroyed by forest clearing, but may disperse into edge habitats in adjacent areas and colonize new edge habitats created by corridor installation. Transmission-line corridors may be managed to provide substantial habitat for grassland birds, raptors, and small mammals by functioning as linear grasslands/shrublands in an otherwise forest-dominated landscape (see Section 5.3.1.2) (Duke 2012m). Thus, overall, transmission-line corridor installation could pose minor adverse effects or could be beneficial for some species that inhabit early successional habitat or use edge environments. However, species dependent on interior forests could only disperse into contiguous forest habitats, which are likely less prevalent in adjacent areas and are not created by installation of the corridor. Thus, forest-interior wildlife may be locally affected to a greater extent than wildlife adapted to early successional or forest-edge habitats. However, because only a relatively small portion (about 4 percent) of the forest habitat in the transmission-line-siting area would be used, forest-interior habitat availability in the siting area is not expected to be a factor limiting populations of affected forest-interior wildlife.

Noise levels associated with installation of the transmission lines are anticipated to be similar to or less than and of shorter duration than noise levels associated with building activities at the Lee Nuclear Station site. Thus, the impact on wildlife from installation noise is expected to be temporary and minor. The potential for traffic-related wildlife mortality is expected to be low because construction crews would be small and dispersed over very large geographic areas. Avian mortality resulting from collisions with structures and equipment during transmission-line installation would represent a negligible hazard for bird populations.

Vegetation clearing (including timber harvest) and grubbing would be scheduled, to the extent practical, to avoid the migratory bird-nesting season (generally March through June). However, if avoidance is not feasible, Duke would apply to amend its existing FWS and SCDNR depredation permits (MB000257-0 and MD-19-10, respectively) (Duke 2010d).

A general description of non-game wildlife known to occur in existing Piedmont transmission-line corridors largely follows that provided by Duke Power Company (1976) as referenced by Duke (2007c). Surrounding hardwood and mixed hardwood-pine forests, interspersed by pasture and fallow fields, provide suitable habitat for a number of wildlife species that would inhabit the transmission-line corridors and the edge habitat of such corridors created for Lee Nuclear Station. Grazed land is generally less suitable for wildlife because of the paucity of food and cover; however, the red fox (*Vulpes vulpes*), killdeer (*Charadrius vociferus*), and garter snake (*Thamnophis sirtalis*) are representative species for this habitat. The open areas and early successional areas (i.e., hayfields, fallow fields, clearcut areas, and existing ROWs) provide feeding areas for birds such as the eastern meadowlark (*Sturnella magna*), field sparrow (*Spizella pusilla*), barn swallow (*Hirundo rustica*), and eastern bluebird (*Sialia sialis*); small game such as cottontail rabbit (*Sylvilagus floridanus*), bobwhite quail (*Colinus virginianus*), and mourning dove (*Zenaida macroura*); and reptiles such as the black racer (*Coluber constrictor*), rough green snake (*Opheodrys aestivus*), and the broadhead skink (*Eumeces laticeps*). Other species in these habitats include the golden mouse (*Ochrotomys nuttali*) and the red-tailed hawk (*Buteo jamaicensis*). These areas provide food (e.g., seeds, insects, small prey) and essential cover. The field borders offer nesting habitat and escape cover for birds such as the Carolina wren (*Thryothorus ludovicianus*), cardinal (*Cardinalis cardinalis*), eastern towhee (*Pipilo erythrophthalmus*), song sparrow (*Melospiza melodia*), and mockingbird (*Mimus polyglottos*).

The hardwood and mixed pine-hardwood forests of the area offer habitat for gray squirrels (*Sciurus carolinensis*), white-tailed deer (*Odocoileus virginianus)*, and wild turkey (*Meleagris gallopavo*). Other representative species found in the forested areas include the southern flying squirrel (*Glaucomys volans*), white-footed mouse (*Peromyscus leucopus*), opossum (*Didelphis virginiana*), northern flicker (*Colaptes auratus*), red-eyed vireo (*Vireo olivaceus*), Carolina wren, great crested flycatcher (*Myiarchus crinitus*), eastern wood pewee (*Contopus virens*), black-and-white warbler (*Mniotilta varia*), indigo bunting (*Passerina cyanea*), eastern box turtle (*Terrapene carolina*), American toad (*Bufo americanus*), and black rat snake (*Elaphe obsoleta obsoleta*). The bottomlands adjacent to the major rivers provide habitat for beaver (*Castor canadensis)*, raccoon (*Procyon lotor*), mallard (*Anas platyrhynchos*), wood duck (*Aix sponsa*), Carolina chickadee (*Poecile carolinensis*), northern parula warbler (*Parula americana*), northern watersnake (*Natrix sipedon sipedon*), gray treefrog (*Hyla versicolor*), northern cricket frog (*Acris crepitans*), and green frog (*Rana clamitans melanota*) (Duke Power Company [1976] as referenced by Duke [2007c]).

Construction Impacts at the Lee Nuclear Station Site

Summary

Installation of the proposed two new transmission-line corridors would be done according to Federal and State regulations, permit conditions, and established BMPs. Wetlands and waterways would be avoided to the extent possible, and unavoidable impacts on jurisdictional wetlands would be compensated (see Section 4.3.1.7). Although a large quantity of upland-forest habitat would be lost locally and some direct wildlife mortality would be incurred, this represents a small portion of the upland-forest habitat and wildlife currently in the upstate Piedmont. Non-lethal wildlife disturbances and displacements, collisions with elevated structures, noise, and increased traffic would result in minor and temporary wildlife impacts. Therefore, the review team concludes that site-preparation and development-related impacts on habitat and associated wildlife in the proposed two new transmission-line corridors would be noticeable but not destabilizing.

4.3.1.4 Terrestrial Resources – Railroad Corridor

Existing Cover Types

Within the original 6.8-mi-long and 50-ft-wide railroad-spur corridor, all trees and shrubs previously had been cleared for the unfinished Cherokee Nuclear Station. Vegetation within the existing corridor currently consists mainly of grasses and forbs, with visible ongoing disturbance by off-road vehicles (Duke 2009c; Enercon 2008). The bed of the existing railroad spur would need to have additional vegetation cleared within the corridor and new ballast, rail ties, and rails installed to become operational for transporting materials and equipment to the Lee Nuclear Station site (Duke 2009b). Because the renovated railroad spur would be aligned along the existing corridor and the existing corridor has been maintained for off-road access to the surrounding area, only negligible impacts on upland habitat are anticipated (Duke 2009c).

An additional area of potential impact would include an approximately 1300-ft section of the railroad spur that would need to be rerouted just west of Reddy Ice, as described in Section 2.4.1.4 (Figure 2-6) (Duke 2010h). The rerouted portion of the railroad spur would negligibly affect habitat because one part is highly disturbed and provides little vegetative cover, another part would require cutting very few trees for railroad-spur refurbishment, and another part lies in an existing Duke transmission-line corridor where trees and shrubs are cut or sprayed every 5 years (Duke 2010c). Thus, only negligible impacts on habitat (approximately 0.5 ac of disturbance) are anticipated.

Duke anticipates requiring more "fill" material along the railroad corridor than will be generated by "cutting." It is anticipated that almost no spoil material will be left after renovation of the new railroad spur and the realignment (Duke 2009c). Thus, any habitat impacts from deposition of excess spoil would be negligible.

Wetlands, Streams, and Floodplains

Permanent and temporary impacts on jurisdictional wetlands would result from the replacement of culverts at London Creek. Permanent impacts would result from culvert placement. Temporary impacts would result from construction of temporary cofferdams and associated backwater flooding during a 10-year storm event. Thus, permanent filling (0.11 ac), temporary filling (0.06 ac), and temporary flooding (0.35 ac) would occur within jurisdictional wetlands. The Reddy Ice Plant realignment portion of the railroad corridor avoids impacts on jurisdictional wetlands. There would be no impacts (e.g., clearing riparian vegetation) on terrestrial resources associated with work that would be done adjacent to streams within the railroad corridor. It is not anticipated that any work would occur within 100-year floodplains; however, if work is required in such areas, potential floodplain impacts would be avoided as indicated below for offsite road improvements in Section 4.3.1.5 (Duke 2011h).

Since preparation of the draft EIS, Duke has designed a railroad turnaround north of Make-Up Pond B (Figure 3-4). Site-development impacts associated with the railroad turnaround are included in the discussion of permanent impacts on the Lee Nuclear Station site in Section 4.3.1.1 and in Table 4-1 under the general grading and transportation category. The current level of design for the railroad turnaround has no additional impacts on wetland or streams compared to the Federal permit application (Duke 2013d). In addition, as previously discussed in Section 4.3.1.1, to further protect adjacent waterbodies from indirect impacts during onsite construction activities, Duke intends to implement a 50-ft undisturbed buffer zone around all existing protected areas, including wetlands, open waterbodies, and streams (Duke 2013d).

Wildlife

Because of the poor habitat conditions within the existing railroad bed and the parallel margins along each side, impacts on mammals and birds are expected to be minor. However, the corridor itself is used by amphibians and reptiles (see Section 2.4.1.4) and provides ideal habitat for box turtles. The relatively open railroad bed contains dense vegetation, including species often consumed by box turtles, and the large puddles in the corridor provide water and prey (e.g., amphibian larvae) (Dorcas 2009c). This habitat would likely be destroyed during renovation of the railroad-spur corridor, and this may result in direct mortality or displacement of the species into surrounding areas over the length of the railroad-spur corridor. Although the conservation status of the box turtle in South Carolina has not been assessed, it is considered to be globally secure (global conservation status rank G5) over most of its range in the southeastern United States (NatureServe Explorer 2010).

Summary

The review team has determined that the impacts of habitat loss and wildlife mortality, disturbance, and displacement would be minor and temporary in nature. Proposed renovation of the railroad spur would be done according to Federal and State regulations, permit conditions, and established BMPs. Wetlands and waterways would be avoided to the extent possible, and unavoidable impacts on jurisdictional wetlands would be compensated (see Section 4.3.1.7). Therefore, the review team concludes that site-preparation and development-related impacts on habitat and associated wildlife from the proposed railroad-spur renovation and realignment would be negligible.

4.3.1.5 Offsite Road Improvements

The six areas that contain the nine offsite road-improvement locations occur in uplands, except for a regulatory 100-year floodplain associated with the Broad River in a portion of the SC 329/ US 29 intersection improvement. Offsite road-improvement effects associated with erosion and sedimentation during construction would be mitigated through implementation of SCDHEC and South Carolina Department of Transportation (SCDOT) BMPs. Because road improvements would be constructed to SCDOT standards to meet Federal Emergency Management Agency regulations (e.g., maintaining the regulatory floodway free of encroachment in order to avoid a more than 1-ft rise in the base flood elevation), no impacts on the Broad River floodplain associated with the SC 329/US 29 intersection improvement project are anticipated (Duke 2011h). Because no jurisdictional wetlands or streams occur in these six areas (Duke 2011h), there would be no impacts on jurisdictional wetlands or stream riparian areas from offsite road improvements. In addition, the offsite road improvements (e.g., ramp reconfigurations, additional turning lanes, new traffic signals) would result in negligible impacts on wildlife resources.

4.3.1.6 Important Terrestrial Species and Habitats

This section describes the potential impacts on important terrestrial species and habitats, including Federal candidate, proposed, and listed (threatened, or endangered) species; species ranked by the State of South Carolina as critically imperiled, imperiled, or vulnerable, some of which may also be designated as threatened or endangered by the State; and other important species described in Section 2.4.1.6. The potential impacts of site preparation and development at the Lee Nuclear Station site, the Make-Up Pond C site, the two new transmission-line corridors, and the railroad-spur corridor are described in the following sections.

In a letter dated April 9, 2008, the NRC requested that the FWS Field Office in Atlanta, Georgia, provide information regarding Federally listed, proposed, and candidate species and critical habitat that may occur in the vicinity of the Lee Nuclear Station site (NRC 2008e). On May 13, 2008, the FWS provided a response letter indicating three listed and one candidate species and no critical habitat in Cherokee, Union, and York Counties (FWS 2008a), which encompass Lee Nuclear Station site, the Make-Up Pond C site, the railroad-spur corridor, the two proposed transmission-line corridors, and the six offsite road-improvement areas (Table 2-9). These species include the pool sprite (*Amphianthus pusillus*), Georgia aster (*Symphyotrichum georgianum* [formerly *Aster georgianus*]), dwarf-flowered heartleaf (*Hexastylis naniflora*), and Schweinitz's sunflower (*Helianthus schweinitzii*). An additional listed species identified that may occur in the project area is the smooth coneflower (*Echinacea laevigata*) (Cantrell 2008). These species were surveyed and only the Georgia aster, a Federal candidate species, was observed on or in the vicinity of the project footprint (Make-Up Pond C study area [see Section 2.4.1.6]) and is, therefore, discussed in this section.

In a letter dated June 13, 2012, the FWS concurred with the review team's determination that the proposed Lee Nuclear Station Units 1 and 2 project (all elements) is not likely to adversely affect Federally protected species nor result in adverse modification to designated or proposed critical habitat, thus completing informal consultation between the FWS and NRC (FWS 2012b). Consultation correspondence between the review team and FWS is listed in Appendix F.

Lee Nuclear Station Site

<u>Loggerhead Shrike (*Lanius ludovicianus*) – State Vulnerable (S3)</u>

The loggerhead shrike (Table 2-9), is a year-round resident in the southeastern United States and likely inhabits Lee Nuclear Station year-round but is rare onsite (see Section 2.4.1.6). Suitable habitat for the shrike consists of grassland or other open habitat with scattered trees and thorny shrubs for foraging, nesting, and perching. Site preparation at the Lee Nuclear Station site would affect the onsite open/field/meadow and upland scrub habitats, but would have a negligible impact on the species in South Carolina. This species has a global conservation status rank of G4, apparently secure (NatureServe Explorer 2013).

<u>Southern Adder's-Tongue Fern (*Ophioglossum vulgatum*) – State Imperiled (S2)</u>

A population of 25 southern adder's-tongue fern was identified during a 2006 field survey (Duke 2009c) and verified in 2013 (Duke 2013d). This population occurs in a ravine in the southwestern portion of the Lee Nuclear Station site (Duke 2009c) now designated for placing a spoil area (Duke 2013d). Southern adder's tongue fern also occurs within the proposed Make-Up Pond C site (Gaddy 2009), the proposed transmission-line corridors (Gaddy 2010), and the Kings Mountain National Military Park located about 10 mi northeast of the Lee Nuclear Station site (White and Govus 2005).

Duke would coordinate with the SCDNR regarding potential mitigation measures, but no plans or commitments have been developed to relocate this population (Duke 2013d). Because the species occurs elsewhere in Cherokee County and 16 other counties in South Carolina and has a global conservation status rank of G5, secure (NatureServe Explorer 2013), the loss of this population would have a negligible impact overall on the species.

No Federally threatened, endangered, proposed, or candidate animal or plant species or species ranked by the State of South Carolina as critically imperiled, imperiled, or vulnerable are known to occur on the Lee Nuclear Station site (Table 2-9). No important habitats exist on the Lee Nuclear Station site that were not discussed previously (e.g., wetlands in Section 4.3.1.1).

Make-Up Pond C Site

Loggerhead Shrike (*Lanius ludovicianus*) – State Vulnerable (S3)

The loggerhead shrike occurs near the Make-Up Pond C study area where it is likely an uncommon year-round resident (see Section 2.4.1.6). Site-preparation and development activities would affect open/field/meadow and upland scrub habitats that are available in the Make-Up Pond C study area, and could potentially inundate any nests of the species. However, because of the species' year-round residence in the southeastern United States, its rarity in the project area, and the abundance of open habitat outside the Make-Up Pond C study area, site-preparation and inundation activities would have a negligible impact on the species.

Georgia Aster (*Symphyotrichum georgianum* [formerly *Aster georgianus*]) – Federal Candidate Species and State Unranked (SNR)

Georgia aster occurs in about 126 extant populations in the southeastern United States, and in 15 counties in South Carolina (including Cherokee County). Its global conservation rank status is G3, vulnerable (NatureServe Explorer 2013). Most of these populations are small, consisting of stands of only 10 to 100 stems but a few have around 1000 stems. These plants are primarily reproducing non-sexually, by means of rhizomes, so each population probably represents just a few genotypes (FWS 2010a; NatureServe Explorer 2013). The greatest threat to the species is the destruction, modification, or curtailment of its habitat (formerly post oak [*Quercus stellata*] savanna/prairie, currently dry oak-pine flatwoods, and open uplands) or range (FWS 2010a). The species occurs within mowed power-line ROWs in Kings Mountain National Military Park located about 10 mi northeast of the Lee Nuclear Station site (White and Govus 2005).

The Georgia aster (Table 2-9) is also located in a transmission-line corridor in the Make-Up Pond C study area. The population is small, consisting of 14 stems in 2009 (see Section 2.4.1.6), and would be destroyed by reservoir development. The inundation of Make-Up Pond C also would destroy suitable habitat for the species (i.e., in the transmission-line corridor where the species was found). Because the species occurs elsewhere in Cherokee County and in 14 other counties in South Carolina, the destruction of this population would represent only relatively minor curtailment of the species' range and habitat. Thus, impacts on the species overall would be minor.

<u>Drooping Sedge (*Carex prasina*) – State Imperiled (S2)</u>

Drooping sedge is distributed over most of the eastern United States and Canada, and is known to occur in three counties in South Carolina (NatureServe Explorer 2013). Drooping sedge is found in the Make-Up Pond C study area (see Section 2.4.1.6). The species was not previously known to occur in Cherokee County, and this occurrence would be lost with creation of Make-Up Pond C. Because the species occurs in three other counties (Oconee, Pickens, and Union) in South Carolina and is widely distributed elsewhere in eastern North America, where it is considered to be apparently secure throughout most of its range (global conservation status rank, G4) (NatureServe Explorer 2013), the loss of this population would have a negligible impact overall on the species.

<u>Southern Enchanter's Nightshade (*Circaea lutetiana* ssp*. canadensis*) – State Vulnerable (S3)</u>

Southern enchanter's nightshade is distributed over most of the eastern United States and Canada, and is known to occur in seven counties, not including Cherokee County, in South Carolina (NatureServe Explorer 2013). The species occurs in Kings Mountain National Military Park located about 10 mi to the northeast of the Lee Nuclear Station site (White and Govus 2005). Southern enchanter's nightshade is found in the Make-Up Pond C study area (see Section 2.4.1.6). The species was not previously known to occur in Cherokee County, and this occurrence would be lost with creation of Make-Up Pond C. However, because the species occurs in seven other counties in South Carolina and is widely distributed elsewhere in eastern North America, where it is considered to be secure throughout its range (global conservation status G5T5, secure) (NatureServe Explorer 2013), the loss of this population would have a negligible impact overall on the species.

<u>Southern Adder's-Tongue Fern (*Ophioglossum vulgatum*) – State Imperiled (S2)</u>

Southern adder's-tongue fern is distributed over most of the eastern United States and Canada and is known to occur in 17 counties, including Cherokee County, in South Carolina (NatureServe Explorer 2013). The species occurs in Kings Mountain National Military Park located about 10 mi to the northeast of the Lee Nuclear Station site (White and Govus 2005). Southern adder's-tongue fern also occurs on the Lee Nuclear Station site (Duke 2009c) and has been identified in three locations along the proposed transmission-line corridors (Gaddy 2010). Its occurrence in the Make-Up Pond C area would be lost with creation of the reservoir. However, because the species occurs elsewhere in Cherokee County, in 16 other counties in South Carolina, and is widely distributed elsewhere in eastern North America, where it is considered to be secure throughout its range (global conservation status rank G5) (NatureServe Explorer 2013), the loss of this population would have a negligible impact overall on the species.

<u>Canada Moonseed (*Menispermum canadense*) – State Imperiled (S2)</u>

Canada moonseed is distributed over most of the eastern United States and Canada and is known to occur in 16 counties, including Cherokee County, in South Carolina (NatureServe Explorer 2013). The species occurs in Kings Mountain National Military Park located about 10 mi to the northeast of the Lee Nuclear Station site (White and Govus 2005). Its occurrence at Make-Up Pond C would be lost with creation of the reservoir. However, because the species occurs in 16 counties in South Carolina and is widely distributed elsewhere in eastern North America, where it is considered to be secure throughout its range (global conservation status rank G5) (NatureServe Explorer 2013), the loss of this population would have a negligible impact overall on the species.

<u>Single-Flowered Cancer Root (*Orobanche uniflora*) – State Imperiled (S2)</u>

Single-flowered cancer root is distributed over the entire United States and southern Canada and is known to occur in six counties, not including Cherokee County, in South Carolina (NatureServe Explorer 2013). The species occurs in Kings Mountain National Military Park located about 10 mi to the northeast of the Lee Nuclear Station site (White and Govus 2005). Single-flowered cancer root was not previously known to occur in Cherokee County, and its occurrence would be lost because of development of Make-Up Pond C. However, because the species occurs in six other counties in South Carolina and is widely distributed across much of North America, where it is considered to be secure throughout its range (global conservation status rank G5) (NatureServe Explorer 2013), the loss of this population would have a negligible impact overall on the species.

No other Federally threatened, endangered, proposed, or candidate animal or plant species or species ranked by the State of South Carolina as critically imperiled, imperiled, or vulnerable are known to occur in the Make-Up Pond C study area. No important habitats exist in the Make-Up Pond C study area that were not discussed previously (e.g., wetlands in Section 4.3.1.2).

Transmission-Line Corridors

<u>Loggerhead Shrike (*Lanius ludovicianus*) – State Vulnerable (S3)</u>

The loggerhead shrike likely inhabits the proposed transmission-line corridors, based on the presence of suitable habitat (see Section 2.4.1.6) and the occurrence of this species in nearby parts of the project area (see above). Impacts on the loggerhead shrike in the proposed transmission-line corridors would be similar to those described above for Lee Nuclear Station and Make-Up Pond C, and would be negligible or minor in nature.

Southern Adder's-Tongue Fern (*Ophioglossum vulgatum*) – State Imperiled (S2)

Southern adder's-tongue fern occurs at three locations—two locations along the proposed east transmission-line corridor (Route O) and one location along the proposed west transmission-line corridor (Route K) (see Section 2.4.1.6) (Gaddy 2010). Impacts on this species from installation of the transmission-line corridors would be similar to those described above for the Lee Nuclear Station site and Make-Up Pond C and would be negligible or minor in nature.

No other Federally threatened, endangered, proposed, or candidate animal or plant species or species ranked by the State of South Carolina as critically imperiled, imperiled, or vulnerable are known to occur within the two transmission-line corridors. No important habitats exist in the transmission-line corridors that were not discussed previously (e.g., wetlands in Section 4.3.1.3).

Railroad Corridor

No Federally threatened, endangered, proposed, or candidate animal or plant species or species ranked by the State of South Carolina as critically imperiled, imperiled, or vulnerable are known to occur within the railroad-spur corridor. No important habitats exist in the railroad-spur corridor (see Section 4.3.1.4).

Offsite Road Improvements

As previously mentioned in Section 2.4.1.6, no Federally listed, proposed, or candidate species or State-ranked species have been documented by the FWS or the SCDNR as occurring within the six offsite road-improvement areas (Duke 2011h).

Other Important Species

Commercially and Recreationally Valuable Species

Commercially and recreationally valuable species include mammalian and avian game species, all of which are common in the project area vicinity (see Section 2.4.1.6). Thus, the impacts on such species from site preparation and development of the proposed Lee Nuclear Station, the Make-Up Pond C site, the two new transmission-line corridors, and railroad-spur corridor would be negligible to minor.

Invasive Species

The mixed hardwood community herbaceous layer on the north side of the Lee Nuclear Station site is occupied by Japanese honeysuckle (*Lonicera japonica*), an introduced species that is a common invasive in much of the southern and eastern United States (see Section 2.4.1.1). Because the mixed hardwood forest on the north side of the site would be disturbed, by site preparation and development, there would be potential for the spread of Japanese honeysuckle vegetatively via deposition of roots or rhizomes in spoils into disturbed areas or via natural dispersal of seeds by birds.

Although 20 (about 5 percent) of the 426 plant species identified within the Make-Up Pond C study area were exotics or invasives, the more common invasive plant species (Chinese privet [*Ligustrum sinense*], autumn olive [*Elaeagnus umbellata*], Japanese honeysuckle, and Vietnam grass [*Microstegium vimineum*]) were scarce (see Section 2.4.1.2). In addition, most of the disturbance in the Make-Up Pond C study area would arise from inundation, which is a relatively ineffective vector for the spread of noxious weeds. However, there would be potential for the spread of exotics via deposition of seed in spoils into disturbed areas or natural colonization of disturbed areas by exotics. This could occur in spoil areas (Figure 3-5) that would replace pine and hardwood forest outside of the inundation zone (Figure 2-14), and as a result of the use of borrow soils taken from within the impoundment area prior to inundation (Duke 2009b).

4.3.1.7 Compensatory Mitigation and Monitoring

Waters of the United States

Duke would use the mitigation sequence of avoidance, minimization, and compensation to mitigate impacts on waters of the United States (wetlands and streams) for the proposed Lee Nuclear Station. Avoidance of wetlands and streams would be accomplished by siting facilities outside the areas of potential effect on these resources (e.g., river water intake pipeline in the uplands adjacent to rather than through the forested wetland along the Broad River [see Section 4.3.1.1], siting transmission-line structures outside of stream buffers and wetlands [see Section 4.3.1.3]), and renovating existing facilities where possible instead of building them anew (e.g., renovation of the existing railroad-spur corridor [see Section 4.3.1.4]). Minimization of impacts would be accomplished by using BMPs to control erosion and convey sediment away from wetlands and streams, and by implementing a SWPPP.

Unavoidable impacts on wetlands and streams would be mitigated through compensatory mitigation. Duke has consulted with the USACE to develop a compensatory mitigation plan in conformance with the requirements of the USACE Charleston, South Carolina District's *Guidelines for Preparing a Compensatory Mitigation Plan, Working Draft* (USACE 2010a) and *Compensatory Mitigation for Losses of Aquatic Resources; Final Rule* (73 FR 19594, 40 CFR Part 230 and 33 CFR Part 332). A watershed-based, permittee-responsible mitigation project or projects, including restoration, preservation, and enhancement, would be used to compensate for unavoidable project impacts on wetlands and streams. A watershed-based mitigation approach may provide substantial ecological benefit, such as conservation of relatively large tracts of land comprising wetlands, riparian corridors, and uplands (Duke 2010t).

Based on Federal law (Section 404 CWA), the prescriptive nature of compensatory mitigation regulations for wetlands and streams (40 CFR Part 230; 33 CFR Part 332; USACE 2010a), and the approach described above, there is a reasonable assurance that any unavoidable impacts on wetlands and streams on the Lee Nuclear Station site, along the two new transmission-line corridors, in the Make-Up Pond C study area, and in the railroad-spur corridor (there are no jurisdictional wetlands or streams in the offsite road-improvement areas [see Section 4.3.1.5]) would be compensated. The details of the mitigation plan are summarized below. Note that there is no State statutory or regulatory nexus and no regulatory prescriptions for mitigating the loss of the seven significant natural areas, some of which may represent three South Carolina ecological associations of concern; four noteworthy ecological associations of concern to the State of South Carolina; and associated occurrences of five uncommon plant species (described in Section 4.3.1.2) in the Make-Up Pond C study area.

Credit Determination

The USACE Charleston District Guidelines were used to calculate the credits needed to provide compensatory mitigation for unavoidable impacts from the construction of the Lee Nuclear Station and the proposed drought contingency pond. Baseline data for affected wetland, stream, and open water resources can be found in Volume 1, Part II, Section 6.0 of the Federal Permit Application (Duke 2011h), and Sections 2.3 and 2.4 of the ER (Duke 2009c) and ER Supplement (Duke 2009b). The USACE Charleston District Guidelines provide separate processes for calculating the required mitigation credits for wetlands (including open-water habitats) and streams. Functional assessments were conducted in the field to determine the existing conditions of wetlands and streams for use in the calculation of required mitigation credits. Based on this methodology, the total mitigation credit needs for Lee Nuclear Station are 54 wetland credits and 484,000 stream credits. Thus, stream impacts play the important role in the mitigation site selection and approach.

Site Selection

Beginning in March 2009, Duke began the search for mitigation options. After confirming that available mitigation banks have inadequate numbers of credits available, Duke investigated existing in-lieu-of-fee programs in the Broad River watershed. None existed at the time, nor are any currently available. Because there were insufficient mitigation bank credits available and no in-lieu-of-fee programs, Duke began an outreach to stakeholders for input on possible appropriate, watershed-based, permittee-responsible mitigation projects. On March 22–23, 2010, Duke held a 2-day interagency meeting in Gaffney, South Carolina, to discuss possible mitigation approaches. Duke also reached out to non-governmental stakeholder organizations and local government officials as well as other Federal agencies such as the Natural Resources Conservation Service.

The proposed Lee Nuclear Station, including the two new transmission-line corridors, spans the upper and lower Broad River watersheds in the Santee River Basin (Duke 2010o) and the Kings Mountain and Southern Outer Piedmont subdivisions of the Piedmont ecoregion (EPA 2007a). As part of a watershed-based approach to compensatory mitigation, and in an effort to perform compensatory mitigation as close as possible to where impacts would occur (USACE 2010a; 33 CFR Part 332), Duke conducted a wide search for appropriate large-scale mitigation properties in the South Carolina portion of the upper and lower Broad River watersheds (hydrologic unit codes 03050105 and 03050106, respectively) within the Kings Mountain and Southern Outer Piedmont ecoregion subdivisions (Duke 2010t). Through discussions with the USACE, Duke evaluated mitigation opportunities at the U.S. Forest Service (USFS), Sumter National Forest, Enoree District. The USFS Enoree District had identified in its forest management plans the need for restoration in areas of the forest affected by historic farming and agricultural practices that had resulted in significant sediment buildup and the creation of a deep-gully landscape.

<u>Mitigation Approach</u>

The mitigation plan includes the purchase of mitigation bank credits (purchased from USACE-approved mitigation banks) as well as permittee-responsible mitigation using a watershed approach. The plan uses large-scale mitigation opportunities that would create benefits within watersheds similar to those in the London Creek watershed affected by the creation of Make-Up Pond C, where the majority of stream impacts would occur. Through a proposed public/private partnership with the USFS, Duke Energy proposes the restoration and enhancement of a network of streams within the Lower Broad River watershed in the Sumter National Forest (Figure 4-1).

The first component of the mitigation plan, the Woods Ferry study area (Duke 2011h), which comprises more than 11,600 ac of contiguous forest located in Chester County in the northeast corner of the USFS Enoree Ranger District , was identified as a unique opportunity to provide wetland and stream mitigation at a landscape level. Streams in the Woods Ferry study area have incised or cut through deep layers of floodplain sediment to historic elevations, and are now entrenched and laterally unstable. This instability results in increased sediment loads, degraded water quality, poor in-stream habitat, reduced water storage and base flow release, and diminished water availability for the riparian plant community.

The proposed restoration and enhancement of streams in the Woods Ferry study area would improve these degraded aquatic stream functions. These streams occur in a watershed similar to that of London Creek. Stream restoration in Sumter National Forest supports the USFS in meeting the needs identified in its Forest Management Plan to restore the functions of aquatic resources (e.g., stabilizing stream bank erosion and improving habitat for fish and macro-benthic communities) for public benefit.

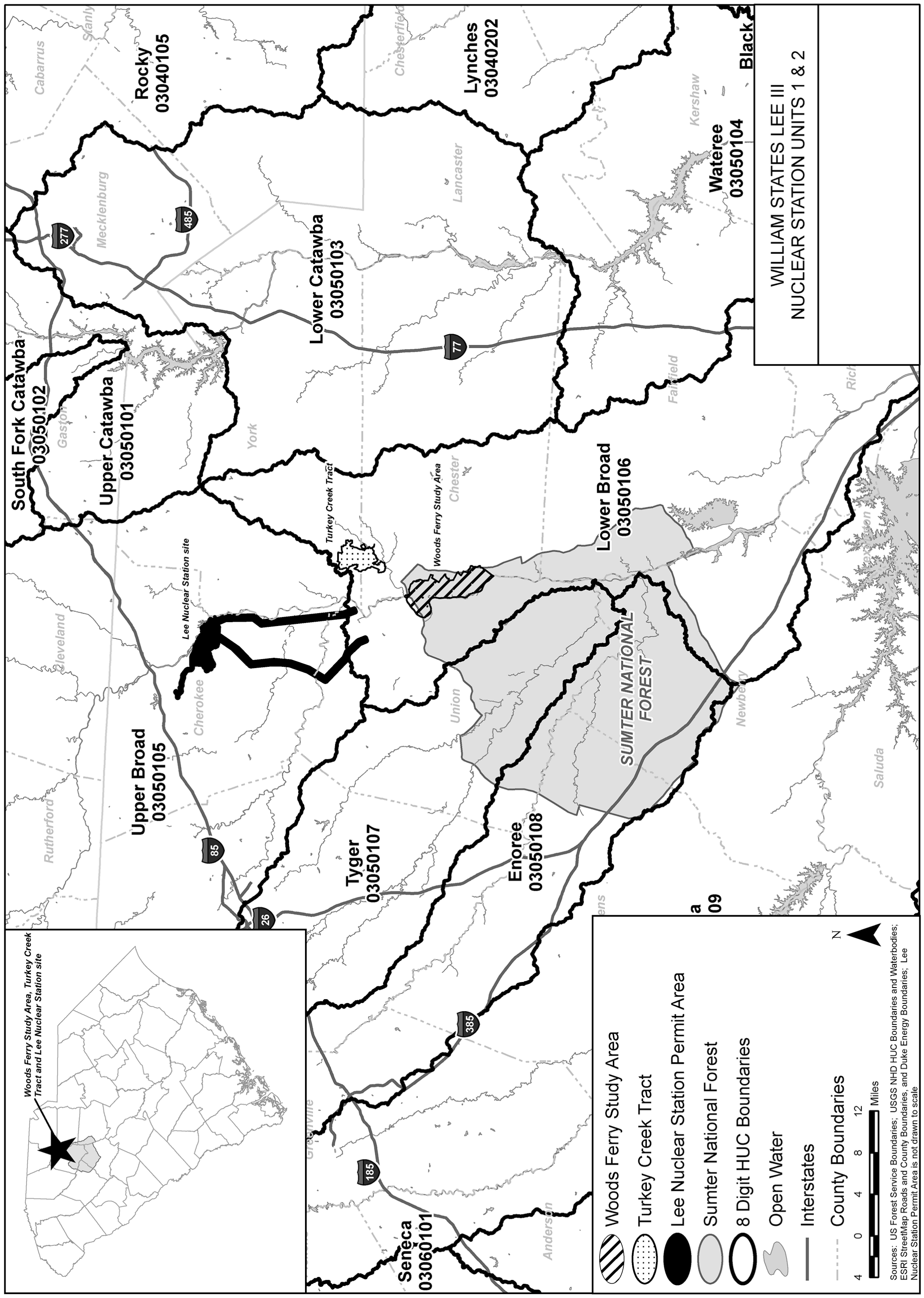

Figure 4-1. Woods Ferry Study Area and Vicinity (USACE 2013b, modified from Duke 2011h)

The second component of the mitigation plan is the Turkey Creek Tract, a large privately owned property in the Sumter National Forest located near the Woods Ferry study area. The Turkey Creek Tract offers an opportunity for mitigation that is substantial enough to provide regional benefits in the form of preservation and buffer enhancement.

Stream Restoration

The mitigation plan proposes primarily Priority 2 stream restoration (Rosgen 1997) for restoring the stream impairments typically found within Woods Ferry. Priority 2 restoration involves excavation to re-establish a functional floodplain along an existing stream channel elevation. This serves to reconnect a floodplain to a stream by reestablishing characteristic bankfull dimensions (defined as stream channel widths at which overbank flow begins during a flood) and flood frequency. This is accomplished by restoring stable stream dimension (cross-sectional area), pattern (view of a stream channel from above), and profile (longitudinal slope).

This approach would convert the existing degraded channels (Rosgen F and G channel types) to more functional channels (Rosgen C, B, and E channel types) by establishing new, stable stream beds (i.e., that neither degrade [incise] nor aggrade [rise due to excessive sediment deposition]) and floodplains without requiring extensive downstream grade controls (Rosgen 1997). Restoration of stable stream physical characteristics would reduce sediment in onsite and downstream receiving waters by removing legacy sediments from the floodplain, stabilizing eroding streambanks, and restoring forested riparian buffers. Construction would target installation of the most appropriate natural channel design to a particular stream reach. This is accomplished by excavating the floodplain, removing legacy sediment, and establishing the belt width of that floodplain at current stream elevations. After excavation of legacy sediment and establishment of the natural channel design, the riparian community along streams would be replanted and reestablished. Bridges and culverts in the restoration area would be replaced to accommodate the larger floodplains. Floodplains and upland slopes adjacent to streams would be re-vegetated.

This hydrological restoration will improve in-stream habitat by reducing sedimentation and enhancing stream bed variability. The restoration efforts have the potential to provide up to an estimated 85,388 linear ft of restored streams in the Woods Ferry area of the Sumter National Forest.

Baseline Information

Baseline data for the Woods Ferry study area and the Turkey Creek Tract are found in the Federal permit application (Duke 2011h). Part III C and Part III D contain details of topography, land use, soil types, hydrology, plant communities, and water quality and existing stream conditions for these areas. The Woods Ferry study area and Turkey Creek Tract exhibit landscape and habitat characteristics similar to the London Creek drainage, although areas of

Woods Ferry are more deeply incised and eroded. Collection of field baseline data for the proposed mitigation areas is ongoing, and includes installation of stream gages, Bank Erosion Hazard Index analysis and mapping, and surveying of each stream reach. General biological surveys (including fish, macroinvertebrates, and amphibians), rare, threatened and endangered species surveys, and water-quality data collection are included in the baseline data.

Monitoring

Constructed streambanks would be monitored and assessed for their stability, stream physical performance standards, including two bankfull flow events, channel stability analysis (such as Bank Erosion Hazard Index) ratings, bank pin installation, bank profile surveys, channel pattern and longitudinal survey, and stream bed material analysis. Post-restoration channel stability and bank erosion monitoring results will be compared to mitigation area pre-restoration data to determine the improvement in channel stability and decreased streambank erosion. Reference stream and associated baseline data will be used to establish performance standards for evaluating streambank and stream bed erosion rates. Physical changes in stream geomorphology are related to aquatic fauna communities. Stream aggradation, degradation, and enlargement affect in-stream habitats (i.e., pool size and frequency) and species diversity. Biological monitoring will be used to compare post-restoration data with reference stream baseline data. Biological monitoring will include changes in the benthic macroinvertebrate community, ambient water-quality monitoring, and fish sampling. Photograph reference stations will be established at locations along the restored streams, including cross sections and bank vegetation monitoring plots. Photographs will be compared from year to year and used to qualitatively evaluate channel aggradation or degradation, bank erosion, growth and survival of riparian vegetation, and effectiveness of erosion-control measures. Performance standards will be established for riparian vegetation community development.

A monitoring report documenting the stream restoration construction work will be completed within 90 days of the completion of vegetation planting. The baseline monitoring report will detail restoration activities, identify success criteria and monitoring plan components, and provide supporting information and data, including drawings, site photographs, permanent stream transect locations, sampling plot locations, a description of initial species composition by community type and density, and monitoring station locations. The report will also describe mitigation site maintenance and repair requirements and contingencies. The 5-year monitoring program will be implemented at the beginning of the first growing season after construction. The monitoring program is designed to document both stream and plant community development and progress toward achieving the performance standards. Annual monitoring reports will be prepared by the end of each calendar year following the guidelines issued for monitoring requirements in the USACE Regulatory Guidance Letter No. 08-03 (USACE 2008). The annual report will be submitted to the USACE by December 31 of the year during which the monitoring was conducted. The fifth (or final) report will include a Summary Report that provides an assessment of the entire 5-year monitoring period.

Adaptive Management

After restoration activities are completed, and annually during the 5-year monitoring period, the restored mitigation sites would be evaluated and their conditions documented in writing, graphics, and photographs. A report would be prepared. The focus will be on success as well as identification of any bank instability, in-stream structure failure, unsuccessful vegetation establishment, wildlife management issues (e.g., deer eating new plantings), or vandalism. If the mitigation or a specific component of the mitigation fails to achieve the defined success criteria, Duke would develop necessary adaptive management plans and/or implement appropriate remedial actions for the project in coordination with the USACE and the review agencies. Required remedial action, if any, would be designed to achieve the success criteria, and would include a work schedule and monitoring plan that would take into account physical and climatic conditions, including any conditions that may have contributed to failure.

Site Protection

As specified in 40 CFR 230.97 Management (a)(4) for mitigation on public lands, long-term protection of the Woods Ferry mitigation site would be provided through a Conservation Land Use Agreement between the USFS and the USACE. Site protection for the Turkey Creek Tract would be provided through use of a conservation easement using the Charleston District Conservation Easement Model (USACE 2010b). Duke will demonstrate financial assurance for completion of the mitigation project to the USACE Charleston District Engineer.

Federally Listed and State-Ranked Plant Species

A population of Georgia aster, a Federal candidate species, and populations of five plant species ranked by the State of South Carolina as imperiled or vulnerable (drooping sedge, southern enchanter's nightshade, southern adder's-tongue fern, Canada moonseed, and single-flowered cancer root) (see Sections 2.4.1.6 and 4.3.1.6) are located in the Make-Up Pond C study area. A population of southern adder's-tongue fern is also located on the Lee Nuclear Station site. Duke would coordinate with the FWS for the Georgia aster and with the SCDNR for the five State-ranked species regarding the potential relocation of any populations that may be affected by site-development activities. Duke is considering the following conceptual approaches:

1. Transplant the populations of the five State-ranked species to species-specific suitable habitats in a mitigation area for the Make-Up Pond C site (not yet identified), if such habitats exist.

2. Relocate the Georgia aster population to a nearby site where a different occurrence of the species was discovered during a recent botanical survey. This newly found site supports four Georgia aster plants and appears to have the preferred soil type for the species (clay with relatively high levels of calcium and magnesium).
3. Relocate the Georgia aster population and populations of the five State-ranked species to recognized botanical gardens in Greenville or Gaffney, South Carolina, or near Charlotte, North Carolina (Duke 2010d, 2012j, 2013d).

Mitigation measures for site-preparation and development-related terrestrial impacts include the implementation of avoidance and minimization measures and BMPs described in Sections 4.3.1.1 through 4.3.1.5. No other mitigation or related monitoring is currently being considered by Duke for site-development impacts at the Lee Nuclear Station site, or within the Make-Up Pond C study area, the two proposed new transmission-line corridors, the railroad-spur corridor, or offsite road-improvement areas.

4.3.1.8 Summary of Impacts on Terrestrial Resources

Duke has indicated that site preparation and development for the Lee Nuclear Station site and vicinity, the Make-Up Pond C site, two new transmission-line corridors, the existing railroad-spur corridor, and offsite road improvements would be conducted according to Federal and State regulations, permit conditions, and established BMPs. Duke stated that it would work with the USACE to determine appropriate mitigation through the permitting process of Section 404 of the CWA (33 U.S.C. 1344), which prohibits the discharge of dredged or fill material into waters of the United States without a Department of the Army permit. Based on information provided by Duke and the review team's independent evaluation, the review team has determined that the site-preparation and development-related impacts on terrestrial habitats at the Lee Nuclear Station site (Section 4.3.1.1), including permanent or temporary losses of forests (approximately 423 ac cleared), jurisdictional wetlands (0.21 ac of forested wetlands hand-cut), and non-jurisdictional features (9.25 ac of water-filled depressions filled), as well as the temporary drawdown of 5.46 ac of jurisdictional wetlands during an approximate 3-year intake/refill structure installation period on the Lee Nuclear Station site, would be spatially extensive and would considerably alter the terrestrial ecology of the local landscape. The associated impact on wildlife would also be considerable, but impacts on two State-ranked species would be negligible.

Site preparation and development of the proposed two new transmission-line corridors would permanently disturb about 690 ac of upland-forest habitat in Cherokee and Union Counties and 1.15 ac of jurisdictional wetlands. Some direct wildlife mortality would be incurred and a small portion of one significant natural area would be disturbed. Employment of BMPs for transmission system installation would serve to minimize potential impacts on about 7.6 mi of streams, 116 stream crossings, and about 11 ac of jurisdictional wetlands. Based on information provided by Duke and the review team's independent evaluation, the review team has determined that the site-preparation and development-related impacts on terrestrial habitats along the two new transmission-line corridors, including disturbance of forests and wetlands, as described in Section 4.3.1.3, would serve to further fragment forest communities and would constitute a noticeable change to the terrestrial habitats of the surrounding landscape. The associated impact on general wildlife would also be noticeable, but impacts on two State-ranked species would be negligible.

As described in Sections 4.3.1.4 and 4.3.1.5, the site-preparation and development-related impacts on terrestrial habitats along the railroad-spur corridor and at the proposed offsite road-improvement areas would be localized and would not noticeably alter the terrestrial ecology of the surrounding landscape. The associated impact on wildlife would be negligible.

The proposed Make-Up Pond C would be the largest reservoir to be permitted in the State of South Carolina since the creation of Lake Russell in 1984. Site preparation and development and inundation of Make-Up Pond C would permanently alter the nature of the terrestrial habitat and wildlife resources in the London Creek watershed (Section 4.3.1.2). Creation of Make-Up Pond C would affect about 821 ac of forest (of which about 545 ac are relatively undisturbed mixed hardwood and mixed hardwood-pine forest) along most of the length of London Creek and its tributaries. Development of Make-Up Pond C would inundate seven significant natural areas, four noteworthy ecological associations of concern to the State, occurrences of five uncommon plant species, diverse amphibian and reptile assemblages, 3.55 ac of jurisdictional wetlands, and vegetation along 884 linear ft of jurisdictional streams. Creation of Make-Up Pond C would also alter the functionality of the London Creek corridor as a wildlife travel corridor, particularly for neotropical migrant songbirds of conservation priority. Development of Make-Up Pond C would disturb one occurrence each of a Federal candidate plant species, four State-ranked plant species, and multiple occurrences of a fifth State-ranked plant species and one State-ranked avian species. However, the potential impacts on these species range-wide would be minor, and Duke has stated it would coordinate with the FWS and the SCDNR regarding the potential relocation of any plant populations that may be affected by site-development activities. The abundance of watersheds of similar size in the upstate Piedmont that support similar high-value resources, either individually or collectively, is uncertain. Based on information provided by Duke and the review team's independent evaluation, the review team has determined that site preparation and development and inundation of Make-Up Pond C would constitute a noticeable change to the terrestrial habitats and wildlife communities of the surrounding landscape, and some important attributes of these resources would be permanently lost.

Based on information provided by Duke and the review team's independent evaluation, the review team concludes that the construction and preconstruction impacts for Lee Nuclear Station and vicinity, including the Lee Nuclear Station site and the proposed Make-Up Pond C, and offsite infrastructure areas, including the two new transmission-line corridors, the railroad spur, and offsite road improvements would be MODERATE. This impact level is primarily driven by the impacts at Make-Up Pond C and in the transmission-line corridors, all of which are related to site-preparation and development activities, not NRC-authorized construction. In consultation with the USACE, Duke is designing compensatory mitigation appropriate to offset impacts on wetlands, streams, and other waters of the United States within the jurisdiction of the CWA.

All of the NRC-authorized construction actions would occur in areas disturbed as part of site preparation and development for the Lee Nuclear Station. Therefore, the NRC staff concludes that the terrestrial ecological impact associated with NRC-authorized construction activities for both the site and vicinity and the offsite infrastructure areas would be SMALL, and no further mitigation would be warranted.

4.3.2 Aquatic Impacts

Aquatic resources in the Broad River and Ninety-Nine Islands Reservoir would be affected mainly by building the new cooling-water intake and discharge systems. Make-Up Pond A and Make-Up Pond B would be affected mainly by dredging and other soil-disturbing activities during modification of structures in the ponds. In addition, water would be drawn down in Make-Up Ponds A and B for an extended period while the temporary cofferdams are in place, which would affect aquatic species in the littoral zone. Aquatic impacts within the Lee Nuclear Station site include permanent (9.37 ac) and temporary (2.68 ac) impacts on 12.05 ac of open water (part of the 29.63 ac of open water impacts in Table 9-19 and an additional 92 ac of temporary open water impacts associated with the approximate 3-year-long intake/refill structure installation in Make-Up Ponds A and B (Duke 2012n, o). There would be no impacts to streams at the Lee Nuclear Station site (Duke 2012n).

Aquatic resources in London Creek and its unnamed tributaries would be affected mainly by breaching and draining the farm ponds, installing a dam across London Creek, and subsequently impounding the creek and filling the Make-Up Pond C reservoir. Installation of pump stations and an intake/discharge facility at Make-Up Pond C would have lesser impact because they would be installed prior to filling the reservoir. Aquatic impacts within the Make-Up Pond C site include permanent impacts on 17.58 ac of existing open water and 64,911 linear ft of stream and temporary impacts on 884 linear ft of stream (Duke 2012n).

There also would be minor offsite impacts on aquatic resources associated with renovating the railroad-spur culvert crossing (Duke 2012n).

4.3.2.1 Aquatic Resources – Site and Vicinity

Broad River

Installation activities associated with the cooling-water intake and discharge structures would result in the loss, both temporarily and permanently, of aquatic habitat in the Broad River. As stated in Duke's ER, all work would be conducted in accordance with the appropriate permitting agencies and authorizations, including the following:

- USACE – A Department of the Army permit for the discharge of dredged and/or fill material into waters of the United States.
- CWA – Section 401 water-quality certification for ensuring water-quality standards are met.
- SCDHEC – NPDES stormwater permit for surface-water discharges associated with land disturbance and industrial activity. This permit requires Duke to have an Erosion Control Plan in place before excavation, as well as an SWPPP.
- FWS – Consultation on the potential for activities to affect Federally listed aquatic species.
- SCDNR – Consultation on the potential for activities to affect State-ranked aquatic species.

<u>Broad River Intake Structure</u>

Installation of the Broad River intake structure will require in-water activities that would permanently disturb 0.54 ac (0.48 ac dredging, 0.06 ac filling for intake structure construction) of the Broad River bottom (Duke 2009c, 2012n). A cofferdam composed of two banks of Z-shaped sheet piles with gravel ballast in-fill (approximately 258 ft long and extending 75 ft into the river at the narrowest width of the river) would enclose the intake structure work area (Duke 2010f). The area inside the cofferdam then would be dewatered so that building activities could proceed in a dry environment. The cofferdam would reduce the potential for erosion and sedimentation, thus minimizing impacts on aquatic organisms in the river and their habitat from the depositing or shifting of sediment. Duke expects work on the intake structure to last approximately 20 months (Duke 2010f). Installation and removal of a cofferdam would be timed to minimize impacts on migratory fish spawning and on aquatic habitat in general. Five months would be needed to install the cofferdam assembly and another three months to remove it. Sediment disturbance from installation of the intake would be limited to areas inside the cofferdam during this period. Leakage through the cofferdams would be pumped through a sock filter and then discharged back into the river. A turbidity screen placed in the river would also be used to minimize turbidity levels (Duke 2011h). Once the project is built, the cofferdam would be removed behind a weighted silt curtain to protect the river from excess silt load during removal. Removal would occur prior to high flows in the spring.

Fish trapped in the cofferdam area should be relocated to the river prior to dewatering. Except for a small proportion of fish that could be lost due to handling stress, fish removal from the cofferdam area is expected to produce only minor, temporary impacts on those fish. Other fish could be adversely affected when sediments are suspended during the installation and removal of the sheet pilings and cofferdam and during startup of the intake system. While in place, the cofferdam is expected to reduce the width of the river from approximately 240 ft to 165 ft (Duke 2009c). This decrease in width would increase the velocity of the river in the vicinity of the installation site and thus increase the potential for bottom scour and bank erosion. After removal of the cofferdam, water velocities would return to normal, and eventually, the river bottom would be expected to fill in and return to conditions that existed before installation of the cofferdam. Because only one-third of the river width would be affected by the cofferdam installation, fish would have many opportunities to avoid a potential sediment plume.

The larvae of important fish species described in Section 2.4.2 were much more abundant in the backwater areas of the river above Ninety-Nine Islands Dam than in the area near the proposed Broad River intake structure, thereby reducing the potential for impact on larvae (Olmsted and Leiper 1978). Because spawning takes place largely outside the area near the intake structure and because installation and removal of the cofferdam will be timed, to the extent practicable, to occur outside the typical spawning season, it is therefore unlikely that impacts from building the Broad River intake structure in the mainstream portion of the reservoir would significantly alter fish reproduction in the Broad River. Each of these potential impacts is temporary and could be managed to limit the extent and magnitude of impacts on aquatic habitats and species.

Some benthic habitat and benthic organisms would be lost when the area inside the cofferdam is dewatered and as the area is dredged. An excavator operating from the riverbank would perform the dredging to minimize in-water impacts (Duke 2009c). Dredged material would be placed in an onsite spoils area (Duke 2013d). The area near the intake structure had low macroinvertebrate bioclassification scores (Fair and Poor), indicating that existing habitat conditions are already deficient for macroinvertebrates at this location (Derwort and McCorkle 2006). Because the 0.54-ac area directly affected is small relative to the habitat available to benthic organisms in the region and the habitat quality is not exceptional, noticeable differences in the benthic community as a result of Broad River intake structure building activities are not expected. Also, after the cofferdam is removed, benthic organisms would be expected to recolonize the area.

Some riparian vegetation would be removed along the shore to accommodate building the intake (Duke 2009c). Removal of riparian vegetation from shorelines can destabilize the riverbank or contribute to water warming because some areas are no longer shaded by vegetation. Hazardous-chemical spills associated with machinery and other installation activities could be injurious to fish and other aquatic organisms. To minimize potential impacts from these activities, all work would be performed in compliance with the conditions of applicable authorizations from the USACE (§404 wetlands), Cherokee County floodplain administration, and the SCDHEC (§401 certification and NPDES program) (Duke 2008f). Duke also would implement BMPs to limit erosion along the bank (Duke 2009c). Perimeter controls, such as vegetated buffer strips, would be used in combination with other techniques, such as silt fences and fiber rolls, where the work site meets the Broad River to minimize the possibility of excess sediments reaching the river (Duke 2009c). A SWPPP and Erosion Control Plan would be in place to limit and mitigate potential impacts on surface waters from stormwater runoff, bank erosion that could occur while the disturbance area is unvegetated, and sedimentation and temporary degradation of surface waters and/or wetlands associated with in-water installation activities (Duke 2009c). These plans would include the use of temporary discrete discharge locations that would be pretreated and equipped with an oil recovery boom to reduce suspended sediment loads and handle an unanticipated release of oil or grease to the aquatic environment (Duke 2009c).

After installation of the intake structure, native vegetation would be allowed to re-establish itself in all areas except along the length of the screen house where the growth of vegetation would be prevented (Duke 2009c). This absence of vegetation may result in a slight decrease in shading along that portion of the west bank, but slope protection would be built around the intake structure to permanently stabilize the slope. Most of the slope protection around the intake structure would be completed prior to removal of the cofferdam (Duke 2009c).

Blowdown and Wastewater Discharge Structure

Installation of the blowdown and wastewater structure would require dewatering activities behind a temporary cofferdam extending 100 ft from the shoreline. This activity would result in the temporary draining of 0.15 ac of open water behind the cofferdam and the temporary placement of fill over 0.04 ac of substrate within the Ninety-Nine Islands Reservoir (Duke 2011f, h; 2012n). Dredging would permanently impact 1 ac of substrate and would be performed in two locations: near the shoreline inside the cofferdam to install the discharge pipe at the correct elevation and in the Ninety-Nine Islands forebay to maximize mixing volume at the forebay (Duke 2011h, 2012n). A 3-ft-inside-diameter, high-density polyethylene pipe would run from the shore out into the Broad River along the upstream side of Ninety-Nine Islands Dam. The top of the pipe would be installed 10 ft below the full-pond elevation of the Ninety-Nine Islands Reservoir (Duke 2011h). The work is expected to take approximately 3 months and would be scheduled for completion during the late summer to fall when water levels are typically low (Duke 2008f). This time frame should also minimize disruption to spawning activities and fish migration (Duke 2009c). Increased noise and movement of workers, equipment, and materials should cause only temporary displacement of fish from the area (Duke 2009c). Minimal impacts on aquatic organisms from piping installation are anticipated because pipe sections would be assembled onshore, positioned using a barge, and attached to the face of the dam by divers. Temporary impacts on benthic macroinvertebrates or other aquatic species from increased turbidity are anticipated in association with dredging activities in the vicinity of the blowdown and wastewater diffuser. As discussed in Section 4.3.1, BMPs, an Erosion Control Plan, a SPCCP, and an SWPPP would be used to minimize the potential for the harmful release of sediments or other pollutants into the water (Duke 2009c). Duke also would be working in accordance with the CWA Section 401 State water-quality certification and the Department of the Army permit that define what activities would and would not be allowed to protect local and downstream habitats and organisms from harm.

Make-Up Pond A

Dredging, excavating, and construction activities would affect aquatic organisms in Make-Up Pond A. The existing cofferdams and soil outcrops in the central portion of Make-Up Pond A would be removed via dredging (3.26 ac). This would help to improve flow conditions in the vicinity of the proposed intake structure (Duke 2011, 2012n). The former Cherokee Nuclear Station intake structure in Make-Up Pond A would be partially removed, but a portion would be left in place to provide access to the proposed new Make-Up Pond A intake structure located further offshore (Duke 2012h). A temporary cofferdam (to be removed upon completion of building the intake) would be placed around the site of the proposed intake structure to allow dewatering 1.08 ac of the work area, followed by excavation and building activities. Cofferdam placement would result in the temporary loss of 0.20 ac of benthic habitat. Installation of the new intake structure would result in the permanent loss of 0.22 ac of substrate in Make-Up Pond A, whereas dredging associated with building the new intake would permanently disturb 1.06 ac of substrate (Duke 2012n). In addition, a discharge structure that would receive water from the Broad River (normal operations) or from Make-Up Pond B (low-flow operations) would be installed near the northwest corner of Make-Up Pond A (Figure 3-4, grid reference C2) and would result in the permanent loss of 0.07 ac of substrate and the temporary draining of 0.48 ac of open water (Duke 2010f, 2012n).

Duke would be regulated by any restrictions imposed by the USACE under the Department of the Army permit. Duke also has indicated it would use BMPs and conform to the standards of the SWPPP that would be developed as part of the NPDES permitting process (Duke 2009c).

Dredging and excavating portions of Make-Up Pond A would temporarily displace fish, remove benthic organisms, and create conditions of higher than normal turbidity for the pond residents. The benthic community is expected to become gradually reestablished, but because operation of a new nuclear power station would result in water input from the Broad River to the pond, turbidity would be at a level greater than current conditions, and there could be a shift in species diversity and abundance (Duke 2009c). Disposal of dredged or excavated material removed from Make-Up Ponds A and B would be in an onsite spoils area (Duke 2013d).

Some drawdown of water level in Make-Up Pond A would be required during installation of the Make-Up Pond A intake and discharge structures to relieve pressure on the cofferdams. Duke expects the water level would be drawn down 20 ft for approximately 32 months. The proposed drawdown would temporarily reduce the water surface area of Make-Up Pond A by approximately 28 ac (Duke 2012o). Benthic, littoral, and shoreline habitats would be temporarily altered. Water temperatures within Make-Up Pond A are likely to increase and dissolved oxygen levels are likely to decrease. Duke maintains that sufficient volume to provide fish refuge would remain (Duke 2011h). The sunfish species present in Make-Up Pond A are resilient and would likely adapt to the altered conditions; however, the benthic community would be lost in the dewatered littoral zone. After water levels are restored, benthic organisms would be expected to recolonize the area.

Impacts associated with cofferdam placement and dewatering in Make-Up Pond A would be less than those described for the river intake structure because there would be no river flow restriction. Leakage through the sheet-pile cofferdams would be pumped through a sock filter and then discharged back into the pond. A turbidity screen placed in the pond would also be used to minimize turbidity levels (Duke 2011). Fish trapped behind the sheet piling should be relocated to the unaffected portion of the pond or to the Broad River prior to dewatering. Except for a small proportion of fish that could be lost due to handling stress, the removal of fish is expected to produce only minor, temporary impacts. Other fish could be adversely affected when sediments are suspended during the installation and removal of the sheet pilings.

Fish currently inhabiting Make-Up Pond A are primarily sunfish species (centrarchids), none of which is considered rare or of special concern in the region (Table 2-12). Fishing is not allowed in the pond, so fish losses would not affect recreational fishing. The temporary disruption, or even loss, of the fish in Make-Up Pond A would not noticeably alter or destabilize the regional fish populations.

Make-Up Pond B

Installing the Make-Up Pond B combined intake/refill structure and its access causeway would involve dredging or excavation, installation of a temporary cofferdam dewatering, and placement of piping and concrete (Duke 2009b, c; 2010l, m, p). Placement of fill for building the new intake/refill structure would result in the permanent loss of 1.07 ac of substrate, whereas dredging would permanently disturb 2.09 ac of substrate (Duke 2012n). In addition, as described in Section 3.2.2.2, a discharge structure that would receive water from the Broad River (during refill operations) or from Make-Up Pond C (during low-flow operations) would be located along the shoreline west of the Make-Up Pond B spillway (Figure 3-4, grid reference B2) and result in the permanent loss of 0.06 ac of substrate (Duke 2009c, 2012n). Temporary cofferdams (to be removed upon completion of building activities) would be placed around the sites of the proposed intake/refill and discharge structures to allow dewatering of each area, followed by excavation and building activities. Placement of the cofferdams would result in the temporary loss of 0.51 ac of benthic habitat (0.43 ac at the intake/refill structure and 0.08 ac at the discharge structure) and the temporary draining of 0.22 ac of open water (0.09 at the intake/refill structure and 0.13 ac at the discharge structure) (Duke 2011h, Duke 2012n).

Drawdown of the pond water level would also be required during installation of the intake/refill and discharge structures to relieve pressure on the cofferdams. Duke expects the water level would be drawn down 20 ft for approximately 34 months. The proposed drawdown would temporarily reduce the surface area of Make-Up Pond B by approximately 64 ac (Duke 2012o). Benthic, littoral, and shoreline habitats would be temporarily altered. Water temperatures would likely increase and dissolved oxygen levels would likely decrease. Duke maintains that sufficient volume to provide fish refuge would remain (Duke 2011h). The fish species present in Make-Up Pond B, primarily sunfish, Carp (*Cyprinus carpio*), catfish, and Gizzard Shad (*Dorosoma cepedianum*) are resilient and would likely adapt to the altered conditions; however, the benthic community would be lost in the dewatered littoral zone. After water levels are restored, benthic organisms would be expected to recolonize the area.

Duke would be required to comply with the requirements of the individual Department of the Army permit issued by the USACE. Duke also has indicated it would use BMPs and conform to the standards of the SWPPP that would be developed as part of the NPDES permitting process (Duke 2009c).

Common fish species in Make-Up Pond B include sunfish, gizzard shad, carp (cyprinids), and catfish (ictalurids) (Duke 2009c). None of these species is considered rare or of special concern in the region. Fishing would not be allowed in the pond, so fish losses will not affect recreational fishing. Fish trapped behind the sheet piling should be relocated to the unaffected portion of the pond or to the Broad River before dewatering. Except for a small proportion of fish that could be lost because of handling stress, fish removal from behind the sheet piling or from the pond to the river is expected to cause only minor, temporary impacts on those fish. Fish could be affected adversely when sediments are suspended during the installation and removal of the sheet pilings and during startup of the intake system. Overall, the temporary disruption, or even loss, of the fish in Make-Up Pond B would not noticeably alter or destabilize the regional fish populations.

Hold-Up Pond A

Because no modifications are planned for Hold-Up Pond A, the primary impact of site-preparation activities on Hold-Up Pond A aquatic biota is expected to come from stormwater runoff. Some stormwater flows would be directed to this pond during site preparation (Duke 2009c). This could temporarily increase turbidity levels within the pond and temporarily affect fish. Only Largemouth Bass (*Micropterus salmoides*), Bluegill (*Lepomis macrochirus*), Redbreast Sunfish (*L. auritus*), and sunfish hybrids (centrarchids) were captured in this pond. None of these species is considered rare or of special concern in the region. Fishing would not be allowed in the pond, so fish losses would not affect recreational fishing. Because Duke has indicated it would use BMPs and conform to the standards of the SWPPP that would be developed as part of the NPDES permitting process, impacts on aquatic biota are expected to be minimal (Duke 2009c).

Make-Up Pond C

Impacts on aquatic resources in London Creek and its unnamed tributaries are identified below:

- *Improvement of temporary logging roads*. Vegetative clearing, grading, roadside ditch excavation, and crushed stone placement could result in increased stream temperatures and turbidity. Roads required for the construction of Make-Up Pond C would result in the permanent placement of culverts and fill material within 223 linear ft of stream substrate. These roads would ultimately be inundated by the Make-Up Pond C and a new aquatic substrate would form (Duke 2012n).
- Removal of vegetation from within the Make-Up Pond C footprint and 50-ft buffer area (i.e., a 50-ft wide area around the full-pond elevation of Make-Up Pond C). Clearing, grubbing outside the footprint (884 linear ft of stream shoreline vegetation within the 50-ft buffer), and grading could result in sediment movement into London Creek and its unnamed tributaries or compaction of sediments in or near stream beds (Duke 2012n). Operation of heavy equipment could result in leaks or spills of petroleum products into the aquatic environment. Because of the reduction in shading from riparian vegetation, water temperatures could increase, leading to decreases in dissolved oxygen concentrations. Removal of vegetation also would result in decreased input of woody debris and leaf litter to London Creek and its tributaries. Woody debris and leaf litter provide habitat structure and food resources for aquatic biota.
- *Installation of the dam and associated structures*. The diversion of London Creek around the work area during installation of the dam and other permanent structures (i.e., water-control structure, toe drain, emergency spillway, spilling basin, riprap, saddle-dike structures, reservoir outfall, pump/intake structure, break tank, buildings, and other structural foundations) is expected to take approximately 2 years (Duke 2010f). The installations would result in dewatering of the work area and permanent loss of some benthic macroinvertebrates, stream habitat, and possibly fish. Fill material associated with building the Make-Up Pond C infrastructure would fill 2663 linear ft of stream substrate, excavation for borrow material would eliminate 267 linear ft of stream substrate, and disposal of spoil material would affect 730 linear ft stream substrate (Duke 2012n). To the extent possible, Duke expects they would avoid known spawning seasons for installation of cofferdams (Duke 2010f). While building of Make-Up Pond C is under way, the London Creek flow would be allowed to pass through sediment settling structures and pipes to downstream of the Make-Up Pond C dam. During the transition period between construction and pond filling, when the pipes would be sealed, pumps would be used (Duke 2012n). While the stream is diverted around the work area, up to seven submersible pumps would be used to pass flows as great as a 25-year, 24-hour storm. Under normal conditions flow would be passed with a single pump, throttled to match incoming flow as closely as possible, so that there would be very little change to downstream flow (Duke 2010c). Pumping for temporary stream diversion would be in accordance with the Department of the Army permit conditions

(Duke 2010c). The pump inlet would be screened with 0.25-in^2 welded wire fabric, which would prevent entrainment of juvenile and adult fish but would not prevent entrainment of fish eggs or larvae. Thus, some small fish could be diverted to the downstream side of the dam during pumping operations, but there would be no effort to capture fish upstream and relocate them downstream (Duke 2009b). A single intake/discharge structure would be built at Make-Up Pond C to receive water from the Broad River and to pump water between Make-Up Ponds B and C (Duke 2009b). The intake/discharge structure includes an access bridge and pump platform (Duke 2011h). Installation would be completed before the pond is filled with water, thus minimizing the potential for aquatic impacts.

- *Filling of the reservoir (proposed Make-Up Pond C)*. Filling the reservoir would result in the permanent loss of lotic (flowing water) habitat within the reservoir footprint. The impoundment of Make-Up C would convert 60,414 linear ft of streams and 0.03 ac of open-water habitat to deep open water (Duke 2012n). With the possible exception of a segment approximately 0.6 mi in length between the Make-Up Pond C dam and the junction with the Broad River (Section 9.5.3.1), the main stem of London Creek would be inundated and the resulting Make-Up Pond C impoundment would replace a lotic system with a lentic system. Some aquatic functions would remain, in particular, flood attenuation and water quality, and some aquatic species (e.g., sunfish) could adapt to the lentic environment. In addition, some of the upper reaches of tributaries to London Creek not impounded would retain their lotic characteristics, but they would become isolated from other lotic habitat.
- *Realignment of SC 329 roadway and construction of a new bridge over the reservoir*. These activities include the placement of three culvert crossings to facilitate water flow from drainage areas (Duke 2011h). Culvert construction would affect 396 linear ft of streams (Duke 2012n). All of these activities would take place before the London Creek channel is inundated. During the building activities, cofferdams and diversions would route existing London Creek flow around the excavation area. Temporary activities such as clearing, grading, and paving have the potential to increase stream water temperatures and introduce sediment to London Creek. Upon completion of the bridge and realigned highway, the former London Creek channel would be inundated by an arm of Make-Up Pond C.
- *Lake Cherokee Dam and Spillway*. The placement of riprap to stabilize the embankment of the Lake Cherokee Dam would permanently affect 218 linear ft of stream substrate and 0.02 ac of open water. The riprapped embankment would ultimately be inundated by Make-Up Pond C (Duke 2012n).
- *Rerouting of a 44-kV transmission-line right-of-way*. The proposed clearing and inundation of the London Creek drainage to form Make-Up Pond C would require removal of an approximately 2-mi-long portion of an existing out-of-service 44-kV transmission line. The new transmission ROW would be rerouted to skirt the west side of the pond (Figure 3-1) (Duke 2011h). The 100-ft-wide easement would cross several unnamed tributaries (estimated 229 linear ft) and impoundments (Duke 2010n). The use of BMPs for erosion

and sediment control in compliance with SCDHEC regulations during removal activities would minimize any adverse impacts on aquatic resources (Duke 2009b). A new transmission line is not currently needed and would not be installed in the new ROW until a need is identified (Duke 2011h).

At the request of the SCDNR and the SCDHEC, Duke has proposed a minimum flow regime below the Make-Up Pond C dam that would commence with the filling of the reservoir and be protective of aquatic resources downstream of the dam to the confluence of London Creek with the Broad River (Duke 2012m). While the pond fills, expected to take approximately 110 days (Duke 2011h), minimum flow would be achieved by pump(s) (Duke 2012n). Once the reservoir reached full pool elevation, Duke would release any continuous minimum flow to London Creek via the Make-Up Pond C spillway structure, approximately 500 ft downstream from the toe of the Make-Up Pond C dam (Duke 2012m). Based on historical flow data collected at London Creek, Duke has proposed the following minimum seasonal flow releases: January through April 1.5 cfs; May, June and December 1.0 cfs; July through November 0.75 cfs (Duke 2012m). A mitigation action plan, including compensatory mitigation incorporating restoration and preservation, for permanently or temporarily affected waters of the United States (e.g., wetlands and streams) within the jurisdiction of the USACE would be developed and implemented by Duke according to conditions to be set forth in an individual Department of the Army permit issued by the USACE and the associated CWA Section 401 water-quality certification issued by the SCDHEC (Duke 2010n). Duke has discussed an approach to compensatory mitigation with the USACE; it is described in Section 4.3.1.7. Site-specific BMPs also would be stipulated by the Department of the Army permit.

Farm Ponds

Dams of farm ponds in the vicinity of proposed Make-Up Pond C would be breached to eliminate dam safety issues (Duke 2011h). Draining the farm ponds would result in impacts on 17.53 ac of open-water habitat (Duke 2012n). Some of the drained open-water areas would be used as spoil stockpiling areas and one small pond (0.03 ac) would be inundated by the impoundment (Duke 2011h). Duke would discuss the disposition of fish and turtles present within the ponds with the SCDNR before dewatering takes place (Duke 2010d).

Railroad Spur

Within the railroad-corridor component of the jurisdictional determination prepared by the USACE (2013a), there are 21 stream crossings and 5942.14 linear ft of streams. Building impacts within the railroad-corridor permit area component include permanent impacts on 145 linear ft of London Creek and temporary impacts on 1345 linear ft of tributaries. Permanent impacts result from culvert replacement, whereas temporary impacts may result from installation of temporary cofferdams (25 linear ft) and the potential for associated backwater flooding (1320 linear ft) during a 10-year storm event. There are no impacts on open waters (Duke

2011h, 2012n). Two 120-in.-diameter steel-pipe culverts under the existing railroad spur would be replaced with a four-cell 12- × 10-ft reinforced concrete box culvert that would expand the hydraulic capacity of the London Creek crossing, reduce erosive velocities downstream, and provide a stable crossing for trains (Duke 2009b, 2010f, 2011h). The invert elevation of one cell would be modified to serve as the primary flow path under ordinary flow conditions. The bottom of the primary flow path cell would be modified into a roughened channel with engineered streambed material to create a more natural channel flow for the passage of fish and other aquatic organisms (Duke 2012j). The effort is expected to take approximately 13 months from start to finish (Duke 2010f). This activity would require diversion of London Creek around the work area while the culvert is replaced. This would result in temporary dewatering of the work area and loss of some benthic macroinvertebrates, fish, and larval salamanders. To minimize potential disturbance and sediment loading to streams, the work would be completed using large cranes and excavators from the top of the railroad embankment (Duke 2011h). Excavated materials would be placed atop the railroad-spur embankment to avoid placement in sensitive areas (Duke 2009b). The Department of the Army permit would be required before earth moving commenced, and the permit process would address the need for any compensatory mitigation. Duke would also submit a SWPPP to the SCDHEC that describes the erosion and sediment-control methods that would be employed during soil disturbance activities. These methods would be in accordance with the SCDHEC Stormwater Management BMP Handbook (2005), the *Duke Energy BMP for Stormwater Management and Erosion Control Policy and Procedures Manual*, and SCDOT BMPs (Duke 2009b, 2011h). After installation of the new culvert, Duke would restore the stream channel (Duke 2009b). Because the new box culvert would result in improved streamflow and because the cofferdams and the potential backwater flooding events would be temporary, the adverse impacts on aquatic resources are expected to be minimal.

4.3.2.2 Aquatic Resources – Transmission Lines

Duke has sited the new 230-kV and 525-kV transmission lines in accordance with SC Code Annotated § 58-33-110. Duke procedures for implementing this code included consultation with the FWS and an evaluation of impacts on special habitats and threatened and endangered species. In addition, Duke would comply with all applicable laws, regulations, and permit requirements and would use good engineering and building practices (Duke 2008b; HDR/DTA 2009b).

Within the proposed 31 miles of new transmission-line corridors, there are 14,596 linear ft of streams within the western corridor (Route K) and 25,530 linear ft of streams and a 4.06-ac open water impoundment within the eastern corridor (Route O) (USACE 2013a). Transmission-line structures would be located within upland areas and streams and open water would be spanned by the transmission lines. No direct impacts on streams or open waters would occur (Duke 2011h). The transmission lines would be installed in accordance with Duke Energy

Stormwater BMP manuals and SCDHEC BMPs (Duke 2011h). BMPs for transmission-line corridor and structure installations consist of considerations for site preparation, sediment traps and barriers, access road placement, stream crossings, runoff-control measures, structure placements, and surface-stabilization measures. A naturally vegetated buffer zone, with a minimum width of 25 ft, would be maintained on each side of the stream or open water. Currently, most of the streams within the proposed transmission-line corridors have forested riparian buffers (Duke 2011h). Vegetation maintenance within these buffer zones would be performed by hand-clearing (i.e., chain saws) and limited to that necessary to provide adequate conductor clearances (i.e., removal of canopy trees). Understory trees and shrubs would be retained, to the extent practicable, to provide erosion control and some shade to aquatic habitat (Duke 2011h). Minimal indirect impacts (i.e., potential for increased sedimentation and reduced shading) are expected on the 46 stream crossings identified in the western corridor (Route K) and the 70 stream crossings and 4.06-ac open-water impoundment identified in the eastern corridor (Route O) (Duke 2011h). The watercourses identified within both corridors range from small, first-order headwater tributaries to the Pacolet River (HDR/DTA 2009b; Duke 2011h). Surveys for threatened and endangered species were conducted by Duke in the delineated corridor between March and May 2009, based on inventory lists for Federally and State-protected species in Cherokee, Union, and the adjacent York and Chester Counties (HDR/DTA 2009b; Duke 2008b). The Carolina heelsplitter (*Lasmigona decorata*) was the only protected aquatic species potentially found in that area. It is listed as endangered by both the FWS and the State of South Carolina and is also State-ranked as S1 (critically imperiled). The survey found no occurrence of the Carolina heelsplitter, known to occur in the Catawba River drainage, and the FWS concurred in a letter to Duke dated August 26, 2009, that construction of the new 230-kV and 525-kV transmission lines would have no effect upon Federally listed species (HDR/DTA 2009b; Duke 2008b).

4.3.2.3 Important Aquatic Species

This section describes the potential impacts on important aquatic species, including Federally and State threatened or endangered species, State-ranked species, and ecologically important species, resulting from building the proposed new nuclear units at the Lee Nuclear Station site, the new transmission-line corridors, the Make-Up Pond C reservoir, and the new expanded culvert under the railroad spur.

Federally Listed Species

As previously discussed in Section 2.4.2.3, Important Aquatic Species, the FWS indicated that one listed mussel species, the Carolina heelsplitter, was known to be present in York County, which bounds the Broad River downstream of Ninety-Nine Islands Dam (Table 2-13). However, the review team reviewed the literature and species summaries and found no evidence there are likely to be any Federally listed aquatic species in the vicinity of the Lee Nuclear Station site (FWS 2010d).

The Carolina heelsplitter, an endangered mussel species, has not been located in the Broad River or its tributaries, but does occur within the Catawba River drainage (SCDNR 2005). Critical habitat has been designated only in Chesterfield, Edgefield, Greenwood, Kershaw, Lancaster, and McCormick Counties in South Carolina, none of which are associated with the proposed Lee Nuclear Station construction or preconstruction activities (67 FR 44501). In a letter dated June 13, 2012, the FWS concurred with the review team's determination that the proposed Lee Nuclear Station Units 1 and 2 project is not likely to adversely affect Federally protected species nor result in adverse modification of designated or proposed critical habitat, thus completing informal consultation between the FWS and NRC (FWS 2012b). No further action under Section 7 of the Endangered Species Act is required. Consultation correspondence between the review team and the FWS is included in Appendix F.

State-Ranked Species

<u>Carolina Fantail Darter (*Etheostoma brevispinum*)</u>

The Carolina Fantail Darter is State-ranked S1 (critically imperiled) (SCDNR 2012a) and is classified by the SCDNR as a species of high priority on its Priority Conservation Species List (SCDNR 2005). This darter has been captured previously in limited numbers in the vicinity of the proposed Broad River intake structure (Duke 2009c) and discharge structure (Duke 2008a). Therefore, it is possible this fish species could be affected by installation activities associated with the Broad River intake and discharge structures, although the preferred habitat of the Carolina fantail darter is gravel riffles where stronger currents exist (SCDNR 2005). The primary impact to the Carolina fantail darter would likely be temporary displacement from the work zones while each area is dewatered (Duke 2009c). Because the areas that would be disturbed by installation activities are not the preferred habitat of the Carolina fantail darter and Duke would employ BMPs in accordance with conditions specified in its CWA Section 401 State water-quality certification, Department of the Army permit, Erosion Control Plan, SPCCP, and SWPPP, the potential for a sediment or other pollutant release to occur and harm the Carolina Fantail Darter in the Broad River is minimal (Duke 2009c).

Additional Species of Ecological Importance

A number of aquatic species are listed by the State of South Carolina as highest or high priority conservation species. This is not a State listing *per se*, but does indicate that the species or their habitat may be in some jeopardy in South Carolina and/or in other states (SCDNR 2005). Five fish species, each listed as highest or high priority conservation species by the SCDNR, were found during surveys conducted by Duke or the SCDNR in the Broad River in the vicinity of the proposed new nuclear station, in London Creek, or in tributaries to the Broad River that may be crossed by new transmission-line corridors associated with the proposed new nuclear station. The five species are (1) Highfin Carpsucker (*Carpiodes velifer*), (2) Quillback (*C. cyprinus*), (3) Seagreen Darter (*Etheostoma thalassinum*), (4) Greenhead Shiner (*Notropis* *chlorocephalus*), and (5) Piedmont Darter (*Percina crassa*). These species may be affected negatively by deterioration in water quality because of sedimentation or habitat degradation from deforestation or loss of riparian cover. The use of BMPs to reduce siltation would minimize impacts from sedimentation. Restoration of riparian vegetation also would keep impacts to a minimum. Duke intends to restore river or creekside habitat after completion of building activities and would adhere to the best practices outlined in the *Duke Energy BMPs for Stormwater Management and Erosion Control Policy and Procedures Manual* (Duke Energy 1999).

The Highfin Carpsucker is given highest conservation status in South Carolina (SCDNR 2005). It may have been captured by the SCDNR in 2002 just below Cherokee Falls Dam and below Ninety-Nine Islands Dam (Bettinger et al. 2003). The Quillback is given high conservation priority (SCDNR 2005). It was captured by the SCDNR in 2001 and 2002 at eight sites on the Broad River, including sites in the vicinity of the Lee Nuclear Station site (Bettinger et al. 2003). A single specimen was captured by Duke while electrofishing in the backwater areas in 2006. Quillback were also captured in 2006 by using gillnetting techniques in the Ninety-Nine Islands Reservoir (Duke 2009c, Barwick et al. 2006) and electrofishing downstream of Cherokee Falls (Barwick et al. 2006). The Seagreen Darter also has high conservation status (SCDNR 2005). It was found by the SCDNR in 2003 and 2004 in Thicketty Creek, a tributary to the Broad River that would be crossed by new transmission-line corridors associated with the Lee Nuclear Station (Bettinger et al. 2006). The Greenhead Shiner has a high conservation status and was captured in 2010 by the SCDNR in London Creek (SCDNR 2011b). The Piedmont Darter has high conservation status as well (SCDNR 2005). This darter species was captured by the SCDNR in 2000, 2001, and 2002 at 10 sites on the Broad River, including sites in the vicinity of the proposed new nuclear station (Bettinger et al. 2003). The Piedmont Darter also was captured by Duke in 2006, but only below Ninety-Nine Islands Dam (Duke 2009c).

Recreational Species

The Broad River, and therefore Ninety-Nine Islands Reservoir, support recreational fisheries for various species of sunfish, crappie, bass (centrarchids); catfish (ictalurids); and suckers (catostomids). Except for catfish, these species have life histories that indicate known use of shallow-water habitats for reproduction and nesting activities. The use of turbidity curtains and cofferdams can minimize impacts on these shallow-water habitats. However, the timing of installation activities may have more detrimental effects on aquatic resources if performed during critical spawning seasons in mid-to-late spring. Duke has stated that, to the extent practicable, they will schedule the installation and removal of cofferdams to avoid spawning seasons, and minimize the extent and magnitude of impacts on aquatic habitats (Duke 2008f).

Aquatic Monitoring during Site Preparation

Duke has not specified any formal site-preparation-related monitoring (Duke 2009c). It bases this decision on the fact that dredging and other site-preparation activities would be permitted by the USACE and other Federal and State regulators, who are likely to specify pre-disturbance-related monitoring as part of the permitting process. Duke has committed to implementing BMPs during site-preparation and development activities and will have an SWPPP and a SPCCP approved in association with its required SCDHEC NPDES stormwater permit.

Duke states it would "… comply with all applicable laws, regulations (including regulatory requirements of the SCDHEC, the South Carolina State Historic Preservation Office, etc.), permit requirements, and good engineering and building practices during installation of the transmission-line corridors" (Duke 2009c).

4.3.2.4 Summary of Impacts on Aquatic Ecosystems

The review team has reviewed the proposed site construction and preconstruction activities associated with Lee Nuclear Station Units 1 and 2 and the potential impacts on aquatic biota in the Broad River and Ninety-Nine Islands Reservoir, onsite ponds and streams, London Creek and its unnamed tributaries, and other offsite waterbodies associated with transmission-line corridors.

The proposed preconstruction and construction activities at the Lee Nuclear Station site, Make-Up Pond C area, and railroad-spur corridor would affect 29.63 ac of open water and 67,285 linear ft of streams (Table 9-19) (Duke 2012n). In addition, there are planned 20-ft drawdowns of Make-Up Ponds A and B, for approximately 32 and 34 months, respectively, to relieve pressure on the cofferdams required for the installation of the intake (Make-Up Pond A), intake/refill (Make-Up Pond B), and discharge (both Make-Up Ponds A and B) structures. These drawdowns would temporarily reduce open-water habitat within Make-Up Pond A by approximately 28 ac and within Make-Up Pond B by approximately 64 ac (Duke 2012o). Impacts on aquatic resources would be mostly controlled by the use of BMPs associated with the management of water quality. The SCDNR has concurred with the proposed work plan for drawdown of Make-Up Ponds A and B (SCDNR 2012m). By following BMPs associated with water quality (developed by Duke and accepted or modified by State and Federal agencies through the permitting process), the impacts of installation of water intake and discharge structures at the Lee Nuclear Station site on aquatic biota would be short term but noticeable. Similarly, the use of BMPs during replacement of a culvert under the existing railroad spur would minimize negative impacts on aquatic resources. There are no impacts on streams or open waters associated with the installation of the offsite transmission lines (Duke 2012n).

Prior to inundation of London Creek and its tributaries, impacts on streams and open waters would occur due to excavation of borrow material, placement of fill and spoil material, building of new haul roads, and temporary flooding associated with the use of cofferdams (Duke 2011h). Impounding London Creek and building the Make-Up Pond C supplemental water reservoir would replace a lotic system with a lentic system, resulting in a clearly noticeable and permanent change in aquatic resources in London Creek and its tributaries. Some of the upper reaches of tributaries to London Creek not impounded would retain their lotic characteristics, but they would become isolated from other lotic habitat. Most of the riparian habitat of the main-stem London Creek would be lost, with the possible exception of a segment approximately 0.6 mi in length between the Make-Up Pond C dam and the confluence with the Broad River. Some aquatic functions would remain, in particular, flood attenuation and water quality, and some aquatic species (e.g., sunfish) could adapt to the lentic environment. Although the aquatic resources found in London Creek are not unique to the region, the habitat type is becoming increasingly rare as development in the region increases. In time, the lacustrine aquatic habitat of the new reservoir would be valuable for other reasons, but it does not mitigate the loss of riparian habitat within a Piedmont watershed.

Based on information provided by Duke and the review team's independent evaluation, the review team concludes that the impacts on aquatic resources from the combined construction and preconstruction activities for the proposed Lee Nuclear Station Units 1 and 2 would be MODERATE, primarily because of the loss of a major portion of London Creek and its aquatic biota. In consultation with the USACE, Duke is designing compensatory mitigation appropriate to offset impacts on wetlands, streams, and other waters of the United States within the jurisdiction of the CWA.

All of the impacts on aquatic resources would be from preconstruction activities, such as clearing and grading forested land; installing drainage and erosion-control systems; building temporary roads and laydown yards; eliminating streams and ponds; adding impervious surfaces to the watersheds; and installing cofferdams, dewatering, and excavating. Therefore, the NRC staff concludes that the impacts on aquatic biota and habitats from NRC-authorized construction activities would be SMALL, and no further mitigation specific to NRC-authorized construction would be warranted.

4.4 Socioeconomic Impacts

Socioeconomic impacts occur in the region surrounding the proposed site. This discussion emphasizes socioeconomic impacts from building activities on the two-county area of Cherokee and York Counties, although it considers the entire 50-mi region surrounding the Lee Nuclear Station site.[a] The scope of the review is guided by the magnitude and nature of the expected impacts of the proposed project activities and by the site-specific community characteristics that can be expected to be affected by these activities.

(a) For the purposes of this EIS, the relevant region is limited to the area necessary to include social and economic base data for (1) the county in which the proposed plant would be located and (2) the specific portions of surrounding counties and urbanized areas (generally, up to 50 mi from the Lee Nuclear Station site) from which the construction and/or operations workforce would be principally drawn, or that would receive stresses to community services by a change in the residence of building and/or operations workers.

Large projects, such as the proposed Lee Nuclear Station, can affect individual communities, the surrounding region, and minority and low-income populations. This evaluation assesses the impacts of project-related activities and of the onsite workforce during the Lee Nuclear Station building activities on the communities and governmental jurisdictions within 50 mi of the site. Unless otherwise specified, the primary sources of information for this section are the ER (Duke 2009c) and the Make-Up Pond C supplement to the ER (Duke 2009b). The review team's conclusions are based upon independent verification of the information in the ER; visits to the site, vicinity, and region; and consultation with local officials.

The Lee Nuclear Station site first saw activity in the late 1970s and early 1980s for the unfinished Cherokee Nuclear Station. The review team found little data on the socioeconomic impacts for the first round of project activities. Therefore, this EIS will not make a comparison of building activities between the previous and the proposed projects.

Parts of the surrounding region have experienced significant growth over recent decades; as a result, the area has adjusted to providing services needed by in-migrating populations. The region has not been insulated from recent negative economic impacts from the current economic downturn. Although the review team considered the entire region within a 50-mi radius of the Lee Nuclear Station site when assessing socioeconomic impacts, the primary region of interest for physical impacts is the area within a 10-mi radius. The region of interest with regard to social and economic impacts encompasses the entire 50-mi radius but includes primarily Cherokee and York Counties in South Carolina. Based on commuter patterns, discussions with local community leaders, and the distribution of residential communities in the area, the NRC review team found *de minimis* impacts on other counties within the 50-mi radius in South Carolina and North Carolina. Although the review team recognizes some construction workers may live outside Cherokee and York Counties, their impacts would be dispersed over a wider, more populated area and therefore have been excluded from much of the socioeconomic analysis pertaining to building and operation of proposed Lee Nuclear Station Units 1 and 2.

The following sections describe the physical impacts on the site (Section 4.4.1), demographic impacts (Section 4.4.2), economic impacts on the community (Section 4.4.3), and the impacts on infrastructure and community services (Section 4.4.4). The impacts on minorities and low-income populations are covered in Section 4.5.

4.4.1 Physical Impacts

Building activities can cause temporary and localized physical impacts such as noise, odors, vehicle exhaust, and dust. Vibration and shock impacts are not expected because of the strict control of blasting and other shock-producing activities. This section addresses potential building impacts that may affect people, buildings, and roads.

4.4.1.1 Workers and the Local Public

The Lee Nuclear Station site and Make-Up Pond C site are located in an unincorporated area of Cherokee County without zoning laws and are bounded by the Broad River to the north and east and McKowns Mountain Road and private properties to the south and west. Two major industrial facilities are located within the vicinity of the Lee Nuclear Station site. The Broad River Energy Center is a natural-gas-fired, peaking electric generation plant located approximately 4.7 mi northwest of the site. Herbies Famous Fireworks is a 49 CFR 173.52, Division 1.4G (Class C) consumer fireworks wholesale distribution company located 2.7 mi north of the site. The recreational area closest to the plant is Kings Mountain State Park, which is located 7.8 mi northeast of the site and adjoined to Kings Mountain Military Park. These industrial and recreational areas could be affected by building proposed Lee Nuclear Station Units 1 and 2 because of increased traffic, noise, and dust from building activities (Duke 2009c).

Most building activities would occur within the Lee Nuclear Station site boundary, with the exception of building the railroad spur, expansion of the culvert along the railroad spur at London Creek crossing, transmission-line corridors, a new pipeline, rerouting of existing transmission lines, rerouting of SC 329 and adding a new bridge, and Make-Up Pond C (Duke 2009c). Work would be performed in compliance with Occupational Safety and Health Administration (OSHA) standards (Duke 2009c).

