CHAPTER 3

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

SQN has been the subject of several environmental reviews. The environmental consequences of constructing and operating SQN were addressed comprehensively in TVA's 1974 FES (TVA 1974a). Subsequent environmental reviews have updated that original analysis (Section 1.4). This chapter updates the information contained in those earlier reviews, and identifies any new or additional effects that could result from the continued operation of SQN during the period of license renewal. The potential environmental impacts of SQN license renewal and alternatives are addressed.

3.1. Surface Water Resources

The dominant water requirement at most nuclear power plants is cooling water, which in most cases is obtained from surface water bodies. For this reason, most power plants are located near suitable supplies of surface water, such as rivers, reservoirs, or lakes. Because of the interaction between power plants and surface water, issues may arise in terms of both usage and quality. A summary of the surface water hydrology and water quality for SQN, including a discussion about alternatives and their impacts, is presented in this subsection.

3.1.1. Surface Water Hydrology and Water Quality

The Tennessee River system is regulated by a series of 49 active dams and reservoirs managed by TVA (Figure 3-1). TVA operates the Tennessee River system to provide year-round navigation, flood-damage reduction, power generation, improved water quality, water supply, recreation, and economic growth. (Bohac and McCall, 2008)

3.1.1.1. Affected Environment

<u>Surface Water Hydrology</u>

Chickamauga Reservoir, an impoundment of the Tennessee River, extends approximately 59 river miles from Watts Bar Dam in southern Tennessee (TRM 529.9) to Chickamauga Dam in southeast Tennessee (TRM 471). Chickamauga Reservoir has a drainage area of 20,790 sq mi. The reservoir has a shoreline length of 784 miles, a volume of 628,000 acre-feet, and a surface water area of 35,400 acres at normal maximum pool elevation of 682.5 feet msl. The width of the reservoir ranges from 700 feet to 1.7 miles. (TVA 1974a) Average flow of Tennessee River at the Chickamauga Dam is approximately 32,300 cfs (Paul Hopping, TVA, personal communication, July 14, 2010).

Consistent with the TVA Act of 1933, Chickamauga Dam and Reservoir are operated for flood protection, navigation, and power production, as well as for aquatic resources, water supply, and recreation. During normal operations, the surface elevation of Chickamauga Reservoir varies between 676 feet msl in winter and 682.5 feet msl in summer. This variation provides a total fluctuation of 6.5 feet between normal minimum pool in the winter and maximum pool in the summer (TVA 2010e). During high-flow periods, the top of the normal operating elevation range may be exceeded to regulate flood flows. From mid-May

to mid-September, TVA varies the elevation of Chickamauga Reservoir by as much as 1 foot to aid in mosquito population control (TVA 2010f).

SQN is located on the western shore of Chickamauga Reservoir at TRM 484.5 (Figures 1-2 and 1-3). TVA's WBN is also located on Chickamauga Reservoir, approximately 31 miles north-northwest of TVA's SQN. (TVA 2008a)

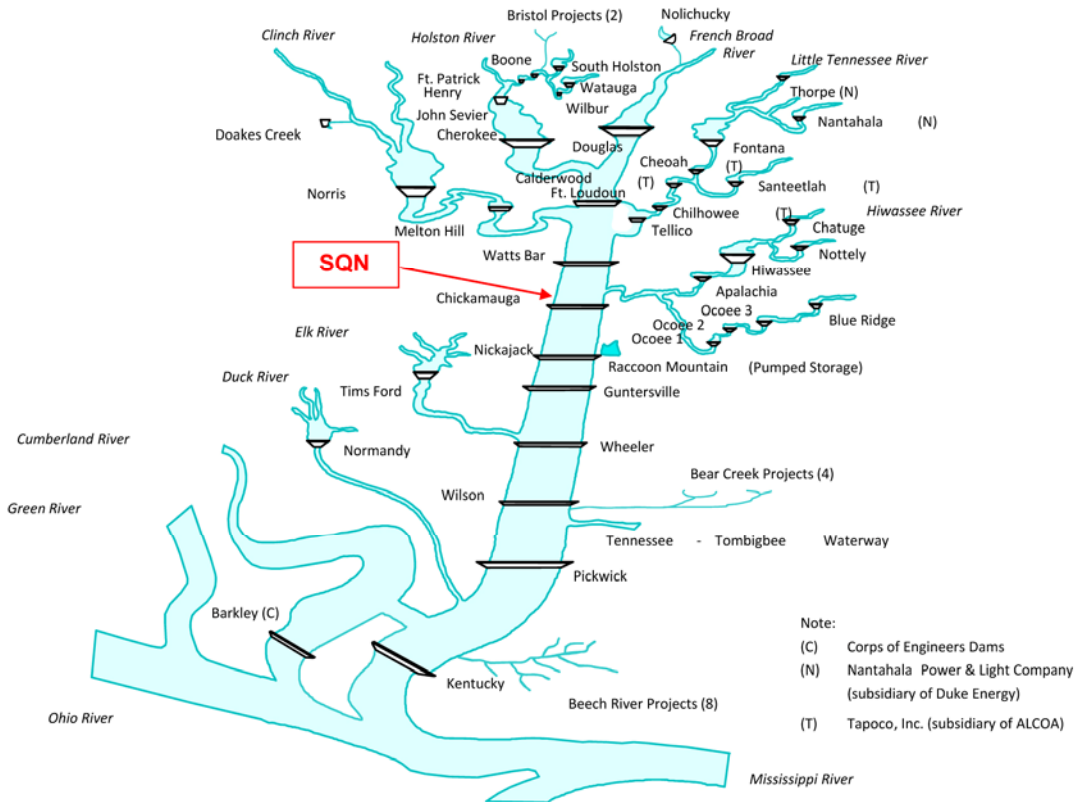

Figure 3-1. TVA Water Control System

Water Quality

The State of Tennessee has designated the reach (river segment of a specific length) of the Tennessee River in the vicinity of SQN for domestic and industrial water supply, fish and aquatic life, recreation, livestock watering, irrigation, and navigation use classifications.

Section 303(d) of the Clean Water Act

The State of Tennessee also assesses the water quality of streams and (biannually) develops a draft 303(d) list for impaired waterbodies. Under Section 303(d) of the 1972 Clean Water Act (CWA), states, territories, and authorized tribes are required to develop lists of impaired waters. These are waters that do not meet water quality standards. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop total maximum daily loads (TMDLs) for these waters.

While Chickamauga Reservoir is not listed on the TDEC 2008, or draft 2010, 303(d) lists for impaired waters, upstream from SQN an unnamed tributary to the Chickamauga Reservoir (between TRM 480 and 481) and the Hiwassee River embayment (TRM 499) are identified on both 303(d) lists (TDEC 2010a). Table 3-1 presents the impairment information from the draft 2010 303(d) list.

The CWA requires that Congress receive a biennial accounting of the water quality for each state. The Tennessee Water Quality Control Act also requires a report on water quality. The TDEC Division of Water Pollution Control (WPC) has primary responsibility for assessment and reporting of the quality of surface waters. Chickamauga Reservoir and the Hiwassee River (tributary) were fully supportive according to the most recent 305(b) report submitted in 2008. The Watts Bar Reservoir (upstream) is considered impaired due to polychlorinated biphenyls (PCB) accumulation in fish tissue. The Nickajack Reservoir (downstream) is only partially supportive due to PCBs and dioxins. (TDEC 2008)

Table 3-1. TDEC Draft 2010 303(d) List of Impaired Tributaries to Chickamauga Reservoir*

Waterbody ID	Impacted Waterbody	County	Cause/TMDL Priority	Pollution Source
TN060200002 008 – 1000	Hiwassee River embayment of Chickamauga Reservoir	Bradley, McMinn	Escherichia coli – NA Mercury – L	Undetermined source. Industrial point source atmospheric disposition.
TN060200002 008 – 2000	Hiwassee River embayment of Chickamauga Reservoir	Bradley, McMinn	Mercury – L	Industrial point source atmospheric disposition.
TN060200001 479 – 1000	Unnamed tributary to Chickamauga Reservoir	Hamilton	Biological integrity loss due to undetermined cause – M	Undetermined source.
TN060200002 001 – 2000	Hiwassee River embayment of Chickamauga Reservoir	Meigs, McMinn, Bradley	Mercury – L	Industrial point source atmospheric disposition.

NA – Not Applicable
L – Low TMDL Priority
M – Moderate TMDL Priority
*Additional information is available in the TDEC draft 2010 303(d) list (TDEC 2010a).

TVA Monitoring Program

TVA has conducted its vital signs monitoring program on Chickamauga Reservoir in alternate years since 1994. The vital signs program uses five metrics to evaluate the ecological health of TVA reservoirs: chlorophyll concentration, fish community health, bottom life, sediment contamination, and dissolved oxygen. Values of good, fair, or poor are assigned to each metric. Scores from monitoring sites in the deep, still area near the Chickamauga Dam (forebay, TRM 472.3), mid-reservoir (TRM 490.5), the Hiwassee River embayment (Hiwassee River mile [HiRM] 8.5), and at the upstream end of the reservoir

(inflow, TRM 518 and 529) are combined for a summary score. The data from these sites characterize the Chickamauga Reservoir's biological conditions and water quality near the SQN site. (TVA 2010g)

Based on the metric evaluation, the overall ecological health condition of Chickamauga Reservoir rated good in 2009 (Figure 3-2). Chickamauga's ecological health scores were good in previous years that were monitored, except for 2007 when Chickamauga rated fair. In 2007, three indicators (dissolved oxygen, chlorophyll, and bottom life) were either at the low end of their historic range or lower than in previous years. The lower ratings were largely due to low reservoir flows in 2007, which was the driest year in 118 years of record. Ecological health scores tend to be lower in most Tennessee River reservoirs during years with low flows, because chlorophyll concentrations are typically higher and dissolved oxygen (DO) levels are lower. (TVA 2010g)

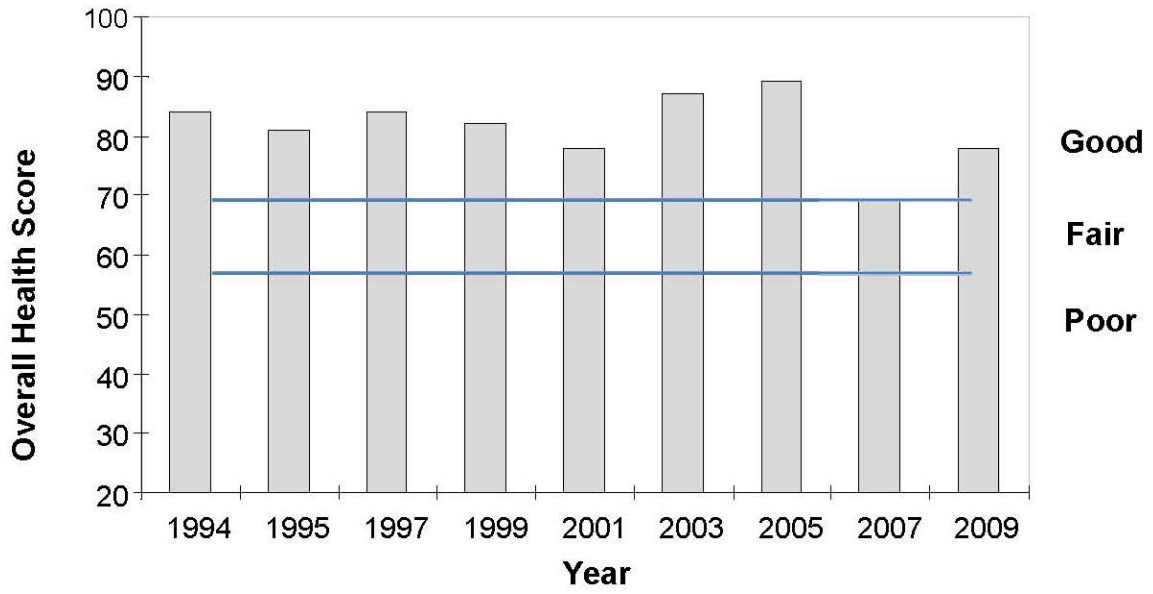

Figure 3-2. Chickamauga Reservoir Ecological Health Ratings, 1994 – 2009

In 2009, the five individual metrics scored good or fair at all sites except for chlorophyll in the forebay and mid-reservoir stations, which rated poor (Table 3-2). These metrics are briefly explained in the paragraphs that follow. (TVA 2010g)

Reservoir Ecological Health Indicators

Dissolved Oxygen

DO levels typically rate good at all monitoring locations (Table 3-2) except during extremely dry, low-flow years such as 2007, which can result in the development of low DO near the bottom and fair ratings.

Table 3-2. Ecological Health Indicators for Chickamauga Reservoir, 2009

Monitoring Locations	Dissolved Oxygen	Chlorophyll	Fish	Bottom Life	Sediment
Forebay	Good	Poor	Fair	Fair	Good
Mid-reservoir	Good	Poor	Fair	Good	Good
Hiwassee River embayment	Good	Good	Fair	Fair	Good
Inflow	*	*	Fair	Good	*

*Not measured at inflow station (TVA 2010g).

Chlorophyll

Chlorophyll ratings have fluctuated between good, fair, and poor at each location, generally in response to reservoir flow conditions. Annual average concentrations indicate a trend of increasing chlorophyll concentrations at the forebay and mid-reservoir, with lower concentrations at the Hiwassee River embayment monitoring location. Elevated concentrations of chlorophyll in the majority of the samples collected at the forebay and mid-reservoir monitoring locations gave those locations a poor rating, while hlorophyll concentrations at the Hiwassee River embayment monitoring location have consistently rated good.

Fish Health

The fish community rated at the high end of the fair range at all monitoring locations. The fish community typically rates good or at the high end of the fair range as it did in 2009.

Bottom Life

Bottom life rated fair at the forebay and Hiwassee River embayment locations and good at the mid-reservoir and inflow locations. Bottom life typically rates between good and fair at each monitoring location. However, bottom life rated at the low end of the fair range at the forebay in 2007, which is lower than in previous years, and poor at the embayment location, because the overall abundance and diversity of animals was lower. The lower rating was likely the result of the low DO conditions that developed along the reservoir bottom in 2007.

Sediment

Sediment quality rated good at all monitoring locations because no PCBs or pesticides were detected, and all metal concentrations were within the expected range. Elevated concentrations of PCBs and selected metals (generally zinc and copper) have been detected in sediment samples from the forebay and Hiwassee River embayment monitoring locations in some previous years.

Fish Consumption Advisories

No fish consumption advisories exist for Chickamauga Reservoir. (TVA 2010g)

Thermophilic Microorganisms

Some thermophilic (heat adapted) microorganisms are pathogens and have potential to affect public health. The plant discharges into a reservoir system, so it is necessary to determine whether discharge characteristics promote survival and reproduction of pathogenic thermophilic microorganisms. Organisms of concern include enteric pathogens *salmonella* and *shigella*, the Pseudomonas *aeruginosa* bacterium, thermophilic *Actinomycetes* (fungi), the many species of *Legionella* bacteria, and pathogenic strains of the free-living *Naegleria* amoeba. (NRC 1996)

Bacteria pathogenic to humans usually thrive at temperatures above 50ºC and are ubiquitous in the environment. During the summer months when SQN ambient temperatures in Chickamauga Reservoir are the warmest, the current NPDES permit specifies that the 24-hour downstream temperature shall not exceed 30.5ºC (86.9ºF), except in cases when the 24-hour ambient temperature exceeds 29.4ºC (84.9ºF). In these cases, the 24-hour downstream temperature can exceed 30.5ºC (86.9ºF) if there are a sufficient number of cooling tower lift pumps in service, but in such situations, the hourly average downstream temperature shall not exceed 33.9ºC (93.0ºF). Impacts to public health from thermophilic microorganisms are not expected.

3.1.1.2. Environmental Consequences

Alternative 1 – License Renewal

For this alternative, there would be no major construction activity. Current plant water withdrawal and discharge water quality would remain the same during the license renewal period. As presented in Subsection 3.1.4.1, treatment chemicals are largely consumed or diluted, leaving very small concentrations by the time they are discharged. The SQN NPDES permit would assure continued compliance with applicable water quality standards and criteria. Therefore, there would be no change in impact from the current level of minor impact.

Alternative 2 – No Action Alternative

Under the No Action Alternative, water quality impacts would be limited to those associated with SQN shutting down, and discharges would be controlled under an NPDES permit associated with discharges for these activities. Given the need for adequate replacement power generation, water quality impacts have been evaluated for the two potential alternatives for replacement power.

Alternative 2a – New Nuclear Generation

For a replacement reactor at an alternate site, new intake and discharge structures would need to be constructed to provide water needs for the facility. The impact would depend on the volume of water withdrawn for makeup, relative to the amount available from the intake source. The characteristics of the surface water impacts would be expected to be minor, because they would be controlled under an NPDES permit that would be regulated by the state in which the plant is located. There is a potential that some erosion and sedimentation may occur during construction; however, construction would be temporary, and the implementation of best management practices (BMP) should limit any potential

impacts to surface water quality. No cumulative construction impacts are anticipated; however, potential cumulative impacts should be evaluated prior to construction activities.

If Alternative 2a is constructed and operated, SQN would be shut down. Under Alternative 2a, water quality impacts for the new nuclear plant, depending on the technology chosen and the location, would be bounded by the current discharge at SQN. If the source of water for the new nuclear power plant were different than the source for SQN, the impact of shutting down SQN might reduce the effects on the Tennessee River system, but would transfer impacts to the other waterbody. Potential impacts to water quality would be evaluated prior to licensing a new plant. In addition, maintaining compliance with the plant's NPDES permit would limit potential impacts.

Alternative 2b – New Natural Gas-Fired Generation

Cooling water at an alternate site would likely be withdrawn from a surface waterbody and its discharge would be regulated by permit. Depending on the water source, the impacts on water quality caused by plant discharge could have noticeable impacts. The impacts of a new gas-fired plant utilizing a closed-cycle cooling system at an alternate site are considered minor, because the plant would have to maintain compliance with the plant's NPDES permit. Potential impacts, including cumulative impacts to water quality, would depend on where the plant was located and would be evaluated during the permit process for a new plant.

Water quality impact from sedimentation during construction is categorized as minor. Operation water quality impacts would be similar to, or less than, those from other centralized generating technologies. Surface water impacts would remain minor. (NRC 1996)

3.1.2. Surface Water Uses and Trends

In 2004, the U.S. Geological Survey (USGS) in cooperation with TVA published a report on water use in the Tennessee River watershed based on the year 2000 water use data. Because of the importance of water supply planning, a new updated report, published in 2008, *Water Use in the Tennessee Valley for 2005 and Projected Use in 2030* was prepared based on 2005 data. These data were used by TVA in the development of a new reservoir operating policy and to identify potential areas of water supply concerns throughout the watershed. (Bohac and McCall, 2008)

For the 2008 report, offstream water use in the Tennessee River watershed was estimated for 2005. Water use was categorized as thermoelectric power, industrial, public supply, and irrigation. Water use was then summarized by category. These summary categories are source of water (surface water or groundwater) and location of withdrawal (state, county, hydrologic unit code, and reservoir catchment area). Water returns to the watershed were used to estimate consumptive use. A projection of water use for 2030 was also analyzed. (Bohac and McCall 2008)

Total water withdrawals during 2005 were estimated to average 12,437 MGD of freshwater for offstream uses. The return flow was estimated to be 12,005 MGD or 96.5 percent of the water withdrawn. Consumptive use accounts for the other 3.5 percent of total withdrawals or 432 MGD. (Bohac and McCall 2008)

Out of the 12,437 MGD of water withdrawn from the Tennessee River system, thermoelectric power withdrawals were an estimated 10,531 MGD (84.7 percent of total withdrawals) with a consumptive use of 33 MGD; industrial, 1,179 MGD (9.5 percent of total withdrawals) with a consumptive use of 82 MGD; public supply, 684 MGD (5.5 percent of total withdrawals) with a consumptive use of 273 MGD; and irrigation, 43 MGD (less than 1 percent of total withdrawals) with a consumptive use of 43 MGD (Bohac and McCall 2008).

By 2030, total water withdrawals are projected to decline about 7 percent to 11,551 MGD. By category, water withdrawals are projected to increase as follows: industrial increases 10 percent to 1,300 MGD, public supply increases 32 percent to 905 MGD, and irrigation increases 65 percent to 71 MGD. Thermoelectric water consumptive water use was 33 MGD in 2005. Thermoelectric water withdrawal is expected to decline by 12 percent to 9,275 MGD, reflecting a change in cooling technology for power plants. (Bohac and McCall 2008)

3.1.2.1. Affected Environment

Consumptive and offstream water uses have not resulted in significant use conflicts due to the large volume of reservoir water available, the high river flow rate, and the return of most of the water withdrawn. Total offstream surface water use for Chickamauga Reservoir in 2005 had a withdrawal rate of approximately 1,577 MGD and total return flow of approximately 1,713 MGD that resulted in a positive net water consumption of approximately 136 MGD. (Bohac and McCall 2008) The reason for the positive net water consumption is that WBN withdraws cooling water from Watts Bar Reservoir then discharges to Chickamauga Reservoir.

In addition, regulatory control of withdrawal rates and NPDES permit limits for return water quality also mitigate potential conflicts. Potential trade-offs can occur with instream water uses (e.g., instream use conflicts affect aquatic life, waste assimilation, navigation, power generation, flood control, and lake levels). These potential conflicts are addressed by historic operating procedures, legal requirements, and regulatory procedures. As indicated in Table 3-3, SQN water intake is one of 21 surface water withdrawals within Chickamauga watershed for the Watts Bar, Chickamauga, and Nickajack reservoir catchment areas.

Using open cycle cooling operations for the majority of the year, SQN surface water withdrawals within the Chickamauga Reservoir catchment area in 2005 averaged 1,539.3 MGD (John Higgins, TVA personal communication, March 22, 2010), or approximately 7 percent of the average flow through Chickamauga Reservoir (TVA 2008a). The total return flow in 2005 was 1,539.2 MGD; thus, the net consumptive use was approximately 0.1 MGD. Table 3-3 identifies the Chickamauga watershed water users, the supply source, actual water demands in 2005, and future projections for 2030.

Plant water, except for potable water and fire suppression water, is withdrawn from the Chickamauga Reservoir via the CCW intake pumping station and the ERCW pumping station. Potable water is supplied by the Hixson Utility District (TVA 2008a). Sanitary sewage collected on site is pumped off site to the Moccasin Bend sewage treatment system.

An intake channel of approximately 1,650 feet (GIS Division, ENERCON, personal communication, May 17, 2010) connects Chickamauga Reservoir with the SQN CCW intake pumping station (Figure 3-3). The CCW station has six intake openings about 15 feet wide and 23.5 feet high (TVA 1974a). A skimmer wall is located along the reservoir

shoreline to protect the intake channel from floating debris. The CCW pumping station is further protected by a trash rack and traveling screen for each of the intake openings (TVA 1974a).

The ERCW pumping station is located at the upstream end of the intake skimmer wall, and has direct communication with the main river channel for all reservoir levels including loss of downstream dam. The ERCW station and all equipment therein remain operable during the probable maximum flood. The system also has the ability to remain operational during flood and loss of downstream dams. The average ERCW supply header water temperature maximum is less than or equal to 87°F. (TVA 2008a)

The intake conduits that deliver cooling water to the plant and the discharge conduit that returns cooling water to Chickamauga Reservoir are shown in Figure 3-3. When the NPDES river temperature limits are not threatened, SQN operates in a once-through, or open, mode of cooling. In open mode, the loss of cooling water is insignificant, so that the water returned to Chickamauga Reservoir by the plant is essentially the same as that withdrawn by the plant (Table 3-4). For the combined operation of SQN Units 1 and 2 in open mode, the withdrawal and discharge of cooling water by the plant is roughly 7 percent of the average flow through the Chickamauga Reservoir. (TVA 2008a)

During a thermally sensitive period when the water temperature in Chickamauga Reservoir approaches an NPDES limit, the plant will operate in helper mode (cooling towers are put into service). In helper mode, the cooling water is treated by the cooling towers before it is returned to the river. In this mode of operation, loss of cooling water occurs due to evaporation and drift from the cooling towers. The amount of loss depends on a number of factors, such as the amount and temperature of flow delivered to the cooling towers and meteorology. In general, however, the amount of loss in helper mode operation is at most about 37 MGD (the maximum evaporation and drift for each tower is less than 13,000 gpm). (TVA 1974b) This represents a loss of cooling water of less than 0.2 percent of the average annual flow through Chickamauga Reservoir (TVA 2008a).

The withdrawal of cooling water from the Chickamauga Reservoir varies with the number of CCW and ERCW pumps in service. Pumps are removed from service during plant outages and equipment outages. With six CCW pumps in operation at approximately 187,000 gpm each and four ERCW pumps in operation at approximately 11,000 gpm each (TVA 2008a), the maximum withdrawal from the Chickamauga Reservoir is 1,679 MGD.

Table 3-3. Surface Water Withdrawals and Returns in Chickamauga Watershed

Facility Name	Use Type	County	State	TRM[1]	Source/Receiving Body	Total Distance from SQN (river miles)*	Transaction Type	2005 Rate (MGD)	2030 Rate (MGD)
Watts Bar Nuclear Plant – 2 Intakes	TH	Rhea	TN	529.9 & 528.0	Tennessee River	45.4 U & 43.4 U	WD	181.19	249.04[2,3]
Watts Bar Nuclear – 3 Discharge Locations	TH	Rhea	TN	529.2, 527.9 & 527.2	Tennessee River	44.7 U & 43.5 U	RT	173.86	206.65[2,3]
Decatur Sewage Treatment Plant	WW	Meigs	TN	514.8	Tennessee River	30.3 U	RT	0.257	0.452
Dayton Sewage Treatment Plant	WW	Rhea	TN	504.5	Richland Creek embayment	23.8 U	RT	1.665	2.178
Dayton Water Department	PS	Rhea	TN	504.0	Tennessee River	19.5 U	WD	2.507	3.279
Calhoun-Charleston Utility District	PS	McMinn	TN	499.4	Hiwassee River	33.9 U	WD	0.212	0.250
Athens Utility Board-North Mouse Creek Sewage Treatment Plant	WW	McMinn	TN	499.4	North Mouse Creek	53.1 U	RT	0.835	0.988
Athens Utility Board-Oostanaula Creek Sewage Treatment Plant	WW	McMinn	TN	499.4	Oostanaula Creek	65.1 U	RT	2.399	2.840
Benton Sewage Treatment Plant	WW	Polk	TN	499.4	Four Mile Creek	52.1 U	RT	0.037	0.044
Bowater Inc. Southern Division	IN	McMinn	TN	499.4	Hiwassee River	32.9 U	RT	0.510	0.647

Facility Name	Use Type	County	State	TRM[1]	Source/Receiving Body	Total Distance from SQN (river miles)*	Transaction Type	2005 Rate (MGD)	2030 Rate (MGD)
Bowater Inc. Southern Division	IN	McMinn	TN	499.4	Hiwassee River	32.9 U	RT	42.283	53.621
Bowater Inc. Southern Division	IN	McMinn	TN	499.4	Hiwassee River	32.9 U	RT	27.651	35.065
Bowater Newsprint	IN	McMinn	TN	499.4	Hiwassee River	32.9 U	WD	30.880	39.160
Bowater Newsprint	IN	McMinn	TN	499.4	Hiwassee River	32.9 U	WD	39.150	49.648
Cleveland Utilities	PS	Bradley	TN	499.4	Hiwassee River	37.9 U	WD	6.453	8.351
Cleveland Utilities Sewage Treatment Plant	WW	Bradley	TN	499.4	Hiwassee River	31.4 U	RT	8.920	11.544
Englewood Sewage Treatment Plant	WW	McMinn	TN	499.4	Chestuee Creek	90.3 U	RT	0.146	0.173
Etowah Sewage Treatment Plant	WW	McMinn	TN	499.4	Conasauga Creek	61.4 U	RT	1.061	1.255
Hiwassee Utility Commission	PS	Bradley	TN	499.4	Hiwassee River	37.9 U	WD	3.725	4.821
J.M. Huber Corporation Etowah	IN	McMinn	TN	499.4	Conasauga Creek	64.1 U	RT	0.745	0.944
John Manville Corporation	IN	McMinn	TN	499.4	Crockett Spring Creek	69.8 U	RT	0.082	0.104
Niota Waste Water Treatment Plant	WW	McMinn	TN	499.4	Little North Mouse Creek	62.9 U	RT	0.221	0.262

Facility Name	Use Type	County	State	TRM[1]	Source/Receiving Body	Total Distance from SQN (river miles)*	Transaction Type	2005 Rate (MGD)	2030 Rate (MGD)
Olin Chemicals Corporation	IN	Bradley	TN	499.4	Hiwassee River	31.9 U	RT	1.070	1.445
Olin Chemicals Corporation	IN	Bradley	TN	499.4	Hiwassee River	31.9 U	RT	2.602	3.513
Olin Chemicals Corporation	IN	Bradley	TN	499.4	Hiwassee River	31.9 U	RT	1.922	2.594
Olin Corporation	IN	Bradley	TN	499.4	Hiwassee River	31.9 U	WD	3.926	5.301
Soddy-Daisy Falling Water Utility District (est 2005)	PS	Hamilton	TN	487.5	Soddy Creek embayment	7.6 U	WD	1.1	1.2
SQN – CCW	TH	Hamilton	TN	485.1	Tennessee River	0.6 U	WD	1539.300	1447.000
SQN	TH	Hamilton	TN	484.5	Tennessee River	0.0	RT	1539.200	1447.000
SQN – Diffuser	TH	Hamilton	TN	483.6	Tennessee River	0.9 D	RT	1539.200	1447.000
The Honors Course	IR	Hamilton	TN	477.5	Wolftever Creek	26.8 D	WD	0.049	0.044
The Honors Course	IR	Hamilton	TN	477.5	Honor Lake	26.8 D	WD	0.041	0.037
Eastside Utility District	PS	Hamilton	TN	473.0	Tennessee River	11.5 D	WD	8.153	9.260
Invista	IN	Hamilton	TN	470.0	Tennessee River	14.5 D	RT	0.003	0.004

Facility Name	Use Type	County	State	TRM[1]	Source/Receiving Body	Total Distance from SQN (river miles)*	Transaction Type	2005 Rate (MGD)	2030 Rate (MGD)
Invista	IN	Hamilton	TN	470.0	Tennessee River	14.5 D	RT	3.040	3.784
Invista (Dupont)	IN	Hamilton	TN	470.0	Tennessee River	14.5 D	WD	4.189	5.213
Catoosa County Utility (Morris est)	WW	Catoosa	GA	468.0	South Chickamauga Creek	34.1 D	RT	0.020	0.032
CITGO Petroleum Corporation	IN	Hamilton	TN	468.0	Unnamed tributary	28.3 D	RT	0.021	0.026
City of Ringgold	PS	Catoosa	GA	468.0	South Chickamauga Creek	48.5 D	WD	0.556	0.877
Crystal Springs Printworks	IN	Walker	GA	468.0	Crawfish Spring Lake	54.3 D	WD	0.510	0.612
Dow Reichhold Specialty Latex	IN	Walker	GA	468.0	West Chickamauga Creek	70.3 D	RT	0.154	0.185
Fort Oglethorpe-Mitchell Acres	WW	Catoosa	GA	468.0	West Chickamauga Creek	36.6 D	RT	0.030	0.047
National Starch & Chemical Corporation	IN	Hamilton	TN	468.0	South Chickamauga Creek	17.3 D	RT	2.390	2.974

Facility Name	Use Type	County	State	TRM[1]	Source/Receiving Body	Total Distance from SQN (river miles)*	Transaction Type	2005 Rate (MGD)	2030 Rate (MGD)
Ringgold Water Pollution Control Program	WW	Catoosa	GA	468.0	South Chickamauga Creek	48.5 D	RT	0.500	0.788
Walker County Water Pollution Control Program	WW	Walker	GA	468.0	West Chickamauga Creek	52.6 D	RT	1.517	1.650
NA Industries Inc.	IN	Hamilton	TN	467.0	Tennessee River	17.5 D	RT	3.540	4.406
Chattanooga-Moccasin Bend Sewage Treatment Plant	WW	Hamilton	TN	465.3	Tennessee River	21.4 D	RT	43.700	49.637
Tennessee-American Water Company	PS	Hamilton	TN	465.3	Tennessee River	19.2 D	WD	41.575	47.223
US Pipe & Foundry Chattanooga	IN	Hamilton	TN	461.5	Tennessee River	23 D	RT	0.015	0.018
US Pipe & Foundry Chattanooga	IN	Hamilton	TN	461.5	Tennessee River	23 D	RT	0.042	0.052
Chattem Chemicals Inc.	IN	Hamilton	TN	460.5	Unnamed tributary	24.7 D	RT	0.248	0.308
Dade County Water and Sewage Authority	PS	Dade	GA	460.0	Lookout Creek	45.1 D	WD	2.348	3.333
Tenton Water Pollution Control Program	WW	Dade	GA	460.0	Lookout Creek	43.5 D	RT	0.305	0.433
Moccasin Bend Golf Course	IR	Hamilton	TN	459.0	Tennessee River	25.5 D	WD	0.025	0.023

Facility Name	Use Type	County	State	TRM[1]	Source/Receiving Body	Total Distance from SQN (river miles)*	Transaction Type	2005 Rate (MGD)	2030 Rate (MGD)
Signal Mountain Cement Company	MI	Hamilton	TN	455.0	Tennessee River	29.5 D	RT	1.612	1.909
Buzzi Unicem USA – Signal Mountain Plant	IN	Hamilton	TN	454.0	Tennessee River	30.5 D	WD	0.603	0.750
Buzzi Unicem USA – Signal Mountain Plant	IN	Hamilton	TN	454.0	Tennessee River	30.5 D	WD	0.603	0.750
Signal Mountain Waste Water Treatment Plant	WW	Hamilton	TN	454.0	Tennessee River	30.5 D	RT	0.734	0.834

[1] Location of water use on Tennessee River (location of outfall, withdrawal, or convergence of a tributary to Tennessee River).
[2] Response to NRC request for additional information regarding environmental review, Tennessee Valley Authority, Watts Bar Nuclear Plant – Unit 2, Docket No. 50-391, Hydrology H-16.
[3] Assumes two-unit full-load operation in 2030.

