

**APPENDIX E**

**Applicant's Environmental Report  
Operating License Renewal Stage  
Sequoyah Nuclear Plant**

## INTRODUCTION

Tennessee Valley Authority (TVA) submits this Environmental Report (ER) in conjunction with the application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating licenses for Sequoyah Nuclear Plant Units 1 and 2 (hereafter referred to as SQN or SQN Units 1 and 2) for 20 years beyond the end of the current license terms. In compliance with applicable NRC requirements, this ER analyzes potential environmental impacts associated with renewal of the SQN operating licenses (OLs). This ER is designed to assist the NRC staff with the preparation of the SQN-specific supplemental environmental impact statement (SEIS) required for license renewal.

The SQN ER is provided in accordance with 10 CFR 54.23, which requires license renewal applicants to submit a supplement to the ER that complies with the requirements of Subpart A of 10 CFR Part 51. This report also addresses the more detailed requirements of NRC environmental regulations in 10 CFR 51.45 and 10 CFR 51.53(c), as well as the intent of the National Environmental Policy Act (NEPA), 42 USC 4321 et seq. For major federal actions, NEPA requires federal agencies to prepare a detailed statement that evaluates environmental impacts, alternatives to the proposed action, and irreversible and irretrievable commitments of resources associated with implementation of the proposed action.

TVA used Supplement 1 to Regulatory Guide 4.2, "Preparation of Supplemental Environmental Reports for Applications to Renew Nuclear Power Plant Operating Licenses," as guidance on the format and content of this ER. In addition, TVA utilized the Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants (NUREG-1437) and Appendix B to 10 CFR Part 51 in preparation of this report. Although not yet regulatory requirements, TVA also considered the proposed amendment to 10 CFR Part 51 during the development of this ER for purposes of completeness but not in order to satisfy governing regulatory requirements. The level of information provided on the various topics and issues in this ER are commensurate with the environmental significance of the particular topic or issue.

Based upon the evaluations discussed in this ER, TVA concludes that the environmental impacts associated with renewal of the SQN OLs are SMALL. No plant refurbishment activities have been identified as necessary to support the continued operation of SQN beyond the end of the existing OLs term. Ongoing plant operational and maintenance activities will be performed during the license renewal period, but no significant environmental impacts associated with such activities are expected because established programs and procedures are in place to ensure that proper environmental monitoring continues to be conducted throughout the renewal term as discussed in [Chapter 9](#).

## ACRONYMS, ABBREVIATIONS AND SYMBOLS

§	section
°C	degree Celsius
°F	degree Fahrenheit
µm	micrometers
AADT	annual average daily traffic
ACHP	Advisory Council on Historic Preservation
ACRES	assessment, cleanup and redevelopment exchange system
AFS	Air Facility System (EPA)
AFW	auxiliary feedwater
ALARA	as low as reasonably achievable
APE	area of potential effect
B&W	Babcock and Wilcox
BFN	Browns Ferry Nuclear Plant
bgs	below ground surface
BLEU	blended low-enriched uranium
BMP	best management practice
BP	before present
BTA	best technology available.
Btu	British thermal unit
Btu/kWh	British thermal unit per kilowatt-hour
BWR	boiling water reactor
CAA	Clean Air Act
CCS	carbon capture and storage
CCS/AFW	component cooling water system/auxiliary feedwater
CCW	condenser circulating water
CDC	U.S. Centers for Disease Control

**ACRONYMS, ABBREVIATIONS AND SYMBOLS (CONTINUED)**

CDCT	cask decontamination collector tank
CECC	Central Emergency Control Center
CEQ	Council on Environmental Quality
Ceq/kWh	carbon equivalents per kilowatt hour
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CHCAPCB	Chattanooga-Hamilton County Air Pollution Control Bureau
CHCRPA	Chattanooga-Hamilton County Regional Planning Agency
cm	centimeter
CO	carbon monoxide
CO <sub>2</sub>	carbon dioxide
CRP	conservation reserve program
CSP	concentrating solar power
CSX	CSX Transportation, Inc.
CVCS	chemical and volume control system
CWA	Clean Water Act
DAW	dry active waste
dBa	A-weighted decibel
DO	dissolved oxygen
DOE	U.S. Department of Energy
DSEIS	draft supplemental environmental impact statement
E	east
EA	environmental assessment
EAB	exclusion area boundary
ED	TVA Energy Delivery



### ACRONYMS, ABBREVIATIONS AND SYMBOLS (CONTINUED)

EDR	Environmental Data Resources
EDS	environmental data station
EEDR	energy efficiency and demand response
EERE	Office of Energy Efficiency and Renewable Energy (DOE)
EF	Enhanced Fujita (tornado scale ranging from 0 to 5)
e.g.	for example (Latin <i>exempli gratia</i> )
EIS	environmental impact statement
ENE	east-northeast
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPRI	Electric Power Research Institute
EPT	Ephemeroptera, Plecoptera, and Trichoptera
EqA	equivalent adult
ER	environmental report
ERCW	essential raw cooling water
ESA	Endangered Species Act
ESE	east-southeast
ESRI	Environmental Systems Research Institute
et seq.	and following (Latin <i>et sequens</i> )
FAA	Federal Aviation Administration
FDCT	floor drain collector tank
F	Fujita (tornado scale ranging from 0 to 5)
FEIS	final environmental impact statement
FES	final environmental statement
FONSI	finding of no significant impact

**ACRONYMS, ABBREVIATIONS AND SYMBOLS (CONTINUED)**

fps	feet per second
FRP	flood risk profile
FSEIS	final supplemental environmental impact statement
ft	foot (feet)
FY	fiscal year
g	gram
gpd	gallons per day
GEIS	Generic Environmental Impact Statement for License Renewal of Nuclear Plants
GHG	greenhouse gas
GIS	geographic information system
GPI	Groundwater Protection Initiative
gpm	gallons per minute
GWh	gigawatt hour
GWPS	gaseous waste processing system
ha	hectares
HCT	high crud tank
HEU	highly enriched uranium
HIC	high integrity container
HiRM	Hiwassee River mile
HMTA	Hazardous Materials Transportation Act
HPA	habitat protection area
HSDT	hot shower drain tank
HUC	hydrologic unit code
HVAC	heating, ventilation and air conditioning
HWSF	hazardous waste storage facility
I-24	Interstate 24

### ACRONYMS, ABBREVIATIONS AND SYMBOLS (CONTINUED)

I-59	Interstate 59
I-75	Interstate 75
i.e.	that is (Latin <i>id est</i> )
IAAO	International Association of Assessing Officers
IGCC	integrated-gasification combined cycle
INPO	Institute of Nuclear Power Operations
IPE	individual plant examination
IPEEE	individual plant examination of external events
IPS	intake pumping station
IRP	Integrated Resource Plan
ISFSI	independent spent fuel storage installation
kg	kilogram
kV	kilovolt
kW	kilowatt
kWh	kilowatt hour
kWh/m <sup>2</sup> /day	kilowatt hour per square meter per day
LEU	low enriched uranium
LIDAR	aerial light detection and ranging
LLRW	low-level radioactive waste
LOCA	loss-of-coolant accident
LOS	level of service
LRA	license renewal application
LWPS	liquid waste processing system
m	meter
m <sup>2</sup>	square meter
m <sup>3</sup>	cubic meter

### ACRONYMS, ABBREVIATIONS AND SYMBOLS (CONTINUED)

mA	milliamperes
MACCS2	Melcor Accident Consequence Code System, Version 2
MACR	maximum averted cost-risk
MGD	millions of gallons per day
MMBtu	million Btu
MOX	mixed oxide
mph	miles per hour
mrad	millirad
mrem	millirem
msl	above mean sea level
MSA	metropolitan statistical area
MW	megawatt
MWD/MTU	megawatt-day per metric ton uranium
MWe	megawatts electric
N	north
NA	not applicable
NAAQS	National Ambient Air Quality Standards
NAICS	North American Industry Classification System
NASS	National Agricultural Statistics Service
NCDC	National Climatic Data Center
NE	northeast
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Corporation
NESC	National Electrical Safety Code
NHPA	National Historic Preservation Act

### ACRONYMS, ABBREVIATIONS AND SYMBOLS (CONTINUED)

NNE	north-northeast
NNW	north-northwest
NO <sub>x</sub>	nitrogen oxides
NPDES	national pollutant discharge elimination system
NPS	National Park Service
NRC	U.S. Nuclear Regulatory Commission
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NRI	Nationwide Rivers Inventory
NRR	Office of Nuclear Reactor Regulation
NRWT	non-reclaimable waste tank
NT	neutralization tank
NUREG	U.S. Nuclear Regulatory Commission Regulation
NW	northwest
NWI	National Wetland Inventory
NW&SR	National Wild and Scenic Rivers
NWR	national wildlife refuge
ODCM	offsite dose calculation manual
OL	operating license
OSHA	Occupational Health and Safety Administration
OTEC	ocean thermal energy conversion
PCB	polychlorinated biphenyls
pCi/L	picocuries per liter
PF	production foregone
PM <sub>2.5</sub>	particulate matter with a diameter less than 2.5 microns
PM <sub>10</sub>	particulate matter with an aerodynamic diameter of up to 10 microns

### ACRONYMS, ABBREVIATIONS AND SYMBOLS (CONTINUED)

PM <sub>f</sub>	total filterable particulates
POTW	publicly owned treatment works
PRA	probabilistic risk assessment
PSD	prevention of significant deterioration
PV	photovoltaic
PWR	pressurized water reactor
RBI	reservoir benthic index
RCDT	reactor coolant drain tank
RCP	reactor coolant pump
RCRA	Resource Conservation and Recovery Act
RCW	raw cooling water
REMP	radiological environmental monitoring program
RFAI	reservoir fish assemblage index
ROD	record of decision
ROI	region of interest
ROW	right-of-way
S	south
SAMA	severe accident mitigation alternative
SCPC	super-critical pulverized coal
SE	southeast
SEIS	supplemental environmental impact statement
SERC	Southeast Electric Reliability Corporation
SMZ	streamside management zone
SO <sub>x</sub>	sulfur oxides
SPCC	spill prevention, control, and countermeasure
SPD	surplus plutonium disposition

### ACRONYMS, ABBREVIATIONS AND SYMBOLS (CONTINUED)

SQN	Sequoyah Nuclear Plant
SR 29	State Road 29
SR 153	State Road 153
SR 312	State Road 312, Birchwood Pike
SR 319	State Road 319, Hixson Pike
SRST	spent resin storage tank
SSE	south-southeast
SSW	south-southwest
SW	southwest
SWPPP	stormwater pollution prevention plan
TDCT	tritiated drain collector tank
TDEC	Tennessee Department of Environment and Conservation
TDOT	Tennessee Department of Transportation
THC	Tennessee Historical Commission
TMDL	total maximum daily load
TPBAR	tritium-producing burnable absorber rod
TRM	Tennessee River mile
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
US 27	U.S. Highway 27
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USDOT	U.S. Department of Transportation
USFWS	U.S. Fish and Wildlife Service

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**ACRONYMS, ABBREVIATIONS AND SYMBOLS (CONTINUED)**

USGS	U.S. Geological Survey
W	west
WAW	wet active waste
WBN	Watts Bar Nuclear Plant
WinMACCS	MELCOR Accident Consequence Code System, Windows interface
WNW	west-northwest
WSW	west-southwest
WPA	Works Progress Administration



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[Attachment B](#): Cultural Resources Correspondence

[Attachment C](#): SQN National Pollutant Discharge Elimination System (NPDES) Permit

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## 1.0 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

For license renewal, the U.S. Nuclear Regulatory Commission (NRC) has adopted the following definition of purpose and need, stated in Section 1.3 of NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants* (GEIS): "The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than USNRC) decision makers."

The Atomic Energy Act of 1954 authorizes the NRC to issue commercial nuclear power plant operating licenses (OLs) for up to 40 years. The 40-year length of the original license period was imposed for economic and antitrust reasons rather than the technical limitations of the nuclear power plant. NRC regulations [10 CFR 50.51] allow for the renewal of these OLs for periods up to an additional 20 years, depending on the outcome of an assessment determining whether the nuclear power plant can continue to operate safely and protect the environment during the 20-year period of extended operation. Additionally, 10 CFR 54.17(c) states, "[A]n application for a renewed license may not be submitted to the Commission earlier than 20 years before the expiration of the operating license currently in effect."