Noise

Noise is an environmental concern because it can cause adverse health effects, annoyance, and disruption of social interactions. Building activities are inherently noisy. Noise would result from clearing, earthmoving, foundation preparation, pile driving (if needed), concrete mixing and pouring, steel erection, and various stages of facility equipment fabrication, assembly, and installation, during which a substantial number of diesel- and gasoline-powered vehicles and other equipment would be used. Noise from the Lee Nuclear Station site and Make-Up Pond C site also would be generated from internal combustion engines, impact equipment, vehicles and other machinery and equipment. The noise impacts that project-related activities have on an area depends on sound intensity, frequency, duration, onsite location, the number of noise sources, time of day, weather conditions, wind direction, and time of year (Duke 2009c) as well as the locations of the receptors themselves. Duke projected noise levels from various equipment and found most building activities would have noise levels below background levels (50 to 55 dBA) and below the 60 to 65 dBA range of acceptable day-night, 24-hour average (Ldn) noise levels set by the U.S. Department of Housing and Urban Development. Building activities above an Ldn range of 60 to 65 dBA would be temporary. Visitors to the historic cemeteries and recreational areas on the Broad River may be affected by project noise. Terrain alterations during the building phase could change noise levels in these areas (Duke 2009c).

Other sources of noise are from transmission-line development and traffic-related noise. Transmission-line building activity noise is similar to building activities onsite except they have a shorter duration at each location along the corridor. Lee Nuclear Station workforce traffic and heavy equipment deliveries would increase noise along McKowns Mountain Road. Workforce-related traffic would be heaviest during shift change. At a speed of 55 mph, traffic-related noise at shift change would be approximately 75 dBA (Duke 2009c). Traffic-related noise impacts can be reduced by lowering the speed limit, shuttling workers, staggering shifts, and using the railroad spur for large deliveries.

Noise generated from building Make-Up Pond C would temporarily increase noise levels at nearby residences. There are residences within the acceptable range for noise levels of 65 dBA or greater. However, noise impacts to some of the nearby residences would be in part reduced due to intervening structures and terrain features (Duke 2009c).

All project activities would also be subject to regulations from the Noise Control Act of 1972, Federal regulations for noise from construction equipment (40 CFR Part 204), OSHA regulations (29 CFR 1910.95), and State regulations. The review team expects that noise impacts on recreation and the general public would be minimal with the use of the mitigation actions included in the above regulations (as applicable) and because noise attenuates rapidly with distance, intervening vegetation, and variations in topography. Consequently, the review team concludes that noise impacts on surrounding communities from these project building activities would be negligible.

Air Quality

Cherokee County is in the Greenville-Spartanburg Intrastate Air Quality Control Region (South Carolina). Cherokee County is classified as in attainment for all criteria pollutants, that is particulate matter, ozone, lead, oxides of nitrogen, carbon monoxide, and sulfur oxides. The baseline air-quality characteristics are described in Section 2.9.2 of this EIS. The nearest nonattainment area to the proposed site is in the Charlotte-Gastonia-Rock Hill metropolitan statistical area, which includes a portion of York County, which is designated a marginal nonattainment area under the 2008 primary and secondary eight-hour ozone standard. Cherokee County is designated as in attainment for National Ambient Air Quality Standards (NAAQS) criteria pollutants (40 CFR 81.341). As a result, a conformity analysis on direct and indirect emissions is not required (40 CFR 93). If building activities include the burning of debris, refuse, or residual building materials, a permit would need to be secured from the State of South Carolina, and Duke would need to contact local county officials to determine which local ordinances, if any, must be followed.

Temporary and minor effects on local ambient air quality could occur as a result of normal project activities at the Lee Nuclear Station site and the development of Make-Up Pond C. Fugitive dust and fine particulate matter smaller than 10 micrometers (PM_{10}) in size would be generated during earthmoving activities, material-handling activities, by wind erosion, and other activities at borrow areas, laydown areas, access roads, and transmission-line and pipeline corridors. Vehicles used to haul debris, equipment, and supplies as well as equipment used for cutting, clearing, and mulching at the Make-Up Pond C area would create pollutants. Mitigation measures (e.g., paving or stabilizing disturbed areas, water suppression, reduced material handling) would minimize such emissions. Odors could result from exhaust emissions; however, odors dissipate onsite and would have no discernible impact on the local air quality. All equipment would be serviced regularly, and all industrial activities would be conducted in accordance with Federal, State, and local emission requirements.

Specific mitigation measures to control fugitive dust would be identified in a dust-control plan, or a similar document, prepared prior to project activities in accordance with all applicable State and Federal permits and regulations. These mitigation measures could include, but are not limited to, the following:

- stabilizing access roads and spoils piles
- limiting speeds on unpaved access roads
- periodically watering unpaved access roads
- housekeeping (e.g., removing dirt spilled onto paved roads)
- covering haul trucks when loaded or unloaded
- minimizing material handling (e.g., drop heights, double handling)
- suspending grading and excavation activities during high winds and during periods of extreme air pollution
- phase grading to minimize the area of disturbed soils
- revegetating road medians and slopes
- phasing project activities to minimize daily emissions
- performing proper maintenance of heavy vehicles to maximize efficiency and minimize emissions.

Therefore, although emissions from project activities and equipment operation are unavoidable, the review team concludes that Duke's mitigation efforts would limit impacts on air quality during project activities and the impacts would not warrant mitigation beyond the possible measures discussed for inclusion in the mitigation plans.

4.4.1.2 Buildings

Several structures present at the site when Duke published the ER in 2007 have since been removed, including partially constructed power unit buildings and several large and small buildings used in support of construction activities at the unfinished Cherokee Nuclear Station. Several other buildings, including a guardhouse, still exist onsite. All structures within the Make-Up Pond C footprint would be removed and properly disposed of. According to Duke, 86 housing units within the Make-Up Pond C site have been demolished (Duke 2012b). Other than Pond C structures, no other offsite buildings were affected. Except for the existing structures on the Lee Nuclear Station site, no other industrial, commercial, or recreational structures would be directly affected by the development of the new facility.

4.4.1.3 Transportation

Public roads and railways would be used to transport building materials and equipment. Building proposed Lee Nuclear Station Units 1 and 2 would have a minimal impact on interstate and state highways in the region. However, local roads such as McKowns Mountain Road would be heavily affected. Duke would build several new access roads within the site boundaries to provide access to the power block, cooling towers, and other areas. Several existing roads within the site would be widened to 24 ft (Duke 2008e). All workers would access the site via McKowns Mountain Road and truck deliveries would use a new access road to the east of the current site entrance off McKowns Mountain Road. Duke plans to upgrade a railroad spur that links the site with the main line with new ballast and track to support equipment delivery. This activity is expected to take place primarily outside the site boundary but within the existing ROW (Duke 2009c). A heavy-haul road from the end of the railroad spur to the project areas is planned. Building of this road is contained within the existing site boundary (Duke 2009c). The railroad culvert at London Creek would be replaced with a box culvert, requiring the installation of sheet-pile cofferdams on both sides of the existing railroad line with a system to pump water (Duke 2009b).

The inundation of Make-Up Pond C would require the realignment of SC 329 slightly east of its current location and the addition of a bridge over London Creek. Approximately 1.3 mi of SC 329 would be affected, beginning approximately 200 ft north of McKowns Mountain Road and continuing approximately 1000 ft north of the intersection with Smith Road. Smith Road would be extended slightly to connect with the realigned SC 329. However, while the new bridge is built and road realigned the existing segment of SC 329 would remain open. The current segment of SC 329 would be removed once the new segment is open to the public and before Make-Up Pond C is inundated.

The review team concludes that the physical impacts of transportation would be limited and would not warrant mitigation.

4.4.1.4 Aesthetics

The Lee Nuclear Station site is bounded by woods and water features. Project-related activities would be visible to those using the Broad River and Ninety-Nine Islands Reservoir. Proposed Lee Nuclear Station Units 1 and 2 would use short and compact mechanical draft cooling towers expected to have minimal effects on local viewsheds. The tallest structures onsite during the building phase are expected to be the meteorology tower and cranes. Both consist predominantly of iron framework, which carries a lower visual weight than the solid concrete reactor domes. The most visible structures onsite would be the shield buildings at 229.4 ft above ground level (Duke 2012f). The reactor domes would be most visible from local parks in Gaffney, South Carolina; Kings Mountain State Park; Croft State Park; and Crowders Mountain State Park (Duke 2012f). Visual effects are inversely proportional to distance. Because most of the parks in the region are located more than 25 mi from the site, the most visible components at the Lee Nuclear Station would occupy less than one-fifth of a degree of vision (about the same perspective as a 1-ft-tall object viewed from a distance of 100 yd). Developing Make-Up Pond C would involve clearing forested land, which could negatively affect travelers on SC 329 and residents in the vicinity of the Make-Up Pond C site. The review team expects the aesthetic impacts would be noticeable but not destabilizing.

4.4.1.5 Summary of Physical Impacts

The review team evaluated information provided by Duke, visited the site and its environs, and performed an independent review of the potential physical impacts of building activities on the local area and region of the proposed Lee Nuclear Station. The review team concludes that physical impacts of construction and preconstruction would be SMALL, with one exception: a MODERATE physical impact on aesthetics. However, mitigation beyond the strategies outlined by Duke in its ER would not be warranted because physical impacts on aesthetics would be temporary. Because most of the aesthetic impacts are associated with developing Make-Up Pond C, the NRC-authorized construction activities represent only a portion of the analyzed activities. Therefore, the NRC staff concludes that the physical impacts of NRC-authorized construction activities would be SMALL. The NRC staff also concludes that no mitigation measures would be warranted for the construction activities.

4.4.2 Demography

Socioeconomic impacts are the result of project expenditures, employment, and the in-migration of workers and their families that changes population and employment baselines by drawing new residents into an area and/or by preventing the departure of existing residents from an area. Growth in population and employment increase spending in the area, leading to increased demand for housing, education, and other facilities and services. The assessment of demographic impacts related to building proposed Lee Nuclear Station Units 1 and 2 are based on the consequences of the employment and in-migration of new workers.

All workers onsite during the project are included in the assessment of impacts of the NRC-authorized activities, whether they are "construction" or "operations" workers. Building of proposed Lee Nuclear Station Units 1 and 2 would be staggered by a year, for a total site project period of approximately 93 months. This schedule would allow for sustained peak employment as employees finishing Unit 1 would be transferred to Unit 2. Duke would gradually reduce employment as both units were completed. Chapter 5 includes a discussion of all operations workers, including those discussed here in the context of the building phase.

Based on information provided by Duke, the peak workforce related to building activities at proposed Lee Nuclear Station Units 1 and 2 occurs in month 27, with an estimated 4613 workers. The 4613 peak workforce includes 4510 workers related to Units 1 and 2 and 103 workers related to Make-Up Pond C. The review team estimates that the 4510 workers related to Units 1 and 2 would consist of approximately 4398 construction workers and 112 operations workers onsite for training purposes during the peak project period.[a] Table 4-4 shows the number of workers during peak employment.

Table 4-4. Number and Type of Worker During Peak Employment

Units 1 and 2 related workers	4510
Construction workers	4398
Operations workers	112
Make-Up Pond C construction workers	103
Total construction workers	4501
Total operations workers	112
Total workforce	4613

As discussed in Section 2.5 of this EIS, the region extends 50 mi from the site boundary. Although the review team considered the entire region within a 50-mi radius of the Lee Nuclear Station site when assessing socioeconomic impacts of building activities, the primary focus is on Cherokee and York Counties, both of which are in South Carolina. Based on the size of the resident workforce within commuting distance of the Lee Nuclear Station site, commuter patterns, discussions with local community leaders, and the distribution of residential communities in the area, the review team expects minimal demographic impacts on other counties within the region.

(a) Duke estimated the peak workforce at proposed Lee Nuclear Station Units 1 and 2 (excluding Make-Up Pond C) would occur in month 32 (4512 workers). However, the overall project peak workforce including Make-Up Pond C activities would occur in month 27, with 4613 workers. Duke further estimated that the 4512 workers in month 32 included 4398 construction workers and 114 operations workers, while the month 27 estimate includes 4510 Units 1 and 2-related workers and 103 Make-Up Pond C-related workers. The review team assumes the difference between the 4510 and 4512 estimates to be two operations workers.

Construction Impacts at the Lee Nuclear Station Site

Based on experience with other large construction projects in the region, Duke, together with Shaw Construction, assumed that 30 percent (1350 workers) of the 4501 Lee Nuclear Station Units 1 and 2 and Make-Up Pond C construction workforce would come from within the existing 50-mi region, 70 percent (3151 workers) would move into the region, and 25 percent (788 workers) of those moving into the region would bring a family (Duke 2008b). Based on staffing at its other nuclear stations, Duke estimated 36 percent (40 workers) of operations workers would in-migrate and each one of them would bring a family (Duke 2009c). Using the average household size in the United States of 2.6 people, 788 construction workers and 40 operations workers would bring an additional 1325 family members, for a total of 2153 people. Together with the remaining in-migrating workers (2363 workers), the total in-migrating population would be 4516 when families are considered.

As indicated in Section 2.5.1.1, the populations of Cherokee and York Counties are 55,342 and 226,073, respectively. The South Carolina Budget and Control Board (SCBCB) baseline population estimates for Cherokee and York Counties are expected to increase steadily between 2010 and 2035 (see Table 2-16). The SCBCB projected population levels in 2015 for Cherokee and York Counties are 58,780 and 235,930, respectively. Although not all in-migrating project workers would reside in York and Cherokee Counties, the review team anticipates that the majority of in-migrating workers would move into these two counties because of their relative proximity to the site. Any remaining workers choosing to reside in the rest of the 50-mi region would be easily absorbed by the larger populations of those counties. Therefore, as an upper bound estimate for the impacts of the in-migrating workers, the review team made the simplifying assumption that all in-migrating workers (building and operations) would move into either Cherokee or York County. For this analysis, the review team assumed that 50 percent would settle in Cherokee County and 50 percent in York County. The influx of project workers and families would represent less than a 4 percent increase in population in Cherokee County and less than 1 percent increase in population in York County based on 2015 SCBCB population projections. Given the large populations of surrounding counties, the review team expects any impacts to all counties within 50 mi of the Lee Nuclear Station site to be minimal and temporary. Therefore, the review team anticipates any population impacts of project activities in Cherokee and York Counties and the remainder of the 50-mi region would not be noticeable and demographic impacts would likely be minor and temporary.

Based on the information provided by Duke and the review team's independent evaluation, the review team concludes that population impacts of construction and preconstruction would be SMALL and no mitigation would be warranted. NRC-authorized construction activities would represent a large fraction of the analyzed activities; however, the NRC staff concludes that the population impacts of NRC-authorized construction activities would also be SMALL. The NRC staff also concludes that no mitigation measures would be warranted.

4.4.3 Economic Impacts on the Community

This section evaluates the economic impacts of building proposed Lee Nuclear Station Units 1 and 2 on the 50-mi region, focusing primarily on the two-county economic impact area of Cherokee and York Counties. The evaluation assesses the impacts of building activities and demands placed by the larger workforce on the surrounding region.

4.4.3.1 Economy

The impacts of building activities on the local and regional economy depend on the region's current and projected economy and population. Characteristics of the economy and workforce in the region are described in Section 2.5.2 of this EIS. At its peak, the project workforce is estimated to require approximately 4613 workers. Building activities would be staggered by one year between Units 1 and 2, which helps avoid dramatic swings in employment. The Lee Nuclear Station COL, if approved, would give Duke up to 20 years to begin building activities.

For this analysis, the review team based its analysis upon the latest information provided by Duke and assumes building activities would last approximately 93 months with a commercial operation date of 2024 for Unit 1 and 2026 for Unit 2 (Duke 2013b).

The in-migration of approximately 3191 workers (i.e., 3151 construction workers and 40 operations workers), some bringing their families, would create new indirect jobs in the area. Through a process called the "employment multiplier effect," a new (direct) job in a given area stimulates spending for goods and services that results in the economic need for a fraction of a new (indirect) job, typically in service-related industries. The cumulative effect of a new direct job workforce being added to an economy induces the creation of a number of new indirect jobs. The ratio of new jobs (direct plus indirect) to the number of new direct jobs is called the "employment multiplier."

In addition, spending by construction workers and contractors during building stimulates additional spending through a second multiplier effect, where each dollar spent on goods and services by one person becomes income to another, who saves some money but re-spends the rest. In turn, this re-spending becomes income to someone else, who in turn saves a portion and re-spends the rest, and so on. The percentage by which the sum of all spending exceeds the initial dollar spent is called the "earnings multiplier." The U.S. Department of Commerce Bureau of Economic Analysis (BEA), Economics and Statistics Division, provides regional multipliers for industry jobs and earnings and a custom set of multipliers was provided by BEA for the two-county economic impact area.

The Regional Input-Output Modeling System (RIMS II) employment multiplier for construction jobs in the economic impact area is 1.617 (BEA 2011), meaning that for each direct job created a total of 1.617 jobs (including the direct job) would be supported in the two-county economic impact area. The employment multiplier for operations jobs during the building phase (primarily operations workers training to begin operations once the two units are completed) is 2.165. In the case of the Lee Nuclear Station, the total 4613 workers at the project peak would support a total of 2908 indirect jobs in the two-county economic impact area. The 3191 in-migrating direct jobs at the project peak would generate 1991 indirect jobs in the two-county economic impact area. Only the in-migrating direct jobs are counted so that a net impact can be estimated. Indirect and induced jobs are assumed to be allocated to area residents who were either unemployed or leaving other jobs to take Lee Nuclear Station-related employment.

The employment of a large workforce over approximately 7.75 years would have positive economic impacts on the surrounding region. Based on data from the Bureau of Labor Statistics (BLS 2009), the average annual salary for construction workers in South Carolina is approximately $34,500. Assuming a benefits package would double that annual amount to $69,000, the review team estimates that annual earnings for construction workers at peak project employment would be approximately $310.6 million. These earnings inject millions of dollars into the regional economy, thus reducing unemployment and creating business opportunities for housing and service-related industries. The $310.6 million represents the direct income effect of the project to the economic impact area. Applying the income multiplier of 1.588 from RIMS II (BEA 2011), the earnings, including benefits, paid to the project workforce would result in generation of an additional $182.6 million annually in the economic impact area during peak employment years, for a total income effect of $493.2 million. As discussed with employment, the real impact would net out to about half ($246.6 million) because only half of the direct and indirect employment supported by the project would count as an impact on the economic impact area. The largest economic impacts would likely be felt in Cherokee County. Although only a relatively small total population increase would be expected in York County relative to its base population and economy, this increase could produce a noticeable upsurge in the local economy during this period, particularly for the western part of the county. The impacts from workers' salaries become more diffuse as a result of interacting with the larger economic base of other counties, such as Mecklenburg County. A large quantity of materials are expected to be purchased to assist with building proposed Lee Nuclear Station Units 1 and 2; however, the amount of materials that would be bought locally is unknown. Any annual expenditures by Duke within the region on materials would benefit the local economy.

The review team concludes, based on its independent review of the likely economic effects of the proposed action, that beneficial economic impacts of the proposed action would be experienced throughout the two-county economic impact area. Depending on actual worker relocation patterns the temporary positive economic and employment impacts in Cherokee County would be noticeable and beneficial and minimal in York County. Economic impacts elsewhere in the 50-mi region would be minimal but beneficial.

4.4.3.2 Taxes

The tax structure of the region is discussed in Section 2.5.2.2 of this EIS. Several tax revenue categories would be affected by building proposed Lee Nuclear Station Units 1 and 2. These include income taxes on wages, salaries, sales and use taxes on corporate and employee purchases, and personal property taxes associated with employees.

South Carolina has personal and corporate income taxes. Project workers would pay taxes to the State of South Carolina on their wages and salaries if their residences are in South Carolina, or if they are nonresidents working in South Carolina and filing a Federal return that would include income from personal services rendered in South Carolina (SCDOR 2008). The impact of these taxes would be small for all counties within the 50-mi region of the Lee Nuclear Station site because the taxes are paid to the State. The number of workers that would in-migrate from out of state is unknown; however, given South Carolina's large tax base, the newly created jobs would have a minimal impact on State revenues. Though millions of dollars in income taxes would be generated from employee earnings, a majority of the revenue would have been generated by workers already working in South Carolina at some place other than the Lee Nuclear Station. Therefore, the review team considers the wages of South Carolina residents who would work at the proposed site to be a net transfer with no analytical worth.

The area around the proposed site would experience an increase in sales and use taxes generated by retail expenditures (e.g., restaurants, hotels, merchant sales, food) by the workforce. The region also would experience an increase in the sales and use taxes collected from materials and supplies purchased by Duke for the project. Duke's regional annual expenditures for materials are not known (Duke 2009c). Given its proximity to the proposed site and relatively small population and economic base, Cherokee County probably would receive the largest benefit from sales tax revenues. York County may also experience an increase in sales and use revenues. However, it would likely be a much smaller percentage because of the larger sales and use tax base in the county.

In addition, the State would experience an increase in the sales and use taxes collected from building materials and supplies purchased for the project and workers spending their incomes on goods and services in South Carolina. These revenues would likely be generally proportional to the wages paid to workers at proposed Lee Nuclear Station Units 1 and 2, increasing through the peak of building activities and then declining until stabilizing after completion of these activities.

Cherokee County has an agreement with Duke to make payments in-lieu-of taxes, provided the overall investment in the project is at least $2.5 billion. However, this would not go into effect until operations begin. As a part of this tax agreement, all building activities are exempted. No property taxes would be collected in regard to the Lee Nuclear Station during its development. Therefore, the value of the property does not change during building activities, and Duke would continue to pay taxes on the property itself for the duration of building activities. A second source of revenue from property taxes would be from housing purchased by the workforce. In-migrating workers may construct new housing, which would add to the counties' taxable property base, or these workers could purchase existing houses, which could drive housing demand and housing prices up, thus slightly increasing values (and property taxes levied). The increased housing demand would have little effect on tax revenues in the more heavily populated jurisdictions.

Based on this assessment, the review team concludes that the potential impact of taxes within the region because of the project activities would be minimal and beneficial. The impact within Cherokee County, where the units would be located, also would be minimal and beneficial because the review team expects most tax impacts to occur during the operations phase.

4.4.3.3 Summary of Economic Impacts on the Community

Based on the information provided by Duke, interviews with local public officials, and the review team's own independent review of data of the regional economy and taxes, the review team concludes that the fiscal impacts of construction and preconstruction activities on the regional and state economy and tax base from building proposed Lee Nuclear Station Units 1 and 2 would be SMALL and beneficial. NRC-authorized construction activities represent a large fraction of the analyzed activities; however, the NRC staff concludes that the fiscal impacts of construction activities would also be SMALL and beneficial.

4.4.4 Infrastructure and Community Services Impacts

Infrastructure and community services include transportation, recreation, housing, public services, and education, as described in the following sections.

4.4.4.1 Traffic

This section deals with the infrastructure impacts of the traffic generated by building activities. Air-quality impacts of transportation are addressed in Section 4.4.1 and the human health impacts are addressed in Section 4.8.3.

The impacts of the proposed project on transportation and traffic would be most obvious on the rural roads of Cherokee County, specifically McKowns Mountain Road, a two-lane county road that provides the only access to the Lee Nuclear Station site. Building-related impacts on traffic are determined by six elements:

1. number and timing of non-Lee Nuclear Station site traffic
2. number and timing of project worker vehicles on the roads per shift
3. number of shift changes for the workforce per day

4. number and timing of truck deliveries to the site per day
5. projected population growth rate in Cherokee County
6. capacity and usage of the roads.

McKowns Mountain Road is a two-lane road that provides the only access to the Lee Nuclear Station site. Approximately 74 residences exist along McKowns Mountain Road and it provides egress to SC 105 and SC 329 for approximately 250 residences, 3 churches, 1 business, and 1 fire station (Duke 2008l).

Duke commissioned a traffic study in 2007 to study the impacts of building proposed Lee Nuclear Station Units 1 and 2. A continuation of the 2007 study was completed in 2011 (Duke 2012k). The study analyzed and provided improvements for the following intersections:

- Shelby Highway and Interstate 85 (I-85) northbound and southbound ramps
- SC 329 and Shelby Highway
- SC 329 and US-29
- SC 329
- SC 329 and McKowns Mountain Road
- McKowns Mountain Road and Darwin Road/Rolling Mill Road
- McKowns Mountain Road and Patrick Road
- McKowns Mountain Road and Sardis Road
- McKowns Mountain Road and Site Drive.

The most recent traffic study was based on a maximum workforce size of 5000 workers, with the workforce split into two shifts, 70 percent on the dayshift and 30 percent on the nightshift and a 1.4-person vehicle occupancy. The original study concluded that with a single dayshift or with staggered dayshifts without mitigation, major intersections near the Lee Nuclear Station site would operate at a level of service (LOS) F, which would fail to meet SCDOT minimum acceptable LOS of D or above (Duke 2008l). The more recent transportation study outlines several improvements, confirmed by the SCDOT, to increase capacity on the roads between I-85 and the site. These recommendations include installing traffic signals at the SC 329 and McKowns Mountain Road, Darwin Road/Rolling Mill Road, Patrick Road, and Site Drive, providing additional storage for intersections and additional turning lanes for some intersections. Large deliveries would use the railroad spur and a second site entrance, further east off McKowns Mountain Road, would be built for heavy deliveries. Additional mitigation measures, if needed, could include encouraging carpooling and scheduling deliveries to avoid shift change or high commute times (Duke 2012k).

Construction Impacts at the Lee Nuclear Station Site

The SCDOT estimates the capacity on a two-lane highway at 1700 vehicles per hour for each direction and 3200 vehicles per hour for both directions. The 2006 Average Annual Daily Traffic (AADT) report indicates approximately 950 vehicles per day travel McKowns Mountain Road between SC 105 and the end of the road near the Broad River (Duke 2009c). Using assumptions for the most recent traffic study discussed above, the maximum traffic on McKowns Mountain Road would be 1307 vehicles.

Based on information provided by Duke and the review team's own independent review, including visits to the site and affected communities, the review team concludes that during peak site employment, traffic from Lee Nuclear Station site activities would have locally noticeable impacts in the immediate vicinity of the site and for residents on McKowns Mountain Road and minimal impacts on other roadways in the region. These impacts would be largely temporary and of short duration, based on the size of the workforce during any one period, and would have lesser impacts before and after peak employment. As mentioned in the previous paragraph, Duke has identified several planned mitigation measures to minimize the building-related impacts on traffic. Therefore, the review team concludes that traffic impacts in the vicinity of the Lee Nuclear Station site would be noticeable, but not destabilizing. The rest of the region would experience little to no traffic-related impacts.

Norfolk Southern Railroad Company owns and operates the primary freight rail that passes 5.5 mi from the Lee Nuclear Station site on its route from Atlanta, Georgia, to Charlotte, North Carolina. This line averages 22 trains per day. An abandoned railroad spur connects the main line to the Lee Nuclear Station site. Duke plans to reactivate this spur before building and operations begin. Reactivating this spur would require upgrading ballast and track mostly within the existing corridor (Section 2.2.3.2). The Lee Nuclear Station site cannot be accessed by barge because of downstream dams (Duke 2009c). Building activities would not affect commercial rail traffic and given that reactivating the railroad spur would occur mainly in the existing corridor, the review team expects that the impacts from rail and waterway activities related to the Lee Nuclear Station site would be minimal.

4.4.4.2 Recreation

Impacts on recreation may result from increased demand/use of existing and planned resources and from aesthetic/visual and noise impacts, which were discussed earlier in Section 4.4.1. The increase in demand on existing or planned resources would result from usage by in-migrating workers and their families in the region. As discussed in Section 2.5.2.4, a variety of recreation areas exist in the region, including national, state, and local parks and public and private facilities that support outdoor activities (e.g., recreational boating and fishing on the Broad River and Ninety-Nine Islands Reservoir, camping, and hunting). The review team expects that recreationists would not be precluded from hunting, fishing, or other outdoor recreation activities in the vicinity of the site as a result of building proposed Lee Nuclear Station Units 1 and 2.

The site is bounded by woods and water features. Therefore, recreationalists using the Broad River and Ninety-Nine Islands Reservoir directly adjacent to the Lee Nuclear Station site would have visual access to building activities. Those farther away on the Broad River and those using other recreational areas, such as local parks in Gaffney, South Carolina, and Kings Mountain State Park, may be able to view the meteorological tower and cranes. Recreational activities on the Broad River, primarily along the northern property line, may be affected by site-development noise. Those seeking access to the Broad River or Ninety-Nine Islands Reservoir via McKowns Mountain Road may be affected by the project workforce traffic to the site. In the context of recreational experience, aesthetic, and noise impacts of building activities would be localized near the site and isolated from most recreation areas except for the Broad River and Ninety-Nine Islands Reservoir. Therefore, the review team anticipates that the impacts on local recreation from building activities would be minimal.

There are no current recreational activities occurring within the Make-Up Pond C area (Duke 2010r). Once the pond is inundated, it would become private and no recreational activities would be allowed (Duke 2009b). The review team expects the building and inundation of Make-Up Pond C would have a minimal impact on recreation.

4.4.4.3 Housing

Regional housing characteristics and availability are described in Section 2.5.2.5 and Table 2-23. The assumptions behind the review team's estimated in-migration of workers were established in Section 4.4.2. If the entire workforce required to build proposed Lee Nuclear Station Units 1 and 2 were to originate from within a reasonable commuting distance of the site, there would be no impact on housing demand. However, the review team expects that approximately 3151 construction workers (70 percent of the total anticipated workers) plus 40 operations workers (36 percent of the 112 operations workers expected at during peak project activities) would in-migrate into Cherokee and York Counties, the review team estimated that half of the workers would live in Cherokee County and half of them would live in York County. Construction workers may choose to rent housing, stay in hotels/motels, or stay in campers or mobile homes, while operations workers are likely to purchase housing. According to the 2006–2010 American Community Survey, 11,049 housing units in the two-county impact area are vacant: 2850 and 8199 in Cherokee and York Counties, respectively (USCB 2010e). Based on these statistics from the U.S. Census Bureau, Cherokee and York Counties have enough additional capacity to house the in-migrating workers.

Approximately 86 housing structures were demolished and removed from the Make-Up Pond C site (Duke 2012b). Duke provided relocation assistance to property owners and renters located within, or adjacent to, the Make-Up Pond C site. After Duke purchased their homes, current residents were allowed to stay up to 18 months rent-free to find new housing. For owners, relocation expenses were included in the selling price. Most rentals were month to month or week to week rentals and occupants were given at least a 30-days' notice to vacate

(Duke 2009b). In 2010, local officials stated that most individuals relocated from the Make-Up Pond C area found other available housing within Cherokee County (NRC 2010c).

In 2008, local officials in Cherokee County stated the current rental stock was limited, but new apartments were being constructed on South Carolina Highway 11 and that individuals were considering constructing trailer parks in the area (NRC and PNNL 2008). According to York County officials, several newer residential developments exist in the area. York County officials believe that hotel rooms in York County would fill up during the proposed Lee Nuclear Station Units 1 and 2 building phase and outages because all were booked up during nearby Catawba Nuclear Station outages. Officials also noted that an overflow of workers would probably live in Cleveland County, North Carolina, because it has available rental stock (NRC and PNNL 2008).

The boom-and-bust nature of large-scale construction projects aggravates the housing impacts in local communities. The typical pattern begins when in-migrating workers and their families (along with local residents with enhanced economic resources because of project- and worker-related jobs and expenditures) increase the demand for housing. Increased demand creates upward pressure on both the housing supply and prices in the local area. When construction ends, most in-migrating workers leave, and most local indirect jobs also are lost. Because part of the workforce already lives locally, many of these impacts could be avoided.

Building the Lee Nuclear Station could affect housing values in the vicinity of the Lee Nuclear Station site. In a review of previous studies on the effect of seven nuclear facilities, including four nuclear power plants, on property values in surrounding communities, Bezdek and Wendling (2006) concluded that assessed valuations and median housing prices have tended to increase at rates above national and State averages. Clark et al. (1997) similarly found that housing prices in the immediate vicinity of two nuclear power plants in California were not affected by any negative imagery of the facilities. These findings differ from studies that looked at undesirable facilities, largely related to hazardous waste sites and landfills, but also including several studies on power facilities (Farber 1998) in which property values were negatively affected in the short-term, but these effects were moderated over time. Bezdek and Wendling (2006) attributed the increase in housing prices to benefits provided to the community in terms of employment and tax revenues, with surplus tax revenues encouraging other private development in the area. Given the findings from the studies discussed above, the review team determines that the impact on housing value from building the Lee Nuclear Station would be minor.

Based on the information provided by Duke, interviews with local real estate agents and city and county planners, and the NRC's own independent review, the review team expects the housing related impacts of building proposed Lee Nuclear Station Units 1 and 2 would be minimal and temporary for the region and in Cherokee and York Counties, and additional mitigation would not be warranted.

4.4.4.4 Public Services

This section describes the public services available and discusses the impacts of building proposed Lee Nuclear Station Units 1 and 2 on water supply; waste treatment; police, fire and medical services; education; and social services in the region.

Water-Supply Facilities

The demand on potable water utilities would increase at the Lee Nuclear Station site during the building phase. A detailed description of project-related water requirements and resulting impacts is presented in Section 4.2. Proposed Lee Nuclear Station Units 1 and 2 would get potable water from the Draytonville Water system to support project activities. Municipal water users in Cherokee County currently consume 8 Mgd compared to the water-supply plant capacity of 18 Mgd. Information about water-supply providers in York County is limited, but York County's largest water supplier is the City of Rock Hill, which has an estimated 4 Mgd of extra capacity (Duke 2009c). The recommended usage requirement for estimating potable water consumption for workers in hot climates is 30 gpd for each worker, which includes drinking water and sanitary needs (Duke 2009c). At peak employment, with 4613 construction and operations workers, there would be a total demand of 138,390 gpd. Using a USGS average per capita amount of water consumed per day of 90 gallons, the overall increase in consumption is 406,440 gpd from the additional population of 4516 from the in-migrating population. For the purposes of this EIS, the review team considers the 30 gpd worker demand to be in addition to the USGS 90 gpd estimate as an upper bound in determining impacts, for a total of 544,830 gpd of water usage. This is well within the excess capacity of local water suppliers in Cherokee and York Counties. A letter from officials at the Draytonville Water Works to Duke dated June 7, 2010, states that no system improvements or capacity increases are needed (Duke 2010h). As discussed in Section 4.2.2, the review team does not expect project activities to affect groundwater or wells in the region. Therefore, the review team concludes that the impacts of building proposed Lee Nuclear Station Units 1 and 2 on water systems would be minimal, and mitigation would not be warranted.

Wastewater-Treatment Facilities

Cherokee County, South Carolina, has two wastewater-treatment facilities with a combined maximum capacity of 9 Mgd. The first facility, Clary Wastewater Treatment Plant, operates at 60 percent capacity, and the Broad River Wastewater Treatment Plant operates at 40 percent capacity. York County's three wastewater-treatment plants have 5.3 Mgd of extra capacity and could also accommodate the extra population. Wastewater-treatment facilities in the two counties have enough additional capacity to treat the entire 544,830 gpd used by workers at the site and the increased in-migrating population. Proposed Lee Nuclear Station Units 1 and 2 would use the Broad River Wastewater Treatment Plant for wastewater needs. In a letter dated June 7, 2010, Gaffney Board of Public Works officials stated that the Broad River Wastewater

Treatment Plant will undergo an upgrade to meet the additional capacity (Duke 2010h). The review team concludes the impacts of building the Lee Nuclear Station on wastewater-treatment facilities would be minimal and mitigation would not be warranted.

Police, Fire and Medical Services

A temporary increase in population from the project workforce for a new nuclear facility could increase the burdens on local fire and police departments, but this increase would be transitory. After the project has been completed, many of the workers would leave the area, relieving those burdens. During the building phase, the temporary increase in demand for community resources could be mitigated in several ways. Larger communities would have an easier time assimilating the influx of new people because the additional new population composes a smaller percentage of the communities' base populations. Likewise, the more communities that host new workers, the less pressure each individual community would experience on its infrastructure. Consequently, any incentives Duke can provide its employees to move into the area in a planned manner would mitigate, but not remove, this short-term demand. Next, communities can avoid the long-term commitment to the maintenance and operation of infrastructure purchases to fulfill short-term demand increases. Instead of purchasing new fire or police equipment, affected communities could lease vehicles or building space.

Cherokee and York Counties employ an estimated 96 and 307 police officers, respectively. The resident-to-police officer ratios in Cherokee and York Counties are 570:1 and 739:1, respectively (Duke 2009c). Assuming that half of the new population live in Cherokee County and the other half live in York County, the respective resident-to-police officer ratios increase to 593:1 and 747:1. Cherokee County has 350 firefighters and York County has 688 firefighters (Duke 2009c). The current resident-to-firefighter ratios are 155:1 and 210:1 for Cherokee and York Counties, respectively. With the increased population, the ratios would rise to 161:1 and 212:1, respectively. The U.S. military has established a ratio of 1 to 4 officers per 1000 citizens (between 1000:1 and 250:1) as generally acceptable levels. With the increased population, the ratios for Cherokee and York Counties are still within acceptable levels. The Draytonville-McKowns Mountain-Wilkinsville Volunteer Fire Department would respond to fires onsite during building activities. Prior to nuclear fuel receipt, an onsite fire brigade is expected to be in place (Duke 2009c). Demands for any new services associated with building proposed Lee Nuclear Station Units 1 and 2 would be readily absorbed by the increase in revenue associated with general growth in the local area. The review team concludes the building-related impacts on fire and police services in Cherokee and York Counties would be minimal and temporary.

Cherokee County has one hospital, Upstate Carolina Medical Center, located in Gaffney, South Carolina. It has 125 beds and nearly 100 medical staff. There are no medical facilities in York County within 10 mi of the Lee Nuclear Station site. However, Piedmont Medical Center is just outside the 10-mi radius and has an existing agreement with Duke to provide emergency medical care for radiological contaminated employees at the Catawba Nuclear Station.

Piedmont Medical Center would also be used by Lee Nuclear Station as part of this agreement (Duke 2009c). Based on the size and availability of medical services in the region, temporary construction workers would not overburden existing medical services. The review team concludes adverse impacts on medical services near the proposed site would be minimal and temporary.

Social Services

Social services such as adoptions, child protective services, family nutrition programs, foster care services, foster home and group home licensing, and food stamps are overseen by the South Carolina Department of Social Services (SCDSS). Social services, such as Medicaid and welfare, are funded through the Federal and State governments. In addition to government-provided services, a number of private, philanthropic, and religious organizations that provide social services within the 50-mi radius of the Lee Nuclear Station site. To the extent Duke's contractors hire individuals who use the services provided by the SCDSS or nonprofit organizations, building proposed Lee Nuclear Station Units 1 and 2 could reduce the burden on social service providers. The enhanced employment opportunities created by the multiplier effect during the project may provide some benefits to the disadvantaged population. However, new families moving into a community would bring new demand for both State and privately provided social services. Overall, the counterbalancing effects of new jobs and new families cannot be fully quantified. As the project nears completion and direct and indirect jobs are lost, demands on social services may increase. The review team concludes the overall impact of building proposed Lee Nuclear Station Units 1 and 2 on social services would be minimal.

4.4.4.5 Education

The percentage of school-aged children between ages 5 and 18 in Cherokee and York Counties is 19 and 18 percent, respectively (Duke 2009c). The review team expects a net building-related increase of about 398 (total in-migrating workers of 828 who bring a family multiplied by the average of 18.5 percent) school-age children. Further, the review team assumes that 50 percent of the in-migrants would settle in Cherokee County and 50 percent would settle in York County, which translates to approximately 200 additional students in each county. Based on the student populations of the school districts presented in Section 2.5.2.7 and Table 2-27 the increased student populations would represent a less than 5 percent increase in student body populations. The Cherokee County School District has recently undergone renovations, and Gaffney high school has room for an additional 1000 students. York County District One is currently undergoing renovations and should not have to worry about capacities for 15 years. According to school district officials, building proposed Lee Nuclear Station Units 1 and 2 would not have a disrupting effect on school districts in either county (NRC and PNNL 2008). Based on Duke's analysis, a discussion with local officials, and the review team's analysis, the review team concludes the impact on education would be minimal.

4.4.4.6 Summary of Infrastructure and Community Services Impacts

The review team has evaluated information provided by Duke, information obtained at the site visit, interviews with county officials and leaders, and performed an independent review of potential infrastructure and community service impacts from building proposed Lee Nuclear Station Units 1 and 2. The review team concludes that impacts on regional infrastructure and community services, including recreation; housing; water and wastewater facilities; police, fire, and medical facilities; social services; and education would be minimal with one exception. The estimated peak workforce of 4613 during construction and preconstruction activities would have a MODERATE temporary and adverse impact on traffic on local roads near the site especially on McKowns Mountain Road, and a minimal and adverse impact elsewhere in the region. These conclusions are predicated on the specific assumptions about the size, composition, and behavior of the project workforce discussed in detail in Section 4.4.2. Mitigation beyond the strategies outlined by Duke in its ER would not be warranted. The NRC staff concludes that the infrastructure and community service impacts of NRC-authorized construction activities would be MODERATE for local roads near the site when building proposed Lee Nuclear Station Units 1 and 2, but would be not be noticeable for the region. The NRC staff also concludes that mitigation beyond the strategies outlined by Duke in its ER would not be warranted.

4.5 Environmental Justice Impacts

The review team evaluated whether the health or welfare of minority and low-income populations in the census blocks identified in Section 2.6 could experience a disproportionately high and adverse impact from activities related to building proposed Lee Nuclear Station Units 1 and 2. To perform this assessment, the review team (1) identified all potentially significant pathways for human health and welfare effects, (2) determined the impact of each pathway for individuals within the identified census block groups and other areas identified through the review team's onsite evaluations, and (3) determined whether the characteristics of the pathway or special circumstances of the minority and low-income populations would result in a disproportionately high and adverse impact on any minority or low-income individuals within each census block group.

As discussed in Section 2.6.3, the review team did not find any evidence of unique characteristics or practices in the region that could lead to a disproportionately high and adverse impact on any minority or low-income population.

4.5.1 Health Impacts

The review team determined, through literature searches and consultations with NRC staff health experts that the expected building-related level of environmental emissions is well below the protection levels established by NRC and EPA regulations and would not impose a disproportionately high and adverse radiological health effect on any identified minority or low-income populations. From the review team's investigation, no project-related potential pathways to adverse health impacts were found to occur in excess of the safe levels stipulated by NRC and EPA health and safety standards (Section 4.9.5). The NRC staff determined that the offsite dose rate would also be well below regulatory limits and impacts would be small. The review team's investigation and outreach did not identify any unique characteristics or practices among any minority or low-income populations that would result in disproportionately high and adverse impacts on those populations (NRC and PNNL 2008). No impacts would be expected on migrant farm worker populations even if they were employed near the Lee Nuclear Station site.

As described in Section 4.4.1, the potential environmental and physical effects of building proposed Lee Nuclear Station Units 1 and 2 would be generally confined within the site boundaries with few exceptions, leading to no offsite health impacts on any identified population. Where there would be potential offsite nonradiological health effects, the review team did not identify any studies, reports, or anecdotal evidence that would indicate any environmental pathway that would physiologically affect minority or low-income populations differently from other segments of the general population during building activities. Moreover, the review team's regional outreach provided no indication in either the location or practices of minority and low-income populations in the 50-mi region that suggests they would experience any disproportionately high and adverse nonradiological impacts. In addition, the review team determined that the nonradiological health effects of building activities and other past, present, and reasonably foreseeable future actions that could contribute to cumulative impacts to nonradiological health would be localized and minimal (Sections 4.8.4 and Section 7.7). The review team's investigation and outreach did not identify any unique characteristics or practices among minority and low-income populations that would result in disproportionately high and adverse nonradiological health impacts (NRC and PNNL 2008).

Traffic is a major component of nonradiological health impacts. Any increase in traffic accidents due to heavier traffic is unlikely to have a disproportionately high impact on any particular population subgroup in the 50-mi region or Cherokee County. The roads nearest the plant would be more crowded and more traffic accidents may occur, but these increases are likely to be located on the principal commuting routes, which are not located in communities with minority or low-income populations of interest. No information suggests that nearby minority or low-income communities would be disproportionately vulnerable to hazards while on the road. Finally, as discussed in Section 2.6.3, the review team did not identify any evidence of unique characteristics or practices in any minority or low-income population that may result in different traffic impacts compared to the general population. Therefore, traffic effects would not have a disproportionately high and adverse impact on minority or low-income populations.

4.5.2 Physical and Environmental Impacts

Building a nuclear power station is very similar in its environmental effects to building any other large-scale industrial project. There are four primary pathways in the environment: soil, water, air, and noise. Discussions of the potential impacts on each of these pathways follow.

4.5.2.1 Soil

Building activities at the Lee Nuclear Station site and Make-Up Pond C site represent the largest source of soil-related environmental impacts. However, these impacts would be localized to those two sites, are sufficiently distant from surrounding populations, have little migratory ability, and would be mitigated through strategies implemented by Duke resulting in no noticeable offsite impacts. The review team concludes soil-related environmental impacts during the building of proposed Lee Nuclear Station Units 1 and 2 would have no impacts on any populations within Cherokee and York Counties.

4.5.2.2 Water

Duke would mitigate impacts on surface water, such as the Broad River and Ninety-Nine Islands Reservoir, by implementing the SCDHEC construction SWPPP and complying with required SCDHEC and USACE regulatory permits and applicable conditions specified in these permits (Duke 2009c). As described in Section 4.2, the review team expects project-related impacts on surface water to be minimal because total water demand would represent a small portion of the available water and because there would be minimal surface-water-quality effects. The review team expects all effects on groundwater to be minimal because usage effects would be localized and temporary and there would be no effect on groundwater quality. Therefore, the review team determined the potential negative offsite environmental effects from impacts on water sources would be small; and, consequently, there would be no disproportionately high and adverse water-related impacts on minority or low-income populations.

4.5.2.3 Air

Air emissions are expected from increased vehicle traffic, heavy equipment operations, and fugitive dust generated by project activities. Emissions from vehicles and heavy equipment are unavoidable, but would be localized and temporary. Emissions from fugitive dust would be localized, and dust-control measures would be implemented to maintain compliance with NAAQS. As discussed in Section 2.6.3, the review team did not identify any evidence of unique characteristics or practices in the minority and low-income populations that may result in different air-quality-related impacts compared to the general population (NRC and PNNL 2008). The review team determined the negative environmental effects from building-related reductions in air quality would be small, localized, and short-lived for any population in Cherokee and

York Counties. Consequently, the review team found no disproportionately high and adverse impacts on minority or low-income populations because of changes in air quality.

4.5.2.4 Noise

Noise levels from building activities may exceed 100 dBA within the site, but would be attenuated by distance, vegetation, and topography. Noise from traffic along the access routes to the Lee Nuclear Station site and Make-Up Pond C site may intermittently exceed levels acceptable for residential areas. However, these impacts would be more noticeable within the vicinity of the site or the site access roads. Sensitive noise receptors closest to the site are likely to experience intermittent, but temporary, noise pollution during the peak of building activities. In addition to the findings in Section 4.8 that noise impacts from building activities are temporary in nature, the distance between the site and minority and low-income populations is large. As discussed in Section 2.6, the review team did not identify any evidence of unique characteristics or practices in the minority and low-income populations that may result in a disproportionately high and adverse impact on minority or low-income populations.

4.5.3 Socioeconomic Impacts

Socioeconomic impacts in Section 4.4 were reviewed to evaluate whether any building-related activities could have a disproportionately high and adverse effect on minority or low-income populations. The review team expects traffic to increase beyond the capacity of McKowns Mountain Road during the building phase. However, as discussed in Section 4.4.4.1, Duke has plans to help mitigate the increased traffic congestion. While adverse impacts on traffic would be likely, the review team did not identify any unique characteristics or practices in the low-income and minority populations that could lead to a disproportionately high and adverse impact.

As discussed in Section 2.6, no minority or low-income block groups reside in the vicinity of the Lee Nuclear Station site. The review team expects that potential adverse socioeconomic impacts from building-related activities for the new plant would not affect the low-income and minority populations in the region disproportionately because the review team found no evidence of any unique characteristics or practices among those communities that could lead to a disproportionately high and adverse impact. Consequently, the review team found no evidence of disproportionately high and adverse impacts on minority or low-income populations because of changes in socioeconomic conditions.

4.5.4 Subsistence and Special Conditions

NRC environmental justice methodology includes an assessment of populations of particular interest or unusual circumstances, (e.g., minority communities exceptionally dependent on subsistence resources or identifiable in compact locations, such as Native American settlements).

As discussed in Section 2.6.1, the review team was made aware of anecdotal evidence of private subsistence fishing among the low-income populations in York County (Niemeyer 2008). However, under closer investigation, no pathways were identified from building activities that would modify or disrupt subsistence fishing in York County. The review team did not identify any unusual resource dependencies (e.g., plants with religious or economic significance or key transportation routes) that might be disrupted by building activities. Therefore, the review team concludes that there would be no disproportionately high and adverse impacts on the subsistence activities of minority or low-income populations from building proposed Lee Nuclear Station Units 1 and 2.

4.5.5 Summary of Environmental Justice Impacts

The review team has evaluated the proposed construction and preconstruction activities related to building proposed Lee Nuclear Station Units 1 and 2 and the potential environmental justice impacts in the vicinity and region. The review team determined there are no environmental, health, or socioeconomic pathways by which the identified minority or low-income populations in the 50-mi region would be likely to suffer disproportionately high and adverse environmental or health impacts as a result of construction and preconstruction activities. Therefore, the review team concludes that the environmental justice impacts of construction and preconstruction activities would be SMALL, and additional mitigation would not be warranted beyond that which Duke has outlined in its ER. Based on the above analysis, and because NRC-authorized construction activities represent only a portion of the analyzed activities, the NRC staff concludes there are no environmental pathways by which the identified minority or low-income populations in the 50-mi region would be likely to suffer disproportionately high and adverse environmental or health impacts as a result of the NRC-authorized construction activities. Therefore, the NRC staff concludes that the environmental justice impacts of NRC-authorized construction activities would be SMALL and additional mitigation beyond the strategies outlined by Duke in its ER would not be warranted.

4.6 Historic and Cultural Resources

The National Environmental Policy Act of 1969, as amended (NEPA) requires Federal agencies to take into account the potential effects of their undertakings on the cultural environment, which includes archaeological sites, historic buildings, and traditional places important to interested parties. The National Historic Preservation Act of 1966, as amended (NHPA), also requires

Federal agencies to consider impacts on those resources if they are eligible for listing in the National Register of Historic Places (National Register). Such resources are referred to as "historic properties" in NHPA. As outlined in 36 CFR 800.8, "Coordination with the National Environmental Policy Act of 1969," the NRC is coordinating compliance with Section 106 of the NHPA in fulfilling its responsibilities under NEPA.

Construction and preconstruction of new nuclear power plants can affect either known or undiscovered historic and cultural resources. In accordance with the provisions of NHPA and NEPA, the NRC and USACE, a cooperating Federal agency, are required to make a reasonable and good faith effort to identify historic properties and cultural resources in the areas of potential effect (APEs) for construction and preconstruction and, if present, determine if any significant impacts are likely. Identification is to occur in consultation with the appropriate State Historic Preservation Officer (SHPO), American Indian Tribes, interested parties, and the public. If significant impacts are possible, efforts should be made to mitigate them. As part of the NEPA/NHPA integration, even if no historic properties or important cultural resources are present or affected, the NRC and USACE are still required to notify the appropriate SHPO before proceeding. If it is determined that historic properties or important cultural resources are present, efforts must be made to assess and resolve any adverse effects of the undertaking.

Section 2.7 provides a detailed overview of historic and cultural resources at the Lee Nuclear Station site, at proposed project developments in the 6-mi vicinity of Lee Nuclear Station Units 1 and 2, and at proposed project developments in offsite areas. As explained in this discussion, archaeological and architectural surveys have been conducted in all onsite and offsite direct (physical) and indirect (visual) APEs by qualified professional cultural resources contractors and potential effects have been considered for a number of historic properties and cultural resources. As part of these investigations, Duke has established ongoing coordination with the South Carolina SHPO and has shared information with four Federally recognized American Indian Tribes and four Native American organizations (Duke 2008f, g; 2009c, h, I; 2010i, j). Duke has established ongoing communications based on responses received from three interested American Indian Tribes: the Catawba Indian Nation, Eastern Band of Cherokee Indians, and the Seminole Tribe of Florida. The NRC has also invited these tribes and organizations, the South Carolina SHPO, and the Advisory Council on Historic Preservation to participate in the initial and supplemental scoping processes for the environmental review and invited their feedback on the draft EIS (Appendices C and F). The USACE has also engaged Duke, the South Carolina SHPO, the Catawba Indian Nation, and Eastern Band of Cherokee Indians in consultation to develop a cultural resources management plan and Memorandum of Agreement (MOA) for the Lee Nuclear Station site and associated offsite developments.

Largely in response to concerns expressed by the aforementioned consulting parties, Duke Energy has developed a corporate policy for cultural resource protection (Duke 2009c, j) that provides guidance to minimize impacts on cultural resources during activities at all facilities owned and operated by Duke Energy and procedures for handling any inadvertent cultural resource discoveries in consultation with the appropriate SHPO and Tribal Historic Preservation Officer(s) (THPO[s]). In 2013, Duke, the USACE, the South Carolina SHPO, and the Catawba Indian Nation THPO finalized a cultural resources management plan and associated MOA that implement the corporate policy and are tailored specifically to the Lee Nuclear Station site and associated developments (USACE et al. 2013).

To develop the impact assessments presented here, the review team

- analyzed the potential impacts on historic properties and cultural resources resulting from proposed construction and preconstruction activities at the Lee Nuclear Station site and vicinity and in offsite areas as described in the ER, the Make-Up Pond C supplement to the ER, 2013 supplemental information related to site design changes, and cultural resource survey reports
- confirmed Duke Energy's corporate policy for cultural resources consideration and protection and inadvertent discovery procedures
- considered Duke's past and ongoing coordination with the South Carolina SHPO and American Indian Tribes that have expressed interest in the proposed activities
- confirmed the scope of the final cultural resources management plan and associated MOA between Duke, the USACE, the South Carolina SHPO, and the Catawba Indian Nation.

4.6.1 Site and Vicinity Direct and Indirect Areas of Potential Effect

In 1974, archaeological surveys in advance of site-preparation activities related to the unfinished Cherokee Nuclear Station resulted in the documentation of 11 archaeological sites and 1 historic cemetery within the 1900-ac Lee Nuclear Station site (SCIAA 1974). It is likely that 6 of the 11 archaeological sites recorded during the 1974 cultural survey were heavily disturbed by site-preparation activities (Duke 2009c; SCIAA 1981; Brockington 2007a). None of these sites was recommended for further investigations in 1974, indicating that it is unlikely that any were eligible for nomination to the National Register. The remaining five archaeological sites and the historic Stroup Cemetery were probably not affected by the unfinished Cherokee Nuclear Station site-development activities (Duke 2009c). In 1975, the South Carolina SHPO concluded that no National Register properties would be affected by the unfinished Cherokee Nuclear Station (Duke 2009c). No architectural resources or indirect visual effects were investigated at that time.

In cooperation with the South Carolina SHPO in 2007 and 2009, Duke and its primary cultural resources contractor, Brockington and Associates, Inc., defined several onsite direct physical APEs within the 1900-ac Lee Nuclear Station site where ground-disturbing activities associated with building and operating the new units would occur (Brockington 2007a, b; 2009a). Under the guidance of the Lee Nuclear Station site cultural resources management plan and MOA in 2013, additional cultural resource investigations were initiated for updated plans for placement of site-specific structures and associated developments such as spoil and laydown areas and a new railroad turnaround (Brockington 2013). Archaeological surveys and testing within all of the 2007, 2009, and 2013 APEs revealed seven new archaeological sites and eight new isolated artifact locations, all of which were evaluated as ineligible for nomination to the National Register (Brockington 2007a, b; 2009a; 2013). Investigators also revisited the reported locations of two previously recorded archaeological sites that were not expected to have been disturbed by the unfinished Cherokee Nuclear Station preparations, but found no evidence of these resources within the current APEs (Brockington 2009a).

It is unlikely that the historic and cultural resources previously recorded in the 750-ac unfinished Cherokee Nuclear Station site are preserved given the high levels of earlier ground disturbance. Duke's corporate procedure for ongoing cultural resources consideration (Duke 2009j) and the Lee Nuclear Station site cultural resources management plan and associated MOA (USACE et al. 2013) would prompt assessment and coordination with the SHPO if any materials are inadvertently discovered. In 2007, the South Carolina SHPO accepted the Lee Nuclear Station site survey reports without specifically commenting on the eligibility of archaeological sites or the probable destruction of resources originally recorded in the 1970s (SCDAH 2007b). Later, in2009 and 2013, the SHPO concurred with the determination that proposed onsite activities would not adversely affect any historic properties (archaeological in nature) (SCDAH 2009a, 2012a, 2013). Information gathered during the 2007 and 2009 investigations was also provided to the Eastern Band of Cherokee Indians (Duke 2010j) and ongoing consultation resulted in concurrence with the findings of no effect to important resources (EBCI 2011).

Investigators have identified four historic cemeteries within the 1900-ac Lee Nuclear Station site: the Stroup Cemetery, Moss Cemetery, McKown Family Cemetery, and an unnamed cemetery (Brockington 2007a, b; 2009a; 2013). Although these resources are evaluated as ineligible for nomination to the National Register, they are protected by State law, are of importance to the South Carolina SHPO (SCDAH 2012a), and continue to be culturally important to local members of the community as indicated by the periodic requests for access that continue to be received by Duke (Duke 2010d). Under the Lee Nuclear Station cultural resources management plan and associated MOA (USACE et al. 2013), Duke intends to continue to provide public access to these culturally important resources, establish protective 50-ft protective buffers as necessary, and maintain the fences that surround them. Prior to ground disturbance, the cemeteries will be marked for avoidance and they will be periodically monitored by security personnel (Duke 2010d, o). No traditional cultural places of importance to interested American Indian Tribes have been identified at the Lee Nuclear Station site.

In cooperation with the South Carolina SHPO, Duke and its cultural resources contractor, Brockington and Associates, Inc., determined that onsite indirect effects, such as viewshed and noise impacts associated with construction and preconstruction activities at the Lee Nuclear Station site, should be considered for aboveground resources located within a 1-mi radius of the tallest proposed structures, including the nuclear units, associated shield buildings, and the meteorological tower (Brockington 2007a, b; 2009a). As discussed in Section 2.7, field and archival investigations resulted in the documentation of 12 architectural resources and 4 historic cemeteries within this indirect visual APE. Visual impacts were also assessed for one National Register-eligible property, the Ninety-Nine Islands Dam and Hydroelectric Project. Investigators recommended that although the tallest proposed structures (proposed nuclear units and associated containment buildings) would be visible from Ninety-Nine Islands Dam and the Ninety-Nine Islands Hydroelectric Project, these historic properties would not be adversely affected because the visibility of these structures would not alter the characteristics of the dam and powerhouse that make them significant, specifically, their unique design and role in the history of hydropower development in the Piedmont region of South Carolina (Brockington 2007a).

The remaining architectural resources located within the Lee Nuclear Station site indirect visual APE were determined to be ineligible for nomination to the National Register and no potential visual impacts on historic cemeteries were identified. No traditional cultural properties were defined by stakeholders in the onsite direct (physical) or indirect (visual) APEs. Archaeological resources located in the direct physical APEs at the Lee Nuclear Station site and vicinity were evaluated as ineligible for National Register nomination and these resources were not considered as part of the onsite indirect effects assessment because they are typically buried and not subject to visual impacts. As a result, investigators concluded that construction and preconstruction activities at the Lee Nuclear Station site would not alter significant aspects of any National Register-eligible or culturally important resources, a determination supported by the review team's independent analysis. The South Carolina SHPO concurred with the eligibility assessments and finding of no adverse effects to the National Register-eligible Ninety-Nine Islands Dam and Hydroelectric Project and an overall determination of no historic properties affected for onsite construction and preconstruction activities (SCDAH 2007b, 2009a, 2012a , 2013). The Eastern Band of Cherokee Indians also found that no resources important to the Tribe would be affected (EBCI 2011).

Proposed Make-Up Pond C, located in the Lee Nuclear Station site vicinity within 6 mi of the proposed plant, would support plant operations during extended drought conditions. Cultural resources investigations of Make-Up Pond C and associated developments (i.e., pipelines, road modifications, spoils piles, and laydown areas) were completed in a phased approach (Brockington 2009b, 2010, 2011, 2013) and included archaeological surveys with test excavations, geomorphological testing, archival investigations, and architectural surveys. Direct (physical) and indirect (visual) APEs were defined in coordination with the South Carolina SHPO as a 620-ac reservoir with a 300-ft shoreline buffer (direct APE) and a 1.25-mi zone surrounding this area to encompass potential visual intrusions (indirect APE).

Cultural resources investigations in the direct physical and indirect visual APEs for Make-Up Pond C resulted in the assessment of 13 archaeological sites, 2 historic cemeteries, 28 architectural resources, and 1 possible historic district. All were recommended as being not eligible for nomination to the National Register, leading to a finding of no historic properties affected for Make-Up Pond C and associated developments (Brockington 2009b, 2010, 2011, 2013). However, the Service Family Cemetery and McKown Family Cemetery were identified as significant cultural resources, protected under South Carolina State law (SC Code Ann 16-17-600; SC Code Ann 27-43, summary also found in CSCPA 2005). Investigators recommended that the Service Family Cemetery be relocated in cooperation with interested members of the local community and in compliance with State law in advance of ground-disturbing project activities. It was also determined that a proposed water pipeline and other developments associated with spoil and laydown areas would not affect the McKown Family Cemetery because a 50 ft protective buffer would be established around the perimeter of the resource (Brockington 2011, 2013). The South Carolina SHPO concurred with the finding of no historic properties affected and the recommendation for relocation of the Service Family Cemetery in consultation with SHPO and interested parties (SCDAH 2009b, 2010a, 2011, 2012a). The Eastern Band of Cherokee Indians and Seminole Tribe of Florida also submitted no objections to the findings (EBCI 2010a, 2010b, 2011); STF 2009, 2010).

Although the Service Family Cemetery and McKown Family Cemetery are not eligible for nomination to the National Register, they are culturally important to local members of the community and protected from disturbance and desecration under South Carolina State law (SC Code Ann 16-17-600, SC Code Ann 27-43, summary also found in CSCPA 2005). Duke confirms that periodic requests for access to identified historic cemeteries continue to be received and a descendant of the Service and Gaffney families has contacted Duke's cultural resources contractor, Brockington and Associates, Inc., specifically about the Service Family Cemetery (Duke 2010d). Duke has confirmed that the future relocation of the Service Family Cemetery will be coordinated with the South Carolina SHPO and completed in accordance with State law, which will include cooperation with identified descendants, solicitation of public input, and an approved petition from the local Cherokee County Council for a resolution approving relocation to a predetermined location (Duke 2010d, h). Completion of these activities will ensure that the Service Family Cemetery is reestablished in a place that is acceptable to descendants and local members of the community and will result in impacts on this culturally important resource that will be noticeable, but not destabilizing. These mitigations are included in the Lee Nuclear Station cultural resources management plan and MOA (USACE et al. 2013) and are conditional to the South Carolina SHPO's concurrence with the finding of no adverse effects under NHPA (SCDAH 2012a). No impacts are expected on the McKown Family Cemetery located near a proposed water pipeline associated with Make-Up Pond C and proposed spoil and laydown areas (Brockington 2011, 2013).

4.6.1.1 Summary of Impacts in the Site and Vicinity

For purposes of consultation under Section 106 of the NHPA, the review team concludes that a finding of no historic properties adversely affected by construction and preconstruction activities would be supported by (1) USACE and NRC consultation and Duke's ongoing coordination with the South Carolina SHPO leading to agreement on a finding of no adverse effects to the National Register-eligible Ninety-Nine Islands Dam and Hydroelectric Project; (2) USACE and NRC consultation and Duke's coordination with the South Carolina SHPO and interested American Indian Tribes leading to agreement on findings that none of the archaeological or architectural resources recorded within defined indirect and direct APEs at the Lee Nuclear Station site or Make-Up Pond C site are National Register-eligible and as a result, construction and preconstruction activities in the site and vicinity will have no effects on historic properties or traditional cultural resources; (3) Duke Energy's corporate policy for the protection of cultural resources, including inadvertent cultural resources discovery procedures as implemented through the Lee Nuclear Station cultural resources management plan and associated MOA (USACE et al. 2013); and (4) the review team's independent analysis and consultation.

For the purposes of the review team's NEPA analysis the review team concludes that impacts on historic and cultural resources would be noticeable, but not destabilizing, based on (1) Duke's commitment to allow continued public access to historic cemeteries within the Lee Nuclear Station site, to maintain protective fencing around these sites, and to protect them from damage during current and future land disturbing or building activities; (2) Duke's commitment to follow the requirements of State law and consult with the South Carolina SHPO on the future removal and relocation of the culturally important Service Family Cemetery located in the Make-Up Pond C site; (3) NRC and USACE consultation and Duke's coordination with the South Carolina SHPO and interested American Indian Tribes leading to findings of no additional significant historic or cultural resources affected directly or indirectly by construction or preconstruction activities within the Lee Nuclear Station site or Make-Up Pond C site; (4) Duke Energy's corporate policy for protection of cultural resources and procedures if cultural resources are inadvertently discovered during ground-disturbing activities as implemented through the Lee Nuclear Station cultural resources management plan and associated MOA (USACE et al. 2013); and (5) the review team's independent analysis and consultation. The review team concludes that potential direct and indirect impacts on historic and cultural resources during construction and preconstruction in the 1900-ac Lee Nuclear Station site and Make-Up Pond C site would be MODERATE.

Preconstruction activities associated with Make-Up Pond C are the primary drivers for concluding an impact greater than SMALL for historic and cultural resources at the Lee Nuclear Station site and vicinity. These activities are not part of the NRC action. Therefore, the NRC staff has determined that the above analysis demonstrates that the potential direct and indirect impacts on historic and cultural resources from NRC-authorized construction activities at the Lee Nuclear Station site would be SMALL and no further mitigation would be warranted.

4.6.2 Offsite Direct and Indirect Areas of Potential Effect

As summarized in Section 2.7, in cooperation with the South Carolina SHPO, Duke has initiated specific cultural resources investigations of three main offsite direct physical APEs and corresponding indirect visual APEs: the offsite railroad line (Brockington 2007c), two proposed routes for new 230-kV and 525-kV transmission lines (Routes K and O) (ACC 2009), and proposed transportation improvements at six key intersections near the Lee Nuclear Station site (Duke 2012d).

Background research and surveys in 2007 confirmed that the existing railroad line to the Lee Nuclear Station site passes through a portion of an National Register-listed archaeological site 38CK68 (Ellen Furnace Works), which is significant for its association with early nineteenth-century ironworks important in the industrial development of Cherokee County (Brockington 2007c). No additional historic architectural resources were identified in the indirect visual APE defined as a 300-ft zone on either side of the existing railroad bed. Based on field inspection, the investigators concluded that the portions of the historic Ellen Furnace Works (38CK68) located within the railroad line direct physical APE had been disturbed by previous grading activities associated with the original railroad bed and recommended that activities associated with reactivation of the railroad line would not result in any additional adverse impacts on cultural features or significant aspects of this historic property (Brockington 2007c). The South Carolina SHPO concurred with the findings of no adverse effects on Ellen Furnace Works (38CK68) and no additional historic properties affected by the proposed reuse of the railroad corridor (SCDAH 2008, 2012a).

In 2007, Duke documented general public concerns about potential impacts on historic homes, churches, and cemeteries during community outreach sessions associated with an initial siting study that narrowed the proposed transmission-line corridors to two routes: Route K and Route O (Duke 2007c). In 2009, intensive archaeological investigations were completed in direct physical APEs for each of the proposed transmission-line routes as well as architectural surveys for indirect visual APEs within 0.5 mi of them (ACC 2009). These investigations resulted in the identification of 37 archaeological sites in the direct physical APEs of the two proposed transmission-line routes. One additional previously recorded archaeological site could not be relocated in spite of intensive survey and testing in its reported location. All of the identified archaeological sites exhibited low potential for preserved cultural features or important information and were evaluated as ineligible for nomination to the National Register (ACC 2009). One site in the inventory, 38CK172, is a possible human burial that is not eligible to the National Register, but potentially subject to consideration under State and Federal burial laws (summary in CSCPA 2005, SC Code Ann16-17-600, SC Code Ann 27-43; Native American Graves Protection and Repatriation Act [NAGPRA], 43 CFR Part 10).

The South Carolina SHPO concurred with the determination that the proposed offsite transmission lines would not affect any archaeological properties listed in or eligible for listing in the National Register (SCDAH 2009c, 2012a). The Eastern Band of Cherokee Indians also concurred, but reiterated the need for protection of the possible human burial site, 38CK172 (EBCI 2009). Duke has confirmed that sensitive cultural resources like 38CK172 will be considered during all phases of transmission-line design, installation, and maintenance through inclusion of these resources in project geographic information system maps and establishment of protective 50-ft radius buffers where no towers or poles will be placed and vegetation will be cleared by hand. Aircraft will also be used for routine inspections, eliminating the need for extensive access roads (Duke 2010o, q). These protective measures are implemented in the cultural resources management plan and associated MOA approved by the USACE, Duke, the South Carolina SHPO, and the Catawba Indian Nation THPO (USACE et al. 2013), so no impacts should occur to 38CK172 and the sensitive human remains that may be located there.

During the 2009 investigations, 39 architectural resources were identified within the indirect visual APE for the two offsite transmission-line routes in a zone extending 0.5 mi from the proposed centerlines. Nine of these resources, including the National Register-eligible Ninety-Nine Islands Dam and Ninety-Nine Islands Hydroelectric Project, are also co-located in the onsite indirect APE for the Lee Nuclear Station. As summarized in Section 2.7, most of the architectural properties identified are twentieth-century residences unlikely to yield any additional important information and evaluated as ineligible for National Register nomination (ACC 2009). However, three National Register-eligible properties were documented. These include Ninety-Nine Islands Dam and Hydroelectric Project, important for its association with early development of hydropower in the region, and two historic farmsteads (Smith's Ford Farm and Reid-Walker-Johnson Farm), important for their association with historic settlement and agricultural economies of the mid-eighteenth and early twentieth centuries. Investigators recommended that the new transmission lines would have no effect on the Ninety-Nine Islands properties given their historic association with power generation and transmission (ACC 2009). Analyses of potential visual impacts on the historic farmsteads demonstrated that distance, topography, and vegetation cover would screen these properties from significant visual modifications in their respective viewsheds (Pike Electric 2010). The South Carolina SHPO concurred that the proposed transmission lines would cause no adverse effects on the two historic farmsteads and no effects on any other historic properties, including Ninety-Nine Islands Dam and Hydroelectric Plant (SCDAH 2009c, 2010b, 2012a).

Cultural resource archive reviews of proposed transportation improvements at six key intersections located from I-85 east to the Lee Nuclear Station site resulted in the identification of five archaeological sites evaluated as ineligible for nomination to the National Register. Limited field inspection confirmed that no evidence remains of these resources in the direct APEs for road building and modification. The South Carolina SHPO concurred with the finding of no historic properties listed in or eligible for listing in the National Register within the direct APEs for transportation improvements (SCDAH 2012b).

4.6.2.1 Summary of Offsite Impacts

For the purposes of consultation under Section 106 of the NHPA for offsite developments, the USACE concludes that a finding of no historic properties adversely affected by offsite preconstruction activities would be supported by: (1) USACE consultation and Duke's coordination with the South Carolina SHPO leading to concurrence on findings of no adverse effects on National Register-eligible properties: Ellen Furnace Works located in the railroad corridor APEs and Ninety-Nine Islands Dam and Hydroelectric Project, Smith's Ford Farm, and Reid-Walker-Johnson Farm located in the offsite transmission-line APEs; (2) USACE consultation and Duke's coordination with the South Carolina SHPO and interested American Indian Tribes leading to agreement that none of the other archaeological or architectural resources located within the direct and indirect APEs defined for the railroad corridor, offsite transmission lines, or the offsite transportation improvements are eligible for nomination to the National Register and as a result, no historic properties or traditional cultural properties in those areas would be affected by the proposed activities; (3) Duke Energy's corporate policy for the protection of cultural resources and inadvertent discovery procedures as implemented through the Lee Nuclear Station cultural resources management plan and associated MOA (USACE et al. 2013); and (4) the review team's independent analysis and consultation.

For the purposes of the review team's NEPA analysis, the review team concludes that the construction and preconstruction impacts on historic and cultural resources would be negligible based on (1) Duke's commitment to implement protective measures to avoid impacts on 38CK172, the culturally important potential human burial site located in transmission-line Route O; (2) NRC and USACE consultation and Duke's coordination with the South Carolina SHPO and interested American Indian Tribes leading to findings of no additional significant historic or cultural resources adversely affected directly or indirectly by preconstruction activities within the railroad corridor, offsite transmission-line corridors, or the offsite transportation improvements; (3) Duke Energy's corporate policy for protection of cultural resources and procedures if cultural resources are unexpectedly discovered during ground-disturbing activities as implemented through the Lee Nuclear Station cultural resources management plan and associated MOA (USACE et al. 2013); and (4) the review team's independent analysis and consultation. On these bases, the review team concludes that the potential direct and indirect impacts on historic and cultural resources during construction and preconstruction activities in offsite project areas would be SMALL and no further mitigation beyond that described above would be warranted.

The NRC staff concludes that almost all the impact on historic and cultural resources would be the result of preconstruction activities. Based on this information, the NRC staff concludes that the historic and cultural resources impacts of NRC-authorized construction would be SMALL. As a result, the NRC staff concludes that the impacts analyzed above are outside the scope of the NRC's APE for the Lee Nuclear Station COL review.

4.7 Meteorological and Air-Quality Impacts

Sections 2.9.1 and 2.9.2 describe the meteorological characteristics and air-quality conditions at and around the Lee Nuclear Station site. The primary impacts of building Lee Nuclear Station Units 1 and 2 on local meteorology and air quality would be from dust generated by land clearing and building activities, emissions from equipment and machinery, concrete batch-plant operations, and emissions from vehicles used to transport workers and materials to and from the site.

4.7.1 Construction and Preconstruction Activities

Development activities at the Lee Nuclear Station site would result in temporary impacts on local air quality. Activities including earthmoving, concrete batch-plant operation and vehicular traffic generate fugitive dust (i.e., larger particles such as total suspended particulates and smaller fine particulate matter emissions such as PM_{10} and $PM_{2.5}$. In addition, gaseous emissions from equipment and machinery used in these activities would contain criteria pollutants such as carbon monoxide, oxides of nitrogen, a small amount of sulfur oxides, and volatile organic compounds. As discussed in Section 2.9.2, Cherokee County is an attainment area for all criteria pollutants for which NAAQS have been established (40 CFR 81.341). As a result, a conformity analysis for direct and indirect emissions is not required (40 CFR Part 93). Further, the closest Class 1 Federal Area is more than 50 mi from the Lee Nuclear Station site.

The SCDHEC regulates air pollution and control through Regulation 61-62. Duke has applied for construction air emission permits through the SCDHEC for operation of a concrete batch plant and other construction equipment requiring air permits (Duke 2009c). Prior to beginning construction and preconstruction activities, Duke stated that it would also develop a mitigation plan to minimize impacts on local ambient air quality. This plan would describe the management controls and measures that Duke intends to implement (e.g., phased construction, vehicle maintenance and inspection programs to minimize air emissions) (Duke 2009c). The mitigation plan would also identify specific mitigation measures to control fugitive dust and other emissions. Section 4.4.1.6 of the ER lists mitigation measures specifically related to dust control. These measures include:

- stabilizing construction roads and spoil piles
- limiting speeds on unpaved construction roads
- watering unpaved construction roads
- performing housekeeping (e.g., remove dirt spilled onto paved roads)
- covering haul trucks when loaded or unloaded
- minimizing material handling (e.g., drop heights, double handling)

- ceasing grading and excavation activities during high winds and extreme air pollution episodes
- phasing grading to minimize the area of disturbed soils
- using temporary or permanent vegetation on-road medians and slopes.

Construction and preconstruction activities including on-road construction vehicles, worker vehicles, off-road construction equipment, marine engines, and locomotive engines would also result in greenhouse gas (GHG) emissions, principally carbon dioxide (CO_2). Assuming a 7-year period for construction and preconstruction activities and typical construction practices, the review team estimates that the total construction equipment CO_2 emission footprint for building Lee Nuclear Station Units 1 and 2 would be of the order of 70,000 metric tons (MT) (i.e., an emission rate of about 10,000 MT annually, averaged over the period of construction and preconstruction), compared to a total United States annual CO_2 emission rate of 5,500,000,000 MT (EPA 2011c). Appendix J provides the details of the review team estimate for a reference 1000-MW(e) nuclear power plant. The control strategies to minimize daily emissions of criteria pollutants would also reduce GHG emissions. Based on its assessment of the relatively small construction equipment carbon footprint as compared to the United States annual CO_2 emissions, the review team concludes that the atmospheric impacts of GHGs from construction and preconstruction activities would not be noticeable and additional mitigation would not be warranted.

In general, emissions from construction and preconstruction activities (including GHGs) would vary based on the level and duration of a specific activity, but the overall impact is expected to be temporary and limited in magnitude. In its ER, Duke lists several strategies that may be used to limit air-quality impacts, such as phasing construction and preconstruction activities to minimize daily emissions and performing construction vehicle maintenance to improve efficiency. These are best industry practices for reducing emissions for construction projects of a comparable size to the proposed project. A mitigation plan could also include strategies to reduce CO_2 emissions, including keeping equipment in good working order, reducing idling time, using clean diesel technologies, or using alternative fuel vehicles. Additionally, after preconstruction activities such as site clearing and grading are performed, Duke may minimize air-quality impacts by mulching non-marketable timber rather than burning it (Duke 2009c). The review team concludes that the impacts from construction and preconstruction activities on air quality would not be noticeable because appropriate mitigation measures would be adopted.

4.7.2 Traffic

Duke (2009c) reports that the average construction workforce for proposed Lee Nuclear Station Units 1 and 2 would be approximately 4398 workers during a 72-month period with a peak workforce of 4613 workers during month 27. The peak workforce includes 4510 workers related to Units 1 and 2 and 103 workers related to Make-Up Pond C (see Section 4.4.2 for additional details). Most of the work activity is expected to occur during a single 10- to 12-hour shift, with the possibility of an additional shift.

In addition, Duke conservatively estimates about 100 truck deliveries during the workday (Duke 2009c). McKowns Mountain Road is the primary access road to the Lee Nuclear Station site; this road would experience a significant increase in traffic during shift changes that could lead to periods of congestion and decreased air quality. However, the overall impact caused by increased traffic volume and congestion would be localized and temporary. Duke has stated that traffic mitigation measures would be considered to reduce the impact of increased traffic on air quality. These mitigation measures are discussed in Section 4.4.4.1. Mitigation measures proposed by Duke include staggering shifts during building activities, installing additional traffic signals at certain intersections, and encouraging carpooling (Duke 2012k). Additional mitigation measures, if needed, could include scheduling deliveries to avoid shift changes or high commute times (Duke 2012k). As discussed in Section 4.4.4.1, SCDOT established a minimum acceptable LOS of D or above (Duke 2008l). Without the traffic mitigation measures proposed by Duke, major intersections near the Lee Nuclear Station site would not meet this LOS.Workforce transportation would also result in GHG emissions, principally CO_2. Assuming a 7-year period for construction and preconstruction, and a typical workforce, the review team estimates that the total workforce CO_2 emission footprint for building Lee Nuclear Station Units 1 and 2 site would be of the order of 300,000 MT (i.e., an emission rate of about 43,000 MT annually, averaged over the 7-year period); again, this is compared to a total United States annual CO_2 emission rate of 5,500,000,000 MT (EPA 2011c). Several of the strategies described as possible traffic mitigation options (e.g., use of carpools) would also lead to reduced CO_2 emissions. Appendix J provides the details of the review team estimate of CO_2 emissions for a reference 1000-MW(e) nuclear power plant.

Based on its assessment of the relatively small construction workforce carbon footprint compared to the United States annual CO_2 emissions, the review team concludes that the atmospheric impacts of GHGs from construction workforce transportation would not be noticeable and additional mitigation would not be warranted. Based on Duke's requirement to develop traffic mitigation measures (Duke 2012k) in order to meet SCDOT's minimum LOS for major intersections, the review team concludes that the impact on the local air quality (including the effects of GHG emissions) from the increase in vehicular traffic related to construction and preconstruction activities would be temporary and minimal because appropriate mitigation measures would be adopted.

4.7.3 Summary of Meteorological and Air-Quality Impacts

Based on information provided by Duke and the review team's independent evaluation of the potential impacts on air quality from construction and preconstruction activities associated with proposed Lee Nuclear Station Units 1 and 2, the review team concludes that the impacts on air quality from criteria pollutants and CO_2 emissions would be SMALL and that no further mitigation, other than that proposed by the applicant, would be warranted. Based on the above analysis and because NRC-authorized construction activities represent only a portion of the analyzed activities, the NRC staff concludes that the air-quality impacts of NRC-authorized construction activities would also be SMALL; the NRC staff also concludes that no further mitigation, beyond the applicant's commitments, would be warranted. The ER (Duke 2009c) is silent regarding meteorological impacts associated with site-preparation and development activities. Nevertheless, based on the review team's evaluation, the activities during this phase of the project would have a negligible impact on meteorological conditions.

4.8 Nonradiological Health Impacts

Nonradiological health impacts on the public and workers from site preparation, building activities, and the transport of materials and personnel to and from the site, include exposure to dust and vehicle exhaust, occupational injuries, and noise. The area around the Lee Nuclear Station site is predominantly rural with a population of approximately 43,132 people living within 10 mi of the site (Duke 2009c). No significant industrial or commercial facilities are currently located or planned within 5 mi of the site (Duke 2009c). People who are vulnerable to nonradiological health impacts from site-preparation and building-related activities include people working or living in the vicinity or adjacent to the site; transient populations in the vicinity (i.e., temporary employees, recreational visitors, tourists); and construction workers and personnel working at the Lee Nuclear Station site. The following sections discuss the results of the review team's assessment of nonradiological health impacts from construction and preconstruction of proposed Lee Nuclear Station Units 1 and 2.

4.8.1 Public and Occupational Health

This section includes a discussion of the impacts of building the proposed Units 1 and 2 on public nonradiological health and the impacts from site preparation and development on worker nonradiological health. Section 2.10 provides background information on the affected environment and nonradiological health at and within the vicinity of the Lee Nuclear Station site.

4.8.1.1 Public Health

Impacts on the public from site-preparation and/or development activities at the Lee Nuclear Station could include dust and vehicle exhaust, and operation of the concrete batch plant, as sources of air pollution. If the project is not completed, similar activities associated with redress would be expected (Duke 2009c). In its ER, Duke (2009c) stated that operational controls would be imposed to mitigate dust emissions (i.e., stabilizing construction roads and spoils piles, limiting speeds on unpaved construction roads, periodically watering unpaved roads, covering haul trucks, minimizing material handling, ceasing grading and excavation activities during periods of strong winds and extreme air pollution episodes, phasing grading to minimize the area of disturbed solids, and revegetating road medians and slopes).

Construction Impacts at the Lee Nuclear Station Site

The Lee Nuclear Station site would be located in Cherokee County, South Carolina, which is currently classified as an attainment area for NAAQS. Regional air quality is discussed in Section 2.9 of this EIS, and impacts on air quality from building activities is discussed further in Section 4.7. Duke stated that applicable Federal, State, and local emission requirements would be adhered to as they relate to open burning or the operation of fuel-burning equipment. Appropriate Federal, State, and local permits and operating certificates would be obtained as required (Duke 2009c). Engine exhaust would be minimized by maintaining fuel-burning equipment in good mechanical order (Duke 2009c).

Particulates resulting from operation of the concrete batch plant would be another potential source of nonradiological health impacts. Duke would operate the batch plant under an air permit issued by the SCDHEC that would specifically apply to the batch plant, and would employ particulate controls required by the permit (Duke 2009c).

The public would not be allowed close to the Lee Nuclear Station site. The nearest accessible area would be the Pick Hill boat access on the east bank of the Ninety-Nine Islands Reservoir, approximately 0.4 mi from the Lee Nuclear Station site (Duke 2009c). The nearest residence is approximately 0.99 mi from the Lee Nuclear Station site (Duke 2013d). Based on the mitigation measures identified by Duke in its ER, the permits and authorizations required by State and local agencies, and the review team's own independent review, the review team concludes that the nonradiological health impacts on the public from site-preparation and building activities would be negligible and that additional mitigation beyond the actions identified above would not be warranted.

4.8.1.2 Construction Worker Health

U.S. Bureau of Labor Statistics reports take into account occupational injuries and illnesses as total recordable cases, which includes cases that result in loss of consciousness, days away from work, restricted work activity or job transfer, or medical treatment beyond first aid. The review team estimated the annual number of recordable cases based on U.S. and South Carolina total recordable case rates for the year 2009. The 2009 recordable incidence rates in utility construction (the number of injuries and illnesses per 100 full-time workers) for the U.S. and South Carolina were 3.8 and 2.8, respectively (BLS 2010a, b). Duke (2009c) reports that the average construction workforce for proposed Lee Nuclear Station Units 1 and 2 would be approximately 4398 workers during a 72-month period with a peak workforce of 4613 workers during month 27 (see Section 4.4.2 for workforce details). Based on this assessment, an estimated 129 occupational illnesses or injuries could occur each year.

Occupational injury and fatality risks are reduced by strict adherence to NRC and OSHA safety standards, practices, and procedures. Appropriate State and local statutes also must be considered when assessing the occupational hazards and health risks associated with construction. Duke stated they would fully adhere to NRC, OSHA, and State safety standards, practices, and procedures during any activities related to site preparation/excavation or building the proposed facility (Duke 2009c).

Other nonradiological health impacts on workers who are clearing land or building the facility discussed in this section include noise, fugitive dust, and gaseous emissions resulting from site-preparation and development activities. Mitigation measures discussed in this section for workers, such as operational controls and practices, would also help limit exposure to the public. Specifically, diesel exhaust is a potential human carcinogen. Measures to reduce worker exposure to diesel exhaust include retrofitting engines with an EPA-certified exhaust filtration device; positioning exhaust pipes away from workers; ensuring engines are fitted with catalytic converters; ensuring proper ventilation when operating diesel-fueled equipment indoors; using enclosed, climate-controlled and pressured cabs equipped with high-efficiency particulate air filters; regularly maintaining diesel engines; and turning diesel engines off when not in use for more than a few minutes (EPA 2012). Onsite impacts on workers also would be mitigated through training and use of personal protective equipment to minimize the risk of potentially harmful exposures (Duke 2009c). Emergency first-aid care and regular health and safety monitoring of personnel also could be undertaken. Based on the mitigation measures identified by Duke in its ER, the permits and authorizations required by State and local agencies, and the review team's own independent review, the review team concludes that the nonradiological health impacts on construction worker health from site-preparation and building activities would be negligible and that additional mitigation beyond the actions identified above would not be warranted.

4.8.2 Noise Impacts

Development of a nuclear power plant is similar to other large industrial projects—it involves many noise-generating activities. Regulations governing noise from site-preparation and building activities are generally limited to worker health. Federal regulations governing construction noise are found in 29 CFR Part 1910 and 40 CFR Part 204. The regulations in 29 CFR Part 1910 govern noise exposure in the construction environment, and the regulations in 40 CFR Part 204 generally govern the noise levels of compressors. Neither South Carolina nor Cherokee County has specific noise regulations; however, Duke stated that all workers would be trained in compliance with regulations outlined in the Noise Control Act of 1972 (42 U.S.C. 4901 et seq.) (Duke 2009c).

Duke (2011b) stated the activities associated with building the proposed Lee Nuclear Station Units 1 and 2 would have peak noise levels in the range of 80 to 95 dBA at a distance of 50 ft from their source. A decrease of 10 dBA in noise level is generally perceived as cutting the loudness in half. At a distance of 100 ft from the source, these noise levels would generally decrease to the 74 to 89 dBA range, and at a distance of 400 ft the noise levels would generally be in the 62 to 77 dBA range (Duke 2011b). For context, Tipler (1982) lists the sound intensity of a quiet office as 50 dBA, normal conversation as 60 dBA, busy traffic as 70 dBA, and a noisy office with machines or an average factory as 80 dBA. Construction noise (at 10 ft) is listed as 110 dBA, and the pain threshold is 120 dBA.

The nearest residence to the Lee Nuclear Station site is approximately 4077 ft from most building activities for the new units (Duke 2011b). A 100 dBA noise level at 50 ft from an activity would be expected to decrease to less than 70 dBA at the exclusionary boundary along the Broad River (Duke 2011b). Similarly, a 100 dBA noise level would be expected to decrease to less than 60 dBA at the nearest residence (Duke 2011b). These estimates are conservative because they do not include the increase of noise attenuation attributed to vegetation and topography at the Lee Nuclear Station site.

There are no major roads, public buildings, or residences within the exclusion area; however, there are four family cemeteries located within the exclusionary boundary, one of which is within 2000 ft of the proposed building site and it may be affected by noise from site preparation and development (Duke 2009c). Recreation activities such as fishing and boating on the Broad River may also be affected by noise during building (Duke 2009c). Building activities would be expected to take place between 0700 and 1700 hours, but there will be occasions when activities will take place during nighttime hours (Duke 2009c).

According to the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NRC 1996), noise levels below 60 to 65 dBA are considered to be of small significance. More recently, the impacts of noise were considered in Supplement 1, *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors* (NRC 2002). The criterion for assessing the level of significance was not expressed in terms of sound levels but based on the effect of noise on human activities and on threatened and endangered species. The criterion in NUREG-0586, Supplement 1, is stated as follows:

> The noise impacts...are considered detectable if sound levels are sufficiently high to disrupt normal human activities on a regular basis. The noise impacts...are considered destabilizing if sound levels are sufficiently high that the affected area is essentially unsuitable for normal human activities, or if the behavior or breeding of a threatened and endangered species is affected.

Considering the anticipated low noise levels at sensitive receptor locations, the implementation of OSHA-required procedures to protect worker health, the temporary nature of construction activities, compliance with Noise Control Act regulations, and the location and site characteristics of the Lee Nuclear Station site, the review team concludes that the noise impacts from construction and preconstruction would be minimal and that additional mitigation beyond the actions identified above would not be warranted.

4.8.3 Impacts of Transporting Construction Materials and Construction Personnel to the Lee Nuclear Station Site

This EIS assesses the impact of transporting workers and construction materials to and from the Lee Nuclear Station site and alternative sites from the perspective of three areas of impact: the socioeconomic impacts, the air-quality impacts of dust and emissions from vehicle traffic, and the potential health impacts due to additional traffic-related accidents. The human health impacts are addressed in this section, while the socioeconomic impacts are addressed in Section 4.4.1.3, and the air-quality impacts are addressed in Section 4.7.2.

The general approach used to calculate nonradiological impacts of fuel and waste shipments is the same as that used for transportation of construction materials and construction personnel to and from the Lee Nuclear Station site. However, preliminary estimates are the only data available to estimate the demand for these transportation services. The assumptions made to fill in reasonable estimates of the data needed to calculate nonradiological impacts are discussed below.

Construction material requirements are based on information provided in the ER (Duke 2009c). Duke estimated that building each new AP1000 reactor requires up to 460,000 yd^3 of concrete, 71,000 T of structural steel and rebar, 1,420,000 linear ft of cable, and 69,000 linear ft of piping. These quantities would be doubled to account for a two-unit plant. In addition, the materials and workers required to construct Make-Up Pond C are also added as part of the preconstruction impacts. For the Make-Up Pond C development, the required materials are approximately as follows:

- 160,000 yd^3 of crushed stone for roads and laydown areas
- 250,000 yd^3 of crushed stone/riprap for dams
- 100,000 yd^3 of soil material for saddle dikes
- 50,000 yd^3 of concrete
- 4000 tons of rebar
- 200 miscellaneous semi-truck/trailer deliveries
- 2000 tons of precast concrete for Highway 329 bridge
- 5000 tons of asphalt paving
- 113,000 linear ft of piping
- 4000 linear ft of cabling.

Development of proposed Make-Up Pond C and its associated facilities is expected to require a maximum of 185 workers.