PS = Public Supply WD = Withdrawal U = Upstream

IN = Industrial RT = Return D = Downstream

IR = Irrigation

TH = Thermoelectric

MI = Mining

WW = Wastewater

* Distance approximate to SQN (includes all tributaries).

(John Higgins, TVA, personal communication, March 22, 2010). Includes surface water withdrawal/return data from TDEC (2006 data) and USGS, Georgia Water Science Center (2007 data).

(USGS 2010) National Hydrology Dataset

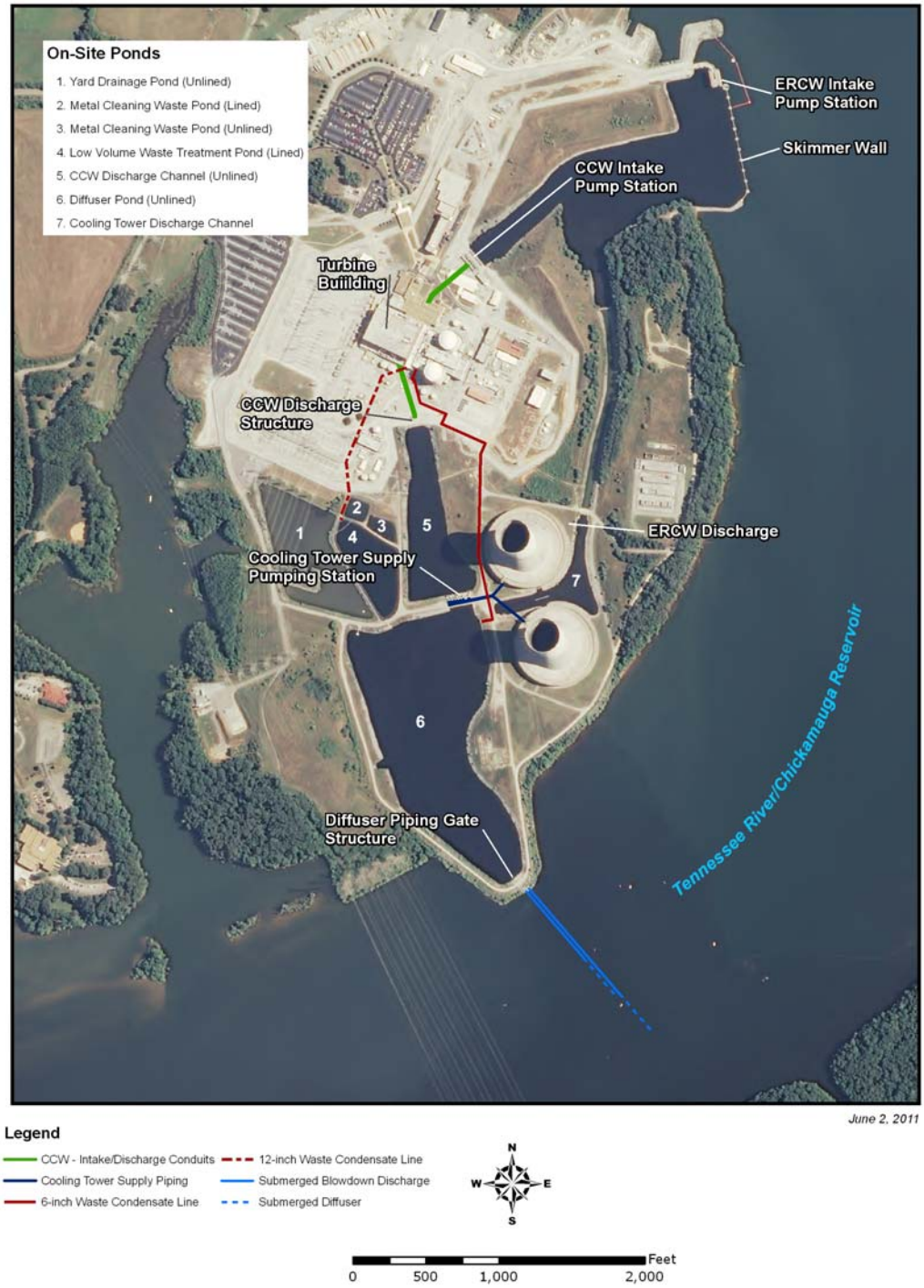

Figure 3-3. SQN Intake and Discharge Facilities

Table 3-4. SQN Water Use for Open Mode and Helper Mode Cooling Operations

Open Mode	Units 1 & 2	Percent Average River Flow*
Discharge	1,068,888 gpm	7%
Withdrawal	1,068,958 gpm	7%
Helper Mode	**Units 1 & 2**	**Percent Average River Flow***
Evaporation (Consumption)	<26,000 gpm	<0.2%

*Average flow at the SQN site is approximately 32,000 cfs (14,361,600 gpm) (Paul Hopping, TVA, personal communication, July 14, 2010).

Hourly flow rates from Chickamauga Dam and Watts Bar Dam from 1976 through 2010 were recorded by TVA. The drainage areas and average flow rates are presented in Table 3-5. (Paul Hopping, TVA, personal communication, July 14, 2010)

Table 3-5. Drainage Area and Average Flow Rate

Location	Drainage Area (sq mi)	Average Flow Rate (cfs)
Watts Bar Dam	17,310	25,900
SQN	20,650	32,000
Chickamauga Dam	20,790	32,300

As discussed in Subsection 3.16, TVA has studied the sensitivity of the river and power systems to extreme meteorology and climate variations (Miller et al. 1993). In terms of water temperature, the studies evaluated the response to changes in meteorology for a typical mainstream reservoir like Chickamauga Reservoir. The results indicate that based solely on changes in air temperature, the average (April through October) natural water temperature in a mainstream reservoir could increase between 0.3°F and 0.5°F for every 1°F increase in air temperature. An assessment of potential climate change in the Tennessee Valley suggests that air temperatures could increase 0.8°C/1.4°F by 2020 and up to 4°C/7.2°F by 2100 (EPRI 2009) for an increase in air temperatures of approximately 2°C/3.6°F by the end of the 20-year license renewal period (2041) of SQN, and the potential increase in water temperatures in Chickamauga Reservoir could range from 0.5°C/1.0°F to 1.1°C/2.0°F (TVA 2010b). Such a temperature rise could impact the operation of both SQN generating units. The facility would have to utilize the helper mode more frequently, and in extreme cases, implement plant derates to maintain compliance with the NPDES permit.

3.1.2.2. Environmental Consequences

<u>Alternative 1 – License Renewal</u>

For this alternative, SQN's surface water withdrawal and discharge volumes during the renewal term are expected to be consistent with the plant's current water withdrawals and discharge volumes. Therefore, impacts to surface water quality would remain unchanged. Based on future water information that indicates a decrease in water withdrawal by 2030 (Bohac and McCall 2008) in the Tennessee River Valley, no cumulative effects are expected from the continued operation of SQN.

Alternative 2 – No Action Alternative

The No Action Alternative is the result of the decision not to extend operation of the SQN units past the current expiration dates of the operating licenses. However, this could lead TVA to a decision to replace the resulting loss of the approximately 2,400 MWe base load generation upon shutdown of SQN. Given the need for adequate replacement power generation, TVA has evaluated in detail two alternative means of doing this.

Alternative 2a – New Nuclear Generation

Surface water use impacts would depend on the volume of water withdrawn for makeup water relative to the amount available from the intake source and the characteristics of the surface water. As stated in Chapter 2, a nuclear or natural gas-fired plant would be built with a closed-cycle cooling system which would increase surface water consumption from operation of the cooling towers; however, the beneficial impact would be a reduction in the number of fish and shellfish entrained or impinged. The overall impacts could be minor for water use impacts during normal flows and possibly substantial impacts during extreme low-flow conditions. Potential impacts can be mitigated by derating (reducing the thermal output of the plant by reducing its electrical power rating) during periods of thermal sensitivity.

Alternative 2b – New Natural Gas-Fired Operation

Surface water use impacts would be expected to be similar but on a smaller scale than those described for Alternative 2a. The volume of water used would be expected to be smaller for a natural gas-fired plant if the waterbodies were of the same size and quality as for the nuclear plant site, and the impact would be expected to be minor.

3.1.3. Hydrothermal Effects of Plant Operation

A summary of the surface water hydrothermal effects of SQN operation including a discussion of alternatives and their impacts is presented in this subsection.

3.1.3.1. Affected Environment

Under Alternative 1, the SQN plant would continue to withdraw water from and discharge cooling water back to Chickamauga Reservoir. The two discharge diffusers each distribute a flow of approximately 535,000 gpm into Chickamauga Reservoir with an average driving head of 7 feet in the diffuser pond. During the once-through open mode cooling operation, which is used the majority of the time, water is discharged to the diffuser pond where it flows through the diffusers into Chickamauga Reservoir. For SQN's cooling tower operations in the helper mode, which averaged 112.7 days per year during 2006 – 2009 (Subsection 3.16.2), two gate structures direct the discharge from the cooling tower into the diffuser pond. Blowdown from the cooling towers is taken from the return channel above the diffuser pond, mixed with the plant radwaste effluent, and discharged directly into the diffuser pond. The system has been designed to ensure that under no conditions does the radwaste backflow into the return channel. (TVA 1974c) Flow from the ERCW system discharges into the return channel, providing a continuous source of water for dilution of plant radwaste effluent.

The SQN heat rejection system is designed to operate in one of three modes: open, helper, or closed. The SQN plant generally operates in open mode. Helper mode operation is used when an NPDES temperature limit for the diffuser outfall is threatened. In

open mode, the water bypasses the cooling towers and is returned to the Chickamauga Reservoir through the diffuser pond and the discharge diffusers. In helper mode, the water is diverted to the cooling towers by lift pumps, passes through the cooling towers, where part of the waste heat is dissipated in the atmosphere, and is returned to the reservoir through the diffuser pond and the discharge diffusers. In closed mode, which is not normally used at SQN, water is diverted to the cooling towers where nearly all the waste heat is dissipated in the atmosphere, and is cycled back to the plant intake channel through a discharge control structure and return channel. (TVA 1974c)

For the operation of the two SQN units, cooling water is discharged to Chickamauga Reservoir via the NPDES-permitted Outfall 101, shown in Figure 3-4. The outfall includes a two-pipe multiport diffuser on the bottom of the Tennessee River, as shown in Figure 3-5. The upstream pipe extends about 1,300 feet into the reservoir at an angle of about 90 degrees from the diffuser pond dike. The diffuser section includes the last 350 feet of the pipe and is 17 feet in diameter. The downstream pipe is parallel to and 350 feet shorter than the upstream pipe. The diffuser section of the downstream pipe includes the last 350 feet of the pipe and is 16 feet in diameter. The two diffusers therefore provide mixing across nearly the entire width of the main channel. For both pipes, the outlets for the diffuser section are perpendicular to the axis of the diffuser and pointed downstream. (TVA 2008a)

Current NPDES Permit

SQN's latest site NPDES permit TN0026450 became effective on March 1, 2011. (TDEC 2011). This permit is amended as new wastewater streams are identified. The NPDES permit establishes criteria protective of water quality in the receiving stream. For SQN, TDEC has established criteria to protect Chickamauga Reservoir water quality for its designated uses in domestic and industrial water supply, fish and aquatic life, recreation, livestock watering, irrigation, and navigation use classifications.

Within the permit, point-source discharge outfalls and internal monitoring points (IMPs) are assigned a discharge serial number (DSN). For each discharge point, the NPDES permit establishes limitations as to the types and quantities of effluents, monitoring and reporting requirements, and required sampling locations. SQN is currently authorized to discharge as presented in Table 3-6 and Figure 3-4.

NPDES Permit Temperature Limits and Mixing Zone for Outfall 101

The NPDES permit for SQN identifies the release of cooling water to the Tennessee River through the plant discharge diffusers as Outfall 101. Under the current NPDES permit, the water temperature at the downstream end of the diffuser mixing zone is limited to a maximum 24-hour average of 86.9°F, a maximum 24-hour average temperature rise of 5.4°F for April through October, a maximum 24-hour average temperature rise of 9.0°F for November through March, and a maximum hourly average temperature rate-of-change of ±3.6°F/hour. The November through March limit for the temperature rise was obtained by a 316(a) variance request in 1989 (TVA 2009d). In cases when the 24-hour ambient temperature exceeds 29.4ºC (84.9ºF), the 24-hour downstream temperature can exceed 30.5ºC (86.9ºF) provided that the plant is operated in helper mode. But in all situations, the

Table 3-6. NPDES Permit Point-Source Discharges

Point-Source Discharge	Receiving Body	Water/Wastewater Type	Status
Outfall 101	Tennessee River (Chickamauga Reservoir)	Process and nonprocess wastewater from the diffuser pond that receives condenser circulating water; essential raw cooling water; cooling tower blowdown; raw cooling water; low-volume wastes; miscellaneous low-volume wastes, including various facilities drains and sumps; A/C condensate; steam generator blowdown; high pressure fire protection water; regeneration wastes from condensate demineralizer; and storm water runoff. Receives discharge from IMP 103.	Active
IMP 103	Diffuser Pond	Wastewater from the low volume waste treatment pond that receives condensate demineralizer, turbine building sump, storm water from IMP 107, essential raw cooling water, raw cooling water, and storm water runoff.	Active
IMP 107	Low Volume Waste Treatment Pond	Rain water from the now defunct metal cleaning ponds. No metal cleaning waste is added; rainwater is pumped as needed into IMP 103, which discharges into the diffuser pond (Outfall 101).	Active Last discharged on December 22, 2009.
Outfall 110	Tennessee River (Chickamauga Reservoir)	Backwash wastewater.	Inactive for at least 14 years; remains in the event the plant goes into closed mode.
Outfall 116	Tennessee River (Chickamauga Reservoir)	Backwash wastewater.	Active
Outfall 117	Tennessee River (Chickamauga Reservoir)	Backwash wastewater.	Active
Outfall 118	Intake forebay	Settling pond water and storm water runoff.	Applicable only when the pond is in service. Last discharged on June 9 – 11, 2010.

hourly average downstream temperature at the downstream end of the mixing zone shall not exceed 33.9ºC (93.0ºF). A summary of SQN instream thermal limits for the discharge is shown in Table 3-7.

The NPDES permit specifies the existing mixing zone as an area 750 feet wide, extending 1,500 feet downstream and 275 feet upstream of the diffusers. The justification for the mixing zone is based on a physical model study of the discharge diffusers, which examined the thermal effluent over a wide range of plant and river conditions, including reverse flows in the reservoir. (TVA 2009d)

Table 3-7. NPDES Discharge Limits for SQN Outfall 101 to the Tennessee River

Type of Limit	Averaging (hrs)	NPDES Limit
Max Downstream Temperature, T_d	24	86.9°F
Max Downstream Temperature, T_d	1	93.0°F
Max Temperature Rise, **ΔT**	24	5.4°F/9.0°F
Max Temperature Rate of Change, dT_d/dt	Mixed	3.6°F

*5.4°F is applicable April through October/9.0°F is applicable November through March.
Note: In cases when the 24-hour ambient temperature exceeds 29.4ºC (84.9ºF), the 24-hour downstream temperature can exceed 30.5ºC (86.9ºF), provided that the plant is operated in helper mode. But in all situations, the hourly average downstream temperature at the downstream end of the mixing zone shall not exceed 33.9ºC (93.0ºF).
(TDEC 2011)

Hydrothermal Modeling of Potential Heat Effects

Since plant startup in 1981, SQN has conducted about 17 comprehensive surveys of the plant thermal effluents, averaging about one survey for every 18 months of operation (TVA 2009d). The August 2001 NPDES permit for SQN required a number of studies related to Section 316(a) of the CWA. Due to the short span of the 2001 permit, these studies were carried forward in an updated NPDES permit that was effective in September 2005. The studies are related to the plant diffuser discharge to the Tennessee River, identified in the NPDES permit as Outfall 101, and were conducted to further calibrate the numerical model for SQN effluent thermal discharge (TVA 2009c) and to confirm the adequacy of the ambient temperature measurement and the configuration of the mixing zone (TVA 2009d).

The numerical model for SQN effluent discharge computes the temperature at the downstream end of the mixing zone with sufficient accuracy for use as the primary method of verifying NPDES thermal compliance for Outfall 101 (TVA 2009e). The numerical model solves a set of governing equations for the mixing of the plant thermal effluent in Chickamauga Reservoir. The numerical model operates in real time and utilizes a combination of measured and computed values for the temperature, flow, and stage in the river, and the temperature and flow from SQN discharge diffusers. (TVA 2009e)

Figure 3-4. SQN NPDES Permit Discharge Points

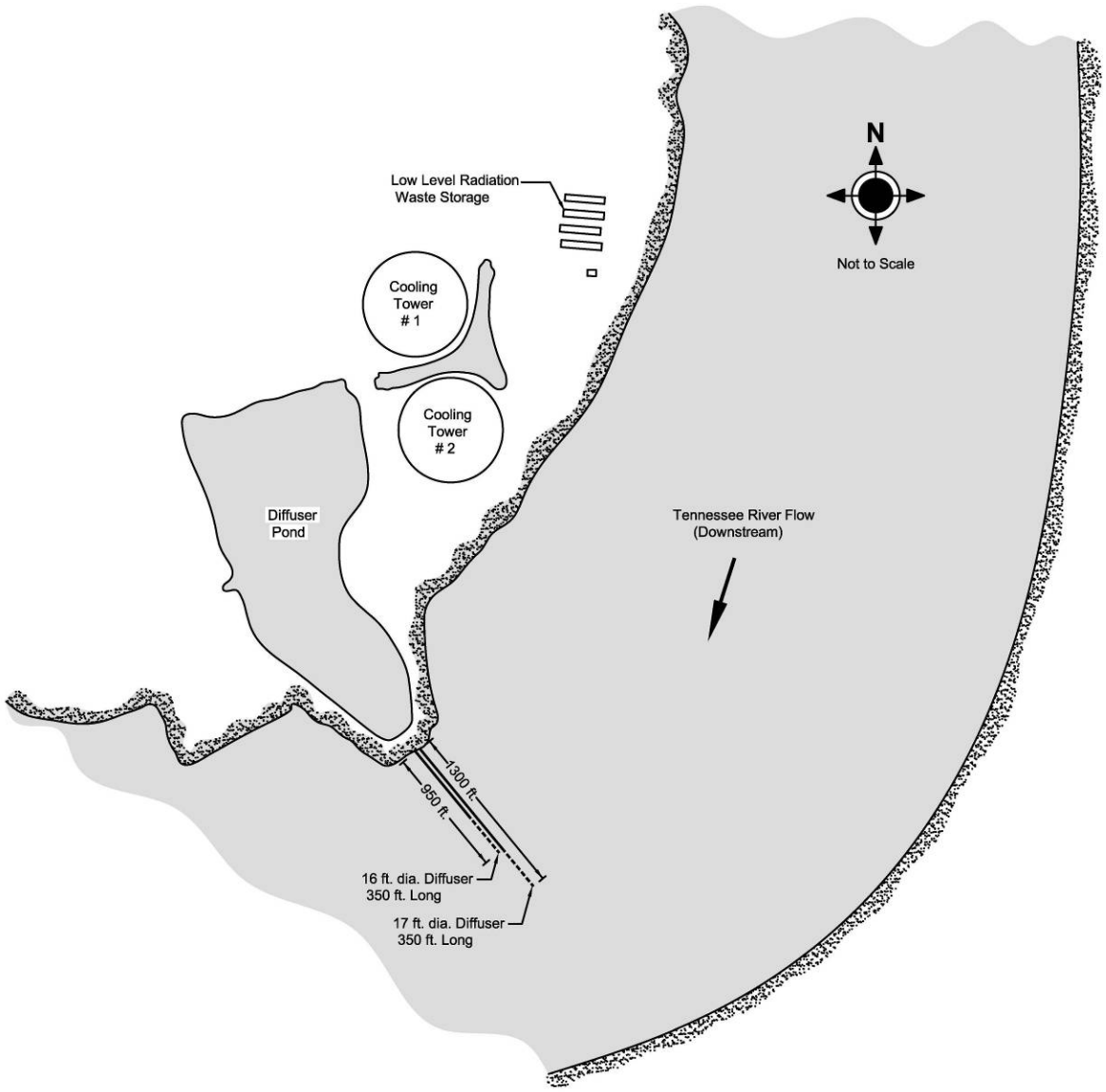

Figure 3-5. SQN Outfall 101

In 1989, a thermal variance was granted for SQN from TDEC's criteria for temperatures under Section 316(a) of the CWA. The request was approved prior to issuance of a permit in 1993. The variance involved allowing a temperature rise of 5°C for the winter operation months, November through March. Section 316(a) allows for variance from established temperature standards as long as permit conditions assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is to be made. Regarding SQN, TDEC determined that the shellfish, fish, and wildlife are being protected. (TDEC 2011)

Due to the evolution in understanding the hydrothermal and biological characteristics of Chickamauga Reservoir, as well as the operational aspects of the nuclear plant and river system, modifications have been necessary over the years in the thermal criteria and monitoring of Outfall 101. The most recent modification, implemented as part of the August 2001 permit, involved changing the period of averaging for the downstream temperature (**Td)** and temperature rise (Δ**T)** from hourly to 24 hours. This modification was done because changes in river flow due to hydro peaking operations were causing unexpected swings in river temperature that could require a near-immediate response by SQN. The hourly averaging placed the plant in situations where thermal violations possibly could not be averted. Previous studies showed that a change from hourly averaging to 24-hour averaging would have no adverse impact on the hydrothermal and biological aspects of Chickamauga Reservoir. However, as part of this change, two special studies were added in the NPDES permit of 2001: one to confirm the adequacy of the ambient temperature measurement, and one to confirm the configuration of the mixing zone. (TVA 2009d)

NPDES monitoring with 24-hour averaging for **Td** and Δ**T** has been in effect since August 2001 with no evidence of adverse impact to the balanced indigenous population of shellfish, fish, and wildlife in Chickamauga Reservoir. Furthermore, the results of the ambient temperature and mixing zone studies suggest that based on current procedures for monitoring the plant thermal compliance, it is very likely that changes in the plant operation that are made to protect the NPDES limits based on 24-hour averaging (e.g., initiating cooling tower operation) also attenuate the most extreme hourly average temperature excursions based on an hourly average. Therefore, the current NPDES permit recommends that the downstream temperature and temperature rise continue to be based on 24-hour averaging. (TVA 2011a) SQN procedures for monitoring water temperatures and operating the plant have successfully maintained thermal compliance for all the instream limits for Outfall 101. There have been no exceedences of the NPDES water temperature limits at SQN.

As presented in Subsection 3.5.2, heat shock to reservoir inhabitants is a site-specific impact that ranges from small to large depending on characteristics of the discharge stream and receiving waters. Plant operations, including the discharge plume, were evaluated for four types of fish considered species of special concern in Chickamauga Reservoir. No instances of attraction or avoidance of the thermal plume have been detected for fish species within the Chickamauga Reservoir (TVA 1995b). Additionally, relatively constant reservoir benthic index (RBI) scores from 2000 – 2009 at TRM 482 indicate the thermal plume is not affecting benthic macroinvertebrates downstream of SQN (TVA 2010i).

As discussed in Subsection 3.16, TVA has studied the sensitivity of the river and power systems to extreme meteorology and climate variations (Miller et al. 1993). In terms of water temperature, the studies evaluated the response to changes in meteorology for a typical mainstream reservoir like Chickamauga Reservoir. The results indicate that based

solely on changes in air temperature, the average (April through October) natural water temperature in a mainstream reservoir could increase between 0.3°F and 0.5°F for every 1°F increase in air temperature. An assessment of potential climate change in the Tennessee Valley suggests that air temperatures could increase 0.8°C/1.4°F by 2020 and up to 4°C/7.2°F by 2100 (EPRI 2009). An increase in air temperatures of approximately 2°C/3.6°F could occur by the end of the 20-year license renewal period (2041) of SQN. The potential increase in water temperatures in Chickamauga Reservoir could range from 0.5°C/1.0°F to 1.1°C/2.0°F. (TVA 2010b) Such a temperature rise could impact the operation of SQN generating units. The facility would have to utilize the helper mode operation more frequently, and in extreme cases, implement plant derates to maintain compliance with the NPDES permit.

3.1.3.2. Environmental Consequences

Alternative 1 – License Renewal

For this alternative, SQN Units 1 and 2 would continue to operate within the thermal limits set by SQN's NPDES permit and without measurable adverse impact to the balanced indigenous population during the renewal term. SQN is in compliance with current NRC and TDEC regulations related to thermal discharge evaluation requirements; therefore, no change regarding any potential impact from the current level of minor impact would be anticipated.

Alternative 2 – No Action Alternative

The No Action Alternative is the result of the decision not to extend operation of the SQN units past the current expiration dates of the operating licenses. However, this could lead TVA to a decision to replace the resulting loss of the approximately 2,400-MWe base load generation upon shutdown of SQN. Given the need for adequate replacement power generation, TVA has evaluated in detail two alternative means of doing this.

Alternative 2a and 2b – New Nuclear or New Natural Gas-Fired Generation

The impacts of operations for Alternatives 2a and 2b are similar and discussed together below.

Hydrothermal impact on surface water from a nuclear operation or gas-fired plant would be site specific, and dependent on the volume and temperature of water discharged. As stated in Chapter 2, either type of plant would be built with a closed-cycle cooling system so the facility could obtain an NDPES permit. The beneficial impact would be cooler discharge water; however, the negative impact would be additional surface water consumption from operation of the cooling towers. Discharge would contain dissolved solids and be regulated by the state issuing the NDPES permit. There could be substantial impacts during low river flow conditions; however, the use of cooling towers and plant derate (reduced power) should mitigate this impact. Because the location of the plant has not been determined, any cumulative impacts would have to be evaluated during the plant licensing or permitting process.

3.1.4. Chemical Additives for Plant Operation

A summary of the chemical additives during SQN operation, including a discussion about alternatives and their impacts, is presented in this section.

3.1.4.1. Affected Environment

Brief descriptions of plant cooling treatments discussed in earlier environmental reviews for the TVA site are provided in the following section. A primary area of concern for surface water quality relates to the chemicals added to treat water used for CCW, equipment cooling, fire protection, and potable water in nuclear plant operations that result in chemical discharges. The sources of chemical discharges from SQN would include cooling water discharge, cooling water makeup and ERCW systems, wastes from various makeup water, component water cooling system, reactor coolant system, and yard drainage systems and various sumps.

The source of fire protection water and potable water for SQN is the Hixson Utility District (TVA 2011b; TVA 2008a). The water supplied by this municipal water system is treated off site in accordance with applicable drinking water standards, and no further treatment for potable water usage would be performed on site. The wastewater associated with potable water usage is routed to the sanitary drainage system, which is discharged off site to the Moccasin Bend sewage treatment system (TVA 2008a) where it is treated.

Chemical additives are used in plant cooling water systems for two primary purposes:

1. To inhibit the chemical process of corrosion (rust formation) on metal piping and other plant equipment surfaces.

2. To maintain efficient heat transfer through all plant heat exchangers for heat removal and heat recovery. Optimal heat transfer cannot be achieved unless heat transfer surfaces are clean. Surfaces that have deposits of metal oxides (rust), scale (such as lime deposits), biological fouling (zebra mussel and Asiatic clam), or bacterial coatings experience lower heat transfer efficiency. In addition, certain types of bacteria can accelerate chemical oxidation or corrosion of surfaces through production of various waste products such as sulfate. This phenomenon is referred to as microbiologically influenced corrosion. A discussion of the two major heat-transfer-related (cooling) systems for SQN is provided below.

Overview of the Major SQN Plant Cooling Systems

Condenser Circulating Water System

The CCW system for Units 1 and 2 includes an intake pumping station at the end of the intake channel. The intake pumping station houses six vertically mounted, 187,000-gpm pumps (three pumps per unit) that discharge into dual concrete conduit tunnels leading to each unit's condenser. The station also houses traveling screens and screen wash pumps.