The proposed action is to renew the OLs for Sequoyah Nuclear Plant (SQN) Units 1 and 2, which would preserve the option for the Tennessee Valley Authority (TVA) to continue operating SQN to provide base load<sup>(1)</sup> power throughout the 20-year period of extended operation and to continue use of an existing asset. The OLs expiration dates are September 17, 2020, for Unit 1 (Facility OL DPR-077) and September 15, 2021, for Unit 2 (Facility OL DPR-079). The requested renewals would allow SQN to operate until midnight on September 17, 2040, for Unit 1 and until midnight on September 15, 2041, for Unit 2.

### 1.1 Environmental Report

NRC regulation 10 CFR 51.53(c) requires that an applicant for license renewal submit with its application an environmental report (ER) (Appendix E of the application) entitled, "Applicant's Environmental Report—Operating License Renewal Stage." The requirements governing information to be included in an ER are codified at 10 CFR 51.45 and 51.53(c), and Table B-1 in Part 51 Appendix B lists the specific issues to be addressed in an ER. The GEIS developed by NRC discusses each of the environmental issues of concern for nuclear plant license renewal (NRC 1996). The specifics of each of the regulatory requirements and the concerns documented in the GEIS are presented by environmental issue in [Chapter 4](#).

NRC has proposed amendments to 10 CFR Part 51 regarding what information is to be included in an ER ([74 FR 38117](#); [NRC 2012](#)). The proposed amendments include combining related environmental issues, reassignment of issue categories, identification of new Category 1 and 2

1. Base load is the minimum amount of electric power over a given period of time at a steady rate. The minimum continuous load or demand in a power system over a given period of time is usually not temperature sensitive.

issues, and the expansion of existing issues. NRC discusses this amended compilation of environmental issues of concern for nuclear plant license renewal in the draft GEIS published in 2009 ([NRC 2009a](#)). Although not yet regulatory requirements, TVA has also included in this ER, for purposes of completeness, but not in order to satisfy governing regulatory requirements, those Category 2 issues, either new or with expanded scope, currently in the proposed amendment to 10 CFR Part 51 ([74 FR 38117](#); [NRC 2012](#)). TVA developed [Table 1.1-1](#) as a crosswalk matrix showing relationships between the 1996 GEIS issues (those required by current regulations) and the proposed 2009 GEIS issues. The matrix identifies where the issue is addressed within the ER, to provide assurance that each issue is addressed as appropriate and guide the reviewer to the specific location in the ER.

This appendix to the TVA license renewal application (LRA) fulfills the requirements of 10 CFR Part 51 for information to be included and proactively addresses those new or expanded Category 2 issues that NRC included in its proposed amendment to 10 CFR Part 51. Moreover, TVA also addressed the proposed new Category 1 issues set forth in the proposed amendments to the GEIS in its new and significant process as discussed in [Chapter 5](#).

## **1.2 Licensee and Ownership**

TVA is a federal agency and the owner and operator of SQN Unit 1 (Facility OL DPR-77) and Unit 2 (Facility OL DPR-79). For the purposes of this ER, TVA is considered the applicant. TVA also owns and operates the transmission lines constructed for purposes of connecting SQN to the electric power grid.

**Table 1.1-1**  
**License Renewal Environmental Issues:**  
**Current 1996 GEIS/Proposed 2009 GEIS Crosswalk**  
**(2009 issue expansions in bold text; new 2009 issues underlined)**

1996 GEIS Issue	2009 GEIS Issue	1996 Category	2009 Category	Applicable to SQN	Where Considered
<b>Surface Water Quality, Hydrology, and Use</b>					
Impacts of refurbishment on surface water quality	<b>Surface water use and quality (both continuing operations and refurbishment)</b>	1	1	1996: No 2009: Yes	ER <a href="#">Section 3.3</a>
Impacts of refurbishment on surface water use		1		1996: No 2009: Yes	ER <a href="#">Section 3.3</a>
Altered current patterns at intake and discharge structures	Altered current patterns at intake and discharge structures	1	1	Yes	ER Sections <a href="#">2.2</a> and <a href="#">3.2</a>
Altered salinity gradients	Altered salinity gradients	1	1	No	ER <a href="#">Section 4.0</a> and <a href="#">Table 4.0-1</a>
Altered thermal stratification of lakes	Altered thermal stratification of lakes	1	1	Yes	ER <a href="#">Section 2.2</a>
Temperature effects on sediment transport capacity	Temperature effects on sediment transport capacity	1	1	Yes	ER <a href="#">Table 4.0-1</a>
Scouring caused by discharged cooling water	Scouring caused by discharged cooling water	1	1	Yes	ER <a href="#">Section 2.2</a> and <a href="#">Table 4.0-1</a>
Discharge of chlorine or other biocides	Discharge of biocides, sanitary wastes, and minor chemical spills	1	1	Yes	ER <a href="#">Section 3.2</a>
Discharge of sanitary wastes and minor chemical spills		1		Yes	ER <a href="#">Section 3.2</a>
Discharge of metals in waste water	Discharge of metals in cooling system effluent	1	1	Yes	ER Sections <a href="#">2.2</a> and <a href="#">3.2</a>
Water use conflicts (plants with once-through cooling systems)	Water use conflicts (plants with once-through cooling systems)	1	1	Yes	ER Sections <a href="#">2.2</a> , <a href="#">2.10.1</a> , and <a href="#">3.2</a>

**Table 1.1-1 (Continued)**  
**License Renewal Environmental Issues:**  
**Current 1996 GEIS/Proposed 2009 GEIS Crosswalk**  
**(2009 issue expansions in bold text; new 2009 issues underlined)**

1996 GEIS Issue	2009 GEIS Issue	1996 Category	2009 Category	Applicable to SQN	Where Considered
Water use conflicts (plants with cooling ponds or cooling towers using makeup water from a small river with low flow)	Water use conflicts (plants with cooling ponds or cooling towers using makeup water from a river with low flow)	2	2	Yes	ER Sections <a href="#">2.2</a> , <a href="#">2.10.1</a> , <a href="#">3.2</a> , and <a href="#">4.1</a>
Not specifically identified as a separate category issue—addressed elsewhere	<u>Effects of dredging on water quality</u>	No category	1	Yes	ER Sections <a href="#">2.2</a> , <a href="#">2.5</a> , and <a href="#">3.2</a>
<b>Aquatic Ecology</b>					
Refurbishment	Refurbishment impacts on aquatic resources	1	1	No	ER Sections <a href="#">2.2</a> and <a href="#">3.3</a>
Accumulation of contaminants in sediments or biota	Effects of nonradiological contaminants on aquatic organisms	1	1	Yes	ER Sections <a href="#">2.2</a> and <a href="#">3.2.8.2</a>
Eutrophication	Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication	1	1	Yes	ER <a href="#">Section 2.2</a>
Gas supersaturation (gas bubble disease)		1		Yes	ER <a href="#">Section 2.2</a>
Low dissolved oxygen in the discharge		1		Yes	ER <a href="#">Section 2.2</a>
Entrainment of fish and shellfish in early life stages	Impingement and entrainment of aquatic organisms	2	2	Yes	ER <a href="#">Section 4.2</a>
Impingement of fish and shellfish		2		Yes	ER <a href="#">Section 4.3</a>
Entrainment of phytoplankton and zooplankton	Entrainment of phytoplankton and zooplankton	1	1	Yes	ER Sections <a href="#">2.2</a> and <a href="#">4.2</a>



**Table 1.1-1 (Continued)**  
**License Renewal Environmental Issues:**  
**Current 1996 GEIS/Proposed 2009 GEIS Crosswalk**  
**(2009 issue expansions in bold text; new 2009 issues underlined)**

1996 GEIS Issue	2009 GEIS Issue	1996 Category	2009 Category	Applicable to SQN	Where Considered
Heat shock (for plants with once-through and cooling pond heat dissipation systems)	Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds)	2	2	Yes	ER Sections <a href="#">2.2</a> and <a href="#">4.4</a> for once-through cooling discharge
Cold shock	Infrequently reported thermal impacts (all plants)	1	1	Yes	ER Sections <a href="#">2.2</a> and <a href="#">4.4</a> for once-through cooling discharge
Thermal plume barrier to migrating fish		1		Yes	ER Sections <a href="#">2.2</a> and <a href="#">4.4</a> for once-through cooling discharge;
Distribution of aquatic organisms		1		Yes	ER <a href="#">Section 4.4</a> for once-through cooling discharge
Premature emergence of aquatic insects		1		Yes	ER <a href="#">Section 4.4</a> for once-through cooling discharge
Stimulation of nuisance organisms (e.g., shipworms)		1		Yes	ER <a href="#">Table 4.0-1</a>
Losses from predation, parasitism, and disease among organisms exposed to sub-lethal stresses		Losses from predation, parasitism, and disease among organisms exposed to sub-lethal stresses		1	1
Not specifically identified as a separate category issue—addressed elsewhere.	<u>Exposure of aquatic organisms to radionuclides</u>	No category	1	Yes	ER <a href="#">Section 3.2.5</a>

**Table 1.1-1 (Continued)**  
**License Renewal Environmental Issues:**  
**Current 1996 GEIS/Proposed 2009 GEIS Crosswalk**  
**(2009 issue expansions in bold text; new 2009 issues underlined)**

1996 GEIS Issue	2009 GEIS Issue	1996 Category	2009 Category	Applicable to SQN	Where Considered
Not specifically identified as a separate category issue—addressed elsewhere.	<u>Effects of dredging on aquatic organisms</u>	No category	1	Yes	ER Sections <a href="#">2.2</a> and <a href="#">9.1</a>
Not specifically identified as a separate category issue—addressed elsewhere.	<u>Impacts of transmission line right-of-way (ROW) management on aquatic resources</u>	No category	1	Yes	ER <a href="#">Section 3.2</a>
<b><i>Aquatic Ecology (for plants with cooling tower-based heat dissipation systems)</i></b>					
Entrainment of fish and shellfish in early life stages	Impingement and entrainment of aquatic organisms (also, incorporates entrainment of phytoplankton and zooplankton, see above)	1	1	Yes	ER Sections <a href="#">2.2</a> , <a href="#">2.5</a> , and <a href="#">4.2</a>
Impingement of fish and shellfish		1		Yes	ER Sections <a href="#">2.2</a> , <a href="#">2.5</a> , and <a href="#">4.3</a>
Heat shock for plants with cooling tower-based heat dissipation systems	Thermal impacts on aquatic organisms (incorporates cold shock, thermal plume barrier to migrating fish, distribution of aquatic organisms, and premature emergence of aquatic insects)	1	1	Yes	ER Sections <a href="#">2.2</a> and <a href="#">4.4</a>

**Table 1.1-1 (Continued)**  
**License Renewal Environmental Issues:**  
**Current 1996 GEIS/Proposed 2009 GEIS Crosswalk**  
**(2009 issue expansions in bold text; new 2009 issues underlined)**

1996 GEIS Issue	2009 GEIS Issue	1996 Category	2009 Category	Applicable to SQN	Where Considered
Consumptive water use conflict impacts on riparian vegetation and associated animal communities is combined with water use conflicts for water resources (plants with cooling towers on river with low flow)	<u>Water use conflicts with aquatic resources (plants with cooling ponds or cooling towers using makeup water from a river with low flow).</u>	No category	2	Yes	ER Sections <a href="#">2.2</a> , <a href="#">3.2</a> , <a href="#">4.0.5</a> , <a href="#">4.1</a> , and <a href="#">4.10</a>
<b>Groundwater Use and Quality</b>					
Groundwater use conflicts (potable and service water; plants that use < 100 gpm)	Groundwater use conflicts (plants that withdraw < 100 gpm)	1	1	No	ER Sections <a href="#">2.3</a> , <a href="#">3.2</a> , and <a href="#">4.0</a>
Groundwater use conflicts (potable, service water, and dewatering; plants that use > 100 gpm)	Groundwater use conflicts (plants that withdraw > 100 gpm including those using Ranney wells)	2	2	No	ER <a href="#">Section 4.5</a>
Groundwater use conflicts (plants using cooling towers withdrawing makeup water from a small river)	Groundwater use conflicts (plants with closed-cycle cooling systems that withdraw makeup water <b>from a river</b> )	2	2	Yes	ER <a href="#">Section 4.6</a>
Groundwater use conflicts (Ranney wells)	See above (Groundwater use conflicts [plants that withdraw > 100 gpm including those using Ranney wells])	2	2	No	ER <a href="#">Section 4.7</a>