Construction Impacts at the Lee Nuclear Station Site

Additional information needed to develop the nonradiological impact estimates is as follows:

- It was assumed that shipment capacities are 10 m^3 (approximately 13 yd^3) of concrete per shipment, 10 MT (11 T) of structural steel, and 300 linear meters (1000 linear ft) of piping and cable per shipment. It was assumed that these materials would be transported to the site in a levelized manner over a 91-month period based on the schedule given in the ER (Duke 2009c).
- The number of construction workers was estimated to peak at 4613 (Duke 2009c). This value represents the peak workforce for construction of both units. This peak construction workforce for both units is conservatively used to estimate impacts for a single unit. Assuming 1.0 persons/vehicle, there would be about 4613 vehicles per day per unit. Each person was assumed to travel to and from the Lee Nuclear Station site 250 d/yr.
- Average shipping distances for construction materials were assumed to be 80 km (50 mi) one way. The average commute distance for construction workers was assumed to be 32 km (20 mi) one way.
- Accident, injury, and fatality rates during transportation of construction materials were taken from Table 4 in ANL/ESD/TM-150 *State-level Accident Rates for Surface Freight Transportation: A Reexamination* (Saricks and Tompkins 1999). Rates for South Carolina were used for construction material shipments, typically transported in heavy, combination trucks. The data in Saricks and Tompkins (1999) are representative of heavy truck accident rates and do not specifically address the impacts associated with commuter traffic (i.e., workers traveling to and from the site). However, a single source that provided all three rates to estimate the impacts from worker transportation to and from the site was not available. To develop representative commuter traffic impacts, a source was located that provided a South Carolina-specific fatality rate for all traffic for the years 2003 to 2007 (DOT 2009). The average fatality rate for this period in South Carolina was used as the base for estimating South Carolina-specific injury and accident rates. Adjustment factors were developed using national level traffic accident statistics in *National Transportation Statistics 2007* (DOT 2007). The adjustment factors are the ratio of the national injury rate to the national fatality rate and the ratio of the national accident rate to the national fatality rate. These adjustment factors were multiplied by the South Carolina-specific fatality rate to approximate the injury and accident rates for commuters in South Carolina.
- The Department of Transportation Federal Motor Carrier Safety Administration evaluated the data underlying the Saricks and Tompkins (1999) rates, which were taken from the Motor Carrier Management Information System, and determined that the rates were under-reported. Therefore, the accident, injury, and fatality rates in Saricks and Tompkins (1999) were adjusted using factors derived from data provided by the University of Michigan Transportation Research Institute (UMTRI) (2003). The UMTRI data indicate that accident rates for 1994 to 1996, the same data used by Saricks and Tompkins (1999), were under-reported by about 39 percent. Injury and fatality rates were under-reported by 16 and

36 percent, respectively. As a result, the accident, injury, and fatality rates were increased by factors of 1.64, 1.20, and 1.57, respectively, to account for the under-reporting. These adjustments were applied to the construction materials transported by heavy truck shipments similar to those evaluated by Saricks and Tompkins (1999) but not to commuter traffic accidents.

The estimated nonradiological impacts of transporting construction materials to the Lee Nuclear Station site and of transporting construction workers to and from the site are shown in Table 4-5. The worker commuter estimates are conservatively calculated for one unit based on peak construction workers for the construction of both units. The impacts for materials and transporting construction workers would be approximately doubled for construction of two units at the Lee Nuclear Station site. The units would be built on a staggered schedule; therefore, the peak construction worker demands for the two units occur in different years. As discussed above, the peak construction workforce is 4613 workers, so the peak nonradiological impact estimates would be slightly lower than double the estimates given in Table 4-4. Note the nonradiological impacts are dominated by transport of construction workers to and from the Lee Nuclear Station site; that is, the nonradiological impacts of transporting construction materials to the site are a small fraction of the impacts of transporting construction workers. The total annual construction fatalities represent about a 2 percent increase above the 45 traffic fatalities that occurred in Cherokee and York Counties in 2007 (DOT 2009). This represents a small increase relative to the current traffic fatality risks in the area surrounding the Lee Nuclear Station site.

The review team concludes that the impacts of transporting construction materials and personnel to the Lee Nuclear Station site would be minimal, and no mitigation would be warranted.

Table 4-5. Annual Nonradiological Impacts of Transporting Workers and Construction Materials to/from the Lee Nuclear Station Site for a Single AP1000 Reactor

	Accidents per Year Per Unit	Injuries per Year Per Unit	Fatalities per Year Per Unit
Workers	$1.50 \times 10^{+2}$	$6.6 \times 10^{+1}$	1.0×10^{0}
Materials			
Concrete	$2.2 \times 10^{+0}$	9.1×10^{-1}	1.2×10^{-1}
Rebar, structural steel	2.0×10^{-1}	8.3×10^{-2}	1.1×10^{-2}
Cable	1.2×10^{-2}	4.8×10^{-3}	6.4×10^{-4}
Piping	1.6×10^{-3}	6.5×10^{-4}	8.7×10^{-5}
Total – Construction	1.5×10^{2}	6.7×10^{1}	1.1×10^{0}

The impacts in Table 4-5 can be divided into preconstruction and construction impacts using data provided by Duke (2009c). Duke estimated that 60 percent of the traffic impacts would occur during preconstruction activities (essentially site preparation and building of non-safety-related structures, including Make-Up Pond C, transmission line, and the railroad spur) and the remainder during construction of safety-related structures. These ratios are applied to the total nonradiological impacts of transporting workers and materials to the site over the preconstruction and construction phases. The total impacts were estimated by the review team by multiplying the annual impacts in Table 4-5 by the equivalent number of years of peak construction activities at the site. For workers, this is equivalent to 3.8 years at the peak building worker demand (4163 workers), assuming a levelized annual increase from zero workers at the start of building activities to 4163 workers after 2 years and then back to zero workers after 6 years. This totals 17,500 worker-years. For materials, it was assumed the materials would be delivered to the site in a levelized manner over 6 years; thus, the materials impacts in Table 4-5 were multiplied by 6 years to obtain the total impacts. The accidents, injuries, and fatalities were then multiplied by the preceding ratios to separate the preconstruction phase impacts from the construction phase impacts. The results are presented in Table 4-6.

Table 4-6. Nonradiological Impacts during Preconstruction and Construction Activities at the Lee Nuclear Station for a Single AP1000

	Total Impacts		
	Total Accidents	**Total Injuries**	**Total Fatalities**
Total Impacts, Preconstruction Plus Construction			
Workers	5.5×10^2	2.5×10^2	3.8×10^0
Materials	1.4×10^1	6.0	8.1×10^{-1}
Total	5.7×10^2	2.5×10^2	4.7
Preconstruction[(a)]			
Workers	3.5×10^2	1.6×10^2	2.4
Materials	1.6×10^1	6.5	8.7×10^{-1}
Total	3.6×10^2	1.6×10^1	3.3
Construction[(a)]			
Workers	2.2×10^2	9.9×10^1	1.5×10^0
Materials	5.8	2.4	3.2×10^{-1}
Total	2.3×10^2	1.0×10^2	1.9×10^0

(a) The separation between preconstruction and construction traffic impacts was estimated by Duke (2009c) at 60 percent preconstruction and 40 percent construction. These percentages were applied to both worker and construction material impacts.

4.8.4 Summary of Nonradiological Health Impacts

As part of its evaluation of nonradiological health impacts, the review team considered the mitigation measures identified by Duke in its ER and relevant permits and authorizations required by State and local agencies for building Units 1 and 2. The team evaluated nonradiological impacts on public and construction worker health from fugitive dust, occupational injuries, noise, and transport of materials and personnel to and from the Lee Nuclear Station site. No significant impacts related to the nonradiological health of the public or workers were identified during the course of this review. Based on information provided by Duke and the review team’s independent evaluation, the review team concludes that the nonradiological health impacts of construction and preconstruction activities associated with the proposed Units 1 and 2 would be SMALL, and no further mitigation would be warranted. Based on the above analysis, and because NRC-authorized construction activities represent only a portion of the analyzed activities, the NRC concludes that the nonradiological health impacts of NRC-authorized construction activities would be SMALL; the NRC staff also concludes that no mitigation, beyond the applicant’s commitments, would be warranted.

4.9 Radiological Health Impacts

Because no nuclear fuel or radioactive waste would be onsite, construction workers on proposed Lee Nuclear Station Unit 1 would receive no radiation exposure above natural background radiation, which is currently estimated to average about 311 mrem/yr to the U.S. population (NCRP 2009).

After fuel for proposed Unit 1 is moved onsite and the reactor is fueled and put into operation, the potential sources of radiation exposure for construction workers on proposed Unit 2 would include direct radiation exposure, exposure from liquid effluents, and exposure from gaseous radioactive effluents from operation of proposed Unit 1. For the purposes of this discussion, construction and site preparation workers are assumed to be members of the public. Therefore, the dose estimates were compared to the dose limits for the public, pursuant to 10 CFR Part 20, Subpart D.

4.9.1 Direct Radiation Exposures

In its ER (Duke 2009c), Duke identified the proposed Unit 1 as a potential source of direct radiation exposure to proposed Unit 2 construction workers. The staff did not identify any additional sources of direct radiation during the site audit or during document reviews.

Because no operating reactors or radioactive materials are currently onsite, Duke based its direct radiation exposure characterization on Revision 19 of the Design Control Document (DCD) for the AP1000 reactor (Duke 2013a). Sources of direct radiation (i.e., refueling water storage tank) would be inside shielded buildings; therefore, the DCD characterized direct radiation from the containment building and other facility buildings as negligible (Westinghouse 2011). Based on the DCD characterization, Duke estimated direct radiation exposure to construction workers would be negligible (Duke 2013a).

In addition, at certain times during construction, Duke would receive, possess, and use specific radioactive byproduct, source, and special nuclear material in support of construction and preparations for operation. These sources of low-level radiation are required to be controlled by the applicant's radiation protection program, provided with physical protection when required, and have very specific uses under controlled conditions. Therefore, these sources are expected to result in a negligible contribution to construction worker doses.

4.9.2 Radiation Exposures from Gaseous Effluents

When operating, proposed Lee Nuclear Station Unit 1 would release gaseous effluents via the plant vent or the turbine building vent that could affect construction workers on Unit 2. Containment venting releases, auxiliary building ventilation releases, annex building releases, radwaste building releases, and the gaseous radioactive waste system would discharge via the plant vent. The condenser air removal system, gland seal condenser exhaust, and the turbine building ventilation would be released via the turbine building vent (Duke 2009c). Duke estimated construction worker dose from gaseous effluents based on gaseous release data from Revision 19 of the DCD (Duke 2013a). Two years of site-specific meteorological data (Duke 2013a) and the computer code XOQDOQ (Sagendorf et al. 1982) were used to predict annual average atmospheric dispersion and deposition values at various receptor locations. The gaseous release data and atmospheric dispersion values were input to the GASPAR II computer code (Strenge et al. 1987) to compute dose rates for the nearest location along the proposed Unit 1 protected area fence in each direction as well as for the nearest point of the Unit 2 shield building construction area (i.e., the principal construction area) (Duke 2013a). The annual dose to a construction worker at the principal construction area from gaseous effluents was estimated to be approximately 0.4 mrem (based on an occupancy of 2080 hr/yr) (Duke 2013a).

4.9.3 Radiation Exposures from Liquid Effluents

Duke estimated that radiation exposures from liquid effluents would not contribute to the proposed Unit 2 construction worker dose. Work performed after Unit 1 becomes operational, such as the tie-in of proposed Unit 2 liquid effluent piping into the discharge structure and blowdown piping of proposed Unit 1, would be completed by Unit 1 personnel under the Unit 1 radiation protection program (Duke 2013a).

4.9.4 Total Dose to Site-Preparation Workers

Duke (2013a) estimated the annual dose to a Unit 2 construction worker to be approximately 0.4 mrem assuming an occupancy of 2080 hr/yr. This estimated annual worker dose is entirely from the gaseous radiation pathway with negligible dose contributions from the other pathways. This dose is less than the 100-mrem annual dose limit to an individual member of the public found in 10 CFR 20.1301.

The maximum estimated annual collective dose to construction workers, based on an annual individual dose of approximately 0.4 mrem and an estimated workforce of 2100 workers, is approximately 0.83 person-rem. The maximum annual dose to a construction worker is much smaller than the approximately 311 mrem/yr that residents of the United States receive on average from background radiation (NCRP 2009).

4.9.5 Summary of Radiological Health Impacts

The NRC staff concludes that the estimate of doses to construction workers during building of the proposed Units 1 and 2 are well within NRC annual exposure limits (i.e., 100 mrem) designed to protect the public health. Based on information provided by Duke and the NRC staff's independent evaluation, the NRC staff concludes that the radiological health impacts on construction workers engaged in building activities related to the proposed Units 1 and 2 would be SMALL, and no further mitigation would be warranted. The NRC regulates radiation exposure from all NRC-licensed activities. Therefore, the NRC staff concludes the radiological health impacts for NRC-authorized construction of proposed Lee Nuclear Station Units 1 and 2 would be SMALL, and no further mitigation would be warranted.

4.10 Nonradioactive Waste Impacts

The following sections provide descriptions of the potential environmental impacts from the generation, handling, and/or disposal of nonradiological waste during building activities for the proposed Lee Nuclear Station. Potential types of nonradioactive wastes include construction debris, dredged spoils, stormwater runoff, municipal and sanitary waste, dust, and air emissions. The assessment of potential impacts resulting from these types of wastes is presented in the following sections.

4.10.1 Impacts on Land

Building activities related to proposed Lee Nuclear Station Units 1 and 2 would result in solid waste materials such as construction debris from excavation, land clearing, and dredge spoils. Construction debris from excavation and land clearing would be removed from the site via road or rail and disposed of at a licensed offsite facility (Duke 2009c). Duke may consider recycling woody debris from clearing activities for beneficial uses (e.g., using wood chips for mulch in landscaped areas of the site) (Duke 2009c).

Spoils generated from dredging the Broad River and Make-Up Ponds A and B for building activities associated with the intake and discharge structures for the new units would be placed in a 10.2-ac upland spoils area at the south end of the Lee Nuclear Station site near

McKowns Mountain Road (Duke 2009c). To reduce the amount of dredged spoils, they would be reused at the Lee Nuclear Station site whenever possible (Duke 2009c). The Department of the Army permit covering dredging during the building of proposed Lee Nuclear Station Units 1 and 2 would stipulate procedures to properly dispose of dredged spoils. Duke stated it would dispose of all waste generated by site-preparation and development activities for the Lee Nuclear Station site in accordance with applicable regulations, including the Resource Conservation and Recovery Act (RCRA) (Duke 2009c).

Based on Duke's stated commitment to manage solid wastes in accordance with all applicable Federal, State, and local requirements and standards, minimizing waste practices, and recycling when possible, the review team expects the impacts on land from nonradioactive wastes generated during the building of proposed Lee Nuclear Station Units 1 and 2 would be minimal, and no further mitigation would be warranted.

4.10.2 Impacts on Water

Building activities have the potential to affect surface water and groundwater on the Lee Nuclear Station site. Duke would obtain an NPDES General Permit for Stormwater Discharges from Large and Small Construction Activities to minimize potential impacts on surface water and groundwater during building activities. The SCDHEC would administer and enforce the NPDES general permit. As part of the permit, a SWPPP would be required, which would contain an erosion and sediment-control plan. Dewatering of the excavation site would be necessary during the site-preparation phase for Units 1 and 2, and that water would be discharged to the Broad River in accordance with the NPDES general permit (Duke 2009c). All dredging and other ground-disturbing activities near streams or waterbodies would implement BMPs associated with the site-specific SWPPP and comply with the NPDES permit requirements (Duke 2009c). Water-use impacts and water-quality impacts during the development of proposed Lee Nuclear Station Units 1 and 2 are further discussed in Section 4.2.

Onsite sanitary wastes generated during the building activities would be accommodated with a permanent sanitary drainage system (SDS), which would be installed and placed into service during site development, and would discharge offsite for processing at the Gaffney Board of Public Works' Broad River Waste Water Treatment Plant (Duke 2009c). The SDS would remain after building activities cease and would be used in the operation of proposed Lee Nuclear Station Units 1 and 2.

Duke consulted with the Gaffney Board of Public Works regarding the need for additional sanitary sewer service capacity (Duke 2010h). The Gaffney Board of Public Works stated that the Broad River Waste Water Treatment Plant has the capacity to handle the influx of wastewater from proposed Lee Nuclear Station Units 1 and 2 (Duke 2010h).

Based on regulated practices for managing liquid discharges including wastewater, the SCDHEC-issued NPDES permit and associated approved SWPPP, and Duke's plans to implement BMPs for managing building impacts on surface water and groundwater, the review team expects that impacts on water from nonradioactive effluents from building proposed Lee Nuclear Station Units 1 and 2 would be minimal, and no further mitigation would be warranted.

4.10.3 Impacts on Air

As discussed in Sections 4.4.1, 4.5.2, and 4.8.1, fugitive dust and other generated emissions during site-development activities would be managed by Duke according to a dust-control plan or similar document (Duke 2009c). Possible mitigation measures described in the dust-control plan would include stabilizing construction roads and spoils piles, limiting speed on unpaved roads, covering haul trucks, and watering unpaved construction roads (Duke 2009c). Equipment and vehicles used for site preparation and the increase in vehicle traffic of workers involved in building proposed Lee Nuclear Station Units 1 and 2 would result in increased gaseous and particulate emissions. Possible mitigation measures that would be used to limit these emissions include phased construction and performance maintenance on construction vehicles and equipment (Duke 2009c).

Based on the regulated practices for managing air emissions from construction equipment and temporary stationary sources, the review team expects that impacts on air from nonradioactive emissions during the building of proposed Lee Nuclear Station Units 1 and 2 would be minimal, and no further mitigation would be warranted.

4.10.4 Summary of Nonradioactive Waste Impacts

Solid, liquid, and gaseous wastes generated during the building of proposed Lee Nuclear Station Units 1 and 2 would be handled according to county, State, and Federal regulations. County and State permits and regulations for handling and disposal of solid waste and USACE permits for disposal of dredged spoils would be obtained and implemented. An NPDES permit with a SWPPP for surface-water runoff and groundwater quality, and the use of permanent facilities for sanitary-waste systems during the building period would ensure compliance with the CWA and the State of South Carolina standards. Based on this information provided by Duke and the review team’s independent evaluation, the review team concludes that nonradiological waste impacts on land, water, and air during construction and preconstruction activities would be SMALL and that additional mitigation would not be warranted. Based on the above analysis and because NRC-authorized construction activities represent only a portion of the analyzed activities, the NRC staff concludes that the nonradioactive waste impacts of NRC-authorized construction activities would be SMALL and that no further mitigation would be warranted. In its draft EIS comment letter dated March 6, 2012, the EPA recommended that the applicant incorporate sustainable or “green” building practices into non-safety-related areas of plant development, as practicable. Suggestions included using permeable pavement, re-planting construction laydown areas with native vegetation, and considering using environmentally friendly (e.g., recycled) materials for non-safety-related buildings and infrastructure (EPA 2012).

Cumulative impacts on water and air from nonradioactive effluents and emissions are discussed in Sections 7.2 and 7.6, respectively. For the purposes of Chapter 9, the review team expects that there would be no substantive differences between the impacts of nonradioactive waste for Lee Nuclear Station site and the alternative sites, and no substantive cumulative impacts that warrant further discussion beyond those discussed for the alternative sites in Section 9.3.

4.11 Measures and Controls to Limit Adverse Impacts During Construction

In its evaluation of environmental impacts during building activities for the proposed Lee Nuclear Station Units 1 and 2, the review team relied on Duke's stated intention to comply with the following measures and controls that would limit adverse environmental impacts:

- compliance with applicable Federal, State, and local laws, ordinances, and regulations intended to prevent or minimize adverse environmental impacts
- compliance with applicable requirements of Federal and State permits or licenses required for building the new units
- implementation of BMPs and good construction practices to limit potential impacts
- incorporation of environmental protection requirements into construction contracts.

The review team considered these measures and controls in its evaluation of the impacts of building proposed Lee Nuclear Station Units 1 and 2. Table 4-7 summarizes the measures and controls to limit adverse impacts when building proposed Units 1 and 2 based on Table 4.6-1 in the ER (Duke 2009b) and other information provided by the applicant. Some measures apply to more than one impact category.

Table 4-7. Measures and Controls to Limit Adverse Impacts when Building Proposed Lee Nuclear Station Units 1 and 2

Impact Category	Specific Measures and Controls
Land-use impacts	
Site and vicinity, including Make-Up Pond C	Limit ground disturbances to the smallest amount of area necessary to construct and maintain the proposed facilities. Minimize work in wetlands, floodplains, and prime farmlands to the extent possible. Perform ground-disturbing activities in accordance with SCDHEC stormwater permit requirements. Use erosion-control and stabilization measures. Limit ground-disturbing activities such as vegetation removal to the area designated for preconstruction and construction activities. Minimize potential spills of hazardous wastes/materials through training and rigorous compliance with applicable regulations.

Table 4-7. (contd)

Impact Category	Specific Measures and Controls
	Restrict soil stockpiling and reuse to designated areas on the Lee Nuclear Station site. Restore temporarily disturbed areas to allow for other land uses.
Transmission-line corridors and offsite areas	Site new corridors to avoid critical or sensitive habitat or species and to minimize work in wetlands, floodplains, and prime farmlands. Limit ground-disturbing activities such as vegetation removal to defined corridors and areas within those corridors to avoid nesting activities to the extent possible. Minimize potential impacts via avoidance and compliance with permitting requirements and BMPs. To the extent possible, avoid disturbing established crops while building the new transmission lines.
Water-related impacts	
Hydrologic alterations	Install rip rap, stemwalls, etc. to stabilize banks. Develop and implement a site-specific construction SWPPP and erosion-control plan. Conduct construction and dredging activities in compliance with USACE requirements, and SCDHEC and NPDES stormwater permits. Dispose of pond dredged material in an onsite spoils area. Place spoil material on top of railroad-spur embankment during construction of box culvert expansion at London Creek crossing. Use of small volume of flow from portion of London Creek above dam as compared to volume of Broad River at confluence.
Water-use impacts	Use BMPs, including cofferdams, to ensure dry conditions are necessary when building the dam and abutments for Make-Up Pond C. Groundwater levels will be lowered during construction; however, this effect will be local to the building site. Potable water will be obtained from a local municipality, and wastewater will be treated by a local municipality, and, therefore, onsite groundwater resources will not be affected.
Water-quality impacts	Install/construct cofferdams, settling basins, and/or use other standard engineering controls to protect affected waterbodies. Install a stormwater drainage system or settling basins at construction site and stabilize disturbed soils. Use BMPs during construction to minimize erosion and sedimentation. Use BMPs during construction to minimize the effects of discharging dewatering product to surface waterbodies.

Table 4-7. (contd)

Impact Category	Specific Measures and Controls
	Use BMPs to maintain equipment and prevent spills and leaks. Prepare and implement an SPCCP for site-development activities. Restrict activities using petroleum products and solvents to designated areas that are equipped with spill containment.
	Develop a SWPPP and erosion-control plans as required by the SCDHEC stormwater permit for construction practices.
	Develop a spill response plan for construction practices.
Ecological impacts	
Terrestrial and wetland ecosystems	Conduct land clearing according to Federal and State regulations, permit requirements, Duke's existing construction practices, and established BMPs.
	Conduct land clearing to minimize disturbance of vegetation and substrate.
	Phase building activities to minimize the duration of soil exposure and implement soil stabilization measures as quickly as possible after disturbance to minimize erosion and sedimentation.
	Obtain and comply with the Department of the Army permit and Clean Water Act Section 401 water-quality certification requirements to avoid, minimize, restore, and/or compensate impacts on wetlands, including development of a mitigation action plan.
	Water access roads and cleared areas to attenuate fugitive dust.
	Schedule vegetation clearing (including timber harvest) and grubbing, to the extent practicable, to avoid the migratory bird-nesting season.
	Locate equipment maintenance in an established yard away from wetlands and waterways.
	Site transmission towers such that wetlands and riparian areas are spanned by the conductors.
	Avoid environmentally sensitive areas as feasible (e.g., those with "important" habitats or species).
	Transplant, if practicable, Federal candidate and State-ranked plant species.
Aquatic ecosystems	Develop and implement a site-development SWPPP plan.
	Prepare and implement an SPCCP for site-development activities. Restrict activities using petroleum products and solvents to designated areas that are equipped with spill containment.
	Implement erosion and sediment-control plans that incorporate recognized BMPs.
	Install appropriate barriers and use BMPs to protect waterbodies and aquatic organisms prior to site-development activities.
	Obtain and comply with the Department of the Army permit, State 401 water-quality certification, and BMPs, including development of a mitigation action plan for wetland/stream impacts.

Table 4-7. (contd)

Impact Category	Specific Measures and Controls
	Screen pump inlets to avoid entraining fish and other large aquatic organisms during water diversion and dewatering activities.
Socioeconomic impacts	
Physical impacts	Implement construction contractual requirements to reduce the risk of potential exposure to noise, dust, and exhaust emissions.
	Stagger shifts, encourage carpooling, and schedule deliveries to mitigate shift change or commute times.
	Allow continued traffic flow during construction of new bridge and approaches for SC 329 alignment, then divert traffic to new alignment once complete.
	Perform construction activities in accordance with U.S. OSHA and South Carolina OSHA requirements.
	Provide appropriate job training to construction workers.
	Use dust-control measures (e.g., watering, stabilizing disturbed areas, covering trucks).
	Post signs near construction entrances and exits to make the public aware of potentially high construction traffic areas.
	Develop a traffic control mitigation plan.
	Establish procedures to ensure that all waste is disposed of according to applicable regulations such as the RCRA.
	Minimize impacts on air quality by mulching non-merchantable timber versus burning.
Social and economic impacts	Temporarily house employees in hotels, rental properties, and park facilities.
	Increase revenues to offset additional school resources, police, and fire protection.
	Increase water production at local facilities not operating at full capacity.
	Use existing landfills.
	In case of future property acquisitions, offer relocation assistance after closing residences and the option of staying in home up to 18 months rent-free, in order to find a replacement residence.
Environmental justice impacts	No mitigation measures required beyond those identified above.

Table 4-7. (contd)

Impact Category	Specific Measures and Controls
Historic and cultural properties impacts	Conduct cultural resource surveys, including subsurface sampling and visual impact assessments prior to initiating proposed and future ground-disturbing activities to identify historic properties and cultural resources.
	Implement the Lee Nuclear Station site cultural resources management plan and MOA between Duke, the South Carolina SHPO, USACE, and Catawba Indian Nation, including procedures to address inadvertent discoveries of potential historic properties or cultural resources.
	Relocate the Service Family Cemetery from Make-Up Pond C in coordination with the South Carolina SHPO, according to State law, and in cooperation with descendants.
	Avoid direct physical impacts on sensitive cultural resource (i.e., 38CK172 – possible human burial) located in transmission-line corridor.
	Avoid direct physical impacts on known historic cemeteries within the boundaries of the Lee Nuclear Station site and maintain public access.
Nonradiological health impacts	Adhere to all OSHA and State safety standards, practices, and procedures during building activities; provide regular training for site workers and visitors.
	Implement a site-wide safety and medical program, including procedures for emergency first aid and regular health and safety monitoring.
	No further mitigation beyond what is discussed under Socioeconomic Impacts–Physical Impacts would be required.
Radiological health impacts	Maintain doses to construction workers below NRC public dose limits (10 CFR Part 20).
Nonradioactive waste impacts	Handle waste generated during building in accordance with local, State, and Federal requirements.
	Implement a waste-minimization plan, including beneficial reuse and recycling of building debris.
	Implement both an SWPPP as required by the State NPDES permit and a SPCCP to reduce impacts from site runoff and spills.
	Implement operational controls (BMPs) to minimize fugitive dust emissions; implement traffic plans to reduce emissions from vehicles; regularly maintain emissions-generating equipment and operate in accordance with State air-quality regulations.

Source: Adapted from Table 4.6-1 of Duke 2009b

4.12 Summary of Construction and Preconstruction Impacts

The impact levels determined by the review team in the previous sections are summarized in Table 4-8. The impact levels for NRC-authorized construction as evaluated in this chapter are denoted in the table as SMALL, MODERATE, or LARGE as a measure of their expected adverse environmental impacts, if any. Combined construction and preconstruction impact levels are similarly noted. Some impacts, such as the addition of tax revenue from Duke for the local economies, are likely to be beneficial impacts on the community.

Table 4-8. Summary of Impacts from Construction and Preconstruction of Proposed Lee Nuclear Station Units 1 and 2

Resource Category	Comments	NRC-Authorized Construction Impact Level	Construction and Preconstruction Impact Level
Land Use			
The site and vicinity	The project would make use of a site with a history of industrial land disturbance, that is large enough to accommodate the new facilities without substantial encroachment into environmentally sensitive areas, and that does not conflict with zoning or surrounding land uses. However, building Make-Up Pond C would require acquisition of approximately 2110 ac of previously undisturbed rural land and long-term termination of agricultural and other rural land uses thereon. Additional land would be affected by building about 31 mi of new transmission lines.	SMALL	MODERATE
Transmission-line corridors and other offsite areas	New transmission-line corridors would occupy approximately 987 ac of land. Other offsite land-use impacts would be limited.	SMALL	MODERATE
Water-Related			
Surface-water use	Construction and preconstruction impacts on surface water would be of limited duration, and peak water demands would represent a small portion of the available water.	SMALL	SMALL
Groundwater use	Construction and preconstruction impacts on groundwater use would be of limited magnitude, localized, and temporary.	SMALL	SMALL
Surface-water quality	Construction and preconstruction impacts on surface-water quality would be minimal and also localized and temporary.	SMALL	SMALL
Groundwater quality	Construction and preconstruction impacts on groundwater quality would be of limited magnitude, localized, and temporary.	SMALL	SMALL

Table 4-8. (contd)

Resource Category	Comments	NRC-Authorized Construction Impact Level	Construction and Preconstruction Impact Level
Ecology			
Terrestrial and wetland ecosystems	The loss of habitat due to preconstruction impacts within the immediate vicinity of Make-Up Pond C, especially the removal of mixed hardwood forest along London Creek and its tributaries, and within the transmission-line corridors, especially the removal of forest habitat, would noticeably alter but not destabilize terrestrial and wetland resources. The loss of habitat at Make-Up Pond C would permanently reduce wildlife populations in the London Creek watershed and reduce the functionality of the watershed as a wildlife travel corridor. The loss of upland habitat on the Lee Nuclear Station site would be spatially extensive, but about half of the loss would occur in previously disturbed, low-quality, early successional habitats. Temporary drawdown of Make-Up Ponds A and B during construction of intake/refill structures could temporarily alter the function of some marginal wetlands. Preconstruction impacts would be minor within the railroad-spur corridor and offsite road-improvement areas.	SMALL	MODERATE
Aquatic Ecosystems	The loss of aquatic biota and lotic habitat associated with preconstruction impacts within the immediate vicinity of Make-Up Pond C, mainly as a result of the impoundment of London Creek to create the supplemental cooling-water reservoir, would noticeably alter but not destabilize aquatic resources. Temporary drawdown of Make-Up Ponds A and B to minimize pressure on cofferdams during construction of intake/refill structures would temporarily alter benthic, littoral, and shoreline habitats. Other preconstruction impacts on aquatic resources would be minor at the Lee Nuclear Station site.	SMALL	MODERATE
Socioeconomics			
Physical impacts	Preconstruction physical impacts on aesthetics would occur; most of the impacts would be associated with development of the Make-Up Pond C site. Other physical impacts would not be noticeable.	SMALL	MODERATE
Demography	Construction and preconstruction demographic impacts on the communities nearest the Lee Nuclear Station site would be small and temporary.	SMALL	SMALL
Economic impacts on the community	Construction and preconstruction economic and tax revenue impacts on the communities nearest the Lee Nuclear Station would be minimal.	SMALL (beneficial)	SMALL (beneficial)

Table 4-8. (contd)

Resource Category	Comments	NRC-Authorized Construction Impact Level	Construction and Preconstruction Impact Level
Infrastructure and community services	Construction and preconstruction traffic impacts would be noticeable, particularly on McKowns Mountain Road near the Lee Nuclear Station site. Other infrastructure and community services impacts would not be noticeable.	MODERATE	MODERATE
Environmental Justice	There are no environmental, health, or socioeconomic pathways by which the identified minority or low-income populations in the 50-mi region would be likely to suffer disproportionately high and adverse impacts as a result of construction and preconstruction activities.	SMALL	SMALL
Historic and Cultural Resources			
The site and vicinity	Construction impacts on historic properties and cultural resources would be negligible with implementation of the Lee Nuclear Station site cultural resources management plan and MOA between Duke, the South Carolina SHPO, USACE, and Catawba Indian Nation. Preconstruction impacts on historic and cultural resources would be noticeable but not destabilizing within the Make-Up Pond C site with successful relocation of the Service Family Cemetery.	SMALL	MODERATE
Transmission-line corridors and other offsite areas	Construction impacts on historic properties and cultural resources would be negligible in the transmission-line and railroad-spur corridors with implementation of Duke Energy's corporate procedures to protect known historic and cultural resources, including avoidance of a possible human burial site (38CK172).	SMALL	SMALL
Air Quality	Construction and preconstruction impacts on air quality would be limited.	SMALL	SMALL
Nonradiological Health	Construction and preconstruction impacts on nonradiological human health would be minimal.	SMALL	SMALL
Radiological Health	Doses to construction workers would be maintained below NRC public dose limits (10 CFR Part 20).	SMALL	SMALL
Nonradioactive Waste	Impacts on land, water, and air would be minimal.	SMALL	SMALL

5.0 Operational Impacts at the Lee Nuclear Station Site

This chapter examines environmental issues associated with operation of proposed Units 1 and 2 at the William States Lee III Nuclear Station (Lee Nuclear Station). Duke Energy Carolinas, LLC (Duke) has applied for combined construction permits and operating licenses (COLs) for two units and submitted an environmental report (ER) that discussed the environmental impacts of station operation (Duke 2009b, c). In its evaluation of operational impacts, the review team, comprising members of the U.S. Nuclear Regulatory Commission (NRC) staff, its contractors, and the U.S. Army Corps of Engineers (USACE), relied on operational details supplied by Duke in its ER, Duke's responses to NRC Requests for Additional Information (RAIs), and the review team's own independent review. The review team also consulted permitting correspondence between Duke and the USACE, a cooperating agency, in this action.

This chapter is divided into 13 sections. Sections 5.1 through 5.11 discuss the potential operational impacts on land use, water, terrestrial and aquatic ecosystems, socioeconomics, environmental justice, historic and cultural resources, meteorology and air quality, nonradiological health, radiological health, nonradioactive waste, as well as postulated accidents. Section 5.12 discusses measures and controls that would limit the adverse impacts of station operation during the 40-year operating period. In accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, impacts have been analyzed and a significance level of potential adverse impacts (i.e., SMALL, MODERATE, or LARGE) has been assigned to each analysis. In the area of socioeconomics related to taxes, the impacts may be considered beneficial and are stated as such, as appropriate. The review team's determination of significance levels is based on the assumption that the mitigation measures identified in the ER or activities planned by various State and county governments, such as infrastructure upgrades discussed throughout this chapter, are implemented. Failure to implement these mitigation measures and upgrades might result in a change in significance level. Mitigation of adverse impacts, beyond what is stated in the Duke ER, is also presented where appropriate.
A summary of operational impacts is presented in Section 5.13.

5.1 Land-Use Impacts

Sections 5.1.1 and 5.1.2 contain information regarding land-use impacts associated with operation of proposed Lee Nuclear Station Units 1 and 2. Section 5.1.1 discusses land-use impacts at the site and in the vicinity of the site. Section 5.1.2 discusses land-use impacts with respect to transmission-line corridors and offsite areas. No part of the Lee Nuclear Station project is proposed for the coastal zone. As explained in Section 4.1, no zoning conflicts or conflicts with land use plans, policies, or controls are expected from the project.

5.1.1 The Site and Vicinity, Including the Make-Up Pond C Site

Duke stated that no additional land on the Lee Nuclear Station site or the Make-Up Pond C site would be disturbed during operations (Duke 2009b, c). As noted in Section 4.1, there are no known zoning conflicts expected for the Lee Nuclear Station project. Duke has also stated that no part of the Lee Nuclear Station site would be used for agriculture during operations (Duke 2009b, c), including the 2 ac of prime farmland onsite. However, the soil properties of that prime farmland would remain undisturbed. The review team expects that no lands on the Make-Up Pond C site would be available for agricultural use, including any remaining areas of undisturbed prime farmland or farmland of statewide importance. Duke has not indicated whether any of the subject lands might one day be managed for forestry. However, the review team expects that limited forest management might be possible on undeveloped lands remaining on the Lee Nuclear Station site or lands owned by Duke around Make-Up Pond C.

Duke has not specifically stated in its application whether it might allow mining or extractive uses of undeveloped lands on the Lee Nuclear Station or Make-Up Pond C sites during operations. However, based on Duke's statements that no additional land on either property would be disturbed after construction (Duke 2009b, c), the review team expects that such uses would not be conducted during operation of the proposed units. The review team does not expect that operation of the proposed Duke facilities would interfere with the active sand mining operation situated approximately 1 mi upstream of the Lee Nuclear Station site or with other extractive operations that might be conducted in the vicinity in the future.

No additional land within the vicinity is expected to be disturbed directly by the operation of the Lee Nuclear Station; however, some offsite indirect land-use changes might result from the need to support plant maintenance and operation workers. Such indirect land-use changes might include conversion of some land, most likely land near the city of Gaffney and along various transportation corridors near the site, to housing developments such as apartment buildings, single-family condominiums and homes, and manufactured home parks.

The expansion of supporting services, such as light commercial and retail development providing services to Lee Nuclear Station workers, may also be expected in the surrounding vicinity. Property tax revenue from the operation of two nuclear units could also indirectly lead to additional growth and land conversion in Cherokee County (less so in York County) because of infrastructure improvements (e.g., upgraded roads and utility services). Additional information regarding operational-related socioeconomic and infrastructure impacts within the vicinity of the Lee Nuclear Station site can be found in Section 5.4.

Proposed Lee Nuclear Station Units 1 and 2 would use evaporative closed cooling systems. However, salt drift is not expected to affect land use outside of the Lee Nuclear Station site. NUREG-1555 (NRC 2000a) suggests that leaf damage is unlikely when salt deposition is less than 1 to 2 kg/ha/mo. The maximum predicted salt deposition rate from operation of proposed

Units 1 and 2 is 0.0103 kg/ha/mo, approximately 200 m north of the cooling towers in the summer, which is well below the suggested threshold value of 1 to 2 kg/ha/mo for possible adverse effects to vegetation, and by extension, the terrestrial environment (Section 5.3.1). This value is considered peak deposition and is expected to be lower in all directions from the cooling tower during each season and annually (Duke 2013a).

Make-Up Pond C would have minimal land-use impacts during operations. However, public access to the pond would be restricted by a fence. The pond would not be available for public recreational use. Duke expects to conduct maintenance associated with pipeline corridors. Maintenance activities for the pipeline may occasionally temporarily close part of Rolling Mill Road (Duke 2010h).

Based on information provided by Duke and the review team's independent review, the review team concludes that operation of Lee Nuclear Station Units 1 and 2 would have a SMALL land-use impact and mitigation would not be warranted.

5.1.2 Transmission-Line Corridors and Offsite Areas

As discussed in Section 4.1.3, approximately 690 ac of forest on the proposed transmission-line corridors would be permanently cleared. Easements are expected to restrict the placement of permanent structures or tree plantings that may interfere with line maintenance. However, Duke would allow farming and crop production within the transmission corridors. Routine or seasonal transmission-line maintenance would take place outside of crop production time frames, limiting impacts to crops. Most of the approximately 163 ac of prime farmland or farmland of statewide importance within the proposed transmission-line corridor could remain in agricultural production, although small amounts of farmland could be removed from agricultural use to place the transmission towers. Allowable uses in the cleared corridors might include pasture, crop production, road construction, parking lots, and other uses that do not interfere with the safe, reliable operation of the transmission lines.

Duke would be responsible for conducting, and expects to conduct, routine maintenance associated with the reliability and safety of the new corridors. These activities include, but are not limited to, inspections, clearing of vegetation in the corridors as needed, repair and replacement of equipment, and any necessary activities regarding the maintenance of lines in the existing Pacolet-Catawba and Oconee-Newport corridors.

Duke anticipates no additional restrictions in the transmission-line corridors. Therefore, the review team concludes that the land-use impacts of operation would be SMALL and additional mitigation would not be warranted.

5.1.3 Summary of Land-Use Impacts during Operations

The review team evaluated the potential land-use impacts from operation of proposed Lee Nuclear Station Units 1 and 2. Based on information provided by Duke in its ER (Duke 2009c), the supplement to the ER (Duke 2009b), other information provided by Duke, and the review team's independent evaluation, the review team concludes land-use impacts from operating proposed Lee Nuclear Station Units 1 and 2 would be SMALL, and additional mitigation would not be warranted.

5.2 Water-Related Impacts

This section discusses water-related impacts to the environment from operation of the proposed Lee Nuclear Station Units 1 and 2.

Managing water resources requires understanding and balancing the tradeoffs between various, often conflicting, objectives. At the Lee Nuclear Station site, these objectives include recreation, visual aesthetics, a fishery, and a variety of beneficial consumptive domestic, farming, and industrial uses of water.

Water-use and water-quality impacts involved with operation of a nuclear plant are similar to the impacts associated with any large thermoelectric power generation facility. Accordingly, Duke must obtain the same water-related permits and certifications as any other large industrial facility. These would include:

- Clean Water Act (CWA) Section 401 Certification. This certification would be issued by the South Carolina Department of Health and Environmental Control (SCDHEC) and would confirm that operation of the plant would not conflict with State water-quality-management programs.
- CWA Section 402(p) National Pollutant Discharge Elimination System (NPDES) Discharge Permit. This permit (Permit No. SC0049140) was issued by the SCDHEC on July 17, 2013, effective September 1, 2013, and regulates limits of pollutants in liquid discharges to surface water.
- CWA Section 316(a). This section regulates the cooling-water discharges to protect the health of the aquatic environment. The scope is covered under the NPDES permit issued to Duke by SCDHEC.
- CWA Section 316(b). This section regulates cooling-water intake structures to minimize environmental impacts associated with location, design, construction, and capacity of those structures. The scope is covered under the NPDES permit issued to Duke by SCDHEC.

- South Carolina Surface Water Withdrawal, Permitting, Use, and Reporting Act (SC Code Ann. 49-4). This act provides for the permitting of surface-water withdrawals greater than 3 million gallons per month.
- Federal Power Act Sections 4(e) and 15. This act requires a license from the Federal Energy Regulatory Commission (FERC) for operation and maintenance of 18-MW Ninety-Nine Islands Hydroelectric Project No 2331.

The responsibility for regulating water quality pursuant to the CWA is delegated by the U.S. Environmental Protection Agency (EPA) to the SCDHEC. On August 11, 2011, Duke submitted an application for an NPDES permit for the proposed Lee Nuclear Station to the SCDHEC (Duke 2011a). The SCDHEC issued NPDES permit SC0049140 to Duke on July 17, 2013 (SCDHEC 2013a).

Details of the operational modes and cooling-water systems associated with operation of the plant can be found in Section 3.4.1 of this environmental impact statement (EIS). A description of the Lee Nuclear Station site's operational hydrological alterations was presented in Section 5.3 of the ER (Duke 2009c).

This section discusses the review team's independent assessment of the impacts of operating proposed Lee Nuclear Station Units 1 and 2 on the affected water resources. The expected hydrologic alterations in surface water and groundwater related to operation of proposed Lee Nuclear Station Units 1 and 2 are discussed in Section 5.2.1. Water-use impacts are discussed in Section 5.2.2 for surface water (5.2.2.1) and groundwater (5.2.2.2). Water-quality impacts are discussed in Section 5.2.3 for surface water (5.2.3.1) and groundwater (5.2.3.2). Water monitoring is discussed in Section 5.2.4 for surface water (5.2.4.1) and groundwater (5.2.4.2).

5.2.1 Hydrological Alterations

The water withdrawals from and discharges to the Broad River from the proposed Lee Nuclear Station Units 1 and 2 are described in Section 3.4.2.1. As described in Section 2.3.1, streamflow in the Broad River was characterized using three different data sets: Duke's 85-year synthetic gap-filled streamflow record, the review team's independently developed long-term gap-filled streamflow record, and the short-term record for the U.S. Geological Survey (USGS) gaging station just downstream of Ninety-Nine Islands Dam. Duke's estimate of the mean annual flow (2495 cfs), the review team's independent estimate (2485 cfs), and the USGS gage (1858 cfs) are not inconsistent. The lower value for the USGS gage reflects the bias caused by a short period of record (2000 through 2010) in which several severe droughts occurred. Based on its flow record, Duke reported a similar value (1956 cfs) as the mean annual flow for the 2001 to 2010 period.

The review team performed an independent confirmatory water budget assessment due to the importance of the water budget outcomes in determining the need for the construction of

Make-Up Pond C, which results in impacts other than SMALL in several resource areas. The review team assessed Duke's proposal for water withdrawal and discharge to the Broad River during operation of the proposed Lee Nuclear Station Units 1 and 2, as well as the projected fluctuations in pool elevations of Make-Up Pond B and Make-Up Pond C.

The review team then reviewed the monthly average estimates of cooling-tower evaporative losses provided by Duke and listed in Section 3.2.2.2. The review team acknowledges that evaporative losses are a function of meteorological conditions and are subject to inter-annual variability not reflected in these monthly averages. In order to estimate evaporative losses, pan evaporation data from July 1948 through December 2010 is available for Clemson, South Carolina (Duke 2011e), which is approximately 80 mi west-southwest of the Lee Nuclear Station site. This data shows an annual average pan evaporation rate of about 55 in. The annual estimated free-surface evaporation from the makeup ponds is less than the estimated annual precipitation.

Section 316(b) of the CWA regulating withdrawals "… requires that the location, design, construction and capacity of cooling-water intake structures reflect the best technology available for minimizing adverse environmental impact…." from the proposed Lee Nuclear Station. Duke would be required to comply with either a withdrawal limitation of 5 percent of the mean annual flow, or propose an alternative requirement. In their NPDES application, Duke proposed an alternative requirement that would limit withdrawal from the Broad River for refill of Make-Up Ponds B and C to the months of July through February to minimize impacts to aquatic biota (Duke 2011a). During these months, a maximum withdrawal from the Broad River would be 304 cfs. In Duke's Water Management Plan, set forth in the NPDES application, withdrawals from the Broad River would never result in the lowest FERC minimum flow requirement downstream of Ninety-Nine Islands Dam being violated. The Proportional Flow Limitation refers to 5 percent of the mean annual flow of the river from which the water is being withdrawn (40 CFR 125.84(b)(3)(i)). The Proportional Flow Limitation is not an instantaneous flow limitation. In the NPDES application, two mean annual flows were provided by Duke. Based on its long-term estimated mean annual flow of 2495 cfs through 2010, Duke estimated 125 cfs as the 5 percent flow limit. However, the 316(b) rule states "… Historical data (up to 10 years) must be used where available…." (40 CFR 125.83, *Annual mean flow*). Based on a mean annual flow of 1956 cfs for only the past 10 years of flow data, Duke estimated 98 cfs as the 5 percent flow limit. Both values were provided in the NPDES application. The review team considered both these limits and additionally the 5 percent of the mean annual flow for the 2000 to 2010 period at the USGS gage (96 cfs) in its independent confirmatory assessment of the hydrological alterations that could occur as a result of operation of the proposed Lee Nuclear Station. Subsequently, the SCDHEC issued NPDES permit SC0049140 to Duke on July 17, 2013 (SCDHEC 2013a) for the Lee Nuclear Station. The permit states: "The design intake flows of 98 cfs for the primary section and 206 cfs for the drought contingency section may not be exceeded."

The South Carolina Surface Water Withdrawal, Permitting, Use, and Reporting Act (SC Code Ann 49-4) states that for a licensed or otherwise flow controlled impoundment, a surface-water withdrawal permit "… may not authorize the withdrawal of surface water in an amount that would cause a reservoir: (a) water level to drop below its minimum water level; or (b) to be unable to release the lowest minimum flow specified in the license for that impoundment as issued by the appropriate government agency." Article 402 of the FERC license for Ninety-Nine Islands Dam issued June 17, 1996 (amended November 15, 2011), specifies continuous minimum flows below the dam for three periods: 966 cfs for January through April; 725 cfs for May, June, and December; and 483 cfs for July through November. It is unclear from Article 402 whether each of the three minimums or just the lowest minimum (483 cfs) is the appropriate criterion to curtail withdrawals. The review team discussed the definition of minimum flows with FERC, and decided to evaluate both seasonal low-flow limitations and a single low-flow limitation (NRC 2011c, NRC 2012c).

As mentioned above, the review team independently estimated daily flows in the Broad River for 1925 to 2011. This flow record was used to estimate the changes in the Broad River flow and fluctuations in the water surface of Make-Up Ponds B and C. In this assessment, the following were explicitly considered: monthly evaporation rates; monthly forced evaporation from the cooling towers; both 483 cfs and seasonal FERC limitations; three Proportional Flow Limit values (125, 98, and 96 cfs) for withdrawals from the Broad River; and transfers between the makeup ponds. The assessment was based on the principle of conservation of mass, and calculated the water budget at a daily time scale.

The review team's independent confirmatory calculation was similar to that used by Duke. The review team determined that the differences between the review team's approach and Duke's were minor and provided the review team confidence that Duke's assessment was appropriate.

5.2.2 Water-Use Impacts

A description of water-use impacts on surface water and groundwater is presented in the next sections. The water resource usage by proposed Lee Nuclear Station Units 1 and 2 operations is limited to the Broad River drainage. Surface water would be used by the proposed Lee Nuclear Station Units 1 and 2 for cooling and all other plant water needs. No local groundwater use is proposed during operation. Information presented in Duke's ER for the proposed Lee Nuclear Station Units 1 and 2 (Duke 2009b, c), information obtained by the review team, and independent analyses performed by the review team were used to assess water-use impacts.

5.2.2.1 Surface-Water Use

The proposed Lee Nuclear Station Units 1 and 2 would withdraw water from the Broad River. Operational surface-water withdrawals for the proposed Lee Nuclear Station Units 1 and 2 are estimated to be 78 cfs during normal operation. For the USGS gage below Ninety-Nine Islands Dam, the mean annual flow in the Broad River was 1858 cfs for the period water years 2000 to 2010 (USGS 2010a). The estimated surface-water withdrawals for the proposed Lee Nuclear Station Units 1 and 2 (78 cfs) would be 4.2 percent of the mean annual flow. Duke's proposed design intake flow would comply with EPA's 316(b) Proportional Flow Limitation (40 CFR 125.84(b)(3)(i)), which states "… for cooling-water intake structures located in a freshwater river or stream, the total design intake flow must be no greater than 5 percent of the source waterbody annual mean flow." Duke's proposed normal withdrawal of 78 cfs is 4 percent of the mean annual flow from the 10-year period of 2001 to 2010 at the USGS gage below Ninety-Nine Islands Dam (1921 cfs). Furthermore, the SCDHEC issued NPDES permit SC0049140 to Duke on July 17, 2013 (SCDHEC 2013a) for the Lee Nuclear Station. The permit states: "The design intake flows of 98 cfs for the primary section and 206 cfs for the drought contingency section may not be exceeded." The 78 cfs withdrawal, however, does not include withdrawals associated with refilling the Make-Up Pond C as described in Duke's proposed alternative requirement to the proportional flow limitation (Duke 2011a).

The majority of water withdrawn would be consumptively used by the proposed Lee Nuclear Station Units 1 and 2 for station cooling, primarily through evaporation. The estimated surface-water normal consumptive use of 55 cfs (cooling-tower evaporation and drift) would be 3.0 percent of the mean annual flow of 1858 cfs for the period of record (water years 2000 to 2010) at the USGS gage below Ninety-Nine Islands Dam. During operations, the proposed Lee Nuclear Station Units 1 and 2 would consumptively use, through cooling tower evaporation and drift (Section 3.4.2.2) and natural evaporation from the makeup ponds (Section 3.2.2.2, Table 3-2), only a small proportion of the Broad River flow. Therefore, the review team concludes that the impacts on surface-water use in the Broad River, as a result of proposed Lee Nuclear Station Units 1 and 2 operations would be SMALL, and mitigation would not be warranted.

5.2.2.2 Groundwater Use

Duke stated that groundwater would not be used during operation of the proposed Lee Nuclear Station Units 1 and 2 (Duke 2009c). Based on the low permeability of the subsurface adjacent to Make-Up Ponds A and B and the relatively temporary drawdown of these ponds, the review team determined that the effects from drawdown-refill events on the groundwater resource due to the makeup ponds would be local, temporary, and infrequent.

As described in Section 4.2.2.2, wells located near Make-Up Pond C may exhibit increased water levels during filling of Make-Up Pond C. Similarly, decreased water levels may occur when the pond is used for plant makeup during droughts. Drawdown events would be infrequent and temporary. Drawdown of Make-Up Pond C would not drop the water table below levels existing prior to initial filling of Make-Up Pond C.

Because (1) there would be no use of groundwater during operation and (2) there would be only local and short-term effects from drawdown of the makeup ponds during low-river-flow events, the review team concludes that groundwater-use impacts due to operation activities would be SMALL and no mitigation would be warranted.

5.2.3 Water-Quality Impacts

This section discusses the impacts on the quality of water resources from the operation of the proposed Lee Nuclear Station Units 1 and 2. Surface-water impacts include thermal, chemical, and radiological wastes, and physical changes in the Broad River resulting from effluents discharged by the proposed units. Section 5.2.3.1 discusses the impacts on surface-water quality and Section 5.2.3.2 discusses the impacts on groundwater quality.

5.2.3.1 Surface-Water Quality

No effluents are proposed to be discharged to any of the makeup ponds. The only source of water to the makeup ponds will be stormwater and water pumped from the Broad River. As discussed in Section 3.2.2.2, effluents from all the various sources, except sanitary wastes, will be discharged through a single blowdown and wastewater discharge structure on the upstream side of Ninety-Nine Islands Dam in the Broad River. Sanitary wastes will be transferred to the Gaffney Board of Public Works Wastewater Treatment Plant. The residual heat in the blowdown water, the residual chemicals used to manage the water chemistry in the cooling towers, and the solutes from the Broad River water that have been concentrated through evaporation from the cooling tower are the factors that the review team considered. The impacts of liquid radiological effluent are discussed in Section 5.9.

Residual Heat in Blowdown Water

Blowdown water from the cooling system represents 98 percent of the discharge. Evaporation and heating of the air are the mechanisms used to dissipate heat in a closed-cycle cooling-tower design, such as proposed at the Lee Nuclear Station site. Water is discharged to control the water chemistry in the cooling-water system and not to dissipate heat to the river. However, the water in the cooling-tower basins is at an elevated temperature when it is discharged. The review team reviewed the document summarizing Duke's simulations of the thermal plume that used a numerical three-dimensional computational fluid dynamics model (Duke 2011a, 2013e).

The review team performed an independent calculation by directly applying the principle of conservation of energy to estimate the increase of temperature downstream of the dam assuming complete and partial mixing downstream of the dam. The review team obtained river temperatures from the USGS stream monitoring station on the Broad River near Carlisle, approximately 50 mi downstream from Ninety-Nine Islands Dam. This was the uppermost monitoring station operated by the USGS with extended water temperature data on the

Broad River that was also downstream of the proposed location of the Lee Nuclear Station site. The USGS monitoring station below Ninety-Nine Islands Dam does not have water temperature data. The Carlisle monitoring station had records of stream temperature measurements extending from October 1996 to January 2011. The review team identified January and August as months representative of the most extreme winter and summer conditions for this assessment. January 2011 was the month with the lowest recorded mean water temperature for the period of record (39°F). August 2007 was the month with the highest mean water temperature (86°F). The review team obtained the lowest monthly flows for January and August based on the USGS gage at the site (USGS 2011a). The lowest monthly mean flows for January and August were 865 and 242 cfs, respectively.

The review team conservatively assumed that the maximum blowdown temperature of 95°F (see Table 3-10) would occur concurrently with the lowest flow. The review team determined, assuming complete mixing of the normal blowdown downstream of the dam, that the temperature in the river would increase only 1.1 and 1.2°F in January and August, respectively. The review team also conservatively estimated the maximum fraction of the stream that could achieve a 5°F rise (typically used to define the extent of a thermal plume) under the warm summer period. The review team estimated that no more than 11 percent of the flow would sustain a temperature increase of 5°F.

In Section 5.2.3.1 of the ER, Duke presented results from a CORMIX (Cornell Mixing Zone Expert System) assessment. While CORMIX is widely used and recognized for discharge mixing-zone analyses, the review team determined that CORMIX was not appropriate for the specific conditions associated with proposed Lee Nuclear Station Unit 1 and 2 discharge. Duke's NPDES permit application included a mixing zone request (Part VI) that included a computational fluid dynamics model analysis of the thermal plume under extreme low-flow conditions (7Q10 of 438 cfs) for discharge temperatures of 95°F and 91°F and an ambient river temperature of 88.2°F. The modeled plume (greater than or equal to 90°F for the steady-state condition) reached a maximum length of 138 ft, width of 71 ft, and volume of 0.195 ac-ft when the discharge temperature was 95°F. At a discharge temperature of 91°F, the modeled plume reached a maximum length of 89 ft, width of 5 ft, and volume of 0.013 ac-ft. Because the top of the diffuser would be 10 ft below the water surface, the plume would mostly dissipate in the subsurface water column (Duke 2011a, 2013e). The review team determined that the use of the computational fluid dynamics modeling technique was appropriate.

Residual of Chemicals Used to Manage Water Chemistry in Cooling Towers

The waste stream concentrations of water-treatment chemicals estimated by Duke in the ER are presented in Table 3-8. Pursuant to 40 CFR Part 423, the chemicals in this waste stream are specifically regulated by the EPA to protect the environment. Duke's NPDES permit requires monitoring to ensure the environment is not adversely affected (SCDHEC 2013a).

Concentrated Solutes from Broad River

Table 3-8 presents Duke's estimates of concentration of the primary metals that will be in the blowdown water due to concentration of water from the Broad River. The review team acknowledges that some of the concentrations of some of the constituents in the blowdown will be above South Carolina State water-quality standards at the point of discharge. However, the constituents will be diluted back to ambient Broad River water-quality levels as the discharge mixes into the rest of the Broad River. The review team determined that the concentrations of the solutes would be diluted by the streamflow within a short distance below the dam, and any localized increase would be undetectable relative to background by the time the water reaches the City of Union, South Carolina public water supply intake 21 mi downstream of the discharge. Pursuant to the CWA, Duke's NPDES permit (Permit Number SC0049140) requires monitoring to ensure the environment is not adversely affected (SCDHEC 2013a).

Impacts on surface-water quality from the operation of the proposed Lee Nuclear Station Units 1 and 2 are limited to residual heat in blowdown water, water-treatment chemicals in blowdown water, and concentrated solutes from the Broad River. Based on its independent assessment, the review team concludes that surface-water-quality impacts of Lee Nuclear Station Units 1 and 2 operations would be SMALL, and additional mitigation would not be warranted.

5.2.3.2 Groundwater Quality

As discussed in Section 5.2.2.2, no groundwater would be used for the operation of the proposed Lee Nuclear Station Units 1 and 2. Additionally, neither active dewatering nor passive dewatering systems are proposed for the site. As a result, the only impact on groundwater quality would be from spills, the stormwater-management system, or from fluctuations in the elevation of Make-Up Pond C.

Best management practices (BMPs) would be applied to prevent spills and minimize their effects. The spill prevention, control, and countermeasure plan required by the SCDHEC pursuant to 40 CFR Part 112 will mitigate impacts on local groundwater because spills are quickly attended to and not allowed to penetrate to groundwater. Examples of materials that may spill during operation are diesel fuel, hydraulic fluid, and lubricants.

As mentioned in Section 3.2.2.1, the stormwater drainage systems would direct stormwater into Make-Up Pond A, Make-Up Pond B, or the Broad River. Therefore, the review team concluded that the alteration in groundwater quality from the stormwater-management system would be undetectable.

Groundwater quality in wells with a close hydraulic connection to proposed Make-Up Pond C may vary in response to fluctuations in the pool elevation during drought events as the pool elevation declines and after drought events when the pool refills. In the ER, Duke stated that temporary increases in turbidity may occur in wells close to Make-Up Pond C. Based on the overall expected stability of the pool elevation in Make-Up Pond C and the filtering provided by the subsurface environment, the review team determined that any changes to the groundwater quality of wells adjacent to Make-Up Pond C would be minor.

Impacts on groundwater quality from the proposed operation of proposed Lee Nuclear Station Units 1 and 2 and Make-Up Pond C are limited by the lack of groundwater use and the factors identified above. Based on all these factors, the review team concludes that groundwater-quality impacts of proposed Lee Nuclear Station Units 1 and 2 and Make-Up Pond C operations would be SMALL, and additional mitigation would not be warranted.

5.2.4 Water Monitoring

The NRC requires water monitoring for radiological protection. The USACE may require monitoring for other purposes. Duke's NPDES Permit, issued by SCDHEC on July 17, 2013 (Permit No. SC0049140), requires highly specific monitoring of discharges to surface water to ensure protection of water quality and biota (SCDHEC 2013a).

In Sections 5.2.3.5 and 6.2.2.1 of the ER, Duke has committed to perform operational monitoring for groundwater that would satisfy the applicable requirements of State and Federal agencies (Duke 2009c, 2013a).

5.3 Ecological Impacts

This section describes the potential impacts on ecological resources from the operation and maintenance of the proposed Lee Nuclear Station Units 1 and 2, existing Make-Up Ponds A and B, a new cooling-water reservoir (proposed Make-Up Pond C), transmission lines in two new corridors, and a renovated and partially rerouted railroad-spur corridor. The impacts are discussed for terrestrial and aquatic ecosystems.

5.3.1 Terrestrial and Wetland Impacts

Impacts on terrestrial communities and species related to operation of the proposed Lee Nuclear Station may result from cooling-system operations (including the cooling towers, water pipelines, and makeup ponds) and transmission-line and railroad-spur operations and maintenance. Operation of the cooling system could result in deposition of dissolved solids; increased local fogging, precipitation, or icing; increased risk of avifauna collision mortality; increased noise levels; and altered shoreline habitats of the source waterbody. Potential impacts to terrestrial species from operation and maintenance of the transmission system include maintenance of vegetation within the transmission-line, railroad-spur, and water-pipeline corridors; avian collision mortality and electrocution; and electromagnetic fields (EMFs).

5.3.1.1 Terrestrial Resources – Site and Vicinity

Vegetation

As described in Chapter 3, the proposed cooling system for the proposed Lee Nuclear Station is a closed-cycle system using circular mechanical draft cooling towers, with two towers per unit, two located west of proposed Unit 1 and two located east of proposed Unit 2 (Figure 3-1). The cooling towers would be 85 ft tall, 360 ft in diameter, and would have a concrete shell (Duke 2013a).

Through the process of evaporation, the total dissolved solids (TDS) concentration in the circulating-water system (CWS) increases. A small percentage of the water in the CWS is released into the atmosphere as fine droplets (i.e., cooling tower drift) containing elevated TDS levels that can be deposited on nearby vegetation. Vapor plumes and drift may affect crops, ornamental vegetation, and native plants, and water losses from cooling tower operation could affect shoreline habitat. Although the cooling towers would be equipped with drift eliminators to minimize the amount of water that is lost via drift, some droplets containing dissolved solids would be ejected from the cooling towers. According to Duke, this drift has essentially the same concentration of dissolved and suspended solids as the water in the cooling tower basins. Operation of the CWS would be based on four cycles of concentration, which means the TDS in the makeup water would be concentrated approximately four times the ambient concentration in the Broad River before being released (Duke 2009b).

Depending on the makeup source waterbody, the TDS concentration in the cooling tower drift can contain high levels of salts that, under certain conditions and for certain plant species, can be damaging. Vegetation stress can be caused by deposition of drift with high levels of total dissolved salts, either directly by deposition onto foliage or indirectly from accumulation in the soils. As discussed in Section 5.7.1, the review team estimates the cooling tower plumes to have a maximum cumulative deposition rate of approximately 0.0103 kg/ha/mo in the summer. The maximum deposition would occur 200 m north of the towers, on the Lee Nuclear Station site (Duke 2013a). These areas would be occupied by facilities, open/field/meadow, upland scrub, and mixed hardwood-pine cover types (Duke 2009c). The native species with the greatest sensitivity to salt deposition at existing nuclear power plants reviewed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) (NRC 1996), was flowering dogwood (*Cornus florida*), which was affected at 4.8 kg/ha/mo, well over the 0.0103 kg/ha/mo estimated for the cooling towers proposed for Lee Nuclear Station. Because the maximum deposition for the proposed Lee Nuclear Station would be below the level that could cause leaf damage in a sensitive species, the impacts onsite would be negligible. The impact of drift on crops and ornamental vegetation also was evaluated for existing nuclear power plants in the GEIS and was found to be of minor significance (NRC 2013a). Thus, based on the overall maximum salt deposition rate, impacts to any ornamental vegetation that may be located around the cooling towers would be negligible also.

As discussed in Section 5.7.1, ground-level fogging will likely be infrequent, and no occurrences of ground-level icing are predicted. Thus, no impacts to native or ornamental vegetation or crops in the vicinity are expected.

Avian Collisions with Cooling Towers and Structures

A potential for avian mortalities resulting from collisions with proposed nuclear power plant structures exists and could adversely affect resident and migratory species populations. The shield buildings, the tallest and most visible structures on the site, each would be 229.5 ft above grade, and the cooling towers would be approximately 85 ft above grade (Table 3-10). The NRC previously concluded in the GEIS that the relatively low height of mechanical draft cooling towers causes negligible avian mortality (NRC 2013a). In addition, the NRC concluded that avian collisions are unlikely to pose a biologically significant source of mortality because of the small fraction of total bird mortality that has been attributed to collisions with nuclear power plant structures (NRC 2013a).

The proposed Lee Nuclear Station is located along a principal inland route of the Atlantic flyway (Bird and Nature 2011) and, thus, could have a higher propensity for avian collisions. Duke's other existing nuclear stations (Oconee [along Lake Keowee, South Carolina], McGuire [along Catawba River, North Carolina], and Catawba [along Catawba River, South Carolina]) also are situated along the same principal inland route of the Atlantic flyway and together can be expected to affect migrating birds cumulatively. Employees at all three of these nuclear stations have been trained in the *Duke Energy Corporation Avian Protection Plan* (Duke Energy 2009); therefore, the review team expects that any known incidences of avian mortality would have been reported (Duke 2008c). There is no evidence that avian collisions at these other three nuclear stations have negatively affected resident or migratory birds. Consequently, avian collisions with plant structures, including containment buildings and cooling towers, on the Lee Nuclear Station site are anticipated to have a negligible impact on resident and migratory populations.

Increased Vehicle Traffic

Operation-related increases in traffic would likely be most obvious on the rural roads of Cherokee County, specifically McKowns Mountain Road, which is a two-lane county road that will provide the only access to the proposed Lee Nuclear Station. The review team assumed current traffic on McKowns Mountain Road is 950 vehicles per day (Section 5.4.4.1). The capacity is 1700 vehicles per hour for each direction and 3200 vehicles per hour for both directions; however, the use of staggered work shifts make it unlikely that road capacities would be exceeded (Section 5.4.4.1). Increased traffic could slightly increase traffic-related wildlife mortalities. Local wildlife populations could suffer declines if roadkill rates were to exceed the rates of reproduction and immigration. However, while roadkill is a highly visible source of wildlife mortality, and would likely increase slightly during operations, except for special situations not applicable to the proposed Lee Nuclear Station (e.g., ponds and wetlands crossed by roads where large numbers of migrating amphibians and reptiles would be susceptible), traffic mortality rates rarely limit population size (Forman and Alexander 1998). Consequently, the overall impact on local wildlife populations from increased vehicular traffic on McKowns Mountain Road during operation of Lee Nuclear Station would be negligible.

Water-Pipeline Corridor Maintenance

The water-pipeline corridors are maintained for safety. Regeneration of trees and large shrubs in permanent water-pipeline corridors is prevented by mechanical mowing, cutting, trimming, or herbicide applications (Duke 2010o), much the same as vegetation management in transmission-line corridors (Section 5.3.1.2). The impacts of transmission-line corridor maintenance on wildlife and habitats, including floodplains and wetlands, was evaluated in the GEIS (NRC 2013a), and the impacts were found to be of minimal significance at operating nuclear power plants with associated transmission-line corridors of variable widths. Duke also has procedures in place that minimize adverse impacts to wildlife and important habitats, such as floodplains and wetlands, from transmission-line corridor maintenance (Duke 2008j). Such procedures also would be applied to maintenance of water-pipeline corridors. Consequently, the potential effects on terrestrial ecology from water-pipeline maintenance would be negligible, and mitigation beyond the use of standard BMPs would not be warranted.

Noise

Operation of the four mechanical draft cooling towers associated with the CWS would be the main source of continuous noise at the proposed Lee Nuclear Station. Each of the four cooling towers would generate approximately 85 A-weighted decibels (dBA) at close proximity and 55 dBA at 1000 ft (Table 3-10). Noise levels would be somewhat higher than 85 dBA near each pair of cooling towers because of the presence of multiple towers. This difference would not be prevalent offsite because of shielding from the cooling towers in each cluster and other plant structures (Duke 2009c). Thus, noise at distances greater than 1000 ft would be well below the 80- to 85-dBA threshold at which birds and small mammals are startled or frightened (Golden et al. 1980), and likely would not disturb wildlife in habitats away from the planned facilities. Further, areas within 1000 ft of any of the proposed cooling tower locations would consist primarily of open water and open/field/meadow and upland scrub vegetation (Duke 2009c) that, in an industrial setting, are of relatively low value to wildlife. Consequently, the potential impact on wildlife posed by incremental noise resulting from operation of the four mechanical draft cooling towers and other facilities on the proposed Lee Nuclear Station would be minimal, and mitigation would not be warranted.

Shoreline Habitat

Based on Figure 3-19, Make-Up Pond B would have experienced drawdowns ranging from 0.5 ft to a maximum of 30 ft below full pool elevation during 191 drawdown events in the 85-year period of record. The duration of these events would have ranged from 2 to 139 days (Table 3-6), with the longer durations associated with deeper drawdowns (Figure 3-20 and Table 3-6) and longer refill periods (Table 3-6). Most of the drawdowns would have occurred from mid-summer through fall (Duke 2009b), and to minimize entrainment of aquatic organisms in Make-Up Pond B, refills would not occur from March through June (Duke 2011a).

The Functional Assessment of Waters of the United States (Duke 2011h) identified three jurisdictional wetlands (total of 1.61 ac) located at the uppermost reach of Make-Up Pond B (USACE 2013a), that may be temporarily affected by the drawdowns (Duke 2013h) (Figure 2-13). The maximum water depth in these wetlands during the functional assessment was between 1 and 2 ft. The longer duration drawdowns with extended refill periods would likely result in the alteration of wetland vegetation and some mortality and displacement of associated wildlife. The wetlands could potentially recover after refilling Make-Up Pond B. These impacts are likely (but not certain) to occur sometime in the future depending on the severity of drought conditions. There are three additional jurisdictional wetlands (total of 0.29 ac) in the vicinity of Make-Up Pond B that are not expected to be affected by the drawdowns since they are not within the influence of Make-Up Pond B. In addition, the jurisdictional wetland south of the dam in the southeastern portion of Make-Up Pond B (Figure 2-13) would not be affected. The invert elevation of the overfill structure is 575 ft, which is approximately 5 ft higher than the full pond elevation of Make-Up Pond B (569.8 ft). The surface-water elevation of the southeastern portion of Make-Up Pond B is not expected to change as a result of the Make-Up Pond B drawdown (Duke 2013h).

Duke has established a shoreline management program at Make-Up Pond B to ensure there is no debris blockage of the spillway (Figure 2-13). As part of the annual inspection of the Make-Up Pond B shoreline, any trees that have fallen to the ground or show distress of falling into the pond are removed. Duke also inspects the spillway after any rainfall event greater than 3 in./hr to ensure the spillway remains clear of any debris. As a secondary measure, Duke will install a debris barrier system designed to rise and fall with fluctuations in the pond water level (Duke 2013f).

Duke has no plans to routinely draw down Make-Up Pond A to support power operations, and it is not required to be used for safe shutdown of the reactors (see Section 3.4.2.1 and Duke 2008f). Thus, it is not anticipated that the 3.85-ac jurisdictional freshwater marsh identified in the jurisdictional determination (USACE 2013a) on the southeast margin of Make-Up Pond A (Figure 2-13) would be significantly affected. Further, there apparently is no hydrologic connection between Make-Up Pond A and the 5.92 ac impoundment located just to the south (Figure 2-13). The earthen dam disconnects the impoundment, which is fed by natural inflows up-gradient of Make-Up Pond A (Duke 2008n). Thus, any reduction in the surface elevation of Make-Up Pond A, however minor, during operation of the proposed Lee Nuclear Station would not be expected to affect the 2.67-ac wetland associated with the impoundment (Figure 2-13).

Make-Up Pond C would provide about 620 ac of open water habitat and could potentially develop some littoral wetlands in areas of shallow bathymetry around its margins and in tributary areas (Duke 2010n, 2011h, 2012j) and, as previously mentioned in Section 3.3.1.8, a log boom would be installed to prevent debris from blocking the spillway (Duke 2012m). However, according to USACE operating procedures (USACE 2010a), the subsequent provision of open water habitat and possible eventual provision of some littoral wetlands following inundation of a stream system does not offset or reduce impacts to existing open water or wetland resources. Further, littoral wetlands that may develop in the future could also be affected by drawdowns of Make-Up Pond C (Figure 3-19), which could occur to a nominal drawdown less than or equal to 30 ft below full pool elevation. However, these occurrences are projected to be much less numerous than drawdowns of Make-Up Pond B based on the 85-year period of record (Figure 3-19). The future development and drawdown impacts to such wetlands are uncertain.

The potential effects on wetland vegetation and wetland wildlife from drawdown of the makeup ponds resulting from operation of the proposed Lee Nuclear Station would be minor because of expected refilling and recovery. These impacts are likely (but not certain) to occur sometime in the future depending on the severity of drought conditions, and the effects may be temporary in nature (Duke 2011h).

The Cherokee Reservoir Dam (commonly called Cherokee Lake Dam) has already reduced flows in London Creek below the dam, especially during drought periods. Make-Up Pond C would likely further reduce the downstream flow of London Creek, particularly during drought periods, and would permanently alter its flow patterns and water fluctuations. London Creek may experience less frequent overbank flood events downstream of the proposed dam; however, the remaining segment of London Creek would still receive floodwaters from the backwater effect of the Broad River. Few wetlands downstream of the proposed dam derive their water from overbank flooding from London Creek flows. Floodplain wetlands downstream of the railroad crossing adjacent to London Creek likely derive most of their water from the backwater effects associated with Ninety-Nine Islands Reservoir during flood events. Other wetlands downstream of the dam are associated with Little London Creek, which will not be affected by Make-Up Pond C (see Section 9.5). Potential effects, if any, to downstream resources, such as wetlands, between the Make-Up Pond C dam and the Broad River would be at least somewhat ameliorated by minimal seasonal flow releases from Make-Up Pond C to London Creek downstream of Make-Up Pond C dam (January through April 1.5 cfs; May, June, and December 1.0 cfs; July through November 0.75 cfs) (Duke 2012m). Thus, any impacts to wetlands located between Make-Up Pond C and the Broad River by adding the Make-Up Pond C dam are anticipated to be minor.

Wastewater Treatment Basins

Two wastewater retention basins would be built to treat plant waste streams (Figure 3-4). Both would be smaller than Hold-Up Pond A (4.2 ac) (Duke 2009c). They would be designed, constructed, and operated such that they would not provide or develop littoral habitat or surface acreage that would readily attract most birds. However, if birds frequent the basins and are exposed to harmful substances or if the birds hinder the effective functioning of the basins, bird exclusion devices (e.g., propane cannons, bird repellent dispersion systems, netting, etc.) would be employed to dissuade birds from frequenting the basins (Duke 2008c).

Avian Protection Policy and Plan

In connection with the potential impacts to birds discussed in this section, Duke Energy has instituted an *Avian Protection Plan* (Duke Energy 2009). In accordance with the plan, Duke intends to ensure compliance with the Migratory Bird Treaty Act of 1918 and all other avian protection regulations and laws. A Duke corporate goal is to manage bird interactions with power generation and transmission facilities, related facilities, and equipment in order to reduce system interruptions caused by birds. Some of Duke's expectations are to:

- comply with migratory bird laws, regulations, permit requirements, and guidelines
- document bird mortalities and injuries and disturbances of active nests through the U.S. Fish and Wildlife Service (FWS) and South Carolina Department of Natural Resources (SCDNR) Migratory Bird Depredation Permits (MB000257-0 and MD-19-10, respectively) (Duke 2010d)
- provide information, resources, and training to improve employee and contractor awareness of responsibilities under bird protection laws.

Nighttime Security Lighting

Light pollution could affect the behavioral and population ecology of wildlife. These effects derive from light-induced disorientation, and attraction or repulsion from the altered light environment. These behavioral effects, in turn, may impact foraging, reproduction, migration, and communication, which could lead to mortality (Longcore and Rich 2004).

The security lighting system for the proposed Lee Nuclear Station is required to conform to NRC requirements in 10 CFR 73.50 and 10 CFR 73.55. Light pole height for stadium-style lighting is expected to be 80 ft. Light pole height along roadways and parking lots is expected to be 35 ft. Lighting requirements are not less than 0.2 foot-candles measured horizontally at ground level (Duke 2008c).

The security lighting system for the proposed Lee Nuclear Station would be similar to that at Duke's other existing nuclear stations (Oconee, Catawba, and McGuire). No incidences of bird or bat mortality have been reported at these other nuclear stations (Duke 2009m), and there is no evidence that would indicate the NRC-required security lighting has negatively affected migrating birds and bats or other wildlife. In addition, the Oconee and Catawba Nuclear Stations, and to a lesser extent the McGuire Nuclear Station, are situated along the same principal inland route of the Atlantic Flyway (Bird and Nature 2011) as the proposed Lee Nuclear Station. Further, there are no known local wildlife migratory corridors or migration routes at the Lee Nuclear Station site that would differentiate it from the other three nuclear station sites. Consequently, the security lighting system for the proposed Lee Nuclear Station is not anticipated to have any adverse effects on wildlife.

Railroad Spur Operation

The relatively open railroad bed contains dense vegetation, including species often consumed by eastern box turtles (*Terrapene carolina*), and large puddles in the railroad corridor provide water and prey (e.g., amphibian larvae) (Dorcas 2009c). Although this habitat would likely be destroyed during renovation of the railroad spur and possibly result in some mortality and displacement (Section 4.3.1.4), the species would remain in surrounding areas and could continue to be affected by railroad operation. The operating railroad could result in the direct mortality of box turtles and fragmentation of the habitat. Unless tunnels or ramps are provided to pass under or over the rails, box turtles could become trapped between the rails and succumb quickly to overheating or predation (Dorcas 2009c).

Dredged Material Disposal

As part of normal operations, areas around the Broad River intake structure and the intake structure of Make-Up Pond A would need to be dredged periodically (Duke 2008o, 2009b). The estimated frequency of maintenance dredging and quantity of dredged material are discussed for each of the above facilities in a response to a request for additional information provided by Duke (2008o). Dredged material disposal would be either in an approved county landfill or in an onsite spoils area (Duke 2009b). Thus, there would be no additional habitat or wildlife impacts from dredged material disposal.

5.3.1.2 Terrestrial Resources − Transmission-Line Corridors

Cutting and Herbicide Application

Duke has over 13,000 circuit miles of transmission lines ranging from 44 kV to 525 kV and has an established Integrated Vegetation Management Program (Duke 2008j). The program employs various corridor-management tools, such as mowing; hand cutting; removing dead, diseased, dying or decaying trees; pruning; and applying environmentally safe herbicides. Within the corridors, vegetation height is managed to not exceed 15 ft. To eliminate undesirable woody species while promoting lower growing vegetation, herbicides are used where it is deemed environmentally sound to do so. Herbicides are applied to corridors approximately every 4 years. Where herbicides are not used (e.g., in wetlands), mechanical mowing or hand cutting is employed approximately every 3 years. Encroaching lateral growth is removed by pruning. All corridors and lines are inspected via helicopter twice a year (Duke 2008j).

The impacts of transmission-line corridor maintenance on wildlife and habitats, including floodplains and wetlands, were evaluated in the GEIS (NRC 2013a), and the impact was found to be of minimal significance at operating nuclear power plants with associated transmission-line corridors of variable widths (NRC 2013a). Duke has procedures in place that minimize adverse impacts to wildlife and important habitats such as floodplains and wetlands (Duke 2008j).

However, such procedures do not necessarily enhance wildlife habitat, including habitat for grassland bird species (wholly or largely dependent upon upland grasslands for their survival) and other species that occupy similar early-successional environments. Birds that use grasslands (e.g., loggerhead shrike [*Lanius ludovicianus*], see Section 4.3.1.6) have shown some of the steepest population declines of any bird group in North America. Vegetative succession and permanent loss, degradation, and fragmentation of grassland and scrub/shrub habitat resulting from urban development and intensified agriculture are primary factors resulting in the long-term population declines experienced by grassland birds (SCDNR 2005). Warm-season (rather than cool-season) sod-forming grasses (Rothbart and Capel 2006) and native forbs and small shrubs (SCDNR 2005) may be employed in transmission-line corridors to provide for greater plant and wildlife diversity. Such plant communities provide enhanced habitat conditions for avian species (Yahner et al. 2003), as well as white-tailed deer (*Odocoileus virginianus*) and amphibian, reptile, small mammal, and butterfly species that are adapted to early-successional environments (Yahner 2009, SCDNR 2005). Duke will collaborate with the SCDNR to develop and maintain transmission-line corridor vegetation where possible to provide suitable habitat for grassland birds and other wildlife species that occupy similar early-successional environments (Duke 2012m). Consequently, the potential effects on terrestrial species and habitats from vegetation maintenance in the Lee Nuclear Station transmission-line corridors are anticipated to be beneficial, and mitigation beyond the use of standard BMPs would not be warranted.

Avian Collisions and Electrocutions – High-Voltage Transmission Lines

Duke would implement the following guidelines for minimizing avian electrocutions and collisions on transmission lines associated with the proposed Lee Nuclear Station (Duke 2008c). These guidelines are based on recommendations of the Avian Power Line Interaction Committee (APLIC 2006):

1. Provide a minimum 60-in. horizontal separation between phase conductors or between a phase conductor and grounded hardware/conductor. The 60-in. separation is accepted industry practice based on the wingspan (wrist to wrist) of the bald eagle (*Haliaeetus*

leucocephalus), the largest bird known from the vicinity of the Lee Nuclear Station site. A vertical separation between conductors or conductor to ground of 48 in. also would be provided based on the height of long-legged wading birds such as the great blue heron (*Ardea herodias*), which is common along the Broad River.

2. Transmission towers offer nesting opportunities for raptors, especially ospreys (*Pandion haliaetus*). If ospreys (or other raptors) establish nests on transmission towers and the nests do not pose a risk to the osprey or the reliability of electricity transmission, the nests would be left in place. If the nests pose a risk to the osprey or the reliability of electricity transmission, artificial nesting platforms would be installed near the affected transmission towers so nest materials and excrement do not contaminate the lines. If artificial nest platforms cannot be installed because of right-of-way restrictions or access limitations, nest discouragers and other exclusion techniques would be employed.
3. Where topography or habitat inhibit transmission-line visibility to birds, or where there are sections of line that birds tend to cross more frequently, the installation of flight diverters or other marking devices on the static or neutral wires would be implemented to increase line visibility.

The NRC's analysis in the GEIS (NRC 2013a) determined that bird collisions with transmission lines are of small significance at operating nuclear power plants, including plants with variable numbers of transmission lines. Thus, addition of the two proposed transmission lines would likely present few new opportunities for bird collisions and would not be expected to cause a measurable reduction in local bird populations. Consequently, the incremental number of bird collisions posed by the operation of the two new transmission lines for the proposed Lee Nuclear Station would be negligible, and mitigation would not be warranted.

Impacts of Electromagnetic Fields on Flora and Fauna

EMFs are unlike other agents that have an adverse impact (e.g., toxic chemicals and ionizing radiation) in that dramatic acute effects cannot be demonstrated and long-term effects, if they exist, are subtle (NRC 2013a). The NRC reviewed biological and physical studies of EMFs but found no consistent evidence linking harmful effects with field exposures (NRC 2013a). The NRC determined that EMFs produced by operating transmission lines for existing nuclear power plants up to 1100 kV were not linked to significant harmful effects on flora (NRC 2013a). Minor damage to plant foliage and buds can occur near strong electric fields, caused by heating of the leaf tips and margins. Damage does not appear within the stem and root systems of the plants and would not significantly affect growth (NRC 2013a).

EMFs have been demonstrated to affect some fauna. Voltage buildup can affect the overall health of honeybee hives (NRC 2013a). Birds that nest within transmission-line corridors experience chronic EMF exposure, but lines energized at levels less than 765 kV do not affect terrestrial biota (NRC 2013a).

The NRC concluded that the impacts of EMFs on terrestrial flora and fauna appear to be of small significance at operating nuclear power plants, including power transmission systems with variable numbers of transmission lines (NRC 2013a). Therefore, the review team concludes that the incremental EMF impact on flora and fauna posed by the operation of the proposed transmission lines for the Lee Nuclear Station would be minimal and mitigation would not be warranted.

5.3.1.3 Important Terrestrial Species and Habitats

In a letter dated April 9, 2008, the NRC requested that the FWS Field Office in Atlanta, Georgia, provide information regarding Federally listed, proposed, and candidate species and critical habitat that may occur in the vicinity of the Lee Nuclear Station (NRC 2008e). On May 13, 2008, the FWS provided a response letter indicating three listed and one candidate terrestrial species and no critical habitat in Cherokee, Union, and York Counties (FWS 2008a), which encompass the Lee Nuclear Station site, the Make-Up Pond C site, the railroad-spur corridor, the two proposed transmission-line corridors, and the six offsite road improvement areas (Table 2-9). These species include the pool sprite (*Amphianthus pusillus*), Georgia aster (*Symphyotrichum georgianum* [formerly *Aster georgianus*]), dwarf-flowered heartleaf (*Hexastylis naniflora*), and Schweinitz's sunflower (*Helianthus schweinitzii*). An additional listed species identified that may occur in the project area is the smooth coneflower (*Echinacea laevigata*)(Cantrell 2008). These species were surveyed, and only the Georgia aster, a Federal candidate species, was observed on or in the vicinity of the project footprint (Make-Up Pond C study area [see Section 2.4.1.6]). The Georgia aster was found only in an area that would be inundated by the creation of Make-Up Pond C, so this species would not be affected by operations. In a letter dated June 13, 2012, the FWS concurred with the review team's determination that the proposed Lee Nuclear Station Units 1 and 2 project is not likely to adversely affect Federally protected species nor result in adverse modification to designated or proposed critical habitat, thus completing informal consultation between the FWS and the NRC (FWS 2012b). Consultation correspondence between the review team and the FWS is included in Appendix F.

Duke surveyed for the State-ranked species discussed in Section 2.4.1.6. None of these species was found in those parts of the project footprint not expected to have previously been altered or inundated during site-development activities, but which would be affected by the operation and maintenance impacts described above.

Therefore, there would be no impacts to known Federally threatened, endangered, proposed, or candidate animal or plant species and no impacts to known State-ranked species from operation of the proposed Lee Nuclear Station, including Make-Up Pond C, and the two proposed transmission lines and railroad spur, and maintenance of transmission-line corridors, water-pipeline corridors, and offsite road improvements. There are no important habitats on the Lee Nuclear Station site other than wetlands. There are wetlands and three important habitats

(Rhododendron Bluff, London Creek Bottoms, Little London Creek Bottoms) in the Make-Up Pond C study area outside the inundation zone (see Sections 2.4.1.2 and 4.3.1.2). The three important habitats would not be affected by operation of Make-Up Pond C. Operational impacts to wetlands from drawdown of Make-Up Ponds B and C are discussed in Section 5.3.1.1.

5.3.1.4 Terrestrial Monitoring During Operations

Duke does not plan to conduct any terrestrial ecological monitoring during the period of operation of the proposed Lee Nuclear Station.

5.3.1.5 Potential Mitigation Measures for Operations-Related Terrestrial Impacts

Duke has committed to employing mitigation measures for operations-related terrestrial impacts including the implementation of BMPs associated with transmission-line operation and corridor-maintenance practices. As described in the above sections, these BMPs include vegetation-management BMPs to avoid impacts to wetlands and floodplains, BMPs to minimize avian electrocutions and collisions on transmission lines, and implementation of Duke's *Avian Protection Plan* (Duke Energy 2009).

5.3.1.6 Summary of Operational Impacts on Terrestrial Resources

The potential impacts of operating the proposed Lee Nuclear Station and the associated cooling system (mechanical draft cooling towers) on vegetation, birds, and shoreline habitat are likely to be minor. The potential impacts of transmission-line operation, including those from EMFs, on birds, and transmission-line corridor maintenance on important habitats, including floodplains and wetlands, are considered minor, assuming related BMPs are implemented. The potential impacts of water-pipeline corridor maintenance, increased traffic, wastewater-treatment basin operation, dredged material disposal, railroad-spur operation, and nighttime security lighting on wildlife are likely to be minor.

The review team evaluated the potential terrestrial ecological impacts of operating the proposed Lee Nuclear Station, including the heat-dissipation system, transmission lines, associated corridor maintenance, and other sources of potential adverse effects. Given the information provided in the ER submitted by Duke (Duke 2009c) and the supplement to the ER (Duke 2009b), responses to RAIs, interactions with State and Federal agencies, the public comment process, and the review team's own independent assessment, the review team concludes the impacts from operation of the proposed new facilities and associated new transmission lines on terrestrial resources would be SMALL, and additional mitigation beyond that mentioned in the text would not be warranted.

5.3.2 Aquatic Impacts

This section discusses the potential impacts of operating the proposed Lee Nuclear Station Units 1 and 2 and the associated operation and maintenance of the transmission-line corridors on the aquatic resources in the Broad River, onsite waterbodies, Make-Up Pond C, and water courses crossed by the transmission-line corridors and the railroad-spur corridor.

5.3.2.1 Aquatic Resources – Site and Vicinity

The potential impacts to aquatic resources through operation of the proposed Lee Nuclear Station Units 1 and 2 are described below according to operational systems and their respective impacts. Therefore, this section describes potential impacts from the Broad River intake system, makeup pond intake systems, and blowdown and wastewater discharge system, respectively.

Broad River Intake System

A closed-cycle cooling tower system is proposed for the proposed Lee Nuclear Station Units 1 and 2. Depending on the quality of the makeup water, closed-cycle, recirculating cooling-water systems can reduce water use by 96 to 98 percent of the amount that the facility would use if it employed a once-through cooling system (66 FR 65256). This significant reduction in the water withdrawal rate results in a corresponding reduction in impingement and entrainment losses.

The primary intake system proposed for the proposed Lee Nuclear Station would be located on the Broad River approximately 1.5 mi upstream of Ninety-Nine Islands Dam on the south bank of the reservoir (Duke 2009c). This Broad River intake structure would provide Make-Up Pond A with makeup water for both the cooling water system and service-water system (SWS) cooling towers, provide water for intake screen-washing flow and for separating fish from debris, and provide water for refilling Make-Up Pond B and Make-Up Pond C after periods of low-flow operation (Duke 2009b). Planned configuration and plan views of the proposed Broad River intake structure are shown in Figures 3-6 and 3-7, respectively. A cross-section view of the Broad River intake structure is shown in Figure 3-8.

The Broad River intake structure would be a single structure with two sections named by Duke as the river water subsystem (also known as the primary section) and the refill subsystem (also known as the drought contingency section). The river water subsystem would withdraw water from the Broad River and supply it to Make-Up Pond A. From Make-Up Pond A, the water can be transferred to Make-Up Pond B. The refill subsystem would withdraw water from the Broad River and supply it to either Make-Up Pond B or Make-Up Pond C. Water then can be transferred between Make-Up Ponds B and C and between Make-Up Ponds A and B. Each subsystem has four forebays, each of which includes a steel bar/trash rack assembly, a dual-flow traveling screen, and an intake pump (Duke 2010f). The traveling screens with ⅜ in. or smaller mesh would allow a flow velocity of less than 0.5 fps through the screens (Duke 2009c, 2012i). Based on information contained in the ER submitted by Duke, the average raw water withdrawal flow rate for two units operating simultaneously is expected to be 35,030 gpm (78 cfs), and the maximum raw water withdrawal flow rate is estimated to be 60,000 gpm (134 cfs) during the power operation mode (Duke 2009c). The four intake pumps associated with the river water subsystem would operate continuously under normal water conditions; the remaining four intake pumps associated with the refill subsystem would be operated when permit conditions on the Broad River support supplemental water withdrawals to refill Make-Up Ponds B and C (Duke 2010f).