The CCW has no safety function. The ultimate heat sink for all seismic Category I (safety related) cooling water systems is provided by the emergency cooling water system taking suction immediately from the Chickamauga Reservoir and Tennessee River. The following design bases apply to the circulating water system, and additional information related to the CCW is available in Section 10.4.5 of the updated final safety analysis report (UFSAR) for SQN dated 2008.

In addition to the CCW system requirements, the CCW supplies water to the plant raw cooling water pumps and raw service water pumps, which in turn supply cooling water to

nonessential systems. Raw cooling water can be supplied by gravity head from the river via the condenser intake tunnels in case of complete outage of the circulating water pumps. (TVA 2008a)

Essential Raw Cooling Water

The ultimate heat sink for all seismic Category I (safety related) cooling water systems is provided by the ERCW system taking suction immediately from the Chickamauga Reservoir and Tennessee River. The ERCW system is designed to supply cooling water to various heat loads in both the primary (radioactive) and secondary (nonradioactive) portions of each unit. If the cooling towers are not in service (open mode), the ERCW discharges provide a continuous source for dilution of the plant effluent. Provisions are made to ensure a continuously available flow of cooling water to those systems and components necessary for plant safety during either normal operation or under accident conditions. The ERCW system consists of eight ERCW pumps, four traveling water screens, four screen wash pumps, four strainers located with the ERCW pumping station, and associated piping and valves. The ERCW station draws water directly from the Chickamauga Reservoir.

During all conditions of operation, the discharge from the various heat exchangers served by the ERCW system go to a seismically qualified open basin with overflow capability, then flow by gravity to the cold water return channel of the cooling towers of the CCW system (TVA 2008a).

Chemicals Added to the Plant Water Cooling Systems

The types of chemicals currently used in operating plant cooling water systems are described as follows:

- Scale Inhibitors. Also called anti-scalants, these chemicals inhibit the formation of lime (calcium oxide) deposits that would otherwise tend to form on the high-temperature surfaces of the heat exchanger tubes and limit the deposition of other chemical forms of oxide scale upon the heat exchanger tubes. Anti-scalants are organic (carbon-based) polymers containing phosphate attachments on the molecule.

- Corrosion Inhibitors. Corrosion inhibitors behave as “oxygen scavengers” and tend to draw up and chemically bind available oxygen, which makes less oxygen locally available to form rust compounds, which are metal oxides.

- Molluscicide. Ammonium chloride or a quaternary amine can be used for zebra mussel and Asiatic clam control.

- Dehalogenation Agent. Sodium bisulfite may be utilized to ensure that the oxidizing biocide (total residual oxidant) discharge limit as it pertains to the total residual halogen, usually chloride, is not exceeded.

- Detoxification Agent. Bentonite clay may be required to detoxify the molluscicide chemical from the water through absorption at a ratio of 5:1 to the quaternary amine.

- Biopenetrant. Non-ionic surfactant (a simple soap) may be applied to increase the efficacy of the oxidizing biocide by cleaning off the surfaces of the biota in order to

make the chlorine-based (or other halogen such as bromine-based) biocide or molluscicide chemical penetrate more effectively into the biological material, or biota.

All chemicals are approved prior to use by the appropriate state regulatory agencies, and qualified TVA personnel who determine the best possible chemicals to use based on site-specific needs. TVA's operational philosophy regarding chemical additives for plant operation reflects minimization of chemical use through an optimization program. The optimization program includes (1) monitoring operating plant parameters, (2) continually evaluating water chemistry, and (3) inspecting equipment to minimize the total amount of chemicals added. Prior to use in TVA plants, chemicals undergo an extensive toxicological review and comparison with maximum instream wastewater concentrations to ensure water quality standards are met.

SQN water treatment processes are controlled to comply with state water quality criteria and applicable NPDES permit conditions to ensure protection of the receiving waterbody. The standards and criteria applied by the state in establishing NPDES permit limits and requirements are to protect public health and water resources, as well as to maintain the designated uses for the receiving waterbody.

In accordance with SQN's NPDES permit, a biocide/corrosion treatment plan (B/CTP) annual report was submitted on February 9, 2010, to the WPC. This report provides biomonitoring data from tests conducted during treatments, a summary of all analytical results, the approximate duration in hours of each chemical used, the quantity in pounds of each chemical used, and any minor changes that have occurred in the B/CTP. Based on the analytical and toxicity biomonitoring, the facility maintained compliance with the current NPDES permit. Details related to the B/CTP are presented in the 2009 annual report. (TVA 2010j)

3.1.4.2. Environmental Consequences

Alternative 1 – License Renewal

The volume of the cooling water discharge would continue to be small when compared to river flow, and the treatment chemicals added are largely consumed, leaving very small or non-detectable concentrations by the time they are discharged. The discharge is regulated by a State of Tennessee NPDES permit and would have to meet applicable water quality standards and criteria. Even under adverse conditions and using conservative assumptions, impacts to the environment due to chemical discharges from SQN would be small (TVA 1974a). Therefore, the direct, indirect, and cumulative effects of chemical discharges would be minor.

Alternative 2 – No Action Alternative

The No Action Alternative is the result of the decision not to extend operation of the SQN units past the current expiration dates of the operating licenses. However, this could lead TVA to a decision to replace the resulting loss of the approximately 2,400 MWe base load generation. Given the need for adequate replacement power generation, TVA has evaluated in detail two alternative means of doing this.

Alternative 2a and 2b – New Nuclear or New Natural Gas-Fired Generation

The impacts of Alternatives 2a and 2b generally are similar in that they depend largely upon the sites that would be chosen and the measures taken to reduce or avoid potential impacts. They are discussed together below.

For a new nuclear plant or gas turbine, the treatment chemicals added would be expected to be largely consumed, leaving very small concentrations by the time they are discharged. (The amount of chemicals used for a gas turbine cooling operation would be less than for a nuclear plant based on the smaller scale of the individual units and components and less restrictive requirements on plant components.) Plant discharges would be regulated by the state in which the plant is located. An NPDES permit would be required, and the plant would comply with applicable water quality standards and criteria. Therefore, when the new generation source commences operation, the direct, indirect, and cumulative effects of chemical discharges would be expected to be minor.

3.1.5. Conclusion

Impacts from plant water discharges would be expected to be minor for operating SQN during the period of license renewal. Surface water impacts would be temporarily minor to moderate during construction of alternative new generation units. Only minor direct impacts would be expected at the proposed new operating sites. Indirect impacts or cumulative effects would also be expected to be minor.

3.2. Groundwater Resources

A discussion of groundwater hydrology, use and trends, and quality for SQN is provided in this section.

3.2.1. Affected Environment

Groundwater conditions at SQN have been documented in several reports over time, from TVA's 1974 FES through the *Sequoyah Nuclear Plant Investigation of Tritium Release to Groundwater* (TVA 2007c) and the UFSAR (TVA 2008a). A summary of that groundwater information is provided in this section.

Site Geology

The Conasauga Formation of Middle Cambrian age underlies SQN, providing the foundation bedrock of the plant. Unconsolidated alluvial, terrace, and residual deposits mantle the Conasauga Formation at the site. More recent alluvial deposits associated with the floodplain of the Tennessee River are now covered by the Chickamauga Reservoir. (TVA 2007c)

The Conasauga Formation at the site is composed of several hundred feet of interbedded limestone and shale in varying proportions. The shale, where fresh and unweathered, is dark gray, banded, and somewhat fissile in character. The limestone is predominantly light gray, medium grained to coarse crystalline to oolitic, with many shaly partings. A statistical analysis of the cores obtained from the site indicates a ratio of 56 percent shale to 44 percent limestone. Farther to the southeast and higher in the geologic section, the amount of limestone increases in exposures along the shore of Chickamauga Reservoir. (TVA 2007c)

Cavities and solution openings are not a major problem in the site foundation. Most solution openings are restricted to the upper few feet of bedrock near the overburden/bedrock interface. The insolubility of interbedded shale in deeper bedrock functions as a lithologic control to the development of large solution openings. However, small solution openings and partings may exist at greater depths within the bedrock along faults and joints, especially along synclinal zones. (TVA 2007c)

Soil

Unconsolidated alluvial, terrace, and residual deposits mantle the Conasauga Formation at the site. More recent alluvial deposits associated with the floodplain of the Tennessee River are now covered by Chickamauga Reservoir. Alluvium within the area of the main plant site was removed during construction, and only residual soils remain. In the plant area not mantled by terrace deposits, the Conasauga is overlain by varying thicknesses of residual silt and clay derived from weathering of the underlying shale and limestone. The residual soils are primarily silts and clays grading downward into saprolitic shale of the Conasauga Formation. In a few localized areas, weathered shale is exposed at the ground surface. However, in most exploratory drilling, the residuum depths ranged from 3 to 34 feet. Grain size analyses shows that soils across the site range from fat clay residual material to sand and gravel terrace deposits. (TVA 2007c)

3.2.1.1. Groundwater Hydrology

The peninsula on which SQN is located is underlain by the Conasauga, a poor water-bearing formation. About 2,000 feet northwest of the plant site, the trace of the Kingston Fault separates the Conasauga Shale from a wide belt of Knox Dolomite. The Knox Dolomite is a major water-bearing formation of eastern Tennessee. Based on a comprehensive examination of bedrock coreholes, groundwater in the Conasauga occurs in small openings along fractures and bedding planes. These openings rapidly decrease in size with depth, and few exist below a depth of 300 feet. Groundwater in the Knox Dolomite occurs in solutionally enlarged openings formed along fractures and bedding planes, and also in locally thick cherty clay overburden. (TVA 2008a)

The source of groundwater below the SQN site is derived from incipient infiltration of precipitation. Within overburden soils at the site, groundwater movement is generally downward. Local areas of natural lateral flow occur likely near some streams, topographic lows, and where extensive root systems exist. Groundwater movement might also occur in the vicinity of pipelines due to preferential groundwater flowpaths created by the permeable fill placed around the pipelines during their installation. (TVA 2007c) Groundwater is first encountered at the site between10 to 25 feet below ground surface (bgs) based on recent groundwater depth measurements. (TVA 2009f)

Groundwater movement is expected to occur mainly along the strike of bedrock, to the northeast and southwest, into Chickamauga Reservoir (TVA 2007c). Based on previous analysis, the permeability across strike in the Conasauga Shale is extremely low, and nearly all water movement is in a southwest-northeast direction, along strike. The Conasauga-Knox Dolomite Contact is a hydraulic barrier across which only a very small volume of water could migrate in the event large groundwater withdrawals were made from the adjacent Knox. Although some water can cross this boundary, the permeability normal to strike in the Conasauga is too low to allow development of an extensive cone of depression. (TVA 2008a)

Groundwater also discharges from overburden soils into the reservoir, site drainage channels (i.e., discharge channel), and surface water impoundments (i.e., diffuser pond). Higher surface water levels of Chickamauga Reservoir (April – October) result in corresponding rises in the groundwater table, and the lateral extent of this effect varies with groundwater hydraulic gradients. Lower surface water levels of Chickamauga Reservoir (November – March) result in corresponding declines in the water table along the reservoir periphery. (TVA 2007c)

Pre-construction boring logs collected by TVA suggest that groundwater transmissivity across the strike in the Conasauga Formation is extremely low. The computed mean time of travel of groundwater from SQN to Chickamauga Reservoir is 303 days. Local variations in hydraulic conductivity within the shallow bedrock are primarily controlled by geologic structure and stratigraphy. Shale beds and clay seams provide lithologic restrictions to the vertical movement of groundwater. The Conasauga/Knox contact northwest of the plant has been described as a hydraulic boundary; however, no field testing has been conducted to verify this assumption. The Conasauga Formation porosity is estimated to be about 3 percent based upon results of exploratory drilling. (TVA 2007c)

Groundwater monitoring and testing have been conducted using a network of wells installed at SQN. Eight bedrock wells were installed originally from 1976 through 1981, prior to plant operation. Additional monitoring wells have been installed since that time. During a tritium release investigation in 2007, 23 geoprobe borings were drilled and groundwater samples were collected. Five of the borings were completed as 1-inch monitoring wells to supplement groundwater level measurements and sampling locations. (TVA 2007c). The well locations are shown on Figure 3-6.

3.2.1.2. Groundwater Use and Trends

There are no groundwater supply wells on the SQN site. TVA contracts with the Hixson Utility District to supply potable water and fire protection water to the SQN plant (TVA 2008a; TVA 2011b). Other cooling water and service water systems are supplied from the Chickamauga Reservoir. The residential area around SQN is also on potable water supplied by Hixson Utility District (CHCRPA 2005a). Hixson Utility District uses water supply wells from the Cave Springs area which are located approximately 8 miles southwest of SQN near state Highway 27 (TVA 2007c). Current groundwater withdrawals from the Cave Springs area by the Hixson Utility District average about 8 MGD from two well fields, Cave Springs (6 MGD) and Walkers Corner (1.7 MGD) (USGS 2001).

Results from a USGS groundwater site inventory (GWSI) database retrieval for wells in Hamilton County are provided in the SQN tritium releases to groundwater report (TVA 2007c). The data are a combination of domestic wells, wells installed for specific investigations, and other groundwater sites. Large capacity (i.e., discharge >100 gpm) well locations from the GWSI database are located more than 1.5 miles from SQN. The closest large capacity wells are northwest of SQN. (TVA 2007c) The direction of groundwater movement at SQN is primarily easterly towards the intake and discharge channels based on historical and recent mapping of the potentiometric surface. Exceptions to this directional flux have occurred locally in areas of topographic highs/lows and from leaking water lines serving the site and operation of the diesel fuel oil interceptor trench. (TVA 2007c)

TVA ordered a water well search to determine if there were any new or newly reported water wells (private or public) in the immediate vicinity of the site. Based on the results of

an Environmental Data Resources (EDR) GeoCheck® search, no water wells were identified within a 1-mile radius (from the plant centerpoint) of the site (EDR 2010).

Hamilton County groundwater usage in 2005 was 16.4 MGD. Groundwater uses and type of use for Hamilton County are presented in Table 3-8. Hamilton County is the largest user of groundwater in the Tennessee River Valley and also has the largest population. (Bohac and McCall 2008)

Table 3-8. Groundwater Use in Hamilton County, Tennessee for 2005

Industrial	Public Supply	Irrigation	Total Groundwater Withdraw (MGD)
6.72	9.29	0.38	16.4

(Bohac and McCall 2008)

There is a declining trend of groundwater withdrawal from 1995 through 2005. As a result, it is assumed that overall groundwater demand would remain flat for the development of the current reservoir operations policy. Therefore, the increase in water demand would be met from surface water sources. Public supply systems, which comprise 78 percent of the surface water use, are slowly transitioning to surface water sources as treatment plants are upgraded or systems are consolidating to meet higher demand and new drinking water regulations. Surface water systems are not switching to groundwater sources; therefore, it is likely that groundwater withdrawal would continue to decline (Bohac and McCall 2008).

3.2.1.3. Groundwater Quality

Groundwater quality at SQN has been monitored over the years to obtain background concentrations, to examine the effect of on-site disposal practices, and in response to specific incidents. Monitored parameters include radionuclides and organics. SQN participates in the Nuclear Energy Institute (NEI) groundwater protection initiative NEI 07-07 to monitor inadvertent releases of radioactive substances that may result in low but detectable levels of plant-related materials in the groundwater (NEI 2007).

Tritium

As part of the SQN on-site REMP,, quarterly groundwater monitoring for tritium began in 1977 at four bedrock monitoring wells (W-1, W-2, W-4, and W-5) located along the perimeter of the site (Figure 3-6).

On-site REMP groundwater monitoring was reduced to a single well (W-5) in 1980. Tritium was initially observed in SQN groundwater during 1989 sampling at well W-5 in a concentration of 379 picocuries per liter (pCi/L). Tritium was not detected at well W-5 again until 1998. From 1998 through 2001, tritium was consistently observed at concentrations ranging from 401 to 2120 pCi/L at well W-5. No further tritium has been observed at well W-5 since 2001. (TVA 2007c)

Beginning in February 2002, TVA expanded groundwater monitoring at SQN with the addition of 12 groundwater monitoring wells (W-24 – W-28 in 2002 and W-29 – W-35 in 2004) and collection of groundwater samples from existing wells in proximity to known areas of tritium contamination. Since August 2003, more than 200 groundwater sampling events have been conducted. (TVA 2007c)

In 2007, groundwater sampling was conducted at 23 geoprobe borings; the results indicated low tritium concentrations (274 – 661 pCi/L) in borings (GP-1 – GP-7) surrounding the Unit 1 refueling water storage tank (RWST). Borings GP-21, GP-22, GP-25, and GP-26 exhibited low tritium concentrations (332 – 2,700 pCi/L) in the area south-southeast of Unit 2. Boring GP-28, just east of this area, provided a similarly low tritium concentration (394 pCi/L). (TVA 2007c) The highest tritium concentration observed within all geoprobe borings occurred at GP-13 (Table 3-9). Due to the relatively high groundwater tritium concentration at boring GP-13, a 1-inch groundwater monitoring well was installed at this location, and additional groundwater sampling was conducted (TVA 2007c). Four other borings were completed as 1-inch monitoring wells to supplement groundwater level measurements in areas lacking groundwater level information. These wells include GP-7A, GP-7B, GP-10, and GP-24 (TVA 2007c).

Current results suggest that sources of tritiated groundwater are primarily associated with past inadvertent releases of liquids containing radioisotopes. In general, the highest tritium concentrations in the shallow groundwater system are associated with two distinct areas north and south of Units 1 and 2 (Figure 3-7). Although data are sparse for the deeper flow regime (i.e., weathered bedrock and shallow bedrock), the extent of the tritium plume has been bounded horizontally by sampling locations. (TVA 2007c)

Elevated tritium concentrations in groundwater north of Unit 1 suggest that the inadvertent water release from the modulated filter transfer demineralization system (MFTDS) in 1997 is likely the primary source of shallow affected groundwater in this area. The estimated volume of water released by the MFTDS is 600 – 1,000 gallons. A secondary source of tritium concentrations in this area is related to relatively small volumes of water that drain from the RWST moat and have discharged to the ground surface for more than 25 years. Results for tritium detected in catch basin SS-6 near the service building suggest that the observed tritium concentration might be associated with direct discharges to the single line entering this catch basin. (TVA 2007c)

Tritium concentrations in groundwater south of Unit 2 suggest that inadvertent releases from the Unit 2 condensate demineralizer waste evaporator and additional equipment buildings have impacted shallow groundwater in this area. Another source of tritium concentrations in this vicinity is related to the moat drain from the RWST that discharged to the ground surface for more than 25 years. Tritium concentrations at monitoring well W-27 appear to be of an isolated nature and may be related to leakage of the 12-inch waste condensate line. (TVA 2007c)

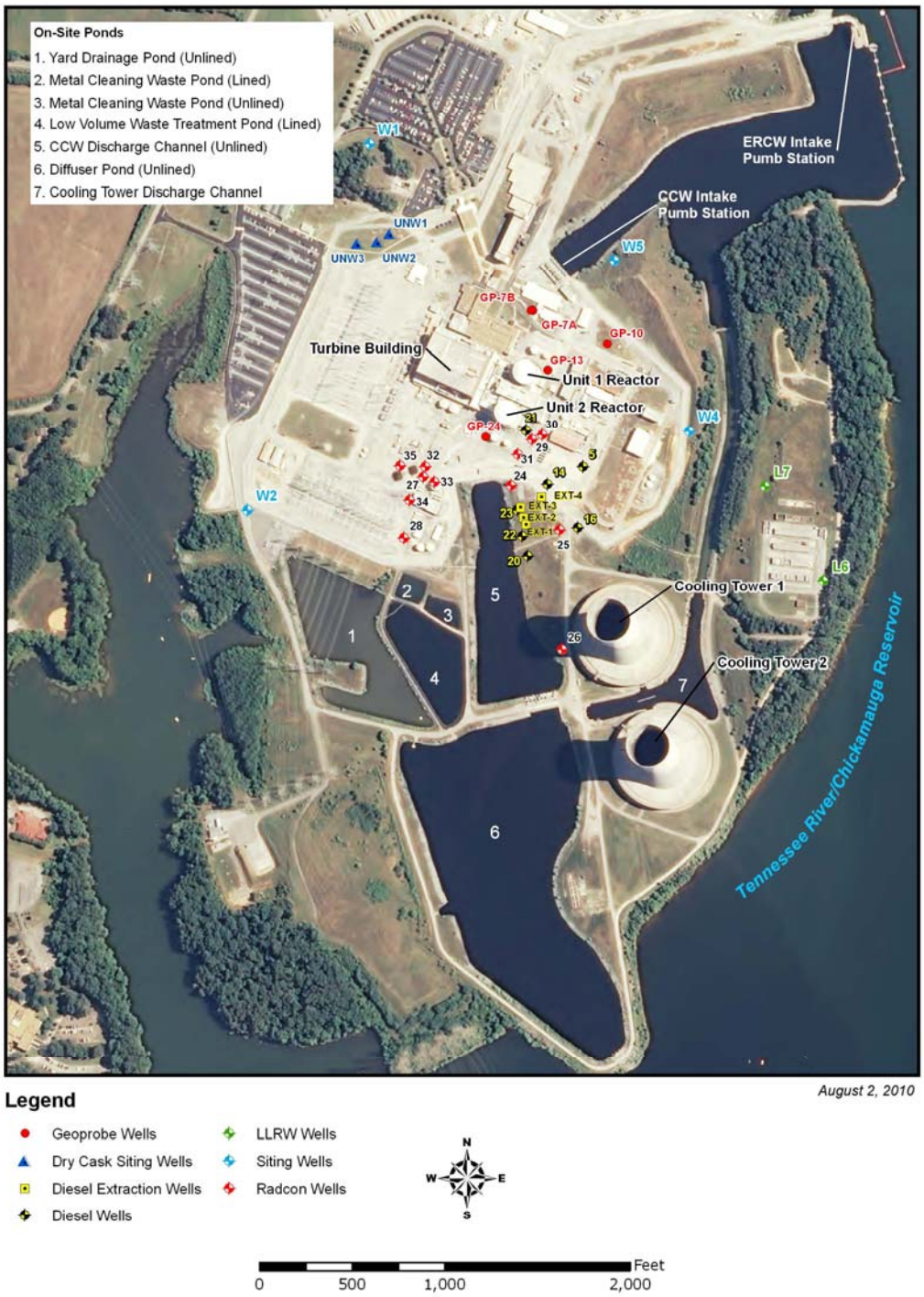

Figure 3-6. Geoprobe and Monitoring Well Locations

Relatively high groundwater samples from several monitoring wells had detectable tritium concentrations; however, there have been no tritium concentrations exceeding the EPA drinking water standard of 20,000 pCi/L for tritium (40 CFR §141.25) (TVA 2007c). The highest tritium concentration detected in 2009 was 8,080 pCi/L in well W-31 (TVA 2009f). Presently, tritium concentrations are being detected in four monitoring wells (GP-13, W-21, W-29, and W-31) (Table 3-9), but not in the other monitoring wells. Since 2008, tritium concentrations in the groundwater samples from the four wells with detectable tritium are all below half of the drinking water standard (less than 10,000 pCi/L), and the trend in tritium concentration is either flat or trending downward, as shown in Table 3-9. (TVA 2009f)

Tritium is not susceptible to attenuation via sorption or biochemical degradation. Reduction of tritium concentrations in the groundwater system at SQN occurs primarily by hydrodynamic dispersion and dilution. However, the fate and transport of tritium in the site groundwater system is also likely to be governed by avenues of relatively rapid groundwater movement that exist within bedding material of larger pipelines and tunnels, and possibly along the weathered bedrock horizon. (TVA 2007c) Tritium reduction also occurs through radioactive decay. Tritium has a half life of 12.32 years and a decay rate of 5.626 percent per year (UMNOLS 2010).

Table 3-9. Summary of Tritium Concentrations

Results	GP-13	Sample Date	W21	Sample Date	W29	Sample Date	W31	Sample Date
Highest Result	18,400	2/27/2007	2,763	3/21/2005	11,490	7/25/2005	19,750	6/14/2005
Lowest Result	7,730	10/16/2009	<270	10/16/2009	466	12/6/2004	2,576	11/24/2004
Most Current	7,730	10/16/2009	<270	10/16/2009	848	4/17/2009	5,338	10/16/2009

Units measured in pCi/L.
(TVA 2009f)

Groundwater and surface water level measurements during the 2007 study confirm that the intake and discharge channels would ultimately receive tritiated groundwater discharge from the site. Dilution ratios in the channels and subsequently the Tennessee River are dependent on plant operation and river flows. (TVA 2007c)

No active remediation has been recommended for the site due to the limited extent of tritium concentrations in groundwater (less than the EPA drinking water standard of 20,000 pCi/L), perceived low exposure and dose risks, and negligible potential for off-site groundwater migration. In addition, measured tritium levels are below 10 CFR Part 20 standards for radiation exposure. As mentioned previously, tritium sources appear to be primarily associated with past inadvertent releases of liquids containing radioisotopes.

In compliance with industry guidelines for groundwater protection initiatives (NEI 2007; EPRI 2007), SQN conducts a hydrogeologic evaluation review every five years. This review updates the predominant groundwater flow characteristics and gradients in a three-dimensional graphic representation of the subsurface based on current site configuration and environmental factors, including complexities in stratigraphy such as bedrock, clay lenses, geologic materials, or aquifers that may have the potential to affect contaminant

flow. The next five-year hydrogeologic review for SQN is due in 2012. To support that review, a project is planned to install additional monitoring wells to better characterize the vertical extent of the two tritium plumes. The revised subsurface model will include land surface elevations and water levels, groundwater sources and sinks, hydraulic conductivity, borehole locations, and well construction details. This enhanced characterization is expected to verify the previously predicted migration pathways both spatially and temporally, and to confirm that the tritium sources are legacy spills.

Diesel Fuel Oil

Nine groundwater monitoring wells were installed as part of an assessment of a No. 2 diesel fuel oil release from an underground transfer line (TVA 2007c) where two leaks were identified and repaired (TVA 1993a). A free product plume was delineated, extending from the fuel oil supply line leak to the CCW discharge channel (TVA 1993a). Diesel fuel oil is recovered in an inceptor trench with four diesel extraction wells. A risk assessment was conducted in 1993 to determine the impact to human health and the environment. The risk assessment concluded that diesel fuel constituents, total petroleum hydrocarbons (TPH) and benzene, toluene, ethyl-benzene, and xylenes (BTEX), do not pose a significant risk to human health under the current land- and water-use conditions, and dissolved TPH and BTEX do not pose a significant risk to the environment in the CCW discharge channel or Chickamauga Reservoir (TVA 1993a). Effective with the March 1, 2011, NPDES permit, TDEC concurred that the diesel fuel recovery project could be terminated (TDEC 2011).

On June 26, 2009, a section of piping that supplied No. 2 diesel fuel from SQN's fuel oil storage tanks (FOSTs) to underground storage tanks (USTs) day tanks failed a pressure test. The test was confirmed later that day and on June 27th. The section of piping was 4 inches in diameter and 180 feet long. These USTs were deferred per TDEC Rule 1200-1-15-.01(b)3. Initial response actions per 1200-1-15-06(3) were completed including notification to TDEC's Chattanooga environmental field office, Division of Underground Storage Tanks, and the NRC on June 29, 2009. It should be noted that no drinking water supplies were within 0.10 mile of the petroleum site. Visual inspections of surrounding soils and water revealed no diesel fuel contamination, including free product and vapor hazards, from the suspected piping breach. The UST system was taken out of service when the confirmatory pressure test was completed on June 27, 2009. The last successful pressure test on this section of piping was in April of 2008. Thirteen diesel fuel transfers have occurred since the last successful pressure test (Timothy Cleary, TVA, personal communication, July 24, 2009). Approximately 200 cubic yards (yd^3) of diesel-contaminated soil from the spill have been removed from the spill location. TDEC officially closed this spill contamination case as of August 5, 2010. TVA sent the diesel-contaminated soil to the Rhea County Landfill under Special Waste Approval SPC ID# 72-5106 (TDEC 2010d). All analytical results [BTEX, TPH, methyl tert-butyl ether (MTBE), and naphthalene] for the soil remaining in the excavation area were below the detection limits (Christopher Church, TVA, personal communication, April 28, 2010).

3.2.2. Environmental Consequences

This section addresses impacts to groundwater from site construction and operation of the Action and No Action Alternatives.

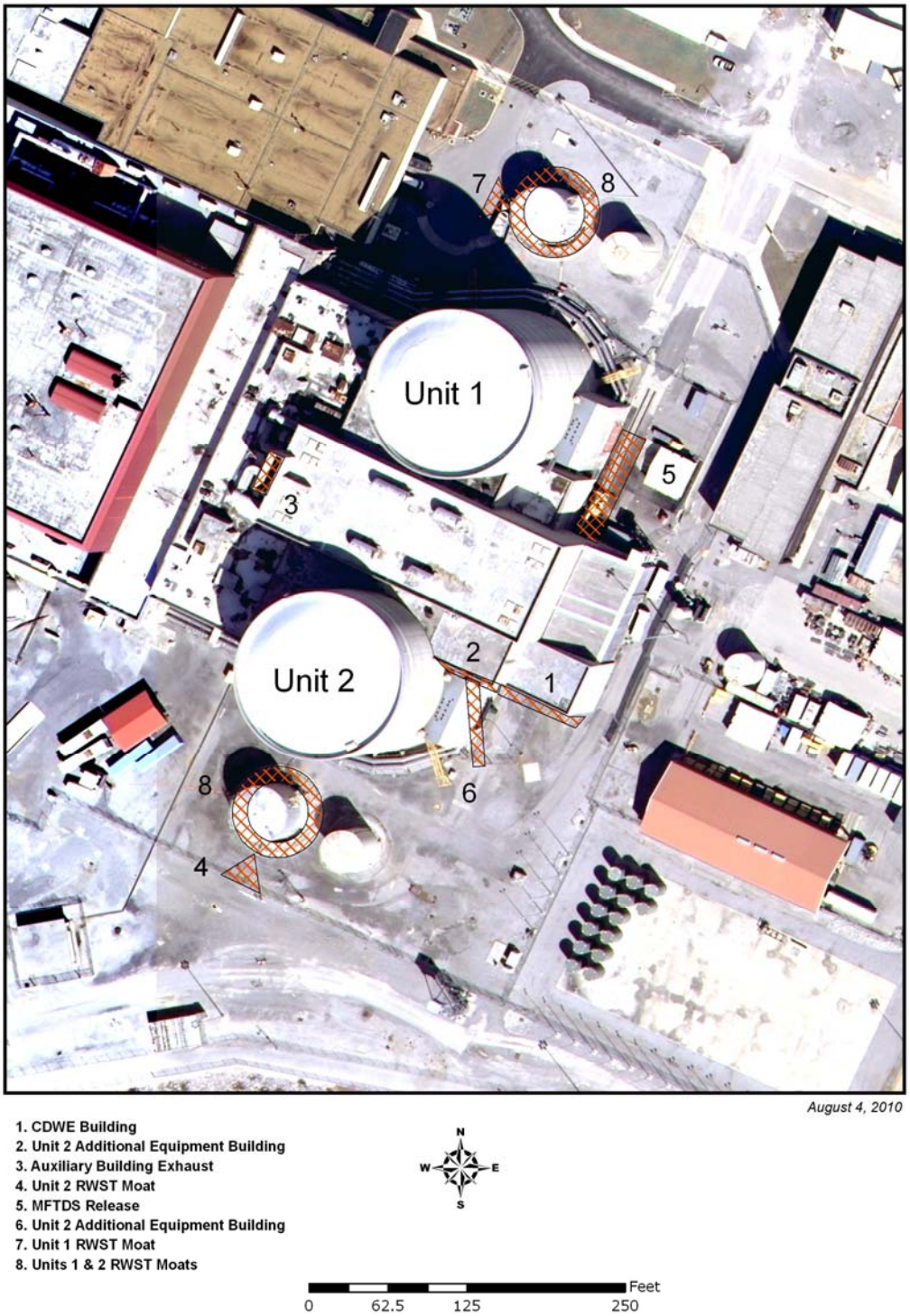

Figure 3-7. Locations of Inadvertent Tritium Releases

Alternative 1 – License Renewal

There is no groundwater use on site, nor is the use of groundwater proposed during the extended license period; therefore, no change in impact is anticipated from the current level of minor impact. The site is currently evaluating tritium impacts to the groundwater from past releases; however, the tritium concentrations are below regulatory action levels and appear to be declining, indicating that there are no active sources. In addition, there are no data showing that any tritium-impacted groundwater has migrated past the site property boundary.