**Table 1.1-1 (Continued)**  
**License Renewal Environmental Issues:**  
**Current 1996 GEIS/Proposed 2009 GEIS Crosswalk**  
**(2009 issue expansions in bold text; new 2009 issues underlined)**

1996 GEIS Issue	2009 GEIS Issue	1996 Category	2009 Category	Applicable to SQN	Where Considered
Groundwater quality degradation (Ranney wells)	Groundwater quality degradation resulting <b>from water withdrawals</b>	1	1	No	ER Sections <a href="#">2.3</a> and <a href="#">3.2</a>
Groundwater quality degradation (saltwater intrusion)		1		No	ER Sections <a href="#">2.3</a> and <a href="#">3.2</a>
Groundwater quality degradation (cooling ponds in salt marshes)	Groundwater quality degradation (cooling ponds in salt marshes)	1	1	No	ER Sections <a href="#">2.3</a> and <a href="#">3.2</a>
Groundwater quality degradation (cooling ponds at inland sites)	Groundwater quality degradation (cooling ponds at inland sites)	2	2	No	ER Sections <a href="#">2.3</a> , <a href="#">3.2</a> , and <a href="#">4.8</a>
Impacts of refurbishment on groundwater use and quality	<u>Groundwater contamination and use (non-cooling system impacts)</u>	1	1	1996: No 2009: Yes	ER Sections <a href="#">2.3</a> , <a href="#">3.2</a> , and <a href="#">9.1.3</a>
Not specifically identified as a separate category issue—addressed elsewhere	<u>Radionuclides released to groundwater</u>	No category	2	Yes	ER Sections <a href="#">2.3</a> , <a href="#">3.2</a> , and <a href="#">9.1.3</a>
<b>Terrestrial Resources</b>					
Refurbishment impacts to terrestrial resources	<u>Impacts of refurbishment and continued plant operations on terrestrial ecosystems.</u>	2	2	1996: No 2009: Yes	ER Sections <a href="#">2.4</a> , <a href="#">3.2</a> , and <a href="#">4.9</a>

**Table 1.1-1 (Continued)**  
**License Renewal Environmental Issues:**  
**Current 1996 GEIS/Proposed 2009 GEIS Crosswalk**  
**(2009 issue expansions in bold text; new 2009 issues underlined)**

1996 GEIS Issue	2009 GEIS Issue	1996 Category	2009 Category	Applicable to SQN	Where Considered
Cooling tower impacts on crops and ornamental vegetation	Cooling tower impacts on vegetation	1	1	Yes	ER Sections <a href="#">2.4</a> , <a href="#">3.2</a> , and <a href="#">4.0</a>
Cooling tower impacts on native plants		1		Yes	ER Sections <a href="#">2.4</a> , <a href="#">3.2</a> , and <a href="#">4.0</a>
Bird collisions with cooling towers	Bird collisions with cooling towers and transmission lines	1	1	Yes	ER Sections <a href="#">2.4</a> , <a href="#">2.5</a> , <a href="#">3.2</a> , and <a href="#">4.0</a>
Cooling pond impacts on terrestrial resources	Cooling system impacts on terrestrial resources ( <b>plants with once-through cooling systems</b> or cooling ponds)	1	1	1996: No 2009: Yes	ER Sections <a href="#">2.4</a> , <a href="#">3.2</a> , and <a href="#">4.0</a>
Power line ROW management (cutting and herbicide application)	Transmission line ROW management impacts on terrestrial resources	1	1	Yes	ER Sections <a href="#">2.4</a> , <a href="#">2.5</a> , <a href="#">3.2</a> , and <a href="#">4.0</a>
Bird collisions with power lines	See above (Bird collisions with cooling towers and transmission lines)	1	1	Yes	ER Sections <a href="#">2.4</a> , <a href="#">2.5</a> , <a href="#">3.2</a> , and <a href="#">4.0</a> .
Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, and livestock)	Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, and livestock)	1	1	Yes	ER Sections <a href="#">2.4</a> , <a href="#">2.5</a> , <a href="#">3.2</a> , and <a href="#">4.0</a>
Floodplains and wetlands on power line ROW	See above (transmission line ROW management impacts on terrestrial resources)	1	1	Yes	ER Sections <a href="#">2.4</a> , <a href="#">3.2</a> , and <a href="#">4.0</a>

**Table 1.1-1 (Continued)**  
**License Renewal Environmental Issues:**  
**Current 1996 GEIS/Proposed 2009 GEIS Crosswalk**  
**(2009 issue expansions in bold text; new 2009 issues underlined)**

1996 GEIS Issue	2009 GEIS Issue	1996 Category	2009 Category	Applicable to SQN	Where Considered
Not specifically identified as a separate category issue—addressed elsewhere	<u>Exposure of terrestrial organisms to radionuclides</u>	No category	1	Yes	ER Sections <a href="#">2.4</a> , <a href="#">3.2</a> , <a href="#">4.0</a> , and <a href="#">9.1.3</a>
Not specifically identified as a separate category issue—addressed elsewhere	<u>Water use conflicts with terrestrial resources (plants with cooling ponds or cooling towers using makeup water from a river with low flow)</u>	No category	2	Yes	ER Sections <a href="#">2.2.1</a> , <a href="#">2.4</a> , <a href="#">4.1</a> , and <a href="#">4.9</a>
<b>Threatened or Endangered Species (for all plants)</b>					
Threatened or endangered species	Threatened, endangered, and protected species and essential fish habitat	2	2	Yes	ER Sections <a href="#">2.2</a> , <a href="#">2.5</a> , and <a href="#">4.10</a>
<b>Air Quality</b>					
Air quality during refurbishment (nonattainment and maintenance areas)	<u>Air quality impacts (all plants)</u>	2	1	1996: No 2009: Yes	ER Sections <a href="#">2.11</a> and <a href="#">4.11</a>
Air quality effects of transmission lines	Air quality effects of transmission lines	1	1	Yes	ER Sections <a href="#">3.2</a> and <a href="#">4.0</a>
<b>Land Use</b>					
See Socioeconomics (Offsite land use [refurbishment])	Offsite land use (refurbishment and continued operations)	2	1	No	ER Sections <a href="#">3.3</a> and <a href="#">4.17</a>
See Socioeconomics (Offsite land use [license renewal term])		2		Yes	ER Sections <a href="#">2.8</a> and <a href="#">4.18</a>

**Table 1.1-1 (Continued)**  
**License Renewal Environmental Issues:**  
**Current 1996 GEIS/Proposed 2009 GEIS Crosswalk**  
**(2009 issue expansions in bold text; new 2009 issues underlined)**

1996 GEIS Issue	2009 GEIS Issue	1996 Category	2009 Category	Applicable to SQN	Where Considered
Onsite land use	Onsite land use (refurbishment and continued operations)	1	1	Yes	ER Sections <a href="#">2.4</a> and <a href="#">4.0</a>
Power line ROW land-use impacts	Offsite land use in transmission line ROWs (refurbishment and continued operations)	1	1	Yes	ER Sections <a href="#">3.2</a> and <a href="#">4.0</a>
<b>Human Health</b>					
Radiation exposures to the public (refurbishment and continued operations)	Radiation exposures to the public (refurbishment and continued operations)	1	1	Yes	ER Sections <a href="#">3.2</a> , <a href="#">3.3</a> , and <a href="#">4.0</a>
Occupational radiation exposures (refurbishment and continued operations)	Radiation exposures to occupational workers (refurbishment and continued operations)	1	1	Yes	ER Sections <a href="#">3.2</a> , <a href="#">3.3</a> , and <a href="#">4.0</a>
Microbiological organisms (occupational health)	Microbiological hazards to plant workers	1	1	Yes	ER <a href="#">Section 4.0</a>
Microbiological organisms (public health) (plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	Microbiological hazards to the public (plants with cooling ponds or canals or cooling towers that discharge to river)	2	2	Yes	ER <a href="#">Section 4.12</a>
Noise	Noise impacts	1	1	Yes	ER Sections <a href="#">2.1</a> and <a href="#">9.1</a>
Electromagnetic fields, acute effects	Electric shock hazards	2	2	Yes	ER <a href="#">Section 4.13</a>

**Table 1.1-1 (Continued)**  
**License Renewal Environmental Issues:**  
**Current 1996 GEIS/Proposed 2009 GEIS Crosswalk**  
**(2009 issue expansions in bold text; new 2009 issues underlined)**

1996 GEIS Issue	2009 GEIS Issue	1996 Category	2009 Category	Applicable to SQN	Where Considered
Electromagnetic fields, chronic effects	Electromagnetic fields, chronic effects	No category	No category	Yes	N&S review
Not specifically identified as a separate category issue—addressed elsewhere	<u>Human health impact from chemicals</u>	No category	1	Yes	ER <a href="#">Section 3.2</a>
Not specifically identified as a separate category issue—addressed elsewhere	<u>Physical occupational hazards</u>	No category	1	Yes	ER Sections <a href="#">4.0</a> and <a href="#">9.1</a>
<b>Socioeconomics</b>					
Housing impacts	<b>Population</b> and housing	2	1	Yes	ER Sections <a href="#">2.6</a> , <a href="#">2.9</a> , <a href="#">3.5</a> , and <a href="#">4.14</a>
Public services: public safety, social services, and tourism and recreation	Employment and income, recreation and tourism	1	1	Yes	ER Sections <a href="#">2.6</a> and <a href="#">2.10</a>
Public services: public utilities	Community services and education	2	1	Yes	ER Sections <a href="#">2.10</a> and <a href="#">4.15</a>
Public services: education (refurbishment)		2		Yes	ER Sections <a href="#">2.10</a> and <a href="#">4.16</a>
Public services: education (license renewal term)		1		Yes	ER <a href="#">Section 2.10</a>
Offsite land use (refurbishment)	See “Land Use” above	2	1	Yes	ER Sections <a href="#">3.3</a> and <a href="#">4.17</a>
Offsite land use (license renewal term)	See “Land Use” above	2	1	Yes	ER Sections <a href="#">2.8</a> and <a href="#">4.18</a>



**Table 1.1-1 (Continued)**  
**License Renewal Environmental Issues:**  
**Current 1996 GEIS/Proposed 2009 GEIS Crosswalk**  
**(2009 issue expansions in bold text; new 2009 issues underlined)**

1996 GEIS Issue	2009 GEIS Issue	1996 Category	2009 Category	Applicable to SQN	Where Considered
Public services: transportation (refurbishment and continued operations)	Transportation (refurbishment and continued operations)	2	1	Yes	ER Sections <a href="#">2.10</a> and <a href="#">4.19</a>
Historic and archaeological resources	Historic and cultural resources	2	2	Yes	ER Sections <a href="#">2.12</a> and <a href="#">4.20</a>
Aesthetic impacts (refurbishment)	Visual resources, aesthetic impacts	1	1	No	ER Sections <a href="#">2.1</a> , <a href="#">3.3</a> , and <a href="#">4.0</a>
Aesthetic impacts (license renewal term)		1		Yes	ER Sections <a href="#">2.1</a> and <a href="#">4.0</a>
Aesthetic impacts of transmission lines (license renewal term)	Visual resources, aesthetic impacts	1	1	Yes	ER Sections <a href="#">2.1</a> and <a href="#">4.0</a>
Not specifically identified as a separate category issue—addressed elsewhere	Tax revenues	No category	1	Yes	ER Sections <a href="#">2.7</a> and <a href="#">4.18</a>
<b><i>Postulated Accidents</i></b>					
Design basis accidents	Design basis accidents	1	1	Yes	ER Sections <a href="#">3.2</a> and <a href="#">4.0</a>
Severe accidents	Severe accidents	2	2	Yes	ER Section <a href="#">4.21</a>
<b><i>Uranium Fuel Cycle and Waste Management</i></b>					
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste)	Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste)	1	1	Yes	ER <a href="#">Section 4.0</a>