Impingement and Entrainment

A major factor affecting impingement and entrainment losses is the percentage of source waterbody flow past the site that is being withdrawn for cooling-water purposes. EPA determined that limiting withdrawal to 5 percent of the source waterbody mean annual flow was technically achievable and economically practicable, and that larger withdrawals may result in greater levels of entrainment (66 FR 65256). Section 316(b) of the CWA regulates withdrawals for the proposed Lee Nuclear Station. Duke would be required to comply with either a withdrawal limitation of 5 percent of the mean annual flow, or propose an alternative requirement. In its August 2011 NPDES application, Duke has proposed an alternative requirement that would limit withdrawal from the Broad River for refill of Make-Up Ponds B and C to the months of July through February to minimize entrainment of aquatic organisms (Duke 2011a). Duke's Water Management Plan is provided verbatim in Section 3.4.2.1. The NPDES permit issued by SCDHEC to Duke on July 17, 2013 (Permit No. SC0049140) calls for Duke to not operate the drought contingency section of the river intake during the months of March, April, May, or June (SCDHEC 2013a).

A second factor affecting impingement and entrainment losses is the hydraulic zone of influence (HZI), defined by EPA in 66 FR 65256 as "… that portion of the source waterbody hydraulically affected by the cooling-water-intake structure withdrawal of water." The review team reviewed the *Cooling Water Intake Structures Hydraulic Zone of Influence Study* prepared for Duke by Geosyntec Consultants (Geosyntec). This study is Attachment 5 in the Lee Nuclear Station NPDES application prepared by Duke and submitted to the SCDHEC (Duke 2011i). Geosyntec used existing data from field surveys and computational fluid dynamics modeling to simulate the flows induced by the intakes (both the Broad River intake and the makeup pond intakes) and then developed an HZI for each intake. Geosyntec modeled three pumping scenarios for the Broad River intake structure: (1) mean annual flow for the past 10 years of data (1956 cfs) and withdrawal of 98 cfs through the primary intake section, (2) low flow (538 cfs) and withdrawal of 78 cfs (normal operation) through the primary intake section, and (3) high river flow (2260 cfs) during a makeup pond refill period and withdrawal of 98 cfs through the primary intake section and 206 cfs through the drought contingency section. For the first scenario, the HZI is 0.129 ac-ft, with a surface area of 0.004 ac that extends into the Broad River a maximum of

9.2 ft perpendicular to the intake structure. The HZI for the second scenario is 0.200 ac-ft, with a surface area of 0.013 ac that extends 14.4 ft into the river. The third scenario results in an HZI of 0.316 ac-ft, with a surface area of 0.025 ac that extends 15.4 ft into the river (Duke 2011i). Because the width of the river is 240 ft at the intake, the HZI would likely not exceed 6.5 percent of the river's width under any of the modeled scenarios. The vast majority of fish eggs and larvae drifting down the river susceptible to entrainment and the fish susceptible to impingement would be unaffected by the water withdrawal of the Broad River intake structure, thereby minimizing entrainment and impingement losses.

For aquatic resources, one of the primary concerns related to water intake is the potential for organisms to be impinged on the intake screens. Impingement occurs when organisms are trapped against the intake screens by the force of the water passing through the cooling-water-intake structure (66 FR 65256). Impingement can result in starvation and exhaustion, asphyxiation (water velocity forces may prevent proper gill movement or organisms may be removed from the water for prolonged periods of time), and descaling (66 FR 65256).

Design features incorporated into the Broad River intake structure include a curtain wall, stop-log assemblies, and bar screens designed to keep logs and debris away from the pumps. Each of the two Broad River intake subsections incorporates four dual-flow traveling screens with a maximum through-screen velocity of less than 0.5 fps for all flows when the river surface elevation is greater than 508 ft above mean sea level (MSL), which is the approximate low-water pumping elevation (Duke 2009c, 2010l, 2012h). The design through-screen velocity for the intake greatly influences the rate of impingement of fish and shellfish at a facility. The higher the through-screen velocity, the greater the number of fish impinged. The EPA established a national standard for new facilities for the maximum design through-screen velocity of no more than 0.5 fps (66 FR 65256). The EPA determined that species and life stages evaluated in various studies could endure a velocity of 1 fps and then applied a safety factor of 2 to derive the threshold of 0.5 fps. Thus, the proposed screen design for the proposed Lee Nuclear Station meets the EPA criteria.

The traveling screens located behind the bar screens are designed to minimize the number of aquatic organisms that are impinged or entrained. Duke plans to use a modified “Ristroph” design (or equivalent) with Fletcher-type, fish-friendly buckets (Duke 2009c). In a study performed for the Electric Power Research Institute, this type of screen exhibited greater than 95 percent survival for all species tested (EPRI 2006). The screens will be equipped with backwashing spray systems and separate buckets for debris and fish. Supplemental water flow will move the fish to a trough that will return them to the Broad River downstream of the Broad River intake structure (Duke 2009c). All of these features will reduce impacts of impingement.

Impingement studies have not been conducted at the Lee Nuclear Station site because no units are present. The Oconee Nuclear Power Station located on Lake Keowee, which is part of the Savannah River Basin in South Carolina, uses a once-through heat-dissipation system. At

Oconee Nuclear Power Station, the most common fish reported as impinged on the station's stationary screens was the Threadfin Shad (*Dorosoma petenense*), estimated at more than 90 percent (NRC 1999b). This species is susceptible to experiencing cold stress, losing equilibrium, and becoming moribund, and is vulnerable to impingement when the water temperature decreases rapidly or when the temperature reaches a critical threshold (McLean et al. 1982). Other species impinged included the Yellow Perch (*Perca flavescens*) and Bluegill (*Lepomis macrochirus*). At the Lee Nuclear Station site, both Threadfin and Gizzard Shad (*D. cepedianum*) are present, but typically, their populations are sparse (Bettinger et al. 2003). However, based on the propensity for shad to become impinged at other cooling-water-intake structure sites, especially during cold winter months, and on the overall percent species composition in the vicinity of the Broad River intake structure, it is likely that Gizzard Shad, Bluegill, and other sunfish (centrarchid) species will be the most common fish impinged (Bettinger et al. 2003). Based on the use of closed-cycle cooling, the low through-screen velocity (less than 0.5 fps), the small HZI, and the location and design of the intake structure, including dual-flow traveling screens with fish-return system, the review team concludes that impacts from impingement of fish at the proposed Lee Nuclear Station Units 1 and 2 would be minor.

For aquatic resources, another of the primary concerns related to water intake is the potential for organisms to be entrained into the cooling-water system. Entrainment occurs when organisms are drawn through the Broad River intake structure into the proposed Lee Nuclear Station Units 1 and 2 cooling system. Organisms that become entrained are normally relatively small benthic, planktonic, and nektonic (organisms in the water column) forms, including early life stages of fish and shellfish, which often serve as prey for larger organisms (66 FR 65256). Entrained organisms are subject to mechanical, thermal, and toxic stresses as they pass through the cooling system. For this analysis, the review team assumes 100 percent mortality as a result of entrainment.

The use of design and building technologies for the Broad River intake system can minimize entrainment. The EPA indicated (66 FR 65256) that the optimal design requirement for the intake location is to place the inlet in an area of the source waterbody where impingement and entrainment of organisms are minimized by locating intakes away from areas with the potential for high productivity. The Broad River intake structure location was purposefully placed near the deepest part of the reservoir (approximately 35-ft depth) where common Broad River fish species are less likely to spawn (Duke 2009c, 2013a). Ichthyoplankton surveys performed in the 1970s showed that many more fish larvae were present in backwater areas of Ninety-Nine Islands Reservoir than in the area where the intake structure is proposed (Table 5-1) (Olmsted and Leiper 1978). Of the six fish groups sampled in 1975 and 1976, only catfish and sucker larvae were always captured more often in the mainstream than in the backwater areas. These two fish groups had very low capture rates relative to other fish groups such as sunfish and shad. Based on this data set and on the habitat characteristics of the Broad River intake structure location, the intake area does not appear to be an area of high productivity.

Table 5-1. Data on Larval Fish Densities Near the Lee Nuclear Station Site, 1975 to 1976

Fish Group	Sampling Location	Larvae per 1000 m^3	
		1975	**1976**
Clupeids (shad)	Backwater	601	1390
	Mainstream	39	52.9
Cyprinids (minnows)	Backwater	3.4	3.5
	Mainstream	1.3	35.5
Catostomids (suckers)	Backwater	2	---
	Mainstream	5.1	6.7
Ictalurids (catfish)	Backwater	---	---
	Mainstream	---	14.8
Centrarchids (sunfish)	Backwater	356.3	373.4
	Mainstream	5	6.5
Centrarchids (crappie)	Backwater	154.8	9.2
	Mainstream	---	---

Source: Olmsted and Leiper 1978

Entrainment studies have not been conducted at the Lee Nuclear Station site because no units exist. However, for the reasons listed below, the review team concludes that the impacts to the aquatic organisms of the Broad River from entrainment would be minor:

- the planned low through-screen intake velocity (less than 0.5 fps)
- the use of closed-cycle cooling
- the small HZI
- compliance with either a withdrawal limitation of 5 percent of the mean annual flow or SCDHEC approval to implement the operational restrictions included in the Duke water management plan (Duke 2011a)
- the location of more suitable spawning habitat in the backwater areas for many of the Broad River fish species
- the low abundance of fish larvae found in the vicinity of the proposed Broad River intake structure
- the typically high fecundity of most species in the river system, and many of the Broad River species' spawning habits (i.e., nest-building rather than broadcast spawning).

Make-Up Pond Intake Systems

Secondary intake and discharge structures would exist in Make-Up Ponds A, B, and C. The design of the proposed intake structure for Make-Up Pond A is shown in Figure 3-9 (configuration), Figure 3-10 (plan view), and Figure 3-11 (cross section). A plan view of the Make-Up Pond B intake/refill structure is shown in Figure 3-12, a side-profile view is provided in

Figure 3-13, and a cross-section view through the concrete wet well of the Make-Up Pond B intake/discharge structure is shown in Figure 3-14. A plan view of the Make-Up Pond C intake/discharge structure is shown in Figure 3-15, a side-profile view is provided in Figure 3-16, and a cross-section view is shown in Figure 3-17.

The modeled HZIs for Make-Up Ponds A, B, and C are localized and small. Under the worst-case modeling scenarios, the HZI extends 7.2 ft outward of the Make-Up Pond B intake structure and 9.2 ft from both the Make-Up Pond A and C intake structures. Complete details of the modeling scenarios are provided in Attachment 5 of the NPDES application (Duke 2011i).

Impingement, Entrainment, and Operational Maintenance

The current intake design for Make-Up Pond A includes dual-flow type traveling screens with a fish-return system (Duke 2012h). Dual screens allow the intake footprint to be narrower than the footprint of traditional single screen types. A spray wash system would help remove debris from the face of the screens. Debris not removed by the spray wash system would be returned to the unscreened waterway rather than being carried over to the clean water side as in a more traditional system. The screens would consist of ⅜-in. or smaller mesh and would have a through-screen velocity less than 0.5 fps to meet CWA §316(b) requirements (Duke 2010f, 2012i). The low intake velocity and fish-return system should minimize fish impingement in Make-Up Pond A. Ichthyoplankton passing through the intake would be assumed to experience 100 percent mortality.

The Make-Up Pond B and Make-Up Pond C intakes would be passive wedge-wire cylindrical drum screens with through-screen flow velocities less than 0.5 fps. The proposed range of slot sizes for the wedge wire are a maximum of 0.375 in. (9.5 mm) to a minimum of 0.079 in. (2.0 mm) (Duke 2010o, p). The intakes would be only operated intermittently, thereby reducing the potential for impingement and entrainment. Impingement also would be minimized by the low through-screen velocity. The intake screens in Make-Up Pond B would have a submerged centerline depth of 42 ft at the full pond elevation and a submerged centerline depth of 12 ft at the 30-ft drawdown elevation. The intake screens within the Make-Up Pond C reservoir would have a submerged centerline depth of 97 ft at the full pond elevation and a submerged centerline depth of 67 ft at the 30-ft drawdown elevation. Therefore, the Make-Up Pond C intake would always be below the thermocline (estimated to be at approximately 20 ft depth in summer) and away from shallow areas where fish tend to spawn and young fish reside (Duke 2009b; 2010o, p). However, ichthyoplankton passing through the intake would be assumed to have a 100 percent mortality rate. The intake screens would be removed from the ponds periodically for cleaning and maintenance (Duke 2010l).

Operational Impacts at the Lee Nuclear Station Site

Low-Flow Operations

Duke plans to use water from Make-Up Ponds B and C to supplement Broad River flows during low-flow conditions (Duke 2009c). Make-Up Pond B would be drawn down first. If Make-Up Pond B drawdown reaches 30 ft, drawdown from this pond would cease and water would be withdrawn from Make-Up Pond C to a nominal drawdown less than or equal to 30 ft (Duke 2011h).

Water level fluctuations can affect all forms of aquatic biota. The severity of the impact depends upon the magnitude, duration, and timing of the fluctuation and the species involved (Cott et al. 2008). Anthropogenic disturbances in particular can cause water level fluctuations that exceed the ability of aquatic organisms to adapt either physiologically or behaviorally (Coops et al. 2003; Cott et al. 2008). For example, extended exposure of shoreline when water is withdrawn could result in the loss of benthic invertebrates, aquatic plants, eggs of various aquatic organisms (including fish), and even juvenile life stages of some species, especially those that lay eggs or rear in shallow waters before a drawdown occurs (Heman et al. 1969; Cott et al. 2008). Even small changes of water level can result in dramatic shifts in aquatic plant communities (Coops et al. 2003). Extended drawdowns may increase the presence of invasive plant species (Cooke et al. 2005). It also should be noted, however, that purposeful drawdowns are used in many parts of the country to enhance existing aquatic macrophyte and fish populations or to control invasive species (Heman et al. 1969; Cooke et al. 2005; Cott et al. 2008). The difference is that intentional drawdowns used to manage particular species are timed to provide the most benefit versus cost, whereas a drawdown associated with low-flow conditions in the Broad River would not be pre-planned to maximize any benefits. Because the timing and extent would not be known in advance, the negative impacts could be more noticeable than under natural or planned conditions.

Because cooling systems typically withdraw from the deeper, cooler portion of the water column of lakes or reservoirs and discharge warmer water to the surface, they have the ability to alter thermal stratification of the surface water (NRC 2013a). The proposed volume of Make-Up Pond C was calculated based on the assumption that the proposed Lee Nuclear Station would continue operating during periods of low flow without disrupting the natural thermal stratification or turnover pattern as required to comply with CWA §316(b) requirements (Duke 2010l). To determine the volume of water required to provide a “zone of refuge” for fish in the event of a full drawdown of Make-Up Pond C, Duke determined that three similar reservoirs in the region typically showed thermal stratification at a depth of approximately 20 ft during the spring and summer months (i.e., the top 20 ft of the reservoir was thermally mixed and provided enough oxygen for aquatic life while the water below 20 ft was colder and less oxygenated). Construction of Make-Up Pond C at an elevation that would provide the full 20 ft of pond preserved as an aquatic refuge would not be feasible because of design constraints based on existing topography (Duke 2011h). Further analysis by Duke as part of the CWA §316(b) compliance demonstration showed the natural stratification and turnover pattern would be maintained by preserving the upper 17 ft of the pond as an aquatic refuge. The volume of water required to provide this 17-ft depth to fish was calculated, assuming 18 ft of dead storage volume was provided to keep the intake pump submerged and the volume of makeup water required to keep the station operating over an estimated 77 days of pumping to support station operation during an extreme low-flow event was withdrawn. In summary, Make-Up Pond C was sized with a total volume of approximately 22,000 ac-ft at a full pond surface elevation of 650 ft above MSL (Duke 2011h). This was based on:

- dead storage volume in the bottom 18 ft of the reservoir (537 to 555 ft above MSL): 147 ac-ft
- usable volume to support station operations (555 to 633 ft above MSL): 12,770 ac-ft
- volume in upper 17 ft of the reservoir (633 to 650 ft above MSL): 9106 ac-ft.

Water withdrawn from Make-Up Pond B or Make-Up Pond C would be used for power station operation and then discharged to the Broad River rather than being returned to the originating makeup pond. Thermal stratification would be maintained because water is removed from the bottom of the reservoir. However, as water is withdrawn from the ponds, the volume of water contained in the upper 17 ft decreases. Thus, while the mixed, oxygenated water above the thermocline may be maintained to 17 ft, the competition of fish vying for the more limited space may increase, based on the amount of water withdrawn and the bathymetry of the reservoir.

River Discharge System

The potential impacts to the Broad River from operation and maintenance of the proposed Lee Nuclear Station Units 1 and 2 would include effects of heated effluents on aquatic resources, chemical impacts, and physical impacts from discharge and dredging.

Thermal Impacts from Discharge

Thermal impacts to the aquatic environment can include effects associated with the discharge of heated water into the Broad River (acute or chronic effects) or the interruption of heated-water releases caused by planned or unplanned shutdowns resulting in cold shock. Section 3.2.2.2 provides a discussion on the location and design of the discharge piping. The discharge water, or blowdown from the plant, would be routed through a 36-in. inner-diameter pipe along the upstream face of the dam. The 88-ft-long diffuser pipe would be perforated with 64 4-in. ports spaced 1.4 ft apart that discharge horizontally (Duke 2011a). The centerline elevation of the diffuser pipe would be 11.75 ft below full pond elevation (Duke 2011h). The diffuser would be located approximately 750 ft from the west shore near the Ninety-Nine Islands Dam trash sluice structure (Duke 2011a). Complete mixing of the discharge with river water is assumed once the water is pulled through the hydroelectric facility.

The review team conservatively assumed the maximum plant blowdown temperature of 95°F (see Table 3-10) would occur concurrently with the lowest river flow. The review team also determined, assuming complete mixing of the normal blowdown downstream of the dam, that the river water temperature downstream of the dam would increase only 1.1°F and 1.2°F in January and August, respectively. While Table 3-10 provides a maximum discharge flow rate of 64 cfs, the review team determined that this condition would not likely occur in the critical low-flow conditions because water would be coming from Make-Up Pond B or Make-Up Pond C and, therefore, would be unlikely to encounter high sediment concentrations that could cause a sustained drop in the number of cycles of concentration feasible. The highest monthly mean river water temperature was 86°F in August 2007. Thus, the addition of the heated discharge to the Broad River would not likely increase temperatures in the river below Ninety-Nine Islands Dam above 90°F.

Currently, the SCDHEC requires that Broad River water temperatures not increase more than 5°F above ambient river temperatures and that river temperatures not exceed 90°F as a result of heated- water discharges, with the exception of a defined mixing zone, which would need to be granted by the SCDHEC (SCDHEC 2008a). On July 17, 2013, SCDHEC issued NPDES Permit No. SC0049140 to Duke for the Lee Nuclear Station (SCDHEC 2013a). The NPDES permit, effective September 1, 2013, requires Duke to submit for SCDHEC's approval a plan for confirmatory monitoring (confirming the accuracy of the computational fluid dynamics modeling that was used to support the thermal and toxicity mixing zone requests) within one year of the effective date of the permit. As stated on page 31 of the NPDES permit:

> The plan shall address the following elements: temperature monitoring methods, locations, and schedule; summer conditions monitoring to verify >90°F temperature plume does not extend beyond #4 turbine inlet; winter conditions monitoring to verify >5°F temperature increase plume does not extend beyond #4 turbine inlet; and consideration of timing of monitoring so that modeled scenarios (i.e. river temperature, river flow, discharge volume, and discharge temperature) are captured to the extent practical.

The thermal tolerance for fish is defined in different ways. Some definitions relate to the temperature that causes fish to avoid the thermal plume, other definitions relate to the temperature that fish prefer for spawning, and others relate to the temperatures (upper and lower) that may kill individual fish. A list of the upper and lower lethal thresholds for several important species found in the Broad River was compiled in the *Final Environmental Statement Related to Construction of Cherokee Nuclear Station, Units 1, 2, and 3* (NRC 1975a); this information is presented in Table 5-2. In every case, the upper lethal threshold is at least 7°F above the acclimation temperature and often is above the 90°F upper limit set by the SCDHEC, indicating that most fish species would be able to tolerate the increase in water temperature created by the thermal discharge from the proposed Lee Nuclear Station Units 1 and 2. The

White Sucker (*Catostomus commersonii*) is the only species with upper lethal thresholds consistently below 90°F. These fish would likely have sought areas away from the discharge area where ambient water temperatures are consistently cooler. In these areas, the White Sucker would not likely be affected because of the small size of the thermal discharge plume.

Table 5-2. Lethal Temperature Thresholds of Important Adult Fish Species of the Broad River

Species *(Scientific Name)*	**Acclimation Temperature**		**Upper Lethal Threshold**		**Lower Lethal Threshold**	
	°C	°F	°C	°F	°C	°F
Largemouth Bass (*Micropterus salmoides*)	20.0	68	32.5	90.5	5.5	41.9
	25.0	77	34.5	94.1		
	30.0	86	36.4	97.5	11.8	53.2
White Sucker (*Catostomus commersonii*)	5.0	41	26.3	79.3		
	10.0	50	27.7	81.9		
	15.0	59	29.3	84.7		
	20.0	68	29.3	84.7	2.5	36.5
	25.0	77	29.3	84.7	6.0	42.8
Channel Catfish (*Ictalurus punctatus*)	15.0	59	30.4	86.7	-17.8	0.0
	20.0	68	32.8	91.0	-17.8	0.0
	25.0	77	33.5	92.3	-17.8	0.0
Bluegill (*Lepomis macrochirus*)	15.0	59	30.5	86.9	2.5	36.5
	20.0	68	32.0	89.6	5.0	41.0
	25.0	77	33.0	91.4	7.5	45.5
	30.0	86	34.6	94.2	11.0	51.8

Smallmouth Bass (*Micropterus dolomieu*) are unique in this part of the Broad River, and concerns have been raised that increased water temperatures resulting from operating the proposed Lee Nuclear Station could negatively affect the population. A 1993 report by the FWS summarized data on temperature response criteria for Smallmouth Bass (Armour 1993). Several critical temperatures included in the report that may be relevant to Broad River fish are presented in Table 5-3. The review team determined, assuming complete mixing of the normal blowdown downstream of the dam, that river water temperature would only increase 1.2°F in August. Even under the warmest water conditions recorded in August (monthly mean temperature of 86°F from August 2007), there should be no significant impact to the bass during any part of their lifecycle, especially if SCDHEC limitations are observed (Duke 2009c). Also, the small area of increased temperature would limit the extent of any impact.

Table 5-3. Temperature Response Criteria for Smallmouth Bass

Criterion	Value	Comments
Maximum weekly average temperature for adequate adult and juvenile growth	32 to 33°C (90 to 91°F)	---
Short-term maximum temperature for adult and juvenile summertime growth	35°C (95°F)	---
Short-term maximum temperature for embryo development	23°C (73°F)	Author of the study estimated that this temperature was conservative and that a maximum of 26°C (79°F) is more realistic for spawning and embryo protection.
Final preferred temperature	27°C to 31.5°C (81 to 89°F)	These were the minimum and maximum final preferred temperatures from three separate studies.

Source: Adapted from Armour 1993

Based on the previous discussion, the review team concludes that the thermal impacts on the fish populations from the discharge of heated water from the proposed Lee Nuclear Station Units 1 and 2 would be minor, and additional mitigation would not be warranted.

Invasive nuisance organisms found in Ninety-Nine Islands Reservoir include one fish (Smallmouth Buffalo [*Ictiobus bubalus*]) and one mussel (Asiatic clam [*Corbicula fluminea*]) (Duke 2009c). Smallmouth Buffalo are tolerant of warm waters during all life stages. They are thought to potentially compete with redhorse sucker species (*Moxostoma* spp.), which prefer slightly lower water temperatures (Edwards and Twomey 1982). However, the small size of the discharge plume and small change in temperature would minimize the impact to native aquatic resources in the Broad River. Similarly, the Asiatic clam also can tolerate warm waters. However, neither species is expected to proliferate beyond the immediate vicinity of the plant as a direct result of station thermal discharge; therefore, potential impacts from invasive species are considered to be minor.

Cold shock occurs when aquatic organisms that have been acclimated to warm water are exposed to a sudden temperature decrease. This sometimes occurs when single-unit power plants shut down suddenly in winter or when an unseasonably cold weather event occurs. Cold shock mortalities at U.S. nuclear power stations are relatively rare and typically involve small numbers of fish (NRC 2013a). It is less likely to occur at a multiple-unit plant, as is proposed for the proposed Lee Nuclear Station, because the temperature decrease from shutting down one unit is moderated by the heated discharge from the unit that continues to operate. In addition, gradual shutdown of plant operations generally precludes cold shock events (NRC 2013a). It is also less of a factor when the discharge is to a river where the volume of the discharge in comparison to the flow of the river is very small, as is the case at the Lee Nuclear Station site.

Even at the proposed maximum rate of discharge (64 cfs), the proposed two new nuclear units should discharge less than 5 percent of the mean annual Broad River flow.

The NPDES permit application submitted by Duke included a computational fluid dynamics model analysis of the thermal plume under winter conditions when the temperature difference between the discharge temperature (maximum 70.4°F) and the river water temperature (mean of approximately 44.1°F in January) would be at its maximum. Results of this modeling indicate that the greater than 5°F plume would be limited to a narrow band in the immediate vicinity of the diffuser, would dissipate before reaching the surface, and would have a maximum depth of approximately 11.5 ft (Duke 2013e). This represents a limited cross-sectional area of the forebay and limits potential exposure to the greater than 5°F plume for free-swimming fish or benthic organisms and their passive life stages. In addition, the small area of thermal enhancement should limit attraction of fish. The submerged multiport diffuser, not fully considered by the computational fluid dynamics model, would provide rapid mixing of the thermal discharge, further reducing the size of the mixing zone, and mitigating impacts to aquatic resources from thermal discharge. Based on the previously discussed analysis, the review team concludes that the thermal impacts on fish populations resulting from cold shock would be minor, and additional mitigation would not be warranted.

Chemical Impacts from Discharge

Other discharge-related impacts include chemical treatment of the cooling water. The ER submitted by Duke indicates that chemicals would be added to the CWS, SWS, demineralized water-treatment system, steam generator blowdown system, and clarification system (Duke 2009c). Biofouling would be controlled using sodium hypochlorite and sodium bromide. These chemicals are used successfully at the Catawba Nuclear Station on the Catawba River, another river located in the Piedmont area in South Carolina. Monitoring data developed under conditions of the Catawba NPDES permit have shown no chemicals present in the blowdown waters above the No-Observable Effects Concentration, a risk assessment parameter that represents the concentration of a pollutant that will not harm the species involved with respect to the effect (e.g., survival, growth, or reproduction) being studied (Duke 2009c). Table 3-9 provides a list of the water-treatment chemicals, frequency of use, and the concentrations expected to be discharged from the proposed Lee Nuclear Station. The review team compared the ecological toxicity data from Material Safety Data Sheets (MSDS) for each of the chemicals to concentrations in the discharge. In every case, the concentrations in the discharge are lower than the LC_{50} (the concentration that kills 50 percent of the sample population in a given time) obtained from the MSDS. The water flow from the Broad River would further dilute the concentration of these chemicals.

Chemical constituents naturally occurring in Broad River water would also be present in the liquid discharge, concentrated by cooling water recirculation and losses to evaporation. Table 3-8 presents Duke's estimates of concentration of the primary metals that will be in the blowdown water due to concentration of water from the Broad River. The review team acknowledges that some of the concentrations of some of the constituents in the blowdown will be above South Carolina State water-quality standards at the point of discharge. However, the constituents will be diluted back to ambient Broad River water-quality levels as the discharge mixes into the rest of the Broad River. The review team determined that the concentrations of the solutes would be diluted by the streamflow within a short distance below the dam, and any localized increase would be undetectable relative to background by the time the water reaches the City of Union, South Carolina. Pursuant to the CWA, Duke has obtained an NPDES permit from SCDHEC (Permit No. SC0049140, issued July 17, 2013 and effective September 1, 2013), which establishes monitoring requirements to ensure the environment is not adversely impacted (SCDHEC 2013a).

Based on the estimated discharge concentrations and the successful use of water-treatment chemicals at another nuclear power station in the region without negative impacts to aquatic resources, the impacts from the chemical discharges to the Broad River should be minimal. As noted above, the SCDHEC worked with Duke to develop an appropriate NPDES permit for the site that requires monitoring and adherence to chemical discharge limits (SCDHEC 2013a). Duke's NPDES permit application included a Whole Effluent Toxicity mixing zone request (Duke 2011a). In January 2013, Duke submitted a revised Whole Effluent Toxicity mixing zone request to the SCDHEC. The revised proposed mixing zone has a length of 84 m (276 ft) and a width of 23 m (76 ft) (Duke 2013e).

Physical Impacts from Plant Discharge and Dredging

Scouring at the plant discharge site is expected because the bottom of the discharge pipe would be approximately 7.5 ft above the river bottom (Duke 2011h). Water from the diffuser would be dispersed horizontally into the water column from 64 4-in. holes spaced 1.4 ft apart over an 88-ft length of a 36-in. inner-diameter high-density polyethylene pipe (Duke 2011a). Some loss of benthic organisms would be expected from the continual discharge of water. Bottom substrates in the area are currently mud and silt. Surveys for benthic invertebrates around the Lee Nuclear Station have shown that such habitat supports fewer ephemeroptera, plecoptera, and trichoptera taxa, resulting in low bioclassification scores (Duke 2008a). Thus, because the discharge is in a place where macroinvertebrate habitat is already degraded, additional scouring would not likely negatively impact the overall aquatic health of the ecosystem.

Dredging can affect aquatic biota in a variety of ways, but it is generally assumed that organisms living on or in the affected sediments will be killed. In addition, suspended sediments may settle onto and bury adjacent habitats, clog the feeding structures of filter-feeding organisms, or temporarily reduce light penetration. The recovery of benthic communities in habitats disturbed by dredging depends on such factors as the character of the remaining sediments, the sources of organisms available to recolonize the area, and the size of the disturbed area. Recovery of benthic communities may take weeks to several years.

Maintenance dredging at the Broad River discharge site is not expected (Duke 2008p). Duke Energy calculated the settling velocity of typical Broad River silt particles to be 0.0001 fps; thus, there would be little chance for sediment to accumulate near the diffuser end of the discharge pipe (Duke 2008p). Sediment could accumulate during a period when the Ninety-Nine Islands Hydroelectric facility does not operate, but the forebay has enough capacity to hold at least 4 months of sediment accumulation under this unlikely scenario (Duke 2008p). Periodic maintenance dredging would be required at the Broad River intake structure. Duke estimated the dredged material volume at approximately 150 yd^3 per year (primarily medium sands), but also stated that they did not anticipate dredging annually (Duke 2008o, 2012b, j). Maintenance dredging events would impact a relatively small area and would be short term; therefore, impacts would be localized and temporary. Benthic macroinvertebrates would likely recolonize the area quickly. Duke estimated periodic maintenance dredging of Make-Up Pond A also would be necessary (Duke 2009b). Maintenance dredging events would be infrequent, and the soft-sediment environment would speed recovery from the effects of dredging in the pond. All dredging would be performed in accordance with SCDHEC and Department of the Army permit conditions. Dredged material disposal would be either in an approved county landfill or in an onsite spoils area (Duke 2009b).

Because Make-Up Pond B and Make-Up Pond C would receive water only during refill operations (i.e., to replenish water levels due to loss from evaporation or from use during low-flow periods), sedimentation rates are expected to be variable, but slow, and maintenance dredging would not be required (Duke 2009b).

Based on this analysis of the potential for physical impacts to the aquatic ecosystem from the discharge of cooling water to the Broad River and maintenance dredging activities, and the review team's own independent assessment, the review team concludes that the physical impacts from thermal discharges from the proposed Lee Nuclear Station and maintenance dredging at the Broad River intake structure and in Make-Up Pond A would be minor.

5.3.2.2 Aquatic Resources – Transmission-Line Corridors

Maintenance activities along the proposed transmission-line corridors could lead to periodic temporary effects on the waterways being crossed. However, it is assumed that the same vegetation-management practices used by Duke for its other existing transmission-line corridors at Oconee and Catawba Nuclear Stations in South Carolina and McGuire Nuclear Station in North Carolina would be applied to the proposed new transmission-line corridors. Duke practices and procedures were developed as tools to help meet or exceed the requirements of the SCDHEC, so that impacts to aquatic ecosystems from operation and maintenance of transmission-line corridors would be minor. Along transmission-line corridors, activities near streams are minimized by the use of buffer zones to decrease the possibility of negative impacts. For example, only hand cutting is allowed within 50 ft of a stream, and tall-growing species are cut only if they will affect lines in the future (Duke 2007c).

The review team concludes that the impacts of transmission-line corridor maintenance activities on aquatic resources would not adversely impact aquatic ecosystems, and additional mitigation beyond that described above would not be warranted.

5.3.2.3 Important Aquatic Species and Habitats

The principal impacts from operation of the proposed Lee Nuclear Station Units 1 and 2 on the important aquatic species listed in Section 2.4.2 would be from operation of the cooling-water intake and discharge systems.

Federally Listed Species

There are no Federally listed threatened or endangered species known to exist at the Lee Nuclear Station site, as described in Sections 2.4.2 and 4.3.2. There are no areas designated as critical habitat for threatened and endangered species in the vicinity of the Lee Nuclear Station site. In a letter dated June 13, 2012, the FWS concurred with the review team's determination that the proposed Lee Nuclear Station Units 1 and 2 project is not likely to adversely affect Federally protected species or result in adverse modification to designated or proposed critical habitat, thus completing informal consultation between the FWS and the NRC (FWS 2012b). In a letter to the National Marine Fisheries Service (NMFS) dated August 14, 2012, the NRC staff documented its no-effect determination for the Shortnose Sturgeon (*Acipenser brevirostrum*) and the Atlantic Sturgeon (*A. oxyrinchus oxyrinchus*) and considered its consultation with NMFS under the Endangered Species Act, Magnuson-Stevens Fishery Conservation and Management Act, and Fish and Wildlife Coordination Act for the proposed Lee Nuclear Station to be complete (NRC 2012d). Consultation correspondence between the review team and the FWS and NMFS is listed in Appendix F.

State-Ranked Species

One State-ranked fish species, the Carolina Fantail Darter *(Etheostoma brevispinum*) has been found in areas potentially affected by operation of the proposed Lee Nuclear Station. It is ranked S1, or critically imperiled statewide because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation. Until recently, the Carolina Fantail Darter was known as the subspecies *E. flabellare brevispinum.* Based on new research, the Carolina Fantail Darter has been elevated to species level (Blanton and Schuster 2008). Previous records of *E. flabellare* in this region were likely *E. brevispinum*.

The Carolina Fantail Darter has been captured in the vicinity of the proposed Broad River intake structure (Duke 2009c). Although it has only been captured in very low numbers, as described in Section 2.4.2.3, it is possible that this fish species could be affected by operation of the Broad River intake structure. The primary impacts are likely to be impingement, entrainment, or a decrease in suitable habitat due to water consumption and heated-water discharge by the proposed Lee Nuclear Station Units 1 and 2. The Carolina Fantail Darter lays adhesive eggs on the underside of stones, which makes it unlikely the eggs could be entrained. The fish prefer to inhabit riffles and runs with rocky substrate. Because this habitat type does not exist near the proposed intake structure, and because of the limited HZI at the intake, it would be uncommon for Carolina Fantail Darters to become impinged or entrained at the Broad River intake structure. According to the Duke NPDES application, consumptive use of water by the proposed Lee Nuclear Station could reduce water flow in the Broad River by up to 3 percent on an annual basis (Duke 2011a). Because the river fluctuates greatly over the course of any year, riverine fish species such as the Carolina Fantail Darter are already well adapted to changes in the amount of wetted habitat. By itself, the amount of water used by the Lee Nuclear Station is unlikely to cause significant losses to Carolina Fantail Darter habitat. The tailrace of Ninety-Nine Islands Dam does contain some rocky habitat; however, as discussed in Section 5.3.2.1, it is unlikely that this fish species would be significantly affected by thermal discharge from the Lee Nuclear Station because of the small increase in temperature over ambient conditions and the small size of the thermal plume.

Additional Species of Ecological Importance

As discussed in Section 4.3.2.3, five fish species, listed as highest or high priority conservation species by the SCDNR (2005), were found during surveys conducted by Duke or the SCDNR in the Broad River in the vicinity of the proposed Lee Nuclear Station site, in London Creek, or in tributaries to the Broad River that may be crossed by new transmission-line corridors associated with the proposed Lee Nuclear Station. These species may be affected negatively through impingement or entrainment at the Broad River intake system; thermal, chemical, or physical impacts from operation of the Broad River discharge system and dredging; maintenance activities along the proposed transmission-line corridors, or by low flows within London Creek.

According to Bettinger et al. (2003), the Highfin Carpsucker (*Carpiodes velifer*) was possibly captured in the tailraces of Cherokee and Ninety-Nine Islands dams. Because the species prefers faster flowing water, it is unlikely to be affected by operation of the Broad River intake system or transmission-line-corridor maintenance. As described in Sections 5.3.2.1 and 5.3.2.2, thermal, physical, and chemical impacts due to operation of the Broad River discharge system are unlikely to affect the Highfin Carpsucker.

The Quillback (*C. cyprinus*) and the Piedmont Darter (*Percina crassa*) were previously found in the Ninety-Nine Islands Reservoir near the proposed Lee Nuclear Station site (Bettinger et al. 2003). These species could be subject to impingement or entrainment at the Broad River intake system, but the intake location, design and operating parameters (e.g., low through-screen velocity) would minimize any potential loss. As described in Sections 5.3.2.1 and 5.3.2.2, thermal, physical, and chemical impacts due to operation of the Broad River discharge system are unlikely to affect these species. Because the Quillback and Piedmont Darter were not found in waters associated with the proposed transmission-line corridors, they are unlikely to be affected by transmission-line-corridor maintenance.

The Seagreen Darter (*Etheostoma thalassinum*) was found in Thicketty Creek, which would be crossed by the planned new transmission-line corridors (Bettinger et al. 2006). As described in Section 5.3.2.2, because Duke would comply with SCDHEC regulations when performing transmission-line-corridor maintenance activities near water, impacts of operation and maintenance to the Seagreen Darter are expected to be minimal.

The Greenhead Shiner (*Notropis chlorocephalus*) was found in London Creek during 2010 surveys (SCDNR 2011b). Most of the creek would be impounded during construction to form proposed Make-Up Pond C. However, the Greenhead Shiner could still potentially inhabit the remaining, short section of London Creek below the impoundment or in Little London Creek. Currently, no minimum flow requirements are in place from Cherokee Dam to London Creek (Duke 2009b); however, Duke has proposed minimum seasonal flow releases from Make-Up Pond C to London Creek downstream of Make-Up Pond C dam (January through April 1.5 cfs; May, June, and December 1.0 cfs; July through November 0.75 cfs) (Duke 2012m). This proposed minimum flow regime would maintain existing water uses and protect the remaining aquatic resources downstream of the Make-Up Pond C Dam to the confluence of London Creek with the Broad River (Duke 2012c). In addition, the primary flow path cell of the new concrete box culvert for the railroad-spur crossing London Creek would have a roughened channel with engineered stream-bed material to create a more natural channel flow for the passage of fish and other aquatic organisms (Duke 2012j).

Recreational Species

As described in Section 2.4.2.3, Ninety-Nine Islands Reservoir and the Broad River support a recreational fishery that consists mainly of sunfish, bass, Black Crappie (*Pomoxis nigromaculatus*), catfish, and suckers. As described in Section 5.3.2.1, the operation of the Broad River intake and discharge structures is not expected to noticeably alter populations of recreational fish species.

Diadromous Fish Species

As described in Section 2.4.2.1, it is possible that fish-passage programs could extend the range of diadromous fish species in the Broad River. It is possible the American Eel (*Anguilla rostrata*) and American Shad (*Alosa sapidissima*) could eventually be found in waters near the proposed Lee Nuclear Station. Thermal, chemical, and physical impacts to reintroduced diadromous fish species from operation of the Broad River intake and discharge systems are expected to be minimal as previously described in Section 5.3.2.1. In a letter to the NMFS dated August 14, 2012, the NRC concluded its consultation with the NMFS under the Endangered Species Act, Magnuson-Stevens Fishery Conservation and Management Act, and

Fish and Wildlife Coordination Act for the Lee Nuclear Station COL application. In the event of successful implementation of the fish-passage program as described in the *Santee River Basin Accord for Diadromous Fish Protection, Restoration, and Enhancement* (SRBA 2008), the NRC staff will consider potential thermal, chemical, and physical impacts to Federally protected species from operations at the Lee Nuclear Station (NRC 2012d).

5.3.2.4 Aquatic Monitoring

Duke has not committed to formal monitoring of the aquatic ecosystems during operations other than that required as a condition of their NPDES permit (Duke 2009c, 2011a; SCDHEC 2013a). The permit requires flow and temperature monitoring and monitoring of certain chemical constituents in the discharge (SCDHEC 2013a). The NPDES permit is required for the entire duration of plant operation and must be renewed every 5 years with provisions for updating monitoring programs and parameters, as necessary.

5.3.2.5 Summary of Operational Impacts on Aquatic Resources

The review team has reviewed the potential impacts of operating the proposed Lee Nuclear Station and the associated Broad River intake system, Make-Up Ponds A, B, and C intake and discharge systems, Broad River discharge system, and transmission-line corridors on aquatic resources. Impingement and entrainment impacts to aquatic ecology of the site and environs from operation of the Broad River intake structure are likely to be minimal. The use of closed-cycle cooling, the low through-screen velocity (less than 0.5 fps), the limited HZI, and the location and design of the intake structure, including dual-flow traveling screens with fish-return system, all contribute to this finding. Impacts to aquatic biota from operation of intakes in Make-Up Ponds A, B, and C are also likely to be minor. The dual-flow traveling screen design proposed for Make-Up Pond A will have low through-screen velocities (less than 0.5 fps) and a fish-return system. The intakes in Make-Up Ponds B and C will be operated only intermittently and will be equipped with passive wedge-wire, drum-type screens with a through-screen velocity less than 0.5 fps. In addition, these intakes would be located in deep-water areas away from primary fish spawning and rearing habitat, and each intake will have a limited HZI. Operation of Make-Up Ponds A, B, and C will not disrupt the natural stratification or turnover in these ponds.

Impacts on aquatic organisms in the Broad River due to the discharge could result from thermal, chemical, and physical effects on the substrate, and hydrological changes. Thermal impacts on the fish populations from the discharge of heated water from the proposed Lee Nuclear Station Units 1 and 2 are expected to be minor because of the small increase in temperature over ambient conditions and the small extent of the thermal plume which limits the number of fish that could be affected. Therefore, the review team concludes that thermal impacts on the fish populations would be minor, and additional mitigation would not be warranted. Based on the estimated discharge concentrations and the successful use of the water-treatment chemicals planned for proposed Lee Nuclear Station Units 1 and 2 at another nuclear power station in the region, the impacts from chemical discharges to the Broad River are expected to be minimal. Also, the SCDHEC worked with Duke to develop an appropriate NPDES permit for the site that requires monitoring and adherence to chemical discharge limits (SCDHEC 2013a). Physical impacts of scouring from the Broad River discharge also are expected to be minimal based on the relative low discharge rate (normally 18 cfs), the design of the multiport diffuser, and the already degraded benthic habitat. Thus, physical impacts from thermal discharges from the proposed Lee Nuclear Station would be minor.

Hydrological alterations resulting from future maintenance dredging activities at the Broad River intake structure and Make-Up Pond A would be localized, involve minimal quantities, and be conducted in accordance with SCDHEC and Department of the Army permit conditions and Duke BMPs. Impacts would be temporary and negligible.

The review team also concludes that the impacts of transmission-line corridor maintenance activities on aquatic resources would not adversely impact aquatic ecosystems because accepted BMPs, already used at three other Duke nuclear power stations in North Carolina and South Carolina, will be followed.

Impacts to the State-ranked Carolina Fantail Darter fish species are expected to be minimal based on its habitat preferences and adhesive egg-laying characteristics. In addition, should fish passage eventually be restored and diadromous fish species (e.g., American Eel or American Shad) reach Ninety-Nine Islands Dam or Ninety-Nine Islands Reservoir, these fish should not be negatively affected by Lee Nuclear Station operation for the reasons presented in Section 5.3.2.1.

Based on the previous discussions, the review team concludes that the aquatic ecological impacts to the Broad River, the onsite ponds, Make-Up Pond C, and waters crossed by the transmission-line corridors from the operation and maintenance of the proposed Lee Nuclear Station facilities and associated new transmission lines would be SMALL, and additional mitigation would not be warranted.

5.4 Socioeconomic Impacts

Operations activities can affect individual communities, the surrounding region, and minority and low-income populations. This evaluation assesses the impacts of operations-related activities and of the operations workforce on the region. Unless otherwise specified, the primary source of information for this section is the Duke ER (Duke 2009c). According to its Integrated Resource Plan (Duke 2013b), Duke expects to bring proposed Lee Nuclear Station Units 1 and Unit 2 online in 2024 and 2026, respectively.

Although the review team considered the entire region within a 50-mi radius of the Lee Nuclear Station site when assessing socioeconomic impacts, the primary region of interest for physical impacts is that within a 10-mi radius. The region of interest with regard to social and economic impacts encompasses the entire 50-mi radius, but primarily includes Cherokee and York Counties in South Carolina. The review team recognizes that many operations workers will live in more populated areas that have more amenities and services, such as the Spartanburg/Greenville area in South Carolina; Boiling Springs, South Carolina; and Shelby, Kings Mountain, and Charlotte, North Carolina. These areas are large cities or near large cities that provide the types of amenities that operations workers and their families enjoy. However, because of the varied dispersion of workers, these communities are able to absorb the increased population. Based on the distribution of residential communities in the area, the review team found *de minimis* impacts on other counties within a 50-mi radius in South Carolina and North Carolina.

5.4.1 Physical Impacts

This section identifies and assesses the direct physical impacts of operations-related activities on the community. The potential physical impacts of operating the proposed Lee Nuclear Station include disturbances from noise, odors, vehicle exhaust, dust, vibration, and visual intrusions. It includes consideration of impacts resulting from plant operations, transmission corridors and access roads, Make-Up Pond C, other offsite facilities, and project-related transportation of goods and materials in sufficient detail to predict and assess potential impacts and to show how these impacts should be treated in the licensing process. The review team concluded that these operations-related impacts will be mitigated through compliance with all applicable Federal, State, and local environmental regulations and, therefore will not significantly affect the region surrounding the site. The following sections assess the potential operations-related physical impacts of the proposed two nuclear units on specific segments of the population, the plant, and nearby communities.

5.4.1.1 Workers and the Local Public

No residences are located within the Lee Nuclear Station site boundary. The nearest resident is located 0.99 mi southeast of the proposed Unit 2 cooling tower (Duke 2013d). The 10-mi area around the Lee Nuclear Station site is predominantly rural and characterized by agricultural and forested land with an estimated 2007 total population of 43,132 (Duke 2009c). An estimated 620 ac of land will be inundated during construction for the development of Make-Up Pond C. No significant industrial or commercial facilities other than the Broad River Energy Center and Herbies Famous Fireworks exist within 5 mi of the Lee Nuclear Station site.

Operational Impacts at the Lee Nuclear Station Site

Noise

The proposed Lee Nuclear Station Units 1 and 2 will produce noise from the operation of pumps, cooling towers, transformers, turbines, generators, switchyard equipment, and loudspeakers (Duke 2009c). The noise levels would be controlled in accordance with applicable local regulations. Most equipment would be located inside structures, reducing the outdoor noise level. Duke will use two mechanical draft cooling towers for each unit to remove excess heat. Natural and mechanical draft cooling towers emit broadband noise, which Duke does not expect to be significantly greater than background levels (Duke 2009c). Noise levels below the 60 to 65 dBA day-night, 24-hour average (Ldn) range are considered to be of small significance (NRC 2013a). The maximum sound level generated by operation of proposed Lee Nuclear Station Units 1 and 2 at the site boundary will range from about 40 to 69 dBA, which would not affect the usage of nearby recreational areas and would not require mitigation. Therefore, the review team determined the noise-related effect on workers, nearby residents, and recreational users of nearby areas would be minimal, and no mitigation would be warranted. Traffic noise would be most noticeable during shift changes and during occasional periods of heavy truck traffic. Noise from heavy truck traffic could reach levels of 70 to 90 dBA at 50 ft from the road. Traffic can be minimized by enforcing low speed limits, maintaining good road conditions, and controlling the time of day peak site-related traffic occurs (Duke 2009c).

Air Quality

Once the proposed nuclear units have begun operation, they will not produce any known air pollutants except for (1) emissions from the periodic testing and operation of standby diesel generators and auxiliary power systems, (2) commuter vehicle dust and exhaust, and (3) odors from operations. Certificates to operate the diesel generators require that air emissions comply with all applicable regulations and operation of the generators would be intermittent and brief, therefore, the review team expects the air-quality impacts would be minimal. Access road maintenance and speed limit enforcement would reduce the amount of dust generated by the commuting workforce. Duke would use a staggered shift schedule for its operations workforce, which would also help mitigate the effects of vehicle exhaust (Duke 2009c). During normal plant operation, proposed Lee Nuclear Station Units 1 and 2 will not use chemicals in amounts that would generate odors exceeding Federal or State limits. Duke plans to use BMPs to control the odors emitted by chemicals and other sources during routine outages. Therefore, the review team estimates that the proposed Lee Nuclear Station Units 1 and 2 would have only minimal impact to air quality and would not require mitigation. Air-quality impacts of plant operation are discussed in more detail in Section 5.7 of this document.

5.4.1.2 Buildings

Approximately 86 housing units within the Make-Up Pond C site have been demolished during the development of Lee Nuclear Station Units 1 and 2. Onsite buildings would be built to safely withstand any possible impact, including shock and vibration, from operations activities associated with the proposed activity (Duke 2009c). Except for the Lee Nuclear Station structures, no other industrial, commercial, or residential structures will be affected.

5.4.1.3 Transportation

Roads within the vicinity of the Lee Nuclear Station site would experience an increase in traffic at the beginning and end of each operations shift and the beginning and end of each outage support shift. Commuter traffic will be controlled by speed limits. The access road to the Lee Nuclear Station site is paved. Maintaining good road conditions and enforcing appropriate speed limits will reduce the noise level and particulate matter generated by deliveries and the workforce commuting to and from the Lee Nuclear Station site. No new public roads would be constructed or be subject to major modifications due to the operation of proposed Lee Nuclear Station Units 1 and 2. Railroad deliveries during the operation phase would be less frequent than during construction. Therefore, the review team determined the road-related impacts from noise and dust to workers, residents, and other users of the roads within the vicinity of the proposed site would be minimal, and additional mitigation would not be warranted.

5.4.1.4 Aesthetics

The nearest residence is 0.99 mi southeast from the site of the proposed Lee Nuclear Station Units 1 and 2, separated by woodland and the Broad River such that the proposed Lee Nuclear Station Units 1 and 2 and associated structures may be visible. In addition, the proposed units and associated structures may be visible from the Broad River and residences along McKowns Mountain Road. The visual impacts would be from the reactor buildings and the cooling towers and their plumes, which will resemble cumulus clouds. Section 5.7 describes these impacts in more detail. Transmission lines are expected to be visible, but the corridors are located in predominately rural farmland. Make-Up Pond C will be visible from the road and local area. Plant-related structures would be visible only to those in close proximity of the site. Therefore, the review team expects the visual impact of the Lee Nuclear Station to be minimal and mitigation would not be warranted.

5.4.1.5 Summary of Physical Impacts

Based on the information provided by Duke, review team interviews with local public officials, and the review team's independent assessment of the physical impacts on workers and local public, buildings, transportation, and aesthetics, the review team concludes that the physical impacts of operation of the proposed Lee Nuclear Station Units 1 and 2 would be SMALL and additional mitigation measures beyond those discussed by Duke in its ER would not be warranted.

5.4.2 Demography

The baseline population of the two most local counties (Cherokee and York Counties) is estimated to increase steadily over the 40-year operating license similarly to population growth till 2035 (see Table 2-16). Duke projects an operations workforce of 957 operations workers, who would start arriving onsite during site development, as discussed in Section 4.4. Based on staffing at their other nuclear plants in the southeast, Duke estimates that 345 (36 percent) of the operations workforce would be highly specialized and would in-migrate into the area and that each in-migrating operations worker will bring a family. Duke expects the remaining new operations workforce, up to 612 workers (64 percent), would come from within the 50-mi region. Based on these assumptions, the review team assumes that impacts outside of Cherokee and York Counties would be minimal. Even if all 957 operations workers migrated into the area, they would constitute a less than 1 percent increase over the baseline population of Cherokee and York Counties. Therefore, the review team concludes that the demographic impact of operations workers on the local area would be minimal.

In addition to the operations workers, each new unit would require an outage workforce of 600 to 800 temporary employees who would be onsite for periods of approximately 30 days for scheduled refueling outages every 18 months (Duke 2009c). This means there would be an outage of one of the two new units approximately every 9 months. The review team expects that outage workers would typically migrate to the area from all over the country and stay only during the outage period at temporary lodging as close to the site as possible. The temporary nature of the work would generate only a minimal impact on Cherokee and York Counties, with little or no effects felt in the larger region. Based on information provided by Duke and the review team's independent review, the review team concludes that operations workers and their families would be expected to have a SMALL beneficial impact on the local communities and governmental entities in Cherokee and York Counties, and the 50-mi region.

5.4.3 Economic Impacts on the Community

The impacts of proposed Lee Nuclear Station Unit 1 and 2 operation on the local and regional economy are dependent on the region's current and projected economy and population. Although future impacts cannot be predicted with certainty, some insight can be obtained for the projected economy and population by consulting with county planners and population data. The primary economic impacts from operation of proposed Lee Nuclear Station Units 1 and 2 over the estimated 40-year operating license and employment of 957 new workers would be related to taxes, housing, and increased demand for goods and services, with the largest impact associated with plant property tax revenues (discussed in Section 5.4.3.2). The majority of economic impacts are expected to occur in the economic impact area of Cherokee and York Counties.

5.4.3.1 Economy

The review team estimated the potential social and economic impacts on the surrounding region as a result of operating proposed Lee Nuclear Station Units 1 and 2 and assuming a 40-year operating license. Social and economic impacts would occur from additional operation workforce jobs, wages paid, and tax revenue impacts during operation of the power plant.

Section 2.5 presents detailed descriptions of local and regional employment trends. The 957 new operations jobs at the proposed Lee Nuclear Station Units 1 and 2 would represent less than 1 percent of the total workforce in the economic impact area. However, in Cherokee County, where the nuclear power station is located, the additional 957 jobs represent approximately 4 percent of total employment. Cherokee County would be the most affected because it would likely receive the largest population and workforce increase as a percentage of its base population and workforce, and it would receive the substantial fee-in-lieu of tax payments (discussed in Section 5.4.3.2). Outside Cherokee County, the impacts become diffuse because of interactions with the larger economic base of the surrounding counties.

The employment of operations workers would have a multiplier effect in the local and regional economy, similar to that described in Section 4.4 for the building workforce. The applicable Regional Input-Output Modeling System (RIMS II) employment multiplier provided to Duke from the U.S. Department of Commerce Bureau of Economic Analysis is 2.165 (BEA 2011). This means that about 1115 indirect jobs would be supported by the Lee Nuclear Station operations in the economic impact area, increasing the total number of jobs supported to about 2072. The review team expects that only a minimal number of jobs would be created in the wider region. Because the review team expects that 36 percent of the operations workforce would migrate to the economic impact area, only 36 percent of the total employment effects would represent a net impact on the area. Employment effects representing upgraded employment for in-area workers also would count as impacts. However, the review team expects most of the operations workforce and associated indirect and induced employment would come from within the economic impact area. Therefore, the review team concludes that the new jobs would not increase the local baseline employment significantly. Because the indirect jobs typically would be service-related and not highly specialized, the review team expects that they would be filled primarily by residents of the region and would not induce new migration to the region.

Duke’s annual expenditures during operations are unknown; however, any expenditures made locally would represent a positive economic impact in the region as does spending of wages and salaries by operations workers. This represents new spending in the economic impact area. The new expenditures and income would result in an income multiplier impact felt in the economic impact area. The applicable income multiplier provided from RIMS II is 0.42 (BEA 2011). This means that for each dollar of new expenditure, 42 cents of new income is generated in the economic impact area.

Operational Impacts at the Lee Nuclear Station Site

The operation of the Lee Nuclear Station would also require an additional workforce needed for scheduled outages. Outages for Units 1 and 2 would be staggered, with each unit requiring an outage every 18 months. Each outage would require between 600 and 800 additional short-term contract employees to perform equipment maintenance, refueling, and special outage projects at the Lee Nuclear Station. Most of the outage workers would stay in local hotels, rent rooms in local homes, or bring travel trailers so they can stay as close as possible to the Lee Nuclear Station site. For nearby, existing nuclear plant outages, all hotel rooms in the area surrounding the plant are typically booked by outage workers. The review team expects the same for Cherokee County during the Lee Nuclear Station outages. Most hotels in Gaffney are also expected to be full during outages. This increases revenues for hotels, restaurants, and other retail establishments that provide services to these temporary workers. Outside Cherokee County, the impacts become more diffuse because of the area's larger economic base, with more available hotel rooms and temporary housing.

Based on information provided by Duke and the review team's own independent review, the review team concludes the overall impact on the economy of the region from operating the proposed Lee Nuclear Station would be positive. The most pronounced economic impacts would occur in Cherokee County, where impacts would be noticeable, and minimal beneficial economic impacts may occur in York County and other nearby counties within commuting distance of the site.

5.4.3.2 Taxes

The tax structure of the region is discussed in Section 2.5. Several types of taxes would be generated during the operational life of proposed Lee Nuclear Station Units 1 and 2. Employees would pay sales, use, personal property, and income taxes, and vendors selling materials and services to the facility would pay a variety of State, Federal, and local taxes. The Lee Nuclear Station site would be subject to property taxes paid to Cherokee County.

Sales, Use, Income, and Corporate Taxes

Duke will pay $3 per $1000 of gross receipts derived from services rendered each year. Based on an average customer cost for electricity in 2007 for South Carolina of $0.0695/kWh and an annual electricity generation of 18,200,000 MW(h), Duke will pay over $3.5 million annually (Duke 2009c). To the extent the new operations employees will move into the area surrounding the proposed site from other areas, or currently unemployed persons living in the state become employed at the plant, the counties within the 50-mi radius of the Lee Nuclear Station site in South Carolina and North Carolina will experience an increase in sales tax, use tax, and income tax revenues; however, a majority of these tax payments go to the general state funds, so tax revenue impact at the regional level would be negligible.

Property Taxes

Property taxes on the plant accrue to Cherokee County. Duke is expected to make fee-in-lieu of tax payments to the county rather than paying property taxes, as discussed in Section 2.5.2.2. Duke's agreement with Cherokee County allows the in-lieu of taxes assessment to drop to 2 percent as long as the project investment reaches $2 billion. Duke expects the cost of proposed Lee Nuclear Station Units 1 and 2 to be approximately $11 billion. Because different classes of property are taxed at different rates, Duke expects its rate to be $11.8 million/yr for 30 years as a part of the Infrastructure Tax Credit Agreement between Duke and Cherokee County (Duke 2009c). Duke's fee-in-lieu payments will represent more than a 20 percent increase in total Cherokee County property tax and fee-in-lieu revenues.

In addition to the fee-in-lieu of tax payments on the Lee Nuclear Station, the region could experience an increase in property tax revenues on new homes if the influx of workers results in any new residential construction and/or increases in existing home prices. This overall impact would likely be minimal, because operation workers and their families would only make up a small percentage of the existing population in the region. The beneficial tax impacts would be expected to be significant for Cherokee County and minimal for York County and the rest of the region.

5.4.3.3 Summary of Economic Impacts on the Community

Based on the information provided by Duke, the review team's interviews with local public officials, and the review team's independent review of data on the regional economy and taxes, the review team concludes that the regional economic impacts of operating proposed Lee Nuclear Station Units 1 and 2 would be SMALL beneficial for all counties except Cherokee County, which would experience a LARGE beneficial impact under South Carolina tax law.

5.4.4 Infrastructure and Community Services Impacts

Infrastructure and community services include transportation, recreation, housing, public services, and education. Operation of the proposed Lee Nuclear Station Units 1 and 2 would impact the transportation network due to additional workforce using local roads to commute and the possibility of truck deliveries being made in support of plant operations. These same commuters could also potentially impact recreation in the area. As the workforce migrates into and settles in the region, housing, education, and public sector services may be affected. While the review team realizes that 112 of these workers will be onsite during peak construction, the following analysis is based on 957 workers to get an accurate assessment of the impact of operations of the proposed Lee Nuclear Station Units 1 and 2 on infrastructure and community services.

Operational Impacts at the Lee Nuclear Station Site

5.4.4.1 Traffic

Similar to the discussion in Section 4.4.4, the impacts of Lee Nuclear Station operations on transportation and traffic would be greatest on the roads of Cherokee County, particularly McKowns Mountain Road, a two-lane road that provides the only access to the site. Beyond McKowns Mountain Road, traffic is disbursed in several directions. Capacity improvements to roads during construction between Interstate 85 and the site would remain in place with the exception of traffic signals on McKowns Mountain Road.

As discussed in Section 4.4.4, the review team assumed current traffic on McKowns Mountain Road is 950 vehicles a day. The capacity for McKowns Mountain Road is 1700 vehicles per hour for each direction and 3200 vehicles per hour for both directions. The Lee Nuclear Station will operate five shifts on a rotating schedule. The shifts will include an 8-hour day 5 days a week, two 10-hour day 4 days a week shifts, and two 12-hour shifts with 3 days on and 3 days off (Duke 2009c). Thus, there is enough capacity for the additional cars attributed to operations at Lee Nuclear Station. During outages, there could be as many as 800 additional workers, increasing traffic and adding congestion on McKowns Mountain Road; however, the staggered shifts make it unlikely that road capacities will be exceeded. Therefore, the operations-related impacts on traffic would be minimal.

5.4.4.2 Recreation

A detailed description of local tourism and recreation is provided in Section 2.5.2.4. The primary impacts on recreation would be similar to but smaller than those described for building proposed Lee Nuclear Station Units 1 and 2 in Section 4.4.4.2. No recreational activities will be allowed within the Make-Up Pond C site. The review team expects impacts on recreation within a 50-mi radius of the Lee Nuclear Station site to be minimal. The aesthetic impacts of the plant operations from the vantage point of local recreational areas would be minimal.

5.4.4.3 Housing

Regional housing characteristics and availability are described in Section 2.5.2.5. The closest cities to the Lee Nuclear Station site are Gaffney and Blacksburg; however, larger economic centers such as Spartanburg, Rock Hill, and Charlotte are all within commuting distance. The review team expects the majority of operations workers to come from within the region, and consequently, they would not represent new net demand for housing. Approximately 36 percent of the operations workforce or 345 workers are expected to in-migrate. The review team expects the largest impacts on housing to occur in Cherokee and York Counties; however, given the relatively small operations workforce compared to the larger construction workforce the operations workers would be easily absorbed by the local communities. The Lee Nuclear Station would need as many as 800 additional workers for 3 to 5 weeks staggered every 18 months during each maintenance outage of the two reactors. It is expected the majority of workers would stay in hotels or trailers, or rent rooms in homes, and would not become permanent residents in the region. This influx of temporary workers would not be expected to impact the permanent housing stock or housing market in the region.

Operation of Lee Nuclear Station could affect housing values in the vicinity of the Lee Nuclear Station site. In a review of previous studies on the effect of seven nuclear power facilities, including four nuclear power plants, on property values in surrounding communities, Bezdek and Wendling (2006) concluded that assessed valuations and median housing prices have tended to increase at rates above national and State averages. Clark et al. (1997) similarly found that housing prices in the immediate vicinity of two nuclear power plants in California were not affected by any negative imagery of the facilities. These findings differ from studies that looked at undesirable facilities, largely related to hazardous waste sites and landfills, but also including several studies on power facilities (Farber 1998) in which property values were negatively affected in the short term, but these effects were moderated over time. Bezdek and Wendling (2006) attributed the increase in housing prices to benefits provided to the community in terms of employment and tax revenues, with surplus tax revenues encouraging other private development in the area. Given the findings from the studies discussed above, the review team determines that the impact on housing and housing value from the operations of the Lee Nuclear Station would be minor.

5.4.4.4 Public Services

This section describes the available public services and discusses the impacts of the operation of the proposed Lee Nuclear Station Units 1 and 2 on water supply and waste treatment; police, fire-protection, and medical services; education; and social services in the region.

Water Supply Facilities

Section 2.5.2.6 describes the water-supply systems and facilities in the vicinity of the Lee Nuclear Station site. The Lee Nuclear Station site would use potable water from the Draytonville water system, which is supplied by the Victor Gaffney Plant and the Cherokee Plant. Municipal water suppliers in Cherokee County have an excess capacity (see Table 2-24) of approximately 10 Mgd. As discussed in Section 4.4.4.4, the local water systems in Cherokee and York Counties are expected to be able to meet the demand for water from the peak population during development of the Lee Nuclear Station site. Therefore, because the planned operations workforce is considerably smaller than the building workforce, the review team expects local water systems would have no difficulty meeting water demand during the operations phase. Therefore, the review team expects the impacts on the water supply would be minimal, and additional mitigation would not be warranted.

Wastewater Treatment Facilities

Section 2.5.2.6 describes the public wastewater treatment systems in Cherokee and York Counties, their permitted capacities, and current demands. Currently, wastewater-treatment facilities have excess capacity (see Table 2-24). The Lee Nuclear Station site will use the Broad River Wastewater Treatment Plant for wastewater needs. Any upgrades to the wastewater facility needed to support building the units would be completed before or during the building of proposed Lee Nuclear Station Units 1 and 2. As discussed in Section 4.4.4.4, the local wastewater systems in Cherokee and York Counties are expected to be able to meet the demand for water from the peak population during the building phase. Therefore, because the planned operations workforce is considerably smaller than the building workforce, the review team expects local water systems would have no difficulty meeting water demand during the operations phase. Therefore, the review team concludes the impact on wastewater treatment from the in-migration of operations workers and their families would be minimal, and mitigation would not be warranted.

Police and Fire Services

Based on analysis provided in Section 2.5.2.6, the review team expects that current levels of law enforcement and fire-protection personnel would be adequate to meet the need of the communities throughout the building phase, as discussed in Section 4.4.2. The review team expects the increase in population for any given county to be less than 1 percent (Section 5.4.2), the impact of new operations workers and their families on police and fire services would be well within the expected population growth planned by the local governments. Even without adding capacity during the building phase, the impact on law enforcement and firefighting services from the operation of proposed Lee Nuclear Units 1 and 2 would not be significant.

Medical, Health, and Human Services

Section 2.5.2.6 describes the level of medical and human services within Cherokee and York Counties, which the review team determined is sufficient to absorb the building-related influx of workers and therefore, could support the smaller operations-related influx of workers. New jobs created to operate and maintain proposed Lee Nuclear Station Units 1 and 2 would benefit the disadvantaged population served by the State health and human resources offices by adding jobs to the region that may go to individuals currently underemployed or unemployed, removing them from social services client lists. While the influx of new workers and their families may also create additional pressure on those same social services, the review team concludes that the net effect of the new permanent operations workforce on local and State health and human services would be minimal.

5.4.4.5 Education

Section 5.4.2 discusses the review team's underlying assumptions about the distribution of workers' families within the 50-mi radius around the proposed site. These assumptions indicate the expected increase in population for any given county within the analytical area would be less than 1 percent. This rate is well within the planned growth rate for each county government. Because there would be relatively few new students coming from the families of operations workers, the review team believes the impact of plant operations on public schools would be minimal. The review team expects that school-age children typically would not accompany temporary outage workers in-migrating into the area to work at the Lee Nuclear Station site.

As discussed in Section 2.5.2.7, both Cherokee and York County District One school districts are undergoing renovations and have room for the extra students that migrate into the region. Furthermore, officials from both districts stated that accommodating new students from the operations workforce would not be a problem (NRC and PNNL 2008).

5.4.4.6 Summary of Infrastructure and Community Services Impacts

The review team has reviewed information provided by Duke, visited the site and its environs, and performed its own independent review of potential infrastructure and community services impacts of operations on the local area and region of the Lee Nuclear Station site. In all cases, the compelling argument in support of the review team's conclusions is that the operations workforce would be considerably smaller than the building peak employment. Therefore, any impacts derived from operations must necessarily be less than the same impact derived from peak building activities. The review team concludes that expected operations impacts on transportation, recreation, housing, public services, and education would be SMALL and require no mitigation.

5.5 Environmental Justice

Environmental justice refers to a Federal policy under which each Federal agency identifies and addresses any disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority or low-income populations. On August 24, 2004, the Commission issued its policy statement on the treatment of environmental justice matters in licensing actions (69 FR 52040). Section 2.6 discusses the locations of minority and low-income populations near the Lee Nuclear Station site and within the 50-mi radius.

The scope of the review, as defined in NRC guidance (NRC 2001, 2004a; 69 FR 52040), should include an analysis of the impacts on minority and low-income populations, the location and significance of any environmental impacts during operations on populations that are particularly sensitive, and any additional information pertaining to mitigation. The descriptions to be provided by this review should include whether the impacts are likely to be disproportionately high and adverse. The review should evaluate the significance of such impacts.

The review team evaluated whether the health or welfare of minority and low-income populations at those census blocks identified in Section 2.6 of this EIS could experience disproportionately high and adverse impacts from operating two nuclear units at the proposed Lee Nuclear Station. To perform this assessment, the review team used the same process employed in Section 4.5.

The nearest minority or low-income populations of interest identified are located in the Gaffney, South Carolina city limits. Gaffney is approximately 8 mi northwest of the Lee Nuclear Station site.

5.5.1 Health Impacts

For all three health-related considerations described in Section 2.6.1, the review team determined through literature searches and consultations with NRC staff health experts that the expected operations-related level of environmental emissions is well below the protection levels established by NRC and EPA regulations and would not impose a disproportionately high and adverse effect on minority or low-income populations. The results of the normal operation dose assessments (Section 5.9) indicate that the maximum individual dose for these pathways would be insignificant, well below the regulatory guidelines in Appendix I of 10 CFR Part 50 and the regulatory standards of 10 CFR Part 20. As discussed in Section 4.5.1 in the context of building activities, there is no evidence that radiological or nonradiological effects from operations affect any demographic subgroup differently from any other subgroup. Furthermore, as discussed in Section 2.6, the review team did not identify any evidence of unique characteristics or practices in the minority and low-income populations that may result in different health pathway impacts compared to the general population. Therefore, the review team concluded that there would be no disproportionately high and adverse health impacts on minority and low-income members of the public from the release of radiological material from operations or from design basis accidents. The health-related environmental justice impacts derived from operating the proposed Lee Nuclear Station would be SMALL.

5.5.2 Physical and Environmental Impacts

There are four primary pathways in the environment: soil, water, air, and noise. The following four subsections discuss each of these pathways in greater detail.

5.5.2.1 Soil-Related Impacts

As discussed in Section 5.8, the review team does not expect operations-related environmental impacts on soils at the Lee Nuclear Station site that would affect nearby residents, and there are no residents onsite. Because soil impacts attenuate rapidly with distance, the review team expects that there would not be soil-related disproportionately high and adverse impact on minority or low-income populations. Land-use impacts in the transmission-line corridors and on the Make-Up Pond C site from operation of proposed Lee Nuclear Station Units 1 and 2 would be minimal and are not expected to have adverse effects on the population. In addition, as discussed in Section 2.6.3 of this EIS, the review team did not identify evidence of unique characteristics or practices that may result in different soil-related impacts compared to the general population. Based on information from Duke and the review team's own independent review, the review team concludes that the operations-related impact from pathways related to soils from the Lee Nuclear Station would not impose disproportionately high and adverse impacts on minority or low-income populations.

5.5.2.2 Water-Related Impacts

As discussed in Section 5.2, the review team determined that operating the proposed Lee Nuclear Station Units 1 and 2 would create a volume of cooling-tower blowdown that would not be significant when compared to the river flow and would comply with applicable State water-quality standards. Plant effluent discharges would be regulated and monitored, and additional mitigation would not be warranted. As discussed in Section 2.6.3 of this EIS, the review team found evidence of some subsistence fishing in the site vicinity, but did not identify an operational pathway that could result in different water-related impacts compared to the general population. The review team did not identify evidence of unique characteristics or practices in minority or low-income populations that may result in different water-related impacts compared to the general population. Therefore, the review team expects no disproportionately high and adverse impacts on identified minority or low-income populations.

Based on Section 5.2, the review team concludes that water use at the Lee Nuclear Station site would have little or no effect on the availability of water for other uses. Based on Section 5.3.2, the water use at the Lee Nuclear Station site would have minimal impacts on the fish population of Ninety-Nine Islands Reservoir or the Broad River. Therefore, the impacts would not warrant mitigation or cause a disproportionately high and adverse impact on identified minority or low-income populations.

Based on information from Duke and the review team's independent evaluation, the review team concludes that given the relatively minimal impact on water quantity and quality in Ninety-Nine Islands Reservoir and the Broad River, and the small consumptive water use of the proposed Lee Nuclear Station Units 1 and 2, there would be no operations-related disproportionately high and adverse environmental impacts on minority or low-income populations.

5.5.2.3 Air-Quality-Related Impacts

As discussed in Section 5.9, the total liquid and gaseous effluent doses from the new units would be well within the regulatory limits of the NRC and EPA, implying that impacts on any population are likely to be minimal from this source. The primary air emissions from a nuclear power plant (e.g., proposed Lee Nuclear Station Units 1 and 2) are water vapor and salt, which do not pose health dangers to the general public. In addition, air-quality impacts attenuate rapidly with distance from the source. The review team concluded in Section 5.7 of this EIS that the potential impacts from nonradiological sources of air emissions would be SMALL. Furthermore, the review team believes that because of the distance between the Lee Nuclear Station site and minority or low-income populations, any airborne pollutants emanating from proposed Lee Nuclear Station Units 1 and 2 would rapidly disperse to near background levels. The review team did not identify any evidence of unique characteristics or practices that may result in different air-quality-related impacts compared to the general population. Given that the total effluent doses from the new units would be well within regulatory limits and given that airborne pollutants released from the new units would rapidly disperse to near background levels, the review team concludes that the potential impacts from operations-related sources of radiological and nonradiological air emissions would not result in disproportionately high and adverse impacts on minority or low-income populations within the site vicinity.

5.5.2.4 Noise Impacts

As discussed in Section 5.4.1 and 5.8.2, primary noise sources associated with operation of Lee Nuclear Station Units 1 and 2 are pumps, cooling towers, transformers, turbines, generators, switchyard equipment, and loudspeakers. As analyzed in Section 5.8.2, the overall projected combined ambient and cooling-tower noise levels range from approximately 48 to 64 dBA. Noise from corona discharge along proposed transmission lines is expected to be less than 10 dBA (Duke 2009c). According to NUREG-1437 (NRC 2013a), noise levels below 60 to 65 dBA are considered to be of small significance. Therefore, the review team determines there is no noise-related pathway by which minority or low-income populations of interest could receive a disproportionately high and adverse impact.

5.5.3 Socioeconomic Impacts

Socioeconomic impacts were concluded to be SMALL in Section 5.4. The review team determined that once the proposed Lee Nuclear Station Units 1 and 2 are operational, any adverse socioeconomic impacts felt by any group within the region of interest would either stop or significantly diminish when the construction workforce leaves the region. However, offsetting the departure of the construction workforce would be the in-migration of the permanent workforce that would operate and maintain Lee Nuclear Station Units 1 and 2. While the addition of these new employees would place pressure on local infrastructures (e.g., schools and hospitals), the review team believes any adverse impact the in-migration might create would be overwhelmed by the positive contributions of that workforce to their new local communities through income, taxes, and fee-in-lieu of tax payments. Furthermore, the review team's interviews of surrounding communities revealed a high level of preparedness with regard to any potential influx of temporary construction or permanent operations workers.

5.5.4 Subsistence and Special Conditions

NRC's environmental justice methodology includes an assessment of populations of particular interest or unusual circumstances, such as minority communities exceptionally dependent on subsistence resources or identifiable in compact locations, such as Native American settlements. As part of its visits to the site and region, the review team interviewed public officials and community leaders of the local minority populations in relation to subsistence practices (Niemeyer 2008). The review team heard anecdotal information about local subsistence fishing in York County, South Carolina from one person. The discussion gave anecdotal evidence of isolated subsistence fishing in ponds, streams, and Lake Wiley in York County.

The review team reviewed this account, but determined that there is no potential for disproportionately high and adverse operational impacts related to subsistence activities on environmental justice populations. The potential radiological releases from the proposed Lee Nuclear Station Units 1 and 2 would be well below regulatory limits. Because adverse radiological or nonradiological health impacts from the operation of the new units are not expected (see Sections 5.8 and 5.9), potential subsistence fishing activities in York County, Ninety-Nine Islands Reservoir, or the Broad River would not have either a radiological or nonradiological adverse health effect. The review team also determined that the impacts from chemical discharges to the Broad River would be minimal (see Section 5.3.2), and no additional mitigation would be warranted. Therefore, minority or low-income individuals who may be engaged in subsistence fishing would not experience disproportionately high and adverse impacts.

No other unique characteristics or practices were identified by the review team for the low-income and minority populations that would indicate a dependence on subsistence resources that would be impacted by operation of the proposed Lee Nuclear Station Units 1 and 2.

5.5.5 Summary of Environmental Justice Impacts

As discussed in Section 2.6.1, the review team identified several census blocks that meet the criteria for minority populations within the site region. The review team determined these areas may have a greater potential for disproportionately high and adverse operations impacts on minority and low-income populations. Consequently, the review team further analyzed these areas of potential impacts to determine whether or not such impacts would be significant.

Based on information provided by Duke and review team interviews conducted with public officials in surrounding counties concerning the potential for environmental pathways and unique characteristics or practices, the review team determined there would be no disproportionately high and adverse impact on any minority or low-income populations.

Therefore, the review team determined the operations-related environmental justice impacts of proposed Lee Nuclear Station Units 1 and 2 would be SMALL.

5.6 Historic and Cultural Resources Impacts

The National Environmental Policy Act of 1969, as amended (NEPA) requires Federal agencies to take into account the potential effects of their undertakings on the cultural environment, which includes archaeological sites, historic buildings, and traditional places important to interested parties. The National Historic Preservation Act of 1966, as amended (NHPA) also requires Federal agencies to consider impacts to those resources if they are eligible for listing on the National Register of Historic Places (National Register). Such resources are referred to as "historic properties" in the National Register. As outlined in 36 CFR 800.8, "Coordination with the National Environmental Policy Act of 1969," the NRC and the USACE are coordinating compliance with Section 106 of the NHPA in fulfilling their responsibilities under NEPA.

Operation of new nuclear power plants can affect either known or undiscovered historic and cultural resources. In accordance with the provisions of NHPA and NEPA, the NRC and the USACE, a cooperating Federal agency, are required to make a reasonable and good faith effort to identify historic properties and cultural resources in the project areas of potential effect (APEs) and, if present, determine if any significant impacts are likely. Identification is to occur in consultation with the appropriate State Historic Preservation Officer (SHPO), American Indian Tribes, interested parties, and the public. If significant impacts are possible, efforts should be made to mitigate them. As part of the NEPA/NHPA integration, even if no historic properties or important cultural resources are present or affected, the NRC and the USACE are still required to notify the appropriate SHPO before proceeding. If it is determined that historic properties or important cultural resources are present, efforts must be made to assess and resolve any adverse effects of the undertaking.

The review team does not expect any significant or adverse impacts on historic properties or important cultural resources during the operation of the proposed Lee Nuclear Station. A detailed discussion of historic and cultural resources at the Lee Nuclear Station site is included in Section 2.7. As explained, archaeological and architectural surveys have been conducted for direct (physical) and indirect (visual) APEs within the Lee Nuclear Station site and vicinity as well as offsite areas by qualified professional cultural resources contractors and potential effects have been considered for a number of historic properties and cultural resources. As part of these investigations, Duke has established ongoing communications with the South Carolina SHPO and has shared information with four Federally recognized American Indian Tribes and four Native American organizations (Duke 2008f, g, 2009c, h, j, 2010i, j). Based on responses received from three interested American Indian Tribes, Duke has established ongoing communications with the Catawba Indian Nation, the Eastern Band of Cherokee Indians, and the Seminole Tribe of Florida. The NRC also has also invited these Tribes and other tribal organizations, the South Carolina SHPO, and the Advisory Council on Historic Preservation to participate in the initial and supplemental scoping processes for the environmental review and invited their feedback on the draft EIS (Appendices C and F). Consultation between the USACE, Duke, the South Carolina SHPO, and interested Tribes has resulted in a final cultural resources management plan and Memorandum of Agreement (MOA) for the Lee Nuclear Station site and associated developments (USACE et al. 2013).

Largely in response to concerns expressed by the aforementioned consulting parties, Duke Energy has developed a corporate policy to minimize impacts to sites, landmarks, and/or artifacts of potential cultural or archaeological importance that includes specific provisions for the protection of cultural resources at all facilities owned and operated by Duke and its employees and contractors as well as procedures for handling any inadvertent cultural resources discoveries in coordination with the South Carolina SHPO and Tribal Historic Preservation Officer(s) (THPOs), as appropriate (Duke 2009b). Throughout the consultation process and information exchange, the South Carolina SHPO has repeatedly requested that an agreement be developed to "… govern future cultural resources identification and address future work to be done at the plant through the life of the license." (Duke 2010n). In 2013, Duke, the USACE, the South Carolina SHPO, and the Catawba Indian Nation THPO finalized a cultural resources management plan and associated MOA tailored specifically to proposed Lee Nuclear Station site and associated developments (USACE et al. 2013).

Operational activities associated with proposed Lee Nuclear Station Units 1 and 2 will occur primarily within the 1900-ac area that constitutes the onsite direct, physical APE. Visual impacts associated with tall structures such as the proposed nuclear units and associated containment buildings and the meteorological tower as well as the temporary effects of operational noise and vapor fumes associated with operating plant components may extend beyond the 1900-ac area to an indirect, visual APE that is defined as the zone within approximately 1 mi of these structures and plumes. As summarized in Section 2.7, periodic cultural resources investigations spanning the past four decades within the 1900-ac Lee Nuclear Station site have resulted in the documentation of 18 archaeological sites and four historic cemeteries. Six of these resources, which were originally evaluated as non-significant by investigators and thus not likely to have been eligible for National Register nomination, were heavily disturbed during original site-preparation activities associated with the former Cherokee Nuclear Station. The remaining archaeological sites identified in current APEs have been determined ineligible for nomination to the National Register in coordination and consultation with the South Carolina SHPO (Duke 2009c; SCDAH 2007b, 2009a, 2012a, 2013). The Eastern Band of Cherokee Indians also concurred with these findings (EBCI 2011).

Cultural resources investigations within the larger onsite indirect, visual APE have resulted in the documentation of the four previously mentioned historic cemeteries as well as 13 architectural resources (Brockington 2007a, b, 2009a). One of these resources, Ninety-Nine Islands Dam and Ninety-Nine Islands Hydroelectric Project, is a National Register-eligible historic property. The remainder have been determined ineligible for nomination to the National Register in consultation with the South Carolina SHPO, and no effects are anticipated (SCDAH 2007b, 2009a, 2012a, 2013). Consultation with the South Carolina SHPO has resulted in a determination that there will be no adverse effects to Ninety-Nine Islands Dam and Hydroelectric Project because the operational components of proposed Lee Nuclear Station Unit 1 and 2 and other onsite developments have been determined to be consistent with the industrial theme of the historic properties and they will not alter the characteristics of the dam and powerhouse that make them historically significant. In this context, the South Carolina SHPO concurs that no adverse effects will occur to the unique design, workmanship, or materials of the dam and plant and their role in the history of hydropower development in the Piedmont region of South Carolina will be unaffected (SCDAH 2007b, 2009a, 2012a).

Four historic cemeteries are located within the 1900-ac Lee Nuclear Station site. Although these resources are not eligible for nomination to the National Register, they are protected by State law and continue to be culturally important to local members of the community as indicated by ongoing periodic requests for access (Duke 2010d). The South Carolina SHPO also has recommended protection (SCDAH 2012a). Duke has added these resources as a spatial layer in the Lee Nuclear Station site GIS for overall management and protection and intends to continue to maintain surrounding fences and provide public access. Any future maintenance will be completed in coordination with the South Carolina SHPO and according to the Lee Nuclear Station site cultural resources management plan and associated MOA (USACE et al. 2013). Operational activities will not prevent visitor access to these resources or cause direct physical impacts, and visual effects are unlikely due to their locations in wooded areas far from proposed plant components (Duke 2009c). No traditional cultural places of importance to interested American Indian Tribes have been identified at the Lee Nuclear Station site.

Operations at the proposed Lee Nuclear Station Units 1 and 2 during drought conditions may require drawdown and refill of proposed Make-Up Pond C. Cultural resources investigations of Make-Up Pond C and associated developments were focused on APEs defined in coordination with the South Carolina SHPO as a 620-ac reservoir with a 300-ft shoreline buffer and associated developments such as water lines, spillways, spoil and laydown areas (direct APE) and a 1.25-mi zone surrounding this area to encompass potential visual intrusions (indirect APE). The investigations resulted in the assessment of 13 archaeological sites, two historic cemeteries, 28 architectural resources, and one possible historic district. All of these resources were recommended not eligible for National Register nomination, leading to a finding of no historic properties affected for Make-Up Pond C and associated developments (Brockington 2009b, 2010, 2011, 2013). However, the historic cemeteries were identified as significant cultural resources, protected under South Carolina State law (South Carolina Code of Laws Title 16-Crimes and Offenses, Chapter 17-Offenses Against Public Policy, Article 7-Miscellaneous Offenses, Section 16-17-600, and Title 27-Property and Conveyances, Chapter 43-Cemeteries, Article 1, Sections 27-43-10 through 27-43-30, 27-43-40, and 27-43-310, summary also found in CSCPA 2005) and recommended for protection by the South Carolina SHPO (SCDAH 2012a).

No impacts were expected at the McKown Family Cemetery, but the Service Family Cemetery was recommended for relocation in advance of ground-disturbing project activities. The South Carolina SHPO concurred with the finding of no historic properties affected and recommendations for relocation of the Service Family Cemetery (SCDAH 2009b, 2010a, 2011, 2012a, 2013). The Eastern Band of Cherokee Indians and Seminole Tribe of Florida also submitted no objections to the findings (EBCI 2010a, b, 2011; STF 2009, 2010).

During operations, Make-Up Pond C will be used to supply supplemental water for plant operations on an as-needed basis (Duke 2009b). Because no National Register-eligible archaeological or architectural resources are located in the direct or indirect APEs for the new reservoir and the culturally important Service Family Cemetery will be moved to another location prior to ground disturbance and inundation, no impacts to historic properties or cultural resources are anticipated from the process of drawing down and refilling the new reservoir.

During operation of the Lee Nuclear Station, Duke also intends to conduct parallel and related operations at offsite developments including reactivation and use of the existing railroad line and operation and maintenance of two proposed offsite transmission lines (Routes K and O). As discussed in Section 2.7 and summarized below, in coordination with the South Carolina SHPO, Duke has completed specific cultural resources investigations of direct, physical APEs and corresponding indirect, visual APEs for preconstruction of these offsite developments (Brockington 2007c, 2009b, 2010; ACC 2009).

Reactivation and use of the existing railroad line will be limited to locomotive traffic and maintenance of the rails, the railroad bed, and other equipment (Duke 2009c). None of these activities will extend outside the disturbed railroad corridor to cause impacts to any identified cultural resources. This includes one National Register-listed property, Ellen Furnace Works (38CK68), which is located on both sides of the disturbed railroad line (Brockington 2007c). The South Carolina SHPO has concurred with the evaluation that none of the significant cultural features or deposits associated with this historic property are present in the rail corridor, and no adverse effects are anticipated (SCDAH 2008, 2012a).

Cultural resources investigations of the proposed routes for two new offsite transmission lines resulted in the documentation of 37 archaeological sites in the direct, physical APEs (ACC 2009). In consultation with the South Carolina SHPO, all of these sites were determined ineligible for nomination to the National Register due to low potential for future research and a finding of no historic properties (archaeological in nature) was concluded (SCDAH 2009c). One of the identified archaeological sites was identified as a possible human burial site (38CK172), and although it is not eligible for National Register nomination, it is potentially subject to consideration under State and Federal burial laws (summary in CSCPA 2005). This site also remains a culturally important resource as indicated by feedback from the Eastern Band of Cherokee Indians requesting protection of the possible burial (EBCI 2009). Duke has confirmed that sensitive cultural resources like 38CK172 will be considered during all phases of transmission-line design, installation, operation, and maintenance through inclusion of these resources in project GIS maps and establishment of protective 50-ft radius buffers where no towers or poles will be placed and vegetation will be cleared by hand, both initially and during subsequent maintenance (Duke 2010t). Periodic required inspections of the lines also will be completed by aircraft, eliminating the need for new roads to support access and egress (Duke 2010q). These mitigations are summarized in the cultural resources management plan and MOA for the Lee Nuclear Station site and associated offsite developments (USACE et al. 2013), so operation and maintenance of the new transmission lines should result in no significant impacts to 38CK172. No additional resources of tribal concern have been identified within transmission-line APEs or any other onsite or offsite APEs (EBCI 2011).

In 2009, 39 architectural resources were identified within the indirect APE for the offsite transmission lines in a zone extending 0.5 mi from the proposed centerlines. Nine of these resources, including the National Register-eligible Ninety-Nine Islands Dam and Hydroelectric Project, also are co-located in the indirect APE for the Lee Nuclear Station site. As summarized in Section 2.7, most of the architectural properties identified are twentieth-century residences unlikely to yield any additional important information and evaluated as ineligible for National Register nomination (ACC 2009). However, three National Register-eligible properties were documented: Ninety-Nine Islands Dam and Hydroelectric Project, important for its association with early development of hydropower in the region; and two historic farmsteads (Smith's Ford Farm and Reid-Walker-Johnson Farm), important for their association with historic settlement and agricultural economies of the mid-eighteenth and early twentieth centuries. Investigators concluded that the new transmission lines would have no effect on Ninety-Nine Islands Dam and Hydroelectric Project properties given their historic association with power generation and transmission (ACC 2009). Analyses of potential visual impacts to the historic farmsteads demonstrated that distance, topography, and vegetation cover will screen these properties from significant visual modifications in their respective viewsheds (Pike Electric 2010). The South Carolina SHPO concurred that the proposed transmission lines will cause no adverse effects to the two historic farmsteads and no effects on any other historic properties (SCDAH 2009c, 2010b, 2012a). Operation and maintenance of the new transmission lines are not likely to cause any additional visual impacts to these resources.

To develop the impact assessments presented here, the review team

- analyzed the potential impacts to historic properties and cultural resources resulting from operational activities in onsite and offsite areas as described in the ER, Make-Up Pond C supplement to the ER, 2013 supplemental information related to site design changes, and cultural resources survey reports

- confirmed Duke Energy's corporate policy for cultural resources consideration and protection at all facilities owned and operated by Duke Energy and the inclusion of inadvertent discovery procedures therein
- considered Duke's past and ongoing coordination with the South Carolina SHPO and American Indian Tribes that have expressed interest in the proposed activities
- reviewed the final cultural resources management plan and associated MOA between Duke, the USACE, the South Carolina SHPO, and the Catawba Indian Nation THPO that formalizes continued consideration of cultural resources at the Lee Nuclear Station site and associated developments (USACE et al. 2013).