Alternative 2 – No Action

Under the No Action Alternative, there would be no effects to the groundwater hydrology, groundwater use, or groundwater quality. There may be a minor but temporary impact on groundwater quality during shutdown and decommissioning activities. The current use at the SQN site of BMPs for handling chemicals, together with the adherence to spill prevention control and countermeasures (SPCC) programs for the management and cleanup of oils, limit the likelihood that oil or chemicals would reach groundwater. Residual chemicals from past spills and discontinued industrial practices would decrease over time, leading to improvement in water quality.

Alternative 2a – New Nuclear Generation

The impacts of Alternatives 2a and 2b are similar and discussed together with the exception of groundwater impacts from radiological sources, which are discussed below.

Impacts on groundwater quality from radiological sources are expected to be minor. Under Alternative 2a, TVA would comply with the NEI's groundwater protection initiative, NEI 07-07 (NEI 2007). This initiative identifies actions to improve utilities management and response to instances where the inadvertent release of radioactive substances may result in low, but detectible, levels of plant-related radioactive materials in subsurface soils and water. Aspects addressed by the initiative include site hydrology and geology, site risk assessment, on-site groundwater monitoring, and remediation. TVA would provide an annual report related to the results of the groundwater monitoring program at the new nuclear plant as directed in NEI 07-07, as well as having the program peer reviewed by industry experts. Actions taken as a result of the groundwater protection initiative would include an increase in monitoring locations, increased number of samples taken, and the review of programs and procedures for best industry practices. The goal of the groundwater protection initiative would be to reduce any impacts on groundwater from the accidental release of radioactive effluents.

Alternative 2b – New Natural Gas-Fired Generation

Groundwater impacts would depend on the use of groundwater and construction activities required to build the plant. Dewatering activities would likely be needed during foundation construction. If groundwater resources were used for sanitary and potable water use, there would normally be a minor impact because the amount of withdrawal would be minimal. Although it is unlikely that groundwater will be used for makeup and/or cooling water, it would depend on site-specific conditions and therefore the impacts could be moderate to substantial. Overall, groundwater impacts on the aquifer from a nuclear operation or gas-fired plant would be site-specific, and dependent on aquifer recharge and other

withdrawals. Under both alternatives, chemicals used during construction would be managed using BMPs, thereby limiting the likelihood of chemical contamination of surface water as well as groundwater. With the adoption of either alternative, nonradiological impacts on groundwater quality are expected to be minor.

3.3. Floodplain and Flood Risk

The federal regulations concerning criteria of design against plant site flooding are provided in U.S. NRC, 10 CFR Part 50, Appendix A Criterion 2 – *Design Bases for Protection Against Natural Phenomena*. Criterion 2 states that structures, systems, and components (SSCs) important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunamis, and seiches without loss of capability to perform their safety functions. The design bases for these SSCs shall reflect (1) appropriate consideration of the most severe of the natural phenomena historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated; (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena; and (3) the importance of the safety functions to be performed.

Floodplain and flood risk assessment involves ensuring that facilities would be sited to provide a reasonable level of protection from flooding. In doing so, the requirements of Executive Order (EO) 11988, *Floodplain Management,* would be fulfilled. For non-repetitive actions, EO 11988 states that all proposed facilities must be located outside the limits of the 100-year floodplain unless alternatives are evaluated, which either would identify a better option or support and document a determination of “no practicable alternative” to siting within the floodplain. (42 FR 26951)

The natural phenomena described in the SQN UFSAR Amendment 21 (TVA 2008a) contains information related to potential flooding of the SQN site from the Tennessee River and potential flooding from the local probable maximum precipitation (PMP) occurring within the site drainage. The PMP is defined as the theoretically greatest depth of precipitation for a given duration that is physically possible over a particular drainage area at a certain time of year. In consideration of the limited knowledge of the complicated processes and interrelationships in storms, PMP values are therefore identified as estimates.

Flood impacts are always considered in evaluating activities related to SQN due to the potential of occurrence and the potential for impacts on the health and safety of the public related to SQN. The following section discusses the floodplain and flood-risk related impacts.

3.3.1. Affected Environment

The SQN site is located on a peninsula on the western shore of Chickamauga Reservoir, at TRM 484.5 (TVA 2008a) in Hamilton County, Tennessee (Figure 1-2). The SQN site could be flooded from the Tennessee River as well as from the occurrence of a PMP event within the total watershed and the watershed for the local area of the plant site. Drainage to the Tennessee River has been provided to accommodate runoff from the PMP on the local area of the plant site (TVA 2008a).

The 100-year floodplain for the Tennessee River is the area below elevation 687 feet msl at TRM 484.5. The 500-year floodplain for the Tennessee River is the area below elevation 688.5 feet msl at TRM 484.5. The TVA flood risk profile (FRP) elevation on the Tennessee

River is elevation 689 feet msl at TRM 484.5 (Roger Milstead, TVA, personal communication, February 3, 2010). The FRP is used to control flood damageable development for TVA projects, and residential and commercial development on TVA lands. Hamilton County, Tennessee, has adopted the 100-year flood as the basis for local floodplain regulations, and any new or future development would be consistent with these regulations (CHCRPA 2009b).

For a "critical action," facilities must be protected to the 500-year flood elevation where there is no practicable alternative. A "critical action" is defined in the *Water Resources Council Floodplain Management Guidelines for Implementing Executive Order 11988* as any activities for which even a slight chance of flooding would be too great (43 FR 6030). One of the criteria used in determining if an activity is a critical action is whether essential and irreplaceable records, utilities, and/or emergency services would be lost or become inoperable if flooded. Some SQN facilities fall under the classification of a "critical action"; as such, facilities must be protected to the 500-year flood elevation where there is no practicable alternative. However, TVA would require that critical facilities must be protected to the FRP elevation, which is higher than the 500-year flood elevation. Based on this criterion, all facilities that would force the shutdown or curtailment of power generation, if flooded, would either be located above or flood-proofed to the FRP elevation (elevation 689 feet msl at TRM 484.5). Many of the support facilities that would not impact power generation if flooded would only be subject to evaluation using the 100-year flood (elevation 687 feet msl at TRM 484.5).

The NRC also requires a flood risk evaluation of possible impacts from the Tennessee River probable maximum flood (PMF) and local PMP site drainage. The SQN drainage system was analyzed for a storm producing the PMP on the local area. The site is graded such that runoff would drain away from safety-related structures to drainage channels and subsequently to the Tennessee River. The local area of the SQN plant site would pass the PMP runoff criteria without exceeding the SQN critical plant grade elevation of 706 feet msl. Most safety-related building accesses are located at elevation 706 feet msl or above. Accesses below elevation 706 feet msl are within the powerhouse and would not be exposed to flood water until plant grade is exceeded (TVA 2008a).

The PMF is defined as the most severe flood that can reasonably be predicted to occur at a site as a result of hydrometeorological conditions. It assumes an occurrence of PMP critically centered on the watershed, and a sequence of related meteorological and hydrologic factors typical of extreme storms. Based on the 2009 flood analysis re-verification, the Tennessee River PMF elevation at the SQN site with the current lock configuration at the Chickamauga Dam would be 722 feet msl, which would exceed the SQN critical plant grade elevation of 706 feet msl. The PMF elevation at the SQN site for the final lock configuration after the addition of a new lock at the Chickamauga Dam will also exceed plant grade.

3.3.2. Environmental Consequences

This section addresses the floodplain and flood risk-related impacts from site construction and operation of the Action and No Action Alternatives.

<u>Alternative 1 – License Renewal</u>

Alternative 1 (license renewal) allows for the continued operation of Units 1 and 2 for an additional 20-year period beyond the expiration dates of the current licenses. The license

renewal program would not require major new construction, alterations, or refurbishment to SQN to maintain consistency with the current licensing basis.

Because SQN has already been constructed and the major exterior accesses of existing safety-related structures are located at elevation 706 feet msl or above, those accesses are above the 100-year flood (687 feet msl) and FRP elevations (689 feet msl), and therefore the project is consistent with EO 11988. Elevations of the major exterior accesses of safety-related structures are also at or above the local PMP site drainage elevation of 706 feet msl. For conditions where the PMF (722 feet msl) exceeds plant grade, the equipment required to maintain the plant safely during the flood, and for 100 days after the beginning of the flood, is either designed to operate submerged, located above the maximum flood level, or otherwise protected (TVA 2008a). Because license renewal involves an existing nuclear generation facility that would not include any major refurbishment at the facility, continued operation of SQN would not increase the flood risk in the Chickamauga Reservoir watershed, and the plant would not impact upstream flood elevations.

The current on-site ISFSI does not have sufficient capacity to support license renewal. Spent fuel storage capacity would be expanded, under a separate action, by the addition of a separate additional concrete storage pad prior to exceeding on-site spent fuel storage capacity. The location of the new concrete pad has not been determined, but would be located outside of the 100-year floodplain (687 feet msl) and above the FRP elevations (689 feet msl), which would be consistent with EO 11988. If license renewal is approved, the planned expansion of spent fuel storage capacity would also meet NRC requirements to evaluate the facility for the effects of the PMF. In addition, all safety-related structures for a future storage site shall be either above or flood-proofed to the Tennessee River PMF elevation, including wave runup. Therefore, there would be no cumulative effects to flood risk associated with the implementation of Alternative 1.

Alternative 2 – No Action Alternative

If the No Action Alternative were chosen, SQN would shut down and begin decommissioning activities.

Alternative 2a and 2b – New Nuclear or Natural Gas-Fired Generation

Under Alternative 2a or 2b, no construction would occur at the SQN site. Construction and operation of a new nuclear plant for Alternative 2a or a new natural gas-fired plant would be at an alternative site. The physical location of the new construction for Alternative 2a or 2b is unknown. Because Alternative 2a involves a nuclear generating facility, the NRC requires a flood risk evaluation of possible impacts from the PMF and local PMP site drainage for the alternative site. Construction and operation of a new plant would introduce construction impacts and new incremental operational impacts. All proposed construction would be evaluated to ensure consistency with EO 11988. Proper standard erosion-control measures would be followed to minimize the potential for adverse impacts on floodplains.

Dredging could also occur for new construction. TVA likely would dispose of dredged material in an on-site spoils area above the 500-year flood elevation. Therefore, under EO 11988, dredging would be a repetitive action that would result in minor impacts.

Potential floodplain impacts during operation of a new plant would be mitigated, and potential impacts would be minor through the use of BMPs as well as consistency with the requirements of the EO 11988.

Most activities necessary to construct and operate a new natural gas-fired power plant (Alternative 2b) would be similar to those implemented under Alternative 2a and would have similar impacts on the floodplain at the new plant site because all proposed construction would be evaluated to ensure consistency with EO 11988.

3.3.3. Conclusion

Floodplain impacts would be expected to be minor during construction at potential alternative sites, depending on the location. Impacts to floodplains would be minor during operation for all alternatives.

Because of the DOE's delay in receiving spent fuel from nuclear utilities, and assuming current operating conditions, SQN has built an ISFSI that operates under a general license to temporarily store spent nuclear fuel on site. The ISFSI for SQN is dry storage (TVA 2002c), which could be supplemented with a separate additional concrete storage pad for increased storage requirements. Floodplain impacts due to any future additions or changes to the on-site ISFSI capacity are expected to be minor.

3.4. Wetlands

3.4.1. Affected Environment

Wetlands are areas inundated or saturated with surface water or groundwater at a frequency and duration sufficient to support, and under normal circumstances, do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Wetlands are regulated under Sections 404 and 401 of the CWA and addressed under EO 11990. To conduct certain activities in the "Waters of the U.S." that may affect wetlands, authorization under a Section 404 permit from the U.S. Army Corps of Engineers is required. Section 401 gives states the authority to certify whether activities permitted under Section 404 are in accordance with state water quality standards. TDEC is responsible for Section 401 water quality certifications in Tennessee. EO 11990 requires all federal agencies to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities.

To determine the presence of wetlands within the SQN boundary, the land cover table (Table 3-10) and National Wetland Inventory (NWI) wetland maps were reviewed. Table 3-10, derived from Figure 3-8, indicates 1.3 percent of the site is composed of woody wetlands. Emergent herbaceous wetlands do not exist on site. Areas labeled as woody

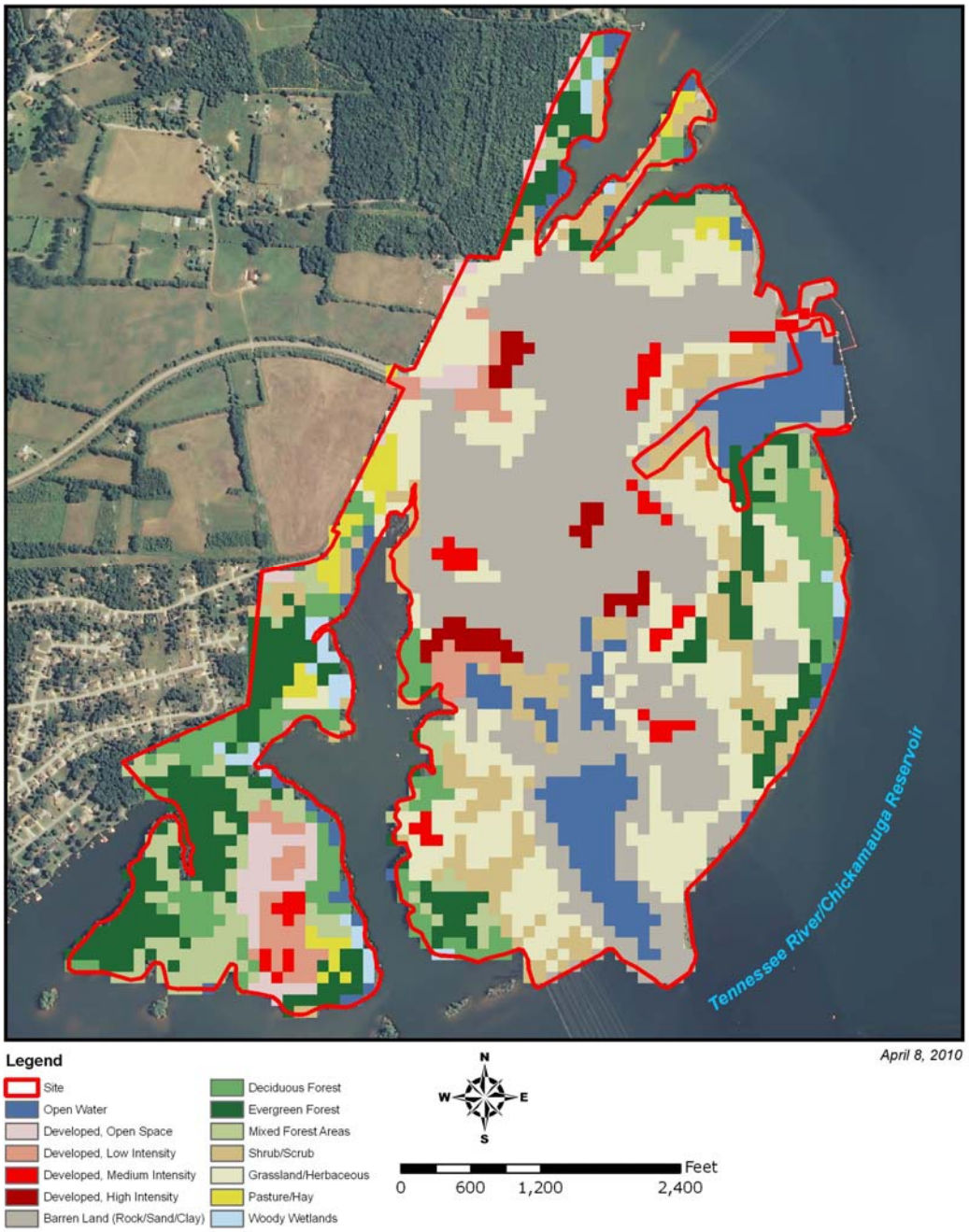

Figure 3-8. SQN Land Cover

wetlands on Figure 3-8 border the Chickamauga Reservoir. Additionally, a single, 0.88-acre wetland classified as PSS1C (palustrine, scrub shrub, broad leafed deciduous, seasonally flooded) is also located on the north side of the plant (Figure 3-9).

Table 3-10. SQN Land Cover

Category	Facility Percentage
Open Water	7.79
Developed – Open Space	2.43
Developed – Low Intensity	2.75
Developed – Medium Intensity	2.04
Developed – High Intensity	1.55
Barren Land (rock/sand/clay)	30.51
Forest – Deciduous	6.73
Forest – Evergreen	10.18
Forest – Mixed	6.69
Scrub/Shrub	9.3
Grassland/Herbaceous	16.88
Pasture/Hay	1.83
Wetlands – Woody	1.3
TOTAL	**100**

(USDA 2001)

NWI maps list most of the aquatic habitat within or adjacent to SQN as wetland acreage. On-site ponds carry the PUBHx (palustrine, unconsolidated bottom, permanently flooded, excavated) classification as defined using the Cowardin method of classification (Cowardin et al. 1979). Four wetland types exist along the Chickamauga Reservoir shoreline adjacent to the SQN site, including:

- L2AB3Fh – lacustrine, littoral, aquatic bed, rooted vascular, semi-permanently flooded, impounded.
- L2AB3Hh – lacustrine, littoral, aquatic bed, rooted vascular, permanently flooded, impounded.
- L2UBHh – lacustrine, littoral, unconsolidated bottom, permanently flooded, impounded.
- L1UBHh – lacustrine, limnetic, aquatic bed, rooted vascular, permanently flooded, impounded.

Figure 3-9. National Wetlands Inventory at SQN Site

Although Chickamauga Reservoir is a run-of-the-river reservoir, seasonal water level fluctuation within the reservoir is substantial enough to sustain wetland areas along the shore.

3.4.2. Environmental Consequences

This section addresses impacts to wetlands from site construction and operation of the Action and No Action Alternatives.

Alternative 1 – License Renewal

Under Alternative 1, no impacts to wetland are anticipated. The license renewal program would not require major new construction, alterations, or refurbishment to SQN to maintain consistency with the current licensing basis. However, expansion of the spent fuel storage capacity by addition of an additional concrete storage pad is assumed. Siting of the additional storage pad would not be in a wetland or other sensitive area. Additionally, the same programs, procedures, permits, and requirements would be followed. Because only minor changes are needed to implement this alternative, no new effects to wetlands are anticipated. Eventually SQN will be shut down and decommissioned, but it is not anticipated that decommissioning activities would have any effect on wetlands.

Alternative 2 – No Action Alternative

Under Alternative 2, the termination of the SQN license and eventual shutdown and decommissioning of SQN are not anticipated to affect area wetlands.

Alternative 2a and 2b – New Nuclear or Natural Gas-Fired Generation

The impacts of Alternatives 2a and 2b are similar and depend upon the locations chosen to site the new plants. They are discussed together below.

The impact to wetlands due to building a new natural gas-fired plant and associated transmission lines would range from minor to substantial depending on the physical location of the plant structures and the quantity and quality of wetlands within the potential plant footprint as well as along transmission line and pipeline corridors. A site-specific environmental review would be conducted to identify wetlands and measures to avoid, minimize, and mitigate impacts as appropriate. TVA actions would comply with the CWA and EO 11990.

3.5. Aquatic Ecology

3.5.1. Affected Environment

TVA has been routinely studying aquatic conditions within the Tennessee River, including Chickamauga Reservoir, as part of its vital signs monitoring program, implemented in 1990 (TVA 2006a). The vital signs monitoring program analyzes five different metrics (dissolved oxygen, chlorophyll, fish, bottom life, and sediment) measured over several different locations within the reservoir to determine a reservoir ecological health rating (Section 3.1). TVA uses its existing vital signs monitoring program collection sites, supplemented with additional fish and benthic macroinvertebrate (bottom life such as insects, mussels, worms, etc.) community monitoring upstream and downstream of SQN to evaluate the effects SQN may have on aquatic ecological communities.

Chickamauga Reservoir ecological health ratings have been classified as “good” in all but one sampling year from 1994 to 2009. In 2007, ecological health ratings for dissolved oxygen and bottom life dropped into the “fair” range. During low-flow years such as 2007, DO decreases along the bottom of the reservoir, which lowers the rating for the DO metric. DO and bottom life measurements are directly proportionate so the bottom life metric also decreased in 2007. Decreases in two of five metrics caused the decrease from “good” to “fair” in 2007.

Fish and macroinvertebrate sample collection is the backbone of the biotic portion of the monitoring program. Fish communities are used to evaluate ecological conditions because of their role in the aquatic food web, and because fish life cycles are long enough to integrate conditions over time. Twelve metrics are scored and summed to determine an overall reservoir fish assemblage index (RFAI) score for each sample collection site. (TVA 2004b)

Benthic macroinvertebrate populations are assessed using the RBI methodology. Because benthic macroinvertebrates are relatively immobile, adverse local impacts to aquatic ecosystems can be detected earlier in benthic macroinvertebrate communities in comparison to fish communities. (TVA 2004b) In the Chickamauga Reservoir, RFAI and RBI data are collected from established sites annually. Supplemental data collected from additional sites near SQN are used in conjunction with RFAI and RBI results to provide an understanding of reservoir conditions over time and determine the effects of various stimuli (e.g., drought conditions or SQN discharge).

Fish Community

In general, reservoir fish communities are different from those found in the river prior to impoundment due to the significant habitat alterations associated with impounding a river. Three flow regimes are common in reservoirs created by impounding rivers. Inflow sections are generally riverine in nature. Transitional zones are located in the mid-reservoir where water velocity decreases due to increased cross-sectional area, suspended materials begin to settle, and water clarity increases. (TVA 2006a) Algal productivity also increases in the transitional zone because of increased water clarity and reduced mixing, which allows the algae to remain in the photic zone, where light reaches, toward the surface of the water column. The forebay area is where water collects behind the dam. Water velocity is diminished and depth increases. (TVA 2005a)

Differences are expected in the fish community along the longitudinal gradient with a more riverine community expected at the upper end of inflow of a reservoir and a more lacustrine (similar to a lake) community expected in the pool near the dam. Other factors to consider in evaluating biotic communities in reservoirs include reservoir operation characteristics such as water depth, fluctuation, drawdown, retention time, stratification, bottom anoxia, substrate type, and stability.

The above factors must be considered in selecting aquatic community characteristics or expectations used to evaluate aquatic resource conditions. Given that reservoirs are artificial systems, TVA developed the RFAI to describe the health of resident fish communities in TVA reservoirs. (TVA 2005a)

The RFAI scores have an intrinsic variability that stems from several sources, including annual variations in air temperature and stream flow; variations in pollutant loadings from

nonpoint sources; changes in habitat, such as the extent and density of aquatic vegetation; and natural population cycles and movements of the species being measured (TVA 2009g).

TVA has conducted the RFAI program in Chickamauga Reservoir since 1993. Traditionally, RFAI data in Chickamauga Reservoir are collected from four sites: Chickamauga Reservoir inflow site, TRM 529.0; the transition site (TRM 490.5), which also acts as the SQN upstream site; the forebay site (TRM 472.3); and the Hiwassee River embayment site, HiRM 8.5, to provide information on the health of the fish community throughout the reservoir. (TVA 2006a) In 1999, a site was added at TRM 482.0 downstream of SQN to discern possible effects to the fish community from SQN discharge over time (TVA 2009g). Upstream and downstream sites are identified in Figures 4 and 5 of *Biological Monitoring of the Tennessee River Near Sequoyah Nuclear Plant Discharge Autumn 2009* (TVA 2010i).

SQN is physically positioned where reservoir characteristics shift from the transitional zone to the forebay. Therefore, the site upstream of SQN is scored with transition criteria, and the downstream site is scored using forebay criteria. Accurate comparisons can only be made between sites located in the same reservoir zone (i.e., transition to transition). The physical and chemical composition of a forebay is different than that of a transition; consequently, inherent differences exist among the aquatic communities (e.g., species diversity is often higher in a transition zone than a forebay zone). However, the RFAI is particularly useful in identifying changes at each site over time.

The average RFAI scores at these five sites over all sampling years have remained in the "good" range with a relatively low standard error (Table 3-11). The inflow and upstream sites have an average score of 45 ±0.91 and 45 ±1.23 (good), the downstream and Hiwassee River Embayment sites have an average score of 41 ±1.23 and 42 ± 0.92 (good), and the forebay site averages a score of 43 ±0.89 (good). Averages from 1993 – 1999 are similar to those from 2000 – 2009, indicating stability over time.

During 2008, the upstream site scored 10 points lower than the previous year while the downstream score remained the same. This was the only site in Chickamauga Reservoir that exhibited a decrease in the RFAI score (TVA 2009g). In 2009, the upstream site rebounded, scoring an RFAI of 41 (good) (TVA 2010i).

Interpretations of fish community changes are complex and multifaceted. Fish communities in reservoirs are subjected to highly variable water conditions (e.g., rate of spring warming, discharges, turbidity, water level fluctuation) that affect planktonic food chains, spawning times and success, early survival of different fish species, and interspecific competition between early life stages of fish species (TVA 1993b). RFAI score anomalies are expected in such a dynamic system.

As previously mentioned, TVA has been studying fish populations in Chickamauga Reservoir for decades using a variety of methods such as cove rotenone (using a toxicant to aid in the collection of all fish in a cove), gill netting, creel surveys, and electroshocking. At times, routine surveys indicate a changing population will trigger a focused study to determine reasons behind shifting populations. For example, declining numbers of white bass (*Morone chrysops*), white crappie (*Pomoxis annularis*), sauger (*Stizostedion canadense*), and channel catfish (*Ictalurus punctatus*) based on cove rotenone samples and harvest rates based on creel surveys prompted the Tennessee Department of Health and Environment and TWRA to express concern regarding these populations in 1986 (TVA

1991). TVA conducted four focused studies as a result of the concerns addressed by the State of Tennessee. The results of the four studies follow.

White bass provide year-round fishing on most Tennessee River reservoirs. They are early spring spawners (March – April) and mature adults congregate and run up tributary streams and into tail waters to spawn. White bass are known to transverse the Tennessee River system. Larval fish and egg studies indicate three primary spawning areas; the Hiwassee River, Sewee Creek, and Hunter Shoals. However, yellow bass (*M. mississippiensis)* appear to spawn in greater numbers in the same areas and likely compete for food and habitat. (TVA 1994) Movement of white bass past SQN during and after the spawning migration is apparently not impeded by SQN operation. Recapture of tagged white bass by fishermen in the vicinity of SQN did not indicate an attraction that would result in overharvest or a significant disruption of adult migration to the spawning areas. It seems likely that competition from yellow bass could be a major factor limiting the population of white bass in Chickamauga Reservoir. (TVA 1994)

White crappie populations were investigated in Chickamauga Reservoir from 1986 through 1989 in response to cove rotenone and creel data indicating a decline in the population. White crappie predominantly spawn in large embayments and smaller tributaries throughout the reservoir. The multi-year investigation revealed good survival through the early juvenile stage, but high mortality in their second summer as determined by aging otoliths (structure in the inner ear of vertebrates). Mortality of young crappie appeared to be correlated to an increase in aquatic vegetation, increased numbers of yearling sunfish, yearling largemouth bass, adult largemouth bass, and gizzard shad. Drought years from 1985 – 1988 caused decreased flow through the reservoir, which enabled aquatic vegetation to increase, effectively changing the habitat structure to a state less suitable for white crappie populations. Incidentally, changes that were unfavorable for white crappie proliferation had a positive effect on black crappie (*P. nigromaculatus*) populations. (TVA 1990a)

Population estimates of sauger in Chickamauga Reservoir declined progressively from 1986 – 1990. Sauger are considered a cool-water fish and migrate throughout the reservoir system (TVA 1994) to spawn at Hunter Shoals (TRM 521-522) (TVA 1995c), which is approximately 35 miles upstream of SQN. A thermal variance was approved for SQN in 1993 that raised the maximum instantaneous temperature increase from 3ºC to 5ºC from November through March (TVA 1995c). The sauger population was at a low density in 1993 prior to implementation of the thermal variance. In 1994, after the variance was implemented in November 1993, the resident sauger population was estimated at its highest level since 1986. No attraction to, or avoidance of, the SQN diffuser area was documented for fishermen or sauger based on a SQN creel survey and tags returned during 1993 and 1994. Critical factors determining reproductive success of sauger in Chickamauga Reservoir are an instantaneous minimum water flow of 8,000 cfs in the reservoir and a gradually increasing water temperature during the spawning period. When flow conditions are unsuitable for natural reproduction, stocking of fingerlings into the reservoir is an effective means of producing a viable year class. (TVA 1995c)

Channel catfish in Chickamauga Reservoir are important to both commercial and sport fisheries. Analysis of historical and recent data collected using a variety of sample methods failed to reveal any steadily declining trends in adult channel catfish densities in Chickamauga Reservoir from 1970 – 1990 (TVA 1991). Sport fishing data indicate the total number of channel catfish estimated harvested in 1989 (27,107) was second only to the number harvested during 1976, and estimated biomass in 1989 (23,700 kg) was the highest

for the period. Estimated harvest of channel catfish from Chickamauga Reservoir in 1988 and 1989 was much higher than from the mainstream reservoirs immediately upstream (Watts Bar) and downstream (Nickajack). Cove rotenone surveys revealed no significant trend in numbers or biomass of adult channel catfish after analysis of data from 1970 through 1990; however, both numbers and biomass of intermediate size and numbers of young-of-year channel catfish have shown a significant decreasing trend since 1970. Total number of channel catfish of all sizes increased in 1988 to the second-highest number collected since 1970. Gill net sampling in 1986 – 1990, which employed similar gear and methods during roughly the same time period each year, resulted in catch rates that again did not indicate declining abundance of channel catfish in upper Chickamauga Reservoir. (TVA 1991)

Trends in RFAI data over time indicate relative stability according to standard error calculations applied to annual RFAI scores (Table 3-11). As previously mentioned, fish communities are complex and multifaceted, and RFAI scores can change substantially from year to year. When RFAI scores indicate a possible trend, focused surveys are performed to determine probable causes of changes in the reservoir and appropriate mitigation. Analysis over time reveals increasing or decreasing trends are not apparent within the data, as evident by comparing the 1994 – 1999 average with the 2000 – 2009 average displayed in Table 3-11, thus indicating relative stability within the reservoir and effectiveness in TVA management.