**Table 1.1-1 (Continued)**  
**License Renewal Environmental Issues:**  
**Current 1996 GEIS/Proposed 2009 GEIS Crosswalk**  
**(2009 issue expansions in bold text; new 2009 issues underlined)**

<b>1996 GEIS Issue</b>	<b>2009 GEIS Issue</b>	<b>1996 Category</b>	<b>2009 Category</b>	<b>Applicable to SQN</b>	<b>Where Considered</b>
Offsite radiological impacts (collective effects)	Offsite radiological impacts (collective effects from other than the disposal of spent fuel and high-level waste)	1	1	Yes	ER <a href="#">Section 4.0</a>
Offsite radiological impacts (spent fuel and high-level waste disposal)	Solid waste, offsite radiological impacts of spent fuel and high-level waste disposal	1	1	Yes	ER Sections <a href="#">3.2</a> and <a href="#">4.0</a>
Nonradiological impacts of the uranium fuel cycle	Nonradiological impacts of the uranium fuel cycle	1	1	Yes	ER <a href="#">Section 4.0</a>
Low-level waste storage and disposal	Solid waste, low-level waste storage and disposal	1	1	Yes	ER Sections <a href="#">3.2</a> and <a href="#">4.0</a>
Mixed waste storage and disposal	Solid waste, mixed waste storage and disposal	1	1	Yes	ER Sections <a href="#">3.2</a> and <a href="#">4.0</a>
Onsite spent fuel	Solid waste, onsite storage of spent fuel	1	1	Yes	ER Sections <a href="#">3.2</a> and <a href="#">4.0</a>
Nonradiological waste	Solid waste, nonradiological waste storage and disposal	1	1	Yes	ER Sections <a href="#">3.2</a> , <a href="#">4.0</a> , and <a href="#">9.1</a>
Transportation	Transportation	1	1	Yes	ER Sections <a href="#">3.1</a> and <a href="#">4.0</a>

**Table 1.1-1 (Continued)**  
**License Renewal Environmental Issues:**  
**Current 1996 GEIS/Proposed 2009 GEIS Crosswalk**  
**(2009 issue expansions in bold text; new 2009 issues underlined)**

1996 GEIS Issue	2009 GEIS Issue	1996 Category	2009 Category	Applicable to SQN	Where Considered
<b><i>Termination of Nuclear Power Plant Operations and Decommissioning</i></b>					
Radiation doses	Termination of nuclear power plant operations and decommissioning	1	1	Yes	ER Sections <a href="#">4.0</a> and <a href="#">7.1</a>
Waste management		1		Yes	ER Sections <a href="#">4.0</a> and <a href="#">7.1</a>
Air quality		1		Yes	ER Sections <a href="#">4.0</a> and <a href="#">7.1</a>
Water quality		1		Yes	ER Sections <a href="#">4.0</a> and <a href="#">7.1</a>
Ecological resources		1		Yes	ER Sections <a href="#">4.0</a> and <a href="#">7.1</a>
Socioeconomic impacts		1		Yes	ER Sections <a href="#">4.0</a> and <a href="#">7.1</a>
<b><i>Environmental Justice</i></b>					
Environmental justice	<u>Minority and low-income populations</u>	No category	2	Yes	ER Sections <a href="#">2.6</a> and <a href="#">4.22</a>
<b><i>Geology and Soils (new topic in 2009)</i></b>					
Not specifically identified as a separate category issue—addressed elsewhere	<u>Impact of nuclear plants on geology and soils</u>	No category	1	Yes	ER Sections <a href="#">2.3</a> and <a href="#">4.0</a>
<b><i>Cumulative Impacts</i></b>					
Not specifically identified as a separate category issue—addressed elsewhere	<u>Cumulative impacts</u>	No category	2	Yes	ER <a href="#">Section 4.23</a>

Note: The review in ER [Chapter 5](#) provides an evaluation of any new and significant information which might result in Category 1 impact conclusions different from those of the GEIS.

## 2.0 SITE AND ENVIRONMENTAL INTERFACES

This chapter discusses the existing environment and environmental interfaces at the SQN site that would continue if license renewals were approved. The environmental descriptions provide sufficient detail to identify those environmental resources that have the potential to be affected by the continued operation of SQN Units 1 and 2.

This ER draws from the original licensing documents and other documents addressing the regional, local, and site characteristics of the SQN site and its environment. Preparation of this ER included reviews and citations, where needed, of other documents, including the following:

- 1974 *Final Environmental Statement, Sequoyah Nuclear Plant Units 1 and 2, and 1978 Update*
- 1980 *Environmental Assessment and Finding of No Significant Impact for Low-Level Radwaste Management, Sequoyah Nuclear Plant*
- 1988 *Environmental Assessment and Finding of No Significant Impact—Change in Expiration Dates of Facility Operating License Nos. DPR-77 and DPR-79, Tennessee Valley Authority, Sequoyah Nuclear Plant, Units 1 and 2*
- 1999 *Environmental Assessment and Finding of No Significant Impact—Low Level Radioactive Waste Transport and Storage Watts Bar and Sequoyah Nuclear Plants*
- 1999 *Final Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor* (U.S. Department of Energy [DOE])
- 2000 *Environmental Assessment and Finding of No Significant Impact—Replacement of Steam Generators, Sequoyah Nuclear Plant, Unit 1*
- 2000 *Environmental Assessment and Finding of No Significant Impact—Independent Spent Fuel Storage Installation Sequoyah Nuclear Plant*
- 2001 *Environmental Assessment and Finding of No Significant Impact—Leading Edge Flow Measurements System Installation*
- 2002 *Supplemental Environmental Assessment and Finding of No Significant Impact—Independent Spent Fuel Storage Installation, Sequoyah Nuclear Plant, Hamilton County, Tennessee*
- 2004 *Reservoir Operations Study, Final Programmatic Environmental Impact Statement*
- 2009 *Environmental Assessment for SQN Unit 2 Steam Generator Replacements and Finding of No Significant Impact for SQN Unit 2 Steam Generator Replacements*

- *2011 Supplemental Environmental Assessment for SQN Unit 2 Steam Generator Replacements and Finding of No Significant Impact for SQN Unit 2 Steam Generator Replacements*
- *2011 Environmental Impact Statement for the Tennessee Valley Authority Integrated Resource Plan*
- *2011 Final Supplemental Environmental Impact Statement, Sequoyah Nuclear Plant Units 1 and 2 License Renewal, Hamilton County, Tennessee*
- *2011 Reevaluation of Finding of No Significant Impact—Low Level Radioactive Waste Transport and Storage Watts Bar and Sequoyah Nuclear Plants*

## **2.1 Location and Features**

SQN is located near the geographical center of Hamilton County, Tennessee, on a peninsula on the western shore of Chickamauga Reservoir at Tennessee River Mile (TRM) 484.5, approximately 6 miles east of Soddy-Daisy, Tennessee, and approximately 31 miles south-southwest of TVA's Watts Bar Nuclear Plant (WBN) site. The SQN property boundary shown in [Figure 2.1-1](#) encompasses approximately 630 acres: 525 acres are associated with the SQN industrial site and 105 acres, known as the training peninsula, are associated with SQN's training center. The SQN site is owned, including mineral rights, by the United States and is in the custody of TVA. TVA maintains control of entrances and exits from the SQN site property. The coordinates of the plant site, based on the coordinates of the Unit 1 Reactor Building center, are as follows:

- Latitude and Longitude Coordinates: 35° 13' 35.65" N and 85° 05' 28.17" W
- Universal Transverse Mercator Coordinates: Zone 16, N 3,899,640.62 and E 673,718.24

### **2.1.1 Vicinity and Regional Features**

The site is bounded by the Tennessee River on the south and east, and by land not owned by TVA on the north and west. The vicinity of the SQN site is defined as a 6-mile radius from the site center of the power block location and includes portions of Hamilton and Bradley counties in Tennessee. The nearest incorporated city is Soddy-Daisy, Tennessee, approximately 6 miles west of the site.

The Tennessee River bisects Hamilton County from northeast to southwest and accounts for 6 percent of the total county area ([CHCRPA 2005a](#)). The SQN site is situated along the Tennessee River, and there are no residences, commercial operations, or public recreational areas within the SQN exclusion area boundary (EAB), as shown in [Figure 2.1-2](#). No public railroads or major highways cross the EAB. Two rural county roads, Igou Ferry and Stone Sage, cross the western boundary of SQN's property and run adjacent to it for a short distance before leaving the site ([Figure 2.1-1](#)). Igou Ferry Road connects with Hixson Pike, which follows the

western shore of Chickamauga Reservoir and joins State Road 153 (SR 153) just north of Chickamauga Dam. The plant access road crosses Igou Ferry Road at the EAB (Figure 2.1-1) and eventually connects with U.S. Highway 27 (US 27) near Soddy-Daisy, Tennessee.

The SQN site is accessible by both river and road. SQN personnel access the site from either US 27 or State Road 319 (SR 319, also known as Hixson Pike), via the Sequoyah Access Road, as illustrated in Figure 2.1-3. The Sequoyah Access Road runs eastward from US 27 and intersects with SR 319 near the site. Chickamauga Reservoir, on the Tennessee River, is a navigable waterway that is also used by commercial and recreational traffic. Through a series of locks and dams, commercial traffic can travel from Knoxville, Tennessee, more than 100 miles northeast of the site, to the mouth of the Tennessee River at the Ohio River. (TVA 2011a, Section 3.13.10.1)

SQN has a private-use helipad, and the nearest airport is the Dallas Bay Sky Park, a general aviation airport approximately 5.5 miles west-southwest of the plant (Figure 2.1-3). The Chattanooga Airport is a full-service commercial airport about 14.5 miles south-southwest of the plant. (TVA 2011a, Section 3.13.10.1)

Two of the nation's largest rail networks serve the region: CSX Transportation, Inc. (CSX) and Norfolk Southern Corporation. CSX operates a rail line from Chattanooga to the Tyner area, where it serves several industries. The largest railroad presence in the region is Norfolk Southern Corporation, which is also the operator of the southwest to northeast line running near the SQN site through Soddy-Daisy (Figure 2.1-3). (CHCRPA 2005a; Norfolk Southern Corporation 2010) A railroad spur runs from the Norfolk Southern line to SQN just outside the EAB. Amtrak does not serve Chattanooga, and there is no local intercity passenger rail service (CHCRPA 2005a).

The major Hamilton County east-west road network on the east side of the river is anchored by Interstate 75 (I-75) and I-24, both of which pass through Chattanooga, as illustrated in Figure 2.1-4. On the west side of the river, running north-south, US 27 becomes a major expressway in Hamilton County, feeding traffic from Chattanooga to Soddy-Daisy and northward into Rhea County.

The 50-mile region from the site center encompasses all of, or portions of, the following counties in Alabama, Georgia, North Carolina, and Tennessee (Figure 2.1-4).

- Alabama: DeKalb and Jackson
- Georgia: Catoosa, Chattooga, Dade, Fannin, Floyd, Gilmer, Gordon, Murray, Walker, and Whitfield
- North Carolina: Cherokee
- Tennessee: Bledsoe, Bradley, Coffee, Cumberland, Franklin, Grundy, Hamilton, Loudon, Marion, McMinn, Meigs, Monroe, Polk, Rhea, Roane, Sequatchie, Van Buren, Warren, and White

The 2010 census data showing that all of the counties within the region have increased in population since the 2000 census, with the exception of one county in Alabama (Jackson) and one county in Tennessee (Grundy), are provided in [Table 2.6-2](#). As shown in [Table 2.6-1](#), three cities within a 50-mile radius of SQN have a population greater than 25,000: Chattanooga, Tennessee (18 miles), with a population of 167,674 in 2010; Cleveland, Tennessee (13 miles), with a population of 41,285 in 2010; and Dalton, Georgia (32 miles), with a population of 33,128 in 2010. One of the largest cities near SQN, Soddy-Daisy (6 miles) ([Figure 2.1-3](#)), had a 2010 population of 12,714 residents. ([USDOT 2008](#); [USCB 2010a](#)) The 2010 population counts for cities within the 50-mile region are listed in [Table 2.6-1](#). Most of the cities and towns serve as small retail or service centers for the surrounding farms, although a number are developing an industrial base ([TVA 2011p](#), Section 2.1.3.2; [USCB 2010a](#)).