For purposes of NHPA Section 106 consultation, the review team does not anticipate any adverse effects to historic properties during the operation of proposed Lee Nuclear Station Units 1 or 2 or parallel and related operations of additional onsite developments, proposed Make-Up Pond C, the offsite railroad line, or two new transmission lines based on (1) a review of the final cultural resources management plan and associated MOA for the Lee Nuclear Station site (USACE et al. 2013), (2) implementation of Duke Energy's corporate policy for continued cultural resources consideration and protection, and (3) inadvertent discovery procedures to ensure that sensitive resources are adequately considered and protected as necessary.

For the purposes of the NEPA analysis, the review team does not expect any significant impacts to historic and cultural resources during operation of proposed Lee Nuclear Station Units 1 and 2 or parallel and related operations of additional onsite developments, proposed Make-Up Pond C, the offsite railroad line, or two new transmission lines based on (1) Duke's successful completion of plans to relocate the Service Family Cemetery and protect the possible human burial site (38CK172) and (2) Duke's commitment to implement the corporate policy for cultural resources consideration and protection at all facilities owned and operated by Duke Energy, its employees and contractors, and associated procedures should cultural resources be inadvertently discovered during ground-disturbing activities. With the corporate procedure consistently implemented by the cultural resources management plan and MOA among Duke, the USACE, the South Carolina SHPO, and the Catawba Indian Nation THPO and tailored specifically for the Lee Nuclear Station site and associated developments (USACE et al. 2013), the review team concludes that the impacts on historic and cultural resources from operations would be SMALL.

5.7 Meteorological and Air-Quality Impacts

The primary impacts of operation of proposed Lee Nuclear Station Units 1 and 2 on local meteorology and air quality would be from releases to the environment of heat and moisture from the mechanical draft cooling towers, emissions from operation of auxiliary equipment (e.g., generators and boilers), and emissions from workers' vehicles. The potential impacts of releases from operation of the cooling system are discussed in Section 5.7.1. Section 5.7.2 addresses potential air-quality impacts from nonradioactive effluent releases at the Lee Nuclear Station site, and Section 5.7.3 addresses the potential air-quality impacts of transmission-line corridors during operation.

5.7.1 Cooling-System Impacts

Each of the proposed Lee Nuclear Station Units 1 and 2 are designed to use a set of two circular mechanical draft cooling towers for the main CWS (Duke 2012g). In addition, each unit will have one mechanical draft cooling tower for the SWS (Duke 2009c). Chapter 3 of the EIS provides the site layout and plant description in detail.

Mechanical draft cooling towers remove excess heat by evaporating water. Upon exiting the cooling tower, water vapor mixes with the surrounding air, which can lead to condensation and the formation of a visible plume. As a result, there could be aesthetic impacts from the visible plume, land-use impacts from cloud shadowing and drift deposition of dissolved salts and chemicals in the cooling water, as well as meteorological impacts from fogging and icing.

Duke used the Seasonal and Annual Cooling Tower Impacts (SACTI) computer code to estimate impacts associated with operating the CWS cooling towers. A set of two CWS cooling towers were simulated in SACTI using a height of 85 ft above site grade (Duke 2012g). Five years of surface meteorological data (2001 through 2005) collected at the Charlotte, North Carolina, first-order National Weather Service (NWS) station and mixing height values for the same period obtained from Greensboro, North Carolina—the closest NWS upper-air station—were used as input to the SACTI model. The climatology for these meteorological stations is presented in Section 2.9; these stations are reasonably representative of the Lee Nuclear Station site. Additional SACTI runs were performed using surface meteorological data from the Lee Nuclear Station site and the Greenville-Spartanburg, South Carolina, NWS station along with upper-air data from Greensboro (Duke 2011j).

Results from the SACTI analysis using the Charlotte NWS surface meteorological data, as reported by Duke (Duke 2012g), indicate that on average the longest plume lengths would occur during the winter, and the shortest plume lengths would occur during the summer. In the winter, 20 percent of plumes are 3.7 mi or longer, while in the summer 20 percent of plumes are only 0.4 mi or longer. There appears to be little seasonal difference in the longest 1 percent of the plumes that are estimated to be 6.2 mi or longer in winter and 6.1 mi or longer in summer. Ground-level fogging is likely to be infrequent and no icing events were predicted during the study period. Deposition of salts from cooling-tower drift would occur in all directions from the towers. The maximum estimated solids deposition rate for each tower is 0.0103 kg/ha/mo and occurs 200 m north of the towers (Duke 2013a). The additional SACTI runs using surface meteorological data from the Lee Nuclear Station site and the Greenville-Spartanburg NWS station yield comparable impacts in terms of magnitude relative to threshold acceptance levels (Duke 2011j); however, the actual location (direction and distance) of the maximum salt deposition varied with the meteorological data set.

The impacts described above apply to a single set of two CWS cooling towers. Two sets of CWS cooling towers (i.e., a total of four) have been proposed. The CWS cooling tower sets are separated by approximately 2000 ft, which is much greater than the 650-ft distance from the towers where the maximum salt deposition is expected to occur (Duke 2009c). Moreover, given the location and orientation of the proposed cooling towers and the predicted radius of the cooling-tower plume, it is unlikely that plumes would interact appreciably for any extended period of time. Heat transferred from the SWS cooling towers would be an order-of-magnitude less than the heat transferred by the CWS cooling towers (Duke 2009c); therefore, the plume associated with the SWS would be smaller than the plume associated with the CWS. Therefore, the review team concludes that there would be no significant meteorological impacts from the cooling towers.

Diesel generators will operate at the Lee Nuclear Station for limited periods. Interaction between pollutants emitted from these sources and the cooling-tower plumes would be intermittent and would not have a significant effect on air quality. Based on these considerations, the review team concludes that impacts on air quality from cooling-tower plume interactions with nearby emission sources would be minimal and would not require mitigation.

5.7.2 Air-Quality Impacts

Air-quality impacts from the operation of the Lee Nuclear Station Units 1 and 2 would include the release of criteria pollutants and greenhouse gases (GHGs) from the intermittent use of standby generators and emissions from worker vehicles. The following subsections describe these air-quality impacts in greater detail.

5.7.2.1 Criteria Pollutants

Air-quality impacts from operation of the proposed Lee Nuclear Station Units 1 and 2 would include intermittent releases from four standby diesel generators, four ancillary diesel generators, and two secondary diesel-driven fire pumps. In addition, the technical support center would use one diesel generator (Duke 2009c). Estimated air emissions from these sources are listed in Table 5-4. Diesel fuel oil storage tanks would be a small source of hydrocarbon emissions, with total emissions of approximately 16 lb/yr (Duke 2009c). Duke will need to obtain an operating permit through the SCDHEC, which regulates air pollution and control through Regulation 61-62 (SC Code Ann R. 61-62). The standby generators and pumps will likely be classified as minor sources due to limited operational use (Duke 2009c).

Table 5-4. Annual Emissions from Diesel Generators and Pumps for Proposed Lee Nuclear Station Units 1 and 2

Source	PM[(a)] (lb/yr)	SO_x[(b)] (lb/yr)	CO[(c)] (lb/yr)	VOC[(d)] (lb/yr)	NO_x[(e)] (lb/yr)
Four standby generators[(f)]	2168	2029	6645	2518	30,848
Four ancillary diesel generators[(f)]	33	31	101	38	467
Two diesel pumps	136	127	415	157	1928
Technical support center diesel generator	111	104	340	129	1578

Source: Duke 2009c
(a) PM = particulate matter
(b) SO_x = oxides of sulfur
(c) CO = carbon monoxide
(d) VOC = volatile organic compounds
(e) NO_x = oxides of nitrogen
(f) Assumes 4 hours of operation per month for each generator and use of No. 2 diesel fuel.

Air-quality impacts would also result from vehicular emissions associated with plant operations. Duke expects to employ 957 workers, spread over five shifts, during normal operation of the proposed Lee Nuclear Station Units 1 and 2. The increased traffic would be comparatively small along the major highways of the region, but obvious on the roads leading directly to the Lee Nuclear Station site, such as McKowns Mountain Road. During shift changes, increased traffic could lead to temporary congestion and idling traffic. However, the overall traffic is expected to still be within the design and capacity limits of these roads (Duke 2009c). Duke has stated that traffic mitigation measures would be considered, which also would act to reduce the impact of increased traffic on air-quality. Potential mitigation measures that Duke would consider include staggering shifts and encouraging carpools (Duke 2012k).

As discussed in Section 2.9.2, Cherokee County is an attainment area for all criteria pollutants for which National Ambient Air Quality Standards have been established (40 CFR 81.341). As a result, a conformity analysis for direct and indirect emissions is not required (40 CFR Part 93). Further, the closest Class I Federal Area (i.e., Linville Gorge Wilderness Area) is more than 50 mi from the Lee Nuclear Station site and it would, therefore, not likely be affected by limited (minor source) emissions from the site. Class I areas are considered of special national or regional natural, scenic, recreational, or historic value and are afforded additional air-quality protection.

5.7.2.2 Greenhouse Gases

The operation of a nuclear power plant involves the emission of some GHGs, primarily carbon dioxide (CO_2). The review team has estimated that the total carbon footprint for actual plant operations of proposed Lee Nuclear Station Units 1 and 2 for 40 years would be on the order of 650,000 metric tons (MT) (the sum of about 190,000 MT per unit from plant operation and about

130,000 MT per unit from operations workforce transportation) of CO_2 equivalent (an emission rate of about 16,000 MT annually, averaged over the period of operation), compared to a total U.S. annual CO_2 emissions rate of 5,500,000,000 MT (EPA 2011c). These estimates are based on carbon footprint estimates in Appendix J and emissions data contained in the ER (Duke 2009c). Based on its assessment of the relatively small plant operations carbon footprint compared to the U.S. annual CO_2 emissions, the review team concludes that the atmospheric impacts of GHGs from plant operations would not be noticeable, and additional mitigation would not be warranted.

The EPA promulgated the Prevention of Significant Deterioration (PSD) requirements and Title V GHG Tailoring Rule on June 3, 2010 (75 FR 31514). This rule states that, among other items, new and existing sources not already subject to a Title V permit, or that have the potential to emit at least 100,000 tons/yr (T/yr) (or 75,000 T/yr for modifications at existing facilities) CO_2 equivalent, will become subject to the PSD and Title V requirements effective July 1, 2011. The rule also states that sources with emissions below 50,000 T/yr CO_2 equivalent will not be subject to PSD or Title V permitting before April 30, 2016. As noted above, the annual emission rate from operations, including workforce transportation, is 16,000 MT/yr (17,600 T/yr) and is, therefore, well below the 50,000 T/yr threshold.

5.7.3 Transmission-Line Impacts

Air-quality impacts from existing transmission lines are addressed in the GEIS (NRC 2013a). Small amounts of ozone and even smaller amounts of oxides of nitrogen are produced by transmission lines. The production of these gases were found to be insignificant for 745-kV transmission lines (the largest lines in operation) and for a prototype 1200-kV transmission line. In addition, potential mitigation measures, such as burying transmission lines, would be very costly and would not be warranted.

Four new transmission lines (two 230-kV and two 525-kV lines) would be constructed to accommodate the new power generating capacity (Duke 2009c). This size is well within the range of transmission lines analyzed in the GEIS; therefore, the review team concludes that air-quality impacts from transmission lines would be minimal, and additional mitigation would not be warranted.

5.7.4 Summary of Meteorological and Air-Quality Impacts

The review team evaluated the meteorological impacts from fogging and icing as a result of cooling-tower operations at the proposed Lee Nuclear Station Units 1 and 2. The review team also considered the timing and magnitude of criteria air pollutant emissions related to operations, the existing air quality at the Lee Nuclear Station site and the distance to the closest Class I Federal Area, and Duke's commitment to manage and mitigate emissions in accordance with applicable regulations. The review team evaluated potential impacts of GHG emissions from operating the proposed Lee Nuclear Station Units 1 and 2. The review team also evaluated potential impacts of cooling-system emissions and transmission lines. In each case, the review team determined that the impacts would be minimal. On this basis, the review team concludes that the impacts of operation of the proposed Lee Nuclear Station Units 1 and 2 on meteorology, air quality from criteria pollutant emissions, GHG emissions, cooling-system emissions, and transmission lines would be SMALL, and no further mitigation is warranted.

5.8 Nonradiological Health Impacts

This section addresses the nonradiological health impacts of operating two proposed nuclear reactors at the Lee Nuclear Station site. Nonradiological health impacts to the public from operation of the cooling system, noise generated by unit operations, EMFs, and transporting operations and outage workers are discussed. Nonradiological health impacts from the same sources also are evaluated for workers at the proposed Lee Nuclear Station. Health impacts from radiological sources during operations are discussed in Section 5.9.

5.8.1 Etiological (Disease-Causing) Agents

Operation of proposed Lee Nuclear Station Units 1 and 2 would result in a thermal discharge through a multiport diffuser to the Broad River/Ninety-Nine Islands Reservoir, just upstream of the Ninety-Nine Islands Dam (Duke 2009c). Such discharges of heated water have the potential to increase the growth of thermophilic microorganisms (microorganisms that favor warmer water), including etiological agents, both in the CWS and the Broad River. Thermophilic microorganisms include enteric pathogens such as *Salmonella* spp., *Pseudomonas aeruginosa*, thermophilic fungi, bacteria such as *Legionella* spp., and free-living amoeba, such as *Naegleria fowleri* (N. fowleri) and *Acanthamoeba* spp. These microorganisms could result in potentially serious human health concerns, particularly at high exposure levels. Section 2.10.1.3 discusses the incidence of waterborne diseases in South Carolina and specifically Cherokee County. Incidence of diseases such as Legionellosis, Salmonellosis, or Shigellosis is possible through exposure to water vapor generated by the operation of cooling towers for the proposed Lee Nuclear Station Units 1 and 2. Although workers would have the potential to be exposed to the water vapor, members of the public would not be allowed close enough to the Lee Nuclear Station site to be exposed to water vapor from operation of the proposed Units 1 and 2.

As discussed in Section 2.10, the main recreational activities associated with the Broad River and the Ninety-Nine Islands Reservoir are fishing, boating, and occasional swimming. Participating in these recreational activities in the vicinity of the Lee Nuclear Station discharge could expose members of the public to etiological agents. However, epidemiological reports from the State of South Carolina indicate a very low risk of outbreaks from disease-causing microorganisms associated with recreational water (CDC 2008). In the South Carolina Annual Report on Reportable Conditions for the years 2007 and 2008, the SCDHEC reported 16 and

12 cases of Legionellosis, 6 and 5 cases of Salmonellosis, and 1 case of Shigellosis in Cherokee County (SCDHEC 2010b). The number of South Carolina cases are far below national trends (SCDHEC 2010b).

Thermophilic microorganisms generally occur at water temperatures of 77 to 176°F, with optimum growth occurring between 122 and 150°F and a minimum tolerance of 68°F (Joklik and Willett 1995). *N. fowleri* is common in freshwater ponds, lakes, and reservoirs throughout the southern states. As discussed in Section 5.2.3.1, the review team determined that the temperature in the Broad River would increase 3.8°F and 3.6°F in January and August respectively, conservatively assuming maximum discharge (64 cfs) downstream of the Ninety-Nine Islands Dam. The highest monthly mean temperature in the Broad River was 86°F in August 2007, and the addition of the heated discharge to the Broad River would likely increase temperatures in some portions of the river below the Ninety-Nine Islands Dam to 90°F. While it is possible that this increase in river water temperature could cause a minor increase in the abundance of thermophilic organisms, there would no discernible impact on health.

It is recommended that nuclear power station staff working around heated effluent take precautions to protect themselves from infection. This action significantly reduces the potential for exposure. Duke has stated they would follow Occupational Safety and Health Administration (OSHA) requirements to protect workers (Duke 2009c). The general public would not be impacted because aerosolized bacteria would travel only a short distance from the cooling towers and condensers. Based on the historically low risk of diseases from etiological agents in South Carolina, the limited opportunities for public exposure, and the limited extent of thermal impacts in the Broad River, the review team concludes that the impacts on human health would be minimal, and mitigation would not be warranted.

5.8.2 Noise

In the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) (NRC 1996), the NRC staff discusses the environmental impacts of noise at existing nuclear power plants. Common sources of noise from operations include cooling towers, transformers, and the operation of pumps, with intermittent contributions from loud speakers and auxiliary equipment (e.g., diesel generators). A common source of noise relevant to high-voltage transmission is corona discharge (Duke 2009c). These noise sources are discussed in this section.

The primary sources of background noise at the Lee Nuclear Station site are discussed in Section 2.10.2. The landscape in the vicinity of the proposed site is rural and forested, with predominately deciduous forests (approximately 45 percent) (Duke 2009c). Noise sources at the proposed site would include pumps, cooling towers, transformers, switchyard equipment, and loudspeakers (Duke 2009c). Many of these noise sources are confined indoors or are infrequent. The main sources of noise are the four mechanical draft cooling towers.

Mechanical draft cooling towers generate noise at level of approximately 85 dBA. Calculations that include the effect of the previously proposed six cooling towers have been made for a number of locations, including approximately 1692 ft away from the cooling towers at the north fence line, 0.99 mi away for the nearest residence, and 4577 ft away for the nearest church. The overall projected combined ambient and cooling-tower noise levels range from approximately 48 to 64 dBA (Duke 2011b). The expected noise from the four cooling towers currently proposed by Duke (Duke 2011j) would be expected to fall within or below this range. Noise from corona discharge along proposed transmission lines is expected to be less than 10 dBA (Duke 2009c). According to the GEIS (NRC 1996), noise levels below 60 to 65 dBA are considered to be of small significance. These estimates are conservative because all four towers are assumed to be the same distance from the receptor, and no shielding of the sound by adjacent structures or topography has been assumed. More recently, the impacts of noise were considered in the GEIS*, Supplement 1* (NRC 2002). The criterion for assessing the level of significance was not expressed in terms of sound levels but rather the effect of noise on human activities and threatened and endangered species. The criterion in GEIS, Sup. 1 (NRC 2002) is stated as follows:

> The noise impacts ... are considered detectable if sound levels are sufficiently high to disrupt normal human activities on a regular basis. The noise impacts ... are considered destabilizing if sound levels are sufficiently high that the affected area is essentially unsuitable for normal human activities, or if the behavior or breeding of a threatened and endangered species is affected.

Given the postulated noise levels for mechanical draft cooling towers and diesel generators, the site characteristics and noise attenuation, and the criteria described in the GEIS, Sup. 1 (NRC 2002), the review team concludes that potential noise impacts would be minor and mitigation would not be warranted.

5.8.3 Acute Effects of Electromagnetic Fields

Electric shock resulting from either direct access to energized conductors or induced charges in metallic structures is an example of an acute effect from EMFs associated with transmission lines (NRC 1999a). Two 230-kV and two 525-kV transmission lines would service the proposed Lee Nuclear Station Units 1 and 2 (Duke 2009c). The National Electric Safety Code (NESC) (IEEE 2011) describes minimum vertical clearances to the ground for transmission power lines exceeding 98 kV such that the current induced in an object below the transmission lines is less than 5 mA. For example, a 500-kV transmission line minimally requires 45 ft of clearance. Duke commits to design any new transmission lines in compliance with the 5-mA standard prescribed by NESC. With Duke’s commitment to design new transmission lines in compliance with NESC criteria, the review team concludes that the impact to the public from acute effects of EMF would be SMALL, and additional mitigation would not be warranted.

5.8.4 Chronic Effects of Electromagnetic Fields

Research on the potential for chronic effects from 60-Hz EMFs from energized transmission lines was reviewed and addressed elsewhere by the NRC in NUREG-1437 (NRC 1996). At that time, research results were not conclusive. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the U.S. Department of Energy. An NIEHS report (NIEHS 1999) contains the following conclusion:

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

This statement is not sufficient to cause the review team to consider the potential impact as significant to the public. Furthermore, Duke states that it will attempt to avoid occupied buildings when selecting transmission-line routes (Duke 2009c).

5.8.5 Occupational Health

As discussed in Section 2.10, occupational health risks for workers at the Lee Nuclear Station site are expected to be dominated by occupational injuries (e.g., falls, electric shock, asphyxiation, etc.) to workers engaged in activities such as maintenance, testing, and plant modifications. Historically, actual injury and fatality rates at nuclear reactor facilities have been lower than the average U.S. industrial rates. The 2009 annual incidence rates (the number of injuries and illnesses per 100 full-time workers) for South Carolina and the United States for electric power generation, transmission and distribution workers are 1.5 and 3.3, respectively (BLS 2011a, b). Occupational injury and fatality risks are reduced by strict adherence to NRC and OSHA safety standards (29 CFR Part 1910), practices, and procedures. Appropriate State and local statutes must also be considered when assessing the occupational hazards and health risks of nuclear reactor operation. For the purposes of the evaluation of nonradiological health impacts, the review team assumes adherence to NRC, OSHA, and State safety standards, practices, and procedures during nuclear power station operations.

Additional occupational health impacts may result from exposure to hazards such as noise, toxic or oxygen-replacing gases, thermophilic microorganisms in the condenser bays, and caustic agents. The *Duke Energy 2010/2011 Sustainability Report* (Duke Energy 2011a) reports that it maintains a health and safety program to protect workers from industrial safety risks. The number of recordable incidents per 100 workers (based on OSHA criteria) was 0.90 in 2010 (for comparison, the lowest incidence for the electric utility industry in 2009 was 0.69) (Duke Energy 2011a). The review team concludes that health impacts to workers from nonradiological emissions, noise, EMFs, and other occupational risks would be monitored and controlled in accordance with applicable OSHA regulations and would be minimal. No further mitigation would be warranted.

5.8.6 Impacts of Transporting Operations Personnel to the Lee Nuclear Station Site

The general approach used to calculate nonradiological impacts of fuel and waste shipments is the same as that used to calculate the impacts of transporting operations and outage personnel to and from the Lee Nuclear Station site. However, preliminary estimates are the only data available to estimate these impacts. The assumptions made to fill in reasonable estimates of the data needed to calculate nonradiological impacts are discussed below.

- The number of workers needed for operating Units 1 and 2 was provided in Duke's ER (2009c) as 1000 workers. An additional 800 temporary workers are estimated to be needed for refueling outages every 18 months (Duke 2009c). With two units operating it is expected there will be an outage every year.
- The average commute distance for operations and outage workers was assumed to be 80 km (50 mi) one way.
- To develop representative commuter traffic impacts, the U.S. Department of Transportation (DOT) provided the South Carolina-specific fatality rate for all traffic for the years 2003 to 2007 (DOT 2009). The average fatality rate for the 2003 to 2007 period in South Carolina was used as the basis for estimating South Carolina-specific injury and accident rates. Adjustment factors were developed using national-level traffic accident statistics in the U.S. Department of Transportation publication *National Transportation Statistics 2007* (DOT 2007). The adjustment factors are the ratio of the national injury rate to the national fatality rate and the ratio of the national accident rate to the national fatality rate. These adjustment factors were multiplied by the South Carolina-specific fatality rate to approximate the injury and accident rates for commuters in South Carolina.

The estimated effects of transporting operations and outage workers to and from the Lee Nuclear Station site are shown in Table 5-5. The annual traffic fatalities during operations, including both operations and outage personnel, represent about a 1.3 percent increase above the 45 traffic fatalities that occurred in Cherokee and York Counties in 2007 (DOT 2009). This represents a small increase relative to the current traffic fatality risk in the area surrounding the Lee Nuclear Station site. The review team concludes that the impacts of transporting construction materials and personnel to the Lee Nuclear Station site would be minimal, and mitigation would not be warranted.

Table 5-5. Nonradiological Impacts of Transporting Workers to/from the Lee Nuclear Station for Two Reactors

	Accidents per Year Per Unit	Injuries per Year per Unit	Fatalities per Year Per Unit
Permanent workers	150	68	1.1
Outage workers	15	6.6	0.1

5.8.7 Summary of Nonradiological Health Impacts

The review team evaluated health impacts to the public and the workers from the proposed cooling systems, noise generated by plant operations, acute and chronic impacts of EMFs, and transporting operations and outage workers to and from the Lee Nuclear Station site. Health risks to workers are expected to be dominated by occupational injuries at rates below the average U.S. industrial rate. Health effects to the public and workers from thermophilic microorganisms, noise generated by unit operations, and acute impacts of EMFs would be minimal. The review team reviewed available scientific literature on chronic effects of EMF on human health and found that the scientific evidence regarding the chronic effects of ELF-EMF on human health does not conclusively link ELF-EMF to adverse health impacts. Based on the information provided by Duke and the NRC's own independent evaluation, the review team concludes that the potential for nonradiological health impacts resulting from the operation of the two proposed nuclear units would be SMALL, and mitigation would not be warranted. The review team has not come to a conclusion on the chronic impacts of EMFs.

5.9 Radiological Health Impacts of Normal Operations

This section addresses the radiological impacts of normal operations of the proposed Lee Nuclear Station Units 1 and 2, including the estimated radiation dose to a member of the public and to the biota inhabiting the area around the Lee Nuclear Station site. Estimated doses to workers at the proposed units are also discussed. Radiological impacts were determined using the Westinghouse Advanced Passive (AP1000) reactor design with expected direct radiation and liquid and gaseous radiological effluent rates in the evaluation (see discussion in Section 3.4.3).

Revision 19 of the AP1000 design (Westinghouse 2011) is a certified design as set forth in 10 CFR Part 52, Appendix D. Duke's application incorporates Revision 19 of the AP1000 Design Control Document (DCD); and, the COL application and evaluation of radiological impacts of normal operations presented here are based on Revision 19 of the AP1000 DCD (Westinghouse 2011).

5.9.1 Exposure Pathways

The public and biota would receive radiation dose from a nuclear power station via the liquid effluent, gaseous effluent, and direct radiation pathways. Duke estimated the potential exposures to the public and biota by evaluating exposure pathways typical of those surrounding the proposed Units 1 and 2 at the Lee Nuclear Station site. They considered pathways that could cause the highest calculated radiological dose based on the use of the environment by the residents located around the site (Duke 2013a). For example, factors such as the location of homes in the area and consumption of meat and vegetables grown in the area were considered.

For the liquid effluent release pathway, Duke considered the following exposure pathways in evaluating the dose to the maximally exposed individual (MEI): ingestion of aquatic food (i.e., sport fishing); ingestion of drinking water; and direct radiation exposure from shoreline activities, swimming, and boating (see Figure 5-1). The analysis for population dose considered the following exposure pathways: ingestion of aquatic food, ingestion of drinking water, and direct radiation exposure from shoreline, swimming, and boating activities. Liquid effluents were assumed to be released via the planned discharge structure into the forebay behind Ninety-Nine Islands Dam, which is located on the Broad River).

As discussed in the DCD, the design of proposed Lee Nuclear Station Units 1 and 2 includes a number of features to prevent and mitigate leakage from system components such as pipes and tanks that may contain radioactive material (Westinghouse 2011). In addition, Duke committed to use the guidance of Nuclear Energy Institute (NEI) 08-08 (NEI 2008), *Generic FSAR Template Guidance for Life-Cycle Minimization of Contamination*, to the extent practicable in the development of operating programs and procedures (Duke 2013a). However, the potential still exists for leaks of radioactive material, such as tritium, into the ground. Based on the discussion above, the NRC staff expects that the impacts from such potential leakage for proposed Lee Nuclear Station Units 1 and 2 would be minimal.

For the gaseous effluent release pathway, Duke (2013a) considered the following exposure pathways in evaluating the dose to the MEI: immersion in the radioactive plume, direct radiation exposure from deposited radioactivity, inhalation, ingestion of garden fruit and vegetables, ingestion of goat and cow milk, and ingestion of meat animals.

For population doses from the gaseous effluents, Duke (2009c) used the same exposure pathways as those used for the individual dose assessment (Figure 5-1). All agricultural products grown within 50 mi of proposed Lee Nuclear Station Units 1 and 2 were assumed to be consumed by the population within 50 mi of the Lee Nuclear Station site.

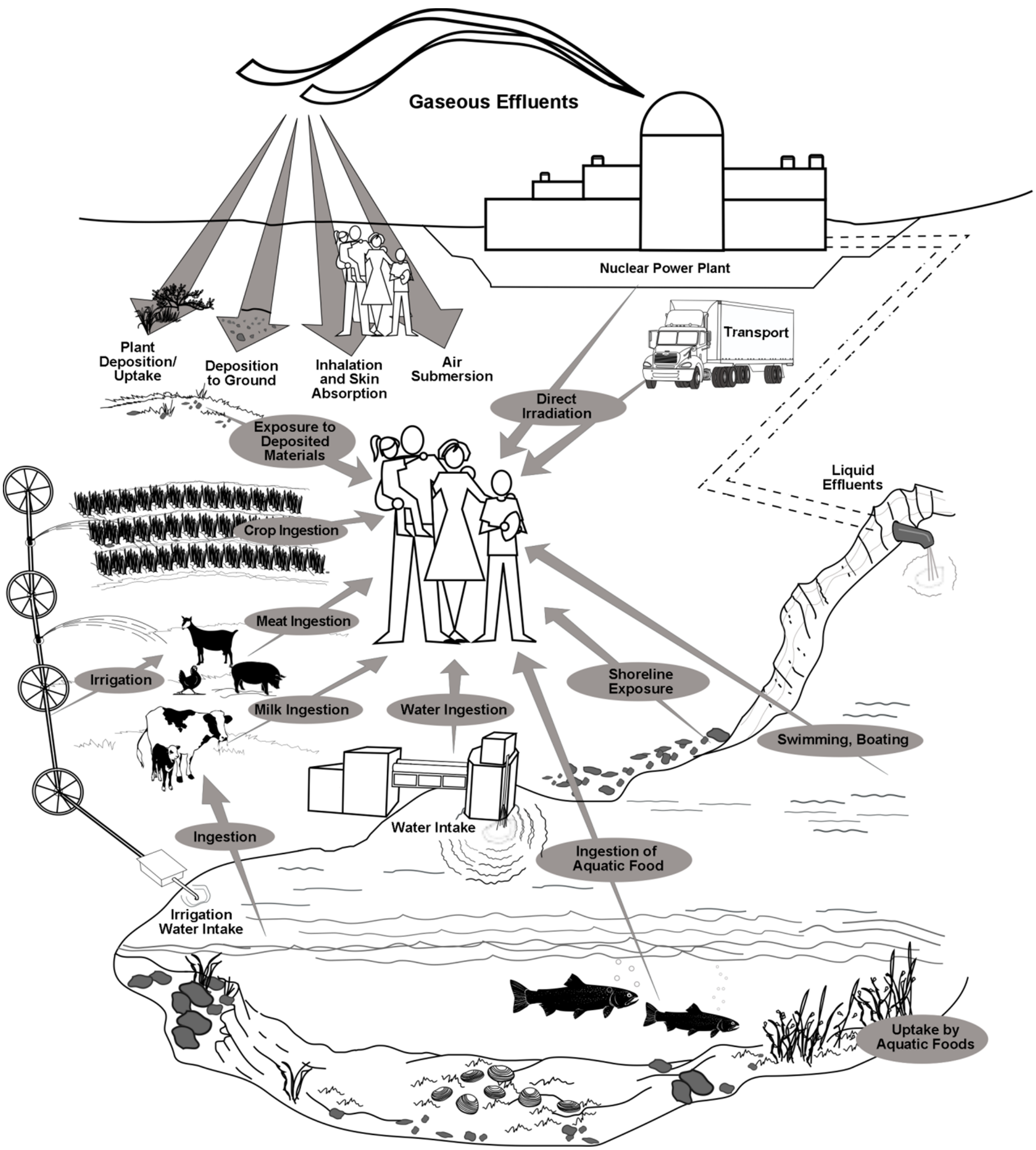

Figure 5-1. Exposure Pathways to Man (adapted from Soldat et al. 1974)

Duke (2009c) stated that direct radiation from the proposed Lee Nuclear Station during normal operation would be a potential source of radiation exposure to the public from the Lee Nuclear Station site. However, Duke assumed that contained sources of radiation at the proposed Lee Nuclear Station Units 1 and 2 would be shielded and would not contribute to the external dose of the MEI or the population. The assumption of negligible contribution from direct radiation beyond the site boundary is supported by the AP1000 DCD (Westinghouse 2011). The containment and other plant buildings would be shielded and direct radiation from them would be negligible. The AP1000 design also provides for the storage of refueling water inside the containment building instead of in an outside storage tank. This planned storage eliminates refueling water as a source of significant direct radiation to offsite receptors.

Source terms used to estimate exposure pathway doses were taken from Tables 11.2-7 and 11.3-3 in the AP1000 DCD (Westinghouse 2011). Duke identified no unusual exposure pathways, such as unusual plants, agricultural practices, animals, game harvests, or food processing operations (Duke 2009c, 2013a).

Exposure pathways considered in evaluating dose to the biota are shown in Figure 5-2 and include the following:

- ingestion of aquatic foods
- ingestion of water
- external exposure from water immersion or shoreline sediments
- inhalation of airborne radionuclides
- external exposure to immersion in gaseous effluent plumes
- surface exposure from deposition of iodine and particulates from gaseous effluents (NRC 1977b).

The NRC staff reviewed the exposure pathways for the public and biota identified by Duke (2009c) and found them to be appropriate, based on a documentation review, a tour of the environs, and interviews with Duke staff and contractors during the site audit in April and May 2008.

5.9.2 Radiation Doses to Members of the Public

Duke calculated the dose to the MEI and the population living within a 50-mi radius of the site from both the liquid and gaseous effluent release pathways (Duke 2009c, 2013a). As discussed in Section 5.9.1, direct radiation exposure to the MEI from sources of radiation at the proposed Lee Nuclear Station Units 1 and 2 would be negligible.

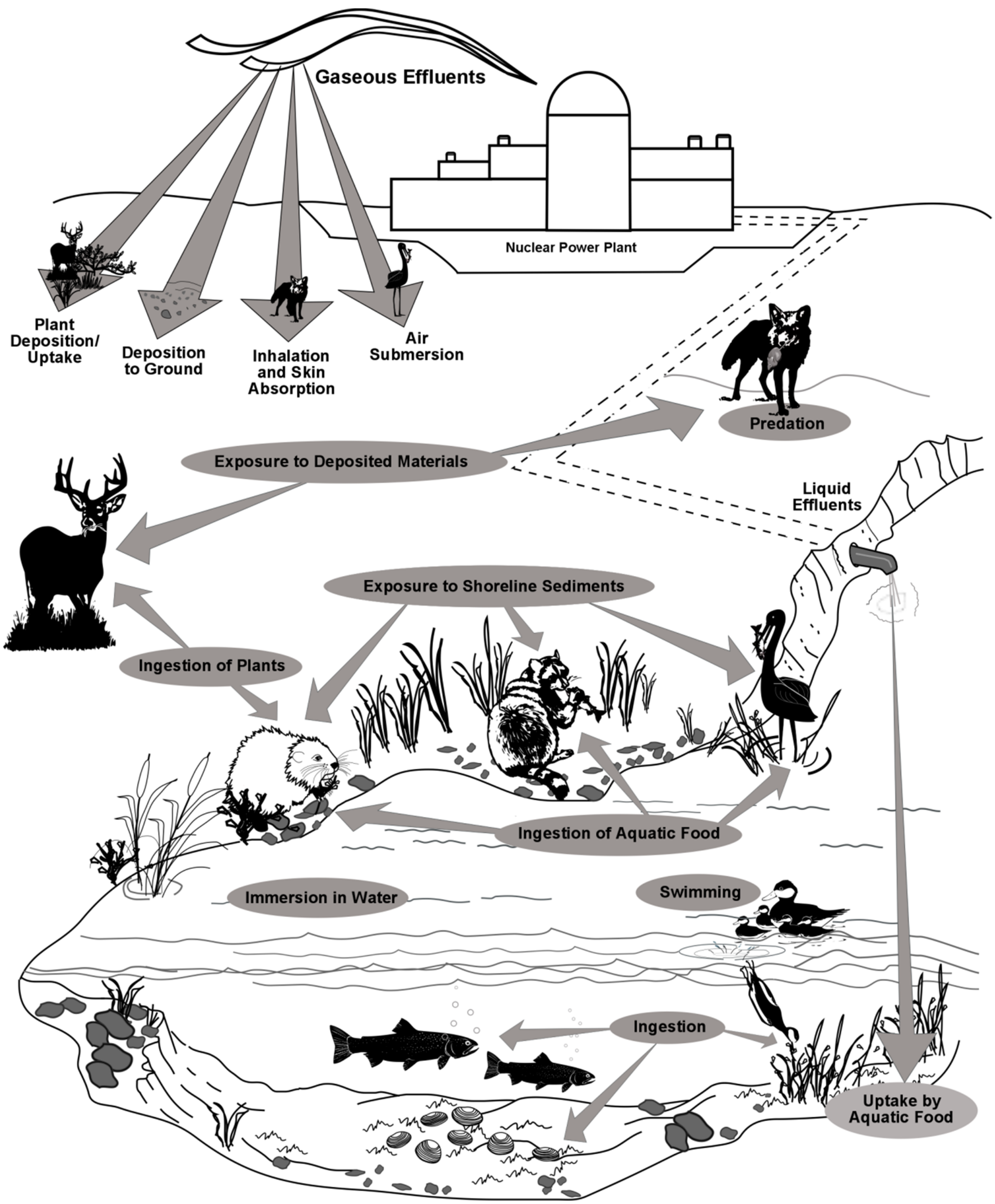

Figure 5-2. Exposure Pathways to Biota Other than Man (adapted from Soldat et al. 1974)

5.9.2.1 Liquid Effluent Pathway

Liquid pathway doses were calculated using the LADTAP II computer program (Strenge et al. 1986). The following activities were considered in the dose calculations: (1) consumption of drinking water contaminated by liquid effluents, (2) consumption of fish from water sources contaminated by liquid effluents, and (3) direct radiation from waterbodies contaminated by liquid effluents during swimming, boating, and recreation along the shoreline. The liquid effluent releases used in the estimates of dose are found in Table 11.2-7 of the AP1000 DCD (Westinghouse 2011) and listed in Table G-1 of Appendix G of this EIS. Other parameters used as inputs to the LADTAP II program include effluent discharge rate, 50-mi populations (total and those using drinking water); transit times to receptors; shoreline, swimming, and boating usage; and liquid pathway consumption and usage factors (i.e., sport fish consumption), and are found in Tables 5.4-1 and 5.4-2 of the ER (Duke 2009c) and listed in Table G-1 of Appendix G of this EIS. The nearest drinking water withdrawal point downstream of the Lee Nuclear Station site is the City of Union, South Carolina, about 21 mi downstream. Duke found no record of irrigation from the Broad River downstream of the Lee Nuclear Station site. Where not otherwise specified, default parameters were used with LADTAP II.

Duke calculated liquid pathway doses to the MEI as shown in Table 5-6. (Duke 2009c, 2013a). The MEI was calculated to be an adult with the majority of the dose from drinking water. The maximally exposed organ was calculated to be the liver of a child.

Table 5-6. Annual Doses to the Maximally Exposed Individual for Liquid Effluent Releases from a New Unit

Pathway	Age Group	Total Body (mrem/yr)	Maximum Organ (Liver) (mrem/yr)	Thyroid (mrem/yr)
Drinking water	Adult	0.0202	0.0204	0.0279
	Teen	0.0141	0.0146	0.0209
	Child	0.0267	0.0282	0.0437
	Infant	0.0261	0.0282	0.0532
Fish and other organisms	Adult	0.0406	0.0550	0.0042
	Teen	0.0232	0.0564	0.0038
	Child	0.0092	0.0492	0.0039
Direct radiation	Adult	0.00004	0.00004	0.00004
	Teen	0.0002	0.0002	0.0002
	Child	0.00005	0.00005	0.00005
Total	Adult	0.0609	0.0755	0.0321
	Teen	0.0375	0.0713	0.0250
	Child	0.0360	0.0775	0.0477
	Infant	0.0261	0.0282	0.0532

Source: Duke 2013a

The NRC staff recognizes the LADTAP II computer program as an appropriate method for calculating dose to the MEI for liquid effluent releases. All input parameters used in Duke's calculations were judged by the NRC staff to be appropriate.

The NRC staff performed an independent evaluation of liquid pathway doses. For its analysis, the NRC staff used a value for the mean annual flow rate of the Broad River of 1858 cfs for the water years 2000 to 2010 as measured at the USGS gage at Ninety-Nine Islands Dam (USGS 2010a); Duke used a longer-term average of 2538 cfs in their estimates (Duke 2009c, 2013a). When this difference is accounted for, the NRC staff obtained similar results to those estimated by Duke. The results of the NRC staff's independent review are found in Appendix G.

5.9.2.2 Gaseous Effluent Pathway

Duke calculated gaseous pathway doses to the MEI using the GASPAR II computer program (Strenge et al. 1987) at the nearest residences and the exclusion area boundary (EAB). The GASPAR II computer program was also used to calculate annual population doses. The following activities were considered in the dose calculations: (1) direct radiation from immersion in the gaseous effluent cloud and from particulates deposited on the ground, (2) inhalation of gases and particulates, (3) ingestion of meat from animals eating contaminated grass, (4) ingestion of milk from animals eating contaminated grass, and (5) ingestion of garden vegetables contaminated by gases and particulates. The gaseous effluent releases used in the estimate of dose to the MEI and population are found in Table 11.3-3 of the AP1000 DCD (Westinghouse 2011) and Table G-3 of Appendix G. Other parameters used as inputs to the GASPAR II program, including population data, atmospheric dispersion factors, ground deposition factors, receptor locations, and consumption factors, are found in Tables 2.3-287 through 2.3-292, and 11.3-201 of the Final Safety Analysis Report (FSAR) (Duke 2013a). Gaseous pathway doses to the MEI calculated by Duke are presented in Table 5-7. Duke added the highest dose for each pathway independent of the location to estimate the MEI dose.

The NRC staff recognizes the GASPAR II computer program as an appropriate tool for calculating dose to the MEI and population from gaseous effluent releases. The NRC staff reviewed the input parameters and values used by Duke (Duke 2013a) for appropriateness, including references made to the AP1000 DCD (Westinghouse 2011). The NRC staff concluded that the assumed input parameters and values used by Duke were appropriate. The NRC staff performed an independent evaluation of gaseous pathway doses and obtained similar results for the MEI (see Appendix G for details).

Table 5-7. Doses to the MEI from Gaseous Effluent Pathway for a New Unit[(a)]

Pathway	Age Group	Total Body Dose (mrem/yr)	Max Organ (mrem/yr)	Skin Dose (mrem/yr)	Thyroid Dose (mrem/yr)
Plume (0.27 mi NW)[(b)]	All	0.732	0.804 (lung)	4.900	0.732
Ground (0.27 mi NW)[(b)]	All	0.253	0.253 (thyroid)	0.298	0.253
Inhalation (0.27 mi NW)[(b)]	Adult	0.123	1.070 (thyroid)	0.120	1.070
	Teen	0.124	1.330 (thyroid)	0.121	1.330
	Child	0.110	1.540 (thyroid)	0.107	1.540
	Infant	0.064	1.380 (thyroid)	0.061	1.380
Vegetables (1.00 mi SSE)[(b)]	Adult	0.138	0.908 (thyroid)	0.127	0.908
	Teen	0.207	1.230 (thyroid)	0.196	1.230
	Child	0.459	2.420 (thyroid)	0.443	2.420
Meat (1.65 mi SE)[(c)]	Adult	0.040	0.173 (bone)	0.039	0.066
	Teen	0.032	0.146 (bone)	0.032	0.051
	Child	0.058	0.274 (bone)	0.058	0.087
Cow milk (1.65 mi SE)	Adult	0.054	0.813 (thyroid)	0.048	0.813
	Teen	0.089	1.290 (thyroid)	0.083	1.290
	Child	0.199	2.600 (thyroid)	0.191	2.600
	Infant	0.399	6.230 (thyroid)	0.388	6.230
Goat milk (1.05 mi SSW)	Adult	0.057	0.996 (thyroid)	0.043	0.996
	Teen	0.086	1.580 (thyroid)	0.071	1.580
	Child	0.171	3.150 (thyroid)	0.156	3.150
	Infant	0.326	7.580 (thyroid)	0.307	7.580

Source: Duke 2013a, d, g

(a) Ground-level releases were assumed. Doses are based on two year's meteorological data.

(b) In response to an NRC staff RAI, Duke re-evaluated its air dispersion modeling and revised their calculations (Duke 2013g). At the time of publication of this final EIS, the NRC staff review of the applicant's RAI response to assure that the applicant meets all applicable regulatory requirements is ongoing. NRC's evaluation of Duke's response will be addressed in the NRC's Final Safety Evaluation Report (FSER) and any changes to the COL application that are deemed necessary will be incorporated into the applicant's FSAR.

(c) No infant doses were calculated for the vegetable and meat pathway because the doses that infants receive from this diet would be bounded by the dose calculated for the child

5.9.3 Impacts on Members of the Public

This section describes Duke's evaluation of the estimated impacts from radiological releases and direct radiation from proposed Lee Nuclear Station Units 1 and 2. The evaluation addresses dose from operations to the MEI located at the Lee Nuclear Station site and the population dose (collective dose to the population within 50 mi) around the site.

5.9.3.1 Maximally Exposed Individual

Duke (2009c) stated that total body and organ dose estimates to the MEI from liquid and gaseous effluents for the two nuclear units would be within the dose design objectives of

10 CFR Part 50, Appendix I. Doses to total body and maximum organ at the Broad River from liquid effluents were well within the respective 3 and 10 mrem/yr Appendix I dose design objectives. Doses at the site boundary and the EAB from gaseous effluents would be well within the Appendix I dose design objectives of 10 mrad/yr air dose from gamma radiation, 20 mrad/yr air dose from beta radiation, 5 mrem/yr to the total body, and 15 mrem/yr to the skin. In addition, dose to the thyroid from gaseous effluents would be within the 15 mrem/yr Appendix I dose design objective. A comparison of dose estimates for each of the proposed units to the Appendix I dose design objectives is found in Table 5-8. The NRC completed an independent evaluation of compliance with Appendix I dose design objectives and found similar results, as shown in Appendix G. Gaseous and liquid effluents from the Lee Nuclear Station would be below the Appendix I dose design objectives (Duke 2009c, 2013a).

Table 5-8. Comparison of MEI Dose Estimates for a Single New Nuclear Unit from Liquid and Gaseous Effluents to 10 CFR Part 50, Appendix I, Dose Design Objectives

Pathway/Type of Dose	Duke Dose Estimates	Appendix I Design Objectives
Liquid effluents		
Total body dose	0.0609 mrem (adult)	3 mrem/yr
Maximum organ dose	0.0775 mrem (child liver)	10 mrem
Gaseous effluents (noble gases only)[a]		
Gamma air dose	1.25 mrad	10 mrad
Beta air dose	7.32 mrad	20 mrad
Total body dose	0.732 mrem	5 mrem/yr
Skin dose	4.90 mrem	15 mrem
Gaseous effluents (radioiodines and particulates)[b,c]		
Organ dose	9.21 mrem (infant thyroid)	15 mrem

Source: Duke 2009c, 2013a, g
(a) Northwest site boundary; ground-level releases assumed.
(b) Includes tritium, carbon-14, food chain, and inhalation doses.
(c) Includes infant drinking home-produced goat milk.

Duke compared the combined dose estimates from direct radiation and gaseous and liquid effluents from the proposed Lee Nuclear Station Units 1 and 2 with the 40 CFR Part 190 standards (Duke 2013a). Duke (2013a) states that dose estimates from combined liquid and gaseous effluents to the MEI at the nearest residence from the Lee Nuclear Station are well within the regulatory standards of 40 CFR Part 190. As stated earlier, exposure at the site boundary from direct radiation sources at the new units would be negligible. Table 5-9 compares Duke's calculated doses from the two proposed units to the dose standards from 40 CFR Part 190; i.e., 25 mrem/yr to the total body, 75 mrem/yr to the thyroid, and 25 mrem/yr to any other organ. The NRC staff completed an independent evaluation of compliance with 40 CFR Part 190 standards and found similar results, as shown in Appendix G.

Table 5-9. Comparison of MEI Dose Estimates from Liquid and Gaseous Effluents to 40 CFR Part 190 Standards

Dose	Estimate (mrem)[a]	Standards (mrem)
Whole body dose	3.74	25
Thyroid dose	20.0	75
Dose to another organ	9.05 (child bone)	25

Source: Duke 2013g; 40 CFR Part 190
(a) Sum of dose from liquid and gaseous effluent releases for two proposed units.

5.9.3.2 Population Dose

Duke estimated that the collective total body dose within a 50-mi radius of the proposed Lee Nuclear Station Units 1 and 2 for the gaseous pathways would be 5.00 person-rem/yr for each unit (Duke 2013a). Duke estimated that the collective total body dose within a 50-mi radius of the proposed Lee Nuclear Station Units 1 and 2 for the aquatic pathways would be 0.296 person-rem/yr for each unit (Duke 2013a). The combined total for both types of effluent and both units would be 10.6 person-rem/yr. The estimated collective dose to the same population from natural background radiation is estimated as 1,305,000 person-rem/yr. The dose from natural background radiation was calculated by multiplying the 50-mi radius population estimate (4,195,000) for the year 2056 by the annual background dose rate (311 mrem/yr) (NCRP 2009).

Collective dose was estimated by summing the doses from the gaseous (calculated using the GASPAR II computer code) and liquid effluent (calculated using the LADTAP II computer code) pathways. The NRC staff performed an independent evaluation of population doses and obtained similar results (see Appendix G).

Radiation protection experts assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. A recent report by the National Research Council (2006), the Biological Effects of Ionizing Radiation (BEIR) VII report, uses the linear, no-threshold dose response model as a basis for estimating risks from low doses. This approach is accepted by the NRC as a conservative method for estimating health risks from radiation exposure, recognizing that the model may overestimate those risks. Based on this method, the NRC staff estimated the risk to the public from radiation exposure using the nominal probability coefficient for total detriment. This coefficient has the value of 570 fatal cancers, nonfatal cancers, and severe hereditary effects per 1,000,000 person-rem (10,000 person-Sv) equal to 0.00057 effect per person-rem. The coefficient is taken from Publication 103 of the International Commission on Radiological Protection (ICRP 2007).

Both the National Council on Radiation Protection and Measurements (NCRP) and ICRP suggest that when the collective effective dose is smaller than the reciprocal of the relevant risk detriment (in other words, less than 1/0.00057, which is less than 1754 person-rem), the risk assessment should note that the most likely number of excess health effects is zero (NCRP 1995; ICRP 2007). As noted above, the estimated collective whole body dose to the population living within 50 mi of the Lee Nuclear Station site is 10.6 person-rem/yr, which is less than the value of 1754 person-rem/yr that ICRP and NCRP suggest would most likely result in zero excess health effects (NCRP 1995; ICRP 2007).

In addition, at the request of the U.S. Congress, the National Cancer Institute (NCI) conducted a study and published, *Cancer in Populations Living Near Nuclear Facilities*, in 1990 (Jablon et al. 1990). The NCI report included an evaluation of health statistics around all nuclear power plants, as well as several other nuclear fuel cycle facilities, in operation in the United States in 1981 and found "… no evidence that an excess occurrence of cancer has resulted from living near nuclear facilities" (Jablon et al. 1990).

5.9.3.3 Summary of Radiological Impacts to Members of the Public

The NRC staff evaluated the potential health impacts from routine gaseous and liquid radiological effluent releases from the proposed Lee Nuclear Station Units 1 and 2. Based on the information provided by Duke, and the NRC's own independent evaluation, the NRC staff concluded that there would be no observable health impacts to the public from normal operation of the units, any health impacts would be SMALL, and additional mitigation would not be warranted.

5.9.4 Occupational Doses to Workers

The collective occupational dose for a single AP1000 reactor was estimated at 63.2 person-rem/yr in the AP1000 DCD (Westinghouse 2011). The licensee of a new plant would be required to maintain individual doses to workers to within 5 rem annually as specified in 10 CFR 20.1201 and incorporate provisions to maintain doses as low as reasonably achievable (ALARA). To maintain doses to workers ALARA, Duke plans to establish comprehensive worker training, monitoring, and radiation safety programs (Duke 2013a based on the NEI 07-03A, *Generic FSAR Template Guidance for Radiation Protection Program Description* (NEI 2009a).

The NRC staff concludes that the health impacts from occupational radiation exposure at the Lee Nuclear Station site would be SMALL based on individual worker doses being maintained within 10 CFR 20.1201 limits and collective occupational doses being typical of doses found in current operating light water reactors. Additional mitigation would not be warranted because the operating plant would be required to maintain doses ALARA.

5.9.5 Impacts on Biota Other than Humans

Duke estimated doses to biota in the environs for the Lee Nuclear Station site using surrogate species. Surrogate species used in the ER are well-defined and provide an acceptable method for evaluating doses to the biota. Surrogate species analysis was performed for aquatic species (e.g., fish, invertebrates, and algae) and terrestrial species (e.g., muskrats, raccoons, herons, and ducks) (Duke 2009c). Aquatic species on the Lee Nuclear Station site are represented by the freshwater fish, invertebrates, and algae surrogates. Terrestrial species are represented by the muskrat and raccoon surrogates; birds are represented by the heron and duck surrogates. Exposure pathways considered in evaluating dose to the biota are discussed in Section 5.9.1 and shown in Figure 5-2. The NRC staff's independent evaluation considered surrogate species and found results similar to those reported by Duke (2009c) (see Appendix G).

5.9.5.1 Liquid Effluent Pathway

Duke (2009c) used the LADTAP II computer code to calculate doses to the biota from the liquid effluent pathway. In estimating the concentration of radioactive effluents in the Broad River, Duke (2009c) used a simple mixing model for the river below Ninety-Nine Islands Dam. (The NRC staff also considered radionuclide concentrations in the forebay of the Ninety-Nine Islands Dam, just before the spillway; see Appendix G.) Liquid pathway doses were higher for biota compared to humans because of considerations for bioaccumulation of radionuclides, ingestion of aquatic plants, ingestion of invertebrates, and increased time spent in the water and on the shoreline compared to humans. The liquid effluent releases used in estimating biota dose are found in the AP1000 DCD (Westinghouse 2011, Table 11.2-7). Total body dose estimates to the surrogate species from the liquid and gaseous pathways are shown in Table 5-10.

Table 5-10. Biota Doses for the Lee Nuclear Station Units 1 and 2

Biota	Liquid Effluents Dose (mrad/yr)	Gaseous Effluents Dose (mrad/yr)	Total Body Biota Dose All Pathways (mrad/yr)
Fish	0.57	-	0.57
Invertebrate	1.61	-	1.61
Algae	4.64	-	4.64
Muskrat	1.71	4.06	5.77
Raccoon	0.67	3.25	3.92
Heron	7.82	3.18	11.00
Duck	1.64	3.80	5.44

Source: Duke 2009c, Table 5.4-17, Duke 2013g

5.9.5.2 Gaseous Effluent Pathway

Gaseous effluents would contribute to the total body dose of the terrestrial surrogate species (i.e., muskrat, raccoon, heron, and duck). The exposure pathways include inhalation of airborne radionuclides, external exposure because of immersion in gaseous effluent plumes, and surface exposure from deposition of iodine and particulates from gaseous effluents. Duke used the calculation methods of dose to the MEI from gaseous effluent releases described in Section 5.9.2 to calculate dose to terrestrial surrogate species, with two modifications (Duke 2009c). One modification increased the ground deposition factors to account for the closer proximity of terrestrial animals to the ground compared with the MEI. The second modification was the assumption that terrestrial surrogate inhalation doses would be similar to inhalation dose for a human infant. The gaseous effluent doses were calculated at the site boundary (0.27 mi northwest of the Lee Nuclear Station site) in estimating terrestrial species doses. Total body dose estimates to the surrogate species from the gaseous pathway are shown in Table 5-10.

5.9.5.3 Summary of Impacts on Biota Other Than Humans

The International Atomic Energy Agency (IAEA 1992) and the NCRP (1991) reported that a chronic dose rate of no greater than 10 mGy/d (1000 mrad/d) to the MEI in a population of aquatic organisms would ensure protection of the population. The IAEA (1992) also concluded that chronic dose rates of 1 mGy/d (100 mrad/d) or less do not appear to cause observable changes in terrestrial animal populations.

Table 5-11 provides a comparison of estimated total body dose rates to surrogate biota species that would be produced by releases from the proposed Lee Nuclear Station Units 1 and 2 to the IAEA/NCRP biota dose guidelines (IAEA 1992; NCRP 1991).

Table 5-11. Comparison of Biota Doses from Proposed Lee Units 1 and 2 to IAEA Guidelines for Biota Protection

Biota	Duke Estimate of Dose to Biota (mrad/d)[(a)]	IAEA/NCRP Guidelines for Protection of Biota Populations (mrad/d)[(b)]
Fish	1.6×10^{-3}	1000
Invertebrate	4.4×10^{-3}	1000
Algae	1.3×10^{-2}	1000
Muskrat	1.6×10^{-2}	100
Raccoon	1.1×10^{-2}	100
Heron	3.0×10^{-2}	100
Duck	1.5×10^{-2}	100

Sources: Duke 2009c, 2013g

(a) Total dose from liquid and gaseous effluents in Table 5-10 converted to mrad/d.

(b) Guidelines in NCRP and IAEA reports expressed in Gy/d (1 mGy/d equals 100 mrad/d).

The maximum total dose from both liquid and gaseous pathways from the bounding calculation is about 11.0 mrad/yr, or about 0.030 mrad/d. Thus, doses to biota calculated by both Duke and the NRC staff are far below the 100 mrad/d (0.1 rad/d) IAEA guidelines (IAEA 1992) for terrestrial biota and the 1000 mrad/d (1-rad/d) IAEA guideline (IAEA 1992) for aquatic biota. Daily dose rates would not exceed the IAEA guidelines for any surrogate species.

Based on the information provided by Duke and the NRC's independent evaluation, the NRC staff concludes that the radiological impact on biota from the routine operation of the proposed Lee Nuclear Station Units 1 and 2 would be SMALL, and additional mitigation would not be warranted.

5.9.6 Radiological Monitoring

A radiological environmental monitoring program (REMP) is not yet in place for the Lee Nuclear Station site; however, Duke has committed (Duke 2013a) to develop a REMP implementing the guidance of NEI 07-09A (NEI 2009b). The proposed REMP includes monitoring of the airborne exposure pathway, direct exposure pathway, water exposure pathway, and aquatic exposure pathway from the Broad River, and ingestion exposure pathways within a 5-mi radius of the Lee Nuclear Station, with indicator locations near the plant perimeter and control locations at distances greater than 10 mi. Milk would also be sampled from dairy cows within 5 mi of the Lee Nuclear Station. An annual survey is planned for the area surrounding the site to verify the accuracy of assumptions used in the analyses, including milk production. A preoperational REMP would sample various media in the environment to determine a baseline from which to observe the magnitude and fluctuation of radioactivity in the environment once the units begin operation. The preoperational program would include collection and analysis of samples of air particulates, precipitation, crops, soil, well water, surface water, fish, and silt as well as measurement of ambient gamma radiation. When operation of the proposed Lee Nuclear Station Unit 1 begins, and later when Unit 2 operations begins, the monitoring program would continue to assess the radiological impacts on workers, the public, and the environment. Radiological releases would be summarized in two annual reports: the *Annual Radiological Environmental Operating Report* and *Annual Radioactive Effluent Release Report*. The limits for all radiological releases would be specified in the *Lee Offsite Dose Calculation Manual*, also planned. Duke operates similar radiological monitoring programs at its other reactor sites (e.g., Catawba Nuclear Station, McGuire Nuclear Station); sample analyses would take place at the central Duke laboratory located at the McGuire Nuclear Station site using existing approved methods. In addition, Duke (Duke 2008c) has endorsed the NEI Groundwater Protection Initiative (NEI 2007a). The goals for the Groundwater Protection Initiative will be to provide a hydrologic characterization of the constructed plant and a monitoring well network capable of providing early detection of releases through the use of near-field wells and verification of no offsite migration through the use of far-field wells. Well locations will be selected based on proximity to plant systems that may be a source of radiological releases and/or in nearby projected down-gradient groundwater flow direction from such sources. Where shallow groundwater is expected to be present, shallow wells will be used as first detection monitoring locations. Deeper wells will be used where plant systems are deep. Wells will be installed such that the well screen is located near the potential release location. Deep wells may be located on top of rock or into rock as appropriate. Wells may be paired, either in shallow or deep locations, to evaluate the vertical component of groundwater flow.

5.10 Nonradioactive Waste Impacts

This section describes the potential impacts on the environment that could result from the generation, handling, and disposal of nonradioactive waste and mixed waste during the operation of the proposed Lee Nuclear Station Units 1 and 2. Section 3.4.4 of this EIS describes the nonradioactive waste systems. Types of nonradioactive waste that would be generated, handled, and disposed of during operational activities include solid wastes, liquid effluents, and air emissions. Solid wastes include municipal waste, sewage-treatment sludge, and industrial wastes. Liquid waste includes NPDES-permitted discharges such as effluents containing chemicals or biocides, wastewater effluents, site stormwater runoff, and other liquid wastes such as used oils, paints, and solvents that require offsite disposal. Air emissions would primarily be generated by vehicles and diesel generators. In addition, small quantities of hazardous waste and mixed waste (i.e., waste with both hazardous and radioactive characteristics) may be generated during plant operations. The assessment of potential impacts resulting from these types of wastes is presented in the following sections.

5.10.1 Impacts on Land

Operational solid wastes such as office waste, cardboard, wood, metal, and organic debris from the intake screens would be transported offsite to be recycled or disposed of in an SCDHEC-permitted landfill (Duke 2009c). Waste from the sanitary and potable water systems will be discharged offsite to the Gaffney Board of Public Works Wastewater Treatment Plant (Duke 2009c). Duke expects to produce less than 220 lb of hazardous waste in any calendar month, thus classifying Lee Nuclear Station as a Conditional Exempt Small Quantity Generator under the Resource Conservation and Recovery Act (RCRA). Duke would follow applicable Federal, State, and local requirements and standards for handling, transporting, and disposing of solid waste, including hazardous wastes (Duke 2009c).

Based on Duke’s plans to manage solid and liquid wastes in a similar manner in accordance with all applicable Federal, State, and local requirements and standards, and the effective practices for reusing, recycling, and minimizing waste, the review team expects that impacts on land from nonradioactive wastes generated during the operation of Lee Nuclear Station Units 1 and 2 would be minimal, and no further mitigation would be warranted.

5.10.2 Impacts on Water

Water withdrawn from the Broad River for cooling and other operational purposes for the proposed Lee Nuclear Station Units 1 and 2 would be discharged to the Ninety-Nine Island Reservoir. These discharges would contain both chemicals and biocides and would be controlled by the NPDES permit administered by the SCDHEC. Site stormwater is another potential nonradioactive liquid effluent from the operation of the proposed Units 1 and 2 that would be regulated by the NPDES permit (Duke 2009c). In all cases, the NPDES permit would limit the volume and constituents concentrations in these effluents. Sections 5.2.3.1 and 5.2.3.2 of this EIS discuss impacts on surface and groundwater quality from operation of the proposed Lee Nuclear Station Units 1 and 2. As noted above, wastewater from the sanitary and potable water systems will be discharged offsite to the Gaffney Board of Public Works Wastewater Treatment Plant (Duke 2009c).

Based on the regulated practices for managing liquid discharges containing chemicals or biocides, wastewater, and the plans for managing stormwater, the review team expects that impacts on water from nonradioactive effluents during operation of Lee Nuclear Station Units 1 and 2 would be minimal, and no further mitigation would be warranted.

5.10.3 Impacts on Air

Operation of the proposed Lee Nuclear Station Units 1 and 2 would result in gaseous emissions from operation of emergency diesel generators. Impacts on air quality are discussed in Section 5.7.2 of this EIS. In addition, vehicular traffic associated with personnel necessary to operate the proposed Lee Nuclear Station Units 1 and 2 would increase vehicle emissions in the area. An air emissions operating permit would be required for the purposes of Title V of the Clean Air Act. However, Lee Nuclear Station may be classifiable as a non-Title V conditional/ synthetic minor facility. Under new South Carolina New Source Review (NSR) rules, a regulatory analysis with appropriate calculations would be performed to determine whether NSR/Prevention of Significant Deterioration is applicable (Duke 2009c).

Based on the regulated practices for managing air emissions from stationary sources, the review team expects that impacts on air from nonradioactive emissions during the operation of proposed Lee Nuclear Station Units 1 and 2 would be minimal, and no further mitigation would be warranted.

5.10.4 Mixed-Waste Impacts

Mixed waste contains both low-level radioactive waste and hazardous waste. The generation, storage, treatment, or disposal of mixed waste is regulated by the Atomic Energy Act; the Solid Waste Disposal Act of 1965, as amended by RCRA; and the Hazardous and Solid Waste Amendments (which amended RCRA in 1984). Duke would implement a waste-minimization plan to reduce the amount of mixed waste produced onsite by reducing generation at the source, recycling, and treatment options (Duke 2009c). Duke stated that it would manage the treatment, storage, and offsite disposal of mixed wastes generated by the proposed Units 1 and 2 in accordance with applicable NRC, EPA, and South Carolina regulations (Duke 2009c).

Based on Duke's plan for waste minimization, management, and treatment of mixed wastes in accordance with all applicable Federal, State, and local requirements and standards, the review team expects that impacts from the generation of mixed waste at the proposed Lee Nuclear Station Units 1 and 2 would be minimal, and no further mitigation would be warranted.

5.10.5 Summary of Nonradioactive Waste Impacts

Solid, liquid, gaseous, and mixed wastes generated during operation of the proposed Lee Nuclear Station Units 1 and 2 would be handled according to county, State, and Federal regulations. County and State permits and regulations for handling and disposal of solid waste would be obtained and implemented. Discharges to the Ninety-Nine Islands Reservoir of liquid effluents generated by operations, including wastewater and stormwater, would be controlled and limited by the site NPDES permit. Air emissions from the proposed Lee Nuclear Station Units 1 and 2 operations would be compliant with local, State, and Federal air-quality standards and regulations. Mixed-waste generation, storage, and disposal impacts during operation of the proposed Lee Nuclear Station Units 1 and 2 would be compliant with NRC, EPA, and South Carolina requirements and standards.

Based on the information provided by Duke; implementation of effective practices for recycling, minimizing, managing, and waste disposal at the Lee Nuclear Station site; expectation that regulatory approvals would be obtained to regulate the additional waste that would be generated from proposed Units 1 and 2; and the independent evaluations as discussed in the referenced sections of this EIS, the review team concludes that the potential impacts from nonradioactive waste resulting from the operation of the Lee Nuclear Station site would be SMALL, and no further mitigation would be warranted.

Cumulative impacts on water and air from nonradiological effluents and emissions are discussed in Sections 7.2 and 7.6, respectively. For the purposes of Chapter 9, the review team expects no substantive differences between the impacts of nonradiological waste for the proposed Units 1 and 2 and the alternative sites, and no substantive cumulative impacts that warrant further discussion beyond those discussed for the alternative sites in Section 9.3.

5.11 Environmental Impacts of Postulated Accidents

The NRC staff considered the radiological consequences on the environment of potential accidents at the proposed Lee Nuclear Station. Duke based its COL application on the proposed installation of AP1000 reactors for Units 1 and 2. On December 30, 2011, Revision 19 of the AP1000 design (Westinghouse 2011) was certified in a design certification amendment (76 FR 82079). The Duke application references Revision 19 of the AP1000 DCD.

The term "accident," as used in this section, refers to any off-normal event not addressed in Section 5.9 that results in release of radioactive materials into the environment. The focus of this review is on events that could lead to releases substantially greater than permissible limits for normal operations. Normal release limits are specified in 10 CFR Part 20, Appendix B, Table 2.

Many safety features combine to reduce the risk associated with accidents at nuclear power plants. Safety features in the design, construction, and operation of the plants, which comprise the first line of defense, are intended to prevent the release of radioactive materials from nuclear plants. The design objectives and the measures for keeping levels of radioactive materials in effluents to unrestricted areas ALARA are specified in 10 CFR Part 50, Appendix I. Additional measures are designed to mitigate the consequences of failures in the first line of defense. These include the NRC's reactor site criteria in 10 CFR Part 100 that require the site to have certain characteristics that reduce the risk to the public and the potential impacts of an accident; emergency preparedness plans and protective action measures for the site and environs, as set forth in 10 CFR 50.47, 10 CFR Part 50, Appendix E, and NUREG-0654/FEMA-REP-1 (NRC 1980). All of these safety features, measures, and plans make up the defense-in-depth philosophy to protect the health and safety of the public and the environment.

On March 11, 2011, and for an extended period thereafter, several nuclear power plants in Japan experienced the loss of important equipment necessary to maintain reactor cooling after the combined effects of severe natural phenomena (i.e., an earthquake followed by the tsunami it caused). In response to these events, the Commission established a task force to review the current regulatory framework in place in the United States and to make recommendations for improvements. The task force reported the results of its review (NRC 2011e) and presented its recommendations to the Commission on July 12 and July 19, 2011, respectively. As part of the short-term review, the task force concluded that while improvements are expected to be made as a result of the lessons learned, the continued operation of nuclear power plants and licensing activities for new plants did not pose an imminent risk to public health and safety. A number of areas were recommended to the Commission for long-term consideration. Collectively, these recommendations are intended to clarify and strengthen the regulatory framework for protection against severe natural phenomena, mitigation of the effects of such events, coping with emergencies, and improving the effectiveness of NRC programs. By nature of the passive design and inherent 72-hour coping capability for core, containment, and spent fuel pool cooling with no operator action required, the AP1000 design has many of the design features and attributes necessary to address the Task Force Recommendations (NRC 2011e).

On March 12, 2012, the NRC issued three orders and a request for information (RFI) to holders of U.S. commercial nuclear reactor licenses and construction permits to enhance safety at

U.S. reactors based on specific lessons learned from the event at Japan's Fukushima Dai-ichi nuclear power plant as identified in the task force report.

The first and third orders apply to every U.S. commercial nuclear power plant, including recently licensed new reactors. The first order requires a three-phase approach for mitigating beyond-design-basis external events. Licensees are required to use installed equipment and resources to maintain or restore cooling of the core, containment, and spent fuel during the initial phase. (For the AP1000 design, this is the first 72 hours.) During the transition phase (the next 4 days), licensees are required to provide portable, onsite equipment and consumables sufficient to maintain or restore these functions until they can be accomplished with resources brought from offsite. During the final phase (after 7 days), licensees are required to obtain sufficient offsite resources to sustain those functions indefinitely (77 FR 16091). The second order requires reliable hardened vent systems at boiling water reactor facilities with "Mark I" and "Mark II" containment structures (77 FR 16098). The third order requires reliable spent fuel pool level instrumentation (77 FR 16082). The RFI addressed five topics: (1) seismic reevaluations, (2) flooding reevaluations, (3) seismic hazard walkdowns, (4) flooding hazard walkdowns, and (5) a request for licensees to assess their current communications system and equipment under conditions of onsite and offsite damage and prolonged station blackout and perform a staffing study to determine the number and qualifications of staff required to fill all necessary positions in response to a multi-unit event (NRC 2012e, f). The RFI requested reactor licensees to reevaluate seismic and flooding hazards using methods to determine if the plants' design to be changed.

The NRC staff issued RAIs to Duke requesting information to address the requirements of the first and third orders, and information sought in the first and fifth RFI topics (NRC 2012g). Duke addressed the first and third orders along with the fifth RFI by proposing license conditions to be implemented prior to initial fuel load (Duke 2012p). The AP1000 containment design differs from those identified in the second order; therefore, the actions addressed in this order are not applicable to the Lee Nuclear Station site. The NRC's evaluation of Duke's responses will be addressed in the NRC's Final Safety Evaluation Report (FSER) and any changes to the COL application that are deemed necessary will be incorporated into the applicant's FSAR.

The severe accident evaluation presented later in this section draws from the analyses developed in the NRC staff's safety review, which includes consideration of severe accidents initiated by external events and those that involve fission product releases. The staff evaluation discusses the environmental impacts of severe accidents in terms of risk, which considers both the likelihood of a severe accident and its consequences. For reasons discussed below, the staff has determined that the Fukushima accident and the NRC's implementation of the task force recommendations do not change the staff's conclusions on the environmental impacts of design basis accidents or severe accidents. These conclusions are based on *William States Lee III Nuclear Station COL Final Safety Analysis Report, Revision 5*, which was submitted to the NRC by a letter dated April 16, 2012 (Duke 2012q). Since then, Duke has indicated that changes will be made to the site grading and footprint of the nuclear island which are integral parts of the design basis flood for the proposed Lee Nuclear Station Units 1 and 2 (Duke 2012l).

Each new reactor application evaluates the natural phenomena that are pertinent to the site for the proposed reactor design by applying present-day regulatory guidance and methodologies. This includes a determination of the characteristics of the flood and seismic hazards. With respect to flooding, Duke documented the flood hazard in the FSAR consistent with present-day guidance and methodologies. In support of changes to the site footprint identified by Duke (Duke 2013a), the final flood hazard analysis was submitted by Duke as part of Revision 7 of the FSAR and is currently under review by the NRC. The NRC staff is performing a review and confirmatory analysis to verify that the reconfigured site layout and resulting flood levels conform to the referenced AP1000 maximum flood level plant parameter.

With respect to the consideration of severe accidents initiated by seismic events, Duke is currently developing its response to the staff's seismic hazard RAI stemming from the first RFI topic (NRC 2012g). The RAI requested that Duke evaluate the impact of the latest information affecting seismic hazard analysis (SHA) for the central and eastern United States. In response to the staff's RAI, Duke is re-evaluating its SHA and performing new calculations (Duke 2012r, 2012s). The NRC considering all possible outcomes of the SHA analysis for the Lee Nuclear Station site. The NRC staff will review Duke's results and RAI response to ensure they meet all applicable regulatory requirements. Duke will need to demonstrate and the NRC staff will confirm that the AP1000 seismic design response spectra are acceptable at the Lee Nuclear Station site. After the final SHA results are submitted by Duke to the NRC for review, the NRC staff will evaluate its impact to determine if Duke would be required to modify the plant design to ensure any change in the seismic hazard can be accounted for with acceptable design margin.

In addition to the above considerations for seismic and flooding, the safety features of the AP1000 design support the conclusion that the Fukushima accident does not warrant a change in the assessment of environmental risks from severe accidents considered in the Lee Nuclear Station EIS analysis. In particular, the potential design-related vulnerabilities raised by the event at Fukushima, such as the impact of the extended loss of alternating-current electric power on core cooling systems, would not materially affect the analysis of severe accidents for Lee because the AP1000 has been designed to prevent and mitigate severe accidents given a loss of all alternating-current electrical power sources. As previously noted in the task force report, on loss of alternating-current electrical power, the AP1000 passive safety systems would remove the decay heat from the reactor core and spent fuel. They will maintain adequate core cooling for a period of 72 hours without further operator action, unlike the facilities at the Fukushima site. This core cooling by the passive safety systems can be sustained for an extended period beyond 72 hours where the only operator actions are to refill the tank that is the source of water for the passive safety systems and distribute the water when needed.

Additional details are provided in the staff's safety evaluation report for the AP1000 design certification. The NRC staff's design certification review (76 FR 82079) regarding the safety of the AP1000 design concluded that the design has a very high capacity to withstand beyond-design-basis events.

In summary, none of the information the staff has identified about the Fukushima accident or the steps taken by the NRC to date to implement the task force recommendations suggests that the seismic and flooding hazards or the available mitigation capability assumed in the Lee Nuclear Station EIS analysis of severe accidents would be affected. For these reasons, the NRC's analysis of the environmental impacts of design basis and severe accidents presented herein remains valid.

This section discusses (1) the types of radioactive materials, (2) the paths to the environment, (3) the relationship between radiation dose and health effects, and (4) the environmental impacts of reactor accidents, both design basis accidents (DBAs) and severe accidents. The environmental impacts of accidents during transportation of spent fuel are discussed in Chapter 6.

The potential for dispersion of radioactive materials in the environment depends on the mechanical forces that physically transport the materials and on the physical and chemical forms of the material. Radioactive material exists in a variety of physical and chemical forms. The majority of the material in the fuel is in the form of nonvolatile solids. However, a significant amount of material is in the form of volatile solids or gases. The gaseous radioactive materials include the chemically inert noble gases (e.g., krypton and xenon), which have a high potential for release. Radioactive forms of iodine, which are created in substantial quantities in the fuel by fission, are volatile. Other radioactive materials formed during the operation of a nuclear power plant have lower volatilities and therefore lower tendencies to escape from the fuel than the noble gases and iodines.

Radiation dose to individuals is determined by their proximity to radioactive material; amount of radioactive material inhaled, ingested, or absorbed through the skin; the duration of their exposure; and the extent to which they are shielded from the radiation. Predominant pathways that lead to radiation exposure include (1) external radiation from radioactive material in the air, on the ground, and in the water; (2) inhalation of radioactive material; and (3) ingestion of food or water containing material initially deposited on the ground and in water.

Radiation protection experts assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. A report by the National Research Council (2006), the BEIR VII report, uses the linear, no-threshold dose response model as a basis for estimating the risks from low doses. This approach is accepted by the

NRC as a conservative method for estimating health risks from radiation exposure, recognizing that the model may overestimate those risks.

Physiological effects are clinically detectable if individuals receive radiation exposure resulting in a dose greater than about 25 rem over a short period of time (hours). Doses of about 250 to 500 rem received over a relatively short period (hours to a few days) can be expected to cause some fatalities.

5.11.1 Design Basis Accidents

Duke evaluated the potential consequences of postulated accidents to demonstrate that an AP1000 reactor could be constructed and operated at the Lee Nuclear Station site without undue risk to the health and safety of the public (Duke 2009c). These evaluations used site-specific meteorological data and a set of surrogate DBAs that are representative for the reactor design being considered for the Lee Nuclear Station. The set of accidents covers events that range from relatively high probability of occurrence with relatively low consequences to relatively low probability with high consequences.

The DBA review focuses on the AP1000 reactors at the Lee Nuclear Station site. The bases for analyses of postulated accidents for this design are well established because they have been considered as part of the NRC's reactor design-certification process. Potential consequences of DBAs are evaluated following procedures outlined in regulatory guides and standard review plans. The potential consequences of accidental releases depend on the specific radionuclides released, the amount of each radionuclide released, and the meteorological conditions. The source terms for the AP1000 reactor and methods for evaluating potential accidents are based on guidance in Regulatory Guide 1.183 (NRC 2000b).

For environmental reviews, consequences are evaluated assuming realistic meteorological conditions. Meteorological conditions are represented in these consequence analyses by an atmospheric dispersion factor, which is also referred to as relative concentration (χ/Q; units of s/m^3). Acceptable methods of calculating χ/Q for DBAs from meteorological data are set forth in Regulatory Guide 1.145 (NRC 1983).

Table 5-12 lists χ/Q values the NRC staff considers pertinent to the environmental review of DBAs for the Lee Nuclear Station. Smaller χ/Q values are associated with greater dilution capability. The first column in Table 5-12 identifies the time periods and boundaries for which χ/Q and dose estimates are needed. For the EAB, the postulated DBA dose and its atmospheric dispersion factor are calculated for a short-term period (i.e., 2 hours). For the low-population zone (LPZ), they are calculated for the course of the accident (i.e., 30 days composed of four time periods). The second column in Table 5-12 lists the corresponding χ/Q values for the Lee Nuclear Station site (Duke 2013c); these values were calculated using

2 years of onsite meteorological data (December 1, 2005, to November 30, 2007) assuming a 448-ft release boundary around each reactor. The values listed in Table 5-12 represent the highest χ/Qs for a given time period selected from the individual analyses for the proposed Units 1 and 2. Credit was taken for enhanced dispersion due to building wake effects. The NRC staff completed an independent evaluation of the χ/Q values and found similar results.

Table 5-12. Atmospheric Dispersion Factors for Lee Nuclear Station Site DBA Calculations

Time Period and Boundary	χ/Q (s/m^3)
0 to 2 hr, exclusion area boundary	8.30×10^{-5}
0 to 8 hr, low-population zone	8.80×10^{-6}
8 to 24 hr, low-population zone	7.51×10^{-6}
1 to 4 d, low-population zone	5.33×10^{-6}
4 to 30 d, low-population zone	3.25×10^{-6}
Source: Duke 2013c	

Table 5-13 lists the set of DBAs considered by Duke and presents estimates of the environmental consequences of each accident in terms of total effective dose equivalent (TEDE). TEDE is estimated by the sum of the committed effective dose equivalent from inhalation and the deep dose equivalent from external exposure. Dose conversion factors from Federal Guidance Report 11 (Eckerman et al. 1988) were used to calculate the committed effective dose equivalent. Similarly, dose conversion factors from Federal Guidance Report 12 (Eckerman and Ryman 1993) were used to calculate the deep dose equivalent.

The NRC staff reviewed Duke's selection of DBAs by comparing the accidents listed in the application with the DBAs considered in the AP1000 DCD. The DBAs in Duke's ER are the same as those considered in Revision 17 (Westinghouse 2008) and also Revision 19 of the DCD (Westinghouse 2011). The NRC concludes that the set of DBAs in Duke's ER is appropriate.

The review criteria used in the NRC's safety review of DBA doses are included in Table 5-13 to illustrate the magnitude of the calculated environmental consequences (TEDE doses) because no environmental criteria exist related to potential consequences of DBAs. In all cases, the calculated TEDE values are considerably smaller than those used as safety review criteria.

The NRC reviewed the DBA analysis in Duke's ER, which is based on analyses performed for design certification of Revision 17 of the AP1000 reactor design with adjustments for site-specific characteristics at the Lee Nuclear Station. The NRC staff also performed an independent DBA analysis with consideration of both Revision 17 and Revision 19 of the AP1000 DCD. The results of the Duke and NRC staff analyses indicate that the environmental risks associated with DBAs from an AP1000 reactor built at the Lee Nuclear Station site would be small. On this basis, the staff concludes that the environmental consequences of DBAs at the Lee Nuclear Station site would be SMALL for an AP1000 reactor.

Table 5-13. Design Basis Accident Doses for a Lee Nuclear Station AP1000 Reactor

Accident	Standard Review Plan Section[(b)]	TEDE in rem[(a)]		
		EAB[(c)]	LPZ[(d)]	Review Criterion
Main steam line break	15.1.5			
Pre-existing iodine spike		8.3×10^{-2}	1.6×10^{-2}	$2.5 \times 10^{+1}$(e)
Accident-initiated iodine spike		9.1×10^{-2}	4.6×10^{-2}	$2.5 \times 10^{+0}$(f)
Steam generator rupture	15.6.3			
Pre-existing iodine spike		1.8×10^{-1}	2.2×10^{-2}	$2.5 \times 10^{+1}$(e)
Accident-initiated iodine spike		9.1×10^{-2}	1.5×10^{-2}	$2.5 \times 10^{+0}$(f)
Loss-of-coolant accident	15.6.5	$4.0 \times 10^{+0}$	9.4×10^{-1}	$2.5 \times 10^{+1}$(e)
Rod ejection	15.4.8	3.0×10^{-1}	1.0×10^{-1}	$6.25 \times 10^{+0}$(f)
Reactor coolant pump rotor seizure (locked rotor)	15.3.3			
No feedwater		6.6×10^{-2}	6.8×10^{-3}	$2.5 \times 10^{+0}$(f)
Feedwater available		5.0×10^{-2}	1.4×10^{-2}	$2.5 \times 10^{+0}$(f)
Failure of small lines carrying primary coolant outside containment	15.6.2	1.7×10^{-1}	1.8×10^{-2}	$2.5 \times 10^{+0}$(f)
Fuel handling	15.7.4	4.3×10^{-1}	4.6×10^{-2}	$6.25 \times 10^{+0}$(f)

Source: Duke 2013c
(a) To convert rem to Sv, divide by 100.
(b) NUREG-0800 (NRC 2007c).
(c) EAB = exclusion area boundary.
(d) LPZ = low-population zone.
(e) 10 CFR 52.79 (a)(1) and 10 CFR 100.21 criteria.
(f) Standard Review Plan 15.0.3 criterion (NRC 2007c).

5.11.2 Severe Accidents

In its ER (Duke 2009c), Duke considers the potential consequences of severe accidents for an AP1000 reactor at the Lee Nuclear Station site. Three pathways are considered: (1) the atmospheric pathway in which radioactive material is released to the air; (2) the surface-water pathway in which airborne radioactive material falls out on open bodies of water; and (3) the groundwater pathway in which groundwater is contaminated by a basemat melt-through with subsequent contamination of surface water by the groundwater.

Duke's consequence assessment is based on the probabilistic risk assessment (PRA) for Revision 15 of the AP1000 design (Westinghouse 2005), which is certified in 10 CFR Part 52,

Appendix D. Westinghouse subsequently upgraded and updated the PRA model; however, Westinghouse reviewed the AP1000 probabilistic risk assessment for Revision 15 and concluded that the PRA remains valid for proposed revisions to the DCD (Westinghouse 2010b). The NRC staff evaluated the current PRA model and its results using "Probabilistic Risk Assessment Information to Support Design Certification and Combined License Applications" (DC/COL-ISG-3; NRC 2008g), and concluded that the Revision 15 results remain conservative and are an acceptable basis for evaluating severe accidents and strategies for mitigating them. Duke is required by regulation to upgrade and update the PRA prior to fuel loading. At that time, the NRC staff expects the PRA to be site-specific and that it will no longer use the bounding assumptions of the design-specific PRA.

Duke's (Duke 2009c) evaluation of the potential environmental consequences for the atmospheric and surface-water pathways incorporates the results of the MELCOR Accident Consequence Code System (MACCS2) computer code Version 1.12 (Chanin and Young 1998) run using AP1000 reactor source-term information and Lee Nuclear Station site-specific meteorological, population, and land-use data. Duke provided the NRC staff with copies of the input and output files for the MACCS2 computer runs (Duke 2008h). The NRC staff reviewed the files, ran confirmatory calculations, and determined that Duke's results are reasonable.

The MACCS computer codes were developed to evaluate the potential offsite consequences of severe accidents for the sites covered by NUREG-1150 (NRC 1990). The MACCS2 codes evaluate the consequences of atmospheric releases of material after a severe accident. The pathways modeled include exposure to the passing plume, exposure to material deposited on the ground and skin, inhalation of material in the passing plume and re-suspended from the ground, and ingestion of contaminated food and surface water.

Three types of severe accident consequences were assessed in the MACCS analysis: (1) human health, (2) economic costs, and (3) land area affected by contamination. Human health effects are expressed in terms of the number of cancers that might be expected if a severe accident were to occur. These effects are directly related to the cumulative radiation dose received by the general population. MACCS2 estimates both early fatalities and latent cancer fatalities. Early fatalities are related to high doses or dose rates and can be expected to occur within a year of exposure (Jow et al. 1990). Latent fatalities are related to exposure of a large number of people to low doses and dose rates and can be expected to occur after a latent period of several (2 to 15) years. Population health-risk estimates are based on the population distribution within a 50-mi radius of the site. Economic costs of a severe accident include costs associated with short-term relocation of people; decontamination of property and equipment; interdiction of food supplies, land, and equipment use; and condemnation of property. The affected land area is a measure of the areal extent of the residual contamination following a severe accident. Farmland decontamination is an estimate of the area that has an average whole body dose rate for the 4-year period following the release that would be greater than

0.5 rem/year if not reduced by decontamination and that would have a dose rate following decontamination of less than 0.5 rem/year. Decontaminated land is not necessarily suitable for farming.

Risk is the product of the frequency and the consequences of an accident. For example, the probability of a severe accident without loss of containment for an AP1000 reactor at the Lee Nuclear Station is estimated to be 2.2×10^{-7}/ Ryr, and the cumulative population dose associated with a severe accident without loss of containment at the site is calculated to be 5.2×10^{3} person-rem (Duke 2009c). The population dose risk for this class of accidents is the product of 2.2×10^{-7}/Ryr and 5.2×10^{3} person-rem, or 1.2×10^{-3} person-rem/Ryr. The following sections discuss the estimated risks associated with each pathway.

The risks presented in the tables that follow are risks per year of reactor operation. Duke indicated that the Lee Nuclear Station site will have two AP1000 reactors. The consequences of a severe accident would be the same regardless of whether one or two AP1000 reactors were built at the Lee Nuclear Station site. If two AP1000 reactors were built, the risks would apply to each reactor, and the total risk for reactors at the site would be double the risk for a single reactor. A discussion of these risks is presented in the following sections.

5.11.2.1 Air Pathway

The MACCS2 code directly estimates consequences of releases to the air pathway. The risk calculated from the results of the MACCS2 runs are presented in Table 5-14. The core damage frequencies (CDFs) given in the following tables are for internally initiated accident sequences while the plant is at power. Internally initiated accident sequences include sequences that are initiated by human error, equipment failures, loss of offsite power, etc. Estimates of the CDFs for externally initiated events and during shutdown are discussed later.

Table 5-14 shows that the probability-weighted consequences (i.e., risks) of severe accidents for an AP1000 reactor located on the Lee Nuclear Station site are small for all risk categories considered. For perspective, Table 5-15 and Table 5-16 compare the health risks from severe accidents for an AP1000 reactor at the Lee Nuclear Station site with the risks for current-generation reactors at various sites and with health risks for AP1000 reactors at the North Anna, Clinton, Grand Gulf, and Vogtle sites.

In Table 5-15, the health risks estimated for an AP1000 reactor at the Lee Nuclear Station site are compared with health-risk estimates for the five reactors considered in NUREG-1150 (NRC 1990). Although risks associated with both internally and externally initiated events were considered for the Peach Bottom and Surry reactors in NUREG-1150, only internally initiated events are presented in Table 5-16. Table 5-16 also compares the health risks of an AP1000 reactor at the Lee Nuclear Station site with the health risks of an AP1000 reactor at four early-site-permit sites (Duke 2009c; NRC 2006a, b, c, 2008c).

Table 5-14. Mean Environmental Risks from an AP1000 Reactor Severe Accident at the Lee Nuclear Station Site

	Release Category Description (Accident Class)	Core Damage Frequency (per Ryr)	Environmental Risk					
			Population Dose (person-rem/Ryr)[(a)]	Fatalities (per Ryr)		Cost[(d)] ($/Ryr)	Farm Land Decontamination[(e)] (ha/Ryr)	Population Dose from Water Ingestion (person-rem/Ryr)[(a)]
				Early[(b,f)]	Latent[(c)]			
IC	Intact containment	2.2×10^{-7}	1.2×10^{-3}	0.0	5.6×10^{-7}	0.97	1.1×10^{-5}	3.3×10^{-6}
BP	Containment bypass, fission products released directly to environment	1.1×10^{-8}	3.6×10^{-2}	5.5×10^{-10}	2.4×10^{-5}	118.00	9.1×10^{-4}	1.3×10^{-3}
CI	Containment isolation failure occurs prior to onset of core damage	1.3×10^{-9}	1.7×10^{-3}	0.0	1.4×10^{-6}	4.30	5.9×10^{-5}	3.6×10^{-5}
CFE	Early containment failure, after onset of core damage but before core relocation	7.5×10^{-9}	1.4×10^{-2}	0.0	7.9×10^{-6}	31.00	4.0×10^{-4}	2.0×10^{-4}
CFI	Intermediate containment failure, after core relocation but before 24 hr	1.9×10^{-10}	2.9×10^{-4}	0.0	2.4×10^{-7}	0.90	8.2×10^{-6}	3.7×10^{-6}
CFL	Late containment failure occurring after 24 hr	3.5×10^{-13}	7.9×10^{-7}	0.0	1.1×10^{-9}	0.004	2.3×10^{-8}	8.4×10^{-10}
Total		2.4×10^{-7}	5.3×10^{-2}	5.5×10^{-10}	3.4×10^{-5}	155.17	1.4×10^{-3}	1.5×10^{-3}

(a) To convert person-rem to person-Sv, divide by 100.
(b) Early fatalities are fatalities related to high doses or dose rates that generally can be expected to occur within a year of the exposure (Jow et al. 1990).
(c) Latent fatalities are fatalities related to low doses or dose rates that can be expected to occur after a latent period of several (2 to 15) years.
(d) Cost risk includes costs associated with short-term relocation of people, decontamination, interdiction, and condemnation. It does not include costs associated with health effects (Jow et al. 1990).
(e) Land risk is an area where the average whole body dose rate for the 4-yr period following the accident exceeds 0.5 rem/yr but can be reduced to less than 0.5 rem/yr by decontamination.
(f) The NRC staff examined the early fatalities for the Lee Nuclear Station site using both a two-plume and four-plume segment model for MACCS2. The values listed are for the four-plume segment model.