Benthic Macroinvertebrate Community

Freshwater macroinvertebrate habitat includes aquatic vegetation, river, and reservoir substrates. The availability of food, nature of the sediment, and current flow generally constitute the primary factors determining the benthic macroinvertebrate distribution patterns. Food is usually the ultimate determinant of macroinvertebrate distribution and abundance. The majority of macroinvertebrates are nonselective feeders taking in a wide range of food substances of acceptable particle dimensions.

Benthic macroinvertebrates serve as a source of food for fish and other higher aquatic life. Presence and absence data can also provide information regarding macroinvertebrate habitat quality. Many species are sensitive to pollution and respond quickly (both positively and negatively) to changes in water quality.

Some have a relatively long and usually complex life cycle of a year or more, and their presence or absence helps describe environmental conditions over a period of time. Because most have limited mobility and are not subject to rapid migrations, they serve as natural monitors of water quality. (TVA 2006a)

Historically, the number and density of macroinvertebrates identified near SQN have been lower than other sampling locations within Chickamauga Reservoir. Substrate data near SQN indicate the silt-to-sand ratio within the substrate near SQN is far reduced from the silt-to-sand ratio measured at other sample locations and would not support as diverse a benthic community. (TVA 1986)

RBI scores are based on seven metrics or characteristics measured for each site (TVA 2004b). Similar to RFAI scores, RBI scores also have an intrinsic variability between samples. (TVA 2010i)

Table 3-11. Summary of RFAI Scores In Chickamauga Reservoir Since 1993

Station	Location	1993	1994	1995	1997	1999	1993 – 1999 Average	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2000 – 2009 Average
Inflow	TRM 529.0	52	52	48	44	42	48	44	46	48	48	42	42	42	42	44	44	45
Transition SQN Upstream	TRM 490.5	51	40	48	39	45	45	46	45	51	42	49	46	47	44	34	41	45
Forebay SQN Downstream	TRM 482.0	-	-	-	-	41	41	48	46	43	45	41	39	35	38	38	37	41
Forebay	TRM 472.3	43	44	47	40	45	44	45	48	46	43	43	46	43	41	41	34	43
Hiwassee River Embayment	HiRM 8.5	46	39	39	40	43	41	43	47	-	36	42	45	-	41	-	42	42

RFAI scores: 12-21 (very poor), 22-31 (poor) 32-40 (fair), 41-50 (good), 51-60 (excellent)
(TVA 2010i)

Six sites sampled for benthic macroinvertebrates include two inflow sites at TRM 527.4 and 518.0, one transition site at TRM 490.5 (SQN upstream site), two forebay sites at TRM 482.0 (SQN downstream site), and TRM 472.3 and HiRM 8.5. Average RBI scores in Chickamauga Reservoir were good except for the site at the HiRM, which scored an average of 23 (fair), aided by one very low RBI score in 2007 (see Table 3-12). (TVA 2009g) The year 2007 was a low-flow year for Chickamauga Reservoir. DO levels dropped in the reservoir, which likely affected benthic macroinvertebrate communities negatively, contributing to the low RBI score.

Benthic macroinvertebrate data collected during 2008 from TRM 490.5 upstream of SQN and 482.0 forebay downstream of SQN, revealed an RBI score of 17 (poor) and 25 (good), respectively. The downstream site was similar to past sampling events; however, the upstream site was uncharacteristically low in 2007 and 2008. The upstream sampling site also received lower RBI scores from 2000 to 2002 but returned with an “excellent” score in 2003 (TVA 2009g). This likely represents natural variation in benthic communities and not a decline related to SQN operation.

RBI variability over time is slightly higher than RFAI variability likely due to sampling protocol and the relative immobility of macroinvertebrates when compared to fish. When sampling for macroinvertebrates, often habitats with high invertebrate concentrations are adjacent to areas of low concentration, which leads to increased variability with regard to invertebrate concentration among samples. (TVA 2005a) For the sampling locations near SQN, some RBI variability is evident from year to year, but no increasing or decreasing trends are apparent. In comparing the averages from 1994 – 1999 and 2000 – 2009, little change is evident, which implies relative stability within the macroinvertebrate community.

As a subset of macroinvertebrates, mollusk populations have been studied throughout the TVA reservoir system since the early 20th century. In 1918, Ortmann documented the freshwater mussel fauna of the upper Tennessee River and concluded that it was the most prolific region in the world for this fauna (Ortmann 1918). In the 1960s, Scruggs and Isom reported the dramatic decline of mussels in the river system, including the reach between Chickamauga Dam (TRM 471) upstream to Watts Bar Dam (TRM 530), citing loss of habitat from impoundment, overharvesting, and water quality degradation as causes (Scruggs 1960; Isom 1969). Isom concluded that suitable habitat for mussels within Chickamauga Reservoir only occurred for 29 miles downstream of Watts Bar Dam with effects of impoundment (e.g., sediment accumulation) as a continuing problem (Isom 1969).

TVA’s 1974 FES on SQN (TVA 1974a) recognized the presence of freshwater mussels (Family: Unionidae) and an active mussel harvest practice within Chickamauga Reservoir during TVA's initial environmental review of the facility; however, it reported that the mussel harvesting activity and a state mussel sanctuary both occurred quite some distance from SQN (i.e., between 24 and 40 miles upstream of SQN in the tail waters of Watts Bar Dam). In 1978 TVA conducted a widespread survey of the mainstem Tennessee River using scuba diving to document the status of freshwater mussels and snails throughout portions of reservoirs between Kentucky Dam and Fort Loudon Dam (TVA 1979); survey efforts in Chickamauga Reservoir included only a 15-mile reach downstream of Watts Bar Dam (i.e., TRM 514.2 – 529). TVA collected 21 species at sites between TRM 520.0 – 521.0 and TRM 526.5 – 528.1, which included the now federally listed as endangered pink mucket (*Lampsilis abrupta*) and dromedary pearly mussel (*Dromus dromas*) at community frequencies of 0.4 and 0.2 percent or less (TVA 1979).

Table 3-12. Summary of RBI Scores in Chickamauga Reservoir Since 1994

Station	Location	1994	1995	1997	1999	1994 – 1999 Average	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2000 – 2009 Average
Inflow	TRM 527.0	-	-	-	-	-	-	29	27	33	35	31	-	23	23	23	28
Inflow	TRM 518.0	19	31	25	21	24	23	29	23	27	35	29	33	25	-	31	27
Transition SQN Upstream	TRM 490.5	33	29	31	31	31	23	25	25	31	31	31	27	21	17	27	27
Forebay SQN Downstream	TRM 482.0	-	-	-	-	-	23	31	29	29	33	31	31	25	25	23	28
Forebay	TRM 472.3	31	27	29	25	28	27	27	21	27	29	27	29	19	25	23	26
Hiwassee River Embayment	HiRM 8.5	17	27	25	21	23	-	21	-	31	-	25	-	13	-	19	23

RBI scores: 7-12 (very poor), 13-18 (poor) 19-23 (fair), 24-29 (good), 30-35 (excellent)
(TVA 2010i)

Ahlstedt and McDonough (1996) reported pre-operational mussel monitoring data (1982 – 1993) from near WBN at TRM 528, which documented the persistence of the endangered pink mucket, but an overall reduction in species and recruitment for most mussel species near WBN prior to operation. In September 2010, TVA surveyed mollusks (mussels and snails) and habitat at three sites that had been surveyed for mussels prior to operation (1983 – 1994) and after operations (1996 – 1997) started at WBN (Third Rock 2010c). The 2010 survey recorded a total of 17 species, including one, old individual each of the federally endangered pink mucket and the proposed endangered sheepnose mussel. Mean mussel density in 2010 was 1.2 mussels/square meter (m^2) and mean catch per hour was 86.1 mussels/hr (Third Rock 2010c). Thus, measures of mussel abundance and species richness in 2010 were very similar to those measured near WBN just before and after its operations began (1992 – 1997).

In addition to mussels, aquatic snails are also an important ecological component of the Tennessee River system, and are considered a highly imperiled taxonomic group within the southeastern United States. Although the TVA Natural Heritage Database (June 2010) indicated no records of state or federally listed aquatic snails within ten miles of SQN, apparently no studies dedicated to assessing the aquatic snail community near SQN have been reported. Data from TVA's RBI monitoring efforts in 2001 – 2009 indicated that aquatic snails are commonly found in Chickamauga Reservoir near SQN (TRM 490.5 and 482.0) at densities averaging 27.7 snails/m^2 (range = 0.0 – 106.7 snails/m^2) among both sites over the nine-year monitoring period. No state or federally listed snail species have been collected at the monitoring sites since the start of monitoring in 2001; however, the RBI monitoring efforts were not meant to fully characterize snail or macroinvertebrate communities, but rather to provide general indications of benthic community health. Few snail taxa have been collected to date from the monitoring sites near SQN. In 2010, TVA's evaluation of the mollusk community near its WBN facility (TRM 528) upstream from SQN found only two species of snails, which occurred at mean site densities ranging from 0.03 to 0.43 snails/m^2 (Third Rock 2010c).

In 2010, TVA conducted a survey of the Tennessee River near SQN (Third Rock 2010a) to document the existing mollusk community (unionid mussels, aquatic snails, and zebra mussel infestation) and habitat conditions in areas that may be affected by plant operations and areas outside the range of potential effects from SQN. TVA studied four sites in the Tennessee River adjacent to SQN in areas that may be affected by plant operations as well as four sites in areas that would not be affected by potential impacts from SQN. Areas most likely to be affected by SQN operations include the water intake and associated skimmer wall, coolant water diffusers and associated mixing zone, and a submersed dam in the historical river channel downstream of the intake site used to help retain colder deep water near the plant intake.

The survey showed that all sites near SQN support relatively low-diversity, low-abundance mussel and snail communities. The study found a total of 280 mussels representing 10 species and 281 snails representing four species. No federally listed mussel or snail species were collected (live or dead) during the study. Mean mussel density among all sites was 0.05 mussels/m^2 from semi-quantitative samples and 0.18 mussels/m^2 from quantitative samples. The highest mussel density of any site was 1.8 mussels/m^2 for any semi-quantitative sample and 0.30 mussels/m^2 for quantitative samples. (Third Rock 2010a)

Mussel species richness and density in the SQN study area are very low compared to other areas of the Tennessee River that still support viable mussel communities (since impoundment), particularly those with listed species like pink mucket. In areas of the mainstem river that still retain quality mussel habitat, species richness typically exceeds 15 species and can exceed 25 species. Mussel densities in these areas are usually two orders of magnitude greater than that observed near SQN (MCD 2006; Dinkins 2008, LEC 2008, Third Rock 2010b). Another indication that the area near SQN does not provide suitable habitat to many mussel species was the lack of apparent recruitment (e.g., very few young individuals) and overall lack of generally suitable substrate conditions throughout the study area (Third Rock 2010a).

Overall mean snail density was 0.2 snails/m^2 from semi-quantitative samples and 1.39 snails/m^2 from quantitative samples. The highest sample densities for snails were 2.90 snails/m^2 (semi-quantitative) and 0.40 snails/m^2 (quantitative) at Sites 5 and 6, respectively (Third Rock 2010a). Like the pattern observed for mussels, general snail abundance was greatest at Sites 5, 6, and 7, which were sites closest to the SQN mixing zone. Because snail habitat (preferably larger rock particles such as cobble, boulder, and bedrock) was sparse throughout the study area, it is not surprising that snail densities were very low at all the sites. Information on snail density is obscure within the Tennessee River mainstem, but in comparison to TVA's monitoring sites at TRM 482.0 and 490.5 where densities averaged 36.3 and 19.1 snails/m^2, respectively, it appears that habitat throughout the SQN study area tends to be poor for snails.

Plankton Communities

Plankton communities are composed of both microscopic and macroscopic algae (phytoplankton) and animals (zooplankton as well as bacteria and various larval forms of free-living and sessile organisms). Similar to terrestrial vascular plants, planktonic algae use energy from the sun and elemental nutrients in the water to transform carbon dioxide into the organic material of their cells. These organisms provide the basis for the food web of aquatic systems and are the principal food of most of the zooplankton and some fish species. Generally, plankton densities in Chickamauga Reservoir increase from upstream to downstream under normal flow regimes (TVA 1990b). However, occasionally reduced cell counts occur at the diffuser location and are thought to be a result of the mixing of the plankton-rich upper and plankton-poor lower stratum caused by the diffuser action in warmer months where stratification is evident in the reservoir rather than a true reduction in plankton cells (TVA 1989).

The plankton community also includes ichthyoplankton, which are the eggs and larvae of fish found mainly in the upper reaches of the water column. The eggs are passive and drift with the water currents. Most fish larvae have a temporary free-floating stage prior to developing the ability to swim effectively. Eggs of some fish species float possibly as a dispersal mechanism and to improve the survival rate of the larvae. Other fish eggs are demersal (i.e., suspended on and or just above the bottom), and some are attached to various substrates. The free-floating eggs are more susceptible to entrainment because they are subject to the currents.

Fish eggs from four locations adjacent to SQN were sampled in 1985. A total of 35,257 eggs were collected in 685 samples. Freshwater drum (*Aplodinotus grunniens*) eggs comprised 99.5 percent of the total (TVA 1986).

Fish larvae collected in 1985 from 685 samples near SQN totaled 121,370. Species of shad dominated at 61 percent of the total followed by sunfish (*Lepomis* spp.) at 17 percent (TVA 1986).

3.5.2. Environmental Consequences

This section addresses impacts to aquatic species from site construction and operation of the Action and No Action Alternatives.

Alternative 1 – License Renewal

Under Alternative 1, no changes in effects to aquatic ecology are anticipated. Impingement and entrainment of aquatic organisms are the most common impacts associated with the intake of water for cooling purposes. Impacts of discharging heated water and chemical treatments back to the reservoir are also of concern for an operational nuclear plant. Thermal plumes within the reservoir can at times attract fish to the warmer water when ambient temperatures are cooler than ideal or repel fish, thus impeding natural migrations through the system. Ongoing impacts of these types, which would continue under Alternative 1, are explained in detail below.

Entrainment

During operational monitoring at SQN from 1981 through 1985, the average hydraulic entrainment of fish larvae was estimated to be 2.8 percent of those passing the plant. In order to compare current level of larval fish and hydraulic entrainment with data collected during operational monitoring, ichthyoplankton sampling was conducted from April through July 2004 (Table 3-13). (TVA 2006b)

In calculating entrainment estimates, one or two species usually comprise a high percentage of the total composition (larvae and eggs), as is the case with clupeids (shad) and freshwater drum in the vicinity of SQN. Freshwater drum spawn in open water while shad spawn near shore, and each female produces thousands of eggs, creating areas in the reservoir with high densities of fish eggs and early larvae. As these high density pulses of eggs and larvae drift downstream, their occurrence within a sampling area during a sample collection, either near the plant intake or in the open reservoir, may substantially affect individual, periodic entrainment estimates. (TVA 2006b) In 2004, freshwater drum eggs comprised 98.8 percent of the total fish eggs collected during all twelve sample periods, demonstrating the extended spawning season for this species. Densities peaked on May 25 at 4,433/1,000m^3 in reservoir samples and on June 2 at 1,594/1,000m^3 in samples collected near the intake. Average seasonal densities for drum eggs were 549 and 652/1,000m^3 in the intake and reservoir samples, respectively. (TVA 2006b)

The estimated total transport of fish eggs (primarily drum eggs) past SQN during 12 weekly sample periods between April 20 and July 12, 2004, was 5.4 billion. The seasonal entrainment estimate for drum eggs was 11.2 percent. (TVA 2006b)

The estimated total transport of fish larvae past SQN during the 12 sampling events from April through July in 2004 was 9.8 billion. Clupeid (shad) larvae comprised 87.9 percent of this total and were entrained at a rate of 15.4 percent of the total passing the plant. The overall estimated rate of entrainment for total fish larvae was 15.6 percent, driven by clupeids as the most dominant taxon. Average seasonal densities of clupeids in the intake vs. reservoir samples were 2,249 and 3,465/1,000m^3 respectively. (TVA 2006b)

Relative abundance for all taxa of larval fish collected during the twelve weekly sample periods of 2004 was dominated by clupeids (87.9 percent), *Morone* (5.5 percent), freshwater drum (3.2 percent), and centrarchids (3.1 percent). Total number of larvae collected for all taxa was 52,881. (TVA 2006b)

Hydraulic entrainment is the portion of Chickamauga Reservoir diverted into the plant by SQN. During the twelve sampling events from April through July 2004, hydraulic entrainment averaged 24.2 percent with a range of 7.4 to 111.1 percent. The peak hydraulic entrainment occurred on May 18, and the lowest was recorded on June 30. The entrainment estimate of 111.1 percent on May 18 was a result of zero release at Chickamauga Dam and 7,100 cfs average release from Watts Bar Dam. (TVA 2006b) The closing of Chickamauga Dam accompanied by minimal releases from Watts Bar Dam causes a temporary sloshing effect within the reservoir. Downstream flow is hindered and at times can be reversed until the reservoir establishes equilibrium. When the flow is substantially reduced or even reversed adjacent to SQN, hydraulic entrainment percentages increase because hydraulic entrainment calculations compare the amount of water flowing past SQN to the amount of water flowing into SQN.

Seasonal mean hydraulic entrainment was 12.2 percent in 1985 compared to 24.2 percent in 2004. Higher hydraulic entrainment was likely the result of a lower reservoir flow rate caused by lower than average runoff from rainfall. This also influenced the total entrainment rate of 15.6 percent for larval fish, which was the highest ever recorded. (TVA 2006b) Sample methods used to collect fish eggs and larvae during 2004 were only slightly different than those used in 1985.

Estimated entrainment of freshwater drum eggs was 11.2 percent in 2004 compared to 16.6 percent in 1985. Drum larval entrainment was estimated at 30.2 percent in 1985 compared to 45.4 percent in 2004. Considering that hydraulic entrainment doubled from 1985 to 2004, this increased rate of entrainment estimated for drum larvae could be expected. Historical data led to the conclusion that substantial spawning by freshwater drum occurs in the vicinity of, or slightly downstream of SQN, producing eggs and larvae that are not subjected to plant entrainment. Even though seasonal larval drum entrainment was abnormally high (45.4 percent) during 2004, it was primarily attributed to the May 18 sample period when the peak density occurred simultaneously with peak hydraulic entrainment (111 percent). (TVA 2006b)

Effects of entrainment on fish communities are measured through the RFAI program outlined in Section 3.5.1. Community assessments in Chickamauga Reservoir near SQN indicate no substantial impacts from current operations of SQN on the fish community near the plant. Furthermore, recent data support conclusions presented in the 1986 historical assessments. Results demonstrate annual variations in the relative abundance and spatial temporal distribution of fish, and fluctuations in reservoir flow are common near SQN. Life history aspects, dynamics of drifting larvae, and fluctuation in reservoir flow past SQN are the primary factors influencing variations observed in the annual entrainment estimates. Variations in fish density and reservoir flow in the Chickamauga transition zone have apparently had little effect on the fish community. (TVA 2006b) Based on the 2004 evaluation and annual RFAI scores for Chickamauga Reservoir, a viable balanced indigenous fish community is present in Chickamauga Reservoir near SQN. Effects of SQN entrainment on fish populations in Chickamauga Reservoir are considered minor. As no change in the amount of water withdrawn is planned, no incremental entrainment impacts would be expected.

Table 3-13. Historical and Current Entrainment Percentages for Fish Eggs and Larvae at SQN for the Years 1981 – 1985 and 2004

	1981	1982	1983	1984	1985	2004
Eggs						
Sciaenidae Freshwater drum	6.7	41.4	22.6	9.7	16.6	11.2
Larvae						
Clupeidae Shad	2.1	1.5	2.7	1.8	1.1	15.4
Cyprinidae Minnows	4.3	4.2	5.9	2.3	3.1	72.6
Catostomidae Suckers	0.0	0.0	6.1	2.6	0.0	0.0
Ictaluridae Catfish	8.4	7.7	9.1	45.9	27.8	0.0
Moronidae Temperate Bass	1.7	2.7	4.8	2.2	2.46	5.0
Centrarchidae Sunfish	1.0	1.8	1.1	0.6	0.7	24.2
Percidae Perch	3.6	1.6	10.7	1.6	3.5	0.0
Sciaenidae Freshwater drum	5.5	25.6	57.8	22.7	30.2	45.4
Total Larvae	2.3	2.2	4.7	2.3	2.6	15.6

(TVA 2006b)

Impingement

Impingement rates were initially monitored to detect impacts to the fish community. In the years monitored, threadfin shad were consistently the most abundant species impinged largely because they have a high fecundity rate, move in large schools, and are intolerant to cold temperatures, often resulting in high mortality rates in winter. In 1985, bluegill (*Lepomis macrochirus*), freshwater drum, yellow bass, and skipjack herring (*Alosa chrysochloris*) also comprised 5 – 7 percent of total numbers impinged. (TVA 1986)

Impingement data during the first seven months of 1985 were similar to the previous four years (i.e., low numbers which do not constitute an adverse environmental impact to the populations of fishes in Chickamauga Reservoir). The 1985 data thus confirmed the conclusion at the end of 1984, that sufficient impingement monitoring has been done to evaluate the impacts of plant operation. (TVA 1986)

In response to the EPA issuance of a 2004 rule for implementing Section 316(b), a rule subsequently suspended in 2007, and in accordance with a proposal for information

collection submitted to TDEC in 2005, TVA conducted additional impingement monitoring at SQN to update the impingement database for potential intake effects.

Weekly impingement sampling at SQN from January 2005 to January 2007 resulted in collection of 2,889 fish (22 species) during the first year (January 25, 2005 – January 23, 2006) and 5,766 fish (21 species) during the second year (January 30, 2006 – January 15, 2007). Threadfin shad predominated (91 percent) in the samples, followed by bluegill (2 percent), freshwater drum (2 percent), and channel and blue catfish (1 percent each). All other species contributed less than 1 percent of the total number collected. Rate of impingement was highest during November and December during the first year, while peak impingement occurred during August, October, and November during the second year. Estimated impingement was calculated by extrapolating impingement rates from weekly samples. An estimated 20,223 fish were impinged during the first year and 40,362 during the second. Estimated impingement during the second year was more than double the impingement estimate during the first year due to collection of more than double the threadfin shad. (TVA 2007d)

To determine the impacts impingement has on fish populations, models that estimate the number of impinged fish which would have been expected to survive to either harvestable size/age or to provide forage for other fish were applied to the number of fish impinged for the first (2005 – 2006) and second (2006 – 2007) year of the study. The numbers of fish representing SQN's biological liability for the first and second years of the study were 1,868 and 821, respectively. (TVA 2007d)

Effects of impingement on fish communities would be detected through the RFAI program. SQN operations do not appear to affect community assemblage in Chickamauga Reservoir. Therefore, the effects of impingement on fish populations residing in Chickamauga Reservoir are minor. As no change in the amount of water withdrawal is planned, no incremental impacts with regard to impingement would be expected.

Discharge

Water leaving the condensers can be routed in one of three ways: (1) to the diffuser pond and out the diffuser pipes (open mode); (2) through the cooling towers, then to the diffuser pond and out the diffuser pipes (helper mode); or (3) through the cooling towers and recirculated to the intake (closed mode) with blowdown being discharged through the diffuser pipes. An underwater dam crosses the river channel 75 m upstream from the diffuser, decreasing the likelihood of any warm water wedge extending upstream from the thermal discharge to the plant intake, and impounding cooler water from lower strata of the reservoir near the intake.

Heat shock to reservoir inhabitants is a site-specific impact dependent on characteristics of the discharge stream and receiving waters. Data for hourly dam releases for winter periods (November through March) over 13 years (1976 – 1989) were used to run a finite-difference, unsteady flow model to evaluate the instantaneous river flows at SQN. Based on this simulated computer model, SQN would have exceeded the 3ºC temperature rise limit 27 percent of the time (on an hourly basis) and a 4ºC limit 4 percent of the time during November through March between 1976 and 1989. However, based on 1993 – 1994 and 1994 – 1995 SQN operational data during the field investigations, a water temperature rise of more than 3ºC occurred only once on January 1, 1995. (TVA 1995b)

During normal plant operation, cooling water is discharged into a discharge pond and then into Chickamauga Reservoir. In 1992, TVA submitted a request to increase the temperature change limit in the SQN NPDES permit to 5ºC from 3ºC. A thermal monitoring program was designed to determine if the additional heat load to Chickamauga Reservoir would affect fish populations within the reservoir. SQN operational data during the 1993 – 1994 and 1994 – 1995 field investigations indicate an increase in water temperature beyond 3ºC is an uncommon event for SQN. (TVA 1995b)

The mixing zone downstream of the diffusers is 750 feet wide (TVA 1979) and extends 1,500 feet downstream and 275 feet upstream of the diffusers. Measurements at the diffuser ports indicate the reservoir width, which includes the main or navigation channel and overbank areas inundated by impoundment, is approximately 2,000 feet (USDA 2009c). The main or navigational channel width is approximately 900 feet in the reservoir section adjacent to the plant. The cooling water discharge to the Chickamauga Reservoir is discharged from two 350-foot-long diffusers that extend into the navigational channel.

Over half the width of the reservoir at the SQN site is unaffected by the plume, leaving ample room for mobile species to avoid the plume when traveling the length of the reservoir. Data collected near the SQN diffuser from gillnets, creel census, and fishermen pressure counts during cold weather (November through March) found fish are neither attracted to nor avoid the thermal plume (TVA 1995b). Furthermore, the determination has been made that shellfish, fish, and wildlife are protected by the current discharge regime (TDEC 2011). Therefore, thermal impacts to aquatic species in Chickamauga Reservoir are small.

White bass, white crappie, sauger, and channel catfish have been considered species of concern in Chickamauga Reservoir due largely to their importance as sport fish and various levels of population decline in the 1980s (TVA 1991). Plant operations, including the discharge plume, were evaluated for all four species. No instances of attraction or avoidance of the thermal plume were detected for fish species within the Chickamauga Reservoir (TVA 1990a; TVA 1991; TVA 1994; TVA 1995b). Additionally, relatively constant RBI scores from 2000 – 2009 at TRM 482 indicate the thermal plume is not affecting benthic macroinvertebrates downriver of SQN (TVA 2010i).

Low concentrations of radioactive effluents and treatment chemicals may be present in the cooling water discharge stream during regular operation. Most liquid radioactive effluents from SQN flow into the cooling tower blowdown line that empties into the diffuser pond before being discharged into Chickamauga Reservoir. ERCW discharge flow in the return channel is diverted to the cooling tower blowdown line and monitored to ensure adequate dilution of the liquid radioactive effluent before discharge into the diffuser pond. The turbine building sump is a potential additional source of radioactive effluent in the event of a primary to secondary leak, such as a steam generator tube rupture, resulting in radioactive materials carried over into the secondary wastewater sump system. When the sump is nearly full, the liquid is automatically discharged to the low-volume waste treatment pond or the yard drainage pond. Water in the yard drainage pond overflows and drains by gravity to the diffuser pond, from which it flows to the river via the diffusers. Release of radioactive materials in liquid effluents results in minimal radiological exposure to biota. Radiological monitors and laboratory analysis ensure impacts on aquatic life from radiological releases are minor (Section 3.17).

In drought years, DO levels have been low in Chickamauga Reservoir adjacent to the plant when the reservoir stratifies during summer months. During stratification events, DO levels in the bottom portion of the reservoir become anoxic or nearly anoxic. Water temperature and DO have an inverse relationship. Because cooling water is collected from the lower reaches of the reservoir and then heated above ambient reservoir water temperatures, DO would be expected to be lower in the cooling water discharge stream. Under normal flow, reduction of DO in the blowdown stream is estimated to lower DO less than 0.1 milligrams per liter (mg/L). During extreme low-flow conditions, DO reductions of 0.5 mg/L could be measured as a result of lower DO in the cooling water discharge stream (TVA 1990b). From 1982 – 1985 DO levels decreased 1.17 mg/L from TRM 484.1 to 483.5 (TVA 1986), indicating an additional cause of decreased DO unrelated to plant operations.

Low-flow events encourage stratification with regard to DO as well as temperature. Localized mixing as would be expected at the plant intake and discharge would cause the low DO water at the bottom to mix with the higher DO water at the top, which decreases DO in the upper strata but raises DO in the lower strata. The state criterion for DO is 5 mg/L at a depth of 5 feet. In 1982 and 1985, DO concentrations measured during the summer sampling event at a depth of 5 feet were below the criterion at TRM 483.4 (downstream of the diffuser). Decreased DO concentrations downstream of the diffusers were likely a function of decreased DO in the cooling water discharge stream coupled with mixing action attributed to the underwater dam. (TVA 1986)

When lowered DO levels were measured adjacent to the plant in 1985, a net gain in DO was observed between the Watts Bar tailrace and the Chickamauga tailrace, indicating the low DO adjacent to the plant was localized and temporary (TVA 1986). Additionally, DO measurements collected in August from 1990 to 2009, at a depth of 1.5m (4.9 ft) at TRM 490.5 (nearly 7 miles upstream of the SQN discharge) averaged lower (6.15 ± 0.28 standard error) than DO measurements collected on the same date and depth at TRM 472.3 (about 11 miles downstream of the SQN discharge) (7.10 ± 0.20 standard error). If the SQN discharge had any lasting effect on DO levels in Chickamauga Reservoir, DO measurements would be lower downstream of the discharge.

Operating SQN has little effect on the chemical composition of the water used for cooling. Comparison of preoperational and post-operational levels of alkalinity as calcium chloride ($CaCO_3$), nutrients, minerals, and metal concentrations within the reservoir were similar. Comparisons of intake and discharge water in 1985 revealed significant ($\alpha = 0.10$) differences in sodium, sulfate, and zinc. Although differences were quantifiable, they were not of a magnitude that would change overall water quality (TVA 1986), nor affect the plant's ability to meet water quality standards, and would not, therefore, reduce habitat quality for reservoir inhabitants.

Additional sampling in 1988 and 1989 revealed concentrations of aluminum in the diffuser pond that exceed the chronic toxicity level. Lead concentrations also exceeded the chronic toxicity criterion in the diffuser pond in 1989. Whole effluent toxicity analysis was performed to ensure effluent was not toxic to organisms within the reservoir. Most whole effluent toxicity tests failed to identify toxicity. On the few occasions when toxicity was documented, flows in Chickamauga Reservoir were more than sufficient to avoid toxicity in the receiving water. (TVA 1990b)

In addition to the planned discharges discussed above, accidental discharges are also possible. Routine maintenance activities may result in rare unplanned chemical or

petroleum spills near water that could, in turn, affect aquatic life. Adherence to the current SPCC plan would limit the likelihood that any such spills would reach aquatic habitat.