The region consists mainly of forest and agricultural lands, with clusters of developed areas. ([MRLC 2006](#)) Hamilton County, where SQN is located, has a well-developed land-use and zoning plan, with every parcel of land carrying a zoning designation ([CHCRPA 2005a](#)). Hamilton County is one of Tennessee's largest counties, with a 2010 estimated population of 336,463 residents ([USCB 2010b](#)). Based upon the number and size of parcels, zoning within the county is primarily agricultural (59.64 percent), followed by residential (30.51 percent), manufacturing/industrial (6.58 percent), commercial (2.20 percent), special zoning (0.64 percent), and office (0.12 percent). ([CHCRPA 2009](#)) Land use is discussed in greater detail in [Section 2.8](#).

### **2.1.2 Station Features**

The principal structures of SQN consist of two reactor buildings, a turbine building, an auxiliary building, a control building, a service and office building, a diesel generator building, an intake pumping station, essential raw cooling water (ERCW) pumping station, two natural draft cooling towers, 161-kilovolt (kV) and 500-kV switchyards, a condensing water discharge and diffuser system, and an independent spent fuel storage installation (ISFSI). ([TVA 2011p](#), Section 1.2.3; [TVA 1974a](#), Section 1.1) [Figure 2.1-1](#) shows the general features of the facility, the EAB, and protected area. Section 3.2 describes key features of the station, including reactor and containment systems, cooling and auxiliary water systems, radwaste systems, and transmission facilities.

The protected area is completely enclosed by a security fence, with access to the area controlled at a security gate. A plant security system monitors the protected area, as well as the buildings within the station. Access to the site is by paved entrance roads from either US 27 or SR 319 (Hixson Pike), via the Sequoyah Access Road. The exclusion area, as defined by 10 CFR 100.3, surrounds the site, as shown in [Figures 2.1-1](#) and [2.1-2](#). The nearest occupied residence lies 0.5 miles beyond the site boundary to the north-northwest ([SQN 2010a](#), Table G-1).

The tallest structures on site are the two cooling towers at approximately 459 feet in height ([TVA 1974b](#)). Predominant visual features of SQN include the reactor containment buildings, powerhouse, cooling towers, and transmission lines and associated structures that can be seen at distances of 1 to 4 miles along the Tennessee River to the north and south. The towers are visible from Harrison Bay State Park located south of the plant. Motorists have broad horizontal

views of the plant site from the east along State Road 312 (SR 312, also known as Birchwood Pike), which includes Skull Island Campground (Figure 2.1-5). Recreationists on the water have similar views from the eastern side of the Tennessee River. However, these views become less dominant closer to the west side of the river near the plant site. Normally, at a range of 1 to 4 miles, an observer may find plant features distinguishable; however, the details are obscure and tend to merge into larger patterns. Topography along the bank becomes very steep, and views are obscured by dense, mature hardwood and evergreen trees (Figures 2.1-1 and 2.1-2). Scenic resources and views are common, including both unique natural features and scenic variety (TVA 2009a).

There are no noise ordinances imposed by federal, state, or local statutes that limit allowable sound levels at SQN. Given the industrial nature of the station, noise emissions from SQN are generally nothing more than an intermittent minor nuisance. Although the U.S. Environmental Protection Agency (EPA) uses 55 A-weighted decibels (dBA) as a threshold level to protect against excess noise during outdoor activities, this threshold does "not constitute a standard, specification, or regulation," but was intended to provide a basis for state and local governments establishing noise standards. Although surveys have not been conducted since the construction of SQN, when the greatest sources of noise would have occurred, current noise levels are considered minor and are not expected to change during the license renewal period, because no new sources of noise are being introduced (TVA 2011a).

### **2.1.3 Federal, Native American, State, and Local Lands**

The SQN site is located on a peninsula on the western shore of Chickamauga Reservoir (Figure 2.1-5). The reservoir is one of a series of highly controlled multiple-use reservoirs located on the Tennessee River whose primary uses are flood control, navigation, and the generation of electric power. Secondary uses include industrial and public water supply and waste disposal, commercial fishing, and recreation. (SQN 2009a)

Within a 6-mile radius of SQN, there are four federal, one state, and 16 locally managed lands (Figure 2.1-5 and Table 2.1-1). The federal lands within a 6-mile radius are all TVA-managed habitat protection areas (HPAs) and their approximate distances from SQN are as follows: Chigger Point (1 mile east), Soddy Creek (2 miles north-northwest), Ware Branch Bend (3 miles north), and Murphy Hill (5 miles north-northeast). These areas are located generally north and east of the site, adjacent to Chickamauga Reservoir.

Harrison Bay State Recreation Park is the only state-managed land within a 6-mile radius of the site. It is located approximately 1.4 miles south of SQN and comprises 1,200 acres with approximately 40 miles of shoreline on Chickamauga Reservoir. Renowned for its boat docking facilities, this park also offers biking and hiking trails, recreational vehicle and tent campsites, lake fishing, an Olympic-sized swimming pool, meeting and picnic facilities, and ballparks. Originally developed as a TVA recreation demonstration area in the 1930s, the park is now part of the Tennessee State Parks system and is managed by the Tennessee Department of Environment and Conservation (TDEC). (TVA 2009a)



The majority of dedicated lands within a 6-mile radius are locally managed. These areas, 16 in total, are a collection of parks, campgrounds, marinas and piers, harbors, and one forest. Most of these lands are located near the town of Soddy-Daisy. The others are near the towns of Lakesite, Sale Creek, and Middle Valley ([Table 2.1-1](#)) ([Figure 2.1-5](#)).

Within the 50-mi region, there is also a mixture of federal, state, and locally managed lands ([Figure 2.1-6](#)). State and federal lands comprise approximately 88 and 37 areas, respectively ([Table 2.1-1](#)). Two federally controlled areas not listed on the table are the Trail of Tears National Historic Trail, and the Chickamauga and Chattanooga National Military Park. Located within 30 miles of the site, these expansive areas are located in multiple states. Numerous local lands lie within the 50-mile region. They are a collection of small, locally and county-maintained parks and recreational areas. Additionally, there are no Indian reservations or Native American controlled areas within the 50-mile region. ([Figure 2.1-6](#)) There was one military installation, the Volunteer Army Ammunition Plant. However, this facility, located in Hamilton County approximately 8 miles from the plant, is currently inactive and being used for recreation and industrial development. ([American Trails 2010](#); [TVA 2011p](#), Section 2.2)

**Table 2.1-1  
Federal, State, and Local<sup>(a)</sup> Lands Within a 50-Mile Radius of SQN**

Name	Management	Distance <sup>(b)</sup>	Direction	Nearest Town	County
<b>Alabama</b>					
Russell Cave National Monument	Federal	45	WSW	Bridgeport	Jackson
Raccoon Creek State Wildlife Management Area	State	48	WSW, SW	Stevenson	Jackson
Crow Creek State Wildlife Management Area	State	50	SW, WSW	Stevenson	Jackson
<b>Georgia</b>					
Sand Mountain	Federal	20	S	Ringold	Catoosa
Georgia Department of Transportation Area 105-001	State	26	SE	Cisco	Murray
Lula Lake Land Trust	State	29	SW, SSW	Chattanooga Valley	Walker
Conasauga River Natural Area	State	30	SSE	Sumac	Murray
Georgia Department of Transportation Area 155-001	State	31	SSE	Spring Place	Whitfield
Cloudland Canyon State Park	State	34	SSE	Trenton	Dade and Walker
Chief Vann House Historic Site	State	35	SSE	Spring Place	Murray
Fort Mountain State Park	State	38	SE	Chattsworth	Murray
Cohutta Wildlife Management Area	Federal	40	SE	Eton	Murray and Gilmer
Crockford-Pigeon Mountain Wildlife Management Area	State	42	SSW	Mount Carmel	Walker
Zahnd Natural Area	State	44	SSW	Rising Fawn	Walker
Resaca Battlefield State Historic Site	State	44	S	Resaca	Gordon
Coosawattee Wildlife Management Area	State	44	SSE	Ramhurst	Murray

**Table 2.1-1 (Continued)**  
**Federal, State, and Local<sup>(a)</sup> Lands Within a 50-Mile Radius of SQN**

Name	Management	Distance <sup>(b)</sup>	Direction	Nearest Town	County
John's Mountain Wildlife Management Area	State	45	S	Sugar Valley	Floyd and Walker
Johns Mountain Wildlife Management Area	Federal	47	S	Sugar Valley	Walker, Whitfield, Floyd, and Gordon
New Echota State Historic Site	State	49	SSE	Resaca	Gordon
Coosawattee Wildlife Management Area (Caters Lake Site)	Federal	49	SE, SSE	Oakman	Murray, Gilmer, and Gordon
Carters Lake	Federal	49	SE,SSE	Oakman	Murray, Gilmer, and Gordon
Chatahoochee National Forest	Federal	51	S to ESE	Cherry Log	Chattooga, Floyd, Gordon, Walker, Whitfield, Murray, Gilmer, Dawson, Fannin, Towns, Union, and Lumpkin
<b>North Carolina</b>					
Nantahala National Forest	Federal	87	E, ESE	Topton	Cherokee, Graham, Clay, and Macon
<b>Tennessee</b>					
Chigger Point TVA Habitat Protection Area	Federal (TVA)	1	E, ESE	Lakesite	Hamilton
University of Tennessee Friendship Forest	Federal (TVA)	1	ENE, NE, NNE, N	Soddy-Daisy	Hamilton

**Table 2.1-1 (Continued)**  
**Federal, State, and Local<sup>(a)</sup> Lands Within a 50-Mile Radius of SQN**

<b>Name</b>	<b>Management</b>	<b>Distance<sup>(b)</sup></b>	<b>Direction</b>	<b>Nearest Town</b>	<b>County</b>
Skull Island Campground	Local	1	NE	Soddy-Daisy	Hamilton
Harbor Lights Marina	Local	2	SW	Lakesite	Hamilton
Lakesite Marina	Local	2	WSW	Lakesite	Hamilton
Lakesite Park	Local	2	SW	Lakesite	Hamilton
Soddy Creek TVA Habitat Protection Area	Federal (TVA)	2	NNW	Soddy-Daisy	Hamilton
Shady Grove Harbor	Local	3	NNW	Soddy-Daisy	Hamilton
Ware Branch Bend TVA Habitat Protection Area	Federal (TVA)	3	N	Soddy-Daisy	Hamilton
Harrison Bay State Park	State	4	S, SSW, SW	Lakesite	Hamilton
Pine Harbor Marina	Local	4	N	Soddy-Daisy	Hamilton
Chester Frost Park	Local	4	SW	Middle Valley	Hamilton
Holly Park	Local	5	NW	Soddy-Daisy	Hamilton
Possum Creek Campground	Local	5	N	Soddy-Daisy	Hamilton
Murphy Hill TVA Habitat Protection Area	Federal (TVA)	5	NNE	Sale Creek	Hamilton
Middle Valley Recreation Park	Local	5	WSW	Middle Valley	Hamilton
Soddy-Daisy Lake Fishing Pier	Local	5	NW	Soddy-Daisy	Hamilton
Scramble Alley Park	Local	6	WNW	Soddy-Daisy	Hamilton
North End Ballpark	Local	6	NW	Soddy-Daisy	Hamilton
Soddy-Daisy Roadside Park	Local	6	NW	Soddy-Daisy	Hamilton
Poe Branch Wetland	State	7	W	Soddy-Daisy	Hamilton
Possum Creek TVA Habitat Protection Area	Federal (TVA)	7	N	Sale Creek	Hamilton
Eagle Roost TVA Habitat Protection Area	Federal (TVA)	7	NNE	Sale Creek	Hamilton