Table 5-15. Comparison of Environmental Risks for an AP1000 Reactor at the Lee Nuclear Station Site with Risks for Current-Generation Reactors at Five Sites Evaluated in NUREG-1150 and for the AP1000 Reactor at Four Sites

	Core Damage Frequency (per Ryr)	50-mi Population Dose Risk (person-rem/Ryr)[a]	Fatalities per Ryr		Average Individual Fatality Risk (per Ryr)	
			Early	Latent	Early	Latent Cancer
Grand Gulf[b]	4.0×10^{-6}	5×10^{1}	8×10^{-9}	9×10^{-4}	3×10^{-11}	3×10^{-10}
Peach Bottom[b]	4.5×10^{-6}	$7 \times 10^{+2}$	2×10^{-8}	5×10^{-3}	5×10^{-11}	4×10^{-10}
Sequoyah[b]	5.7×10^{-5}	$1 \times 10^{+3}$	3×10^{-5}	1×10^{-2}	1×10^{-8}	1×10^{-8}
Surry[b]	4.0×10^{-5}	$5 \times 10^{+2}$	2×10^{-6}	5×10^{-3}	2×10^{-8}	2×10^{-9}
Zion[b]	3.4×10^{-4}	$5 \times 10^{+3}$	4×10^{-5}	2×10^{-2}	9×10^{-9}	1×10^{-8}
AP1000[c] Reactor at the Lee Nuclear Station site	2.4×10^{-7}	5.3×10^{-2}	5.5×10^{-10}	3.4×10^{-5}	0.0	3.0×10^{-11}
AP1000[d] Reactor at North Anna	2.4×10^{-7}	8.3×10^{-2}	1.2×10^{-10}	4.0×10^{-5}	2.6×10^{-13}	4.9×10^{-11}
AP1000[e] Reactor at Clinton	2.4×10^{-7}	2.2×10^{-2}	1.4×10^{-8}	1.2×10^{-5}	6.4×10^{-13}	5.5×10^{-11}
AP1000[f] Reactor at Grand Gulf	2.4×10^{-7}	1.4×10^{-2}	$< 1.0 \times 10^{-12}$	6.9×10^{-6}	$<1.0 \times 10^{-14}$	2.0×10^{-11}
AP1000[g] Reactor at the Vogtle Electric Generating Plant site	2.4×10^{-7}	2.8×10^{-2}	1.9×10^{-10}	1.9×10^{-5}	1.6×10^{-12}	1.1×10^{-11}

(a) To convert person-Sv to person-rem, multiply by 100.
(b) Risks were calculated using the MACCS code and presented in NUREG-1150 (NRC 1990).
(c) Calculated with MACCS2 code using Lee Nuclear Station site-specific input.
(d) NUREG-1811 (NRC 2006a).
(e) NUREG-1815 (NRC 2006b).
(f) NUREG-1817 (NRC 2006c).
(g) NUREG-1872 (NRC 2008h).

Table 5-16. Comparison of Environmental Risks from Severe Accidents Initiated by Internal Events for an AP1000 Reactor at the Lee Nuclear Station Site with Risks Initiated by Internal Events for Current Nuclear Power Plants Undergoing Operating License Renewal Review and Environmental Risks of the AP1000 Reactor at Other Sites

	Core Damage Frequency (per Ryr)	**50-mi Population Dose Risk (person-rem/Ryr)[a]**
Current Reactor Maximum[b]	2.4×10^{-4}	6.9×10^{1}
Current Reactor Mean[b]	2.7×10^{-5}	1.6×10^{1}
Current Reactor Median[b]	1.6×10^{-5}	1.3×10^{1}
Current Reactor Minimum[b]	1.9×10^{-6}	3.4×10^{-1}
AP1000[c] Reactor at Lee	2.4×10^{-7}	5.3×10^{-2}
AP1000[d] Reactor at North Anna	2.4×10^{-7}	8.3×10^{-2}
AP1000[e] Reactor at Clinton	2.4×10^{-7}	2.2×10^{-2}
AP1000[f] Reactor at Grand Gulf	2.4×10^{-7}	1.4×10^{-2}
AP1000[g] Reactor at Vogtle	2.4×10^{-7}	2.8×10^{-2}

(a) To convert person-Sv to person-rem, multiply by 100.
(b) Based on MACCS and MACCS2 calculations for over 70 current plants at over 40 sites.
(c) Calculated with MACCS2 code using Lee Nuclear Station site-specific input.
(d) NUREG-1811 (NRC 2006a).
(e) NUREG-1815 (NRC 2006b).
(f) NUREG-1817 (NRC 2006c).
(g) NUREG-1872 (NRC 2008h).

The last two columns of Table 5-15 provide average individual fatality risk estimates. To put these estimates into context for the environmental analysis, the staff compares these estimates to the safety goals. The Commission has set safety goals for average individual early fatality and latent cancer fatality risks from reactor accidents in the Safety Goal Policy Statement (51 FR 30028). These goals are presented here solely to provide a point of reference for the environmental analysis and do not serve the purpose of a safety analysis. The Safety Goal Policy Statement expressed the Commission's policy regarding the acceptance level of radiological risk from nuclear power plant operation as follows:

- Individual members of the public should be provided a level of protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and health.
- Societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks.

Operational Impacts at the Lee Nuclear Station Site

The following quantitative health objectives are used in determining achievement of the safety goals:

- The risk to an average individual in the vicinity of a nuclear power station of prompt fatalities that might result from reactor accidents should not exceed 0.1 of 1 percent (0.1 percent) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed.
- The risk to the population in the area near a nuclear power station of cancer fatalities that might result from nuclear power plant operation should not exceed 0.1 of 1 percent (0.1 percent) of the sum of cancer fatality risks resulting from all other causes.

These quantitative health objectives are translated into two numerical objectives as follows:

- The individual risk of a prompt fatality from all "… other accidents to which members of the U.S. population are generally exposed…." is about 4.0×10^{-4}/yr, including a 1.3×10^{-4}/yr risk associated with transportation accidents (NSC 2010). One-tenth of 1 percent of these figures implies that the individual risk of prompt fatality from a reactor accident should be less than 4.0×10^{-7}/Ryr.
- "The sum of cancer fatality risks that result from all other causes" for an individual is taken to be the U.S. cancer fatality rate, which is about 1 in 500 or 2×10^{-3}/yr (Reed 2007). One-tenth of 1 percent of this implies the risk of cancer to the population in the area near a nuclear power plant from its operation should be limited to 2×10^{-6}/Ryr.

MACCS2 calculates average individual early and latent cancer fatality risks. The average individual early fatality risk is calculated using the population distribution within 1 mi of the plant boundary. The average individual latent cancer fatality risk is calculated using the population distribution within 10 mi of the plant. For the plants considered in NUREG-1150, these risks were well below the Commission's safety goals. Risks calculated by Duke for the AP1000 reactor design at the Lee Nuclear Station site are also well below the Commission's safety goals.

The NRC staff compared the CDF and population dose risk estimate for an AP1000 reactor at the Lee Nuclear Station site with statistics summarizing the results of contemporary severe accident analyses performed for over 70 reactors at over 40 sites. The results of these analyses are included in the final site-specific Supplements 1 through 49 to the GEIS for license renewal (NRC 2013a), and in the ERs included with license renewal applications for the plants for which supplements have not been published. All of the analyses were completed after publication of NUREG-1150 (NRC 1990), and the analyses for most of the reactors used MACCS2, which was released in 1997. Table 5-16 shows that the CDFs estimated for the AP1000 reactor are significantly lower than those for current-generation reactors. Similarly, the population doses estimated for an AP1000 reactor at the Lee Nuclear Station site are well below the mean and median values for current-generation reactors undergoing license renewal.

Finally, the population dose risk from a severe accident for an AP1000 reactor at the Lee Nuclear Station site, 5.3×10^{-2} person-rem/Ryr, may be compared with the dose risk for normal operation of a single AP1000 reactor at the Lee Nuclear Station site (4.79 person-rem/Ryr; see Section 5.9.3.2); comparatively, the population dose risk for a severe accident is small.

5.11.2.2 Surface-Water Pathway

Surface-water pathways are an extension of the air pathway. These pathways cover the effects of radioactive material deposited on open bodies of water and include the ingestion of water and aquatic foods as well as water submersion and activities occurring near the water. Of these surface-water pathways, the ingestion of contaminated water was evaluated by the MACCS2 codes. The risks associated with this pathway were calculated for the Lee Nuclear Station and are included in the last column of Table 5-14. The water-ingestion dose risk of 1.5×10^{-3} person-rem/Ryr is small compared to the total population dose risk of 5.3×10^{-2} person-rem/Ryr (Duke 2009c).

Although surface-water pathways beyond water ingestion are not considered in the MACCS2 code, they have been examined in the GEIS for license renewal in the context of renewal of licenses for current-generation reactors (NRC 2013a). The Lee Nuclear Station, which would be situated near the Broad River, can be classified as a small-river site. Table 5.17 in the GEIS indicates that, at small-river sites, water ingestion is the dominant liquid pathway rather than seafood ingestion and shoreline exposure (NRC 1996). In addition, if a severe accident occurred at the Lee Nuclear Station site, it is likely that Federal, State, and local officials would restrict access to the river below the site and in contaminated areas above the site thereby greatly reducing these surface-water pathway exposures. On this basis, the NRC staff believes that the overall surface-water pathway risk remains small when compared to the total population dose risk.

5.11.2.3 Groundwater Pathway

The groundwater pathway involves a reactor core melt, reactor vessel failure, and penetration of the floor (basemat) below the reactor vessel. Ultimately, core debris reaches groundwater where soluble radionuclides are transported with the groundwater. In the GEIS for license renewal (NRC 2013a), the NRC staff assumed that the probability of a severe accident with basemat penetration was 1×10^{-4}/Ryr and concluded that the groundwater-pathway risks were small. The Duke ER summarizes the discussion in the 1996 version of NUREG-1437 (NRC 1996) and reaches the same conclusion.

The NRC staff has re-evaluated its assumption of a 1 × 10^{-4}/Ryr probability of a basemat melt-through. The NRC staff believes that the 1 × 10^{-4} probability is too large for new power stations. Design elements have been included in the AP1000 design to minimize the potential for reactor core debris to reach groundwater. These elements include external reactor vessel cooling and ex-vessel core debris cooling. Further, the probability of core melt with a basemat melt-through should be no larger than the total CDF estimate for the reactor. Table 5-16 gives a total CDF estimate of 2.4 × 10^{-7}/Ryr for the AP1000 reactor. NUREG-1150 (NRC 1990) indicates that the conditional probability of a basemat melt-through ranges from 0.05 to 0.25 for current-generation reactors. If the CDF for AP1000 severe accidents in which containment remains intact are subtracted from the total AP1000 CDF to get the CDF for severe accidents in which basemat melt-through is a possibility, the CDF is on the order of 2 × 10^{-8}/Ryr. On this basis, the staff believes that a basemat melt-through probability of 2 × 10^{-8}/Ryr is reasonable and still conservative. The groundwater pathway is also more tortuous and affords more time for implementing protective actions than the air pathway and, therefore, results in a lower risk to the public. As a result, the NRC staff concludes that the risks associated with releases to groundwater are sufficiently small that they would not have a significant effect on the overall plant risk.

5.11.2.4 Externally Initiated Events

The analyses described above are specifically for internally initiated events. Duke's ER also addresses potential consequences from externally initiated events (Duke 2009c). The AP1000 reactor vendor and the NRC have addressed three externally initiated events during initial design certification of the AP1000 reactor: (1) seismic, (2) internal fire, and (3) internal flooding events. The results of these analyses are described in Section 19.1.5 of the FSER for Revision 15 of the AP1000 DCD (NRC 2004b). While amending the certified design, the seismic hazard was re-evaluated and the seismic margin analysis was revised. The results are described in Revision 19 of the AP1000 design certification document (Westinghouse 2011). The NRC staff's evaluation is documented in Section 19.55 of Supplement 2 to the AP1000 FSER (NRC 2011g). In addition, high winds, external flooding, transportation-related events, and potential hazards from nearby industrial facilities were assessed. The NRC staff's evaluation is documented in Section 19.58 of the same supplement.

With respect to seismic events, the AP1000 reactor vendor performed a PRA-based seismic margin analysis. The analysis results indicated that there is high confidence (95 percent) that safety systems and components would survive 0.5-g peak acceleration during a seismic event. The safe-shutdown earthquake for the AP1000 reactor design is 0.3 g. Consequently, the NRC staff concluded in the FSER that the AP1000 reactor design is acceptable (NRC 2004b). After re-evaluating the seismic hazard for the amended design and for a spectrum of site characteristics ranging from soft soil to hard rock and updating the PRA-based seismic margin analysis, Duke reported the same results for the amended design. Consequently, the NRC staff concluded that the amended design is acceptable (NRC 2011g).

With respect to internal fires, the AP1000 reactor vendor estimated the fire-induced CDFs to be about 5.6×10^{-8} yr^{-1} during power operation and about 8×10^{-8} yr^{-1} during shutdown, and considers these estimates to be conservative. While the NRC staff believes that such a conclusion is not possible without a detailed PRA, the NRC staff, in its safety review, concluded that the AP1000 reactor design is capable of withstanding severe accident challenges from internal fires in a manner superior to most, if not all, operating plant designs (NRC 2004b).

With respect to internal flooding, the AP1000 reactor vendor did not perform a detailed PRA to assess the risk from internal flooding. Instead, the vendor performed an internal flooding PRA commensurate with the level of detail available and where detailed information was not available, made conservative assumptions to bound the flooding analysis. In its safety review, the NRC staff found that this analysis was adequate to identify potential vulnerabilities and to lend insight into the design that could be used to support design-certification requirements. Quantification of potential scenarios with the plant at power resulted in a total CDF from internal floods of about 1×10^{-9} yr^{-1}. The CDF from internal floods when the power station is shutdown is estimated to be about 3.2×10^{-9} yr^{-1}. The vendor considers these estimates to be conservative. While the NRC staff believes that such a conclusion is not possible without a detailed PRA, the NRC staff, in its safety review, concluded that the AP1000 reactor design is capable of withstanding severe accident challenges from internal floods in a manner superior to operating plants and is consistent with the conclusions from the vendor's internal flood risk analysis (NRC 2004b).

With respect to high winds, the AP1000 reactor vendor considered extratropical cyclones, hurricanes up to Category 5 on the Saffir-Simpson scale, and tornadoes up to EF5 on the enhanced Fujita scale. For hurricanes and tornadoes, the vendor assumed event frequencies that also bound the corresponding frequencies at the Lee Nuclear Station site. The total contribution of high winds to CDF was reported to be 1.38×10^{-8} yr^{-1}, assuming that only safety systems are available. The NRC staff concluded that, for the Lee Nuclear Station site, the contribution to CDF attributable to high winds is bounded by the contribution reported for the certified design (NRC 2011g).

With respect to external flooding, the AP1000 reactor vendor considered all sources of flooding that could occur at any site and concluded that, as long as floodwaters did not rise to the level of the plant grade, there would be no contribution to CDF. The plant grade at the Lee Nuclear Station site is higher than any floodwaters could reach, even considering maximum precipitation in relevant watersheds, coincident dam failure, and wind-driven wave action. The NRC staff concludes that external flooding has negligible consequences at the Lee Nuclear Station site (NRC 2011g).

With respect to risk from accidents related to transportation and nearby industrial activities, the AP1000 reactor vendor addressed aviation, marine and nearby industrial facilities, pipelines, as well as railroad and truck accidents.

For the frequency of accidental impact by commercial aircraft, the AP1000 reactor vendor assumed that such impacts are of negligible frequency. For general aviation, the frequency of accidental impact was assumed to be higher, but the contribution to CDF is negligible. For the Lee Nuclear Station site, the expected frequency of accidental impact was shown to be less than the frequencies assumed by the vendor. The NRC staff concluded that the risk from accidental aircraft impact on the Lee Nuclear Station site was bounded by the risk reported generically (NRC 2011g).

For marine and nearby facility accidents, the AP1000 reactor vendor considered two hazards: (1) release of hazardous material and (2) explosion. There is no commercial traffic on the Broad River, so marine accidents are not applicable to the Lee Nuclear Station site. In addition, hazardous materials in sufficient quantity to affect control room habitability are not stored within 5 mi of the plant, including materials stored onsite. The NRC staff concluded that marine transportation accidents and accidents in nearby facilities would occur at negligible frequency at the Lee Nuclear Station site (NRC 2011g).

For pipeline accidents, the AP1000 reactor vendor assumed rupture of a 30-in. gas pipe, 5800 ft from the plant and demonstrated that the probability of such a rupture, formation of a flammable gas cloud, transportation to the site without dispersion, and ignition at a location that would challenge plant safety is less than 1×10^{-7} yr^{-1}. Site habitability was also considered even though no operator action is required to prevent core damage. With advanced warning, operators can actuate a passive system for ensuring control room habitability, raising control room pressure above atmospheric and preventing the intrusion of toxic substances. There are no pipelines of comparable size within 5 mi of the Lee Nuclear Station site. The NRC staff concluded that risk from pipelines near the Lee Nuclear Station site was bounded by the risk reported generically (NRC 2011g).

For rail accidents, the safe standoff distance was computed and found to be less than the distance from the Lee Nuclear Station site boundary to the nearest railway. Similarly, for accidents involving a truck, the safe standoff distance is less than the distance from the site boundary to the nearest highway. These accidents would have negligible consequence to the plant. The NRC staff concluded that these accidents do not contribute to the risk of core damage (NRC 2011g).

5.11.2.5 Summary of Severe Accident Impacts

The Duke application refers to proposed Revision 17 of the AP1000 reactor certified design (10 CFR Part 52, Appendix D). The consequence assessment is based on the PRA for

Revision 15 of the AP1000 design (Westinghouse 2005), which is certified in 10 CFR Part 52, Appendix D. Westinghouse subsequently upgraded and updated the PRA; however, Westinghouse reviewed the AP1000 PRA report submitted with Revision 15 of the DCD and concluded that the reported results and insights remain valid for proposed revisions of the DCD (Westinghouse 2010b). The NRC staff evaluated the current PRA model and its results using DC/COL-ISG-3 (NRC 2008g), *Probabilistic Risk Assessment Information to Support Design Certification and Combined License Applic*ations, and concluded that the Revision 15 results remain conservative and are an acceptable basis for evaluating severe accidents and strategies for mitigating them. Duke is required by regulation to upgrade and update the PRA prior to fuel loading. At that time, the NRC staff expects the PRA to be site-specific and that it will no longer use the bounding assumptions of the design-specific PRA. The NRC staff considers it unlikely that the PRA would change sufficiently to cause the staff to materially change its conclusions related to severe accident risks.

The NRC staff reviewed the risk analysis in the ER and conducted a confirmatory analysis of the probability-weighted consequences of severe accidents for the proposed Lee Nuclear Station Units 1 and 2 using the MACCS2 code. The results of both the Duke analysis and the NRC evaluation indicate that the environmental risks associated with severe accidents if an AP1000 reactor were to be located at the Lee Nuclear Station site would be small compared with risks associated with operation of the current-generation reactors at other sites. These risks are below the NRC safety criteria. On these bases, the NRC staff concludes that the probability-weighted consequences of severe accidents at the Lee Nuclear Station site would be SMALL for an AP1000 reactor.

5.11.3 Severe Accident Mitigation Alternatives

The purpose of the evaluation of severe accident mitigation alternatives (SAMAs) is to determine whether there are severe accident mitigation design alternatives (SAMDAs), procedural modifications, or training activities that can be justified to further reduce the risks of severe accidents (NRC 2000b). Duke based its COL application on the AP1000 reactor design (see Appendix D of 10 CFR Part 52 – Design Certification Rule for the AP1000 Design), which incorporates many features intended to reduce severe accident CDFs and the risks associated with severe accidents. The effectiveness of the AP1000 reactor design features is evident in Table 5-14 and Table 5-15, which compare CDFs and severe accident risks for the AP1000 reactor with CDFs and risks for current-generation reactors. The CDFs and risks have generally been reduced considerably when compared to the existing current-generation reactors.

Consistent with the direction from the Commission to consider the SAMDAs at the time of certification, the AP1000 reactor vendor (Westinghouse 2005) and the NRC staff (NRC 2004b, 2005), considered a number of design alternatives for an AP1000 reactor at a generic site. The conclusion of the NRC staff's review was the following:

> "… none of the potential design modifications evaluated are justified on the basis of cost-benefit considerations. NRC further concludes that it is unlikely that any other design changes would be justified in the future on the basis of person-rem exposure because the estimated CDFs are very low on an absolute scale."

Westinghouse reviewed the AP1000 PRA for Revision 15 and concluded that the PRA remains valid for a proposed revision of the DCD (Westinghouse 2010b); this is unchanged for subsequent revisions through Revision 19 (Westinghouse 2011). Furthermore, the NRC staff evaluated the current PRA using DC/COL-ISG-3 (NRC 2008g), *Probabilistic Risk Assessment Information to Support Design Certification and Combined License Applications*, and concluded that the PRA submitted with Revision 15 is a conservative and acceptable basis for evaluating severe accidents and strategies for mitigating them. Therefore, the NRC considers the PRA for DCD Revision 15 to be an appropriate basis for a SAMDA analysis for an application referencing DCD Revision 19. Consequently, the NRC staff incorporates by reference the environmental assessment accompanying the design-certification rulemaking for Appendix D to 10 CFR Part 52 (NRC 2006a, b, c).

Section 5.11.2 presents the environmental risks from various classes of severe accidents for the Lee Nuclear Station site. Site-specific information appears in SAMDA evaluations as population dose risk (person-rem/Ryr) and offsite economic costs ($/Ryr). The NRC staff considers these two elements to be the appropriate metrics to use to determine whether the site characteristics are bounded by the site parameters because they are calculated from the site-specific meteorology, population distribution, and land-use data. Appendix 1B of the AP1000 DCD lists the population dose risk (person-rem/Ryr) used in the DCD generic SAMDA review. While it does not list the offsite economic costs, it does include a maximum attainable benefit that considers offsite economic costs, onsite exposure costs, onsite cleanup costs, and replacement power costs, in addition to the cost associated with the offsite population dose risk. To perform a like-kind comparison, the NRC staff used the maximum attainable benefit-cost for the Lee Nuclear Station site. The DCD probability-weighted, mean population dose risks from Table 1B-1 in Appendix 1B and the base-case maximum attainable benefit listed in Table 1B-4 are the metrics used by the NRC staff to determine whether the Lee Nuclear Station site characteristics are within the site parameters specified in Appendix 1B of the AP1000 DCD.

Table 5-17 presents the comparison of Lee Nuclear Station site-specific values (Duke 2009c) with the generic values from Appendix 1B of the AP1000 DCD (Westinghouse 2011). Table 5-17 shows that the population dose risk for the Lee Nuclear Station site is about 23 percent larger than the DCD Appendix 1B value, while the maximum attainable benefit for the Lee Nuclear Station site is only about 51 percent of the DCD Appendix 1B value. The NRC staff examined the sensitivity of the maximum attainable benefit at the Lee Nuclear Station site to a higher plant capacity factor in replacement power costs; the NRC staff concluded that although the maximum attainable benefit would be higher, it would still be less than the DCD Appendix 1B value.

Table 5-17. Comparison of the Lee Nuclear Station Site SAMDA Characteristics with Parameters Specified in Appendix 1B of the AP1000

	Population Dose Risk, person-rem/Ryr	Maximum Attainable Benefit
DCD Appendix 1B (internal events)	4.3×10^{-2}	\$21,000
Lee Nuclear Station site (internal events)	5.3×10^{-2}	\$10,700
Lee Nuclear Station site risk as fraction of DCD risk	123%	51%

The generic AP1000 SAMDA analysis is presented in Appendix 1B of the DCD (Westinghouse 2011). Design alternatives considered by Westinghouse and their estimated implementation costs are presented in Table 5-18 (Westinghouse 2011, Table 1B-5). In the base-case analysis, the benefit-cost methodology of NUREG/BR-0184 (NRC 1997) is used to calculate the maximum attainable benefit. The analysis assumes that the implementation of the design alternative completely eliminates all potential for core damage. For the AP1000, the maximum attainable benefit was valued at \$21,000 (Westinghouse 2011, Appendix 1B, Section 1B.1.8). Only one design alternative identified in Table 5-18—the self-actuating containment isolation valves—has a cost (\$33,000) comparable to the maximum attainable benefit. To evaluate the benefit of this SAMDA, the design change was assumed to eliminate the containment isolation severe accident release category, which is only a small contributor to the total CDF. Therefore, this design alternative provides almost no benefit in reducing the AP1000 CDF.

Table 5-18. Design Alternatives Considered for SAMDA in the AP1000 DCD

No.	Design Alternative	Cost (\$)
1	Upgrade chemical, volume, and control system for small loss-of-coolant accident	1,500,000
2	Containment filtered vent	5,000,000
3	Self-actuating containment isolation valves	33,000
4	Safety grade passive containment spray	3,900,000
6	Steam generator shell-side heat removal	1,300,000
7	Steam generator relief flow to in-containment refueling water storage tank (IRWST)	620,000
8	Increased steam generator pressure capability	8,200,000
9	Secondary containment ventilation with filtration	2,200,000
10	Diverse IRWST injection valves	570,000
12	Ex-vessel core catcher	1,660,000
13	High-pressure containment design	50,000,000
14	More reliable diverse actuation system	470,000

Source: Westinghouse 2011, Table 1B-5

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The Duke ER updates the SAMDA analysis conducted for AP1000 design certification using the results of the Lee Nuclear Station site-specific consequence analysis (MACCS2) discussed in Section 7.2 of the ER and Section 5.2 of this EIS. The results of the Duke analysis indicate that the maximum potential benefit if the total risk for the Lee Nuclear Station could be reduced to zero has a value of about $10,700. Similar to the finding in the AP1000 DCD SAMDA analysis, only the self-actuating containment isolation valves design alternative (Table 5-18) has a value comparable to the maximum attainable benefit for the Lee Nuclear Station site.

Table 5-14, which lists the mean environmental risks from an AP1000 reactor severe accident at the Lee Nuclear Station site, shows that the containment isolation severe accident category only contributes a small fraction to the total population dose and cost risk (approximately 3 percent each) at the Lee Nuclear Station site. Assuming that implementation of the self-actuating containment isolation valves completely eliminates the risks associated with this release category, then the value of the reduction in risk would only be approximately $321. Thus, the site-specific SAMDA review conducted by Duke confirms the results of the design-certification SAMDA review. Although the dose risk for the Lee Nuclear Station site exceeds the DCD value, the site-specific SAMDA analysis for the Lee Nuclear Station site shows that the resulting design alternative (self-actuating containment isolation valves) would only reduce this total risk by a small fraction. The next lowest cost design alternative has more than an order-of-magnitude higher cost than the self-actuating containment isolation valves. On this basis, the NRC staff concludes that, in fact, none of the potential design modifications are justified on the basis of benefit-cost considerations, and it is unlikely that any other design changes would be justified in the future on the basis of person-rem exposure because the estimated CDFs are very low on an absolute scale.

Duke is required by regulation to update the PRA prior to fuel loading. The NRC staff expects the PRA to be site-specific rather than use the bounding assumptions used for the design-specific PRA. The NRC staff considers it unlikely that the PRA would change sufficiently to cause the NRC staff to conclude that any SAMDA considered in the design certification process would become cost beneficial.

The SAMDA issue is a subset of the SAMA review. Duke has not yet addressed the other attributes of the SAMA review (i.e., procedural modifications and training activities). However, Duke has stated (Duke 2009c) that risk insights would be considered in the development of plant procedures and training. Because the maximum attainable benefit is so low, a SAMA based on procedures or training for an AP1000 reactor at the Lee Nuclear Station site would have to reduce the CDF or risk to near zero to become cost beneficial. Based on its evaluation, the NRC staff concludes that it is unlikely that any of the SAMAs based on procedures or training would reduce the CDF or risk that much. Therefore, the NRC staff further concludes it is unlikely that these SAMAs would be cost effective. In addition, based on statements by Duke in the ER (Duke 2009c), the NRC staff expects that Duke will consider risk insights in the development of procedures and training. However, this expectation is not crucial to the staff's conclusions because the staff already concluded procedural and training SAMAs would be unlikely to be cost effective. Therefore, the NRC staff concludes that SAMAs have been appropriately considered.

5.11.4 Summary of Postulated Accident Impacts

The NRC staff evaluated the environmental impacts from DBAs and severe accidents for an AP1000 reactor at the Lee Nuclear Station site. Based on the information provided by Duke and the NRC's own independent review, the NRC staff concludes that the potential environmental impacts (risks) from a postulated accident from the operation of the proposed Lee Nuclear Station Units 1 and 2 would be SMALL, and no further mitigation would be warranted.

5.12 Measures and Controls to Limit Adverse Impacts During Operation

In its evaluation of environmental impacts during operation of the proposed Lee Nuclear Station Units 1 and 2, the review team relied on Duke's compliance with the following measures and controls that would limit adverse environmental impacts:

- compliance with applicable Federal, State, and local laws, ordinances, and regulations intended to prevent or minimize adverse environmental impacts (e.g., solid waste management, erosion and sediment control, air emissions, noise control, stormwater management, spill response and cleanup, hazardous material management)
- compliance with applicable requirements of permits or licenses required for operation of the new units (e.g., Department of the Army Section 404 Permit, NPDES)
- implementation of BMPs.

The review team considered these measures and controls in its evaluation of the impacts of plant operation. Table 5-19 lists a summary of measures and controls to limit adverse impacts during operation proposed by Duke.

Table 5-19. Summary of Measures and Controls Proposed by Duke to Limit Adverse Impacts During Operation of Proposed Lee Nuclear Station Units 1 and 2

Impact Category	Specific Measures and Control
Land-use impacts	
The site and vicinity, including Make-Up Pond C	Operations are not expected to result in land-use changes.
Transmission-line corridors and offsite areas	Duke did not propose any additional measures or controls.
Historic properties and cultural resources	Implement Duke's corporate procedures as outlined in the Lee Nuclear Station site cultural resources management plan and associated MOA to protect known historic and cultural resources and halt work and contact the South Carolina SHPO and THPO(s), as appropriate, if a potential historic property or cultural resource is unexpectedly discovered.
	Ensure continued avoidance of potential human burial site (38CK172) during maintenance of transmission lines.
Water-related impacts	
Hydrologic Alterations and Plant Water Supply	Makeup water is primarily supplied by the Broad River. Under low-flow conditions, supplemental water can be transferred from Make-Up Pond B to Make-Up Pond A, or from Make-Up Pond C to Make-Up Pond B to Make-Up Pond A.
	Operate proposed Lee Nuclear Station Units 1 and 2 within the minimum release constraints of Ninety-Nine Islands Hydroelectric Project License (FERC).
	Prepare and maintain a stormwater pollution prevention plan (SWPPP) and comply with NPDES permit to minimize releases.
	Install multiport diffuser pipe to maximize thermal and chemical dissolution.
	Install riprap, stemwalls, or other erosional control devices to stabilize the banks.
	Refill Make-Up Ponds B and C from the Broad River only during non-low-flow conditions.
	Significant drawdown events of Make-Up Pond C are rare.
	Infrequent use/refill minimizes sediment deposition.

Table 5-19. (contd)

Impact Category	Specific Measures and Control
Water-use impacts	Operate the proposed Lee Nuclear Station Units 1 and 2 within the minimum release constraints of Ninety-Nine Islands Hydroelectric Project License (FERC).
	Makeup water is supplied onsite from Make-Up Pond B and Make-Up Pond C when flow in the Broad River is less than 483 cfs.
	Dilute blowdown with receiving water.
	Limit planned effluent discharges in compliance with an NPDES permit.
Water-quality impacts	Proposed Lee Nuclear Station Spill Prevention, Control, and Countermeasure Plan
	Prepare and maintain an SWPPP and an NPDES permit to minimize releases.
	Install multiport diffuser to maximize thermal and chemical mixing.
	Limit planned effluent discharges in compliance with CWA regulations (40 CFR Parts 100 and 400-501), Federal Water Pollution Control Act, and NPDES permit specifications.
	Monitor water discharges.
Cooling-system impacts	
Intake system	
Hydrodynamic descriptions and physical impacts	Stabilize banks of the embayment and shoreline with concrete mats, riprap, or other appropriate means.
	Periodically dredge intake as required.
Aquatic ecosystems	Use closed-cycle technology and cooling towers, size and design intake structures to ensure water velocity across screens is less than 0.5 fps. Use return systems to deposit impinged fish and other aquatic biota downstream of the Broad River intake and outside the influence of the Make-Up Pond A intake, respectively.
	Supply makeup water from Make-Up Pond B and Make-Up Pond C during low-flow conditions.
	Minimize drawdown events and refill Make-Up Ponds as soon as practicable.
	Use BMPs to minimize sediment loading during maintenance dredging activities.

Table 5-19. (contd)

Impact Category	Specific Measures and Control
Terrestrial ecosystems	Maximum drawdown events are rare; most drawdown events are less than 1 ft.
	Drawdowns that could temporarily affect existing wetlands around Make-Up Pond B and wetlands that could develop around Make-Up Pond C are rarer than most drawdown events which are less than 1 ft.
Discharge system	
Aquatic ecosystems	Use and strategically position a multiport diffuser to mitigate thermal impacts.
	To the extent practicable, employ and position equipment to reduce erosion or sedimentation effects.
	Treat effluents according to NPDES permit specifications.
	Use reactors' cooling towers and a closed-loop cooling cycle to significantly reduce the thermal plume effects on aquatic organisms.
Cooling towers	
Terrestrial ecosystems	Use drift eliminators to minimize cooling-tower drift.
	Train employees in Duke corporate Avian Protection Plan.
	Document bird mortalities and injuries through the FWS and SCDNR Migratory Bird Depredation Permits (MB000257-0 and MD-19-10, respectively).
Radiological impacts of normal operation	
Radiation doses to members of the public	Calculated radiation doses to members of the public within NRC and EPA standards (10 CFR Part 20, Appendix I of 10 CFR Part 50, and 40 CFR Part 190).
	Implement radiological effluent and environmental monitoring programs.
Impacts on biota other than members of the public	Calculated doses for biota are well within NCRP and IAEA guidelines.
	Implement REMP.
Occupational radiation doses	Estimated occupation doses are within NRC standards (10 CFR Part 20).
	Implement program to maintain occupational doses ALARA (10 CFR Part 20).

Table 5-19. (contd)

Impact Category	Specific Measures and Control
Environmental impact of waste	
Nonradioactive waste system impacts	All emissions and discharges comply with SCDHEC regulations and applicable air- and water-quality standards.
	Treat sanitary waste at an offsite municipal sewage-treatment plant.
	Carefully monitor and transfer hazardous waste to approved transporters and disposers.
	Dispose of nonhazardous nonradioactive waste according to applicable local, State, and Federal regulations.
Mixed-waste impacts	Limit mixed-waste generation through source reduction, recycling, and treatment options.
	Manage mixed-waste inventory in accordance with applicable NRC and EPA regulations.
	Maintain inventory of mixed waste in a designated storage area and monitor it prior to offsite disposal.
Waste minimization	Develop a hazardous waste minimization plan to address hazardous waste management, equipment maintenance, recycling and reuse, segregation, treatment, work planning, waste tracking, and awareness training.
Terrestrial ecosystems	Design, construct, and operate wastewater-treatment basins to minimize use by avifauna.
	Employ avian exclusion devices at wastewater-treatment basins.
Transmission and water-pipeline corridor impacts	
Terrestrial ecosystems	Implement procedures that minimize adverse impacts to wildlife and important habitats such as floodplains and wetlands from transmission-line and water-pipeline corridor maintenance.
	Minimize potential impacts (e.g., erosion and sedimentation) through compliance with permitting requirements and BMPs.
	Minimize avian electrocutions and collisions on transmission lines by following Avian Power Line Interaction Committee guidelines (e.g., minimal separation distances between conductors, nest platforms, diverters).
	Train employees in Duke corporate Avian Protection Plan.

Table 5-19. (contd)

Impact Category	Specific Measures and Control
	Document bird mortalities and injuries and disturbances of active nests through the FWS and SCDNR Migratory Bird Depredation Permits (MB000257-0 and MD-19-10, respectively).
	As practicable, vehicles/machinery use noise suppression/mufflers and vehicles are maintained to reduce emissions.
	Make spill response materials and trained personnel readily available to respond to, clean up, and report spills.
	Train employees in hazardous materials/waste procedures to minimize the risk of spills.
	Use trained, licensed employees to apply herbicides.
Aquatic ecosystems	Minimize potential impacts through compliance with permitting requirements and BMPs.
	To the extent feasible, avoid any additional disturbances on sensitive aquatic habitats/species.
	As practicable, reseed cleared areas to limit erosion.
	Apply appropriate erosion controls (grassed or wooded buffer strips, board roads, and removable mats). Obtain a permit before dredge or fill activities.
	Apply herbicides using proper management practices and trained employees who possess an herbicide application permit.
	Train employees in hazardous materials/waste procedures to minimize risk of spills.
Impacts on members of the public	Build lines to specifications minimizing electrocution (high enough to comply with 5 mA standard away from existing buildings).
	Retain natural vegetation at road and river crossings during construction to help minimize ground-level visual impacts unless engineering requirements dictate otherwise.
	Avoid Important viewsheds.
	No towers along the new transmission lines are expected to exceed 200 ft in height, nor are there any airports, airstrips, or heliports within 20,000 ft of the transmission-line corridors currently under review by Duke.

Table 5-19. (contd)

Impact Category	Specific Measures and Control
Socioeconomic impacts	
Physical impacts of proposed units	Follow 1910.95, OSHA noise standard.
	Air emissions conform to SCDHEC permit limitations.
Social and economic impacts of proposed units	Increased property and worker-related taxes can help offset some of the problems related to increased population such as community facilities and infrastructure, police, fire protection, and schools.
	Refer to mitigations listed for Section 5.3.
	Based on vacancy data from the 2000 Census, sufficient housing units are available.
	Operate the Lee Nuclear Station within the minimum release constraints of the Ninety-Nine Islands Hydroelectric Project license (FERC).
	Comply with OSHA regulations for worker safety and health.
Environmental justice	No mitigation required beyond that listed above.

Source: Adapted from Table 5.10-1 of Duke 2009c

5.13 Summary of Operational Impacts

Impact level categories are denoted in Table 5-20 as SMALL, MODERATE, or LARGE as a measure of their expected adverse impacts, if any. When socioeconomic impacts are likely to be beneficially MODERATE or LARGE, it is noted both in the comments and impact level columns.

Table 5-20. Summary of Operational Impacts for the Proposed Lee Nuclear Station

Resource Category	Comments	Impact Level
Land Use		
The site and vicinity	In general, land uses onsite would not change during plant operations. Facility maintenance activities may require continued removal or disturbance of vegetation on portions of the site. Access to Make-Up Pond C will be restricted, and some temporary closures of part of Rolling Mill Road may occur during pipeline corridor maintenance.	SMALL
Transmission corridors and other offsite areas	Some temporary closures of part of Rolling Mill Road may occur during pipeline corridor maintenance. Land-use impacts related to corridor maintenance would be minimal.	SMALL
Water-Related		
Surface-water use	Consumptive water use by Units 1 and 2, through cooling-tower evaporation and drift, would be only a small proportion of Broad River flow.	SMALL
Groundwater use	There would be no use of groundwater during operation. There would be only local and short-term effects on groundwater from drawdown of the makeup ponds during low-river-flow events.	SMALL
Surface-water quality	Blowdown and other wastewater discharges represent a very small proportion of Broad River flow; all effluent discharges require an NPDES permit.	SMALL
Groundwater quality	There would be no use of groundwater and no discharges to groundwater during operation. The effects of Make-Up Pond C during fill events on water quality in nearby groundwater wells would be similar to existing groundwater quality in the region, temporary, and minor.	SMALL

Table 5-20. (contd)

Resource Category	Comments	Impact Level
Ecology		
Terrestrial and wetland ecosystems	Impacts on terrestrial and wetland resources from operation of two new nuclear units, including the cooling towers, makeup ponds, transmission lines, railroad spur, wastewater-treatment basins, nighttime security lighting, transmission and water-pipeline corridor maintenance, increased vehicle traffic, dredged material disposal, and EMFs would be minor.	SMALL
Aquatic ecosystems	Because of the use of low through-screen intake velocity, the use of closed-cycle cooling, the design of the Broad River intake structure flush with the shoreline, and the use of proven fish-friendly technologies, impacts on aquatic resources from operation of two new nuclear units would be minimal.	SMALL
Socioeconomics		
Physical impacts	Physical impacts of operation on workers and the local public, buildings, transportation, and aesthetics would be minimal.	SMALL
Demography	Operations workers would constitute a less than 1 percent increase over the baseline population of Cherokee and York Counties. Outage workers would be onsite for approximately 30 days every 18 months per unit.	SMALL (beneficial)
Economic impacts on the community	Tax base impacts would be SMALL except in Cherokee County where they would be LARGE and beneficial.	SMALL to LARGE (beneficial)
Infrastructure and community services	The operations workforce would be considerably smaller than the building peak employment and would have a minimal impact.	SMALL
Environmental Justice	There would be no disproportionately high and adverse impact on any minority or low-income populations in the region during operation of the Lee Nuclear Station.	SMALL

Table 5-20. (contd)

Resource Category	Comments	Impact Level
Historic and Cultural Resources	Operations impacts to historic and cultural resources would be negligible with implementation of Duke's corporate procedures and the Lee Nuclear Station site cultural resources management plan and associated MOA to protect known historic and cultural resources and address any unexpected discoveries of potential historic properties or cultural resources.	SMALL
Air Quality	Potential impacts from operation of proposed Lee Nuclear Station Units 1 and 2 on air quality from emissions of criteria pollutants, CO_2 emissions, cooling-system emissions, and transmission lines would be minimal.	SMALL
Nonradiological Health	Health risks to workers would be dominated by occupational injuries at rates below the average U.S. industrial rate. Health effects to the public and workers from thermophilic microorganisms, noise generated by unit operations, and acute impacts of EMFs would be minimal. The chronic effects of ELF-EMF on human health does not conclusively link ELF-EMF to adverse health impacts. Traffic accident impacts during operations would increase the rate of local traffic impacts marginally.	SMALL
Radiological Health		
Members of the public	Doses to members of the public would be below NRC and EPA standards and there would be no observable health impacts (10 CFR Part 20, Appendix I to 10 CFR Part 50, 40 CFR Part 190).	SMALL
Plant workers	Occupational doses to plant workers would be below NRC standards (10 CFR 20.1201) and a program to maintain doses ALARA would be implemented.	SMALL
Biota other than humans	Doses to biota other than humans would be well below NCRP and IAEA guidelines.	SMALL

Table 5-20. (contd)

Resource Category	Comments	Impact Level
Nonradioactive Waste	Based on the effective practices for recycling, minimizing, managing, and waste disposal planned to be used at the Lee Nuclear Station site, and the expectation that regulatory approvals will be obtained to regulate the additional waste that would be generated from proposed Units 1 and 2, potential impacts would be minimal.	SMALL
Postulated Accidents		
Design basis accidents	Impacts of DBAs would be well below regulatory limits.	SMALL
Severe accidents	The environmental risks of severe accidents are well below the NRC safety criteria.	SMALL

(a) The ICRP (ICRP 1977, 1991) states that if humans are adequately protected, other living things are also likely to be sufficiently protected.

6.0 Fuel Cycle, Transportation, and Decommissioning

This chapter addresses the environmental impacts from (1) the uranium fuel cycle and solid waste management, (2) the transportation of radioactive material, and (3) the decommissioning of proposed William States Lee III Nuclear Station (Lee Nuclear Station) Units 1 and 2. In its evaluation of uranium fuel-cycle impacts from proposed Units 1 and 2, Duke Energy Carolinas, LLC (Duke) used the Westinghouse Electric Company, LLC (Westinghouse) Advanced Passive 1000 (AP1000) pressurized water reactor design. While the capacity factor reported by Westinghouse (Westinghouse 2008) for the AP1000 reactor design is 95 percent, Duke assumed two units with a capacity factor of 93 percent (Duke 2009c).

6.1 Fuel-Cycle Impacts and Solid Waste Management

This section contains a discussion of the environmental impacts from the uranium fuel cycle and solid waste management for the AP1000 reactor design. The environmental impacts of this design are evaluated against specific criteria for light water reactor (LWR) designs in Title 10 of the *Code of Federal Regulations* (CFR) 51.51.

The regulations in 10 CFR 51.51(a) state the following:

> Under § 51.50, every environmental report prepared for the construction permit stage or early site permit stage or combined license stage of a light-water-cooled nuclear power reactor, and submitted on or after September 4, 1979, shall take Table S–3, Table of Uranium Fuel Cycle Environmental Data, as the basis for evaluating the contribution of the environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low-level wastes and high-level wastes related to uranium fuel cycle activities to the environmental costs of licensing the nuclear power reactor. Table S–3 shall be included in the environmental report and may be supplemented by a discussion of the environmental significance of the data set forth in the table as weighed in the analysis for the proposed facility.

The AP1000 reactors proposed for the Lee Nuclear Station would be LWRs that use uranium dioxide fuel; therefore, Table S–3 in 10 CFR 51.51(b) can be used to assess environmental impacts of the uranium fuel cycle. Table S–3 values are normalized for a reference 1000 megawatt electrical (MW[e]) LWR at an 80 percent capacity factor. The Table S–3 values are reproduced in Table 6-1.

Table 6-1. Table of Uranium Fuel Cycle Environmental Data[(a)]

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000 MW(e) LWR
Natural Resource Use		
Land (acres):		
Temporarily committed[(b)]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to a 100-MW(e) coal-fired power plant.
Permanently committed	13	
Overburden moved (millions of MT)	2.8	Equivalent to a 95-MW(e) coal-fired power plant.
Water (millions of gallons):		
Discharged to air	160	= 2 percent of model 1000-MW(e) LWR with cooling tower.
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	<4 percent of model 1000 MW(e) with once-through cooling.
Fossil fuel:		
Electrical energy (thousands of MW-hr)	323	<5 percent of model 1000 MW(e) LWR output.
Equivalent coal (thousands of MT)	118	Equivalent to the consumption of a 45-MW(e) coal-fired power plant.
Natural gas (millions of standard cubic feet)	135	<0.4 percent of model 1000 MW(e) energy output.
Effluents--Chemical (MT)		
Gases (including entrainment):[(c)]		
SO_x^{-1}	4400	
NO_x^{-1}[(d)]	1190	Equivalent to emissions from 45 MW(e) coal-fired plant for a year.
Hydrocarbons	14	
CO	29.6	
Particulates	1154	
Other gases:		
F	0.67	Principally from uranium hexafluoride (UF_6) production, enrichment, and reprocessing. The concentration is within the range of State standards–below the level that affects human health.
HCl	0.014	

Table 6-1. (contd)

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000 MW(e) LWR
Liquids:		
SO_4^-	9.9	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are: NH_3—600 cfs, NO_3—20 cfs, fluoride—70 cfs.
NO_3^-	25.8	
Fluoride	12.9	
Ca^{++}	5.4	
Cl^-	8.5	
Na^+	12.1	
NH_3	10	
Fe	0.4	
Tailings solutions (thousands of MT)	240	From mills only–no significant effluents to environment.
Solids	91,000	Principally from mills–no significant effluents to environment.
Effluents–Radiological (curies)		
Gases (including entrainment):		
Rn-222		Presently under reconsideration by the Commission.
Ra-226	0.02	
Th-230	0.02	
Uranium	0.034	
Tritium (thousands)	18.1	
C-14	24	
Kr-85 (thousands)	400	
Ru-106	0.14	Principally from fuel reprocessing plants.
I-129	1.3	
I-131	0.83	
Tc-99		Presently under consideration by the Commission.
Fission products and transuranics	0.203	
Liquids:		
Uranium and daughters	2.1	Principally from milling–included tailings liquor and returned to ground–no effluents; therefore, no effect on environment.
Ra-226	0.0034	From UF_6 production.
Th-230	0.0015	

Table 6-1. (contd)

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000 MW(e) LWR
Th-234	0.01	From fuel fabrication plants–concentration 10 percent of 10 CFR Part 20 for total processing 26 annual fuel requirements for model LWR.
Fission and activation products	5.9×10^{-6}	
Solids (buried onsite):		
Other than high level (shallow)	11,300	9100 Ci comes from low-level reactor wastes and 1500 Ci comes from reactor decontamination and decommissioning—buried at land burial facilities. 600 Ci comes from mills—included in tailings returned to ground. Approximately 60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment.
TRU and HLW (deep)	1.1×10^{7}	Buried at Federal repository.
Effluents—thermal (billions of British thermal units)	4063	<5 percent of model 1000-MW(e) LWR.
Transportation (person-rem):		
Exposure of workers and general public	2.5	
Occupational exposure (person-rem)	22.6	From reprocessing and waste management.

Source: 10 CFR 51.51, Table S-3.

(a) In some cases where no entry appears, it is clear from the background documents that the matter was addressed and that, in effect, the table should be read as if a specific zero entry had been made. However, other areas are not addressed at all in the table. Table S–3 does not include health effects from the effluents described in the table, estimates of releases of radon-222 from the uranium fuel cycle, or estimates of technetium-99 released from waste-management or reprocessing activities. These issues may be the subject of litigation in the individual licensing proceedings.
Data supporting this table are given in the *Environmental Survey of the Uranium Fuel Cycle* (WASH-1248, AEC 1974); *Environmental Survey of the Reprocessing and Waste Management Portion of the LWR Fuel Cycle* (NUREG-0116, Supp.1 to WASH-1248) (NRC 1976b); *Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle* (NUREG-0216, Supp. 2 to WASH-1248) (NRC 1977c); and in the record of the final rulemaking pertaining to *Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management*, Docket RM-50-3 (NRC 1978). The contributions from reprocessing, waste management, and transportation of wastes are maximized for both fuel cycles (uranium only and no-recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor, which are considered in Table S–4 of Sec. 51.20(g). The contributions from the other steps of the fuel cycle are in columns A-E of Table S-3A in WASH-1248.

(b) Contributions to temporarily committed land from reprocessing are not prorated over 30 years because the complete temporary impact accrues whether the plant services 1 reactor for 1 year or 57 reactors for 30 years.

(c) Estimated effluents based upon combustion of equivalent coal for power generation.

(d) 1.2% from natural gas use and process.

Specific categories of environmental considerations are included in Table S–3 (see Table 6-1). These categories relate to land use, water consumption and thermal effluents, radioactive releases, burial of transuranic and low-level waste (LLW) and high-level waste (HLW), and radiation doses from transportation and occupational exposures. In developing Table S–3, U.S. Nuclear Regulatory Commission (NRC) staff considered two fuel-cycle options that differed in the treatment of spent fuel removed from a reactor. The “no-recycle” option treats all spent fuel as waste to be stored at a Federal waste repository, while the “uranium-only recycle” option involves reprocessing spent fuel to recover unused uranium and return it to the system. Neither cycle involves the recovery of plutonium. The contributions in Table S–3 resulting from reprocessing, waste management, and transportation of wastes are maximized for both of the fuel cycles (uranium only and no-recycle); that is, the identified environmental impacts are based on the cycle that results in the greater impact. The uranium fuel cycle is defined as the total of those operations and processes associated with provision, utilization, and ultimate disposition of fuel for nuclear power reactors.

The Nuclear Non-Proliferation Act of 1978 (22 U.S.C. 3201 et seq.) significantly affected the disposition of spent nuclear fuel by deferring indefinitely the commercial reprocessing and recycling of spent fuel produced in the U.S. commercial nuclear power program. While the ban on the reprocessing of spent fuel was lifted during the Reagan administration, economic circumstances changed, reserves of uranium ore increased, and the stagnation of the nuclear power industry provided little incentive for industry to resume reprocessing. During the 109^{th} Congress, the Energy Policy Act of 2005 (42 U.S.C. 15801) was enacted. It authorized the U.S. Department of Energy (DOE) to conduct an advanced fuel-recycling technology research and development program to evaluate proliferation-resistant fuel-recycling and transmutation technologies that minimize environmental or public health and safety impacts. Consequently, while Federal policy does not prohibit reprocessing, additional DOE efforts would be required before commercial reprocessing and recycling of spent fuel produced in the U.S. commercial nuclear power plants could begin.

The no-recycle option is presented schematically in Figure 6-1. Natural uranium is mined in open-pit or underground mines or by an *in situ* leach solution mining process. *In situ* leach mining, presently the primary form of mining in the United States, involves injecting a lixiviant solution into the uranium ore body to dissolve uranium and then pumping the solution to the surface for further processing. The ore or *in situ* leach solution is transferred to mills where it is processed to produce “yellowcake” (U_3O_8). A conversion facility prepares the U_3O_8 by converting it to uranium hexafluoride (UF_6), which is then processed by an enrichment facility to increase the percentage of the more fissile isotope uranium-235 and decrease the percentage of the non-fissile isotope uranium-238. At a fuel fabrication facility, the enriched uranium, which is approximately 5 percent uranium-235, is then converted to uranium dioxide (UO_2). The UO_2 is pelletized, sintered, and inserted into tubes to form fuel assemblies, which are placed in a reactor to produce power. When the content of the uranium-235 reaches a point where the nuclear reactor has become inefficient with respect to neutron economy, the fuel assemblies are withdrawn from the reactor as spent fuel. After being stored onsite for sufficient time to allow for short-lived fission product decay and to reduce the heat generation rate, the fuel assemblies would be transferred to a waste repository for internment. Disposal of spent fuel elements in a repository constitutes the final step in the no-recycle option.

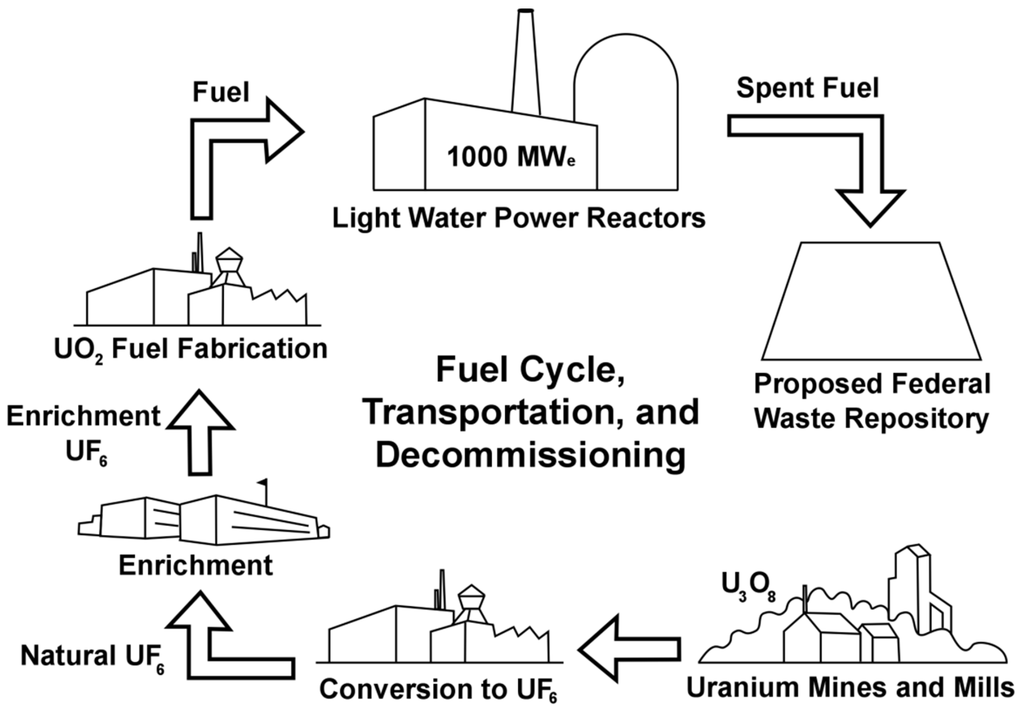

Figure 6-1. The Uranium Fuel Cycle No-Recycle Option (derived from NRC 1999a)

The following assessment of the environmental impacts of the fuel cycle as related to the operation of the proposed project is based on the values given in Table S–3 (Table 6-1) and the NRC staff's analysis of the radiological impact from radon-222 and technetium-99. In *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) (NRC 1996, 1999a, 2013a)[(a)], the NRC staff provides a detailed analysis of the environmental impacts from the uranium fuel cycle. Although the GEIS is specific to the impacts related to license renewal, the information is relevant to this review because the advanced LWR design considered here uses the same type of fuel. The NRC staff's analyses in Section of the GEIS are summarized and set forth here.

(a) The GEIS for license renewal (NUREG-1437) was originally issued in 1996. Addendum 1 was issued in 1999. NUREG-1437, Revision 1, was issued in June 2013. The version cited, whether 1996 or 2013, is the version where the relevant technical information is discussed. Revision 1 is cited in cases where the relevant technical information is discussed in both documents.

Each AP1000 reactor unit is rated at 3400 MW(t) (Westinghouse 2008). Assuming that two AP1000 reactors would be located on the Lee Nuclear Station site (Duke 2009c), the power rating for the new units would be 6800 MW(t). Each AP1000 reactor unit is rated at greater than 1000 MW(e) (Westinghouse 2011). Duke conservatively assumes that total electrical output will be 15 percent greater than that, or 1150 MW(e), and then applies a capacity factor of 93 percent (Duke 2009c). Thus, each AP1000 unit is assumed to produce an average of 1070 MW(e). For two AP1000 units, this corresponds to 2140 MW(e).

The fuel-cycle impacts in Table S–3 are based on a reference 1000-MW(e) LWR operating at an annual capacity factor of 80 percent for a net electric output of 800 MW(e). As explained above, the NRC staff considered the capacity factor of 93 percent with a total net electric output of 2140 MW(e) for the proposed two new units at the Lee Nuclear Station (Duke 2009c); this is about 2.68 times (i.e., 2140 MW(e) divided by 800 MW(e) yields 2.68) the output value in Table S–3 (see Table 6-1). For added conservatism in its review and evaluation of the environmental impacts of the nuclear fuel cycle, the NRC staff multiplied the values in Table S–3 by a factor of 3, rather than a factor of 2.68, scaling the impacts upward to account for the increased electric generation of the two proposed AP1000 units. Scaling up by a factor of 3 is referred to as using the 1000-MW(e) LWR-scaled model.

Recent changes in the fuel cycle may have some bearing on environmental impacts; however, as discussed below, the NRC staff is confident that the contemporary fuel-cycle impacts are below those identified in Table 6-1. This is especially true in light of the following recent fuel-cycle trends in the United States:

- Increasing use of *in situ* leach uranium mining, which does not produce mine tailings.
- Transitioning of U.S. uranium enrichment technology from gaseous diffusion to gas centrifuge. The centrifuge process uses only a small fraction of the electrical energy per separation unit compared to gaseous diffusion. (U.S. gaseous diffusion plants relied on electricity derived mainly from the burning of coal.)
- Current LWRs use nuclear fuel more efficiently due to higher fuel burnup. Therefore, less uranium fuel per year of reactor operation is required than in the past to generate the same amount of electricity.
- Fewer spent fuel assemblies per reactor-year are discharged, hence the waste storage/repository impact is lessened.

The values in Table S–3 were calculated from industry averages for each type of facility or operation within the fuel cycle. Recognizing that this approach meant that there would be a range of reasonable values for each estimate, the NRC staff followed the policy of choosing the assumptions or factors to be applied so that the calculated values would not be underestimated. This approach was intended to ensure the actual environmental impacts would be less than the quantities shown in Table S–3 for all LWR nuclear power plants within the widest range of operating conditions. The NRC staff recognizes that many of the fuel-cycle parameters and interactions vary in small ways from the estimates in Table S–3; the NRC staff concludes that these variations would have no impacts on the Table S–3 calculations. For example, to determine the quantity of fuel required for a year's operation of a nuclear power plant in Table S–3 the NRC staff defined the model reactor as a 1000-MW(e) LWR reactor operating at 80 percent capacity with a 12-month fuel reloading cycle and an average fuel burnup of 33,000 MWd/MTU. This is a "reference reactor year" (Table S–3 or GEIS, Revision 1 (NRC 2013a)).

If approved, the combined licenses (COLs) for proposed Lee Nuclear Station Units 1 and 2 would allow 40 years of operation. The sum of the initial fuel loading plus all of the reloads for the lifetime of the reactor can be divided by the 60-year lifetime (40-year initial license term and 20-year license renewal term) to obtain an average annual fuel requirement. This approach was followed in the original GEIS (NRC 1996) and carried forward into Revision 1 (NRC 2013a) for both boiling water reactors and pressurized water reactors; the higher annual requirement, 35 MT of uranium made into fuel for a boiling water reactor, was chosen in the GEIS, Revision 1, as the basis for the reference reactor year (NRC 2013a). The average annual fuel requirement presented in the GEIS, Revision 1, would only be increased by 2 percent if a 40-year lifetime was evaluated. However, a number of fuel-management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel and separative-work (enrichment) requirements. Since the time when Table S–3 was promulgated, these improvements have reduced the annual fuel requirement, which means the Table S–3 assumptions remain bounding as applied to the proposed two units.

Another change supporting the bounding nature of the Table S–3 assumptions with respect to impacts is the elimination of the U.S. restrictions on the importation of foreign uranium. Until recently, the economic conditions of the uranium market favored using foreign uranium at the expense of the domestic uranium industry. From the mid-1980s to 2004, the price of U_3O_8 remained below $20/lb. These market conditions forced the closing of most U.S. uranium mines and mills, substantially reducing the environmental impacts in the United States from uranium-mining activities. However, the spot price of uranium has increased dramatically from $24/lb in April 2005 to $135/lb in July 2007 and has decreased to near $41/lb as of November 2012 (UxC 2012). As a result, there is a renewed interest in uranium mining and milling in the United States and the NRC anticipates receiving multiple license applications for uranium mining and milling in the next several years (NRC 2013a). The majority of these applications are expected to be for *in situ* leach solution mining, which does not produce tailings. Factoring in changes to the fuel cycle suggests that the environmental impacts of mining and tail millings could drop to levels below those given in Table S–3; however, Table S–3 estimates remain bounding as applied to the proposed two units.

In summation, these reasons highlight why Table S–3 is likely to overestimate impacts from the proposed units and, therefore, remains a bounding approach for this analysis.

The preceding information shows that Table S–3 likely overestimates the impacts of the proposed units and, therefore, its use remains a bounding approach for this analysis. Section 4.12.1.1 of the GEIS, Revision 1 (NRC 2013a) and Section 6.2 of the GEIS (NRC 1996) discuss in greater detail the sensitivity to changes in the fuel cycle since issuance of Table S–3 on the environmental impacts.

6.1.1 Land Use

The total annual land requirement for the fuel cycle supporting the 1000-MW(e) LWR-scaled model is about 339 ac. Approximately 39 ac are permanently committed land, and 300 ac are temporarily committed. A "temporary" land commitment is a commitment for the life of the specific fuel cycle plant (e.g., a mill, enrichment plant, or succeeding plants). Following completion of decommissioning, such land can be released for unrestricted use. "Permanent" commitments represent land that may not be released for use after plant shutdown and decommissioning because decommissioning activities do not result in removal of sufficient radioactive material to meet the limits in 10 CFR Part 20, Subpart E, for release of that area for unrestricted use. Of the approximately 300 ac of temporarily committed land, about 237 ac are undisturbed and about 66 ac are disturbed. In comparison, a coal-fired power plant using the same MW(e) output as the LWR-scaled model and using strip-mined coal requires the disturbance of about 528 ac per year for fuel alone. The NRC staff concludes that the impacts on land use to support the 1000-MW(e) LWR-scaled model would be SMALL.

6.1.2 Water Use

The principal water use for the fuel cycle supporting a 1000-MW(e) LWR-scaled model is that required to remove waste heat from the power stations supplying electrical energy to the enrichment step of this cycle. Scaling from Table S-3, of the total annual water use of 3.41×10^{10} gal, about 3.33×10^{10} gal are required for the removal of waste heat, assuming that a new unit uses once-through cooling. Also, scaling from Table 6-1, other water uses involve the discharge to air (e.g., evaporation losses in process cooling) of about 4.80×10^{8} gal/yr and water discharged to the ground (e.g., mine drainage) of about 3.81×10^{8} gal/yr.

On a thermal-effluent basis, annual discharges from the nuclear fuel cycle are about 4 percent of the 1000-MW(e) LWR-scaled model using once-through cooling. The consumptive water use is about 2 percent of the 1000-MW(e) LWR-scaled model using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle use cooling towers) would be about 6 percent of the 1000-MW(e) LWR-scaled model using cooling towers. Under this condition, thermal effluents would be negligible. The NRC staff concludes that the impacts on water use for these combinations of thermal loadings and water consumption would be SMALL.

6.1.3 Fossil Fuel Impacts

Electric energy and process heat are required during various phases of the fuel-cycle process. The electric energy is usually produced by the combustion of fossil fuel at conventional power plants. Electric energy associated with the fuel cycle represents about 5 percent of the annual electric power production of the reference 1000-MW(e) LWR. Process heat is primarily generated by the combustion of natural gas. This gas consumption, if used to generate electricity, would be less than 0.4 percent of the electrical output from the model plant. The NRC staff concludes that the fossil fuel impacts from the direct and indirect consumption of electric energy for fuel-cycle operations would be SMALL relative to the net power production of the proposed project.

The largest use of electricity in the fuel cycle comes from the enrichment process. It appears that gas centrifuge (GC) technology is likely to eventually replace gaseous diffusion (GD) technology for uranium enrichment in the United States. The same amount of enrichment from a GC facility uses less electricity and, therefore, results in lower amounts of air emissions such as carbon dioxide (CO_2) than a GD facility. Therefore, the NRC staff concludes that the values for electricity use and air emissions in Table S–3 continue to be appropriately bounding values.

As indicated in Appendix J, the largest source of CO_2 emissions associated with nuclear power is from the fuel cycle, not operation of the plant. The largest source of CO_2 in the fuel cycle is production of electric energy from combustion of fossil fuel in conventional power plants. This energy is used to power components of the fuel cycle such as the enrichment process. The NRC staff compared emissions from a 45 MW(e) coal-fired power plant in Table 6-1 to the nuclear fuel cycle, and accounted for differences in generating capacity between a nuclear power plant and coal-fired power plant. The CO_2 emissions from the fuel cycle are about 5 percent of the CO_2 emissions from an equivalent coal-fired power plant.

In Appendix J, the NRC staff estimates that the carbon footprint of the fuel cycle to support a reference 1000-MW(e) LWR for a 40-year plant life is on the order of 17,000,000 MT of CO_2, including a very small contribution from other greenhouse gases. Scaling this footprint to the power level of the two proposed AP1000 reactor units using the scaling factor of 3 discussed earlier, the NRC staff estimates the carbon footprint for 40 years of fuel-cycle emissions to be approximately 51,000,000 MT (an emissions rate of about 1,300,000 MT annually, averaged over the period of operation) of CO_2, as compared to a total U.S. annual emissions rate of 5,500,000,000 MT (EPA 2011c).

On this basis, the NRC staff concludes that the fossil fuel impacts, including greenhouse gas emissions from the direct and indirect consumption of electric energy for fuel-cycle operations, would be SMALL.

6.1.4 Chemical Effluents

The quantities of chemical, gaseous, and particulate effluents with fuel-cycle processes are given in Table S-3 for the reference 1000-MW(e) LWR and, according to WASH-1248 (AEC 1974), result from the generation of electricity for fuel-cycle operations. The principal effluents are sulfur oxides, nitrogen oxides, and particulates. Table 6-1 states that the fuel cycle for the reference 1000-MW(e) LWR requires 323,000 MWh of electricity. The fuel cycle for the 1000-MW(e) LWR-scaled model would therefore require 969,000 MWh of electricity, or less than 0.024 percent of the 4.1 billion MWh of electricity generated in the United States in 2008 (DOE/EIA 2009a). Therefore, the gaseous and particulate chemical effluents from fuel-cycle processes to support the operation of the 1000-MW(e) LWR-scaled model would add less than 0.024 percent to the national gaseous and particulate chemical effluents for electricity generation.

Liquid chemical effluents produced in fuel-cycle processes are related to fuel enrichment and fabrication and may be released to receiving waters. These effluents are usually present in dilute concentrations such that only small amounts of dilution water are required to reach levels of concentration that are within established standards. Table 6-1 specifies the amount of dilution water required for specific constituents. Additionally, all liquid discharges into the navigable waters of the United States from plants associated with the fuel-cycle operations would be subject to requirements and limitations set by appropriate Federal, State, Tribal, and local agencies.

Tailings solutions and solids are generated during the milling process and, as indicated in Table 6-1, are not released in large enough quantities to have a significant impact on the environment.

Based on the above analysis, the NRC staff concludes that the impacts of these chemical effluents would be SMALL.

6.1.5 Radiological Effluents

Radioactive effluents estimated to be released to the environment from waste-management activities and certain other phases of the fuel-cycle process are listed in Table S–3. The GEIS (NRC 2013a) provides the 100-year environmental dose commitment to the U.S. population from the fuel cycle of 1 year of operation of the model 1000-MW(e) LWR using the radioactive effluents in Table 6-1. Excluding reactor releases and dose commitments because of exposure to radon-222 and technetium-99, the total overall whole body gaseous dose commitment and whole body liquid dose commitment from the fuel cycle were calculated to be approximately 400 and 200 person-rem, respectively. Scaling these dose commitments by a factor of about 3 for the 1000-MW(e) LWR-scaled model results in whole body dose commitment estimates of 1200 person-rem for gaseous releases and 600 person-rem for liquid releases. For both pathways, the estimated 100-year environmental dose commitment to the U.S. population would be approximately 1800 person-rem for the 1000-MW(e) LWR-scaled model.

Currently, the radiological impacts associated with radon-222 and technetium-99 releases are not addressed in Table S–3. Principal radon releases occur during mining and milling operations and as emissions from mill tailings, whereas principal technetium-99 releases occur from GD enrichment facilities. Duke provided an assessment of radon-222 and technetium-99 (Duke 2010l). This evaluation relied on the information discussed in the 1996 version of the GEIS (NRC 1996); NRC staff adapted the Duke assessment with the multiplier of 3, rather than Duke's multiplier of 2.675, as discussed in Section 6.1.

In Section 6.2 of the 1996 version of the GEIS (NRC 1996), the NRC staff estimated the radon-222 releases from mining and milling operations and from mill tailings for each year of operations of the reference 1000-MW(e) LWR. The estimated releases of radon-222 for the reference reactor year for the 1000-MW(e) LWR-scaled model, or for the total electric power rating for the site for a year, are approximately 15,600 Ci. Of this total, about 78 percent would be from mining, 15 percent from milling operations, and 7 percent from inactive tails before stabilization. For radon releases from stabilized tailings, the NRC staff assumed that the LWR-scaled model would result in an emission of 3 Ci per site year (i.e., about three times the estimate in the 1996 version of the GEIS [NRC 1996] for the reference reactor year). The major risks from radon-222 are from exposure to the bone and the lung, although there is a small risk from exposure to the whole body. The organ-specific dose-weighting factors from 10 CFR Part 20 were applied to the bone and lung doses to estimate the 100-year dose commitment from radon-222 to the whole body. The estimated 100-year environmental dose commitment from mining, milling, and tailings before stabilization for each site year (assuming the 1000-MW(e) LWR-scaled model) would be approximately 2800 person-rem to the whole body. From stabilized tailings piles, the estimated 100-year environmental dose commitment would be approximately 54 person-rem to the whole body. Additional insights regarding Federal policy/resource perspectives concerning institutional controls comparisons with routine radon-222 exposure and risk and long-term releases from stabilized tailing piles are discussed in the 1996 version of the GEIS (NRC 1996).

The NRC staff also considered the potential health effects associated with the releases of technetium-99 (NRC 2013a). The estimated releases of technetium-99 for the reference reactor year for the 1000-MW(e) LWR-scaled model are 0.02 Ci from chemical processing of recycled UF_6 before it enters the isotope enrichment cascade and 0.015 Ci into the groundwater from a repository. The major risks from technetium-99 are from exposure of the gastrointestinal tract and kidney, although there is a small risk from exposure to the whole body. Applying the organ-specific dose-weighting factors from 10 CFR Part 20 to the gastrointestinal tract and kidney doses, the total-body 100-year dose commitment from technetium-99 to the whole body was estimated to be 300 person-rem for the 1000-MW(e) LWR-scaled model.

Radiation protection experts assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. A report by the National Research Council (2006), the Biological Effects of Ionizing Radiation (BEIR) VII report, uses the linear, no-threshold dose response model as a basis for estimating the risks from low doses. This approach is accepted by the NRC as a conservative method for estimating health risks from radiation exposure, recognizing that the model may overestimate those risks. Based on this method, the NRC staff estimated the risk to the public from radiation exposure using the nominal probability coefficient for total detriment. This coefficient has the value of 570 fatal cancers, nonfatal cancers, and severe hereditary effects per 1,000,000 person-rem (10,000 person-Sv), equal to 0.00057 effect per person-rem. The coefficient is taken from Publication 103 of the International Commission on Radiological Protection (ICRP 2007).

The nominal probability coefficient was multiplied by the sum of the estimated whole body population doses from gaseous effluents, liquid effluents, radon-222, and technetium-99 discussed above (approximately 5000 person-rem/yr) to calculate that the U.S. population would incur a total of approximately 2.8 fatal cancers, nonfatal cancers, and severe hereditary effects annually.

Radon releases from tailings are indistinguishable from background radiation levels at a few kilometers from the tailings pile (at less than 0.6 mi in some cases) (NRC 1996). The public dose limit in the U.S. Environmental Protection Agency's (EPA's) regulation, 40 CFR Part 190, is 25 mrem/yr to the whole body from the entire fuel cycle, but most NRC licensees have airborne effluents resulting in doses of less than 1 mrem/yr (61 FR 65120).

In addition, at the request of Congress, the National Cancer Institute conducted a study and published *Cancer in Populations Living Near Nuclear Facilities* in 1990 (Jablon et al. 1990). This report included an evaluation of health statistics around all nuclear power plants, as well as several other nuclear fuel-cycle facilities, in operation in the United States in 1981 and found "no evidence that an excess occurrence of cancer has resulted from living near nuclear facilities" (Jablon et al. 1990). The contribution to the annual average dose received by an individual from fuel-cycle-related radiation and other sources as reported in a publication of the National Council on Radiation Protection and Measurements (NCRP 2009) is listed in Table 6-2. The nuclear fuel-cycle contribution to an individual's annual average radiation dose is extremely small (less than 0.1 mrem/yr) compared to the annual average background radiation dose (about 311 mrem/yr).

Based on the analyses presented above, the NRC staff concludes that the environmental impacts of radioactive effluents from the fuel cycle are SMALL.

Table 6-2. Comparison of Annual Average Dose Received by an Individual from All Sources

	Source	Dose (mrem/yr)[a]	Percent of Total
Ubiquitous background	Radon and thoron	228	37
	Space	33	5
	Terrestrial	21	3
	Internal (body)	29	5
	Total background sources	**311**	**50**
Medical	Computed tomography	147	24
	Medical x-ray	76	12
	Nuclear medicine	77	12
	Total medical sources	**300**	**48**
Consumer	Construction materials, smoking, air travel, mining, agriculture, fossil fuel combustion	13	2
Other	Occupational	0.5[b]	0.1
	Nuclear fuel cycle	0.05[c]	0.01
Total		**624**	**100**

Source: NCRP 2009.
(a) NCRP Report 160 table expressed doses in mSv/yr (1 mSv/yr equals 100 mrem/yr).
(b) Occupational dose is regulated separately from public dose and is provided here for informational purposes.
(c) Estimated using 153 person-Sv/yr from Table 6.1 of NCRP 160 and a 2006 U.S. population of 300 million.

6.1.6 Radiological Wastes

The estimated quantities of buried radioactive waste material (LLW, HLW, and transuranic waste) generated by the reference 1000-MW(e) LWR are specified in Table S–3. For LLW disposal at land burial facilities, the Commission notes that there would be no significant radioactive releases to the environment; such wastes generated by the Lee Nuclear Station would be shipped to the Energy Solutions disposal facility in Barnwell, South Carolina, or a similar replacement facility, because the proposed nuclear power station is within the Atlantic Compact. Class A LLW generated by the Lee Nuclear Station could also be shipped to the Energy Solutions disposal facility near Clive, Utah, as some Class A LLW generators within the state of South Carolina have done (DOE 2013).

The Barnwell facility is expected to be closed to LLW in 2038, including LLW generated in South Carolina (Chem-Nuclear Systems 2010). At that time, Duke could enter into an agreement with another licensed facility that would accept LLW from Lee Nuclear Station Units 1 and 2. Alternatively, Duke could implement measures to reduce the generation of Class B and C wastes, extending the capacity of the onsite solid waste storage system. Duke could also construct additional temporary storage facilities onsite. Finally, Duke could enter into an agreement with a third-party contractor to process, store, own, and ultimately dispose of LLW from Lee Nuclear Station Units 1 and 2. The Waste Control Specialists, LLC, site in Andrews County, Texas, is licensed to accept Class A, B, and C LLW from the Texas Compact

(Texas and Vermont). Waste Control Specialists, LLC, may accept Class A, B, and C LLW from outside the Texas Compact for disposal subject to established criteria, conditions, and approval processes (31 TAC Chapter 675.23). Because Duke would likely have to choose one or a combination of these options, the NRC staff considered the environmental impacts of each of these options.

Table S–3 addresses the environmental impacts if Duke enters into an agreement with a licensed facility for disposal of LLW, and Table S–4 addresses the environmental impacts from transportation of LLW as discussed in Section 6.2. The use of third-party contractors was not explicitly addressed in Tables S–3 and S–4; however, such third-party contractors are already licensed by the NRC or Agreement States and currently operate in the United States. Experience from the operation of these facilities shows that the additional environmental impacts are not significant compared to the impacts described in Tables S–3 and S–4.

Measures to reduce the generation of Class B and C wastes, such as reducing the service run length of resin beds, could increase the volume of LLW, but would not increase the total activity (in curies) of radioactive material in the waste. The volume of waste would still be bounded by, or very similar to, the estimates in Table S–3, and the environmental impacts would not be significantly different.

In most circumstances, the NRC's regulations (10 CFR 50.59) allow licensees operating nuclear power plants to construct and operate additional onsite LLW storage facilities without seeking approval from the NRC. Licensees are required to evaluate the safety and environmental impacts before constructing the facility and make those evaluations available to the NRC inspectors. A number of nuclear power plant licensees have constructed and operate such facilities in the United States. Typically, these additional facilities are constructed near the power block inside the security fence on land that has already been disturbed during initial plant construction. Therefore, the impacts on environmental resources (e.g., land use and aquatic and terrestrial biota) would be very small. All of the NRC (10 CFR Part 20) and EPA (40 CFR Part 190) dose limitations would apply both for public and occupational radiation exposure. The radiological environmental monitoring programs around nuclear power plants that operate such facilities show that the increase in radiation dose at the site boundary is not significant; the radiation doses continue to be below 25 mrem/yr, the dose limit of 40 CFR Part 190. The NRC staff concludes that doses to members of the public within the NRC and EPA regulations are a small impact. Therefore, the impacts from radiation would be SMALL.

In addition, the NRC staff assessed the impacts of onsite LLW storage at currently operating nuclear power plants and concluded that the radiation doses to offsite individuals from interim LLW storage are insignificant (NRC 2013a). The types and amounts of LLW generated by the proposed reactors at Lee Nuclear Station Units 1 and 2 would be very similar to those generated by currently operating nuclear power plants and the construction and operation of these interim LLW storage facilities would be very similar to the construction and operation of the currently operating facilities. Additionally, in the GEIS, the NRC staff concluded that there should be no significant issues or environmental impacts associated with interim storage of LLW generated by nuclear power plants (NRC 2013a). Interim storage facilities would be used until these wastes could be safely shipped to licensed disposal facilities.

Current national policy, as found, for example, in the Nuclear Waste Policy Act (42 U.S.C. 10101 et seq.) mandates that HLWs and transuranic wastes are to be buried at deep geologic repositories. No release to the environment is expected to be associated with deep geologic disposal because it has been assumed that all of the gaseous and volatile radionuclides contained in the spent fuel are released to the atmosphere before the disposal of the waste. In NUREG-0116 (NRC 1976b), which provides background and context for the Table S–3 values established by the Commission, the NRC staff indicates that these HLWs and transuranic wastes will be buried and will not be released to the environment.

As part of the Table S–3 rulemaking, the NRC staff evaluated, along with more conservative assumptions, this zero-release assumption associated with waste burial in a repository, and the NRC reached an overall generic determination that fuel-cycle impacts would not be significant. In 1983, the Supreme Court affirmed the NRC's position that the zero-release assumption was reasonable in the context of the Table S–3 rulemaking to address generically the impacts of the uranium fuel cycle in individual reactor licensing proceedings (Baltimore Gas & Electric v. Natural Resources Defense Council, 462 U.S. 87(1983)).

Environmental impacts from onsite spent fuel storage have been studied extensively and are well understood. In the context of operating license renewal, the staff (NRC 2013a) provides descriptions of the storage of spent fuel during the licensed lifetime of reactor operations. Radiological impacts are well within regulatory limits; thus, radiological impacts of onsite storage during operations meet the standard for a conclusion of small impact. Nonradiological environmental impacts have been shown to be not significant; thus, they are classified as small. The overall conclusion for onsite storage of spent fuel during the licensed lifetime of reactor operations is that the environmental impacts will be small (NRC 2013a).

The NRC staff concludes, based on Table S–3 and the above conclusions regarding storage of LLW and spent fuel during the licensed lifetime of reactor operations, that the environmental impacts from radioactive waste storage and disposal associated with the operation of Lee Nuclear Station Units 1 and 2 would be SMALL.

Since 1984, the NRC has considered the environmental impacts of spent nuclear fuel storage following the licensed lifetime of reactor operations to be a generic issue that is best addressed through rulemaking. Thus, the Commission's Waste Confidence Decision and Rule, 10 CFR 51.23, undergirds many agency licensing decisions involving the management of spent nuclear fuel after the licensed life of a reactor. In 2010, the Commission completed its most recent update of the Waste Confidence Decision and Rule, to reflect information gained from experience in the storage of spent nuclear fuel and HLW (75 FR 81032). On June 8, 2012, the U.S. Court of Appeals for the District of Columbia Circuit (the Court) vacated the 2010 Waste Confidence Decision and Rule, finding that it did not comply with the National Environmental Policy Act (NEPA). The Court decision held that (1) the Waste Confidence rulemaking is a major Federal action necessitating either an environmental impact statement (EIS) or a finding of no significant environmental impact, and (2) the Commission's evaluation has several deficiencies in considering the environmental impacts of spent nuclear fuel storage after the licensed life of reactor operation (New York v. NRC 2012).

In response to petitions subsequently filed under multiple NRC hearing dockets that requested suspension of final licensing decisions for applications relying on the vacated Rule, on August 7, 2012, the Commission stated that

> "…in recognition of our duties under the law, we will not issue licenses dependent upon the Waste Confidence Decision or the Temporary Storage Rule until the Court's remand is appropriately addressed. This determination extends just to final license issuance; all current licensing reviews and proceedings should continue to move forward" (NRC 2012h).

On September 6, 2012, the Commission directed the NRC staff to proceed with the development of an EIS to support publication of an updated Waste Confidence Decision and Rule by September 7, 2014 (NRC 2012i). The updated Rule and supporting EIS must address the deficiencies identified in the Court's remand and provide the necessary NEPA assessment of the environmental impacts from long-term storage of spent nuclear fuel following the licensed lifetime of reactor operations. In October 2012, the NRC staff began the NEPA scoping process and established rulemaking docket NRC–2012–0246 (77 FR 65137).

As directed by the Commission in CLI-12-16 (NRC 2012h), the NRC will not issue licenses dependent on the Waste Confidence Decision or Temporary Storage Rule prior to resolution of waste confidence-related issues. This action will ensure that there would be no irretrievable or irreversible resource commitments or potential harm to the environment before waste confidence impacts have been addressed. In the meantime, however, the NRC staff will follow the Commission's instructions to move forward with current licensing reviews and proceedings.

The environmental impacts of spent fuel storage after the licensed life of operations for Lee Nuclear Station Units 1 and 2 are being addressed generically through rulemaking and development of a generic EIS (77 FR 65137). On September 13, 2013, the NRC published a proposed revision of 10 CFR 51.23 (i.e., the Waste Confidence Rule) which generically addresses the environmental impacts of continued storage of spent nuclear fuel beyond the license lifetime of a reactor (78 FR 56776). The NRC also prepared a draft generic EIS to support this Proposed Rule (NRC 2013b). According to the Proposed Rule, no discussion of environmental impacts of spent nuclear fuel storage in a reactor facility storage pool or an independent spent fuel storage installation (ISFSI) for the period following the term of the reactor combined license is required in any EIS prepared in connection with the issuance of a COL for a nuclear power reactor. The Final Rule is scheduled to be published by September 2014. Upon issuance of the Final Rule, the NRC staff will identify any changes between the proposed and final rules; assess the significance of the changes; and, if necessary, perform additional NEPA reviews prior to the final licensing decision for Lee Nuclear Station Units 1 and 2.

6.1.7 Occupational Dose

The annual occupational dose attributable to all phases of the fuel cycle for the 1000-MW(e) LWR-scaled model is about 1800 person-rem. This is based on a 600 person-rem occupational dose estimate attributable to all phases of the fuel cycle for the model 1000-MW(e) LWR (NRC 1996). The NRC staff concludes that the environmental impact from this occupational dose is considered SMALL because the dose to any individual worker would be maintained within the limits of 10 CFR Part 20, which is 5 rem/yr.

6.1.8 Transportation

The transportation dose to workers and the public related to the uranium fuel cycle is approximately 2.5 person-rem annually for the reference 1000-MW(e) LWR in accordance with Table S–3 (Table 6-1). This corresponds to a dose of 7.5 person-rem for the 1000-MW(e) LWR-scaled model. For purposes of comparison, in the year 2016 the population within 50 mi of the Lee Nuclear Station site is estimated to be 2.71 million people (Duke 2009c). Using 0.311 rem/yr as the average dose to a U.S. resident from natural background radiation (NCRP 2009), the collective dose to that population is estimated to be 845,000 person-rem/yr. On the basis of this comparison, the NRC staff concludes that the environmental impacts of transportation would be SMALL.

6.1.9 Conclusions

The NRC staff evaluated the environmental impacts of the uranium fuel cycle as given in Table 6-1, considered the effects of radon-222 and technetium-99, and appropriately scaled the impacts for the 1000-MW(e) LWR-scaled model. The NRC staff also evaluated the environmental impacts of greenhouse gas emissions from the uranium fuel cycle and appropriately scaled the impacts for the 1000 MW(e) LWR-scaled model. Based on this evaluation, the NRC staff concludes that the impacts of the uranium fuel cycle would be SMALL.

6.2 Transportation Impacts

This section addresses both the radiological and nonradiological environmental impacts from normal operating and accident conditions resulting from (1) shipment of unirradiated fuel to the Lee Nuclear Station site, (2) shipment of spent fuel to a monitored retrievable storage facility or a permanent repository, and (3) shipment of low-level radioactive waste and mixed waste to offsite disposal facilities. For the purposes of these analyses, the NRC staff considered the proposed Yucca Mountain site in Nevada as a surrogate destination for a permanent repository. The impacts evaluated in this section for two new nuclear generating units at the Lee Nuclear Station site are appropriate to characterize the alternative sites discussed in Section 9.3 of this EIS. Sites evaluated in this EIS include the Lee Nuclear Station site (proposed), and alternative sites at Perkins, Keowee, and Middleton Shoals. No meaningful differentiation exists among the proposed and the alternative sites regarding the radiological and nonradiological environmental impacts from normal operating and accident conditions; therefore, alternative sites are not discussed further in Chapter 9.

The NRC performed a generic analysis of the environmental effects of transportation of fuel and waste to and from LWRs in the *Environmental Survey of Transportation of Radioactive Materials To and From Nuclear Power Plants*, WASH-1238 (AEC 1972) and in a supplement to WASH-1238, NUREG-75/038 (NRC 1975b) and found the impact to be SMALL. These documents provided the basis for Table S–4 in 10 CFR 51.52, which summarizes the environmental impacts of transportation of fuel and waste to and from one LWR of 3000 to 5000 MW(t) (1000 to 1500 MW(e)). Impacts are provided for normal conditions of transport and accidents in transport for a reference 1100-MW(e) LWR. The transportation impacts associated with the Lee Nuclear Station site were normalized for a reference 1100-MW(e) LWR at an 80-percent capacity factor for comparison with Table S–4.[(a)] Dose to transportation workers during normal transportation operations was estimated to result in a collective dose of 4 person-rem per reference reactor year. The combined dose to the public along the route and to onlookers was estimated as a collective dose of 3 person-rem per reference reactor year.

Environmental risks (radiological) during normal transport and accident conditions, as stated in Table S–4, are small. Nonradiological impacts from postulated accidents were estimated as one fatal injury in 100 reactor years and one nonfatal injury in 10 reference reactor years. Subsequent reviews of transportation impacts in NUREG-0170 (NRC 1977d) and NUREG/CR-6672 (Sprung et al. 2000) concludes that impacts were bounded by Table S–4 in 10 CFR 51.52.

(a) Note that the basis for Table S–4 is an 1100-MW(e) LWR at an 80-percent capacity factor (AEC 1972; NRC 1975b). The basis for Table S–3 in 10 CFR 51.51(b) that was discussed in Section 6.1 of this EIS is an 1000-MW(e) LWR with an 80-percent capacity factor (NRC 1976b). However, because fuel cycle and transportation impacts are evaluated separately, this difference does not affect the results and conclusions in this EIS.

In accordance with 10 CFR 51.52(a), a full description and detailed analysis of transportation impacts are not required when licensing an LWR (i.e., impacts are assumed bounded by Table S–4) if the reactor meets the following criteria:

- The reactor has a core thermal power level not exceeding 3800 MW(t).
- Fuel is in the form of sintered uranium oxide pellets having a uranium-235 enrichment not exceeding 4 percent by weight, and pellets are encapsulated in zirconium-clad fuel rods.
- The average level of irradiation of fuel from the reactor does not exceed 33,000 MWd/MTU, and no irradiated fuel assembly is shipped until at least 90 days after it is discharged from the reactor.
- With the exception of irradiated fuel, all radioactive waste shipped from the reactor is packaged and in solid form.
- Unirradiated fuel is shipped to the reactor by truck; irradiated (spent) fuel is shipped from the reactor by truck, rail, or barge; and radioactive waste other than irradiated fuel is shipped from the reactor by truck or rail.

The environmental impacts of the transportation of fuel and radioactive wastes to and from nuclear power facilities were resolved generically in 10 CFR 51.52 provided that the specific conditions in the Rule (see above) are met; if not, a full description and detailed analysis are required for initial licensing. The NRC may consider requests for licensed plants to operate at conditions above those in the facility's licensing basis; for example, higher burnups (above 33,000 MWd/MTU), enrichments (above 4 percent uranium-235), or thermal power levels (above 3800 MW(t)). Departures from the conditions itemized in 10 CFR 51.52(a) must be supported by a full description and detailed analysis of the environmental effects, as specified in 10 CFR 51.52(b). Departures found to be acceptable for licensed facilities cannot serve as the basis for initial licensing for new reactors.

In its application, Duke requested COLs for proposed Lee Nuclear Station Units 1 and 2. Each proposed new unit would be an AP1000, which has a thermal power rating of 3400 MW(t) and a design gross electrical output of approximately 1200 MW(e) (Duke 2009c). The AP1000s are expected to operate with a 93 percent capacity factor, so the net electrical output (annualized) would be about 1117 MW(e). Fuel for the plants would have an average enrichment of about 4.51 weight percent uranium-235, which exceeds the 10 CFR 51.52(a) condition. In addition, the expected irradiation level of about 62,000 MWd/MTU exceeds the 10 CFR 51.52(a) condition. Therefore, a full description and detailed analysis of transportation impacts is required.