Conclusion

The 2004 316(b) data and recent fish community assessments in Chickamauga Reservoir near SQN, including focused studies on four fish species, show no substantial impacts from current operation of SQN on the fish community near the plant. Furthermore, current 316(b) data support conclusions presented in the 1986 historical assessments. Results demonstrate that annual variations in the relative abundance and spatial temporal distribution of fish and fluctuations in the reservoir flow are common in the vicinity of SQN. Variations in fish density and reservoir flow in the Chickamauga Reservoir transition zone have had little apparent effect on the fish community. Based on the 2004 316(b) evaluation and the annual RFAI scores for Chickamauga Reservoir, a viable balanced indigenous fish community is present in Chickamauga Reservoir in the vicinity of SQN. (TVA 2006b)

TVA has been monitoring conditions within Chickamauga Reservoir annually using a thorough, comprehensive monitoring plan for over a decade. Impacts to aquatic biota associated with the intake and discharge of cooling water are small and do not appear to adversely affect aquatic populations individually or cumulatively.

Alternative 2 – No Action Alternative

The No Action Alternative is the result of the decision not to extend operation of the SQN units past the current expiration dates of the operating licenses. However, this could lead TVA to a decision to replace the resulting loss of the approximately 2,400 MWe base load generation upon shutdown of SQN. Given the need for adequate replacement power generation, TVA has evaluated in detail two alternative means of doing this.

Alternative 2 would also require the shutdown of SQN. Should SQN cease to operate, impacts associated with intake and discharge of SQN would also cease. Impingement, entrainment, and the presence of a thermal discharge plume associated with SQN would no longer affect the aquatic environment. However, impacts to the aquatic biota as a result of SQN operation are minor, and effects to aquatic populations have not been observed.

Alternative 2a – New Nuclear Generation

Effects to aquatic ecosystems associated with building a new nuclear plant would vary depending on the physical location of the plant, the location of the intake and discharge structures, and the type of cooling employed by the plant.

Construction impacts to aquatic ecology are usually preventable by using industry-approved standards to contain sediment runoff and accidental spills. Construction along the banks or in a body of water can be mitigated by using BMPs. However, temporary and localized effects such as increases in turbidity would be expected.

Should dredging be necessary, loss of the local benthic community and temporary increases in turbidity would be expected. Pre-dredge conditions should return as benthic communities re-colonize the area and suspended solids settle out of the water column. Effects from dredging would have only minor direct and indirect effects on aquatic communities.

Effects of operation to aquatic habitat would depend on the nature of the source water quality. The source water for cooling in a plant using a closed-cycle cooling system is concentrated up to four times in the cooling tower operations before being discharged as wastewater blowdown, which concentrates the potential impurities already dissolved in the source water. However, the blowdown stream and all wastewater discharges would be regulated by and in compliance with the site-specific NPDES permit.

Impingement and entrainment effects of operation would also be dependent on the quality of the source water and organisms residing within the local habitat. Intake velocities are required to adhere to 316(b) of the CWA (33 USC Section 1326), which minimizes impingement of aquatic organisms. Intake and discharge volumes are lower from plants using a closed-cycle cooling system (as opposed to a once-through system), but the volume of water required increases as the source water quality decreases (as water quality decreases fewer cycles of concentration are possible), which may affect entrainment, impingement, and effects to organisms sensitive to a thermal plume. However, plants that use a closed-cycle cooling system consume more water through evaporation in the cooling towers than plants using a once-through cooling system.

Aquatic organisms susceptible to entrainment are usually planktonic, and thus quite small with limited swimming ability and subject to the motion of the water. The effects of entrainment would depend on local species residing in the source water and the percentage of source water being routed through the plant.

Cooling water discharge is at times warmer than ambient and causes a thermal plume within the receiving waters. Thermal plumes can impede migration of temperature-sensitive aquatic organisms. During winter months, a thermal plume might attract fish, which could increase predation or cause cold shock should the plant cease operation or the fish be chased out of the plume in an attempt to escape predation.

Additionally, discharge can contain contaminants associated with treatment of the intake water or normal plant operation. Depending on the contaminant load within the cooling tower blowdown stream, impacts could range from minor to substantial. However, an NPDES permit would be required prior to discharge and would regulate toxic substances entering receiving waters.

Impacts to aquatic ecology from building a new nuclear plant could range from minor to substantial depending on the plant design, organisms present, source water, and receiving water. Depending on the proximity of other industry affecting area ecology, cumulative effects may also be apparent.

Alternative 2b – New Natural Gas-Fired Generation

Effects to aquatic ecosystems associated with building a new natural gas powered plant would range from minor to substantial depending upon the physical location of the plant, the location of the intake and discharge structures, and the type of cooling employed by the plant. A natural gas-powered generation plant would employ a cooling system similar to that of a nuclear-powered generation facility. Although the intake demand associated with natural gas-fired generation is substantially less than that of a nuclear powered plant (14.4 MGD compared to 34.56 MGD [Section 2.2.2.1]), impacts associated with thermal and chemical discharge, and impingement/entrainment of organisms, would be similar as described under Alternative 2a.

3.6. Terrestrial Ecology

SQN is located within the Ridge and Valley ecoregion, also known as the Great Valley of East Tennessee. Ecoregions are areas of land or water within an ecosystem that contain a geographically distinct collection of environmental resources (e.g., species, natural communities, environmental conditions). Many state agencies use ecoregions to establish geographically specific environmental standards such as chemical and biological water quality. The Ridge and Valley ecoregion is a relatively low-lying region between the Blue Ridge Mountains to the east and the Cumberland Plateau on the west. As a result of extreme folding and faulting events, the roughly parallel ridges and valleys come in a variety of widths, heights, and geologic materials, including limestone, dolomite, shale, siltstone, sandstone, chert, mudstone, and marble. Springs and caves are relatively numerous. Present-day forests cover about 50 percent of the region. The ecoregion has great aquatic habitat diversity in Tennessee and supports a diverse fish fauna rivaled only by that of the Highland Rim ecoregion. (Griffith 1997)

SQN is an industrial facility where approximately 40 percent of the site is developed and includes a mix of barren land, urbanized open space, and low, medium, and high intensity improvements. SQN also comprises other areas such as open water, forests, grasslands, pastures, and wetlands (Section 3.4). A more detailed discussion of land use at SQN can be found in Section 3.13.8.

The terrestrial flora at SQN includes invasive plant species in habitats such as forest, grasslands, and pastures. Terrestrial species such as Chinese privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*), Japanese stilt grass (*Microstegium vimineum*), multiflora rose (*Rosa multiflora*), and Chinese bush clover or sericea lespedeza (*Lespedeza cuneata*) occur in small populations within these SQN environments and in surrounding areas as well. EO 13112, *Invasive Species,* (64 FR 6183), requires federal agencies like TVA to avoid actions that are likely to cause or promote the introduction or spread of invasive species. This EO defines an invasive nonnative species as any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, which is not native to that ecosystem, and whose introduction does or is likely to cause economic or environmental harm or harm to human health. Invasive nonnative plants can occur as trees, shrubs, vines, grasses, ferns, and forbs. Because they tend to lack many of the natural controls (e.g., insects, animals, and competing plants) that keep them in check in their native environments, they can spread rapidly and out-compete some native plants.

This section characterizes existing terrestrial plants and wildlife as well as invasive species on site and in the general vicinity of SQN, and states potential impacts resulting from implementation of the alternatives described in Chapter 2.

3.6.1. Affected Environment

3.6.1.1. Plants

Vegetation at the SQN site and in the general vicinity has been continuously disturbed via decades of agricultural activities and land development (e.g., residential, light commercial, infrastructure, farming, etc.). Construction of the SQN plant converted approximately 525 acres of mixed hardwood forest, pine forest, pasture and old field into buildings, parking lots, landscaped areas, and other industrial uses. In addition, approximately 2,700 acres of mixed-hardwood forest, hardwood forest, pine forest, pasture, etc. were converted into transmission line ROW (TVA 1974a).

Terrestrial plant communities were assessed during the initial environmental review for the construction of SQN Units 1 and 2; however, TVA's 1974 FES for SQN did not specify the on-site methodology for ecological surveys (e.g., aerial data, plots, transects, or cursory paths) (TVA 1974a). It is assumed that on-site surveys were completed for the tract, and additional data were extracted from a 1969 Bradley-Hamilton County survey (TVA 1974a). Prior to construction of SQN, the peninsula on which the facility is currently located was 93 percent forested (54 percent pine, 32 percent pine-hardwood, 7 percent hardwood). The remaining 7 percent included pasture (3 percent), old field (2 percent), and ROW (2 percent) (TVA 1974a).

Dominant evergreen tree species included shortleaf pine (*Pinus echinata*) and Virginia pine (*P. virginiana*). Other tree species included oak (*Quercus* spp.), hickory (*Carya* spp.), beech (*Fagus* spp.), and other local ridge and valley deciduous species. Field surveys on adjacent property identified the following dominant tree species: white oak (*Q. alba*), post oak (*Q. stellata*), black oak (*Q. velutina*), southern red oak (*Q. falcata*), shagbark hickory (*C. ovata*), mockernut hickory (*C. tomentosa*), yellow poplar (*Liriodendron tulipifera*), and American beech (*F. grandifolia*). (TVA 1974a)

During the January 2010 SQN site walkover, general plant populations were identified that include herbaceous vegetation along fencerows, roadsides, and various unnamed lawn and weedy species. There are also wooded areas adjacent to Chickamauga Reservoir, around the training center, west of the ponds, along the reservoir between intake channel and cooling towers, northwest of the old steam generator storage facility, and in the northern portion of SQN. Common tree species identified during the January 2010 SQN site walkover included short leaf pine and Virginia pine. Other common plants include Japanese honeysuckle, trumpet creeper (*Campsis radicans*), various unnamed lawn species, and weedy species such as crab grass (*Digitaria spp.*). Plant communities on site are representative of hardy species that survive well in an industrial facility setting.

SQN's native flora has been altered extensively by previous disturbance. Common invasive nonnative plant species occurring in and around the area of SQN include Chinese privet, Japanese honeysuckle, Japanese stilt grass, multiflora rose, and Chinese bush clover or sericea lespedeza. All of these species have the potential to affect the native plant communities adversely because of their potential to spread rapidly and displace native flora (TVA 2009h).

3.6.1.2. Wildlife

Terrestrial habitats of SQN offer suitable habitat to a variety of wildlife species, particularly those adapted to urban and semi-urban environments. Chickamauga Reservoir's shorelines are used extensively by a variety of waterfowl and wading bird species. Habitats in the vicinity are used by many species of mammals, birds, amphibians, and reptiles. Table 3-14 presents common wildlife identified at SQN and adjacent areas.

Flooded areas in and around the SQN site provide habitat for beavers and common amphibians such as the American toad and Fowler's toad. The shoreline areas along the Chickamauga Reservoir provide suitable habitat for wading birds such as great blue herons and gulls; however, some shoreline areas have eroded and are covered in riprap, preventing those areas from providing suitable habitat to terrestrial wildlife (TVA 2009h).

During the January 2010 SQN site visit, a heron rookery was identified along the eastern shoreline of SQN near the intake structure in the Chickamauga Reservoir. Approximately

15 to 20 herons were seen nesting in pine trees. Two additional heron colonies occur within 3 miles of SQN.

According to the TVA Natural Heritage Database (TVA 2010k), there are three caves within 6 miles of SQN. Posey Cave, Havens Cave, And Harrison Bluff Cave are all within Hamilton County and within 2.3 miles, 5.9 miles, and 5.95 miles of SQN, respectively. Most caves form through the dissolution of limestone by acidic groundwater, otherwise known as karst topography. Caves accommodate a variety of ecosystems and typically provide an important habitat for many species of wildlife (USFWS 2010a). The TVA Natural Heritage Database identified these caves; however, the database does not list any of the species associated with the caves (TVA 2010k).

3.6.2. Environmental Consequences

This section addresses impacts to terrestrial ecology from site construction and operation of the Action and No Action Alternatives.

Alternative 1 – License Renewal

Under Alternative 1 – Action Alternative, current activities would continue on the existing site, resulting in no new impact to the terrestrial plants and wildlife. Land-use changes would not occur as a result of this alternative; therefore, no indirect effects to terrestrial plants and wildlife are expected. The current on-site ISFSI does not have sufficient capacity to support license renewal. Spent fuel storage capacity would be increased by expanding the ISFSI under a separate licensing process and adding a separate concrete storage pad inside the SQN protected area. Construction and operation of additional space for a new concrete storage pad would be a negligible impact and would not change the land use at SQN. Because the plants and wildlife present on and around the SQN site are common and representative of the area and region, no cumulative impacts to the terrestrial plant and wildlife ecology of the area would be expected under this alternative. Invasive plant species present on site would not be disturbed; therefore, this alternative would not contribute to the introduction of new exotic invasive plant species on or near the SQN site.

Alternative 2 – No Action Alternative

Under the No Action Alternative, the operating licenses of SQN would not be renewed, resulting in shutdown and decommissioning of SQN. Because the terrestrial plants and wildlife present on and around the SQN site are common and representative of the region, no direct, indirect, or cumulative impacts to terrestrial plant and wildlife ecology of the area are expected under this alternative.

Alternative 2a – New Nuclear Generation

A new nuclear plant at an alternate greenfield site would result in potentially substantial land-use impacts. If a brownfield site is selected, potential impacts would be similar; however, the impacts would be smaller, or less intense. Alternative 2a could require approximately 1,000 acres of property plus land to support water lines and the potential construction of a railroad spur or barge dock to transport equipment during construction and operation. In addition, new transmission lines and associated ROWs would be required as part of Alternative 2a. A new nuclear generation facility would integrate into TVA's existing transmission line system with the construction of new transmission lines from the plant site to the power grid system.

Table 3-14. SQN Common Wildlife

Common Name	Scientific Name	Species Type
American toad	*Bufo americanus*	amphibian
Fowler's toad	*Bufo fowleri*	amphibian
Northern cricket frog	*Acris crepitans*	amphibian
Upland chorus frog	*Pseudacris feriarum*	amphibian
American crow	*Corvus brachyrhynchos*	bird
American robin	*Turdus migratorius*	bird
Eastern bluebird	*Sialia sialis*	bird
Great blue herons	*Ardea herodias*	bird
Gulls	*Larus spp.*	bird
Killdeer	*Charadrius vociferus*	bird
Northern cardinal	*Cardinalis cardinalis*	bird
Tree swallow	*Tachycineta bicolor*	bird
Coyote	*Canis latrans*	mammal
Eastern cottontail	*Sylvilagus floridanus*	mammal
Eastern mole	*Scalopus aquaticus*	mammal
Hispid cotton rat	*Sigmodon hispidus*	mammal
Least shrew	*Cryptotis parva*	mammal
North american beaver	*Castor canadensis*	mammal
Striped skunk	*Mephitis mephitis*	mammal
Virginia opossum	*Didelphis virginiana*	mammal
White-tailed deer	*Odocoileus virginianus*	mammal
Black racer	*Coluber constrictor*	reptile
Eastern garter snake	*Thamnophis sirtalis*	reptile
Rat snake	*Zamenis longissimus*	reptile

(TVA 2009h)

Selection of Alternative 2a would require the existing greenfield site setting to be converted into industrial land use by the construction of a nuclear facility similar to the power generation size of SQN. Direct impacts would likely occur to terrestrial plants and wildlife as a result of clearing and construction operations. These impacts could include important terrestrial habitats such as:

- Adjacent shorelines of open waters: ponds, lakes, and large bodies of water.
- Forests: hardwood, pine-hardwood, mixed hardwood, etc.

- Open fields: fallow fields, old fields, barren land, etc.
- Wetlands: forested, scrub shrub, emergent, etc.
- Riparian areas along streams.
- Native grass fields: pastures, agriculture, etc.

Impacts to terrestrial plants could be greater than impacts to wildlife, because many wildlife species have the ability to relocate by their own means. Plant communities in the proposed construction footprint would be cleared to accommodate the new plant site, and wildlife would be displaced. Disturbed areas would be revegetated with native and non-invasive flora species to reduce the introduction and spread of exotic invasive plant species associated with ground disturbance and other construction activities. In addition, wildlife species that recolonize the area are expected to be suited for life in and around an industrial/urban environment.

Minor indirect impacts would likely occur as a result of this alternative. Wildlife are expected to experience minor indirect impacts due to displacement, local habitat loss, and fragmentation. Plant communities would also be expected to experience minor indirect impacts due to habitat fragmentation and land-use conversion (e.g., forested and shrub areas converted into grassy areas, landscaped areas, or fields). Over time, these minor changes may induce larger changes such as alterations in the pattern of land use in and around the new facility and human population density and growth rates that may affect terrestrial plants and wildlife and their habitats.

Adoption of Alternative 2a could result in minor cumulative impacts to terrestrial plants and wildlife because of the potential collective habitat loss, habitat fragmentation, and decreased biological diversity. Construction of a new nuclear plant at an undetermined location along with associated transmission lines in the Tennessee Valley could result in minor cumulative impacts to terrestrial vegetation and wildlife when combined with all of the past, present, and future construction in the region.

Alternative 2b – New Natural Gas-Fired Generation

Adoption of Alternative 2b would result in impacts similar to those associated with Alternative 2a. Alternative 2b could require 110 – 132 acres of land for improvement to construct a plant. Additional land would also be required for a new natural gas pipeline, compressor station, meter stations to serve natural gas to the new plant, and new transmission lines to integrate the new plant into TVA's existing power grid. Gas line and transmission line requirements for a new site would depend on the environmental setting and location of the proposed ROWs. In addition to the land required for a new site and associated transmission lines/pipelines, additional land would be required for natural gas wells and collection stations.

Direct impacts from Alternative 2b are dependent on the location and environmental setting of the site, pipelines, meter stations, compressor station, gas wells, collection stations, and the proposed intake and discharge surface water body. It is expected that direct impacts to terrestrial plants and wildlife species would occur because of the construction of the plant and its associated components. Impacts would be similar to those described in new nuclear generation alternative; see Alternative 2a. Alternative analysis, permitting, and

avoidance planning may reduce or offset impacts to these resources, but are not likely to avoid them altogether.

Indirect and cumulative impacts associated with Alternative 2b would be similar to but smaller than those impacts described for Alternative 2a.

3.7. Endangered and Threatened Species

Under the terms of Section 7 of the Endangered Species Act (ESA), 16 USC Section 1536(a)(2), federal agencies are required to ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat. The ESA places protected plants and animals into two classifications: endangered and threatened. Endangered species are defined as flora and fauna species faced with danger of imminent extinction. Threatened species are in less danger, but require special protection in order to maintain their populations and prevent them from being endangered. Species of special concern are those where a concern for welfare or risk of endangerment has been documented.

TVA, along with each of the seven valley states, maintains copies of the lists of federal- and state-listed endangered, threatened, or otherwise protected species. TVA also keeps track of where those species have been encountered in the region. This occurrence information is routinely stored in a natural heritage database, where a common format and compatible storage systems facilitate sharing data among agencies. For the 201-county area included in the TVA power service area, the TVA Natural Heritage Database includes occurrence information on about 2,200 federal- and state-protected species (TVA 2010l).

TVA completed a Natural Heritage Database query for a 6-mile radius around SQN in March 2010 (TVA 2010k). Table 3-15 presents the findings of TVA's query that identified known occurrences of threatened or endangered species, and other species of conservation concern within the 6-mile range. The TVA Natural Heritage Database identified known occurrences for a total of 14 species, which include seven plants, four birds, one fish, and two mussels within the 6-mile radius of SQN. No listed species have been identified on the SQN site.

In addition, the U.S. Fish and Wildlife Service (USFWS) critical habitat mapper was reviewed to identify any known critical habitat for threatened or endangered species in Hamilton County. The critical habitat portal is an online service for information regarding the threatened or endangered species final critical habitat designation across the United States. The USFWS critical mapper did not list any critical habitat for Hamilton County (USFWS 2010b).

The state rank and state status is referenced from the TDEC Natural Heritage Inventory Program (NHIP). The state rank of a species in Tennessee is a non-legal rank indicating the rarity and vulnerability of a species at the state level. The state status is the legal listing in Tennessee, and the federal status is the legal listing under the ESA (TDEC 2010b). TDEC and TVA collaborate on a dual natural heritage inventory list and share information on species such as occurrences, rarity, surveys, etc.

The USFWS removed the bald eagle from the ESA list of threatened species on August 8, 2007, and subsequently published the National Bald Eagle Management Guidelines (Eagle Guidelines) to assist the public in understanding protections afforded to and prohibitions

related to the bald eagle under the Bald and Golden Eagle Protection Act (16 USC Sections 668–668d) (Eagle Act), the Migratory Bird Treaty Act (16 USC Sections 703–712), and the Lacey Act (16 USC Sections 3371–3378). The Eagle Act prohibits anyone without a permit issued by the Secretary of the Interior from "taking" bald eagles, including their parts, nests, or eggs. The Eagle Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb."

Most of the disturbances to aquatic and terrestrial habitats associated with completion of SQN have already occurred. The following sections provide updated information on the presence of federally listed and state-listed species found within a 6-mile radius of SQN, and the potential impacts from proposed alternatives.

3.7.1. Affected Environment

Review of the rare species lists for Hamilton County from TVA's Natural Heritage Database and the TDEC's Natural Heritage Inventory Program indicated three federally listed and 11 additional state-listed species have been recorded within 6 miles of SQN. However, neither those species nor habitat suitable for those species is present on or adjacent to SQN (TVA 2010k).

3.7.2. Environmental Consequences

This section addresses impacts to threatened and endangered species from site construction and operation of the Action and No Action Alternatives.

Alternative 1 – License Renewal

Under Alternative 1 – Action Alternative, current activities would continue on the existing site. There would be no impacts to threatened or endangered species, because there are no known endangered or threatened species on or adjacent to the SQN site (TVA 2010k). The distance between existing threatened or endangered individuals or populations and the SQN site provides ample buffer from the operations originating on the SQN site. In addition, land-use changes would not occur as a result of this alternative; therefore, no indirect or cumulative impacts to these endangered and threatened species would be expected under this alternative.

Alternative 2 – No Action Alternative

Under the No Action Alternative, the SQN operating licenses would not be renewed, resulting in shutdown of SQN. No impacts to threatened or endangered species are expected from the shutdown of SQN under this alternative, because there are no known endangered and threatened species located within or adjacent to the SQN site (TVA 2010k).

Table 3-15. Endangered, Threatened, and Other Species of Conservation Concern Identified Near SQN

Common Name	Scientific Name	Federal Status	State Status	State Rank	Habitat	Notes
Plants						
Gibbous panic-grass	*Sacciolepis striata*	--	S	S1	Flood plains and shallow pools.	The plant was identified in 1985 (amount is unknown) within approximately 1.5 miles of SQN.
Pink lady-slipper	*Cypripedium acaule*	--	S-CE	S4	Piney woods.	Two “clumps” of the plants were identified in 2007 within approximately 6 miles of SQN.
Ovate-leaved arrowhead	*Sagittaria platyphylla*	--	S	S2S3	Swamps and emergent wetlands.	The plant was identified in 1980 (amount is unknown) within approximately 6 miles of SQN.
Fragrant bedstraw	*Galium uniflorum*	--	S	S1	Dry woods.	The plant was identified in 1997 (amount is unknown) within approximately 6 miles of SQN.
Tall larkspur	*Delphinium exaltatum*	--	E	S2	Glades and barrens.	The plant was identified in 1938 (amount is unknown) within approximately 5.75 miles of SQN.
American ginseng	*Panax quinquefolius*	--	S-CE	S3S4	Rich woods.	The plant was identified in 2007 within approximately 6 miles of SQN.
Large-flowered skullcap	*Scutellaria montana*	T	T	S2	Escarpments and dry woods.	Between 3 and 136 plants identified at 27 different locations from 1986 to 2006; locations were between 0.75 mile and 6 miles from SQN.

Common Name	Scientific Name	Federal Status	State Status	State Rank	Habitat	Notes
Birds						
Appalachian's Bewick's wren	*Thryomanes bewickii atlus*	--	E	S1	Brushy areas, scrub and thickets in open country, open and riparian woodland.	A small number (amount is unknown) of this bird was spotted in 1908 within approximately 6 miles of SQN.
Bald eagle	*Haliaeetus leucocephalus*	--	D	S3	Areas close to large bodies of water.	From 1975 through 2005, between five and seven individuals, a pair, and a nest have been observed along Chickamauga Reservoir between approximately 1 and 6 miles from SQN.
Bachman's sparrow	*Aimophila aestivalis*	--	E	S3B, S4N	Dry open pine or oak woods.	One to two individuals were spotted in 1969 within approximately 3 miles of SQN.
Great egret	*Ardea alba*	--	D	S2B, S3N	In and around marshes, swampy woods, streams, lakes, ponds; fields and meadows.	A nest was identified in 1991 within approximately 5.9 miles SQN.
Fish						
Highfin carpsucker	*Carpiodes velifer*	--	D	S2S3	Large rivers, mostly in Tennessee River drainage.	One individual was identified in 1994 during an electro-fishing survey within approximately 5.75 miles of SQN.

Common Name	Scientific Name	Federal Status	State Status	State Rank	Habitat	Notes
Mussels						
Dromedary pearly mussel	*Dromus dromas*	E	E	S1	Medium to large rivers with riffles and shoals with relatively firm rubble, gravel, and stable substrates.	One individual was identified in 1978 (date may not be accurate) within approximately 3 miles of SQN.
Pink mucket	*Lampsilis abrupta*	E	E	S2	Generally a large river mussel, preferring sand-gravel or rocky substrates with moderate-to-strong currents.	More than one individual was identified (exact amount is unknown) in 1963 (date may not be accurate) within approximately 5.5 miles of SQN.

Status Information
-- = No status
Federal abbreviations: E = Endangered; T = Threatened; C = candidate;
State abbreviations: E = Endangered; T = Threatened; D = Deemed in need of management; S = Special concern; S-CE = Special concern, commercially exploited

Rank Information
S1: Extremely rare and critically imperiled in the state;
S2: Very rare and imperiled within the state;
S3: Rare and uncommon in the state;
S4: Widespread, abundant, and apparently secure within the state, but with cause for long-term concern;
_N: Occurs in Tennessee in a non-breeding status (mostly applies to vertebrates); _B: Breeds in Tennessee

(TVA 2010k; TDEC 2010b; TDEC 2010c)

Alternative 2a – New Nuclear Generation

An alternate greenfield site of approximately 1,000 acres would be needed for Alternative 2a, plus land to support water lines and potentially construct a railroad spur or barge dock to transport equipment during construction and operation. In addition, new transmission lines and associated ROWs would be required as part of Alternative 2a. A new nuclear generation facility would integrate into TVA's existing transmission line system with the construction of new transmission lines from the plant site to the power grid system. A new nuclear plant at an alternate greenfield site would result in potentially substantial land-use impacts.

Direct impacts may occur to threatened or endangered species as a result of clearing and construction operations. Impacts could occur to important threatened or endangered species habitats such as:

- Open waters (e.g., ponds, lakes and large bodies of water).
- Forests (e.g., hardwood, pine-hardwood, mixed hardwood, etc.).
- Waters of the U.S.
    - Wetlands: forested, scrub shrub, emergent, etc.
    - Streams: perennial, intermittent, ephemeral.

Minor indirect impacts may occur as a result of this alternative. Over time, the minor changes may induce larger changes such as alterations in the pattern of land use in and around the new facility, and human population density and growth rates that could alter threatened or endangered species and their habitats.

Minor to severe cumulative impacts may also occur to threatened or endangered species as a result of this alternative because of the potential habitat loss, habitat fragmentation, and decreased biological diversity. Construction of a new plant at an undetermined location and associated power lines in the Tennessee Valley could result in cumulative impacts when combined with all of the past, present, and future construction in the region.

Site-specific environmental reviews would be conducted to identify potential impacts to federally listed and state-listed species and their habitats. Measures to avoid, minimize, or mitigate potential impacts would be evaluated. TVA would comply with the ESA and other applicable regulations pertaining to federally listed and state-listed species.

Alternative 2b – New Natural Gas-Fired Generation

Adoption of Alternative 2b would result in impacts similar to those associated with Alternative 2a. Alternative 2b could require 110 – 132 acres of land for improvement to construct a plant of similar generation size. Additional land would also be required for a new natural gas pipeline, compressor station, meter stations to serve natural gas to the new plant and new transmission lines to integrate the new plant into TVA's existing power grid. Gas line and transmission line requirements for a new site would depend on the environmental setting and location of the proposed ROWs. In addition to the land required

for a new site and associated pipelines, additional land would also be required for natural gas wells and collection stations.

Direct impacts from Alternative 2b are dependent on the location and environmental setting of the site, pipelines, meter stations, compressor station, gas wells, collection stations, transmission lines and the proposed intake and discharge surface water body. Direct impacts to endangered and threatened species could occur because of the construction of the plant and its associated components. Ecological surveys, alternative analysis, permitting, and avoidance planning may reduce or offset direct impacts to endangered or threatened species as well.

Indirect and cumulative impacts associated with Alternative 2b are similar to but smaller than those impacts described for Alternative 2a.

Site-specific environmental reviews would be conducted to identify potential impacts to federally listed and state-listed species and their habitats. Measures to avoid, minimize, or mitigate potential impacts would be evaluated. TVA would comply with the ESA and other applicable regulations pertaining to federally listed and state-listed species.

3.8. Natural Areas

Natural areas include managed areas, sites, ecologically significant sites, the U.S. National Park Service's (NPS) Nationwide Rivers Inventory (NRI), and the National Wild and Scenic Rivers (NWSR) system. Managed areas typically have an owner or management entity (e.g., TVA, TWRA, municipalities), but they may or may not have an on-site staff or developed facilities. Ownership by a management entity is the main criterion for calling a natural area a managed area.

The NWSR system was created by Congress in 1968 (Public Law 90-542; 16 USC 1271 et seq.) to protect certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. Section 5(d) of the NWSR Act (16 USC Sections 1271–1287) requires that all planning for the use and development of water and related land resources, consideration shall be given by all federal agencies involved to potential national wild, scenic, and recreational river areas (NWSR 2010). In partial fulfillment of the NWSR Act-Section 5(d), the NPS also compiles and maintains the NRI, which is a register of river segments that potentially qualify as national wild, scenic, or recreational river areas. The NRI also qualifies as a comprehensive plan under Section 10(a)(2)(A) of the Federal Power Act (NPS 2010). This section addresses natural areas on, immediately adjacent to, or within 6 miles of SQN.

3.8.1. Affected Environment

No known natural areas are located within or adjacent to SQN. Within 6 miles of the site, there are nine managed areas. According to the TVA Natural Heritage Database, the boundaries of these natural areas are completely within the 6-mile radius of SQN. Species federally listed as threatened or endangered have been recorded within some of these natural areas and are also located within the 6-mile radius of SQN (TVA 2010k). Federally listed species recorded within 6 miles of SQN are listed in Table 3-15 and described in Section 3.7 above. The following are brief descriptions of natural areas within 6 miles of SQN.