**Table 2.1-1 (Continued)**  
**Federal, State, and Local<sup>(a)</sup> Lands Within a 50-Mile Radius of SQN**

<b>Name</b>	<b>Management</b>	<b>Distance<sup>(b)</sup></b>	<b>Direction</b>	<b>Nearest Town</b>	<b>County</b>
Soddy Natural Area	State	7	NW, WNW	Soddy-Daisy	Hamilton
Fairview Slopes Protection Planning Site	Federal (TVA)	8	SW	Harrison	Hamilton
Grasshopper Creek TVA Habitat Protection Area	Federal (TVA)	8	NNE	Sale Creek	Hamilton
Three B TVA Habitat Protection Area	Federal (TVA)	8	SSW	Harrison	Hamilton
Booker T. Washington State Park	State	9	SSW	Harrison	Hamilton
North Chickamauga Creek Oak Forest Potential National Natural Area	Federal (TVA)	10	SW	Hixson	Hamilton
Possum State Park	State	10	NW, NNW	Sale Creek	Hamilton
Big Ridge Registered State Natural Area	State	11	SW	Hixson	Hamilton
Big Ridge TVA Habitat Protection Area	Federal (TVA)	11	SW	Hixson	Hamilton
Falling Water Falls	State	11	WSW	Walden	Hamilton
Middle Clemons Rock	State	13	N, NNW	Sale Creek	Hamilton
North Chickamauga Creek Gorge Natural Area	State	13	SW to WNW	Fairmount	Hamilton and Sequatchie
Audubon State Park	State	13	N	Sale Creek	Hamilton
Blythe Ferry State Wildlife Area	State	13	NNE	Graysville	Meigs
Nickajack Reservoir State Mussel Sanctuary	State	14	SW	Red Bank	Hamilton
Hiwassee Refuge State Wildlife Management Area	State	14	NE, NNE	Dayton	Meigs and Rhea
Sugar Creek State Wildlife Observation Area	State	14	NE	Hopewell	Meigs

**Table 2.1-1 (Continued)**  
**Federal, State, and Local<sup>(a)</sup> Lands Within a 50-Mile Radius of SQN**

Name	Management	Distance <sup>(b)</sup>	Direction	Nearest Town	County
Amnicola Marsh State Wildlife Refuge	State	15	SW	Chattanooga	Hamilton
Gilliland Glade/Oak Forest Potential National Natural Area	Federal (TVA)	15	ESE	East Cleveland	Bradley
Ledford Island Wildlife Management Area	State	16	ENE	Charleston	Bradley
Graysville State Park	State	16	N	Graysville	Hamilton and Rhea
Johnson Bottoms TVA Habitat Protection Area	Federal (TVA)	17	ENE	Charleston	Bradley
Williams Island State Archaeological Area	State	18	SW, WSW	Signal Mountain	Hamilton
Red Clay State Park	State	18	SSE	Cohutta	Bradley
Chickamauga State Wildlife Management Area	State	19	E to NW	Dayton	Hamilton, Bradley, McMinn, Meigs, and Rhea
Raccoon Mountain Pumped Storage State Wildlife Observation Area	State	21	SW	Lookout Mountain	Marion
Charlotte Anne Finnell Neal Wildlife Management Area	State	21	ESE	Ocoee	Bradley
Prentice Cooper State Forest & Wildlife Management Area	State	21	W, WSW, SW	Signal Mountain	Marion and Hamilton
Tennessee River Gorge	State	22	SW, WSW	Signal Mountain	Hamilton and Marion
Laurel Snow	State	23	N	Dayton	Rhea
Hicks Gap State Park	State	23	SW, WSW	Lookout Mountain	Marion
Nancy Ward Gravesite	State	24	E	Benton	Polk

**Table 2.1-1 (Continued)**  
**Federal, State, and Local<sup>(a)</sup> Lands Within a 50-Mile Radius of SQN**

Name	Management	Distance <sup>(b)</sup>	Direction	Nearest Town	County
Dry Creek Ravine	State	24	WSW	Victoria	Marion
Cummings Cove	State	26	SW	Morganville	Marion
Chimneys	State	26	W	Whitwell	Marion
Butcher Bluff TVA Habitat Protection Area	Federal (TVA)	27	NE	Decatur	Meigs
Eaves Bluff TVA Habitat Protection Area	Federal (TVA)	28	NE	Decatur	Meigs
Yuchi Wildlife Refuge	State	28	NE, NNE	Decatur	Rhea
Marion Bridge TVA Habitat Protection Area	Federal (TVA)	29	WSW	Jasper	Marion
Sequatchie Cave State Park	State	29	WSW	Victoria	Marion
Chickamauga Shoreline TVA Habitat Protection Area	Federal (TVA)	30	NE, NNE	Decatur	Meigs
Cumberland Trail State Park	State	30	WSW to NNE	Spring City	Marion, Hamilton, Rhea, Cumberland, Morgan, Campbell, and Claiborne
Harp Wetland	State	31	N	Pikeville	Bledsoe
Shellmound TVA Habitat Protection Area	Federal (TVA)	31	WSW	New Hope	Marion
Hiwassee Ocoee	State	31	E	Delano	Polk
Little Cedar Mountain TVA Small Wild Area	Federal (TVA)	31	WSW	Jasper	Marion
Piney River	State	33	N, NNE	Spring City	Rhea
Savage Gulf	State	33	WNW	Beersheba Springs	Grundy and Sequatchie
Nickajack Oak TVA Habitat Protection Area	Federal (TVA)	33	WSW	New Hope	Marion

**Table 2.1-1 (Continued)**  
**Federal, State, and Local<sup>(a)</sup> Lands Within a 50-Mile Radius of SQN**

Name	Management	Distance <sup>(b)</sup>	Direction	Nearest Town	County
Nickajack Cave State Wildlife Observation Area	State	34	WSW	New Hope	Marion
Nickajack Cave TVA Habitat Protection Area	Federal (TVA)	34	WSW	New Hope	Marion
Fall Creek Falls	State	35	NNW	Spencer	Bledsoe and Van Buren
Stinging Fork Falls State Park	State	35	NNE	Spring City	Rhea
Grundy Lakes	State	35	W	Tracy City	Grundy
Guntersville Reservoir State Mussel Sanctuary	State	35	WSW	New Hope	Marion
Bledsoe State Forest	State	36	N, NNW	Pikeville	Cumberland Bledsoe, and Van Buren
Piney Falls	State	36	NNE	Grandview	Rhea
South Cumberland	State	37	W	Tracy City	Grundy and Marion
Battle Creek	State	37	WSW	Kimball	Marion
Grundy Forest	State	37	W	Tracy City	Grundy
Devil Step Hollow	State	40	N	Grandview	Cumberland
Hubbard's Cave State Park	State	40	WNW	Beersheba Springs	Warren
William L. Davenport Refuge	State	41	ESE	Ducktown	Polk
Fourth Fractional Township Wildlife Management Area	State	42	ESE	Ducktown	Polk
Watts Bar State Wildlife Management Area	State	42	NNE	Ten Mile	Meigs
Big Mouth Cave Protection Planning Site	Federal (TVA)	42	W	Coalmont	Grundy
Ducktown Basin Museum	State	42	ESE	Ducktown	Polk



**Table 2.1-1 (Continued)**  
**Federal, State, and Local<sup>(a)</sup> Lands Within a 50-Mile Radius of SQN**

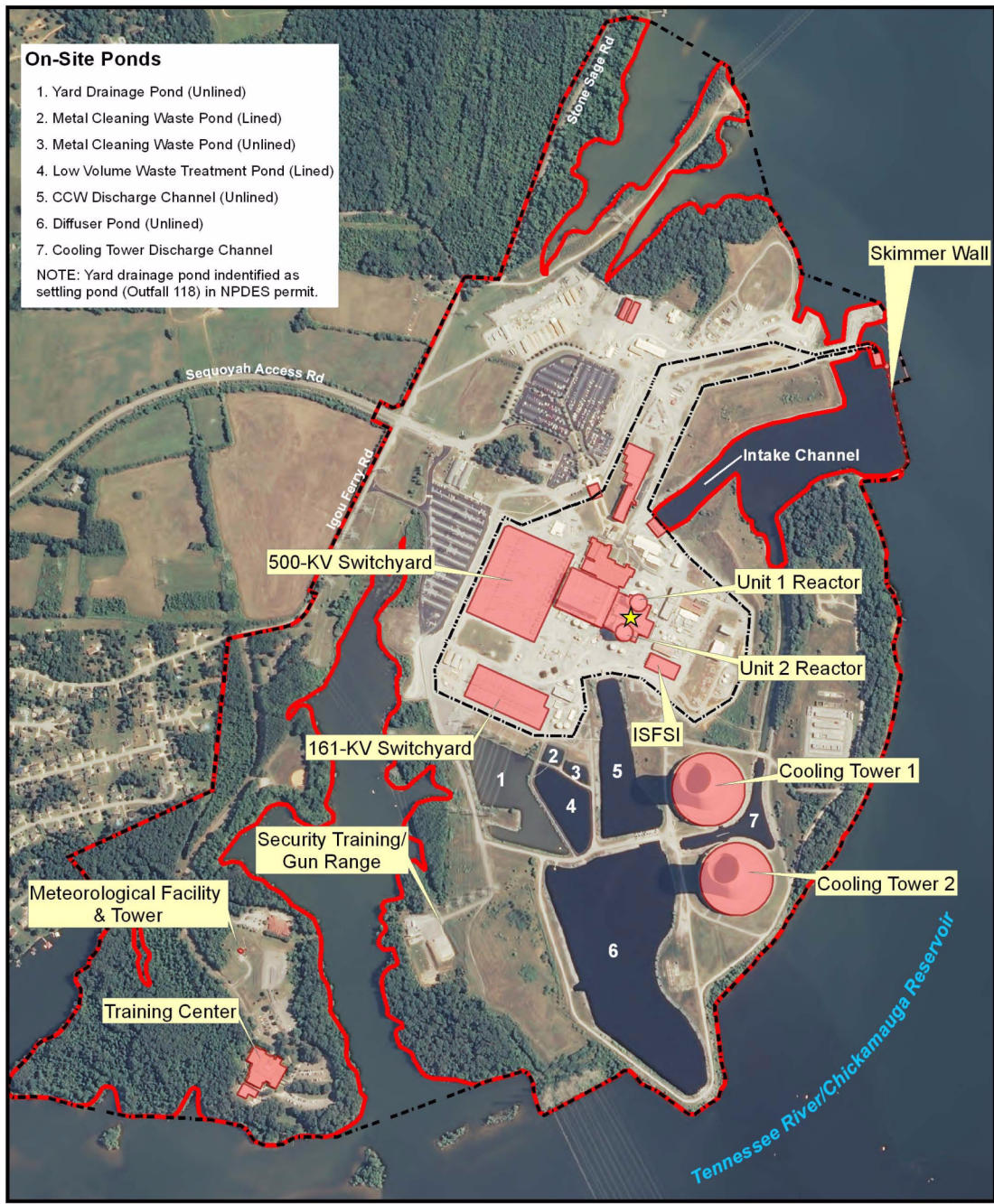
Name	Management	Distance <sup>(b)</sup>	Direction	Nearest Town	County
Bridgestone/Firestone Wildlife Management Area	State	42	N, NNW	Bon Air	Van Buren and White
Centennial Wilderness	State	43	NNW	Bon Air	Van Buren and White
Plateau Properties	State	43	N	Crab Orchard	Cumberland
Whites Creek	State	44	NNE	Westel	Rhea
Goose Pond Protection Planning Site	Federal (TVA)	44	W	Monteagle	Grundy
Trussle Cave Protection Planning Site	Federal (TVA)	44	W	Monteagle	Grundy
Franklin State Forest	State	44	W, WSW	Sherwood	Franklin and Marion
Virgin Falls	State	44	NNW	Bon Air	White
Bone Cave State Park	State	46	NW	Quebeck	Van Buren
Braswell	State	46	W	Sherwood	Franklin
Cumberland Mountain	State	47	N	Crossville	Cumberland
Bluebell Island Registered State Natural Area	State	47	W	Monteagle	Franklin
Mr. and Mrs. Harry Lee Carter Natural Area	State	47	W	Sherwood	Franklin
Natural Bridge State Park	State	47	W	Sewanee	Franklin
Ozone Falls State Park	State	48	NNE	Ozone	Cumberland
Hawkins Cove	State	49	W	Cowan	Franklin
Mt. Roosevelt Wildlife Management Area	State	51	NNE	Rockwood	Roana, Cumberland, and Morgan
Rock Island State Park	State	51	NW	Campaign	Warren and White
Bear Hollow	State	52	W	Cowan	Franklin

**Table 2.1-1 (Continued)**  
**Federal, State, and Local<sup>(a)</sup> Lands Within a 50-Mile Radius of SQN**

Name	Management	Distance <sup>(b)</sup>	Direction	Nearest Town	County
Woods Reservoir Reservation	State	54	W	Estill Springs	Coffee and Franklin
Tellico Lake	State	56	ENE	Vonore	Monroe and Loudon
AEDC and Woods State Wildlife Management Area	State	57	W	Hillsboro	Coffee and Franklin
Cherokee National Forest	Federal	110	SE to ENE	Hartford	Polk and Monroe

(CHCRPA 2005a; GAGIS 2009; National Atlas 2005; NPS 2010a; TDEC 2009; TNSP 2010; TSDS 2009; TVA 2011b; USDOT 2010; USGS 2009a)

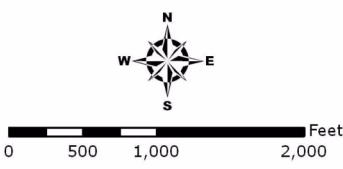
- a. Only locally operated lands within a 6-mile radius are included in the table. A complete record of local lands, and their geographic location, within a 50-mile radius was unavailable.
- b. Distances are approximate (rounded to nearest whole number) and based on SQN and land centroid data. Therefore, although the distances for some of the state and federal lands shown in this table are greater than 50 miles, the nearest property boundary for these lands are within 50 miles.