In its environmental report (Duke 2009c), Duke provided a full description and detailed analyses of transportation impacts. In its analyses, radiological impacts of transporting fuel and waste to and from the Lee Nuclear Station and alternative sites were calculated using the RADTRAN 5.6

computer code (Weiner et al. 2008). For this EIS, radiological impacts of transporting fuel and waste to and from the Lee Nuclear Station and alternative sites were estimated using the RADTRAN 5.6 computer code. RADTRAN 5.6 is the most commonly used transportation impact analysis computer code in the nuclear industry, and the NRC staff concludes that the code is an acceptable analysis method.

Based on comments on previous nuclear power plant EISs, an explicit analysis of the nonradiological impacts of transporting workers and construction materials to and from the Lee Nuclear Station and alternative sites is now included. Nonradiological impacts of transporting construction workers and materials and operations workers are addressed in Sections 4.8.3 and 5.8.6, respectively. Publicly available information about traffic accidents, injury, and fatality rates was used to estimate nonradiological impacts. In addition, the radiological impacts to maximally exposed individuals (MEIs) are evaluated.

6.2.1 Transportation of Unirradiated Fuel

The NRC staff performed an independent analysis of the environmental impacts of transporting unirradiated (i.e., fresh) fuel to the Lee Nuclear Station. Radiological impacts of normal operating conditions and transportation accidents as well as nonradiological impacts are discussed in this section. Radiological impacts to populations and MEIs are presented. Because the specific fuel fabrication plant for Lee Nuclear Station unirradiated fuel is not known at this time, the staff's analysis assumes a "representative" route between the fuel fabrication facility and the Lee Nuclear Station site or alternative sites. This means that one analysis was done using a "representative" route with one set of route characteristics (distances and population distributions), and that analysis was used to conclude that the impact from radiation dose would be small for the Lee Nuclear Station site and each of the alternative sites. Once the location of the fuel fabrication site is known, there would likely be small differences in the route and dose estimates for the Lee Nuclear Station site and the alternative sites. However, the radiation doses from transporting unirradiated fuel to the Lee Nuclear Station site and alternative sites would still be small.

6.2.1.1 Normal Conditions

Normal conditions, sometimes referred to as "incident-free" transportation, are transportation activities in which shipments reach their destination without releasing any radioactive material to the environment. Impacts from these shipments would be from the low levels of radiation that penetrate the unirradiated fuel shipping containers. Radiation exposures would occur to (1) persons residing along the transportation corridors between the fuel fabrication facility and the Lee Nuclear Station site; (2) persons in vehicles traveling on the same route as an unirradiated fuel shipment; (3) persons at vehicle stops for refueling, rest, and vehicle inspections; and (4) transportation crew workers.

Truck Shipments

Table 6-3 provides the NRC staff's estimate of the number of truck shipments of unirradiated fuel for the AP1000 compared to those of the reference 1100-MW(e) reactor specified in WASH-1238 (AEC 1972) operating at 80 percent capacity (880 MW(e)). After normalization, the number of truck shipments of unirradiated fuel to the Lee Nuclear Station site is fewer than the number of truck shipments of unirradiated fuel estimated for the reference LWR in WASH-1238 (AEC 1972).

Table 6-3. Numbers of Truck Shipments of Unirradiated Fuel for Each Advanced Reactor Type

Reactor Type	Number of Shipments per Reactor Unit			Unit Electric Generation, MW(e)[c]	Capacity Factor[c]	Normalized, Shipments per 1100 MW(e)[d]
	Initial Core[a]	Annual Reload	Total[b]			
Reference LWR (WASH-1238)	18	6	252	1100	0.8	252
Lee Nuclear Station AP1000	23	6	257	1117	0.93	244

(a) Shipments of the initial core have been rounded up to the next highest whole number.
(b) Total shipments of unirradiated fuel over a 40-year plant lifetime (i.e., initial core load plus 39 years of average annual reload quantities).
(c) Unit capacities and capacity factors were taken from WASH-1238 (AEC 1972) for the reference LWR and the environmental report (ER) (Duke 2009c) for the AP1000.
(d) Normalized to net electric output for WASH-1238 reference LWR [i.e., 1100-MW(e) plant at 80 percent or net electrical output of 880 MW(e)].

Shipping Mode and Weight Limits

In 10 CFR 51.52, a condition is identified that states all unirradiated fuel is shipped to the reactor by truck. Duke (2009c) specifies that unirradiated fuel would be shipped to the reactor site by truck. Section 10 CFR 51.52 includes a condition that the truck shipments shall not exceed 33,100 kg (73,000 lb) as governed by Federal or State gross vehicle weight restrictions. Duke (2009c) states that the unirradiated fuel shipments to the proposed Lee Nuclear Station site would comply with applicable weight restrictions.

Radiological Doses to Transport Workers and the Public

Section 10 CFR 51.52, Table S–4, includes conditions related to radiological dose to transport workers and members of the public along transport routes. These doses are a function of many variables, including the radiation dose rate emitted from the unirradiated fuel shipments, the number of exposed individuals and their locations relative to the shipment, the time in transit (including travel and stop times), and number of shipments to which the individuals are exposed. For this EIS, the NRC staff independently calculated the radiological dose impacts to transport workers and the public from the transportation of unirradiated fuel using the RADTRAN 5.6 computer code (Weiner et al. 2008).

One of the key assumptions in WASH-1238 (AEC 1972) for the reference LWR unirradiated fuel shipments is that the radiation dose rate 1 m (3.3 ft) from the transport vehicle is 0.001 mSv/hr (0.1 mrem/hr), which is one percent of the regulatory limit. This assumption was also used in the NRC staff's analysis of the AP1000 unirradiated fuel shipments. This assumption is reasonable because the AP1000 fuel materials would be low-dose-rate uranium radionuclides and would be packaged similarly to that described in WASH-1238 (i.e., inside a metal container that provides little radiation shielding). The numbers of shipments per year were obtained by dividing the normalized shipments in Table 6-3 by 40 years of operation. Other key input parameters used in the radiation dose analysis for unirradiated fuel shipments are shown in Table 6-4.

Table 6-4. RADTRAN 5.6 Input Parameters for Fresh Fuel Shipments

Parameter	RADTRAN 5.6 Input Value	Source
Shipping distance, km	3200	AEC (1972)[(a)]
Travel fraction – Rural	0.90	NRC (1977d)
Travel fraction – Suburban	0.05	
Travel fraction – Urban	0.05	
Population density – Rural, persons/km^2	10	DOE (2002a)
Population density – Suburban, persons/km^2	349	
Population density – Urban, persons/km^2	2260	
Vehicle speed – km/hr	88.49	Conservative in transit speed of 55 mph assumed; predominantly interstate highways used
Traffic count – Rural, vehicles/hr	530	DOE (2002a)
Traffic count – Suburban, vehicles/hr	760	
Traffic count – Urban, vehicles/hr	2400	
Dose rate at 1 m from vehicle, mrem/hr	0.1	AEC (1972)
Packaging length, m	7.3	Approximate length of two LWR fuel element packages placed on end
Number of truck crew	2	AEC (1972), NRC (1977d), DOE (2002a)
Stop time, hr/trip	4	Based on one 30-minute stop per 400 km (Griego et al. 1996)
Population density at stops, persons/km^2	See Table 6-8 for truck stop parameters.	

(a) AEC (1972) provides a range of shipping distances between 40 km (25 mi) and 4800 km (3000 mi) for fresh fuel shipments. A 3200-km (2000-mi) "representative" shipping distance was assumed here.

The RADTRAN 5.6 results for this "generic" unirradiated fuel shipment are as follows:

- worker dose: 1.71 × 10^{-5} person-Sv/shipment (1.71 × 10^{-3} person-rem/shipment)
- general public dose (onlookers/persons at stops and sharing the highway): 2.95 × 10^{-5} person-Sv/shipment (2.95 × 10^{-3} person-rem/shipment)
- general public dose (along route/persons living near a highway or truck stop): 4.17 × 10^{-7} person-Sv/shipment (4.17 × 10^{-5} person-rem/shipment).

These values were combined with the average annual shipments of unirradiated fuel for the AP1000 to calculate annual doses to the public and workers. Table 6-5 presents the annual radiological impacts calculated by the NRC staff to workers, public onlookers (persons at stops and sharing the road), and members of the public along the route (i.e., residents within 800 m [0.5 mi] of the highway) for transporting unirradiated fuel to the Lee Nuclear Station site and alternative sites. The cumulative annual dose estimates in Table 6-5 were normalized to 1100 MW(e) (880 MW(e) net electrical output). The NRC staff performed an independent review and determined that all dose estimates are bounded by the Table S–4 conditions of 4 person-rem/yr to transportation workers, 3 person-rem/yr to onlookers, and 3 person-rem/yr to members of the public along the route.

Table 6-5. Radiological Impacts Under Normal Conditions of Transporting Unirradiated Fuel to the Lee Nuclear Station Site

Plant Type	Normalized Average Annual Shipments	Cumulative Annual Dose; person-Sv/yr per 1100 MW(e)[(a)] [880 MW(e) Net]		
		Workers	Public - Onlookers	Public - Along Route
Reference LWR (WASH-1238)	6.3	1.1 × 10^{-4}	1.9 × 10^{-4}	2.6 × 10^{-6}
Lee Nuclear Station AP1000	6.1	1.2 × 10^{-4}	2.1 × 10^{-4}	2.9 × 10^{-6}
10 CFR 51.52, Table S–4 condition	<1 per day	4.0 × 10^{-2}	3.0 × 10^{-2}	3.0 × 10^{-2}

(a) Multiply person-Sv/yr times 100 to obtain doses in person-rem/yr.

Radiation protection experts assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. A recent report by the National Research Council (2006), the BEIR VII report, uses the linear, no-threshold dose response model as a basis for estimating the risks from low doses. This approach is accepted by the NRC as a conservative method for estimating health risks from radiation exposure, recognizing that the model may overestimate those risks. Based on this method, the NRC staff estimated the risk to the public from radiation exposure using the nominal probability coefficient for total detriment. This coefficient has the value of 570 fatal cancers, nonfatal cancers, and severe hereditary effects per 1,000,000 person-rem (10,000 person-Sv), equal to 0.00057 effects per person-rem. The coefficient is taken from ICRP's Publication 103 (ICRP 2007).

Both the NCRP and ICRP suggest that when the collective effective dose is smaller than the reciprocal of the relevant risk detriment (in other words, less than 1/0.00057, which is less than 1754 person-rem), the risk assessment should note that the most likely number of excess health effects is zero (NCRP 1995; ICRP 2007). The largest annual collective dose estimate for transporting unirradiated fuel to the Lee Nuclear Station site and alternative sites was 2.0×10^{-2} person-rem, which is less than the 1754 person-rem value that ICRP and NCRP suggest would most likely result in zero excess health effects.

To place these impacts in perspective, the average U.S. resident receives about 311 mrem/yr effective dose equivalent from natural background radiation (i.e., exposures from cosmic radiation, naturally occurring radioactive materials such as radon, and global fallout from testing of nuclear explosive devices) (NCRP 2009). Using this average effective dose, the collective population dose from natural background radiation to the population along this representative route would be about 2.2×10^{5} person-rem. Therefore, the radiation doses from transporting unirradiated fuel to the proposed Lee Nuclear Station site and alternative sites are minimal compared to the collective population dose to the same population from exposure to natural sources of radiation.

Maximally Exposed Individuals under Normal Transport Conditions

The NRC staff conducted a scenario-based analysis to develop estimates of incident-free radiation doses to MEIs for fuel and waste shipments to and from the Lee Nuclear Station site. An MEI is a person who may receive the highest radiation dose from a shipment to and/or from the proposed Lee Nuclear Station site. This discussion applies to unirradiated fuel shipments to, and spent fuel and radioactive shipments from the proposed Lee Nuclear Station site and any of the alternative sites. The analysis is based on information in DOE's *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (DOE 2002b) and incorporates information about exposure times, dose rates, and the number of times an individual may be exposed to an offsite shipment. Adjustments were made where necessary to reflect the fuel and waste shipments addressed in this EIS. In all cases, the NRC staff assumed that the dose rate emitted from the shipping containers is 10 mrem/hr 6.6 ft from the side of the transport vehicle, the maximum dose rate allowed by U.S. Department of Transportation (DOT) regulations (49 CFR 173.441), even though most unirradiated fuel and radioactive waste shipments would have much lower dose rates than the regulations allow (AEC 1972; DOE 2002a). The analysis is described below.

Truck crew member. Truck crew members would receive the highest radiation doses during incident-free transport because of their proximity to the loaded shipping container for an extended period of time. The analysis assumed that crew member doses are limited to 2 rem/year, which is the DOE administrative control level presented in DOE-STD-1098-99, *DOE Standard, Radiological Control*, Chapter 2, Article 211 (DOE 2005). This limit is anticipated to apply to shipments of spent nuclear fuel to a disposal facility, because DOE would take title to the spent fuel at the reactor site. There would be more shipments of spent nuclear fuel from the Lee Nuclear Station site or alternative sites than shipments of unirradiated fuel to, and radioactive waste other than spent fuel from, these sites. This is because the capacities of spent fuel shipping casks are limited due to their substantial radiation shielding and accident resistance requirements. Spent fuel shipments would also have significantly higher radiation dose rates than unirradiated fuel and radioactive waste (DOE 2002a). As a result, crew doses from shipments of unirradiated fuel and radioactive waste would be lower than the doses from shipments of spent nuclear fuel. The DOE administrative limit of 2 rem/yr (DOE 2009a) is less than the NRC limit for occupational exposures of 5 rem/yr (10 CFR Part 20).

The DOT does not regulate annual occupational exposures but recommends limits to air crew members that are a 5-year effective dose of 2 rem/yr with no more than 5 rem in a single year (DOT 2003). As a result, a 2-rem/yr MEI dose to truck crews is a reasonable estimate to apply to shipments of fuel and waste from the Lee Nuclear Station site.

Inspectors. Radioactive shipments are inspected by Federal or State vehicle inspectors at, for example, State ports of entry. DOE (2002a) assumed that inspectors would be exposed for 1 hour at a distance of 3.3 ft from the shipping containers. The dose rate at 3.3 ft is about 14 mrem/hr; therefore, the dose per shipment is about 14 mrem. This is independent of the location of the reactor site. Based on this conservative value, the annual doses to vehicle inspectors were calculated by the NRC staff to be about 0.9 rem/yr, assuming the same person inspects all shipments of fuel and waste to and from the proposed Lee Nuclear Station site and alternative sites. This value is about one-half of the 2-rem/yr DOE administrative control level on individual doses and one-fifth of the 5-rem/yr NRC occupational dose limit.

Resident. The analysis assumed that a resident lives adjacent to a highway where a shipment would pass and would be exposed to all shipments along a particular route. Exposures to residents on a per-shipment basis were extracted from RADTRAN 5.6 output files. These dose estimates are based on an individual located 100 ft from shipments that are traveling 15 mph. The potential radiation dose to the maximally exposed resident is 0.039 mrem/yr for shipments of fuel and waste to and from the proposed Lee Nuclear Station site and alternative sites.

Individual stuck in traffic. This scenario addresses potential traffic interruptions that could lead to a person being exposed to a loaded shipment for 1 hour at a distance of 4 ft. The analysis assumed this exposure scenario would occur only one time to any individual, and the dose rate was at the regulatory limit of 10 mrem/hr at 6 ft from the shipment. The dose to the MEI was calculated in DOE (2002a) to be 16 mrem.

Person at a truck service station. This scenario estimates doses to an employee at a service station where all truck shipments to and from the proposed Lee Nuclear Station site are assumed to stop. DOE (2002a) assumed this person is exposed for 49 minutes at a distance of 52 ft from the loaded shipping container. The exposure time and distance were based on the observations discussed by Griego et al. (1996). This results in a dose of 0.34 mrem/shipment and an annual dose of about 23 mrem/yr for the proposed Lee Nuclear Station site and alternative sites, assuming that a single individual services all unirradiated fuel, spent fuel, and radioactive waste shipments to and from the site.

6.2.1.2 Radiological Impacts of Transportation Accidents

Accident risks are a combination of accident frequency and consequence. Accident frequencies for transportation of unirradiated fuel to the Lee Nuclear Station site and alternative sites are expected to be lower than those used in the analysis in WASH-1238 (AEC 1972), the basis for Table S–4 of 10 CFR 51.52, because of improvements in highway safety and security and an overall reduction in traffic accident, injury, and fatality rates since WASH-1238 was published. There is no significant difference in consequences of accidents severe enough to result in a release of unirradiated fuel particles to the environment between the AP1000 and current-generation LWRs because fuel form, cladding, and packaging are similar to those analyzed in WASH-1238. Consequently, the impacts of accidents during transport of unirradiated fuel for advanced LWRs to the proposed Lee Nuclear Station site and alternative sites are expected to be smaller than those listed in Table S–4 for current-generation LWRs.

6.2.1.3 Nonradiological Impacts of Transportation Accidents

Nonradiological impacts are the human health impacts projected to result from traffic accidents involving shipments of unirradiated fuel to the Lee Nuclear Station site and alternative sites; they do not consider radiological or hazardous characteristics of the cargo. Nonradiological impacts include the projected number of traffic accidents, injuries, and fatalities that could result from shipments of unirradiated fuel to the site and return shipments of empty containers from the site.

Nonradiological impacts are calculated using accident, injury, and fatality rates from published sources. The rates (i.e., impacts per vehicle-km traveled) are then multiplied by estimated travel distances for workers and materials. The general formula for calculating nonradiological impacts is as follows:

$$\text{Impacts} = (\text{unit rate}) \times (\text{round-trip shipping distance}) \times (\text{annual number of shipments}).$$

In this formula, impacts are presented in units of the number of accidents, number of injuries, and number of fatalities per year. Corresponding unit rates (i.e., impacts per vehicle-km traveled) are used in the calculations.

Accident, injury, and fatality rates were taken from Table 4 in ANL/ESD/TM-150, *State-Level Accident Rates for Surface Freight Transportation: A Reexamination* (Saricks and Tompkins 1999). Nationwide median rates were used for shipments of unirradiated fuel to the site. The data are representative of traffic accident, injury, and fatality rates for heavy truck shipments similar to those to be used to transport unirradiated fuel to the Lee Nuclear Station site. In addition, the DOT Federal Motor Carrier Safety Administration evaluated the data underlying the Saricks and Tompkins (1999) rates, which were taken from the Motor Carrier Management Information System, and determined that the rates were under-reported. Therefore, the accident, injury, and fatality rates in Saricks and Tompkins (1999) were adjusted using factors derived from data provided by the University of Michigan Transportation Research Institute (UMTRI 2003). The UMTRI data indicates that accident rates for 1994 to 1996, the same data used by Saricks and Tompkins (1999), were under-reported by about 39 percent. Injury and fatality rates were under-reported by 16 and 36 percent, respectively. As a result, the accident, injury, and fatality rates were increased by factors of 1.64, 1.20, and 1.57, respectively.

The nonradiological accident impacts calculated by the NRC staff for transporting unirradiated fuel to (and empty shipping containers from) the Lee Nuclear Station site are shown in Table 6-6. The nonradiological impacts associated with the WASH-1238 reference LWR are also shown for comparison. Note that there are only small differences between the impacts calculated for an AP1000 reactor at the Lee Nuclear Station site and the reference LWR in WASH-1238 due entirely to the smaller number of shipments.

Table 6-6. Nonradiological Impacts of Transporting Unirradiated Fuel to the Lee Nuclear Station Site with Single AP1000 Reactor, Normalized to Reference LWR

Plant Type	Annual Shipments Normalized to Reference LWR	One-Way Shipping Distance, km	Annual Round-Trip Distance, km	Annual Impacts: Accidents per Year	Annual Impacts: Injuries per Year	Annual Impacts: Fatalities per Year
WASH-1238	6.3	3200	4.0×10^{4}	1.9×10^{-2}	9.3×10^{-3}	5.8×10^{-4}
Lee Nuclear Station	6.1	3200	3.9×10^{4}	1.8×10^{-2}	9.0×10^{-3}	5.6×10^{-4}

6.2.2 Transportation of Spent Fuel

The NRC staff performed an independent analysis of the environmental impacts of transporting spent fuel from the proposed Lee Nuclear Station site to a spent fuel disposal repository. For the purposes of these analyses, the NRC staff considered the proposed geologic HLW repository at Yucca Mountain in Nevada as a surrogate destination. Currently, the NRC has not made a decision about the DOE application for the proposed geologic repository at Yucca Mountain. However, the NRC staff considers an estimate of the impacts of transportation of spent fuel to a possible repository in Nevada as a reasonable bounding estimate of the transportation impacts to a storage or disposal facility because of the distances involved and the representativeness of the distribution of members of the public in urban, suburban, and rural areas (i.e., population distributions) along the shipping routes. Radiological and nonradiological environmental impacts of normal operating conditions and transportation accidents, as well as nonradiological impacts, are discussed in this section. The NRC Yucca Mountain adjudicatory proceeding is currently suspended and Yucca Mountain-related matters are pending in Federal Court. Regardless of the outcome of these proceedings, the NRC staff concludes that transportation impacts are roughly proportional to the distance from the reactor site to the repository site, in this case South Carolina to Nevada.

The NRC's analysis is based on shipment of spent fuel by legal-weight trucks in shipping casks with characteristics similar to casks currently available (i.e., massive, heavily shielded, cylindrical metal pressure vessels). Each shipment is assumed to consist of a single shipping cask loaded on a modified trailer. These assumptions are consistent with assumptions made in the evaluation of the environmental impacts of transportation of spent fuel in Addendum 1 to NUREG-1437 (NRC 1999a). These assumptions are conservative because the alternatives involve rail transportation or heavy-haul trucks, which would reduce the overall number of spent fuel shipments (NRC 1999a), thus reducing impacts. Also, use of current shipping cask designs results in conservative impact estimates because the current designs are based on transporting short-cooled spent fuel (approximately 120 days out of reactor). Future shipping casks would be designed to transport longer-cooled fuel (greater than 5 years out of reactor) and would require much less shielding to meet external dose limitations. Therefore, future shipping casks are expected to have higher cargo capacities, thus reducing the numbers of shipments and associated impacts.

The NRC staff calculated the radiological impacts of transportation of spent fuel using the RADTRAN 5.6 computer code (Weiner et al. 2008). Routing and population data used in RADTRAN 5.6 for truck shipments were obtained from the Transportation Routing Analysis Geographic Information System (TRAGIS) routing code (Johnson and Michelhaugh 2003). The population data in the TRAGIS code are based on the 2000 census. Nonradiological impacts were calculated using published traffic accident, injury, and fatality data (Saricks and Tompkins 1999) in addition to route information from TRAGIS. The NRC staff adjusted traffic accident rates to account for under-reporting as discussed in Sections 4.8.3 and 6.2.1.3.

6.2.2.1 Normal Conditions

Normal conditions, sometimes referred to as "incident-free" transportation, are transportation activities in which shipments reach their destination without an accident occurring enroute. Impacts from these shipments would be from the low levels of radiation that penetrate the heavily shielded spent fuel shipping cask. Radiation exposures would occur to (1) persons residing along the transportation corridors between the Lee Nuclear Station site and the proposed repository location; (2) persons in vehicles traveling on the same route as a spent fuel shipment; (3) persons at vehicle stops for refueling, rest, and vehicle inspections; and (4) transportation crew workers. For purposes of this analysis, the NRC staff assumed that the destination for the spent fuel shipments is the proposed geologic HLW repository at Yucca Mountain in Nevada. This assumption is conservative because it tends to maximize the shipping distance from the Lee Nuclear Station site and alternative sites.

Shipping casks have not been designed for the spent fuel from advanced reactor designs such as the AP1000. Idaho National Engineering and Environmental Laboratory (INEEL 2003) indicated that advanced LWR fuel designs would not be significantly different from existing LWR designs; therefore, current shipping cask designs were used for the analysis of AP1000 reactor spent fuel shipments. The assumed capacity of a truck shipment of AP1000 reactor spent fuel was 0.5 MTU/shipment, the same capacity as that used in WASH-1238 (AEC 1972).

Input to RADTRAN 5.6 includes the total shipping distance between the origin and destination sites and the population distributions along the routes. This information was obtained by running the TRAGIS computer code (Johnson and Michelhaugh 2003) for shipments from the Lee Nuclear Station site and alternative sites to the proposed geologic HLW repository at Yucca Mountain. The resulting route characteristics, generated by the NRC staff, are shown in Table 6-7.

Table 6-7. Transportation Route Information for Shipments from Lee Nuclear Station Site and Alternative Sites to the Yucca Mountain Spent Fuel Disposal Facility[(a)]

	One-way Shipping Distance, km				Population Density, persons/km^2			Stop Time per Trip, hr
Reactor Site	**Total**	**Rural**	**Suburban**	**Urban**	**Rural**	**Suburban**	**Urban**	
Lee Nuclear Station	4041	3209	754	78	9.7	310.4	2213.8	5
Keowee[(b)]	4044	3153	793	98	9.6	320.6	2285.7	5
Middleton Shoals[(b)]	4019	3144	778	97	9.6	322.4	2286.3	5
Perkins[(b)]	4187	3250	850	86	9.8	317.4	2202.6	5

Source: Johnson and Michelhaugh 2003

(a) This table presents aggregated route characteristics. Input to the RADTRAN 5.6 computer code was disaggregated to a state-by-state level.

(b) The highway distance between the reactor site and the nearest TRAGIS node are included. Google Maps™ was used to determine the highway distance between these sites and the nearest TRAGIS node.

Note that for truck shipments, all the spent fuel is assumed to be shipped to the Yucca Mountain site over designated highway-route controlled-quantity routes. In addition, TRAGIS data was loaded into RADTRAN 5.6 on a state-by-state basis, which increases precision and allows results to be presented for each state along the route between the Lee Nuclear Station site or alternative sites and the proposed geologic HLW repository at Yucca Mountain, if desired.

Radiation doses are a function of many parameters, including vehicle speed, traffic count, dose rate, packaging dimensions, number in the truck crew, stop time, and population density at stops. The values for these parameters and others used in the NRC staff's analysis and the sources of the information are provided in Table 6-8.

Table 6-8. RADTRAN 5.6 Normal (Incident-free) Exposure Parameters

Parameter	RADTRAN 5.6 Input Value	Source
Vehicle speed, km/hr	88.49	Based on average speed in rural areas given in A Resource Handbook on DOE Transportation Risk Assessment (DOE 2002a). Conservative in-transit speed of 55 mph assumed; predominantly interstate highways used.
Traffic count – Rural, vehicles/hr	State-specific	Weiner et al. (2008)
Traffic count – Suburban, vehicles/hr		
Traffic count – Urban, vehicles/hr		
Vehicle occupancy, persons/vehicle	1.5	DOE (2002a)
Dose rate at 1 m from vehicle, mrem/hr	14	DOE (2002a, b) – approximate dose rate at 1 m that is equivalent to maximum dose rate allowed by Federal regulations (i.e., 10 mrem/hr at 2 m from the side of a transport vehicle.
Packaging dimensions, m	Length – 5.2 Diameter – 1.0	DOE (2002b)
Number of truck crew	2	AEC (1972), NRC (1977d), DOE (2002a, b)
Stop time, hr/trip	4	See Table 6-5
Population density at stops, persons/km^2	30,000	Sprung et al. (2000). Nine persons within 10 m of vehicle (see Figure 6-2).
Min/Max radii of annular area around vehicle at stops, m	1 to 10	Sprung et al. (2000)
Shielding factor applied to annular area surrounding vehicle at stops	1 (no shielding)	Sprung et al. (2000)
Population density surrounding truck stops, persons/km^2	340	Sprung et al. (2000)
Min/Max radius of annular area surrounding truck stop, m	10 to 800	Sprung et al. (2000)
Shielding factor applied to annular area surrounding truck stop	0.2	Sprung et al. (2000)

For this analysis, the transportation crew for spent fuel shipments delivered by truck is assumed to consist of two drivers. Escorts were considered but not included because their distance from the shipping cask would reduce the dose rates to levels well below those experienced by the drivers. Stop times were assumed to accrue at the rate of 30 minutes per 4 hours driving time. TRAGIS outputs were used to determine the number of stops. Doses to the public at truck stops have been significant contributors to the doses calculated in previous RADTRAN 5.6 analyses. For this analysis, stop doses are the sum of the doses to individuals located in two annular rings centered at the stopped vehicle, as illustrated in Figure 6-2. The inner ring represents persons who may be at the truck stop at the same time as a spent fuel shipment and extends 1 to 10 m from the edge of the vehicle. The outer ring represents persons who reside near a truck stop and extends from 10 to 800 m from the vehicle. This scheme is similar to that used in Sprung et al. (2000). Population densities and shielding factors were also taken from Sprung et al. (2000), which were based on the observations of Griego et al. (1996).

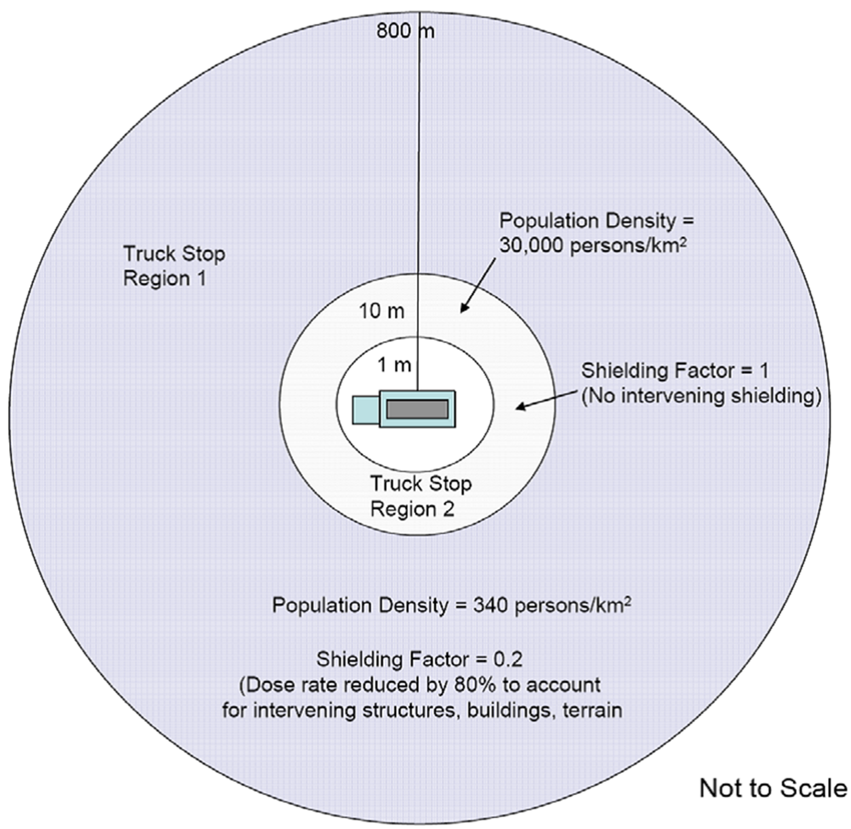

Figure 6-2. Illustration of Truck Stop Model (Sprung et al. 2000)

The results calculated by the NRC staff for these normal (incident-free) exposure calculations are shown in Table 6-9 for the proposed Lee Nuclear Station site. Population dose estimates are given for workers (i.e., truck crew members), onlookers (doses to persons at stops and persons on highways exposed to the spent fuel shipment), and along the route (persons living near the highway). Shipping schedules for spent fuel generated by the proposed new Lee Nuclear Station site units have not been determined. The NRC staff concluded it is reasonable to calculate annual doses assuming that the annual number of spent fuel shipments is equivalent to the annual refueling requirements. Population doses were normalized to the reference LWR in WASH-1238 (880 net MW(e)). This corresponds to an 1100-MW(e) LWR operating at 80 percent capacity.

There are only small differences in transportation impacts among the Lee Nuclear Station site and alternative sites. The differences are due to the route characteristics (e.g., distance and population density) for shipments from the proposed Lee Nuclear Station site and alternative sites to the proposed geologic HLW repository at Yucca Mountain.

Table 6-9. Normal (Incident-Free) Radiation Doses to Transport Workers and the Public from Shipping Spent Fuel from the Lee Nuclear Station Site and Alternative Sites to the Proposed Geologic HLW Repository at Yucca Mountain

	Normalized Impacts, Person-rem/yr[a]		
Site and Reactor Type	**Worker (Crew)**	**Onlookers**	**Along Route**
Reference LWR, (WASH-1238)[b]	1.1×10^{1}	2.0×10^{1}	2.0×10^{1}
Lee Nuclear Station normalized impacts	7.5×10^{0}	1.3×10^{1}	3.7×10^{-1}
Keowee site normalized impacts	7.5×10^{0}	1.4×10^{1}	4.0×10^{-1}
Middleton Shoals site normalized impacts	7.5×10^{0}	1.3×10^{1}	3.9×10^{-1}
Perkins site normalized impacts	7.8×10^{0}	1.4×10^{1}	4.2×10^{-1}
Table S–4 condition	4×10^{0}	3×10^{0}	3×10^{0}

(a) To convert person-rem to person-Sv, divide by 100.
(b) Based on 60 shipments per year.

The bounding cumulative doses to the exposed population given in Table S–4 are as follows:

- 4 person-rem/reactor-year to transport workers
- 3 person-rem/reactor-year to general public (onlookers) and members of the public along the route.

The calculated population doses to the crew and onlookers for the reference LWR and to onlookers for the Lee Nuclear Station site shipments exceed Table S–4 values. A key reason for the higher population doses relative to Table S–4 is the longer shipping distances assumed for this analysis (i.e., to a possible repository in Nevada) than were used in WASH-1238

(AEC 1972). WASH-1238 used a "typical" distance for a spent fuel shipment of 1000 mi, whereas the shipping distance used in this assessment was about 2500 mi. If the shorter distance were used to calculate the impacts for the Lee Nuclear Station spent fuel shipments, the doses in Table 6-9 could be reduced by half or more. Other important differences are the model related to vehicle stops described above and the additional precision that results from incorporating state-specific route characteristics and vehicle densities on highways (vehicles per hour).

Where necessary, the NRC staff made conservative assumptions to calculate impacts. Some of the key conservative assumptions are the following:

- <u>Use of the regulatory maximum dose rate (10 mrem/hr at 2 m) in the RADTRAN 5.6 calculations</u>. The shipping casks assumed in the EIS prepared by DOE in support of the application for the proposed geologic HLW repository at Yucca Mountain (DOE 2002b) were designed to transport spent fuel that has cooled for 5 years. Most spent fuel will have cooled for much longer than 5 years before it is shipped to a possible geologic repository. Shipments from the Lee Nuclear Station site are also expected to be cooled for longer than 5 years. Consequently, the estimated population doses in Table 6-9 could be further reduced if more realistic dose rate projections and shipping cask capacities are used.
- <u>Use of 30 minutes as the average time at a truck stop in the calculations</u>. Many stops made for actual spent fuel shipments are of short duration (e.g., 10 minutes) for brief visual inspections of the cargo (e.g., checking the cask tie-downs). These stops typically occur in minimally populated areas such as an overpass or freeway ramp in an unpopulated area. Furthermore, empirical data provided in Griego et al. (1996) indicate that 30 minutes is toward the high end of the stop time distribution. Average stop times observed by Griego et al. (1996) are on the order of 18 minutes.

A sensitivity study was performed to demonstrate the effects of using more realistic dose rates and stop times for the incident-free population dose calculations. For this sensitivity study, the dose rate was reduced to 5 mrem/hr, the approximate 50 percent confidence interval of the dose rate distribution estimated by Sprung et al. (2000) for future spent fuel shipments. The stop time was reduced to 18 minutes per stop. All other RADTRAN 5.6 input values were unchanged. The result is that the annual crew doses were reduced to 2.7 person-rem/yr, or about 36 percent of the annual dose shown in Table 6-9. The annual onlooker doses were reduced to 3.6 person-rem/yr (27 percent) and the annual doses to persons along the route were reduced to 1.4×10^{-1} person-rem/yr (37 percent). All of these dose estimates are below the Table S–4 conditions.

Using the linear no-threshold dose response relationship discussed in Section 6.2.1.1, the annual public dose impacts for transporting spent fuel from the Lee Nuclear Station site or alternative sites to Yucca Mountain are about 20 person-rem, which is less than the

1754 person-rem value ICRP (ICRP 2007) and NCRP (NCRP 1995) suggest would most likely result in no excess health effects. This dose is very small compared to the estimated 1.8×10^5 person-rem that the same population along the route from the proposed Lee Nuclear Station site to the proposed geologic HLW repository at Yucca Mountain would incur annually from exposure to natural sources of radiation. Note that the estimated population dose along the route from Lee Nuclear Station site to Yucca Mountain from natural background radiation is different than the natural background dose calculated by the NRC staff for unirradiated fuel shipments in Section 6.2.1.1 of this EIS because the route characteristics are different. A generic route was used in Section 6.2.1.1 for unirradiated fuel shipments and actual highway routes were used in this section for spent fuel shipments.

Dose estimates to the MEI from transport of unirradiated fuel, spent fuel, and wastes under normal conditions are presented in Section 6.2.1.1.

6.2.2.2 Radiological Impacts of Transportation Accidents

As discussed previously, the NRC staff used the RADTRAN 5.6 computer code to estimate impacts of transportation accidents involving spent fuel shipments. RADTRAN 5.6 considers a spectrum of postulated transportation accidents ranging from those with high frequencies and low consequences (e.g., “fender benders”) to those with low frequencies and high consequences (i.e., accidents in which the shipping container is exposed to severe mechanical and thermal conditions).

Radionuclide inventories are important parameters in the calculation of accident risks. The radionuclide inventories used in this analysis were from Duke’s environmental report (ER) (Duke 2009c) and *Early Site Permit Environmental Report Sections and Supporting Documentation* (INEEL 2003). Spent fuel inventories used in the NRC staff analysis are presented in Table 6-10. The radionuclides listed in the table include all those used in the analysis conducted by Sprung et al. (2000). The analysis also included the inventory of crud (i.e., radioactive material deposited on the external surfaces of LWR spent fuel rods). Because crud is deposited from corrosion products generated elsewhere in the reactor cooling system and the complete reactor design and operating parameters are uncertain, the quantities and characteristics of crud deposited on AP1000 reactor spent fuel are not available at this time. For this analysis, the Lee Nuclear Station spent fuel transportation accident impacts were calculated assuming the cobalt-60 inventory in the form of crud is 120 Ci/MTU, based on information in Sprung et al. (2000).

Robust shipping casks are used to transport spent fuel because of the radiation shielding and accident resistance required by 10 CFR Part 71. Spent fuel shipping casks must be certified Type B packaging systems, meaning they must withstand a series of severe postulated accident conditions with essentially no loss of containment or shielding capability. These casks are also designed with fissile material controls to ensure the spent fuel remains subcritical under normal and accident conditions. According to Sprung et al. (2000), the probability of encountering accident conditions that would lead to shipping-cask failure is less than 0.01 percent (i.e., more than 99.99 percent of all accidents would result in no release of radioactive material from the shipping cask). The NRC staff assumed that shipping casks for AP1000 spent fuel would provide equivalent mechanical and thermal protection of the spent fuel cargo.

Table 6-10. Radionuclide Inventories Used in Transportation Accident Risk Calculations for AP1000

Radionuclide	Ci/MTU[(a)]	Physical-Chemical Group
Pu-241	6.96×10^4	Particulate
Pu-238	6.07×10^3	Particulate
Cm-244	7.75×10^3	Particulate
Am-241	7.27×10^2	Particulate
Pu-240	5.43×10^2	Particulate
Pu-239	2.55×10^2	Particulate
Sr-90	6.19×10^4	Particulate
Cs-137	9.31×10^4	Cesium
Am-243	3.34×10^1	Particulate
Cm-243	3.07×10^1	Particulate
Am-242m	1.31×10^1	Particulate
Ru-106	1.55×10^4	Ruthenium
Eu-154	9.13×10^3	Particulate
Cs-134	4.80×10^4	Cesium
Ce-144	8.87×10^3	Particulate
Sb-125	3.83×10^3	Particulate
Pu-242	1.82×10^0	Particulate
Cm-242	2.83×10^1	Particulate
Pm-147	1.76×10^4	Particulate
Cm-245	1.21×10^0	Particulate
Y-90	6.19×10^4	Particulate
Eu-155	4.62×10^3	Particulate
Co-60[(b)]	1.20×10^2	Crud

(a) The source of the spent fuel inventories is Duke (2009c).
(b) Cobalt-60 is the key radionuclide constituent of fuel assembly crud.

Accident frequencies were calculated in RADTRAN 5.6 using user-specified accident rates and conditional shipping-cask failure probabilities. State-specific accident rates were taken from Saricks and Tompkins (1999) and used in the RADTRAN 5.6 calculations. The state-specific accident rates were adjusted to account for under-reporting, as described in Section 4.8.3.

Conditional shipping-cask failure probabilities (i.e., the probability of cask failure as a function of the mechanical and thermal conditions applied in an accident) were taken from Sprung et al. (2000).

The RADTRAN 5.6 accident risk calculations were performed using radionuclide inventories (Ci/MTU) given in Table 6-10. The resulting risk estimates were then multiplied by assumed annual spent fuel shipments (MTU/yr) to derive estimates of the annual accident risks associated with spent fuel shipments from the proposed Lee Nuclear Station site or alternative sites to the proposed geologic HLW repository at Yucca Mountain in Nevada. The NRC staff assumed that the number of shipments of spent fuel per year is equivalent to the annual discharge quantities.

For this assessment, release fractions for current-generation LWR fuel designs (Sprung et al. 2000) were used to approximate the impacts from the AP1000 reactor spent fuel shipments. This assumes that the fuel materials and containment systems (i.e., cladding, fuel coatings) behave like current LWR fuel under applied mechanical and thermal conditions.

The NRC staff used RADTRAN 5.6 to calculate the population dose from the released radioactive material from four of five possible exposure pathways:[a]

- External dose from exposure to the passing cloud of radioactive material (cloudshine)
- External dose from the radionuclides deposited on the ground by the passing plume (groundshine)—the NRC staff's analysis included the radiation exposure from this pathway even though the area surrounding a potential accidental release would be evacuated and decontaminated, preventing long-term exposures from this pathway
- Internal dose from inhalation of airborne radioactive contaminants (inhalation)
- Internal dose from resuspension of radioactive materials deposited on the ground (resuspension)—the NRC staff's analysis included the radiation exposures from this pathway even though evacuation and decontamination of the area surrounding a potential accidental release would prevent long-term exposures.

Table 6-11 presents the environmental consequences calculated by the NRC staff for transportation accidents when shipping spent fuel from the Lee Nuclear Station site or alternative sites to the proposed geologic HLW repository at Yucca Mountain. The shipping distances and population distribution information for the routes were the same as those used for the normal "incident-free" conditions (see Section 6.2.2.1). The results are normalized to the WASH-1238 reference reactor (i.e., 880-MW(e) net electrical generation, 1100-MW(e) reactor operating at 80 percent capacity) to provide a common basis for comparison to the impacts

(a) Internal dose from ingestion of contaminated food was not considered because the NRC staff assumed evacuation and subsequent interdiction of foodstuffs following a postulated transportation accident.

listed in Table S–4. Note that the impacts for all site alternatives are less than the reference LWR impacts. Also, although there are slight differences in impacts among the alternative sites, none of the alternative sites would be clearly favored over the proposed Lee Nuclear Station site or other alternative sites.

Using the linear no-threshold dose response relationship discussed in Section 6.2.1.1, the annual collective public dose estimates for transporting spent fuel from the Lee Nuclear Station site and alternative sites to the proposed geologic repository at Yucca Mountain are on the order of 1×10^{-3} person-rem, which is less than the 1754 person-rem value that ICRP (ICRP 2007) and NCRP (NCRP 1995) suggest would most likely result in zero excess health effects. This risk is very minute compared to the estimated 1.8×10^{5} person-rem that the same population would receive annually along the route from the proposed Lee Nuclear Station site to the proposed geologic HLW repository at Yucca Mountain from exposure to natural sources of radiation.

Table 6-11. Annual Spent Fuel Transportation Accident Impacts for the Proposed Lee Nuclear Station AP1000 and Alternative Sites, Normalized to Reference 1100-MW(e) LWR Net Electrical Generation

	Normalized Population Impacts, Person-rem/yr[(a)]
Reference LWR	1.0×10^{-4}
Lee Nuclear Station site	7.1×10^{-5}
Keowee site	1.3×10^{-4}
Middleton Shoals site	1.3×10^{-4}
Perkins site	8.5×10^{-5}

(a) Divide person-rem/yr by 100 to obtain person-Sv/yr.

6.2.2.3 Nonradiological Impacts of Spent Fuel Shipments

The general approach used to calculate nonradiological impacts of spent fuel shipment transportation accidents is the same as that used for unirradiated fuel shipments. The main difference is that the spent fuel shipping route characteristics are better defined so the state-level accident statistics in Saricks and Tompkins (1999) may be used. State-by-state shipping distances were obtained from the TRAGIS output file and combined with the annual number of shipments and accident, injury, and fatality rates by state from Saricks and Tompkins (1999) to calculate nonradiological impacts. The results are shown in Table 6-12.

Table 6-12. Nonradiological Impacts of Transporting Spent Fuel from the Proposed Lee Nuclear Station Site and Alternative Sites to the Proposed Geologic HLW Repository at Yucca Mountain for a Single AP1000 Reactor, Normalized to Reference LWR

Site	One-Way Shipping Distance, km	Nonradiological Impacts, per year		
		Accidents/yr	Injuries/yr	Fatalities/yr
Lee Nuclear Station	4041	1.1×10^{-1}	7.2×10^{-2}	5.6×10^{-3}
Keowee	4044	1.3×10^{-1}	7.9×10^{-2}	5.8×10^{-3}
Middleton Shoals	4019	1.3×10^{-1}	8.0×10^{-2}	5.8×10^{-3}
Perkins	4187	1.2×10^{-1}	7.6×10^{-2}	5.9×10^{-3}

Note: The number of shipments of spent fuel assumed in the calculations is 39 per year after normalizing to the reference LWR.

6.2.3 Transportation of Radioactive Waste

This section discusses the environmental effects of transporting waste from the Lee Nuclear Station site. The environmental conditions listed in 10 CFR 51.52 that apply to shipments of radioactive waste are as follows:

- Radioactive waste (except spent fuel) would be packaged and in solid form.
- Radioactive waste (except spent fuel) would be shipped from the reactor by truck or rail.
- The weight limitation of 73,000 lb per truck and 100 tons per cask per railcar would be met.
- Traffic density would be less than the one truck shipment per day or three railcars per month condition.

Radioactive waste other than spent fuel from AP1000 reactors at the Lee Nuclear Station site is expected to be capable of being shipped in compliance with Federal or State weight restrictions. Table 6-13 presents the NRC staff's estimates of annual waste volumes and annual waste shipment numbers for an AP1000 at the Lee Nuclear Station normalized to the reference 1100-MW(e) LWR defined in WASH-1238 (AEC 1972). The expected annual radioactive waste volumes for the AP1000 reactor, except for spent fuel, was estimated at 1964 ft^3/yr/unit, and the annual number of waste shipments was estimated at 21 shipments per year (Duke 2009c). The expected annual waste volume is less than that for the 1100-MW(e) reference reactor that was the basis for Table S–4. Therefore, the number of radioactive waste shipments for the AP1000 is smaller than the reference LWR. The NRC staff reviewed the radioactive waste generation and shipment data in the ER (Duke 2009c) and concluded that the information is consistent with current LWR operating experience. Therefore, the number of shipments of radioactive waste, other than spent fuel, to disposal facilities is expected to be smaller than the reference LWR in WASH-1238.

Table 6-13. Summary of Radioactive Waste Shipments from the Lee Nuclear Station

Reactor Type	Waste Generation Information	Annual Waste Volume, m^3/yr/unit	Electrical Output, MW(e) per Unit	Normalized Rate, m^3/ 1100 MW(e) Unit [(a)]	Shipments per 1100 MW(e) Electrical Output[(b)]
Reference LWR (WASH-1238)	3800 ft^3/yr/unit	108	1100	108	46
Lee Nuclear Station AP1000, expected	1964 ft^3/yr/unit[(c)]	56	1117[(c)]	47	21

Conversions: 1 m^3 = 35.31 ft^3. Drum volume = 210 L (0.21 m^3).

(a) Capacity factors used to normalize the waste generation rates to an equivalent electrical generation output are 80 percent for the reference LWR (AEC 1972) and 90 percent for the Lee Nuclear Station AP1000 (Duke 2009c). Waste generation for the AP1000 is normalized to 880 MW(e) net electrical output (1100-MW(e) unit with an 80 percent capacity factor).

(b) The number of shipments per 1100 MW(e) was calculated assuming the WASH-1238 average waste shipment capacity of 2.34 m^3 per shipment (108 m^3/yr divided by 46 shipments per year).

(c) These values were taken from the ER (Duke 2009c).

The sum of the daily shipments of unirradiated fuel, spent fuel, and radioactive waste is well below the one-truck-shipment-per-day condition given in 10 CFR 51.52, Table S–4 for a AP1000 reactor located at the Lee Nuclear Station site. Doubling the shipment estimates to account for empty return shipments of fuel and waste is included in the results.

Dose estimates to the MEI from transport of unirradiated fuel, spent fuel, and waste under normal conditions are presented in Section 6.2.1.1.

Nonradiological impacts of radioactive waste shipments were calculated using the same general approach as unirradiated and spent fuel shipments. For this EIS, the shipping distance was assumed to be 500 mi one way (AEC 1972). Because the actual destination is uncertain, national median accident, injury, and fatality rates were used in the calculations (Saricks and Tompkins 1999). These rates were adjusted to account for under-reporting, as described in Section 4.8.3. The results calculated by the NRC staff are presented in Table 6-14. As shown, the calculated nonradiological impacts for transportation of radioactive waste, other than spent fuel, from the Lee Nuclear Station site to waste disposal facilities are less than the impacts calculated for the reference LWR in WASH-1238.

Table 6-14. Nonradiological Impacts of Radioactive Waste Shipments from an AP1000 Reactor at the Lee Nuclear Station

	Shipments per Year	One-Way Distance, km	Fatalities per Year	Injuries per Year	Accidents per Year
WASH-1238	46	800	1.1×10^{-3}	1.7×10^{-2}	3.4×10^{-2}
Lee Nuclear Station AP1000	21	800	4.9×10^{-4}	7.8×10^{-3}	1.6×10^{-2}

Note: The shipments and impacts have not been normalized to the reference LWR; the expected waste volumes from the Lee Nuclear Station AP1000 were used. Normalized shipments and impacts would be slightly smaller (see Table 6-12).

6.2.4 Conclusions

The NRC staff conducted a confirmatory analysis and performed independent calculations of the impacts under normal operating and accident conditions of transporting construction materials, construction and operations personnel, and fuel and wastes to and from an AP1000 proposed to be located at the Lee Nuclear Station site. To make comparisons to Table S–4, the environmental impacts are normalized to a reference reactor year. The reference reactor is an 1100-MW(e) reactor that has an 80 percent capacity factor, for a total electrical output of 880 MW(e) per year. The environmental impacts can be adjusted to calculate impacts per site by multiplying the normalized impacts by the ratio of the total electric output for the proposed AP1000 at the Lee Nuclear Station to the electric output of the reference reactor.

Because of the conservative approaches and data used to calculate impacts, actual environmental effects are not likely to exceed those calculated in this EIS. Thus, the NRC staff concludes that the environmental impacts of transportation of construction materials, personnel, fuel, and radioactive wastes to and from the Lee Nuclear Station site would be SMALL and consistent with the environmental impacts associated with transportation of materials, personnel, fuel, and radioactive wastes from current-generation reactors presented in Table S–4 of 10 CFR 51.52.

On March 3, 2010, DOE (2010a) submitted a motion to the Atomic Safety and Licensing Board to withdraw with prejudice its application for a permanent geologic repository at Yucca Mountain, Nevada. Regardless of the outcome of this motion, the NRC staff concludes that transportation impacts are roughly proportional to the distance from the reactor site to the repository site, in this case South Carolina to Nevada. The distance from the Lee Nuclear Station site or any of the alternative sites to any new planned repository in the contiguous United States would be no more than double the distance from the Lee Nuclear Station or alternative sites to Yucca Mountain. Doubling the environmental impact estimates from the transportation of spent reactor fuel, as presented in this section, would provide a reasonable bounding estimate of the impacts for NEPA purposes. The NRC staff concludes that the environmental impacts of these doubled estimates would still be SMALL.

6.3 Decommissioning Impacts

At the end of the operating life of a nuclear power reactor, NRC regulations require that the facility be decommissioned. The NRC defines decommissioning as the safe removal of a facility from service and the reduction of residual radioactivity to a level permitting termination of the NRC license. The regulations governing decommissioning of power reactors are found in 10 CFR 50.75 and 10 CFR 50.82. The radiological criteria for termination of the NRC license are in 10 CFR Part 20, Subpart E. Minimization of contamination and generation of radioactive waste requirements for facility design and procedures for operation are addressed in 10 CFR 20.1406.

An applicant for a COL is required to certify that sufficient funds will be available to provide for radiological decommissioning at the end of power operations. As part of its COL application for proposed Units 1 and 2 on the Lee Nuclear Station site, Duke included a Decommissioning Funding Assurance Report (Duke 2010r). Duke would establish an external sinking funds account to accumulate funds for decommissioning.

Environmental impacts from the activities associated with the decommissioning of any reactor before or at the end of an initial or renewed license are evaluated in the *Generic Environmental Impact Statement for Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors* (GEIS-DECOM) (NRC 2002). Environmental impacts of the DECON, SAFSTOR, and ENTOMB decommissioning methods are evaluated in the GEIS-DECOM. A COL applicant is not required to identify a decommissioning method at the time of the COL application. The NRC staff's evaluation of the environmental impacts of decommissioning presented in the GEIS-DECOM identifies a range of impacts for each environmental issue for a range of different reactor designs. The NRC staff concludes that the construction methods that would be used for the AP1000 are not sufficiently different from the construction methods used for the current plants to significantly affect the impacts evaluated in the GEIS-DECOM. Therefore, the NRC staff concludes that the impacts discussed in the GEIS-DECOM remain bounding for reactors deployed after 2002, including the AP1000.

The GEIS-DECOM does not specifically address the carbon footprint of decommissioning activities. However, it does list the decommissioning activities and states that the decommissioning workforce would be expected to be smaller than the operational workforce and that the decontamination and demolition activities could take up to 10 years to complete. Finally, the GEIS-DECOM discusses SAFSTOR, in which decontamination and dismantlement are delayed for a number of years. Given this information, the NRC staff estimated the CO_2 footprint of decommissioning to be of the order of 105,000 MT for two units without SAFSTOR. This footprint is about equally split between decommissioning workforce transportation and equipment usage. The details of the NRC staff's estimate are presented in Appendix J for a single unit. A 40-year SAFSTOR period would increase the footprint of decommissioning by about 40 percent. These CO_2 footprints are roughly three orders of magnitude lower than the CO_2 footprint presented in Section 6.1.3 for the uranium fuel cycle.

Therefore, the staff relies upon the bases established in GEIS-DECOM and concludes the following:

1. Doses to the public would be well below applicable regulatory standards regardless of which decommissioning method considered in GEIS-DECOM is used.
2. Occupational doses would be well below applicable regulatory standards during the license term.

3. The quantities of Class C or greater than Class C wastes generated would be comparable to or less than the amounts of solid waste generated by reactors licensed before 2002.
4. Air-quality impacts of decommissioning are expected to be negligible at the end of the operating term.
5. Measures are readily available to avoid potential significant water-quality impacts from erosion or spills. The liquid radioactive waste system design includes features to limit release of radioactive material to the environment, such as pipe chases and tank collection basins. These features will minimize the amount of radioactive material in spills and leakage that would have to be addressed at decommissioning.
6. The ecological impacts of decommissioning are expected to be negligible.
7. The socioeconomic impacts would be short-term and could be offset by decreases in population and economic diversification.

On the basis of the GEIS-DECOM and the evaluation of air-quality impacts from greenhouse gas emissions above, the NRC staff concludes that, as long as the regulatory requirements on decommissioning activities to limit the impacts of decommissioning are met, the decommissioning activities would result in a SMALL impact.

7.0 Cumulative Impacts

The National Environmental Policy Act of 1969, as amended (NEPA), requires Federal agencies to consider the cumulative impacts of proposals under its review. Cumulative impacts may result when the environmental effects associated with the proposed action are overlaid or added to temporary or permanent effects associated with past, present, and reasonably foreseeable future projects. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. When evaluating the potential impacts of two new nuclear units at the William States Lee III Nuclear Station (Lee Nuclear Station) site proposed by Duke Energy Carolinas, LLC (Duke) in its application for combined construction permits and operating licenses (COLs) (Duke 2009c), the U.S. Nuclear Regulatory Commission (NRC) staff and the U.S. Army Corps of Engineers (USACE) staff considered potential cumulative impacts on resources that could be affected by the construction, preconstruction, and operation of two Westinghouse Electric Company, LLC (Westinghouse) Advanced Passive 1000 (AP1000) pressurized water reactors at the site. Cumulative impacts result when the effects of an action are added to, or interact with, other past, present, and reasonably foreseeable future effects on the same resources. For the purposes of this analysis, past actions are those prior to the receipt of the COL application. Present actions are those related to resources from the time of the COL application until the start of NRC-authorized construction of the proposed new units. Future actions are those that are reasonably foreseeable to occur during building and operating the proposed Lee Nuclear Station, including decommissioning. The geographic area over which past, present, and reasonably foreseeable future actions could contribute to cumulative impacts is dependent on the type of resource considered and is described below for each resource area.

The approach for evaluating cumulative impacts in this environmental impact statement (EIS) is outlined in the following discussion. To guide its assessment of environmental impacts of a proposed action or alternative actions, the NRC has established a standard of significance for impacts based on guidance developed by the Council on Environmental Quality (CEQ) (Title 40 of the *Code of Federal Regulations* [CFR] 1508.27). The three significance levels established by the NRC – SMALL, MODERATE, and LARGE – are defined as follows:

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

The impacts of the proposed action, as described in Chapters 4 and 5, are combined with other past, present, and reasonably foreseeable future actions near the Lee Nuclear Station site that would affect the same resources affected by proposed Units 1 and 2, regardless of what agency (Federal or non-Federal) or person undertakes such actions. These combined impacts are defined by CEQ as cumulative in 40 CFR 1508.7 and include 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.

The description of the affected environment in Chapter 2 serves as the baseline for the cumulative impacts analysis, including the effects of past actions. The incremental impacts related to the construction activities requiring NRC authorization (10 CFR 50.10(a)) are described and characterized in Chapter 4 and those related to operations are described in Chapter 5. These impacts are summarized for each resource area in the sections that follow. The level of detail is commensurate with the significance of the impact for each resource area.

The specific resources and components that could be affected by the incremental effects of the proposed action and other actions in the same geographic area were assessed. This assessment includes the impacts of construction and operation of the proposed new units as described in Chapters 4 and 5; impacts of preconstruction activities as described in Chapter 4; impacts of fuel cycle, transportation, and decommissioning as described in Chapter 6; and impacts from past, present, and reasonably foreseeable Federal, non-Federal, and private actions that could affect the same resources affected by the proposed actions.

The review team visited the Lee Nuclear Station site from April 28 through May 2, 2008 (NRC 2008d) and the Make-Up Pond C study area from August 9 through 11, 2010 (NRC 2010c). The review team then used the information provided in the environmental report (ER), the Make-Up Pond C supplement to the ER, responses to requests for additional information, information from other Federal and State agencies, and information gathered during the visits to the Lee Nuclear Station and Make-Up Pond C sites to evaluate the cumulative impacts of building and operating two new nuclear power plants at the site. To inform the cumulative analysis, the review team searched U.S. Environmental Protection Agency (EPA) databases for recent EISs and for permits for water discharges in the geographic area (to identify water-use projects and industrial facilities). In addition, the review team used the www.recovery.gov website to identify projects in the geographic area funded by the American Recovery and Reinvestment Act of 2009 (ARRA) (Public Law 111-5). Other actions and projects identified during this review and considered in the review team's independent analysis of the potential cumulative effects are described in Table 7-1. Approximate locations are given with respect to the Lee Nuclear Station site.

Table 7-1. Past, Present, and Reasonably Foreseeable Projects and Other Actions Considered in the Cumulative Analysis in the Vicinity of the Lee Nuclear Station Site

Project Name	Summary of Project	Location	Status
Nuclear projects			
Cherokee Nuclear Station	Uncompleted nuclear power plant	At the same location as the proposed Lee Nuclear Station	The site had cooling ponds and some infrastructure in place when work on the Cherokee project was halted in 1982; in 2007 Duke announced the site was chosen for the proposed Lee Nuclear Station (Duke 2009c)
Catawba Nuclear Station Units 1 and 2	Nuclear power plant, two 1129-MW(e) Westinghouse reactors	York, South Carolina, approximately 25 mi east	Operational (NRC 2012a)
McGuire Nuclear Station Units 1 and 2	Nuclear power plant, two 1100-MW(e) Westinghouse reactors	Huntersville, North Carolina, approximately 42 mi northeast	Operational (NRC 2012a)
Virgil C. Summer Nuclear Station (VCSNS) Unit 1	Nuclear power plant, one 996-MW(e) Westinghouse reactor	Jenkinsville, SC, approximately 52 mi south	Operational (NRC 2012a)
VCSNS Units 2 and 3	Nuclear power plant, two 1199.5-MW(e) Westinghouse AP1000 pressurized water reactors	Jenkinsville, SC, approximately 52 mi south	Proposed, operation would begin in 2016 and 2019 (NRC 2011f). COLs issued March 30, 2012 (NRC 2012a)
Independent Spent Fuel Storage Installation	Dry spent fuel storage at the VCSNS site	Jenkinsville, SC, approximately 52 mi south	Proposed (NRC 2011f)
Carolinas-Virginia Tube Reactor	Experimental pressurized tube heavy water nuclear power reactor	Jenkinsville, SC, approximately 55 mi south-southeast	Decommissioned 2010 (SCE&G 2011)
Oconee Nuclear Station, Units 1, 2, and 3	Nuclear power plant, three 846-MW(e) Babcock and Wilcox pressurized water reactors	Seneca, SC, approximately 80 mi west	Operational (NRC 2012a)

Table 7-1. (contd)

Project Name	Summary of Project	Location	Status
Westinghouse Fuel Manufacturing Plant	Design and fabricate completed nuclear fuel assemblies and fuel-related products	Columbia, SC, approximately 87 mi south-southeast	Operational (Westinghouse 2009)
H.B. Robinson Steam Electric Plant Unit 2	Nuclear power plant, one 710-MW(e) Westinghouse reactor	Hartsville, SC, approximately 89 mi southeast	Operational (NRC 2012a)
Nuclear Fuel Services, Inc. Erwin Plant	Prepares high-enriched uranium and fabrics fuel for use in U.S. Department of Energy Naval Reactor Program. Also recovers high-enriched uranium from scrap, and blends high-enriched uranium with natural uranium to produce low-enriched uranium.	Erwin, Tennessee, approximately 91 mi northwest	Operational. License SNM-124 renewed August 2, 2012. Licensed through August 31, 2037 (NRC 2012j)
Coal and natural gas energy projects			
Columbia Gas Transmission Corporation Grover Compressor Station	Natural gas compressor station	Blacksburg, SC, approximately 4 mi north	Operational (EPA 2010c)
Broad River Energy Center	Gas-fired power plant, 847 MW	Gaffney, SC, approximately 5 mi northwest	Operational (EPA 2010d)
Cherokee County Cogeneration	60-MW gas-fired turbine generator, and 26-MW condensing steam turbine generator	Gaffney, SC, approximately 6 mi northwest	Operational (EPA 2010e)
Mill Creek Combustion Turbine Station	Gas-fired power plant, 640 MW	Cherokee County, 10 mi northeast on Kings Creek, tributary of the Broad River	Operational (EPA 2011d; Duke Energy 2010e)
Cleveland County Power Plant	Gas-fired power plant, 720 MW	Cleveland County, NC; approximately 11 mi northeast	Operational (Southern Power 2012)
Cliffside Steam Station Unit 6	Coal-fired power plant (clean coal unit), 825 MW	Cleveland and Rutherford Counties, NC, approximately 20 mi northwest	Operational (Duke Energy 2013a)

Table 7-1. (contd)

Project Name	Summary of Project	Location	Status
Cliffside Steam Station Units 5	Coal-fired power plant, 562 MW	Cleveland and Rutherford Counties, NC, approximately 20 mi northwest	Operational (Duke Energy 2013a)
Lincoln Combustion	Gas-fired power plant, 1200 MW	Lincoln County, NC, approximately 38 mi northeast	Operational (Duke Energy 2010b)
Riverbend Steam Station	454-MW coal-fired power plant permanently shut down in March 2013	Gaston County, NC, approximately 38 mi northeast	Ceased Operations (Duke 2013d)
Various smaller electrical generation plants	35 electrical plants capable of generating <20 MW each	Within 50 mi	Operational
Hydroelectric energy projects on the Broad River			
Ninety-Nine Islands Hydroelectric Project	Hydroelectric power plant, 18 MW	South-adjacent to Lee Nuclear Station	Operational, licensed through 2036 (Duke Energy 2010d; FERC 2011c)
Cherokee Falls Hydraulic Turbine	Hydroelectric power plant, 4.3 MW	Gaffney, SC, approximately 2 mi northwest on the Broad River	Operational, licensed through 2021 (FERC 2011b)
Gaston Shoals Hydraulic Turbines	Hydroelectric power plant, 6.7 MW	Gaston Shoals, approximately 9 mi northwest on the Broad River	Operational, licensed through 2036 (Duke Energy 2010d)
Lockhart Dam	Hydroelectric power plant, 18 MW	Approximately 17 mi south on the Broad River	Operational, licensed through 2040 (FERC 2011b)
Upper Pacolet Hydroelectric Project	Hydroelectric power plant, 0.84 MW	Approximately 17 mi southwest on the Pacolet River, a tributary to the Broad River	Proposed (FERC 2009; 74 FR 68815

Table 7-1. (contd)

Project Name	Summary of Project	Location	Status
Neal Shoals Hydroelectric Project	Hydroelectric power plant, 4.4 MW	Approximately 26 mi south on the Broad River	Operational, licensed through 2036 (FERC 2011b)
Mining projects adjacent to the Broad River and within 5 mi of the Lee Nuclear Station site			
Thomas Sand Co.	Sand mining	Approximately 1 mi west-northwest	Operational (USGS 2010c)
Thomas Sand Co./Blacksburg Plant	Sand and gravel mining	Approximately 8 mi east-southeast	Operational (USGS 2010c)
Browns Sand Dredge	Sand and gravel mining	Approximately 10 mi northwest	Operational (USGS 2010d)
Cunningham Brick/Martin Mine	Clay, ceramic, and refractory minerals	Approximately 4 mi northeast	Operational (EPA 2011e)
Hanson Brick East/Sericite Pit	Clay, ceramic, and refractory minerals	Approximately 4 mi northeast	Operational (EPA 2010g)
Industrial Minerals Number 2	Minerals and earths, ground or otherwise treated	Approximately 4 mi northeast	Operational (EPA 2010h)
Industrial Minerals, Inc.	Miscellaneous nonmetallic minerals	Approximately 4 mi northeast	Operational (EPA 2010i)
Red Clay-Higgins	Common clay and shale	Approximately 5 mi north	Operational (USGS 2010e)
P&L Erosion/Carroll Dr Mine	Miscellaneous nonmetallic minerals	Approximately 5 mi north	Operational (EPA 2010j)
Water supply and treatment facilities on the Broad River and major tributaries			
City of Gaffney/Peoples Creek PLT	Wastewater treatment facility on the Broad River, permitted flow at discharge pipe 4 million gallons per day (Mgd)	Approximately 3 mi northwest	Operational, major National Pollutant Discharge Elimination System (NPDES) domestic permit No. SC0047091 (EPA 2010k)
City of Gaffney/Clary Waste Water Treatment Plant	Wastewater treatment facility on Thicketty Creek (tributary to the Broad River), permitted flow at discharge pipe 5 Mgd	Approximately 8 mi east	Operational, major NPDES domestic permit No. SC0031551 (EPA 2010l)
City of Gaffney water supply	Withdrawals up to 18 Mgd from Broad River	Approximately 7 mi north-northwest	Operational (GBPW 2010)

Table 7-1. (contd)

Project Name	Summary of Project	Location	Status
Spartanburg Sanitary Sewer District/Town of Cowpens/Pacolet River Wastewater Treatment Plant	Wastewater treatment facility on the Pacolet River (tributary to the Broad River); permitted flow at discharge pipe 1.5 Mgd	Approximately 12 mi west	Operational, NPDES domestic permit No. SC0045624 (EPA 2008c)
Spartanburg Sanitary Sewer District/Fairforest Creek Wastewater Treatment Plant	Wastewater treatment facility that discharges to the Pacolet River and Fairforest Creek; permitted flow at discharge pipe 19 Mgd	Approximately 16 mi west-southwest	Operational, major NPDES domestic permit No. SC0020435 (EPA 2006)
Shelby, North Carolina Wastewater Treatment Plant	Discharges to the First Broad River	Approximately 15 mi north-northwest	Operational, major NPDES permit No. NC0024538 (EPA 2010m)
Shelby, North Carolina water supply	Withdrawals water from the First Broad River	Approximately 17 mi northwest	Operational (City of Shelby 2007)
Kings Mountain, North Carolina water supply	Withdrawals water from Kings Mountain Reservoir, upstream of Lee Nuclear Station	Approximately 17 mi north-northeast	Operational (NCDEH 2010a)
Union, South Carolina water supply	Withdrawals water from the Broad River upstream of Lee Nuclear Station	Approximately 21 mi south	Operational (surface-water user downstream of Lee) (EPA 2011f)
Cleveland County Water Board	Withdrawals water from the First Broad River upstream of Lee Nuclear Station	Lawndale, NC, approximately 26 mi north	Operational (NCDEH 2010b, EPA 2010n)
Cleveland County Water Board	1200 ac proposed reservoir off the First Broad River	Lawndale, NC, approximately 26 mi northwest	Proposed (USACE 2009b)
Forest City, North Carolina water supply	Withdrawals water from the Second Broad River	Approximately 28 mi northwest	Operational (NCDEH 2010c)
Broad River Water Authority	Withdrawals water from the Broad River	Rutherford, North Carolina, approximately 35 mi northwest	Operational (NCDEH 2010d)
Manufacturing facilities within 20 mi			
SC Distributors, Inc.	Fabric mill along Broad River	Approximately 3 mi northwest	Operational, minor NPDES permit No. SC0002755 (EPA 2010o)

Table 7-1. (contd)

Project Name	Summary of Project	Location	Status
National Textiles, LLC/Coker International, LLC	Knitwear mill and fabric finishing plant that discharges to the Broad River; permitted flow at discharge pipe 0.0005 Mgd	Approximately 5 mi northwest	Operational, minor NPDES industrial permit No. SC0035947 (EPA 2010p)
Hanson Brick, Blacksburg Plant	Brick and clay tile manufacturing	Approximately 6 mi north	Operational; minor NPDES permit No. SC000155 (EPA 2010q)
Milliken and Co. Magnolia Finishing Plant	Fabric finishing plant that discharges to the Broad River; permitted flow at discharge pipe 3.89 Mgd	Approximately 6.5 mi northwest on Buffalo Creek	Operational, major NPDES industrial permit No. SC0003182 (EPA 2010r)
Core Molding Technologies, Inc.	Plastics manufacturing	Approximately 7 mi northwest	Operational, minor NPDES permit No. SCG250199 (EPA 2010s)
BIC Corporation	Manufactures pens and mechanical pencils	Approximately 7 mi northwest	Operational (EPA 2010t)
Bommer Industries	Electroplating, plating, polishing and anodizing metals	Approximately 11 mi west-northwest	Operational (EPA 2010u)
Accurate Plating, Inc.	Electroplating, plating, polishing and anodizing metals	Approximately 12 mi west	Operational (EPA 2010v)
CNA Holdings Inc., Shelby Plant	Manufactures plastics and synthetic resins	Approximately 12 mi north	Operational, major NPDES permit No. NC0004952, discharges to Buffalo Creek, tributary to Broad River (EPA 2010w)
Linpac (US Corrugated)	Paperboard mill	Approximately 15 mi west	Operational (EPA 2010x)
Chemetall Foote Corp.	Miscellaneous inorganic chemical manufacturing	Approximately 16 mi northeast	Operational (EPA 2010y)
Invista SARL / Spartanburg	Plastics materials and resins manufacturing; discharges to the Pacolet River; monitor and report for NPDES compliance	Approximately 17 mi east	Operational major NPDES permit No. SC0002798 (EPA 2010z)

Table 7-1. (contd)

Project Name	Summary of Project	Location	Status
Various minor NPDES wastewater discharges	Various businesses with smaller wastewater dischargers to waterbodies	Within 10 mi	Operational
Transportation			
South Carolina Strategic Corridor System Plan	Strategic system of corridors forming the backbone of the State's transportation system. A planning document exists with no explicit schedules for projects. Includes SC 11 to S 42 near Spartanburg, SC 161 to US 321 through York, SC 72 to S 46 near Chester, US 123 to US 29 mostly to the south of Cherokee County.	South Carolina (Statewide)	In progress (SCDOT 2009a)
ARRA grants to SC Dept. of Transportation	$5 million for highway infrastructure improvements in Cherokee County	Within 20 mi	In progress (ARRA 2011)
Parks, national forests, and historic sites			
Broad Scenic River	The Broad River is classified as a State Scenic River, 15 mi long from Ninety-Nine Islands Dam to confluence with Pacolet River	Broad River, 1 to 16 mi downstream	Managed by the South Carolina Department of Natural Resources (SCDNR 2009d)
Kings Mountain State Park	6885 ac with hiking, fishing, and horse trails	Approximately 10 mi northeast	Managed by the South Carolina Department of Parks, Recreation & Tourism (SCSP 2011a)
Kings Mountain National Military Park	Historic site, hiking	Approximately 10 mi northeast	Managed by the National Park Service (NPS 2010)
Crowders Mountain State Park	Camping, hiking	Kings Mountain, NC, Approximately 11 mi northeast	Managed by North Carolina Division of Parks & Recreation (NCDPR 2011)
Cowpens National Battlefield	Historic battlefield	Chesnee, SC, Approximately 18 mi northwest	Managed by the National Park Service (NPS 2011a)

Table 7-1. (contd)

Project Name	Summary of Project	Location	Status
Sumter National Forest	371,000 ac National Forest	Approximately 20 mi south	Currently managed by U.S. Forest Service (USFS 2004a)
Croft State Natural Area	7054 ac natural area with bike, horse, and hiking trails	Spartanburg, SC, approximately 22 mi southwest	Managed by the South Carolina Department of Parks, Recreation & Tourism (SCSP 2011b)
Chester State Park	523 ac area for hiking, boating, and fishing	Chester, SC, approximately 28 mi southwest	Managed by the South Carolina Department of Parks, Recreation & Tourism (SCSP 2011c)
Rose Hill Plantation State Historic Site	44 ac plantation	Union, SC, approximately 30 mi south-southwest	Managed by the South Carolina Department of Parks, Recreation & Tourism (SCSP 2011d)
Other projects			
Future Urbanization	Construction of housing units and associated commercial buildings; roads, bridges, and rail; and water and/or wastewater treatment and distribution facilities and associated pipelines as described in local land-use planning documents	Throughout region	Construction would occur in the future, as described in State and local land-use planning documents

7.1 Land-Use Impacts

The description of the affected environment in Section 2.2 serves as a baseline for the following cumulative assessment of land-use impacts. As described in Section 4.1, the impacts of NRC-authorized construction activities on land use would be SMALL and no further mitigation would be required. As described in Section 5.1, the land-use impacts of operations would be SMALL, and no further mitigation would be warranted.

The combined impacts from construction and preconstruction are also described in Section 4.1 and have been determined by the review team to be MODERATE, primarily due to the extensive acreage that would be inundated or otherwise excluded from other uses to accommodate Make-Up Pond C and development of new transmission-line corridors. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis considers other past, present, and reasonably foreseeable future actions that could affect land use. For the cumulative analysis of land use, the geographic area of interest is considered to be the 50-mi region described in Section 2.2.4. The geographic area of interest encompasses the Lee Nuclear Station site and vicinity, the proposed Make-Up Pond C site, the railroad corridor, the two proposed transmission-line corridors, and the offsite road-improvement areas, as well as other areas where land use could be affected by one or more Lee Nuclear Station features. Roads and other public facilities and services in rural areas tend to serve people who are spread thinly but broadly over large portions of the landscape. Therefore, land-use changes can affect roads and other facilities at greater distances than similar changes in more densely populated areas.

The Lee Nuclear Station site is located in a sparsely populated, largely rural area, where forests and pasture land are the predominant land uses. The Piedmont terrain varies from gently rolling to hilly and is punctuated by relatively narrow stream valleys. Historically, most upland areas have been used for crop production, but many are presently used for silviculture. Gaffney and Blacksburg are the closest communities. Several electric transmission lines, state highways, and interstate highways currently traverse the area. Industries and facilities that have historically affected land use near the Lee Nuclear Station site are described in Table 7-1. The geographic area of interest has changed dramatically since the damming of the Broad River by Ninety-Nine Islands Dam in 1910. Prior to impoundment, land now inundated was primarily forestland, riparian land, and farmland (SCDNR 2003). No part of the geographic area of interest is located in the coastal zone.

The proposed project would indirectly result in land conversions to residential areas, roads, and businesses to accommodate growth, new workers, and services related to the proposed nuclear facility. Other reasonably foreseeable projects in the area that could contribute to an increase in urbanization include potential development of new residences along McKowns Mountain Road and other rural roadways within easy commuting distance of the new plant. This would result in a conversion of farmland, pastures, and forests to residential areas. The amount of land converted to residences, roads, or businesses would be minimal compared to the amount of land available in the area.

As described in Section 4.1, development of the Lee Nuclear Station project would permanently occupy approximately 619 ac and temporarily occupy an additional 327 ac, for a total footprint of approximately 946 ac on a site encompassing approximately 1928 ac (Duke 2013d). The site therefore appears to be large enough to readily accommodate the proposed footprint with only minimal encroachment on environmentally sensitive land (e.g., wetlands, floodplains, and prime farmland). Much of the site was cleared during the partial development of the unfinished

Cherokee Nuclear Station, which was halted in 1982. Of the estimated 946 ac of total onsite land needed to build and operate the proposed new facilities, about 585 ac would be located within the footprint of the earlier Cherokee Nuclear Station development work and only about 361 ac would be located elsewhere on the site (Duke 2013d). The review team expects that the anticipated land demands within the Lee Nuclear Station site would not noticeably alter land-use patterns within the geographic area of interest.

However, the proposed project would have substantial offsite land demands. Approximately 1100 ac of offsite land, mostly on a 2110-ac outparcel termed the Make-Up Pond C site, would be permanently or temporarily occupied for the development of Make-Up Pond C (Duke 2013d). About 3 ac of those 1100 ac would be on land close to the Make-Up Pond C site rather than on the site itself. In addition, approximately 31 mi of new transmission-line corridors would be established in offsite areas not adjacent to existing transmission-line corridors (Duke 2011h). The transmission-line corridors would occupy an estimated 987 ac of offsite land. These impacts outside of the Lee Nuclear Station site would noticeably alter land-use patterns within the geographic area of interest.

Farmland of Statewide-importance and/or prime farmland exists on the Lee Nuclear Station site (2 ac) and the Make-Up Pond C site (260 ac); this land would be unavailable for farming during the operating life of proposed Lee Nuclear Station Units 1 and 2. Loss of this farmland is not expected to noticeably alter agricultural activity in the vicinity or region. In addition, approximately 163 ac of the proposed transmission-line corridors are considered prime farmland, or farmland of Statewide-importance. However, Duke allows farming and crop production within transmission-line corridors and expects limitations to these conditions related only to where transmission structures are located. Impacts to wetlands are discussed in Section 7.3.

Because the other projects described in Table 7-1 do not include any substantial reasonably foreseeable changes in types of land use within 50 mi of the Lee Nuclear Station site, other than general growth and urbanization development discussed above, no additional substantive cumulative impacts on land use would result from those activities.

Cumulative land-use impacts within the geographic area of interest would not be inconsistent with existing land-use plans or zoning. As discussed in Sections 4.1 and 5.1, Duke's proposed land-use changes do not involve zoning conflicts and are not expected to result in other land-use conflicts. Although Duke had to displace several existing residences to acquire and prepare the land needed for Make-Up Pond C, Duke provided relocation services (as needed) for property owners and renters. After purchasing the property, Duke allowed former homeowners to remain in their homes from 1 to 18 months rent-free to find other living arrangements. Renters were usually given between 30 and 90 days' notice to vacate the property (Duke 2009b).

Primarily because of the extensive land demands needed to build Make-Up Pond C and the new transmission-line corridors, the review team concludes that the cumulative land-use impacts associated with the proposed Lee Nuclear Station, related facilities, and other projects in the geographic area of interest would be MODERATE. Development of Make-Up Pond C and the new transmission-line corridors is the principal contributor to the MODERATE conclusion for cumulative land-use impacts. The expected contribution from the projects in Table 7-1, including general urbanization in the surrounding landscape, is expected to be minimal. Because neither transmission-line corridor nor Make-Up Pond C development requires NRC authorization, the NRC staff concludes that the incremental impacts from NRC-authorized activities would be SMALL.

7.2 Water-Related Impacts

This section addresses the cumulative impacts of proposed Lee Nuclear Station Units 1 and 2, and other past, present, and reasonably foreseeable future projects on water use and quality.

7.2.1 Water-Use Impacts

This section describes the cumulative water-use impacts from construction, preconstruction, and operation of the proposed Lee Nuclear Station Units 1 and 2, in addition to and other past, present, and reasonably foreseeable future projects.

7.2.1.1 Surface-Water-Use Impacts

The description of the affected environment in Section 2.3 of this document serves as a baseline for surface-water use. As described in Section 4.2.2.1, the impacts from NRC-authorized construction on surface-water use would be SMALL, and no further mitigation would be warranted. As described in Section 5.2.2.1, the review team concludes that the impacts of operations on surface-water use would also be SMALL, and no further mitigation would be warranted.

The combined surface-water-use impacts from construction and preconstruction are described in Section 4.2.2.1 and were determined to be SMALL. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis for surface-water use considers other past, present, and reasonably foreseeable future actions that could potentially affect this resource. For the cumulative analysis of impact on surface-water use, the geographic area of interest is the drainage basin of the Broad River upstream and downstream of the Lee Nuclear Station site because other actions within this region could result in a cumulative impact. The Broad River has provided water for agricultural, industrial, and municipal use since colonial times. Dams have been installed on the river to provide flood control, increase the reliability of water supply to the region, and provide power. On the Lee Nuclear Station site, work on the unfinished Cherokee Nuclear Station resulted in alteration of surface water through site grading and the development of Make-Up Ponds A and B. Key actions that have current and reasonably foreseeable future potential impacts on the surface-water use in the Broad River basin include operation of Ninety-Nine Islands Hydroelectric Project and building and operation of the Virgil C. Summer Nuclear Station (VCSNS) Units 2 and 3.

Peak water needs during construction and preconstruction, as described in Section 4.2.2.1, are estimated to be approximately 0.39 cubic feet per second (cfs). This water would be obtained from the Draytonville Water District (see Table 3-5). The impact of its use would not be noticeable in the Broad River basin. The surface-water-use impacts of construction, preconstruction, and operation are dominated by the higher water demands that would occur under normal operation. The projected consumptive water use by the proposed units is expected to be 55 cfs, which is 3 percent of the Broad River mean annual flow of 1858 cfs at the gage near the site and below Ninety-Nine Islands Dam, as described in Section 5.2.2.1. This mean river flow reflects upstream cumulative consumptive uses of current users. Increases in consumptive use of water in the Broad River drainage are anticipated in the future.
Duke Energy has prepared an assessment of water availability and project use for the Broad River to determine the availability of water to support expansions of Duke's generating capability (Duke Energy 2007). Duke Energy considered future agriculture and irrigation projects, power projections, public water supplies and wastewater projections, and future industrial use. Duke Energy also considered future trends in water use such as water reuse, water conservation, and changes in regulations and the regional economy. The Duke Energy study does not consider the impact of climate change. The study indicates the consumptive water use would increase in the Broad River drainage from the 241.5 cfs (0.33 acre-feet per year [ac-ft/yr]) in 2006 to 412.9 cfs (0.57 ac-ft/yr) by 2070. Duke Energy (2007) asserts that the study will enable resource agencies in the Broad River basin to plan for water needs and develop water-storage facilities necessary to support future water needs. Because proposed Lee Nuclear Station Units 1 and 2 and VCSNS Units 1, 2, and 3 would all rely on water from reservoirs during periods of low flow, impacts would not likely alter surface-water resources in the Broad River. The impacts of other projects listed in Table 7-1 are considered in the analysis included in Sections 4.2 and 5.2 or would have little or no impact on the surface-water use.

The review team is also aware of potential climate changes that could affect the water resources available for cooling and the impacts of reactor operations on water resources for other users. A recent compilation of the state of the knowledge in this area (GCRP 2009) has been considered in the preparation of this EIS. Projected changes in the climate for the region during the life of the proposed units include an increase in average temperature of 2 to 3°F and a decrease in precipitation in the winter, spring, summer and a small increase in the fall (GCRP 2009). Changes in climate during the life of the proposed units could result in either an increase or decrease in the amount of precipitation; the divergence in the model projections for the southeastern United States precludes a definitive estimate (GCRP 2009). Based on a review of the GCRP (2009) assessment of the southeastern United States, the review team conservatively estimated a decrease in streamflow of 10 percent over the license period of the station. This would reduce the long-term mean annual flow by approximately 250 cfs. Based on the Duke Energy (2007) water-use report, the predicted upstream future water use would further reduce the mean annual flow by approximately 63 cfs (Duke Energy 2007). Therefore, the combined reduction in streamflow at the Lee Nuclear Station site, including operation of Lee Nuclear Station Units 1 and 2 (55 cfs consumptive use), would be 368 cfs, or 15 percent of the long-term mean annual flow.

Based on the potential decreases in the future water supply, the review team determined that the cumulative impact during construction, preconstruction, and operation of the proposed Lee Nuclear Station on surface-water use would be MODERATE. The incremental impact associated with water use for operation of Lee Nuclear Station Units 1 and 2 was determined not to be a significant contributor to this cumulative impact.

7.2.1.2 Groundwater-Use Impacts

The description of the affected environment in Section 2.3 of this EIS serves as the baseline for the cumulative impact assessments in this resource area. As described in Section 4.2.2.2, the impacts from NRC-authorized construction on groundwater would be SMALL and no further mitigation would be warranted. As described in Section 5.2.2.2, the review team concludes that the impacts of operations on groundwater use would also be SMALL, and no further mitigation would be warranted.

The combined groundwater-use impacts from construction and preconstruction are described in Section 4.2.2.2 and were determined to be SMALL. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis for groundwater use considers other past, present, and reasonably foreseeable future actions that could potentially affect this resource. For the cumulative analysis of impacts on groundwater, two geographic areas of interest have been identified: the Lee Nuclear Station site and the Make-Up Pond C site. The geographic area of interest affected by dewatering activities for construction and preconstruction activities at the Lee Nuclear Station site is limited to a roughly circular area extending approximately 1700 ft from the center of the excavation, (i.e., an onsite area bounded by Make-Up Pond B, Make-Up Pond A, and Hold-Up Pond A; see Figure 2-11). The geographic area of interest affected by dewatering activities for construction and preconstruction activities at the Make-Up Pond C site would be limited to the immediate vicinity of the dam and abutment, because other construction and preconstruction activities at Make-Up Pond C are not expected to require dewatering.

The two geographic areas of interest are essentially the watersheds that overlie and provide recharge to the aquifer. Groundwater would not be used as a source of water for the construction, preconstruction, or operation of proposed Lee Nuclear Station Units 1 and 2 including Make-Up Pond C; therefore, the groundwater geographic areas of interest are local to the sites (i.e., a regional aquifer is not used as a water supply).

As discussed in Section 4.2.2.2, groundwater will not be a source of water during construction and preconstruction; therefore, onsite groundwater withdrawal would not contribute to a cumulative impact offsite. Private groundwater wells are located on the property adjacent to the Lee Nuclear Station site and the Make-Up Pond C site. As noted in Section 4.2.2.2, offsite wells in the vicinity of the Lee Nuclear Station site would not be influenced by onsite activities. Offsite wells located adjacent to Make-Up Pond C may be influenced by the filling of Make-Up Pond C during the construction and preconstruction period. The water level in the wells adjacent to the pond would rise in response to filling Make-Up Pond C to its maximum pool elevation of 650 ft.

While some residents still rely on groundwater wells, in the last decade the Draytonville Water District has provided potable water service to the region, and individuals are moving to the public water supply (Duke 2008b, 2009c). In 2009, an estimated 83 percent of residents within 2 mi of the Lee Nuclear Station site have the public water supply available to them; 59 percent are served by the system. In 2004 these numbers were 57 and 38 percent, respectively (Duke 2008b). The Draytonville Water District obtains its water from the Gaffney Board of Public Works, and Gaffney withdraws the water from the Broad River. Therefore, the public water supply does not affect the groundwater resource.

The review team has examined the cumulative consumptive use of groundwater including the construction and preconstruction of the proposed units and the potential effects on the groundwater resource from other past, present, and reasonably foreseeable future actions. The review team identified only the past action of the unfinished Cherokee Nuclear Station as potentially affecting the groundwater resource. Reshaping the landscape of the unfinished Cherokee Nuclear Station site removed elevated areas, created a plateau for the three proposed units and several onsite waterbodies (i.e., Make-Up Ponds A and B, and Hold-Up Pond A), and excavated for deep foundations in the power block area. This landscape, which is changed from the preconstruction condition of the unfinished Cherokee Nuclear Station site, forms the initial preconstruction landscape for the Lee Nuclear Station site. In terms of its physical setting (e.g., height, connectedness to surface waterbodies, presence within fill material), the original groundwater aquifer has changed in response to this reshaped environment. However, the water resource it represents in terms of a water source and its water quality are consistent with the pre-site conditions documented in the application for the unfinished Cherokee Nuclear Station (Duke 2009c). For this reason the review team concludes that cumulative impacts of construction and preconstruction on the groundwater resource from other past, present, and reasonably foreseeable future actions would be minimal.

As discussed in Section 5.2.2.2, impacts on groundwater use during operations are anticipated to be SMALL because Duke does not plan to use groundwater or to discharge waste to groundwater during operations at either the Lee Nuclear Station site or the Make-Up Pond C site. Impacts on groundwater use in Cherokee County from operations are not anticipated because Lee Nuclear Station would obtain all water for operations directly from the Broad River and the Draytonville Water District. Offsite wells located adjacent to Make-Up Pond C influenced during the filling of the pond during construction and preconstruction would also be influenced by the discharge and refill of Make-Up Pond C during operation of proposed Lee Nuclear Station Units 1 and 2. If influenced at all, the water level within wells would rise in response to the full-pond water level of 650 ft above mean sea level, and fall no lower than their preconstruction levels. The review team has examined the cumulative consumptive use of groundwater including the operation of the proposed units, and other consumptive uses (past, present, and reasonably foreseeable future uses). Given that no industrial, agricultural, or power generation uses are identified for groundwater, the review team concludes that the cumulative impact on groundwater use during operation would be minimal.

Based on its evaluation, the review team concludes that the cumulative impacts on groundwater use during construction, preconstruction, and operation of proposed Lee Nuclear Station Units 1 and 2 would be SMALL.

7.2.2 Water-Quality Impacts

This section describes cumulative water-quality impacts resulting from construction, preconstruction, and operation of the proposed units and impacts from other past, present, and reasonably foreseeable future projects.

7.2.2.1 Surface-Water-Quality Impacts

The description of the affected environment in Section 2.3 serves as a baseline for this resource area. As described in Section 4.2.3.1, the impacts from NRC-authorized construction on surface-water quality would be SMALL and no further mitigation would be warranted. As described in Section 5.2.3.1, the review team concludes that the impacts of operations on surface-water quality would also be SMALL, and no further mitigation would be warranted. The analysis of operational impacts in Section 5.2.3.1 accounted for the NPDES permit (Permit No. SC0049140) issued by the South Carolina Department of Health and Environmental Control (SCDHEC) to Duke on July 17, 2013 and effective September 1, 2013 (SCDHEC 2013a). In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis for surface-water quality considers other past, present, and reasonably foreseeable future actions that could potentially affect this resource.