Chigger Point TVA Habitat Protection Area (HPA) − is located on the Chickamauga Reservoir and within approximately 0.8 miles of SQN. It is a 15.4-acre steeply wooded

shoreline tract. According to the TVA Natural Heritage Database, a single large-flowered skullcap plant was recorded within this natural area (TVA 2010k).

Chickamauga State Wildlife Management Area − a portion of the 7,500-acre wildlife management area is located within approximately 3 miles of SQN. It is a 300-acre area, managed by the TWRA and located in the Soddy Creek embayment on Chickamauga Reservoir. It is an extensive area of moist mudflats and aquatic bed wetlands, attracting large numbers of shorebirds and waterfowl (TVA 2005b).

Chester Frost Park – is located within approximately 4.6 miles of SQN. The park is located on a 280-acre peninsula island and includes a campground, multiple fishing piers, boat ramps, tennis courts, and a beach. The park is partially open year round. According to the TVA Natural Heritage Database, a single Bachman's sparrow was recorded within this natural area (TVA 2010k).

Holly City Park − is located within approximately 4.8 miles of SQN. The park includes a boat ramp and automobile/boat parking.

Murphy Hill TVA HPA – is located within approximately 5.25 miles of SQN. According to the TVA Natural Heritage Database, five individual large-flowered skullcap plants were recorded within this natural area (TVA 2010k).

Soddy Creek TVA HPA − is located within approximately 2.3 miles of SQN and is a 35.5-acre tract that occupies over a mile of very steep shoreline. According to the TVA Natural Heritage Database, a single dromedary pearly mussel was recorded along the boundary of this natural area (TVA 2010k). Many species of water birds also occupy the nearby shallow waters and mudflats during fall and winter months (TVA 2009h).

Soddy Municipal Park − is located within approximately 5.25 miles of SQN. The park includes baseball fields, fishing, parking areas, and basketball courts.

Ware Branch Bend TVA HPA − is a 41.5-acre tract of steep, rocky shorelines. It is located within approximately 2.3 miles of SQN. It is habitat for large-flowered skullcap and the bald eagle (TVA 2009h). According to the TVA Natural Heritage Database, a single large-flowered skullcap plant was recorded within this natural area (TVA 2010k).

University of Tennessee Friendship Forest − is located within approximately 0.8 miles of SQN. The 680-acre tract is owned by TVA and is leased to the University of Tennessee as a forestry experiment station. It contains some of the oldest documented research on genetic tree breeding and pine management in Tennessee (TVA 2005a, TVA 2009h). According to the TVA Natural Heritage Database, six individual large-flowered skullcap plants and a single Gibbous panic-grass plant were recorded within this natural area (TVA 2010k).

In addition, no streams in the vicinity of the SQN site are included on the NRI or the NWSR databases (NPS 2010, NWSR 2010). The only NWSR resource located in the state of Tennessee is the Obed River, which is approximately 80 miles north and slightly east of the SQN site. The NPS lists the North Chickamauga River as the only NRI resource within Hamilton County. The North Chickamauga River is approximately 7 miles west of the SQN site. These two resources are the closest in proximity to the SQN site, according to their applicable databases.

3.8.2. Environmental Consequences

This section addresses impacts to natural areas from site construction and operation of the Action and No Action Alternatives. Impacts to threatened or endangered species associated with natural areas are described in Section 3.7 above.

Alternative 1 – Licensing Renewal

Under Alternative 1 – Action Alternative, current activities would continue on the existing SQN site, resulting in no impacts to natural areas because there are no known natural areas on or adjacent to the SQN site (TVA 2010k). The distance between existing natural areas and the SQN site provides ample buffer from any operation noise originating from the SQN site. In addition, land-use changes would not occur as a result of this alternative; therefore, no indirect or cumulative impacts to the natural areas would be expected under Alternative 1.

Alternative 2 – No Action Alternative

Under No Action Alternative 2, the SQN operating licenses would not be extended, resulting in the shutdown of SQN. No impacts to natural areas are expected under this alternative, because there are no known natural areas located within or adjacent to the SQN site.

Alternative 2a – New Nuclear Generation

An alternate greenfield site of approximately 1,000 acres would be needed for Alternative 2a, plus land to support water lines and potentially construct a railroad spur or barge dock to transport equipment during construction and operation. In addition, new transmission lines and associated ROWs would be required as part of Alternative 2a. A new nuclear generation facility would be integrated into TVA's existing transmission line system that would include the constructing of new transmission lines from the plant site to the power grid system. A new nuclear plant at an alternate greenfield site could result in potentially extensive land-use impacts.

Under Alternative 2a, land would be improved to construct a nuclear facility of similar power generation size as SQN. It is unlikely that direct impacts to natural areas would occur because of the importance of these resources to local city and county governments, the state of Tennessee, and the federal government. Avoidance planning would likely place any potential new nuclear generation plant at a safe distance from most natural areas.

Minor indirect impacts may occur as a result of Alternative 2a. A new nuclear generation facility would require water for a cooling source as well as a plant discharge point. These typical power plant functions could potentially affect downstream aquatic natural areas with minor changes in water flow, contamination, nutrient loads, etc. Over time, the minor changes may induce larger changes such as alterations in the pattern of land use in and around the new facility, the population density, and population growth rates.

Minor to severe cumulative impacts may also occur to natural areas and any associated threatened or endangered species as a result of this alternative because of potential habitat loss, habitat fragmentation, and decreased biological diversity. Impacts of a new nuclear generation facility may occur at a considerable distance from many natural areas; however, the impacts could be compounded by other land improvements and development in the general area between the facility and any natural area. Construction of a new plant at an

undetermined location and associated transmission lines in the Tennessee Valley could result in cumulative impacts when combined with all of the past, present, and future construction in the region.

Alternative 2b – New Natural Gas-Fired Generation

Adoption of Alternative 2b may result in similar minor to substantial cumulative impacts associated with Alternative 2a because a natural gas-powered generation plant would utilize similar resources to that of a nuclear-powered generation facility (e.g., cooling system, water source, discharge source, land, etc.). Alternative 2b could require 110 – 132 acres of land for improvement to construct a plant. In addition to site requirements, additional land would be necessary for a new natural gas pipeline, compressor station, meter station(s), natural gas wells, and collection stations to serve natural gas to the new plant. In addition, new transmission lines to integrate the new plant into TVA's existing power grid would also require additional land.

3.9. Recreation

3.9.1. Affected Environment

SQN has approximately 1,144 workers, the majority of whom reside in Hamilton County (Sections 3.13.1 and 3.13.2). The governments of Hamilton County and its 10 municipalities operate a variety of parks and recreation systems. The largest park systems in Hamilton County are the City of Chattanooga Parks and Recreation Department, with 53 parks and 15 recreation centers covering over 3,400 aces, and facilities operated by Hamilton County Parks and Recreation, with 27 parks and joint-operated school facilities covering 895 acres. Most of Hamilton County's smaller municipalities also have parks and recreation systems. (CHCRPA 2005a)

The SQN site is near the geographical center of Hamilton County, on a peninsula on the western shore of Chickamauga Reservoir. The reservoir is one of a series of highly controlled multiple-use reservoirs 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. Public access areas, boat docks, and residential subdivisions have been developed along the Chickamauga Reservoir shoreline. (TVA 2009i)

As described in the *Sequoyah Nuclear Plant Unit 2 Steam Generator Replacements Environmental Assessment*, there is a local ball field located on the western side of the SQN site near the TVA Training Center and the Live Well Center. No natural areas are located within or adjacent to the site (Figure 3-10). Several natural areas are located within 6 miles of SQN and are described in Section 3.8. (TVA 2009h)

Harrison Bay State Recreation Park is approximately 1.2 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 TDEC. (TVA 2009h)

Chester Frost Park sits on 455 acres next to Chickamauga Reservoir and includes tennis courts, nine fishing piers, two boat ramps, a sand beach/swimming area, sand volleyball, picnic areas, and playgrounds. The park is operated by the Hamilton County, Tennessee, Parks and Recreation Department. The park has recreational vehicle camping and associated facilities. (HCPR 2010)

Also located on the banks of Chickamauga Reservoir by Chattanooga, 353-acre Booker T. Washington State Park has numerous recreational amenities, including swimming, biking, boating, and fishing (TNSP 2010). In addition, there are many commercial marinas, group camps, and cottage developments, as well as formal and informal public access areas along the reservoir shoreline. The Soddy, Possum, and Sale Creek embayments to the northwest of the site are especially popular with anglers and family boaters. (TVA 2008a)

3.9.2. Environmental Consequences

This section addresses impacts to area recreation from site construction and operation of the Action and No Action Alternatives.

Alternative 1 – License Renewal

Under Alternative 1 – Action Alternative, SQN license renewal would result in no change to the plant site or operations, and there would be no new impacts to area recreation.

Alternative 2 – No Action Alternative

Under the No Action Alternative, cessation of SQN operation would not adversely affect recreational facilities or activities.

Alternative 2a and 2b – New Nuclear or Natural Gas-Fired Generation

The impacts of Alternatives 2a and 2b are similar and discussed together below.

As described in Section 3.13.9, the Hamilton County tax base would not change significantly due to plant closure, and activities at SQN are unrelated to the operation and maintenance of area recreational facilities. Public use is also not anticipated to change should plant operational personnel choose to move from the area, because the county population is expected to continue to increase.

Under Alternative 2a or 2b, a site-specific environmental review would include an investigation of the locations of any national and state parks, public recreation, cultural and historic areas, wild and scenic rivers, etc. These locations would be assessed for potential adverse impacts that could result from construction and operation. Typically, these locations are considered avoidance areas; however, if a potential facility were sited near a recreational, scenic, or culturally significant area, then noise, dust, viewshed, and watershed impacts would be analyzed. The type and level of impact would vary depending upon proximity, mitigation measures, and general construction and operation practices. Impacts could range from minor to moderate. Some examples of potential mitigation methods could be the use of water to minimize dust, limiting noisy activities to specific times, and utilizing landscaping and painting techniques to limit viewshed impacts.

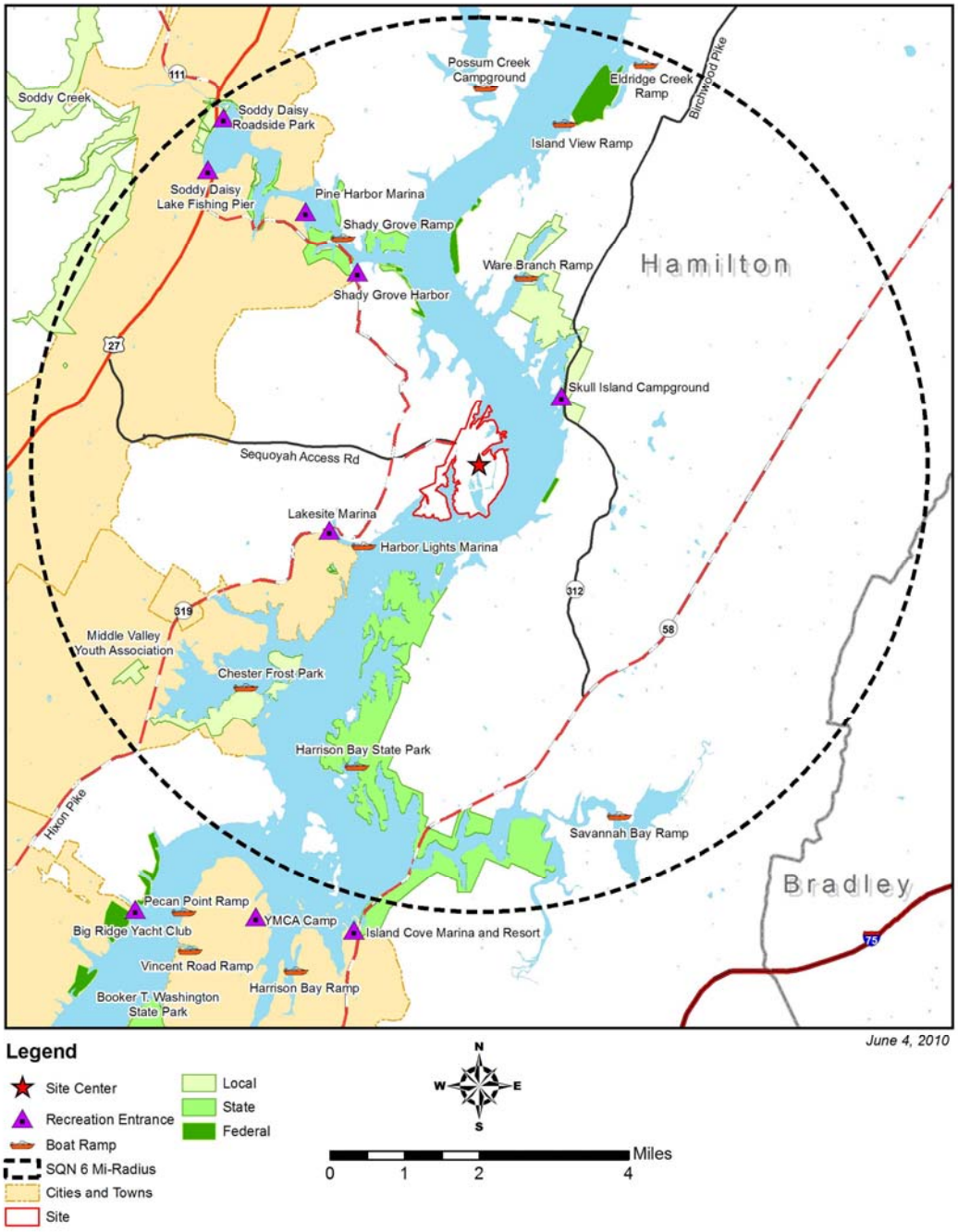

Figure 3-10. Federal, State, and Local Lands Within a 6-Mile Radius of SQN

3.10. Archaeological Resources and Historic Structures

Under the National Historic Preservation Act (NHPA) of 1966, as amended (16 USC 470), TVA as a federal agency is required to identify and manage historic properties located on land affected by TVA undertakings.

Prior to taking any action to implement an undertaking, Section 106 of the NHPA (16 USC 470) requires federal agencies to:

- Take into account the effects of an undertaking on historic properties, including any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places (NRHP).

- Afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on such undertaking.

State historic preservation officers serve as proxies to the ACHP (16 USC 470; 36 CFR Part 800). The Tennessee SHPO has been consulted by TVA concerning the license renewal application for SQN and any potential effects on historic properties (see Appendix C). Consultation included submission of a Phase 1 cultural resource survey report (McKee et al. 2010) and supplemental 10-mile radius architectural sensitivity report (Ted Karpynec, TRC, personal communication, March 22, 2010) documenting the results of records searches and the Phase 1 survey. The investigations were conducted in compliance with Section 106 of the NHPA, as amended, and its implementing regulations (36 CFR Part 800).

As required by federal regulations (36 CFR Part 800), Native American groups recognized as stakeholders at SQN were consulted by TVA with the opportunity for comment (see Appendix C). TVA has consulted with the following federally recognized Indian tribes regarding properties within the proposed project's area of potential effects (APE) that may be of religious and cultural significance to them and eligible for the NRHP: Cherokee Nation, Eastern Band of Cherokee Indians, United Keetoowah Band of Cherokee Indians in Oklahoma, The Chickasaw Nation, Seminole Tribe of Florida, Muscogee (Creek) Nation of Oklahoma, Alabama-Coushatta Tribe of Texas, Alabama-Quassarte Tribal Town, Kialegee Tribal Town, Thlopthlocco Tribal Town, Absentee Shawnee Tribe of Oklahoma, Eastern Shawnee Tribe of Oklahoma, and the Shawnee Tribe.

3.10.1. Affected Environment

SQN lies on a bend in the Tennessee River between river miles 482 and 486. The plant is situated on an irregular peninsula created when the lower floodplain was inundated by the waters of Chickamauga Reservoir in 1940. Presently, the project site is an industrial area with a strongly secured perimeter.

The area surrounding the SQN property is likely to have been continuously occupied by humans since at least 12,000 years before present (B.P.) (McKee et al. 2010). Archaeological records for the Tennessee River valley document four major prehistoric occupational periods with some overlap of cultural markers: the Paleoindian (10,500 – 8000 B.C.), the Archaic (8000 – 600 B.C.), the Woodland (1000 B.C. – A.D. 1000), and the Mississippian (A.D. 1000 – A.D. 1600).

The earliest European contact with what is now Hamilton County consisted of Spanish expeditions in the sixteenth century. When English explorers arrived in the seventeenth century, the Cherokee tribe was the dominant native group, with control of an area including eastern Tennessee, western North Carolina, and northern Georgia (Chapman 1985). American settlers began moving into Cherokee territory in the late eighteenth century, and Hamilton County was established in 1819. In 1838, the Cherokees were removed from the area by federal troops. An acceleration in white settlement followed.

Following European contact and settlement, the project area was used primarily for timber and agriculture. Early roads through the area connected the first county seat of Hamilton County, Dallas, with Chattanooga and Igou's Ferry, which was located on the SQN site (McKee et al. 2010). Harrison replaced Dallas as the county seat in 1840, leading to the decline of Dallas.

Igou's Ferry was established by General Samuel Igou on property he owned by the river. The ferry connected roads on the east and west banks. A road near the present-day site still bears the name Igou Ferry Road. General Igou is buried in the Igou Cemetery, still in existence on the SQN site and maintained by TVA (Figure 3-11).

During the Civil War, the Union Army guarded the ferry in 1863 and probably used the farmsteads near the crossing for their camp (McKee et al. 2010). After the war, Dallas declined further, but Igou's Ferry was still in existence and served by a postal route that followed the west bank of the Tennessee River from Chattanooga. According to a 1913 Tennessee Geological Survey map, Igou's Ferry was still operational at that time (McKee et al. 2010), but by 1936, a TVA survey of the area showed no active ferry.

TVA surveyed the area again in 1937 in preparation for the creation of Chickamauga Reservoir. A second cemetery was documented on the SQN site, identified as the McGill Cemetery #1 (TVA 1938). Sometime before 1983, the eleven graves from this cemetery were relocated to a nearby cemetery associated with the same family group (McKee et al. 2010).

Chickamauga Reservoir was completed in 1940. The waters of the reservoir covered all lands below the 683-foot contour level, including the site of Igou's Ferry. Most of the former house sites in SQN were not inundated, and property owners were permitted to retain possession and remove buildings for salvage prior to the end of the calendar year of 1939 (TVA 1942).

The earliest known documentation of cultural resources on the grounds now occupied by SQN (Figure 3-11) was the 1913 recording and testing of site 40HA22 by C.B. Moore (Moore 1915). Moore described the site as containing a mostly undisturbed mound, 52 feet in diameter and 7.5 feet high, and a light scatter of midden material in the surrounding cultivated field. His excavation into the mound identified nine human burials. The site was revisited in 1936 by Buckner, who reported that the mound was still visible with ceramic fragments on the surface (Buckner 1936).

The 1930s produced pre-inundation surveys and related work for the Chickamauga Reservoir. This work included the recording and testing of site 40HA20, known as the McGill Site (different from McGill Cemetery), also located within the current SQN boundaries (Figure 3-11). The results of the testing of 40HA20 are discussed in a compilation on the prehistory of the Chickamauga Reservoir (Lewis and Lewis 1995), where the site is interpreted as a Late Woodland/Early Mississippian mound complex. Site 40HA20 was first recorded for the Tennessee Division of Archaeology Site Survey Records by Buckner in 1936 (Buckner 1936).

During that same year, 1936, Buckner also recorded the only known archaeological sites located outside but within 0.5 miles of the SQN APE. These adjacent sites range from a Late Archaic or later (unknown) period village site with projectile points and ceramics (40HA21) to a Paleoindian/Transitional Paleoindian open habitation/lithic workshop with projectile points and ground-stone tools (40HA43), both now inundated by the Chickamauga Reservoir, to an unknown period burial ground with eight to ten visible stone graves (Buckner 1936).

TVA also surveyed the SQN area in 1937 to produce the original property acquisition map for the Chickamauga Reservoir (TVA 1937). The map documented public and private roads, structures, fields, orchards, fences, property boundaries, and cemeteries, along with other information, and displayed at least fourteen residences and associated structures along with two cemeteries within the current SQN boundaries (McKee et al. 2010). Additional work by TVA on the two cemeteries soon followed with records of names and locations of burials (TVA 1938, TVA 1940). Following the cemetery reports, no known cultural resource investigations occurred on the SQN grounds until 1973, when they were conducted in association with the original construction of SQN.

Because construction began at SQN early in the development of historic preservation regulations, no comprehensive archaeological survey was conducted on the SQN site prior to construction of the plant. TVA conducted an archaeological survey in 1973, but it was conducted after construction of the plant had begun (Calabrese et al. 1973). Although construction was not yet complete, the emphasis of the 1973 report was that both previously recorded archaeological sites (40HA20 and 40HA22) were destroyed during the construction of SQN prior to the archaeological survey (Calabrese et al. 1973, McKee et al. 2010). The 1973 survey located only one intact cemetery (the Igou Cemetery) and remnants suggesting one possible former house.

The past surveys of the area specific to SQN were conducted before the Secretary of the Interior's Historic Preservation Professional Qualification Standards were issued on September 29, 1983 (48 FR 44716). When TVA began developing assessments for continued production at SQN, new cultural resource surveys were done. Two modern surveys were subsequently conducted at SQN. The first was a 2009 Phase 1 survey (Jones and Karpynec 2009) conducted in the preparation of an environmental assessment (EA) for a proposed SQN steam generator replacement project. The APE for the 2009 undertaking was limited to three separate locations within SQN for potential direct effects and a 0.5-mile (indirect or visual effect) APE for considering architectural resources. As stated in the EA (TVA 2009h), the survey confirmed that the APE had been disturbed previously by the construction of SQN. No cultural resources were identified by the survey, and no historic properties were identified within the 0.5-mile viewshed of the proposed actions.

The second modern investigation was a Phase 1 archaeological survey conducted for the entire SQN site in early 2010 in preparation for the license renewal application (McKee et al. 2010). The APE for the survey was defined as the entire area occupied by SQN (Figure 3-11). The APE for architectural field studies included those portions of a 0.5-mile area surrounding the plant facility where a visual link to the plant was unobstructed by topography or vegetation (McKee et al. 2010).

Figure 3-11. SQN Site With Area of Potential Effects Shown

Note: To protect cultural resources, archaeological site locations are not shown.

Results of the 2010 Phase 1 archaeological survey confirmed the 1973 findings that sites 40HA20 and 40HA22 were destroyed during plant construction. A search of THC records also found no previously recorded architectural resources on SQN or within the 0.5-mile visual APE. Previously identified aboveground resources on SQN included the Igou and the McGill cemeteries. During the records investigation, it was determined that for the original SQN construction, the burials at the McGill Cemetery were disinterred and moved to McGill Cemetery #2, across the Tennessee River (see Appendix C).

The 2010 Phase 1 archaeological survey identified one new site (40HA549) and three isolated finds, none of which were considered eligible for the NRHP. Site 40HA549 was interpreted as a short-term open habitation represented by three artifacts, including one small quartz flake and two complete Early/Middle Archaic projectile points found in two positive shovel tests. The three isolated finds consisted of separate occurrences of lithic flakes and debitage.

Two architectural/aboveground resources were also identified (HS-1 and HS-2). HS-1 is a ca. 1930, one-story gable-front house located beyond the APE but within 0.1 miles of the APE boundary and within the 0.5-mile viewshed. HS-2 is the previously investigated Igou Cemetery located on the SQN APE. Both of these resources are considered ineligible for the NRHP due to a lack of historic and architectural distinction.

The Igou Cemetery (HS-2), which contains about 45 graves, is in the southwestern portion of the APE near the security practice firing range. It is maintained by TVA, and for security reasons, access is only granted by special permission. The cemetery is in no danger of disturbance or destruction from SQN operations as TVA plans to avoid the cemetery in accordance with the Tennessee laws regarding the treatment of human remains (see Appendix C).

As part of the assessment for the LRA, a supplemental records study and report focused on a 10-mile radius sensitivity analysis for potential visual effects on architectural historic properties. The 10-mile radius was drawn from a point equidistant between the two cooling towers at SQN (Figure 3-12). The study considered all previously recorded architectural properties within the radius covering portions of Bradley, Hamilton, and Meigs counties, Tennessee. Architectural information included maps and county architectural survey files housed at the THC in Nashville. (Ted Karpynec, TRC, personal communication, March 22, 2010)

The report located five NRHP-listed properties (Figure 3-12). The Hiram Douglas House (nominated in 1973), the Brown House (nominated in 1973), the Matthews L. Pleasant House (nominated in 1976), and the Retro School (nominated in 2010) are located in Hamilton County. The fifth, in Meigs County, is the Bradford Rymer Barn (nominated in 1982). For the three properties nominated after SQN operations began, potential adverse effects on the visual integrity of the property were already determined inconsequential to the nomination. The two resources nominated in 1973 are both located over 4 miles from SQN, and the view of the cooling towers is blocked by intervening topography. In fact, all five properties are located over 4 miles from SQN, in valleys where intervening topography blocks the view of SQN.

The 10-mile architectural study also reported buildings that have never been assessed as eligible or not eligible for the NRHP, including seven individual buildings, the closest of which is approximately 7.2 miles southeast of SQN, and multiple buildings located in the

town of Soddy, including the downtown district, approximately 5.8 miles northwest of SQN. However, none of these properties have been determined eligible for the NRHP by the Tennessee SHPO, and all are at distances and in topographic positions where visual effects from continued operations at SQN are implausible.

The 2010 archaeological survey recommended that no further investigation of cultural resources on the SQN APE (Figure 3-11) is necessary in connection with the license renewal application and any future undertakings at SQN. The 10-mile architectural sensitivity study found that no historic properties would receive adverse effects from continued operation of SQN. In letters dated May 5 and May 20, 2010, TVA received concurrence with the findings and recommendations of the report from the Tennessee SHPO (see Appendix C).

No specific properties of religious or cultural significance were identified through tribal consultation. Comments were received from three of the thirteen tribes contacted: the Alabama-Coushatta Tribe of Texas, the United Keetoowah Band of Cherokee Indians in Oklahoma, and the Seminole Band of Florida. All concurred with the finding of no effects from continued operation of SQN (see Appendix C).

Alternative 2 – No Action Alternative

Under the No Action Alternative, no impact to cultural resources on the SQN site would result from shutting down SQN Units 1 and 2 at the end of the current license term.

Alternative 2a – New Nuclear Generation

Construction of a new nuclear power plant at SQN is not considered feasible due to the lack of available land adjacent to the site. At an alternate greenfield site, given that the undertaking would fall under Section 106 of the NHPA, a cultural resource inventory and sensitivity study would likely be needed for any on-site property that has not been previously (or recently) surveyed. Other lands, if any, acquired to support the plant would also likely be subject to the Section 106 process. All such lands involved in the undertaking would likely need an inventory and evaluation of cultural resources to identify historic properties, and may require avoidance plans or other actions to mitigate adverse effects from proposed ground-disturbing actions and/or visual effects related to physical activities at the plant site.

The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission and pipeline corridors, or other ROWs). The effects on cultural resources could, depending on the site, range from minor to substantial. The anticipated NHPA Section 106 process would ensure that direct, indirect, and cumulative effects would be considered for the undertaking, and that any historic properties would be properly identified and managed.

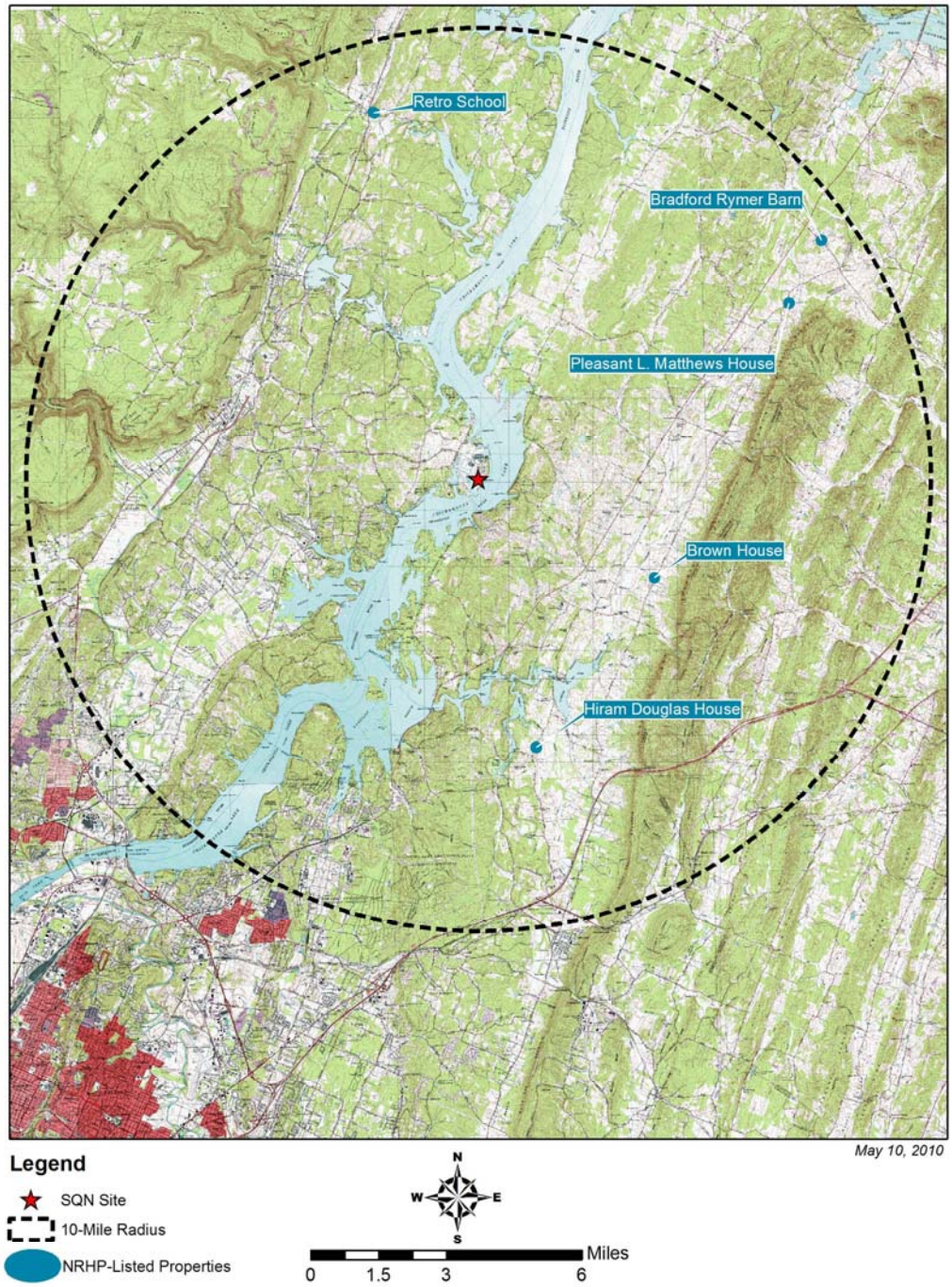

Figure 3-12. SQN 10-Mile Vicinity With Associated Historic Properties

Alternative 2b – New Natural Gas-Fired Generation

The impacts for Alternative 2b are similar to those of Alternative 2a and are described for Alternative 2a. Neither of these No Action Alternatives would have any direct, indirect, or cumulative effects on the historic properties within the SQN APE, as none have been identified. Direct, indirect, or cumulative effects elsewhere due to actions at any alternative location would be addressed within associated studies under the appropriate federal regulations.