- On-Site Ponds**
1. Yard Drainage Pond (Unlined)
  2. Metal Cleaning Waste Pond (Lined)
  3. Metal Cleaning Waste Pond (Unlined)
  4. Low Volume Waste Treatment Pond (Lined)
  5. CCW Discharge Channel (Unlined)
  6. Diffuser Pond (Unlined)
  7. Cooling Tower Discharge Channel
- NOTE: Yard drainage pond identified as settling pond (Outfall 118) in NPDES permit.

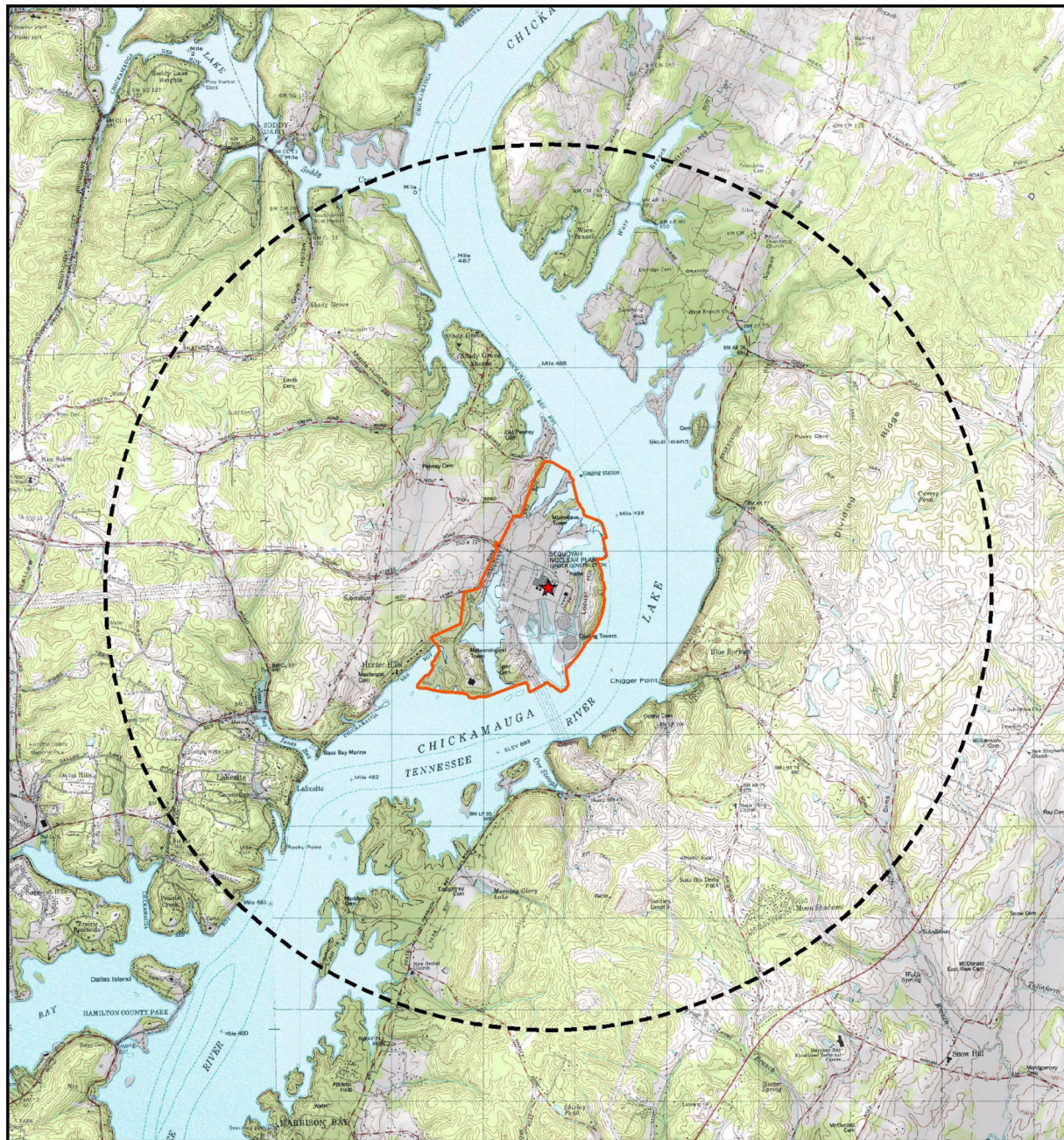
(USDA 2008)

- Legend**
- ★ Site Center
  - - - Protected Area
  - Site Features
  - Site
  - - - Exclusion Area Boundary (EAB)



**Figure 2.1-1**  
**SQN Site Boundary and Aerial Site Layout**

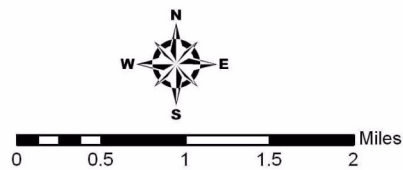




(USGS 2009b)