As described in Section 4.2.3.1, the surface-water-quality impacts from construction and preconstruction would be SMALL, and no further mitigation would be warranted. In addition to the impacts from construction, preconstruction and operations, the cumulative analysis considers past, present, and reasonably foreseeable future actions that could impact surface-water quality. For this cumulative analysis the geographic area of interest is the Broad River basin, the same as that described for surface-water use (Section 7.2.1.1).

The impacts on water quality from building and operating proposed Lee Nuclear Station Units 1 and 2 were determined to be minimal, and were evaluated using the current conditions in the Broad River. The hydrological conditions described in Sections 4.2 and 5.2 include the impact of activities listed as currently operational in Table 7-1 that are distinct from the activities at the site. These activities include facilities other than the proposed Lee Nuclear Station Units 1 and 2 with NPDES permits to discharge water to the Broad River and its tributaries. The NPDES permit program for point source discharges and the Total Maximum Daily Load program for nonpoint sources are designed to protect water quality.

The review team performed an independent assessment of the primary water-quality impacts on Ninety-Nine Islands Reservoir and the Broad River in its analysis of the estimated blowdown discharge of proposed Lee Nuclear Station Units 1 and 2 (see Section 5.3). The review team determined that both the thermal impacts and the impact of discharging solutes and solids concentrated through evaporation in the cooling towers would be minimal and localized to the zone defined by the thermal plume. The impacts of the other projects listed in Table 7-1 are either considered in the analysis included in Sections 4.2 and 5.2 or would have little or no impact on surface-water quality. Based on the predicted increase in temperature associated with climate change (see 7.2.1.1), the review team determined that the temperature of the streamflow in the Broad River is similarly likely to increase. However, the projected temperature increase is not expected to result in a significant decrease in the beneficial uses of the Broad River.

Although the cumulative effects on surface-water quality may be detectable, they would not noticeably alter the resource; therefore, the review team concludes that cumulative impacts of surface-water quality would be SMALL.

7.2.2.2 Groundwater-Quality Impacts

The description of the affected environment in Section 2.3 of this document serves as a baseline for the cumulative impacts assessments in this resource area. The groundwater-quality impacts for NRC-authorized construction are described in Section 4.2.3.2 and were determined to be SMALL and no further mitigation would be warranted. As described in Section 5.2.3.2, the review team concludes the groundwater-quality impacts from operation of the proposed units would also be SMALL and no further mitigation would be warranted.

The combined groundwater-quality impacts from construction and preconstruction are described in Section 4.2.3.2 and were determined to be SMALL. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis for groundwater quality considers other past, present, and reasonably foreseeable future actions that could potentially impact this resource. The geographic area of interest is the same as that described for groundwater use (Section 7.2.1.2).

As discussed in Section 4.2.3.2, impacts on groundwater quality would be localized and temporary during construction and preconstruction. Aside from the unfinished Cherokee Nuclear Station, no past, present, and reasonably foreseeable actions in the local watersheds that recharge aquifers underlying the Lee Nuclear Station site and the Make-Up Pond C site would potentially affect the groundwater resource. The review team's review of the effects of the unfinished Cherokee Nuclear Station in Section 7.2.1.2 applies, and the review team concludes that cumulative impacts on the groundwater resource from other past, present, and reasonably foreseeable future actions would be minimal.

Impacts on groundwater quality during operations, as discussed in Section 5.2.3.2, are anticipated to be localized because Duke does not plan to use groundwater or to discharge waste to groundwater during operations. The minimal impact to groundwater quality in groundwater wells located adjacent to Make-Up Pond C during discharge and fill events is noted in Section 5.2.3.2.

The cumulative effects on groundwater quality may be detectable on a single-well or group-of-wells basis, but not on a regional basis. The review team concludes that cumulative effects would be minor such that they would neither destabilize nor noticeably alter the groundwater resource. Therefore, the review team concludes that the cumulative impacts to groundwater quality during construction, preconstruction, and operation would be SMALL.

7.3 Ecological Impacts

This section addresses the potential cumulative impacts on ecological resources from building and operating Lee Nuclear Station; building and operating Make-Up Pond C); building and operating transmission-line and water-pipeline corridors; renovating and partially rerouting a railroad-spur corridor; making offsite road improvements, and past, present, and reasonably foreseeable future activities within the geographic area of interest of each resource.

7.3.1 Terrestrial Ecology and Wetlands

The description of the affected environment in Chapter 2.4.1 provides the baseline for the cumulative impacts assessments for terrestrial and wetland ecological resources. As described in Section 4.3.1, the impacts from NRC-authorized construction on terrestrial and wetlands ecology would be SMALL, and no further mitigation would be warranted. As described in Section 5.3.1, the impacts of operations on terrestrial and wetlands ecology would be SMALL, and no further mitigation would be warranted.

The combined impacts from preconstruction and NRC-authorized construction were also described in Section 4.3.1 and determined by the review team to be MODERATE, primarily because of the impacts from development of Make-Up Pond C and the transmission-line corridors. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis considers other past, present, and reasonably foreseeable future actions that could affect terrestrial resources. For the cumulative analysis of potential impacts to terrestrial and wetland ecology, the geographic area of interest is a 15-mi radius around the proposed Lee Nuclear Station, which encompasses Make-Up Pond C, the railroad-spur corridor, the water-pipeline corridor, the two proposed transmission-line corridors, and the offsite road improvements. The geographic area of interest is located within two subdivisions of the Piedmont ecoregion of South Carolina: the Kings Mountain subdivision and the Southern Outer Piedmont subdivision. The Kings Mountain subdivision includes the proposed Lee Nuclear Station and associated facilities with the exception of the terminal portions of the transmission-line corridors, which are in the Southern Outer Piedmont subdivision (EPA 2007b). The two subdivisions are similar in terms of previous disturbances and existing land covers (Glenn et al. 2002) and are indicative of the Piedmont ecoregion as a whole. This area is expected to encompass the ecologically relevant landscape features, habitats, and species potentially affected by the Lee Nuclear Station.

7.3.1.1 Habitat

The Piedmont ecoregion has been altered to a greater extent than the other ecoregions of South Carolina since the time of European settlement, primarily because of farming, agriculture, and silviculture. During the time of early settlement, the forests were primarily a mixture of oaks (*Quercus* spp.), hickories (*Carya* spp.), and shortleaf pine (*Pinus echinata*), which are still the prevalent vegetation types in the Piedmont. The introduction of cotton farming changed much of the original hardwood and pine forests into agricultural fields. By the 1930s, various factors, including the Great Depression, severe erosion, and boll weevil (*Anthonomus grandis*) outbreaks, led to widespread abandonment of farmlands. Loblolly pine (*P. taeda*), introduced during the nineteenth century as a cash lumber crop, is currently the dominant tree species throughout much of the ecoregion (SCDNR 2005). Most forests in the geographic area of interest are a mosaic, dominated by privately owned monotypic pine plantations and natural mixed hardwood-pine and pine-mixed hardwood forest located on regenerating old field sites and other previously disturbed sites (Glenn et al. 2002).

The geographic area of interest has changed dramatically since the damming of the Broad River by Ninety-Nine Islands Dam in 1910. Prior to impoundment, the land currently inundated was primarily forestland, riparian land, and farmland (Duke 2011h, SCDNR 2003). Other dams in the geographic area of interest that have likewise impounded riparian and upland habitat include Gaston Shoals Dam on the Broad River in 1927 (Duke 2011h) and the damming of Cherokee Creek in 1964 to create Lake Whelchel (Duke 2009c). Land alteration occurred on the Lee Nuclear Station site from 1977 through 1982 during construction of the incomplete Cherokee Nuclear Station (Duke 2009c). During that period, Duke Power Company cleared and graded approximately 750 ac of the more than 1900-ac site for the unfinished Cherokee Nuclear Station and impounded riparian and upland habitats associated with approximately 23,000 linear ft of streams to create Make-Up Ponds A and B (Duke 2011h) (Section 2.4.1.1). In 1971, the South Carolina Department of Natural Resources (SCDNR) impounded riparian and upland habitat associated with about 1 mi of London Creek and associated headwater tributaries to create Lake Cherokee (Duke 2009b, 2011h). In addition, over the years, many small ponds have been created (for flood control, stormwater, irrigation, water supply, recreation, etc.) that have flooded riparian and upland habitat (Duke 2011h).

Overlaying the historic impacts described above, current projects within the geographic area of interest include numerous surface mining operations; several hydroelectric and gas-fired energy plants; several manufacturing facilities; several wastewater treatment plants; transportation projects; Kings Mountain National Military Park; several State parks (e.g., Kings Mountain State Park, which adjoins Kings Mountain National Military Park, and Crowders Mountain State Park); the Broad Scenic River; and continued silviculture, agriculture, farming, and urbanization (Table 7-1). The development of most of these projects has further reduced, fragmented, and degraded natural forests and decreased their connectivity. In contrast, the scenic river designation protects the natural resources of the designated section of the Broad River corridor in perpetuity. The Kings Mountain National Military Park and State parks also protect local terrestrial resources in perpetuity.

Most of the geographic area of interest of today remains rural and consists of scattered, privately owned pine plantations and pine-hardwood forests on upland sites; regenerating mixed hardwood and mixed hardwood-pine forest on relatively narrow floodplains and upland sites; small farms and recently abandoned farmland; agriculture fields such as pasture and hay; limited commercial development; single family residences; the City of Gaffney; and open water (e.g., Ninety-Nine Islands Reservoir and the Broad River and its tributaries). The landscape, which once was almost continuously forested, now exhibits fragmentation and degradation. Reasonably foreseeable projects and land uses within the geographic area of interest that could affect wildlife habitat include ongoing silviculture, farming, and agricultural development and limited commercial, residential, and urban development, particularly in conjunction with the Interstate 85 corridor (Duke 2011h).

Site preparation and development of the proposed Lee Nuclear Station and associated facilities would disturb a total of about 2824 ac, of which about 1934 ac is forest, including 545 ac of mixed hardwood forest and mixed hardwood-pine forest at the Make-Up Pond C site. In addition, four noteworthy ecological associations of concern to the State of South Carolina, seven significant natural areas, and habitat that supports populations of rare species, including one Federal candidate plant species and five State-ranked plant species, would be permanently lost via inundation and/or site development. The loss of habitat, particularly forest habitat along the two transmission-line corridors and the bottomland mixed-hardwood forest along London Creek and its tributaries, would noticeably reduce, fragment, and degrade natural forest habitat and decrease its connectivity in the geographic area of interest.

Although the habitat in the geographic area of interest has been significantly altered since the time of European settlement, habitat impacts from the projects and activities listed above, with the exception of the Broad River scenic river designation, Kings Mountain National Military Park, and State parks, combined with building and operating the proposed Lee Nuclear Station, would be noticeable but not destabilizing to terrestrial resources because the affected habitat types are generally common in the geographic area of interest.

7.3.1.2 Wetlands

Historically, the majority of South Carolina's wetlands were in the eastern half of the state, with relatively few in the Piedmont (Dahl 1999). The original Piedmont wetlands probably featured numerous depressions of swamp tupelo (*Nyssa biflora*) and willow oak (*Quercus phellos*) that served as natural "green-tree reservoirs" for ducks and other wildlife. The severe erosion of farmland soil and the abandonment of farmland during the Great Depression led to the sedimentation of an unknown amount of Piedmont wetlands (SCDNR 2005). In 1989, wetlands made up 21 percent of the state's land area, but less than 5 percent of the state's wetlands were located in the geographic area of interest (Dahl 1999). Hydroelectric projects may have had greater wetland impacts than other past activities, but actual acreages of previous wetland removal resulting from the activities listed in Table 7-1 are not known for the geographic area of interest. Currently available wetlands in the geographic area of interest are primarily scattered along creeks and rivers (Duke 2007c).

Site preparation and development of the proposed Lee Nuclear Station and required ancillary features such as Make-Up Pond C, two new transmission-line corridors, and railway spur would result in direct impacts to 5.43 ac of jurisdictional wetlands and 29.63 ac of open waters (Table 9-19) (Duke 2012n). In addition, temporary drawdown of Make-Up Ponds A and B during installation of intake/refill structures has the potential to result in temporary secondary impacts to an additional 5.46 ac of jurisdictional wetlands along the shoreline. Affected wetlands comprise approximately 0.35 percent of the total projected disturbed area. Unavoidable impacts to wetlands and streams would be mitigated through compensatory mitigation. A summary of Duke's mitigation plan, as provided by the USACE, is included in Section 4.3.1.7. Duke consulted with the USACE to develop a compensatory mitigation plan in conformance with the requirements of the USACE Charleston, South Carolina District's *Guidelines for Preparing a Compensatory Mitigation Plan, Working Draft* (USACE 2010a) and *Compensatory Mitigation for Losses of Aquatic Resources; Final Rule* (73 FR 19594, 40 CFR Part 230 and 33 CFR Part 332). A watershed-based, permittee-responsible mitigation project or projects, including restoration, preservation, and enhancement, would be used to compensate for unavoidable project impacts on wetlands and streams (Duke 2010o). It is likely that a relatively minor amount of wetland habitat has been or would be removed by past, present, and reasonably foreseeable future activities in the geographic area of interest, including the proposed Lee Nuclear Station. Consequently, wetland impacts are considered minor in the geographic area of interest.

7.3.1.3 Wildlife

The wildlife that occupies an area at any given time is indicative of the habitat that supports it. As noted in Section 7.3.1.1, oak-hickory forests dominated the Piedmont prior to European settlement. Pre-settlement oak-hickory forests experienced natural surface fires that were frequent and of low intensity. Frequent fires created a mosaic of habitat in various stages of succession, which ranged from prairie to mature forest. Consequently, it is likely that wildlife species adapted to all stages of succession were present, including those that required large blocks of habitat (i.e., area-sensitive species), such as the bobwhite quail (*Colinus virginianus*), and those that prefer interior forest habitat, such as the scarlet tanager (*Piranga olivacea*) and hooded warbler (*Wilsonia citrina*) (SCDNR 2005).

The extensive forest clearing and low-intensity agriculture that accompanied early settlement dramatically increased the amount of early successional (prairie-like) and edge habitat (forest/open habitat interface) in the Piedmont, which peaked in the early twentieth century. However, during the second half of the twentieth century, the quantity and quality of early successional habitats diminished due to fire suppression, fragmentation of habitat into small isolated units due to the establishment of pine plantations and smaller-scale farming and agriculture operations, increasing land development, and encroachment of invasive vegetation (e.g., Chinese privet [*Ligustrum sinense*]). Populations of many wildlife species that depend on open habitats also declined during this time period. Today, the only known remnant of Piedmont prairie habitat is located on the eastern fringe of York County, South Carolina, outside the geographic area of interest (SCDNR 2007). Hardwood forests generally are not allowed to mature because of timber harvest rotation schedules and pine plantations generally provide poor wildlife habitat. Consequently, the current landscape habitat mosaic in the Piedmont, and in the geographic area of interest, favors wildlife adapted to mid-successional hardwood forest conditions, pine plantations, and/or small farm fields (e.g., pasture). Current habitat does not favor prairie or late-successional (i.e., mature forest) wildlife, or wildlife that require large blocks of habitat.

Reasonably foreseeable projects within the geographic area of interest that would affect wildlife populations include the ongoing silviculture, farming, and agriculture and the expected limited commercial, residential, and urban development, especially that surrounding Interstate 85 (Duke 2011h) described in Section 7.3.1.1. These influences would perpetuate reduction, fragmentation, and degradation of natural hardwood forests and decrease habitat connectivity. The resulting habitat mosaic would tend to continue to favor wildlife adapted to mid-successional hardwood forest conditions and generally worsen conditions for wildlife adapted to prairie and late-successional conditions. It would also continue to favor species adapted to a fragmented forested landscape rather than species favoring broad, unbroken swaths of forest.

The removal of large blocks of upland habitat for the proposed Lee Nuclear Station and associated facilities would cause wildlife mortality, disturbance, and displacement. Less mobile animals would incur greater mortality than more mobile animals, which would be displaced into nearby undisturbed habitat where increased competition for resources may result in population reductions. Riparian species, especially amphibians, would be lost from the bottomland mixed hardwood forest habitat along London Creek. Species adapted to open habitats could be lost from extant farm fields and scrub-shrub habitats, but could disperse into similar adjacent habitats. Similarly, species adapted to forest/clearing edge habitats could disperse into other areas created by inundation or forest clearing. Thus, the proposed Lee Nuclear Station and associated facilities would pose short-term temporary adverse impacts for some wildlife species that use early successional habitat or edge environments. However, riparian and bottomland hardwood forest species would face long-term mortality, disturbance, and displacement.

Although wildlife resources in the geographic area of interest have been significantly altered since the time of European settlement, impacts to wildlife resulting from ongoing and reasonably foreseeable future activities, including the proposed Lee Nuclear Station, would not be destabilizing, but would be noticeable for some groups of wildlife (e.g., late-successional [mature forest] wildlife or wildlife that require large blocks of habitat).

7.3.1.4 Important Species

Five South Carolina State-ranked plant species: (1) drooping sedge (*Carex prasina*) (imperiled [S2]), (2) southern enchanter's nightshade (*Circaea lutetiana* ssp. *canadensis*) (vulnerable [S3]), (3) southern adder's-tongue fern (*Ophioglossum vulgatum*) (imperiled [S2]), (4) Canada moonseed (*Menispermum canadense*) (imperiled [S2]), and (5) single-flowered cancer root (*Orobanche uniflora*) (imperiled [S2]) and a State-ranked avian species, the loggerhead shrike (*Lanius ludovicianus*) (vulnerable [S3]), would be affected by the proposed Lee Nuclear Station and associated facilities. A total of 16 additional State-ranked plant species and one State-ranked animal species are also known to occur in the geographic area of interest, although they were not found within the project footprint (Section 2.4.1.6, Table 2-9, Footnote [c]). Four noteworthy ecological associations of concern to the SCDNR would be affected by the creation of Make-Up Pond C. In addition, two plant communities of interest to the SCDNR also occur within the geographic area of interest: basic forest (State-ranked as imperiled [S2]) and pine-oak heath (State-ranked as vulnerable [S3]) (SCDNR 2012b). The State ranks of these species and communities range from vulnerable (S3) to imperiled (S2) in South Carolina, but all are generally secure range-wide, which includes much of eastern North America (NatureServe Explorer 2010; SCDNR 2012b). Although the past, present, and reasonably foreseeable future activities described in Section 7.3.1.1, including the proposed Lee Nuclear Station and associated facilities, have affected, and would continue to affect, individual populations of these species and occurrences of these communities, cumulative effects in the geographic area of interest would have a negligible impact on these species and communities range-wide.

Georgia aster (*Symphyotrichum georgianum*), a Federal candidate species, also would be affected by development of Make-Up Pond C (Section 4.3.1.6). The species occurs in five southeastern states, including South Carolina. It is considered vulnerable range-wide (NatureServe Explorer 2010). Georgia aster is an early successional relict species of the post oak (*Quercus stellata*) savanna/prairie of the Piedmont. The species currently occupies a variety of dry habitats along roadsides; along woodland borders; in dry, rocky woods; and in utility corridors on low-acidic or highly-alkaline soil where current land management mimics natural disturbance (FWS 2010a). Reasonably foreseeable projects within the geographic area of interest that would affect the species include ongoing silviculture and farming; agricultural development; and limited commercial, residential, and urban development described in Section 7.3.1.1. Although range-wide losses of Georgia aster populations and suitable habitat for the species resulting from past, present, and reasonably foreseeable future activities are considered noticeable and potentially destabilizing (as indicated by the species being a candidate for Federal listing as threatened or endangered), cumulative effects in the geographic area of interest, including the proposed Lee Nuclear Station and associated facilities, would not be expected to have more than a minor impact on the species range-wide.

7.3.1.5 Summary of Terrestrial Impacts

Cumulative impacts to terrestrial and wetland resources from construction, preconstruction, and operation of the proposed Lee Nuclear Station and other past, present, and reasonably foreseeable projects were estimated based on the information provided by Duke, the U.S. Fish and Wildlife Service (FWS), the SCDNR, and the review team's independent evaluation. Terrestrial resources in the geographic area of interest have been significantly altered since the time of European settlement. Ongoing silviculture and farming; agricultural development; and commercial, residential, and urban development, would continue to reduce, fragment, and degrade terrestrial resources in the geographic area of interest.

The loss of habitat associated with the proposed Lee Nuclear Station and associated facilities, especially lowland mixed-hardwood forest along London Creek and its tributaries and forest habitat along transmission-line corridors, would noticeably impact but not destabilize terrestrial resources in the geographic area of interest. Impacts to wetlands and important species, including the Georgia aster, would be minimal. Unavoidable impacts to wetlands and streams would be mitigated through compensatory mitigation as discussed in Section 4.3.1.7.

Based on this evaluation, the review team concludes that cumulative impacts from past, present, and reasonably foreseeable future actions, including construction, preconstruction, and operations of the proposed Lee Nuclear Station, to terrestrial ecology and wetland resources in the geographic area of interest would be MODERATE. Although impact from the development of the Lee Nuclear Station site would be considerable, development of Make-Up Pond C and the transmission-line corridors are the principal contributors to the MODERATE rating of cumulative terrestrial impacts. While impacts from the development of Make-Up Pond C and the proposed transmission-line corridors would noticeably impact terrestrial resources within the

15-mi geographic area of interest, cumulative impacts over the range of occurrence for the affected habitat and wildlife (i.e., the Piedmont ecoregion) would not be destabilizing.

Neither Make-Up Pond C development nor development of the transmission-line corridors requires NRC authorization. Incremental impacts from NRC-authorized activities (which are limited to the Lee Nuclear Station site and confined mostly to the low-quality habitats within the previously disturbed footprint of the unfinished Cherokee Nuclear Station) do not significantly contribute to the impact, and would not noticeably alter the terrestrial ecology within the geographic area of interest.

7.3.2 Aquatic Ecosystem

The description of the affected environment in Section 2.4.2 serves as a baseline for the cumulative impacts assessment for aquatic ecological resources. As described in Section 4.3.2, the impacts of NRC-authorized construction activities on aquatic biota would be SMALL, and no further mitigation would be warranted. As described in Section 5.3.2, the review team concludes that impacts of Lee Nuclear Station Units 1 and 2 operations and maintenance on aquatic resources inhabiting onsite waterbodies, Make-Up Pond C, the Broad River, and waterbodies crossed by the transmission-line corridors would be SMALL.

The combined impacts on aquatic resources from construction and preconstruction, including building new cooling-water intake and discharge systems, dredging and other soil-disturbing activities during modification of structures in Make-Up Ponds A and B, temporarily drawing down Make-Up Ponds A and B to facilitate cofferdam installation, installing a dam across London Creek with the subsequent impoundment of London Creek and its unnamed tributaries, filling Make-Up Pond C, installing pump stations and an intake/discharge facility at Make-Up Pond C, installing new transmission-line corridors, renovating the railroad-spur culvert crossing, and breaching and draining offsite farm ponds, were described in Section 4.3.2 and determined to be MODERATE. The adverse impacts are associated primarily with the permanent conversion of approximately 11.4 mi of Outer Piedmont tributaries to a reservoir (Duke 2012n).

In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis considers other past, present, and reasonably foreseeable actions that could affect aquatic ecology. For this analysis, the geographic area of interest and areas most likely to show the impact of water-use and water-quality criteria for aquatic biota are the drainage basin of the Broad River from Gaston Shoals Dam downriver approximately 33 mi to Lockhart Dam just below the Broad River’s junction with the Pacolet River; Make-Up Ponds A, B, and C; Hold-Up Pond A; London Creek and its tributaries; and corresponding intermittent and seasonal streams on the Lee Nuclear Station site. In addition, waterbodies crossed by the transmission-line corridors are considered within each corridor as described for terrestrial resources in Section 4.3.1, and include Abingdon Creek, Fanning Creek, Gault Creek, Gilkey Creek, the Pacolet River, Quinton Branch, Reedy Branch, Service Branch, Thicketty Creek, and numerous unnamed tributaries to those waterbodies. The corridors are included as part of the geographic area of interest because of the potential for impacts to aquatic resources. According to the Joint Permit Application submitted by Duke to the USACE, there will be no fill impacts to tributaries within the offsite transmission-line permit area components because the transmission lines will span the tributaries and the transmission structures will be located within the uplands (Duke 2011h). Other actions listed in Table 7-1 within the geographic area of interest that have present and reasonably foreseeable potential impacts on the aquatic ecological resources of the Broad River drainage basin from Gaston Shoals Dam to Lockhart Dam include operation of several hydroelectric facilities (i.e., Gaston Shoals, Cherokee Falls, Ninety-Nine Islands, and Lockhart), discharge of water by domestic and industrial NPDES permit holders, withdrawal of water for domestic and industrial purposes, use of managed parks and preserves such as the Broad Scenic River, implementation of the *Santee-Cooper Basin Diadromous Fish Passage Restoration Plan* (FWS 2001) and the *Santee River Basin Accord for Diadromous Fish Protection, Restoration, and Enhancement* (SRBA 2008), and future urbanization in the region. The evaluation of cumulative impacts on aquatic biota from these actions is described below.

Southern Power Company completed building Ninety-Nine Islands Dam in 1910 (Taylor and Braymer 1917). Parr Shoals Dam and Gaston Shoals Dam were completed in 1914 and 1927, respectively. By the 1930s, access to many miles of riverine habitat in the Broad River basin was blocked by hydroelectric dams that supplied electricity to cotton mills and to towns for lighting, power, and street railway service (Taylor and Braymer 1917). While providing many benefits to people, the dams blocked the movement of resident and diadromous fish and fragmented the river system by altering flows, bed-load movements, water chemistry, and habitats (FWS 2001). Partial building of the unfinished Cherokee Nuclear Station between 1977 and 1982 significantly changed surface-water characteristics in the vicinity of the station. McKowns Creek, impounded to create Make-Up Pond B, originally flowed down a moderate gradient through alternating pools and gravel riffles (NRC 1975a). Mean annual flow was small, estimated at 1 to 3 cfs. Phytoplankton and benthic invertebrates were diverse and abundant. Creek Chub (*Semotilus atromaculatus*) was the only fish species collected from the creek. Site runoff was impounded to create Hold-Up Pond A, while the building of an additional dam permanently separated part of the full-pond backwater area from the rest of Ninety-Nine Islands Reservoir to create Make-Up Pond A (NRC 1975a). These areas, although isolated from the river, did develop their own aquatic communities, as described in Section 2.4.2.1. Creek Chub do not survive in the ponded areas.

Building of Make-Up Pond A also affected Ninety-Nine Islands Reservoir because dam-building activities occurred directly in the waters of the reservoir (NRC 1975a). Estimates in the Cherokee Nuclear Station Final Environmental Statement indicated that up to 50 percent of the reservoir would be affected by temporary increases in turbidity from building activities (NRC 1975a). However, following building activities, the biota of affected areas in the reservoir were expected to slowly revert back to their former composition. Species checklists developed before building activities at the site compared with 2006 species survey data show the same number of species were captured in 1973 to 1974 as in 2006, although the actual species composition is somewhat different (Duke 2009c). In general, the number of cyprinid (minnow) and darter species appears to have declined, while the number of centrarchid (sunfish and bass) species has increased (Table 2-11) (Duke 2009c).

Overall, the partial building of the Cherokee Nuclear Station affected approximately 3.2 mi^2 of the McKowns Creek and the Broad River watersheds when Make-Up Ponds A and B and Hold-Up Pond A were built (Table 2-5).

The review team considered the potential cumulative impacts due to impingement and entrainment of aquatic biota. Operation of the proposed Lee Nuclear Station Units 1 and 2 would result in some losses resulting from impingement and entrainment of aquatic biota in the Broad River and in Make-Up Ponds A, B, and C. As discussed in Section 5.3.2.1, the proposed closed-cycle wet cooling system with cooling towers for the proposed Lee Nuclear Station Units 1 and 2 would not be expected to result in measurable impingement or entrainment-related impacts. In addition, most of the suitable spawning habitat for the fish species present in the Broad River in the vicinity of the Lee Nuclear Station site is in the backwater of the reservoir rather than near the proposed intake structure. Lower abundances of fish larvae were found in the vicinity of the proposed intake compared to the backwater areas, and many of the fish species' spawning habits (i.e., nest-building rather than broadcast spawning) reduce potential impacts from entrainment.

Some aquatic species are entrained through the Gaston Shoals, Cherokee Falls, Ninety-Nine Islands, and Lockhart Dams. These organisms may survive but are essentially lost to the reservoir from which they originated. For example, the hydroelectric plant at Ninety-Nine Islands Dam generates 18 MW through operation of six turbine units (Huff and Lewis 2010). A continuous minimum flow requirement of no less than 483 cfs results in the transport of aquatic biota within the influence of the turbine intake systems downriver below Ninety-Nine Islands Dam. The operation of the hydroelectric plant influences aquatic communities within Ninety-Nine Islands Reservoir by preventing organisms that pass through the hydropower facility from returning upstream of the facility.

Overall, the review team concludes that the cumulative impacts of impingement and entrainment on the fishery is minor and would not negatively affect aquatic populations, including species of special interest or Federally listed or State-ranked species.

The review team considered the potential cumulative impacts resulting from thermal discharges. Blowdown from the proposed Lee Nuclear Station Units 1 and 2 would enter the Broad River. The blowdown discharge to the Broad River, described in more detail in Section 5.3.2.1, is not likely to noticeably affect the biota, water quality outside the proposed mixing zone, or consumptive use at Ninety-Nine Islands Hydroelectric Project. Two companies within the geographical area of interest currently hold major industrial NPDES permits to discharge to the Broad River and Pacolet Rivers, respectively (Table 7-2). Four major domestic NPDES permits currently allow significant discharges to the Broad River, Pacolet River, and Thicketty Creek (Table 7-2). The Pacolet River and Thicketty Creek are tributaries to the Broad River downstream of the Lee Nuclear Station site. Should other industrial or domestic plants begin operations in the future, thermal discharges from those facilities would be regulated by the State. Currently, the SCDHEC requires that Broad River water temperatures not increase more than 5°F above ambient river temperatures and that river temperatures not exceed 90°F as a result of heated water discharge, with the exception of a defined mixing zone, which would require approval by the SCDHEC (2008a). Duke submitted an NPDES permit application to the SCDHEC that included a mixing zone request (Duke 2011a). SCDHEC issued the NPDES permit (Permit No. SC0049140) on July 17, 2013, effective September 1, 2013 (SCDHEC 2013a). As discussed in Section 5.3.2.1, the NPDES permit requires Duke to submit for SCDHEC's approval a plan for confirmatory monitoring.

Table 7-2. Major NPDES Permit Holders Discharging to Waters in the Aquatic Geographic Area of Interest (SCDHEC 2007b)

NPDES Permit	Facility Name	Receiving Water	Permitted Flow at Pipe (Mgd)
SC0003182, Industrial	Milliken & Co./Magnolia PLT	Broad River	3.89
SC0047091, Domestic	City of Gaffney/Peoples Creek PLT	Broad River	4.0
SC0031551, Domestic	City of Gaffney/Clary Waste Water Treatment Plant	Thicketty Creek	5.0
SC0002798, Industrial	Invista SARL/Spartanburg	Pacolet River	Volume discharge not specified in permit; Monitor and Report
SC0045624, Domestic	Spartanburg Sanitary Sewer District/ Town of Cowpens/Pacolet River	Pacolet River	1.5
SC0020435, Domestic	Spartanburg Sanitary Sewer District/ Fairforest Regional Waste Water Treatment Facility	Pacolet River	19.0

The review team conservatively estimated the maximum fraction of the Broad River that could achieve a 5°F temperature increase (typically used to define the extent of a thermal plume) during a warm summer period (monthly mean temperature of 86°F). Under normal discharge conditions (18 cfs), the review team estimated that no more than 11 percent of the flow could sustain a temperature increase of 5°F. However, under maximum discharge conditions (64 cfs), the review team estimated that no more than 34 percent of the flow could sustain a temperature increase of 5°F. In either scenario, motile species such as fish would be able to find adequate refuge from the heated water discharge. The review team's independent analysis determined the increase in ambient water temperatures would not adversely affect aquatic organisms in the river, including Smallmouth Bass (*Micropterus dolomieu)* (Section 5.3.2.1).

Thus, the review team considers the cumulative impacts from thermal discharges would be minor and would not negatively impact aquatic organisms, including species of special interest or Federally listed or State-ranked species.

The review team also considered the potential cumulative impacts from chemical releases. Duke's Catawba Nuclear Station uses similar chemicals as those proposed for the Lee Nuclear Station. The Catawba Nuclear Station, located on the Catawba River in South Carolina, is in compliance with NPDES permit requirements. The Lee Nuclear Station must be able to meet chemical discharge criteria set by the SCDHEC in its NPDES Permit, issued July 17, 2013 (SCDHEC 2013a). In addition, Broad River water quality may be affected by discharges from other plants or facilities in the geographical region of interest, such as the major permit holders listed in Table 7-2 and at least 37 other existing minor NPDES permit holders in the Broad River basin currently discharging to the Broad River and its numerous tributaries (i.e., Bells Branch tributary, Buffalo Creek and a tributary, Cherokee Creek, Irene Creek, Island Creek, Jones Creek, Kings Creek and a tributary, Little Buck Creek, Little Cherokee Creek, Long Branch, Manning Branch, Mill Creek and a tributary, the Pacolet River and tributaries, Peoples Creek, Peters Creek and a tributary, Providence Branch, Spencer Branch and a tributary, and Thicketty Creek). The SCDHEC, which grants NPDES permits in South Carolina, took cumulative chemical releases from the proposed Lee Nuclear Station Units 1 and 2 and from other domestic and industrial sites discharging to the Broad River and its tributaries into consideration before approving its NPDES permit for the proposed units (Permit No. SC0049140, issued July 17, 2013). Therefore, the cumulative effects from the existing NPDES permit holders and the proposed Lee Nuclear Station Units 1 and 2 are not expected to negatively affect aquatic organisms, including species of special interest or Federally listed or State-ranked species, and are considered to be minor.

The review team considered the potential cumulative impacts resulting from surface-water withdrawals. Duke estimates that water withdrawal rates for the proposed Lee Nuclear Station would vary between 78 cfs (normal operations) and 134 cfs (maximum-use operations) from March through June and up to 304 cfs (maximum-use operations) between July and February when water could be withdrawn for station operation and makeup pond refill (Duke 2009c, 2011a). Within the geographic area of interest, one large community water system currently withdraws surface water from the Broad River. The Gaffney Board of Public Works has an 18 Mgd treatment capacity (GBPW 2010). Other community water systems in the geographical region of interest purchase water from other entities or obtain groundwater from wells. Many communities have above-ground and ground-level water storage to mitigate water needs during low water conditions. On January 1, 2011, Act No. 247, which amended the "South Carolina Surface Water Withdrawal and Reporting Act", went into effect. The Act was renamed the

"South Carolina Surface Water Withdrawal, Permitting, Use, and Reporting Act," and provides that, subject to certain exemptions, surface-water withdrawals must be made pursuant to a permit issued by the SCDHEC (SC Code Ann. 49-4). This new permitting process should ensure that future water withdrawals from the Broad River basin will not compromise aquatic uses or resources in South Carolina. The Broad River basin extends into North Carolina. While a permitting process for surface-water withdrawal does not yet exist in North Carolina (the Water Resource Policy Act of 2009 [NCGA 2009] has been brought before the General Assembly but has not passed), the North Carolina Department of Environment and Natural Resources (NCDENR) does require surface and groundwater withdrawers who meet conditions established by the General Assembly to register their water withdrawals and surface-water transfers with the State and to report their water usage annually (NCDENR 2011a). A proposal for a 1200-ac water-storage reservoir on the First Broad River in North Carolina by the Cleveland County Water Board is outside the regional area of interest, but is an example of another demand on Broad River water resources that will have to be considered by the SCDHEC.

The review team considered the potential cumulative impacts resulting from maintenance dredging activities at the Lee Nuclear Station site, including Make-Up Pond A and the Broad River intake and discharge structures. Periodic dredging would be required at the Broad River intake structure (Duke 2008o, 2012b). These events would impact a relatively small area and would be short term in duration. As such, impacts would be localized and temporary, and benthic macroinvertebrates would likely recolonize the area quickly. Maintenance dredging at the Broad River discharge site is not expected (Duke 2008p). Periodic dredging of Make-Up Pond A may be required (Duke 2009b). The soft-sediment environment would help to speed recovery from the effects of dredging in the pond. All maintenance dredging activities would be performed in accordance with SCDHEC and USACE permit conditions, and Duke has committed to using best management practices (BMPs) while performing dredge operations, thereby mitigating potential impacts. Because Make-Up Ponds B and C would receive water only during refill operations (i.e., to replenish water levels due to loss from evaporation or from use during low-flow periods), sedimentation rates are expected to be variable, but slow, and maintenance dredging would not be required (Duke 2009b).

The review team considered diadromous fish species potentially available in the future. The *Santee-Cooper Basin Diadromous Fish Passage Restoration Plan* (Plan) (FWS 2001) and the *Santee River Basin Accord for Diadromous Fish Protection, Restoration, and Enhancement* (Accord) (SRBA 2008) focus on restoring habitat connectivity for diadromous fish that were historically present within the basin. Within the Santee-Cooper basin, the Plan identified the Broad River sub-basin as a high priority for restoration because of the amount of potential habitat available as well as the quality of existing habitat. There is currently no evidence that the Plan's targeted diadromous fish species reside within the vicinity of the Lee Nuclear Station site; but there are documented historical accounts that some species (e.g., American Eel

[*Anguilla rostrata*] and American Shad [*Alosa sapidissima*]) migrated to the upper reaches of the Broad River. Future restoration efforts may result in the reestablishment of migratory fish populations upstream of Ninety-Nine Islands Dam. Potential impacts on aquatic biota resulting from the operation of the proposed Lee Nuclear Station Units 1 and 2 are evaluated in Section 5.3.2. With respect to future populations of migratory fish that may become established in the Broad River, impacts stemming from impingement and entrainment are likely to be minimal because of the use of closed-cycle cooling, the low through-screen velocity (less than 0.5 fps), the limited hydraulic zone of influence, and the location and design of the intake structure, including dual-flow vertical traveling screens with fish return system. The discharge effluent may result in localized thermal, chemical, and physical impacts; however, as discussed in Section 5.3.2.1, impacts on populations of aquatic biota, including diadromous fish species, would likely be minimal. In a letter to National Marine Fisheries Service (NMFS) dated August 14, 2012, the NRC concluded its consultation with the NMFS under the Endangered Species Act, Magnuson-Stevens Fishery Conservation and Management Act, and Fish and Wildlife Coordination Act for the Lee Nuclear Station COL application. In the event of successful implementation of the fish passage program as described in the Accord, the NRC staff will consider potential thermal, chemical, and physical impacts to Federally protected species from operations at the Lee Nuclear Station (NRC 2012d).

As previously discussed in Section 2.4.2.3, the FWS indicated that one listed mussel species, the Carolina Heelsplitter (*Lasmigona decorata*), was known to be present in York County, which bounds the Broad River downstream of Ninety-Nine Islands Dam (Table 2-13). However, the review team reviewed the literature and species summaries and found no evidence there are likely to be any Federally listed aquatic species in the vicinity of the Lee Nuclear Station site or in any waterbodies crossed by the transmission-line corridors (FWS 2010c). Further, there are no areas designated by the FWS as critical habitat for Federally listed threatened and endangered species in the vicinity of the Lee Nuclear Station site or the new transmission-line corridors (FWS 2008a). One South Carolina State-ranked fish species, the Carolina Fantail Darter (*Etheostoma brevispinum*) (Table 2-13), and recreational fisheries for sunfish, crappie, and bass (centrarchids); catfish (ictalurids); and suckers (catostomids) occur in the Broad River in the vicinity of Lee Nuclear Station. In addition, some aquatic taxa encountered near the proposed site have been identified as State conservation priority species. Five fish species listed as highest or high priority species by the SCDNR (2005) were found during surveys conducted by Duke or the SCDNR in the Broad River in the vicinity of the proposed new nuclear station, in London Creek, or in tributaries to the Broad River that may be crossed by new transmission-line corridors associated with the proposed Lee Nuclear Station. The five species are (1) Highfin Carpsucker (*Carpiodes velifer*), (2) Quillback (*C. cyprinus*), (3) Seagreen Darter (*Etheostoma thalassinum*), (4) Greenhead Shiner (*Notropis chlorocephalus*), and (5) Piedmont Darter (*Percina crassa*). Site-preparation and installation activities at Lee Nuclear Station site waterbodies, adjacent portions of the Broad River, London Creek and its tributaries, Broad River tributaries crossed by the new transmission-line corridors, and the new culvert under the existing railroad spur would use BMPs associated with water quality (developed by Duke and accepted or modified by State and Federal agencies through the permitting process). Therefore, the impact to State-ranked, recreational, and State conservation priority species would be short-term and minimal. Similarly, BMPs and environmentally responsible practices would be followed during maintenance activities at the Lee Nuclear Station site, Make-Up Pond C, railroad-spur corridor, and transmission-line corridors.

Cumulative impacts on aquatic resources within Ninety-Nine Islands Reservoir and Make-Up Ponds A, B, and C may also include activities or events that are distinct from the Lee Nuclear Station site. Anthropogenic activities such as residential or industrial developments near the vicinity of the nuclear facility can present additional constraints on aquatic resources. Future activities may include shoreline development (i.e., removal of habitat), increased water needs for domestic and industrial purposes, increased discharge of effluents into the Broad River, and increased recreational use of the river. Although the potential for long-term development in this area exists, its interactions with plant operations are not expected to result in significant adverse impacts to the river in the vicinity of Lee Nuclear Station. In fact, the Broad River below Ninety-Nine Islands Dam to the confluence of the Pacolet River is designated as a scenic river. A voluntary, cooperative community-based process is used by the SCDNR, landowners, and other community interests to accomplish river conservation goals (SCDNR 2006a).

In addition to direct anthropogenic activities, physical disturbances and climatic events may impose external stressors on aquatic communities. Aquatic ecosystem responses to these events are difficult to predict. At certain times of the year, operation of Lee Nuclear Station, other anthropogenic stressors, and climatic events could combine to adversely affect the aquatic populations of Ninety-Nine Islands Reservoir and Make-Up Ponds A, B, and C. The level of impact resulting from these activities or events would depend on the intensity of the perturbation and the resiliency of the aquatic communities.

During drought periods, Duke will be required to manage water withdrawals from the river to maintain adequate downstream flow and meet the Ninety-Nine Islands Federal Energy Regulatory Commission (FERC) license continuous minimum release requirements. This is important to ensure that adequate habitat and water-quality conditions are provided for both aquatic organisms and downstream users. When water flow in the Broad River falls below 538 cfs (FERC minimum release of 483 cfs plus Lee Nuclear Station average consumptive use of 55 cfs), Duke has committed to use water stored in Make-Up Ponds B and C as cooling water for the condensers to maintain the necessary water flows in the Broad River (Duke 2009b).

7.3.2.1 Summary of Aquatic Ecology Impacts

Cumulative impacts on aquatic ecology from construction, preconstruction, and operation of the proposed Lee Nuclear Station and other past, present, and reasonably foreseeable projects are estimated based on the information provided by Duke, the FWS, the SCDNR, and the review team's independent evaluation. Based on the findings discussed above, with emphasis on the impacts associated with creation of Make-Up Pond C, the review team concludes that cumulative impacts on aquatic biota related to proposed Lee Nuclear Station Units 1 and 2 would be MODERATE. The loss of a major portion of London Creek and its aquatic biota during development of Make-Up Pond C is the principal contributor to the cumulative impact. Development of Make-Up Pond C does not require NRC authorization; incremental impacts from NRC-authorized activities (which are limited to the Lee Nuclear Station site) do not significantly contribute to the cumulative impact to the aquatic ecology of the geographic region of interest.

7.4 Socioeconomics and Environmental Justice Impacts

The evaluation of cumulative impacts on socioeconomics and environmental justice is described in the following sections.

7.4.1 Socioeconomics

The description of the affected environment in Section 2.5 serves as the baseline for the cumulative impact assessment in this resource area. As described in Section 4.4, any negative impacts of the NRC-authorized construction on socioeconomics would be SMALL, and no further mitigation would be warranted with two exceptions in Cherokee County. NRC-authorized construction would result in a MODERATE and adverse impact on infrastructure and community services because of traffic on roads near the site (particularly on McKowns Mountain Road) and a MODERATE physical impact because of aesthetics. As described in Section 5.4, any negative impacts of operations on socioeconomics would be SMALL, and no further mitigation would be warranted beyond that which was identified by the applicant. The review team concluded that operations would result in LARGE beneficial economic impacts because of tax revenue in Cherokee County and SMALL beneficial economic and tax revenue impacts elsewhere in the region.

The combined impacts from building proposed Lee Nuclear Station Units 1 and 2, new transmission corridors, and Make-Up Pond C were described in Section 4.4 and determined to be SMALL and adverse with two exceptions. The review team determined that an impact on infrastructure and community services because of traffic and a physical impact on aesthetics in the vicinity of the site would be MODERATE. In addition to the impacts from preconstruction, construction, and operations, the cumulative analysis considers other past, present, and reasonably foreseeable future projects that could impact socioeconomics. For this analysis, the geographic area of interest is considered to be Cherokee and York Counties because these counties are the principal areas where the review team expects socioeconomics impacts would occur. However, the geographic area of interest was modified as appropriate for specific impact analyses; for example, taxation jurisdictions were used when appropriate.

In the early 1970s, Duke started construction of the Cherokee Nuclear Station. Construction was halted on the three unit facility in the early 1980s due to financial reasons. The unfinished plant was converted into a movie set in the late 1980s and then left idle for about two decades. Historically, Cherokee and York Counties were rural communities with significant employment in textile mills. However, recently these counties have shifted away from textiles and both, particularly York County, have become more suburban.

The socioeconomic impact analyses in Chapters 4 and 5 are cumulative by nature. Economic impacts associated with activities listed in Table 7-1 already have been considered as part of the socioeconomic baseline presented in Section 2.5. For example, the economic impacts of existing enterprises (e.g., mining and other electrical utilities) are part of the base used for establishing the Regional Input-Output Modeling System (RIMS II) multipliers. Regional planning efforts and associated demographic projections formed the basis for the review team's assessment of reasonably foreseeable future impacts. Thus, no cumulative impacts are associated with building and operating the Lee Nuclear Station beyond those already evaluated in Chapters 4 and 5.

Based on the above considerations, Duke's ER, and the review team's independent evaluation, the review team concludes that cumulative impacts from preconstruction, construction, and operation of proposed Lee Nuclear Station Units 1 and 2 and from other past, present, and future projects within the geographic area of interest could make a temporary adverse contribution to the cumulative effects associated with some socioeconomic issues. Those impacts would include physical impacts (i.e., workers and the local public, buildings, transportation, and visual aesthetics), demography, and local infrastructure and community services (i.e., traffic, recreation, housing, public services, and education).

The review team concludes that the cumulative economic impacts on regional economies and tax revenues would be beneficial and SMALL with the exception of Cherokee County, which would see a LARGE and beneficial cumulative economic impact on taxes. The NRC-authorized activities would be a significant contributor to the LARGE and beneficial economic impact on taxes in Cherokee County.

The review team concludes that the cumulative infrastructure and community impacts are SMALL with the exception of a MODERATE and adverse cumulative impact related to traffic near the Lee Nuclear Station site (particularly on McKowns Mountain Road). The NRC-authorized activities would be a significant contributor to the MODERATE and adverse impact on infrastructure and community services related to traffic near the site.

The review team concludes that the cumulative physical impacts are SMALL with the exception of a MODERATE and adverse cumulative impact on aesthetics near the site. Construction of transmission-line corridors and Make-Up Pond C do not require NRC authorization; therefore, the NRC staff concludes that the incremental impacts from NRC-authorized activities for the proposed plant, which are limited to the Lee Nuclear Station site, Make-Up Pond C site, and transmission-line corridors, would not be a significant contributor to the MODERATE physical impact on aesthetics.

The review team concludes that building the proposed Lee Nuclear Station in addition to other past, present, and reasonably foreseeable future projects would have SMALL cumulative impacts on demography.

7.4.2 Environmental Justice

The description of the affected environment in Section 2.6 serves as a baseline for the cumulative impacts assessment in this resource area. As described in Section 4.5, the NRC staff concludes that the NRC-authorized construction would impose no disproportionately high and adverse impacts on minority or low-income populations and, therefore, the environmental justice impacts would be SMALL. As described in Section 5.5, the review team concludes that the impacts of operations on environmental justice would be SMALL, and no mitigation would be warranted.

The combined environmental justice impacts from building were described in Section 4.5 and determined to be SMALL. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis considers other past, present, and reasonably foreseeable future projects that could cause disproportionately high and adverse impacts on minority and low-income populations. For this cumulative analysis, the geographic area of interest is considered to be the 50-mi region described in Section 2.5.1.

From an environmental justice perspective, the potential exists for minority and low-income populations to experience disproportionately high and adverse impacts from large industrial projects. As discussed in Section 2.6.1, the review team found low-income, black, Asian, American Indian or Alaskan Native, Hispanic, and aggregated minority populations of interest. However, most of these populations were either located in cities and towns or near the edge of the 50-mi region and not near the proposed Lee Nuclear Station site. The nearest minority population of interest was found in the town of Gaffney in Cherokee County. The nearest low-income population of interest was in York County. As discussed in Sections 2.6, 4.5, and 5.5, the review team found no unique characteristics or practices through which minority or low-income populations would experience a disproportionately high and adverse impact from building or operating proposed Lee Nuclear Station Units 1 and 2.

The environmental justice impact analyses in Chapters 4 and 5 are cumulative by nature. Environmental justice impacts associated with activities listed in Table 7-1 already have been considered as part of the environmental justice baseline presented in Sections 2.6 and 7.4.1. Based on the above considerations, information provided by Duke, and the review team's independent evaluation, the review team concludes that building and operating proposed

Lee Nuclear Station Units 1 and 2 would not contribute additional environmental justice cumulative impacts beyond those described in Chapters 4 and 5. As discussed in Section 2.6.1, factors that went into the review teams determination included an assessment of the unique characteristics and practices of minority and low-income populations of interest with regard to the following socioeconomic impact areas: physical impacts (i.e., workers and the local public, noise, air quality, buildings, transportation, and visual aesthetics), and local infrastructures and community services (i.e., transportation; recreation; housing; water and wastewater facilities; police, fire, and medical services; social services; and schools).

The review team concludes there would be no disproportionately high and adverse cumulative impacts to minority or low-income populations from the above socioeconomic impact areas. The environmental justice impacts would be SMALL, and no further mitigation beyond that described in Chapters 4 and 5 would be warranted.

7.5 Historic and Cultural Resources Impacts

The description of the affected environment in Section 2.7 serves as a baseline for the cumulative impacts assessment in this resource area. The cultural resources management plan and associated Memorandum of Agreement (MOA) between Duke, the USACE, the South Carolina State Historic Preservation Officer (SHPO), and the Catawba Indian Nation Tribal Historic Preservation Officer (THPO) formalizing ongoing cultural resources protection and consideration at the Lee Nuclear Station site and associated developments (USACE et al. 2013) are also important elements for the cumulative impacts assessment.

As described in Section 4.6, for the purposes of NEPA analysis and consultation under Section 106 of the National Historic Preservation Act (NHPA), the NRC staff reviewed the final cultural resources management plan and MOA (USACE et al. 2013), cultural resources survey reports, NRC and USACE consultation records, Duke's past and ongoing record of coordination with the South Carolina SHPO and American Indian Tribes that have expressed interest in the proposed undertaking, and Duke Energy's corporate policy for cultural resources consideration and protection (Duke 2009j). The NRC staff concludes that the impacts of NRC-authorized construction on historic and cultural resources would likely be SMALL and no further mitigation would be warranted. As described in Section 5.6, the review team concludes that the impacts of operations on historic and cultural resources would likely be SMALL. Mitigative actions may be warranted only in the event of an unanticipated discovery during ground-disturbing activities associated with construction or maintenance of the operating facility. Procedures for addressing discoveries of this nature, including work stoppage and coordination with the South Carolina SHPO and appropriate THPOs, are an important part of Duke Energy's corporate cultural resources policy and are specifically tailored to the proposed Lee Nuclear Station site and associated developments in the cultural resources management plan and associated MOA between Duke, the USACE, the South Carolina SHPO, and the Catawba Indian Nation THPO (USACE et al. 2013).

Cumulative Impacts

The combined impacts from construction and preconstruction are described in Section 4.6 and are concluded to be MODERATE for preconstruction of Make-Up Pond C and offsite developments, including the railroad line, two new transmission lines (Routes K and O), and transportation improvements at six key intersections. Mitigative actions associated with the future removal and relocation of the historic Service Family Cemetery, a locally important cultural resource, from Make-Up Pond C and avoidance and protection of a possible human burial site (38CK172) located in the direct, physical Area of Potential Effect (APE) for transmission-line Route O will be completed by Duke (Duke 2010d, o). The cultural resources management plan and associated MOA between Duke, the USACE, the South Carolina SHPO, and the Catawba Indian Nation THPO (USACE et al. 2013) formally accepts and implements Duke Energy's corporate policy for cultural resources protection and inadvertent discovery procedures.

In addition to the combined impacts from construction, preconstruction, and operations, cumulative impact analyses consider other past, present, and reasonably foreseeable future actions that could impact historic and cultural resources in the defined geographic area of interest. For this cumulative analysis, the geographic area of interest corresponds to the direct and indirect APEs that encompass physical and visual impacts reasonably determined to occur during construction, preconstruction, and operation of proposed Lee Nuclear Station Units 1 and 2; development and operation of Make-Up Pond C; and development, operation, and maintenance of associated offsite developments including the railroad line, two new transmission lines, and six intersections proposed for transportation improvements. These APEs have been defined by Duke in coordination with the South Carolina SHPO and are described in Section 2.7.

The cumulative impacts assessment considers all historic and cultural resources within the geographic area of interest, including those eligible for listing on the National Register of Historic Places (National Register), which are also known as historic properties. Potentially, this could include prehistoric archaeological sites representing as many as 12,000 years of human occupation, architectural sites representing important regional historic contexts (e.g., eighteenth- and nineteenth-century farmsteads, nineteenth-century ironworks, and twentieth-century hydroelectric plants), or sites of importance to local communities or American Indian tribes (e.g., historic cemeteries, burial sites, and traditional cultural properties). As residential areas, roads, utilities, and businesses have generally increased in the region over the past few decades, historic and cultural resources have probably decreased. One past project, partial development of the unfinished Cherokee Nuclear Station (Table 7-1), impacted six historic and cultural resources within the geographic area of interest. As described in Sections 4.6 and 5.6, the six historic and cultural resources impacted by intensive ground disturbance during this project in the 1970s were not considered to be significant by the cultural resources specialists who recorded them and it is unlikely that any were eligible for National Register nomination.

Table 7-1 identifies other past, present, and reasonably foreseeable future projects and other actions considered in the cumulative analyses for proposed Lee Nuclear Station Units 1 and 2.

Present projects within the geographic area of interest for historic and cultural resources include operational hydroelectric plants on the Broad River. One of these facilities, Ninety-Nine Islands Dam and Hydroelectric Project, is historically significant and eligible for National Register listing. These projects could have minimally impacted historic and cultural resources through ground disturbance, but any potential adverse effects would have likely been addressed through environmental review and associated NHPA and NEPA compliance during Federal licensing or relicensing by FERC. Table 7-1 also identifies small-scale surface mining projects (i.e., sand, clay, other mineral products, and construction materials), the Gaffney Wastewater Treatment Facility, and the SC Distributors Inc. fabric mill currently in operation within the geographic area of interest (indirect APE for Make-Up Pond C). These projects could have caused minimal impacts to archaeological resources through ground-disturbing activities or visual impacts to architectural resources if new above-ground structures have altered the historic setting or visual characteristics that make these properties significant. However, adverse impacts are unlikely as no National Register-eligible historic properties have been identified in the geographic area of interest during architectural surveys for the Lee Nuclear Station site and associated developments (Brockington 2007a, b, 2009a, 2013) or Make-Up Pond C and associated developments (Brockington 2009b, 2010, 2011, 2013).

Future projects listed in Table 7-1 within the geographic area of interest include transportation improvement projects throughout South Carolina and in Cherokee County. These projects could impact historic and cultural resources through ground disturbance or visual impacts to historic settings or architectural properties. However, since these projects would likely include Federal funding, impacts would be analyzed through Federal agency compliance with NHPA and NEPA, and it is unlikely that adverse effects to historic properties or important cultural resources would occur.

Historic and cultural resources are nonrenewable; therefore, the impact of their destruction is cumulative. For the purposes of the review team's NEPA analysis, based on the information provided by the applicant and the review team's independent evaluation, the review team concludes that the cumulative impacts from preconstruction, construction, and operation of proposed Lee Nuclear Station Units 1 and 2 and from other past, present, and future projects within the geographic area of interest would be MODERATE. The incremental impacts associated with the past destruction of unassessed archaeological resources during preparations for the unfinished Cherokee Nuclear Station in the 1970s and currently proposed preconstruction activities, including removal and relocation of the Service Family Cemetery from the direct, physical APE for Make-Up Pond C and project avoidance of a possible human burial site (38CK172) in the direct, physical APE for transmission Route O, are the principal contributors to the MODERATE rating of cumulative impacts. The NRC staff further concludes that the incremental impacts associated with the NRC-authorized activities would not significantly contribute to the cumulative impact because no significant historic or cultural resources would be affected by these activities in the geographic region of interest.

7.6 Air-Quality Impacts

The description of the affected environment in Section 2.9 serves as a baseline for the cumulative impacts assessment in this resource area. As described in Section 4.7, the NRC staff concludes that the impacts of NRC-authorized construction on air quality would be SMALL, and no further mitigation would be warranted. As described in Section 5.7, the review team concludes that the impacts on air quality from operations would be SMALL, and no further mitigation would be warranted.

7.6.1 Criteria Pollutants

The combined impacts from construction and preconstruction were described in Section 4.7 and were determined to be SMALL. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis considers other past, present, and reasonably foreseeable future actions that could contribute to cumulative impacts on air quality. The geographic area of interest defined for this evaluation is Cherokee County, South Carolina. The single county was selected because EPA air quality designations are made on a county-by-county basis.

Cherokee County is designated as unclassifiable or in attainment for all criteria pollutants for which National Ambient Air Quality Standards (NAAQS) have been established (40 CFR 81.341). Criteria pollutants include ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead. Emissions from building proposed Lee Nuclear Station Units 1 and 2 are expected to be temporary and limited in magnitude, as described in Section 4.7. As described in Section 5.7, air emissions from operations would be primarily from the intermittent use of standby diesel generators and pumps. Table 5-4 provides estimates of annual air emissions from these sources; these sources would be permitted and operated in accordance with State regulatory requirements (Duke 2009c).

There are eight major sources of air emissions in Cherokee County with existing Title V operating permits (EPA 2013a). There are no new major sources proposed for Cherokee County (EPA 2013b). The existing sources include energy and industrial projects and are listed in Table 7-1. Future development of the region around the Lee Nuclear Station site could also lead to increases in gaseous emissions related to transportation. Table 7-1 lists low-to-moderate potential for growth within Cherokee County.

Given that Cherokee County is currently designated unclassifiable or in attainment for existing sources identified in Table 7-1 and the expected low-to-moderate potential for growth in the county, the review team concludes that the cumulative impacts on air quality from the additional air emissions from intermittent operation of diesel generators at the Lee Nuclear Station site would be minimal, and mitigation would not be warranted.

7.6.2 Greenhouse Gas Emissions

As discussed in the state of the science report issued by the U.S. Global Change Research Program (GCRP), it is the "… production and use of energy that is the primary cause of global warming, and in turn, climate change will eventually affect our production and use of energy. The vast majority of U.S. greenhouse gas emissions, about 87 percent, come from energy production and use…" Approximately one-third of the greenhouse gas (GHG) emissions are the result of generating electricity and heat (GCRP 2009).

GHG emissions associated with building, operating, and decommissioning a nuclear power plant are addressed in Sections 4.7, 5.7, 6.1.3, and 6.3. The review team concluded that the atmospheric impacts of the emissions associated with each aspect of building, operating, and decommissioning a single plant are minimal. The review team also concluded that the impacts of the combined emissions for the full plant life cycle would be minimal.

It is difficult to evaluate cumulative impacts of a single source or combination of GHG emission sources because:

- the impact is global rather than local or regional
- the impact is not particularly sensitive to the location of the release point
- the magnitude of individual GHG sources related to human activity, no matter how large compared to other sources, are small when compared to the total mass of GHGs in the atmosphere
- the total number and variety of GHG emission sources are extremely large and are ubiquitous

These points are illustrated by the following comparison of annual carbon dioxide (CO_2) emission rates (Table 7-3).

Table 7-3. Comparison of Annual CO_2 Emission Rates

Source	Metric Tons per Year
Global emissions	30,000,000,000[(a)]
United States	5,500,000,000[(a)]
1000-MW nuclear power plant (including fuel cycle, 80 percent capacity factor)	500,000[(b)]
1000-MW nuclear power plant (operations only)	5000[(b)]
Average U.S. passenger vehicle	5[(c)]

(a) EPA 2011c
(b) Appendix J of this EIS
(c) EPA 2010ac

Evaluation of cumulative impacts of GHG emissions requires the use of a global climate model. The GCRP (2009) report referenced above provides a synthesis of the results of numerous climate modeling studies. The review team concludes that the cumulative impacts of GHG emissions around the world as presented in the report are the appropriate basis for its evaluation of cumulative impacts. Based on the impacts set forth in the GCRP (2009) report and the CO_2 emissions criteria in the final EPA CO_2 Tailoring Rule (75 FR 31514), the review team concludes that the national and worldwide cumulative impacts of GHG emissions are noticeable but not destabilizing. The review team further concludes that the cumulative impacts would be noticeable but not destabilizing, with or without the GHG emission of the proposed project.

Consequently, the review team recognizes that GHG emissions, including CO_2, from individual stationary sources and, cumulatively from multiple sources, can contribute to climate change and that the carbon footprint is a relevant factor in evaluating energy alternatives. Section 9.2.5 contains a comparison of carbon footprints of the viable energy alternatives.

7.6.3 Summary of Air-Quality Impacts

Cumulative impacts on air-quality resources are estimated based on the information provided by Duke and the review team's independent evaluation. Other past, present, and reasonably foreseeable future activities exist in the geographic areas of interest (local for criteria pollutants and global for GHG emissions) that could affect air-quality resources. The cumulative impacts on criteria pollutants from air emissions from the Lee Nuclear Station site and other projects would be minimal. The national and worldwide cumulative impacts of GHG emissions are noticeable but not destabilizing. The review team concludes that the cumulative impacts would be noticeable but not destabilizing, with or without the GHG emissions from the Lee Nuclear Station site. The review team concludes that cumulative impacts from other past, present, and reasonably foreseeable future actions on air-quality resources in the geographic areas of interest would be SMALL for criteria pollutants and MODERATE for GHGs. The incremental contribution of impacts on air-quality resources from building and operating proposed Lee Nuclear Station Units 1 and 2 do not significantly contribute to the MODERATE air-quality impact from GHGs.

7.7 Nonradiological Health Impacts

The description of the affected environment in Section 2.10 serves as a baseline for the nonradiological health cumulative impact assessment. As described in Section 4.8, the NRC staff concludes that the impacts from NRC-authorized construction on public and worker nonradiological health would be SMALL, and no further mitigation other than that described in Duke's ER (Duke 2009c) would be warranted. As described in Section 5.8, the review team concludes that the impacts of operations on nonradiological health would also be SMALL, and no further mitigation would be warranted.

As described in Section 4.8, the combined nonradiological health impacts from construction and preconstruction would be SMALL, and no further mitigation would be warranted beyond what is described in Duke's ER. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis considers other past, present, and reasonably foreseeable future actions that could contribute to cumulative impacts to nonradiological health (see Table 7-1). Based on the localized nature of nonradiological health impacts, the geographic area of interest for this cumulative impacts analysis includes projects adjacent to the Lee Nuclear Station site and Make-Up Pond C vicinity. For cumulative impacts associated with transmission lines, the geographic area of interest is the transmission system associated with proposed Lee Nuclear Station Units 1 and 2, as described in Section 2.2.3.1.

Current operational projects within the geographic areas of interest that could contribute to cumulative impacts on nonradiological health include the Broad River Energy Center; the Cherokee County Cogeneration plant; Nine-Nine Islands Hydroelectric Project; withdrawals of surface water from the Broad River by Gaffney, South Carolina, and Shelby and Kings Mountain, North Carolina; and the Hanson Brick Blacksburg plant. One past project—partial construction of the Cherokee Nuclear Station—could contribute to cumulative nonradiological health impacts. Reasonably foreseeable projects that could contribute to cumulative nonradiological health impacts include future urbanization, highway improvements and development stemming from the South Carolina Strategic Corridor and System Plan, and American Reinvestment and Recovery Act of 2009 (ARRA) grants to the South Carolina Department of Transportation.

Preconstruction, construction, and operation activities with the potential to impact nonradiological health of the public and workers include exposure to fugitive dust and vehicle emissions, occupational injuries, noise from building and operating proposed Lee Nuclear Station Units 1 and 2, exposure to etiological (disease-causing) agents, exposure to electromagnetic fields (EMFs), and transportation of construction materials and personnel to and from the Lee Nuclear Station site.

Past partial development of the Cherokee Nuclear Station could contribute to cumulative occupational injuries for workers (i.e., slips, trips, and falls caused by remaining remnants of Cherokee Nuclear Station and associated excavations); however, adherence to Occupational Health and Safety Administration and State safety standards, practices, and procedures while onsite would help minimize these occurrences. Existing and potential development of new transmission lines could increase nonradiological health impacts from exposure to acute EMFs. However, as stated in Section 5.8.3, adherence to Federal criteria and State utility codes would create minimal cumulative nonradiological health impacts. With regard to chronic effects of EMFs, the scientific evidence on human health does not conclusively link extremely low frequency EMFs to adverse health impacts. Noise, along with emissions from operation and vehicles associated with currently operational projects (e.g., Broad River Energy Center, Cherokee County Cogeneration, and Ninety-Nine Islands Hydroelectric Project), and future projects (i.e., highway development and improvement and general future urbanization) could cumulatively contribute to public nonradiological health impacts. However, as discussed in Sections 4.8 and 5.8, the contribution of proposed Lee Nuclear Station Units 1 and 2 to these impacts would be temporary and minimal, and existing facilities and future development would likely comply with local, State, and Federal regulations governing noise and air emissions. Section 7.11.2 discusses cumulative nonradiological health impacts related to additional traffic on the regional and local highway networks leading to and from the Lee Nuclear Station site, and the review team determines that these impacts would be minimal.

In Section 5.8.1, the review team evaluated the health impacts of operating proposed Lee Nuclear Station Units 1 and 2 with regard to ambient temperature and flow conditions in the Broad River, and the potential formation of thermophilic microorganisms, including those that can cause disease (i.e., etiological agents). The review team's evaluation concluded that due to thermal mixing, operation of proposed Lee Nuclear Station Units 1 and 2 would not significantly increase the presence of etiological agents in the Broad River. Future withdrawals of surface water from the Broad River upstream of the Lee Nuclear Station site by the cities of Gaffney, South Carolina and Shelby and Kings Mountain, North Carolina, could impact the flow regime of the Broad River (i.e., decrease flow) and potentially increase the presence of etiological agents. However, as discussed in Section 2.10.1.3, the low incidence of waterborne diseases in the geographic area of interest, and South Carolina as a whole, indicates that the public uses these waters for recreation in a manner that minimizes potential exposure to these organisms.

The review team is also aware of the potential climate changes that could affect human health; a recent compilation of the state of the knowledge in this area (GCRP 2009) has been considered in the preparation of this EIS. As discussed in Section 7.2, projected climate changes for the southeastern region of the United States during the life of proposed Lee Nuclear Station Units 1 and 2 (40 years) include an increase in average temperature of 2 to 3°F; a decrease in precipitation in the winter, spring, and summer; and a small increase in precipitation in the fall (GCRP 2009). This may result in a gradual, small increase in river water temperature, which may alter the presence of microorganisms and parasites in the Broad River (i.e., warmer water may encourage the growth of thermophilic organisms). While the changes attributed to climate change in these studies (GCRP 2009) may not be insignificant on a national or global level, the review team did not identify anything that would alter its conclusion regarding cumulative impact contributing to the presence of etiological agents or a change in the incidence of waterborne diseases.

Cumulative impacts on nonradiological health are based on information provided by Duke and the review team's independent evaluation of impacts resulting from building and operation of proposed Lee Nuclear Station Units 1 and 2, along with a review of potential impacts from other past, present, and reasonably foreseeable projects and future urbanization located in the geographic areas of interest. The review team concludes that cumulative impacts on public and worker nonradiological health would be SMALL, and that mitigation beyond that discussed in Sections 4.8 and 5.8 would not be warranted. The review team acknowledges, however, that there is still uncertainty associated with chronic effects of EMFs.

7.8 Radiological Impacts of Normal Operation

The description of the affected environment in Section 2.11 serves as a baseline for the cumulative impacts assessment in this resource area. As described in Section 4.9, the NRC staff concludes that the radiological impacts to construction workers engaged in building activities would be SMALL, radiological impacts from NRC-authorized construction would be SMALL, and no further mitigation would be warranted. As described in Section 5.9, the NRC staff concludes that the radiological impacts from normal operations would be SMALL, and no further mitigation would be warranted.

The combined impacts from construction and preconstruction were described in Section 4.9 and were determined to be SMALL. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis considers other past, present, and reasonably foreseeable future actions that could contribute to cumulative radiological impacts. For the purposes of this analysis, the geographic area of interest is the area within the 50-mi radius of the Lee Nuclear Station site. Historically, the NRC has used the 50-mi radius as a standard bounding geographic area to evaluate population doses from routine releases from nuclear power plants. The area within a 50-mi radius of the proposed site includes two of Duke's other nuclear stations—McGuire, a two-unit station in Mecklenburg County, North Carolina and Catawba, a two-unit station in York County, South Carolina. South Carolina Electric &Gas's VCSNS and its planned Independent Spent Fuel Storage Installation are just beyond the 50-mi distance, located about 52 mi south of the proposed site. In addition, hospitals and industrial facilities that use radioactive materials are likely to be within the 50-mi radius of the site.

As described in Section 4.9, the estimate of dose to construction workers during the building of proposed Units 1 and 2 is well within NRC annual exposure limits (i.e., 100 millirem [mrem] per year), which are designed to protect the public health. This estimate includes exposure to construction workers at Unit 2 from operation of Unit 1 after Unit 1 begins operation. As described in Section 5.9, the public and occupational doses predicted from the proposed operation of two new units at the Lee Nuclear Station site are well below regulatory limits and standards. Also, based on the estimates of doses to biota given in Section 5.9, the staff concludes that the cumulative radiological impact on biota would not be significant. As stated in Section 5.9.6, Duke plans to conduct a radiological environmental monitoring program (REMP) around the Lee Nuclear Station. The REMP would measure radiation and radioactive materials from all sources, including Lee Nuclear Station, area hospitals, and industrial facilities. The REMP would monitor the levels in the environment to confirm the estimates of radiological impact to the public and biota presented in Section 5.9.

Currently, no other nuclear facilities are planned within 50 mi of the Lee Nuclear Station site; however, VCSNS Units 2 and 3, which were granted COLs in March 2012 and are under construction, would be at about 52 mi from the site. The NRC and South Carolina officials would regulate or control any reasonably foreseeable future actions in the region that could contribute to cumulative radiological impacts.

Therefore, the staff concludes that the cumulative radiological impacts of operating two new units along with the influence of other man-made sources of radiation nearby would be SMALL.

7.9 Nonradioactive Waste Impacts

Cumulative impacts on water and air are discussed in Sections 7.2 and 7.6, respectively. The cumulative impacts of nonradioactive waste destined for land-based treatment and disposal are primarily related to the available capacity of area treatment and disposal facilities and the amount of waste expected to be generated by the proposed project and other reasonably foreseeable projects. As described in Section 4.10, the impacts from NRC-authorized construction on nonradioactive waste would be SMALL, and no further mitigation other than that described in Duke's ER (Duke 2009c) would be warranted. As described in Section 5.10, the review team concludes that the impacts of operations on nonradioactive waste would also be SMALL, and no further mitigation would be warranted.

As described in Section 4.8, the combined nonradioactive health impacts from construction and preconstruction would be SMALL, and no further mitigation would be warranted beyond that described in Duke's ER. During building of proposed Lee Nuclear Station Units 1 and 2, offsite land-based waste treatment and disposal would be minimized by storing spoils generated by excavation and dredging at the site and reusing them onsite whenever possible (Duke 2009c). Duke (2009c) also stated it may consider recycling woody debris generated from onsite clearing activities for beneficial use such as mulch for landscaping. Building activities would generate small quantities of construction debris and the construction workforce would produce small quantities of municipal solid waste (MSW). In South Carolina, Class 1 landfills accept land-clearing debris; Class 2 landfills accept construction and demolition debris; and Class 3 landfills accept MSW. The City of Gaffney and Cherokee County each have one Class 2 landfill permitted to accept up to 8,930 and 20,000 T/y of waste, respectively. The estimated remaining life of these landfills is 34 and 29 years, respectively (SCDHEC 2011b). Due to Duke's efforts to recycle construction and demolition debris and the availability of landfill space, cumulative impacts of increased nonradioactive waste during building of proposed Lee Nuclear Station Units 1 and 2 would be minimal.

During operation, Duke would ship MSW and recyclable materials offsite to municipal or county solid waste facilities (Duke 2009c). Most of the projects listed in Table 7-1 typically produce MSW, and energy and manufacturing facilities could produce small quantities of hazardous wastes. Some projects in Table 7-1 would produce waste streams of a different nature (e.g., mining and park projects). Cherokee County does not have a MSW landfill; however, regional landfills are available in upstate South Carolina (SCHDEC 2011b). As of 2010, South Carolina had 25 SCDHEC-permitted Class 3 landfills (SCDHEC 2011b). Based on an estimate for the Levy Nuclear Station, another proposed two-unit (AP1000) nuclear station, Lee Nuclear Station would likely generate approximately 1600 T/y of MSW (PEF 2009). From 2008 through 2010, Duke's recycling rate increased from 52 to 63 percent (Duke Energy 2011a). Because adequate landfill capacity exists in South Carolina, and Duke would continue to implement an aggressive recycling program, cumulative impacts of increased nonradioactive waste generation during operation of proposed Lee Nuclear Station Units 1 and 2 would be minimal.

Duke anticipates that the proposed Lee Nuclear Station would be classified as a conditionally exempt small quantity generator (CESQG) of hazardous wastes under the Resource Conservation and Recovery Act (RCRA) (Duke 2009c). Among other rules, CESQGs must produce less than 220 lb of hazardous waste in one calendar month (EPA 2008d). Duke (2009c) states that hazardous wastes would be treated, stored, and disposed of in accordance with RCRA, and any other applicable Federal, State, and local laws and regulations. Some coal or natural gas energy projects and manufacturing projects listed in Table 7-1 could also produce hazardous waste; however, these facilities would also be required to comply with RCRA and SCDHEC regulations regarding the treatment, storage, and disposal of hazardous waste. Therefore, cumulative impacts from the generation of hazardous wastes would be expected to be minimal.

Based on the available treatment and disposal capacity in South Carolina for MSW and construction, demolition, and land-clearing debris, and the expected generation of only minimal mixed and hazardous waste, the review team concludes that cumulative impacts of nonradioactive and mixed waste would be SMALL, and additional mitigation would not be warranted.

7.10 Impacts of Postulated Accidents

As described in Section 5.11.1, the staff concludes that the environmental consequences of design basis accidents (DBAs) at the Lee Nuclear Station site would be SMALL for an AP1000 reactor. DBAs are addressed specifically to demonstrate that a reactor design is robust enough to meet NRC safety criteria. The consequences of DBAs are bounded by the consequences of severe accidents. As described in Section 5.11.2, the NRC staff concludes that the severe-accident probability-weighted consequences (i.e., risks) of an AP1000 reactor at the Lee Nuclear Station site are SMALL compared to risks to which the population is generally exposed, and no further mitigation would be warranted.

The cumulative analysis considers risk from potential severe accidents at all other existing and proposed nuclear power plants that have the potential to increase risks at any location within

50 mi of the proposed Lee Nuclear Station Units 1 and 2. The 50-mi radius was selected to cover any potential risk overlaps from two or more nuclear plants. Existing reactors that contribute to risk within this geographic area include VCSNS Unit 1; H.B. Robinson Unit 2; Oconee Units 1, 2, and 3; Catawba Units 1 and 2; and McGuire Units 1 and 2. In addition, an Independent Spent Fuel Storage Installation has been proposed and two reactors (Units 2 and 3) are under construction at the VCSNS site. Nuclear Fuel Services Inc., located in Erwin, Tennessee, and the Westinghouse Fuel Manufacturing Plant near Columbia, South Carolina, are also within the geographic area of interest.

Tables 5-15 and 5-16 in Section 5.11.2 provide comparisons of estimated risk for the proposed AP1000 units at the Lee Nuclear Station site and current-generation reactors. The estimated population dose risk for the proposed AP1000 units at the Lee Nuclear Station site is well below the mean and median value for current-generation reactors. In addition, estimates of average individual early fatality and latent cancer fatality risks are well below the Commission's safety goals (51 FR 30028). For existing plants within the geographic area of interest, namely VCSNS Unit 1; H.B. Robinson Unit 2; Oconee Units 1, 2, and 3; Catawba Units 1 and 2; and McGuire Units 1 and 2 nuclear generating stations, the Commission has determined that the probability-weighted consequences of severe accidents are SMALL (10 CFR 51, Appendix B, Table B-1). Finally, according to the *Final Environmental Impact Statement for Combined Licenses for VCSNS Units 2 and 3* (NRC 2011f), the risks from VCSNS Units 2 and 3 would also be well below risks for current-generation reactors and would meet the Commission's safety goals. The severe-accident risk due to any particular nuclear power plant gets smaller as the distance from that plant increases. However, the combined risk at any location within 50 mi of the Lee Nuclear Station site would be bounded by the sum of risks for all of these operating and proposed nuclear power plants. Even though several plants could potentially be included in the combination, this combined risk would still be low. There is no irradiated fuel located at Nuclear Fuel Services Inc. or the Westinghouse Fuel Manufacturing Plant, and the facilities are designed to prevent inadvertent criticalities; therefore, the additional risk is not significant in the evaluation of the cumulative severe-accident risk for a nuclear power plant at the Lee Nuclear Station site. On this basis, the NRC staff concludes that the cumulative risks from severe accidents at any location within 50 mi of the Lee Nuclear Station likely would be SMALL, and no further mitigation would be warranted.

7.11 Fuel Cycle, Transportation, and Decommissioning Impacts

The cumulative impacts related to the fuel cycle, transportation of radioactive materials (fuel and waste), and facility decommissioning for the proposed site are described below.

7.11.1 Fuel Cycle

As described in Section 6.1, the NRC staff concludes that the environmental impacts of the fuel cycle due to operation of proposed Lee Nuclear Station Units 1 and 2 would be SMALL. Fuel-cycle impacts would occur not only at the Lee Nuclear Station site but also at other locations in the United States or, in the case of foreign-purchased uranium, in other countries as described in Section 6.1.

Other nuclear facilities located within 50 mi of the Lee Nuclear Station site include Catawba Nuclear Station Units 1 and 2 about 25 mi east of the Lee Nuclear Station site and McGuire Nuclear Station Units 1 and 2 about 42 mi northeast of the Lee Nuclear Station site; the VCSNS site is located 52 mi south of the Lee Nuclear Station site. Table S–3 provides the environmental impacts from uranium fuel-cycle operations for a model 1000-MW(e) light water reactor operating at 80 percent capacity with a 12-month fuel-loading cycle and an average fuel burnup of 33,000 megawatt-days per metric ton of uranium (MWd/MTU). Per 10 CFR 51.51(a), the NRC staff concludes that those impacts would be acceptable for the 1000-MW(e) reference reactor. The impacts of producing and disposing of nuclear fuel include mining the uranium ore, milling the ore, converting the uranium oxide to uranium hexafluoride, enriching the uranium hexafluoride, fabricating the fuel (where the uranium hexafluoride is converted to uranium oxide fuel pellets), and disposing of the spent fuel in a proposed Federal waste repository. As discussed in Section 6.1, advances in reactors since the development of Table S–3 in 10 CFR 51.51 would reduce environmental impacts relative to the operating reference reactor. For example, a number of fuel-management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel and separative work (enrichment) requirements. As discussed in Section 6.1, the environmental impacts of fuel-cycle activities for the proposed units would be about three times those presented in Table S–3 of 10 CFR 51.51. The staff concludes the cumulative fuel-cycle impacts of operating the Lee Nuclear Station to be SMALL, and additional mitigation would not be warranted.

7.11.2 Transportation

The description of the affected environment in Section 2.5.2.3 serves as a baseline for the cumulative impacts assessment in this resource area. As described in Sections 4.8.3 and 5.8.6, the review team concludes that impacts of transporting personnel and nonradiological materials to and from the Lee Nuclear Station site would be SMALL. In addition to impacts from preconstruction, construction, and operations, the cumulative analysis considers other past, present, and reasonably foreseeable future actions that could contribute to cumulative transportation impacts. For this analysis, the geographic area of interest is the 50-mi region surrounding the Lee Nuclear Station site.

Nonradiological transportation impacts are related to the additional traffic on the regional and local highway networks leading to and from the Lee Nuclear Station site. Additional traffic would result from shipments of construction materials and movements of construction personnel to and from the site. Additional traffic increases the risk of traffic accidents, injuries, and fatalities. A review of the projects listed in Table 7-1 indicates that other projects in the region could potentially increase nonradiological impacts. The most significant cumulative nonradiological impacts in the vicinity of the Lee Nuclear Station site would result from major construction projects, including the construction at nearby mining projects and highway improvement projects. Traffic flow to and from operating facilities in the region would be of lesser importance because fewer workers and material shipments are needed to support operating facilities than major construction projects.

In Sections 4.8.3 and 5.8.6, the review team concluded that the impacts of transporting construction material and construction and operations personnel to and from the Lee Nuclear Station site would be a small fraction of the existing nonradiological impacts. Based on the magnitude of nonradioactive transportation impacts of nuclear power plant construction relative to the other construction activities already listed, the review team concludes the cumulative nonradiological transportation impacts of constructing and operating the proposed new reactors at the Lee Nuclear Station site and other past, present, and reasonably foreseeable future impacts would be minimal, and no further mitigation would be warranted.

As described in Section 6.2, the NRC staff concludes that impacts of transporting unirradiated fuel to the Lee Nuclear Station site and irradiated fuel and radioactive waste from the Lee Nuclear Station site would be SMALL. In addition to impacts from construction and operations, the cumulative analysis considers other past, present, and reasonably foreseeable future actions that could contribute to cumulative transportation impacts. For this analysis, the geographic area of interest is the 50-mi region surrounding the Lee Nuclear Station site.

The NRC staff uses the 50-mi radius as a standard bounding geographic area to evaluate the radiological impacts to the public and environment associated with transportation of radioactive materials. The area within a 50-mi radius of the proposed site includes two of Duke's other nuclear stations – McGuire, a two-unit station in Mecklenburg County, North Carolina and Catawba, a two-unit station in York County, South Carolina. SCE&G's VCSNS (Unit 1 and Units 2 and 3 under construction) and its planned Independent Spent Fuel Storage Installation, are just beyond the 50-mi distance, located about 52 mi south of the proposed site. These sites may also contribute to the cumulative radiological impacts of transportation due to sharing highway links with some Lee Nuclear Station site shipments. Radiological impacts of transporting radioactive materials would occur along the routes leading to and from the Lee Nuclear Station site, fuel fabrication facilities, and waste disposal sites located in other parts of the United States. No other major activities with the potential for cumulative radiological impacts from transportation of unirradiated and irradiated fuel were identified in the geographic region of interest. The past, present, and reasonably foreseeable future impacts in the region surrounding the Lee Nuclear Station site are a small fraction of the impacts from natural background radiation.

As discussed in Section 6.2, the proposed new units at the Lee Nuclear Station site would result in the need for additional unirradiated nuclear fuel and generation of additional spent nuclear fuel and radioactive waste. The impacts of transporting this fuel and radioactive waste to and from the Lee Nuclear Station site would be consistent with the environmental impacts associated with transportation of fuel and radioactive wastes from current-generation reactors presented in Table S–4 of 10 CFR 51.52, which the NRC staff considers to be acceptable for the 1000-MW(e) reference reactor. Advances in reactor technology and operations since the development of Table S-4 would reduce environmental impacts relative to the values in Table S–4. For example, fuel-management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel requirements. This leads to fewer unirradiated and spent fuel shipments than those estimated for the 1000-MW(e) reference reactor discussed in 10 CFR 51.52. In addition, advances in shipping cask designs to increase their capabilities would result in fewer shipments of spent fuel to offsite storage or disposal facilities.

Therefore, the NRC staff considers the cumulative radiological and nonradiological transportation impacts of operating the proposed new reactors at the Lee Nuclear Station site to be SMALL, and no further mitigation would be warranted.

7.11.3 Decommissioning

As discussed in Section 6.3, environmental impacts from decommissioning the Lee Nuclear Station are expected to be SMALL because the licensee would have to comply with decommissioning regulatory requirements.

In this cumulative analysis, the geographic area of interest is within a 50-mi radius of the Lee Nuclear Station site. Other nuclear facilities located within 50 mi of the Lee Nuclear Station site include Catawba Nuclear Station Units 1 and 2 about 25 mi east of the Lee Nuclear Station site and McGuire Nuclear Station Units 1 and 2 about 42 mi northeast of the Lee Nuclear Station site; the VCSNS site is located 52 mi south of the Lee Nuclear Station site. In Supplement 1 to the *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, the NRC found the impacts on radiation dose to workers and the public, waste management, water quality, air quality, ecological resources, and socioeconomics to be small (NRC 2002). In addition, in Section 6.3, the NRC staff concluded that the impact of GHG emissions on air quality during decommissioning would be minimal. Therefore, the cumulative impacts from decommissioning the Lee Nuclear Station would be SMALL, and additional mitigation would not be warranted.

7.12 Summary of Cumulative Impacts

The review team considered the potential cumulative impacts resulting from construction, preconstruction, and operation of Lee Nuclear Station Units 1 and 2 together with past, present, and reasonably foreseeable future actions in the same resource-specific geographic area of interest. The specific resources that could be affected by the incremental effects of the proposed action and the other actions listed in Table 7-1 were assessed. This assessment included the impacts of construction and operations for the proposed new units as described in Chapters 4 and 5; impacts of preconstruction activities as described in Chapter 4; impacts of fuel cycle, transportation, and decommissioning described in Chapter 6; and impacts of past, present, and reasonably foreseeable Federal, non-Federal, and private actions that could affect the same resources affected by the proposed action. Table 7-4 summarizes the cumulative impacts by resource area.

Table 7-4. Cumulative Impacts on Environmental Resources, Including the Impacts of Proposed Lee Nuclear Station Units 1 and 2

Resource Category	Comments	Impact Level
Land use	In addition to the land requirements for proposed Lee Nuclear Station Units 1 and 2, Make-Up Pond C, transmission lines, and other associated facilities, the surrounding area is expected to experience continued low-density urban growth.	MODERATE
Water-related		
Surface-water use	Potential decrease in the future water supply in the Broad River basin is the primary driver of the review team's MODERATE conclusion.	MODERATE
Groundwater use	Groundwater would not be used for proposed Lee Nuclear Station Units 1 and 2, and no other significant demands on regional groundwater resources were identified.	SMALL
Surface-water quality	Surface-water-quality impacts would be detectable but would not noticeably alter the resource.	SMALL
Groundwater quality	Temporary groundwater-quality impacts resulting from makeup pond level fluctuation could be detectable on a local basis, but would not noticeably alter the resource.	SMALL
Ecology		
Terrestrial and wetland ecosystems	The loss of habitat associated with the proposed Lee Nuclear Station and associated facilities, especially lowland mixed hardwood forest along London Creek and its tributaries and forest habitat along transmission-line corridors, would noticeably impact but not destabilize terrestrial resources, including wildlife and wetlands, in the geographic area of interest.	MODERATE

Table 7-4. (contd)

Resource Category	Comments	Impact Level
Aquatic ecosystems	The loss of a major portion of London Creek and its tributaries during the development of Make-Up Pond C would noticeably alter, but not destabilize, aquatic resources including aquatic biota in the geographic area of interest.	MODERATE
Socioeconomics		
Physical impacts	Physical impacts on aesthetics occurring during preconstruction would be noticeable, with most of the impacts associated with development of the Make-Up Pond C site. Other physical impacts would be minimal.	SMALL to MODERATE
Demography	Small and temporary demographic impacts would occur on the communities nearest the Lee Nuclear Station site associated with building activities for Units 1 and 2.	SMALL
Economic impacts on the community	Substantial beneficial economic impacts from operation of the proposed Lee Nuclear Station would occur in Cherokee County. Other economic impacts in the region would be minimal.	SMALL to LARGE (beneficial)
Infrastructure and community services	Traffic impacts would be noticeable during peak building employment for the proposed Lee Nuclear Station. Other infrastructure and community services impacts would be minimal.	SMALL to MODERATE
Environmental justice	There would be no disproportionately high and adverse cumulative impacts to minority or low-income populations.	SMALL
Historic and cultural resources	Installation of Make-Up Pond C and the transmission lines would noticeably alter but not destabilize cultural resources in the geographic area of interest.	MODERATE
Air quality		
Criteria pollutants	The cumulative impacts on criteria pollutants from air emissions from the Lee Nuclear Station site and other projects would be minimal.	SMALL
Greenhouse gas emissions	The national and worldwide cumulative impacts of greenhouse gas emissions are noticeable but not destabilizing. The proposed Lee Nuclear Station would not significantly contribute to GHG emissions in the region.	MODERATE
Nonradiological health	Cumulative impacts on public and worker nonradiological health would not be noticeable.	SMALL

Table 7-4. (contd)

Resource Category	Comments	Impact Level
Radiological health	Public and occupational doses predicted from operating proposed Lee Nuclear Station Units 1 and 2 are well below regulatory limits and standards. The cumulative radiological impact on biota would not be significant.	SMALL
Nonradioactive waste	There is available treatment and disposal capacity in South Carolina for MSW and construction, demolition, and land-clearing debris, and the generation of mixed and hazardous waste would be minimal.	SMALL
Severe accidents	The probability-weighted consequences of severe accidents are SMALL for all of the existing plants within the geographic area of interest, and the combined risk would also be low.	SMALL
Fuel cycle, transportation, and decommissioning	The cumulative impacts related to the fuel cycle, transportation of radioactive materials (fuel and waste), and facility decommissioning for all nuclear facilities located within 50 mi of the Lee Nuclear Station would be minimal.	SMALL

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11. ABSTRACT (200 words or less)
This environmental impact statement (EIS) has been prepared in response to an application submitted to the U.S. NRC by Duke Energy Carolinas, LLC (Duke) for two combined construction permits and operating licenses (combined licenses or COLs). The proposed actions requested in Duke's application are (1) NRC issuance of COLs for two nuclear power reactors at the William States Lee III Nuclear Station (Lee Nuclear Station) site in Cherokee County, South Carolina, and (2) U.S. Army Corps of Engineers (USACE) permit action on a Department of the Army individual permit application to perform certain construction activities on the site. The USACE is participating with the NRC in preparing this EIS as a cooperating agency and participates collaboratively on the review team.
This EIS includes the review team's analysis that considers and weighs the environmental impacts of building and operating two new nuclear units at the proposed Lee Nuclear Station site and at alternative sites, and mitigation measures available for reducing or avoiding adverse impacts. The EIS includes the evaluation of the proposed project's impacts on waters of the United States pursuant to Section 404 of the Clean Water Act.

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environmental impact statement, EIS, Duke, combined construction permits and operating licenses, combined licenses, COLs, nuclear power reactors, William States Lee III Nuclear Station, Lee Nuclear Station, Cherokee County, South Carolina, U.S. Army Corps of Engineers, USACE, Department of the Army individual permit application, cooperating agency, least environmentally damaging practicable alternative, U.S. Environmental Protection Agency, Section 404(b) of the Clean Water Act, tribes

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