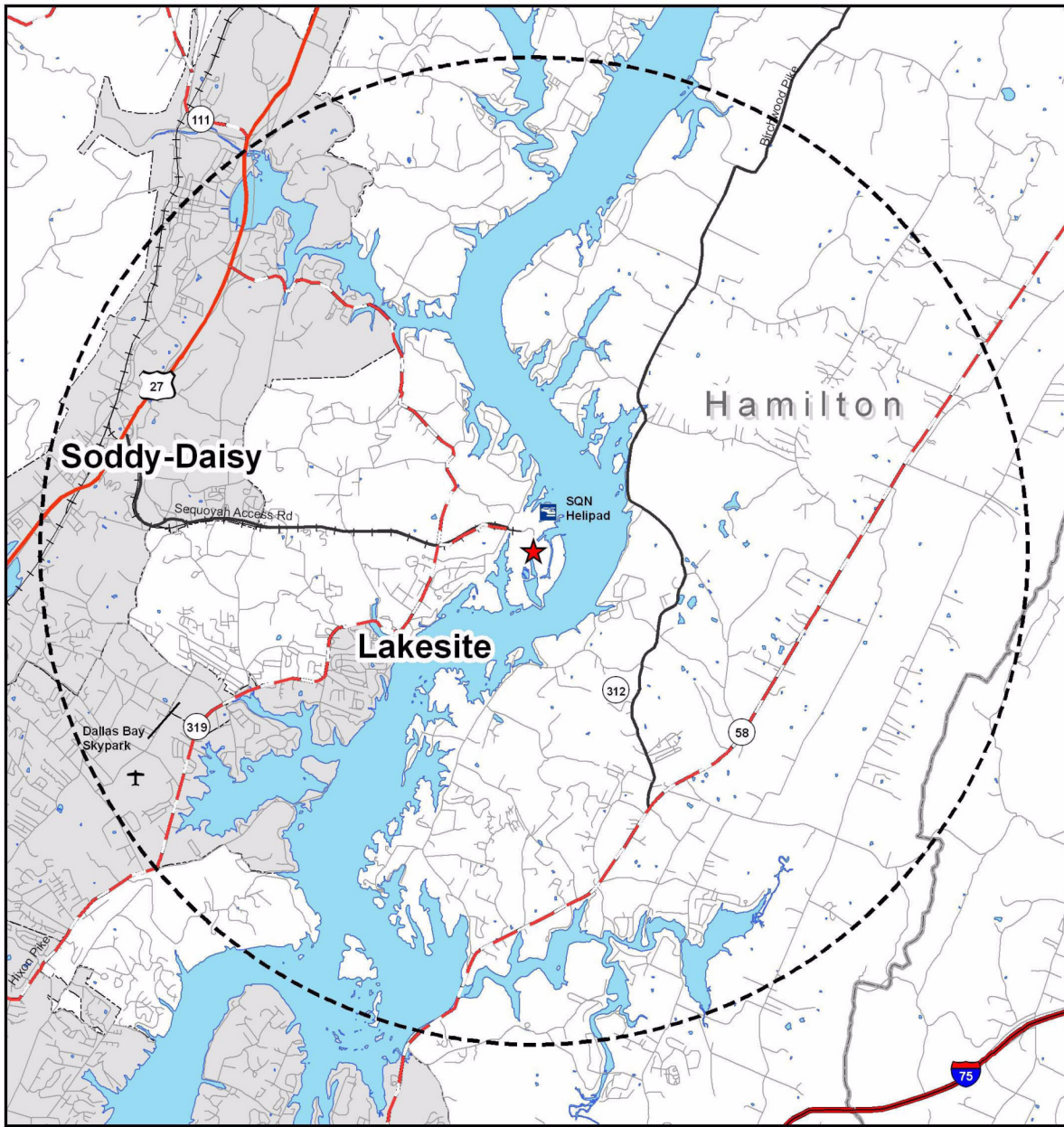
**Legend**

- ★ Sequoyah Site
- SQN Exclusion Area Boundary (EAB)
- ⊞ LPZ - 3 mile Radius



**Figure 2.1-2**  
**SQN Exclusion Area Boundary and Area Topography**

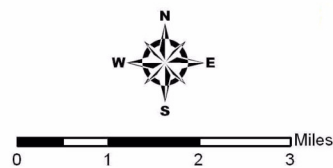




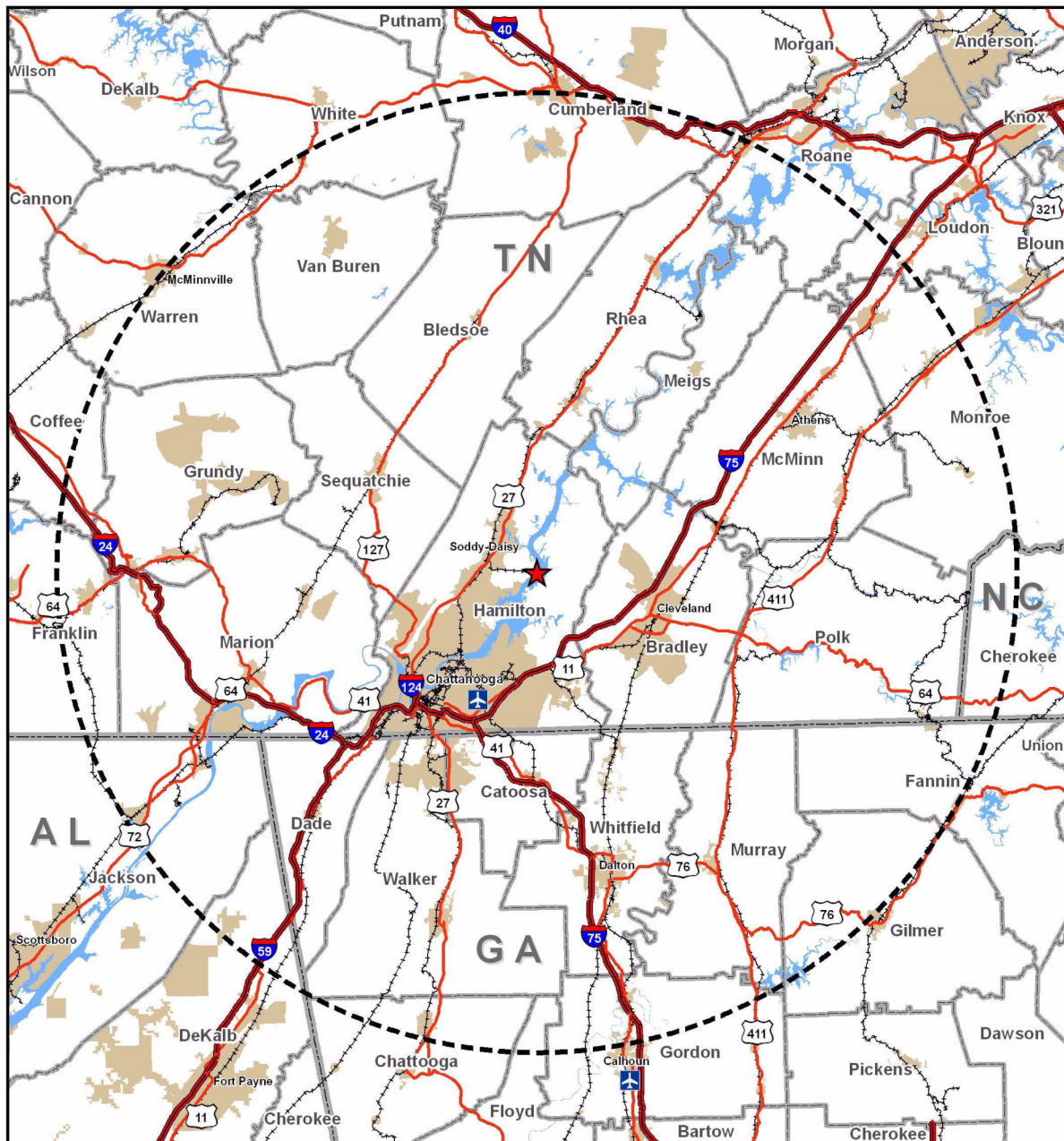
(USCB 2010c; USDOT 2008; USGS 2010a)

**Legend**

- ★ Site Center
- ✈ Heliport
- ⊥ Small Airport/Airfield
- ⊞ 6-Mile Radius
- ▭ Municipalities
- ▭ County
- ☪ Surface Water
- ⚡ Railroad
- ⚡ Interstate
- ⚡ U.S. Route
- ⚡ State Highway
- ⚡ Roads



**Figure 2.1-3**  
**SQN Site and 6-Mile Radius**



(USCB 2010c; USDOT 2008; USGS 2010a)

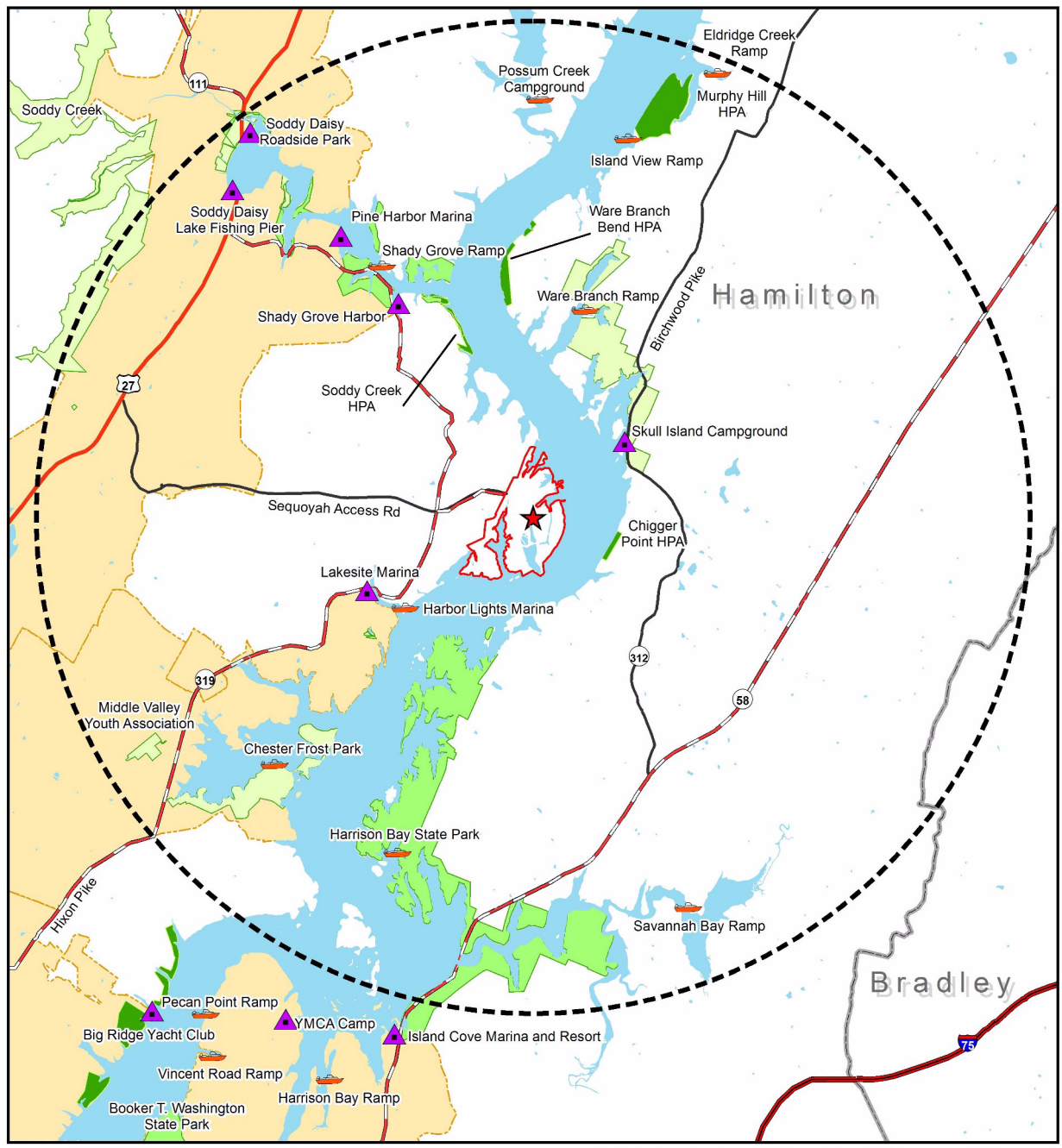
**Legend**

- ★ Site Center
- ✈ Airport
- ⬢ 50-Mile Radius
- Surface Water
- Cities & Towns
- County
- State
- Interstate
- U.S. Route
- Railway



**Figure 2.1-4**  
**SQN Site and 50-Mile Radius**

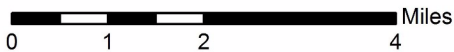




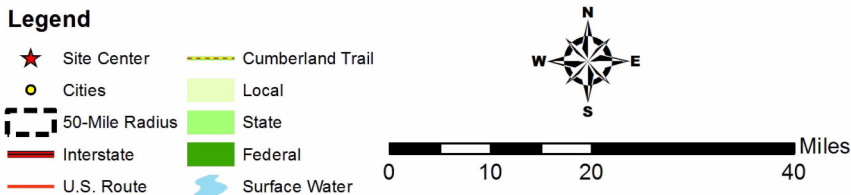
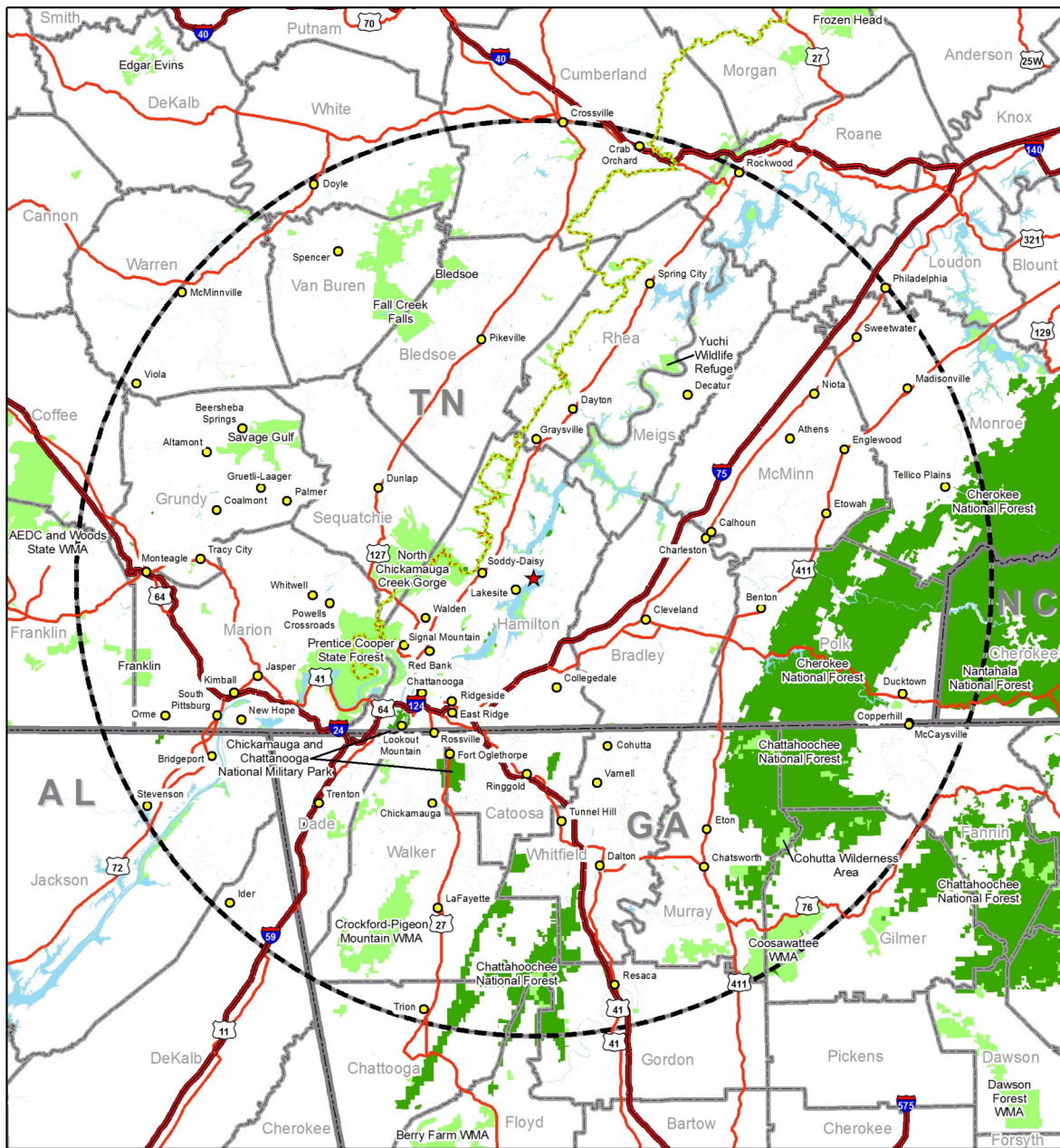
(ESRI 2005; TVA 2011b; USCB 2008; USDOT 2008; USGS 2010a)

**Legend**

- ★ Site Center
- ▲ Recreation Entrance
- 🚤 Boat Ramp
- ⊖ 6-Mile Radius
- 🏘 Cities and Towns
- Site
- 🌿 Local
- 🌳 State
- 🌲 Federal



**Figure 2.1-5  
 Federal, State, and Local Lands Within a 6-Mile Radius of SQN**



(CHCRPA 2005a; ESRI 2005; GAGIS 2009; National Atlas 2005; TDEC 2009; TVA 2011b; USDA 2008; USDOT 2010; USGS 2000a)

**Figure 2.1-6**  
**Federal, State, and Local Lands Within a 50-Mile Radius of SQN**