3.11. Visual Resources

3.11.1. Affected Environment

SQN is approximately 18 miles northeast of Chattanooga's city center, often referred to as the Scenic City, and 6 miles from Soddy-Daisy (Figures 1-2 and 1-3). This area is characterized by residential subdivisions, urban environments around the cities, and open land. Residential subdivision growth has continued to increase within a 10-mile radius of the plant (Section 3.13.8). There is also some small-scale farming and at least one dairy farm located within 5 miles of the plant. The nearest residence is located 0.5 miles north northwest of the plant, with additional residences to the north, northwest, west, west southwest, and west northwest, located less than 1 mile from the plant. (TVA 2009i)

The tallest buildings on site are the cooling towers at approximately 459 ft. (TVA 1974d). Predominant visual features of SQN include the reactors, 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 west along SR 312 (Birchwood Pike), which includes Skull Island recreation area near Cooley Road and a TWRA boat ramp south of Skull Island. 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 between 1 and 4 miles, an observer may find that plant features may be 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. Scenic resources and views, including both unique natural features and scenic variety, are common (TVA 2009h).

3.11.2. Environmental Consequences

This section addresses impacts to visual resources from site construction and operation of the Action and No Action Alternatives.

Alternative 1 – License Renewal

Under Alternative 1 – Action Alternative, SQN license renewal would result in no change to the plant site or operations, and there would be no new impacts to the landscape or area visual resources.

Alternative 2 – No Action Alternative

Under No Action Alternative 2, the SQN operating licenses would not be extended, resulting in shutdown of SQN. No impacts to visual resources would occur from the shutdown of SQN, but during decommissioning, the objects currently visible to off-site persons may be

removed, depending on future land-use plans. Future land-use options would not be determined until formal decommissioning begins. If Alternative 2 were chosen and SQN were decommissioned, the plant would probably become a brownfield site. Structures would remain in place or might be dismantled to make way for new development. The removal of the cooling towers, transmission lines, or other structures would make the site less visible from the surrounding residential and recreational areas. Should dismantlement of the site become an option, construction cranes would be visible on the skyline, but only for a short-term duration. Otherwise, there would be no change to visual resource impacts in the area.

Alternative 2a or 2b– New Nuclear or Natural Gas-Fired Generation

The impacts of Alternatives 2a and 2b are similar and discussed together below.

Under Alternative 2a or 2b, the impact on the visual resources of an area would be dependent upon the physical, biological, and cultural characteristics of the potential site. Topographical relief, vegetative cover, proximity to the public, rural or urban location, construction and operation practices, facility visual features, and atmospheric conditions are all factors that would influence the perception of how a new facility would impact the visual resources of an area.

During the construction phase, there would be the potential for temporary and minor impacts to visual aesthetics in an area due to the staging of construction materials and site preparation, the introduction of construction cranes, and an increase of dust from additional traffic on local dirt roads. More permanent impacts to the viewshed during the operation phase could result from the cumulative effects of introducing cooling towers or exhaust stacks to the skyline, water vapor plume release, transmission lines, and visibility of other prominent facility features. The level of impact anticipated during construction and operation would range from minor to moderate and vary depending upon viewer distance from the site, the abundance of trees, hilly terrain, and mitigation measures used, such as utilizing landscape materials on site, and painting techniques applied to facility structures.

3.12. Noise

Generating electricity is an industrial process, and the process necessarily produces noise as a result. TVA is aware of the impact that noise can have on the workers at the plant, the public surrounding the site, and the animals within the area. Noise impacts are always considered in evaluating activities related to SQN. The following section discusses noise and related impacts.

3.12.1. Affected Environment

At high levels, noise can cause hearing loss, and at moderate levels, noise can interfere with communication, disrupt sleep, and cause stress. At relatively low levels, noise can cause annoyance. Noise is measured in decibels (dB), a logarithmic unit, so an increase of 3 dB is just noticeable, and an increase of 10 dB is perceived as a doubling of the sound level. Because not all noise frequencies are perceptible to the human ear, A-weighted decibels (dBA) that filter out sound in frequencies above and below human hearing are used for this assessment. Ambient environmental noise is usually assessed using the day-night average noise level (Ldn). The Ldn is a weighted logarithmic 24-hr average with a 10-dB penalty added to noise between 10 p.m. and 7 a.m. to account for the potential for sleep disruption (CERES 2009).

Community noise impacts are typically judged based on the magnitude of the increase above existing background sound levels. There are no federal, state, or local industrial noise statutes for the communities immediately surrounding the SQN site. The EPA recommends an Ldn less than 55 dBA to protect the health and well-being of the public with an adequate margin of safety (EPA 1974). The U.S. Department of Housing and Urban Development (HUD) considers areas with an upper limit Ldn of 65 dBA to be acceptable for residential development (FRA 2010). The Federal Interagency Committee on Noise recommends that a 3-dB increase indicates a possible impact requiring further analysis when the existing Ldn is 65 dBA or less (FICON 1992).

SQN is located in a rural area along the Tennessee River in Hamilton County, Tennessee. There is scattered residential development in the area around the plant site. The nearest resident lives approximately 0.5 miles from the reactor units' centerpoint in the north-northwest direction. There is a subdivision approximately 1 mile north of the plant site as measured from the reactor units' centerpoint, and another within 1 mile of this centerpoint to the west along Hixson Pike, State Route (SR) 319, and Igou Ferry Road. This subdivision is separated from the main part of the SQN site by an embayment that has a border of trees on both sides. There are also residences on the eastern shoreline of Chickamauga Reservoir within 1 mile of the plant site. (TVA 2009h)

Noise sources in the vicinity of the SQN site include river and lake traffic, road traffic, dogs barking, insects, power line hum, and plant equipment at SQN: fans, turbine generators, transformers, cooling towers, compressors, emergency diesels, main steam-safety relief valves (MS-SRV), and emergency sirens. The MS-SRVs occasionally produce loud noises and visible steam and are therefore easily noticed by residents in the vicinity. The release of steam and noise would only be expected for a few hours when these valves are used and that use is rare (fewer than five days per year). Under some atmospheric conditions, a light humming may be noticed directly under 500-kV lines, but this noise is rarely heard outside the ROWs. Emergency sirens are deliberately very loud and easily heard in the community. These sirens provide a warning to area residents as part of the local community emergency plans for various emergencies, such as a tornado warning, as well as serving as a warning for an SQN radiological emergency. Emergency sirens would probably remain part of the community even if SQN were shut down in the future. Average noise levels in rural areas are typically about 40 dBA during the day (TVA 2009h). SQN is an industrial facility in which the average noise levels can approach approximately 65 – 75 dBA or greater on site, although this is not based on actual measurements at SQN (WHO 2001). At the site boundary, the noise levels are consistent with a rural residential area.

3.12.2. Environmental Consequences

Noise impacts are normally a temporary nuisance. The noise is heard, and the background noise level is reestablished to the receptor. If the noise does not cause any damage to the receptor's hearing capability, the receptor's hearing returns to normal. There is normally no cumulative effect of noise unless damage has occurred. After a period of time, even following exposure to occasional loud noise, most of the effects are not permanent and hearing returns to normal after a period of rest from noise exposure. Lasting effects do occur from continuous or repetitive exposure to damaging levels of noise, but that condition is not expected for any off-site receptors exposed to construction or operation noise-producing activities. Workers potentially exposed to damaging levels of noise are required to wear appropriate hearing protection. Noise impacts would be expected to be minor, and no cumulative impacts would be expected for the public or workers.

Alternative 1 – License Renewal

Because there would be no major construction, implementation of the license renewal alternative would have no impact on noise levels near SQN due to construction activities. The planned future expansion spent fuel storage capacity, based on need during the period of license renewal, would be of short duration and follow the construction methods of the current ISFSI, which produced no noticeable impacts from construction noise-producing activities. Therefore, noise is currently a minor impact in the area surrounding SQN, and there are no expected direct or indirect impacts due to noise.

Noise impacts associated with operation of SQN are minor, even with the operation of the cooling towers. The noise sources of motors, generators, pumps, trucks, and cars are typical of an industrial facility. Off-site noise levels are currently similar to the noise levels in a rural residential area and would be expected to remain at the current levels.

During the period of license renewal, no new sources of noise would be introduced. There are no plans for changes to the facility, procedures, or programs that could increase the noise generated from the SQN facility. Therefore, the noise impacts due to license renewal are expected to be minor with no change from the current conditions.

Alternative 2 – No Action Alternative

If the No Action Alternative were chosen, the expected impacts from noise during shutdown of the SQN site would be minor.

Alternative 2a – New Nuclear Generation

Construction

The site of a new nuclear generation alternative is unknown. Noise impacts are dependent on the distance to the nearest critical receptor, so no specific dBA values for receptor locations can be determined. Noise for the construction of a new nuclear plant is expected to be minor to moderate (depending on location and type of sensitive receptor) because most noise-producing construction activities are of short duration (minutes to hours per day) and the construction is temporary, being completed in approximately five to seven years (short-term), and there are numerous mitigation methods that can be implemented to limit the impact of noise.

Sources of noise in the construction of a new nuclear power generation facility are numerous and include large heavy equipment such as bulldozers, draglines, scrapers, and haulers to excavate earth, grade, and prepare for building placement. Other phases of construction would require the use of cranes, front loaders, graders, forklifts, man lifts, compressors, backhoes, dump trucks, a pier driller, and portable welding machines. This type of equipment would generate noise levels up to 98 dB at 50 feet (USDOT 1973). Construction noise of 98 dBA at 50 feet would be about 65 dBA at an approximate half-mile site boundary; a 6 dBA decrease each time the distance is doubled from the source (CERES 2009). This noise level would continue to decrease until reaching the nearest residence or noise-sensitive receptor location (hospital, library, nursing home, etc.). Noise at a sensitive receptor location at 1 mile would be below 60 dBA. Noise from construction equipment is expected to be audible over background noise levels, but it is not expected to cause a noticeable adverse impact. Mitigation measures might include noise shields around

stationary equipment, limited hours of operation, properly maintained noise suppression equipment on machinery, and equipment operation limited to the day shift only.

A concrete batch plant would probably be placed on site to provide the large volume of concrete needed to construct the facility. However, the noise level from the batch plant would not exceed the levels from heavy machinery. Limiting most of the construction activities to daytime hours would reduce potential noise impacts.

Depending on site geology and soils, site preparation for the construction of a new nuclear plant may require blasting, which would cause temporary noise impacts. Potential mitigation measures include, but are not limited to, the use of blasting blankets, notification of the surrounding receptors prior to blasting, and limiting blasting activities to daylight hours.

Traffic noise from the commuting of potentially 5,000 workers (Chapter 2) would be noticed and the impact would be moderate. Mitigation can be accomplished by using multiple shifts and encouraging car-pooling activities.

Construction noise associated with new transmission systems are expected to be minor. The construction is usually of short duration, measured in days for each substation or tower location, while access roads and corridors may take a few weeks. The amount of heavy equipment needed to construct transmission systems is considerably less than a major construction site. Cranes and trucks are the major types of heavy equipment, whereas wood-clearing equipment such as chain saws and chippers may be used to clear vegetation. Out of safety concerns, construction activities for transmission systems are usually daytime-only projects, which helps limit the noise interfering with nighttime sleeping hours.

Based on projected noise levels and the temporary duration of construction activities, noise impacts from construction activities associated with Alternative 2a are expected to be minor for the surrounding communities, and minor to moderate for the nearest residents. There is a direct impact on the construction site due to noise, but mitigation measures would be employed, and a formal worker hearing protection program would be implemented that would be similar to the current program in effect at SQN. Indirect impacts off site would be minor and temporary during construction for surrounding animals. Some animals might avoid the area, but many would become accustomed to the noise.

Operation

The major noise source in the operation of a new nuclear plant is normally the cooling tower, with noise level dependent on the type of cooling tower chosen. A reasonable expectation for a nuclear unit with mechanical draft cooling towers is approximately 85 dBA near the tower and 55 dBA at 1,000 feet from the towers. The cooling tower design noise criteria presented are for noise from Babcock and Wilcox PWR cooling towers, which are similar to AP1000 PWR designed cooling towers (TVA 2010b). At the potential nearest residence (approximately 0.5 miles from the site boundary), noise from the cooling tower is expected to be well below 50 dBA, which is similar to rural background noise levels in a typical rural area. These levels would not exceed EPA's recommendation or HUD's guideline for residential areas.

The noise sources of motors, generators, pumps, trucks, and cars are typical of an operating industrial facility. The permanent work force would produce traffic noise during its commute to and from work. Off-site noise levels are in line with rural residential areas.

Based on the projected noise levels, noise impacts associated with the implementation of Alternative 2a are expected to be minor for the surrounding communities and the nearest residents. Direct impacts on site would require a formal hearing protection program as per Occupational Safety and Health Administration requirements (29 CFR Part 1910). There would not be any indirect impacts off site needing mitigation. Noise impacts are not normally cumulative and would not provide any cumulative impacts in the long term.

Alternative 2b – New Natural Gas-Fired Generation

Construction

Most activities necessary to construct a new natural gas-fired power plant would be similar to those implemented under Alternative 2a and would have similar impacts on noise levels in the vicinity of the new plant site. Noise impacts from transmission system construction activities would be minor, as explained in the Alternative 2a – New Nuclear Generation section.

Based on projected noise levels and the duration of construction activities, noise impacts from construction activities associated with Alternative 2b are expected to be minor for the surrounding communities, and minor to moderate for the nearest residents. There is a direct impact at the construction site due to noise, but mitigation measures would be employed, and a formal hearing protection program would be implemented that would be similar to the current program in effect at SQN. Indirect impacts would be minor and temporary during construction for animals in the area. Some animals might avoid the area, but many would become accustomed to the noise.

Operation

The operation of a new natural gas-fired plant would have noise sources similar to other large industrial facilities. Cooling towers, fans, pumps, compressors, boilers, etc. are usually on a smaller scale than nuclear or coal plants, but still produce noise as they are used to support plant operations. Natural gas-fired sites are usually smaller than coal or nuclear facilities, and may be located closer to residences or sensitive receptors due to the smaller area required to separate the site from the public. However, noise levels would still be expected to be within acceptable background noise levels at the nearest residence.

Based on projected noise levels, noise impacts from the operation of Alternative 2b are expected to be minor for both the surrounding communities and for the nearest residents.

Conclusion

Impacts from noise would be expected to be minor to moderate during the short term of construction, depending on the type of sensitive receptor and location of the construction. Noise would be a minor impact during operation for all alternatives at the nearest receptor locations off site. Only minor direct impacts would be expected at the proposed operating sites. No indirect impacts or cumulative effects would be expected, and are therefore minor.

3.13. Socioeconomics

3.13.1. Population

This section evaluates population characteristics in Hamilton County and potential socioeconomic impacts of the proposed action alternatives.

3.13.1.1. Affected Environment

Socioeconomic issues associated with SQN were originally evaluated with the SQN FES (TVA 1974a). The FES concluded that the majority of employee settlement would occur in Hamilton County. Because of the county's large population base, socioeconomic impacts associated with the initial construction and operation of SQN were small and ultimately found to not be significant. The demography and population projections for the area surrounding SQN are discussed in the TVA 2008 UFSAR, Section 2.1.3. (TVA 2008a). The UFSAR information was based on 1990 U.S. Census data. Updated data from the 2000 census and other more current sources are provided below.

The population of Hamilton County, Tennessee, as reported in the 2000 census was 307,896, a density of 568 persons per square mile (See Appendix E; USCB 2008a). The U.S. Census 2008 estimate for Hamilton County was 332,848 residents (USCB 2008a).

Because the proposed renewal of the SQN Units 1 and 2 operating licenses would extend plant operations to the year 2041 as described in Chapter 1, the population growth trend established in state-provided population projection data was also extended out to include the years leading up to 2041. For Hamilton County, the University of Tennessee's Center for Business and Economic Research (UTCBER) 2010 – 2030 population projections released June 2009, and again in March 19, 2010, were the analysis data source. These projections utilize the latest decennial census (year 2000) population data and a county population estimate. From these datasets, the Hamilton County ratio of population change was established for 2010 to 2030, and applied to the years 2031 through 2041. Based on June 2009 data, Hamilton County projected population for 2041 is expected to be 339,237. (See Appendix E.) This is a 10.2 percent increase since 2000. The average projected annual growth rate for this period is 0.24 percent (Table 3-16). New population projection data released March 19, 2010, indicate Hamilton County's population could grow at a much greater rate and increase to 420,352 by 2041 (see Appendix E). This is a 36.5 percent increase in population for Hamilton County since 2000, and an average annual growth rate of 0.76 percent a year. These population numbers are subject to change. State projection information, like census data, is updated periodically for public release.

There are three cities in a 50-mile radius of SQN that have a population greater than 25,000. These cities are Chattanooga, Tennessee (18 mi), with an estimated population of 170,880 in 2008; Cleveland, Tennessee (13 mi), with an estimated population of 39,753 in 2008; and Dalton, Georgia (32 mi), with an estimated population of 33,648 in 2008 (Figure 1-3). (USDOT 2008; USCB 2008b; USCB 2008c; USCB 2008d) One of the largest cities near SQN, Soddy-Daisy (6 mi), has a 2008 estimated population of 12,511 residents (Figure 1-2) (USCB 2008e).

The radial population density for the region was estimated from the plant centerpoint of a line connecting the two reactors using the 2000 U.S. Census block data. The radial population was based on county projections obtained from the associated states. (See Appendix E, and USCB 2000a; UACB 2001; GAOPB 2005; NCOSBM 2009a; NCOSBM

2009b; NCOSBM 2009c) The population density was calculated for the total area included in the 20- and 50-mile radius. For the 20-mile radius, the 2000 permanent population was 339 people per square mile. For the 50-mile radius, the 2000 population density was 124 people per square mile.

In addition to the permanent population in the 20- and 50-mile radius, there is a substantial transient population. The transient information was derived from state tourism data. (ATD 2008; GDED 2006; GDED 2010; NCDOC 2008; TDTD 2007; USCB 2000b; USCB 2005) With the addition of the transient population, the total population density in the 20-mile radius increases to 369 people per square mile in 2000. For the 50-mile radius, the total population density increases to 134 people per square mile in 2000.

Table 3-16. Hamilton County Projected Population Estimates and Growth Rates

Year	Hamilton County Projected Population June 2009	Average Annual Growth Rate (percentage per year)	Hamilton County Projected Population March 19, 2010	Average Annual Growth Rate (percentage per year)
2000	307,896*		307,910	
2005	323,426	0.99	323,162	0.97
2010	326,104	0.17	339,551	0.99
2015	327,665	0.10	350,362	0.63
2020	328,290	0.04	363,285	0.73
2025	329,514	0.07	376,747	0.73
2030	329,365	-0.01	390,229	0.71
2035**	335,861	0.39	404,158	0.70
2040**	338,674	0.17	417,653	0.66
2041**	339,237	0.17	420,352	0.65

* US 2000 Census count, Hamilton County population.

** Projected population values for 2035, 2040, and 2041 are based on the extension of the population projection growth trend established in the years 2000 to 2030.

(See Appendix E.)

3.13.1.2. Environmental Consequences

This section addresses impacts to population from site construction and operation of the Action and No Action Alternatives.

Alternative 1 – License Renewal

Under Alternative 1 – Action Alternative, SQN license renewal would result in no changes in operating employment levels at the plant, and there should be no new impacts to population through this action.

Alternative 2 – No Action Alternative

Under No Action Alternative 2, the SQN operating licenses would not be extended, resulting in shutdown of SQN. If the No Action Alternative were chosen, and operation of the SQN plant should cease, the loss of operational jobs and potential relocation of employees would have a negligible effect on the permanent population of Hamilton County, Tennessee. As of 2010, SQN employed a staff of approximately 1,144 permanent and contract employees. Of these, 892 employees, or 78 percent, reside in Hamilton County, Tennessee. (Dennis Lundy, TVA, personal communication, August 3, 2010) SQN employees may decide to move to other power plant locations. These employees comprise 0.3 percent of the population of Hamilton County, based on the 2000 census count. As the county continues to grow as projected, the effect of the potentially reduced area population would be short-lived and the overall impact likely would be minor.

Alternative 2a or 2b – New Nuclear or Natural Gas-Fired Generation

The impacts of Alternatives 2a and 2b are similar and discussed together below.

Should a new nuclear or new natural gas facility be constructed, impacts on the local population would vary, depending on the location. Plants are more likely to be located in low density areas. The level of impacts would vary greatly depending on the work force requirements, which are much greater for a typical nuclear plant than for a typical natural gas plant. During construction, many of the workers (5,000 peak construction work force for a new nuclear facility, and a 1,200 – 1,440 peak work force for a new natural gas facility) are likely to temporarily relocate to the area. However, temporary workers often will commute relatively long distances rather than relocate. A new nuclear plant could require a permanent operational staff of between 650 – 1,000 employees and a new natural gas facility would need approximately 180 employees. A plant operations work force would most likely permanently relocate within commuter range of the new facility. Impacts would depend to a great extent on the size of the population around the site and the availability of housing and amenities. Impacts would be evaluated on a specific project basis and would potentially range from minor to substantial.

3.13.2. Employment and Income

This section addresses the impacts on employment and income in the vicinity of SQN.

3.13.2.1. Affected Environment

As discussed in Section 3.13.1, the 2008 estimated population for Hamilton County was 332,848 people, with a total employment of 251,211 people. Overall, the distribution of employment by industry in Hamilton County is similar to the statewide distribution. Consistent with its metropolitan status, it has relatively fewer workers in farm and farm-related jobs, and relatively more in transportation and warehousing and in finance and insurance. Government employment is 11.6 percent of the total in Hamilton County, slightly below the state level of 12.1 percent (see Table 3-17 for data on major sectors). (BEA 2008a) Total compensation of employees within Hamilton County in 2008 was nearly $10

billion. The annual average wage per job within Hamilton County for 2008 was approximately $38,958, which is slightly less than the state average wage of $39,469. (BEA 2008b)

The fourth largest in the state, the Chattanooga Metropolitan Statistical Area (MSA) has an estimated 2008 population of 520,089 (BEA 2008c). With a combined total personal income of over $18 billion, the Chattanooga MSA employed 321,197 people in 2008, an increase of approximately 23,600 jobs since 2003. (CHCRPA 2005b; BEA 2008a; BEA 2008c) Because Hamilton County dominates the MSA, the industrial distribution of employment in the Chattanooga MSA was similar to that of the county (Table 3-17). (BEA 2008a) Comparatively, the Chattanooga MSA annual average wage for 2008 was less than both the state and Hamilton County averages at $37,433 per year. (BEA 2008b)

Table 3-17. Top Employing NAICS Industry Categories

Category	Number of Jobs		
	Chattanooga MSA	Hamilton County	Tennessee
Construction	20,274	15,267	249,188
Manufacturing	35,107	24,312	375,063
Retail Trade	32,811	24,328	410,433
Transportation and Warehousing	22,277	19,497	176,507
Finance and Insurance	19,934	17,564	160,470
Real Estate, Rental, Leasing	11,547	9,042	156,138
Professional, Scientific, Technical Services	15,484	13,666	188,754
Administrative and Waste Services	18,681	17,748	256,510
Health Care and Social Assistance	29,304	24,651	366,745
Accommodation and Food Services	22,806	18,749	263,888
Other Services	20,531	14,757	234,129
Government	38,249	29,023	454,184

(BEA 2008a)

Unemployment within the Chattanooga MSA, which increased significantly from 2007 to 2009, showed some signs of improvement in 2010 with a 0.2 percent decrease since 2009 (Table 3-18). This decrease in unemployment could be partly due to the addition of new manufacturing, similar to the new Volkswagen automotive assembly plant that is anticipated to bring 2,000 new direct jobs and as many as 12,000 indirect jobs associated with parts supplies. (SDRG 2009) In addition, the Amnicola Industrial Park and other existing industrial parks have prime industrial land available for development, specifically the Enterprise South Industrial Park. A new interstate exchange is nearing completion and will provide direct access to Enterprise South Industrial Park from Interstate-75 (I-75),

potentially bringing more industrial jobs to the Chattanooga MSA. (SDRG 2009) Tennessee, by comparison, has not shown signs of improvement, with the unemployed labor force expanding from 4.6 percent in 2007 to 10.8 percent in 2010. (BLS 2008; BLS 2010)

Table 3-18. Chattanooga MSA and Tennessee Unemployment: 2007 – 2010

Geography	2007 (March)	% of Labor Force	2008 (March)	% of Labor Force	2009 (March)	% of Labor Force	2010 (March)	% of Labor Force
Chattanooga (MSA)	9,900	3.8	14,400	5.4	24,900	9.7	24,200	9.5
Tennessee	139,200	4.6	177,500	5.9	320,900	10.6	324,400	10.8

(BLS 2008; BLS 2010)

3.13.2.2. Environmental Consequences

This section addresses impacts to employment and income from site construction and operation of the Action and No Action Alternatives.

Alternative 1 – License Renewal

SQN license renewal would result in no change to operating employment levels at the plant, therefore; there would be no changes to the local economy within the county or region. No new impacts to local employment or income are anticipated through this action.

Alternative 2 – No Action Alternative

Under No Action Alternative 2, the SQN operating licenses would not be extended, resulting in shutdown of SQN.

Alternative 2a or 2b – New Nuclear or Natural Gas-Fired Generation

The impacts of Alternatives 2a and 2b are similar and discussed together below.

If the No Action Alternative were chosen, and operation of the SQN plant should cease, the loss of 1,144 jobs within the region would not likely result in noticeable impacts to the economy. (SQN 2010) However, because a majority of these jobs, including the related indirect jobs, are located in Hamilton County, the level of impact to local communities would depend on whether SQN employees would choose to continue work within or near their current communities, or whether they would choose to find employment elsewhere.

Should a new nuclear or new natural gas facility be constructed at an alternate greenfield site, changes to local employment would be anticipated. A natural gas facility would require a smaller construction and operation work force than that required for a nuclear facility. The necessary construction work force would likely come from local and regional sources, creating hundreds of new direct and indirect jobs for several years. The phasing out of construction personnel and phasing in of a smaller operational work force has the potential to cause a boom and bust scenario, where a community might not only experience a subsequent drop in overall population, but also the need for staffing certain indirect jobs. This could result in substantial employment impacts to local communities and counties near

the selected site. An incoming permanent operational work force would help offset the loss of certain jobs and also create others. The overall impact could range from minor to moderate, depending on specific site conditions.

3.13.3. Low-Income and Minority Populations (Environmental Justice)

This section addresses the impacts on low-income and minority populations in the vicinity of SQN.

3.13.3.1. Affected Environment

Regarding environmental justice, EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, issued on February 11, 1994, is designed to focus the attention of federal agencies on the human health and environmental effects of its programs, policies, and activities on minority and low-income communities. (59 FR 7629) While TVA is not subject to this executive order, it evaluates potential environmental justice impacts as a matter of policy. The environmental justice review involves identifying potential off-site environmental impacts, their geographic locations, minority and low-income populations that may be affected, the significance of such effects, and whether they are disproportionately high and adverse compared to the population at large within the geographic area, and if so, what mitigative measures are available, and which would be implemented.

According to the 2000 Census "Aggregate of All Minority Races and Hispanic" category, Hamilton County, Tennessee, has a higher percentage of minorities compared to the percentage of minorities within the overall state's population (Table 3-19). As shown in Table 3-19, the census categories for "Black," "Asian," and "Native Hawaiian" are greater for Hamilton County than they are for the state of Tennessee. The "Black" census category, representing 20.1 percent of the county population, represents the greatest minority population difference between the county and state. (USCB 2000c; USCB 2000d)

The 2000 U.S. Census block group that includes the SQN site is number 470650103012. As shown in Table 3-19, within this block group none of the census minority categories, or low-income category, has a higher population percentage than the county or state percentages. (USCB 2000i; USCB 2000j)

The environmental justice evaluation for low-income populations is based on the use of census block groups, the finest resolution of data available for this particular population characteristic. A minority or low-income population is considered present if 1) the minority or low-income population identified in the census block or block group exceeds 50 percent, or 2) the minority or low-income population percentage is significantly greater (typically at least 20 percentage points) than the minority population percentage in the geographic area chosen for comparative analysis (individual states and combined states). (NRC 2004a)

As seen in Figure 3-13, based on environmental justice criteria, no minority population blocks were identified with the SQN census block group 470650103012. Additionally, the SQN block group does not meet the environmental justice criteria to be classified as containing a low-income population. Based on 2000 Census data, Hamilton County has a smaller percentage of low-income populations when compared to the state. As shown in Table 3-19, the county's low-income population is 12.1 percent, while the state of Tennessee has 13.5 percent. (USCB 2000e; USCB 2000f)

Table 3-19. U.S. Census Race Category and Low-Income Populations

U.S. Census Categories	SQN Block Group 470650103012 Population by Census Category	%	Hamilton County Population by Census Category	%	Tennessee Population by Census Category	%
Black	5	0.4	62,005	20.1	932,809	16.4
American Indian\Alaskan Native	0	0	900	0.3	15,152	0.3
Asian	6	0.5	3924	1.3	56,662	1
Native Hawaiian\other Pacific Islander	0	0	196	0.06	2,205	0.04
Other	0	0	2356	0.8	56,036	1
Two or More Races	9	0.8	3,515	1.1	63,109	1.1
Aggregate of All Minority Races	20	1.7	72,896	23.7	1,125,973	19.8
Hispanic	2	0.2	5,481	1.8	123,838	2.2
Aggregate of All Minority Races and Hispanic	22	1.9	78,377	25.5	1,249,811	22
Low Income - Number of Persons Below Poverty Level (DP-3)	68	5.8	36,308	12.1	746,789	13.5

(USCB 2000c; USCB 2000d; USCB 2000e; USCB 2000f; USCB 2000i; USCB 2000j)

The identified minority population closest to SQN is approximately 1.2 miles away in census block number 470650101012009. The census block contains 12 people total, with 7 people in the “White” category, and 5 people in the “Asian” category. Along with identified individual minority blocks, clusters of blocks containing minority populations are present in the region. The closest cluster to SQN contains 301 people and is approximately 6 miles north of the SQN centerpoint. The blocks in this cluster consist of 122 people in the “White” category, 175 people in the “Black” category, and 4 people in the “Two or More Races” category. The U.S. Census block numbers are 470650102002002, 470650102002004, 470650102002043, and 470650102003079. (NRC 2004a; USCB 2000a)

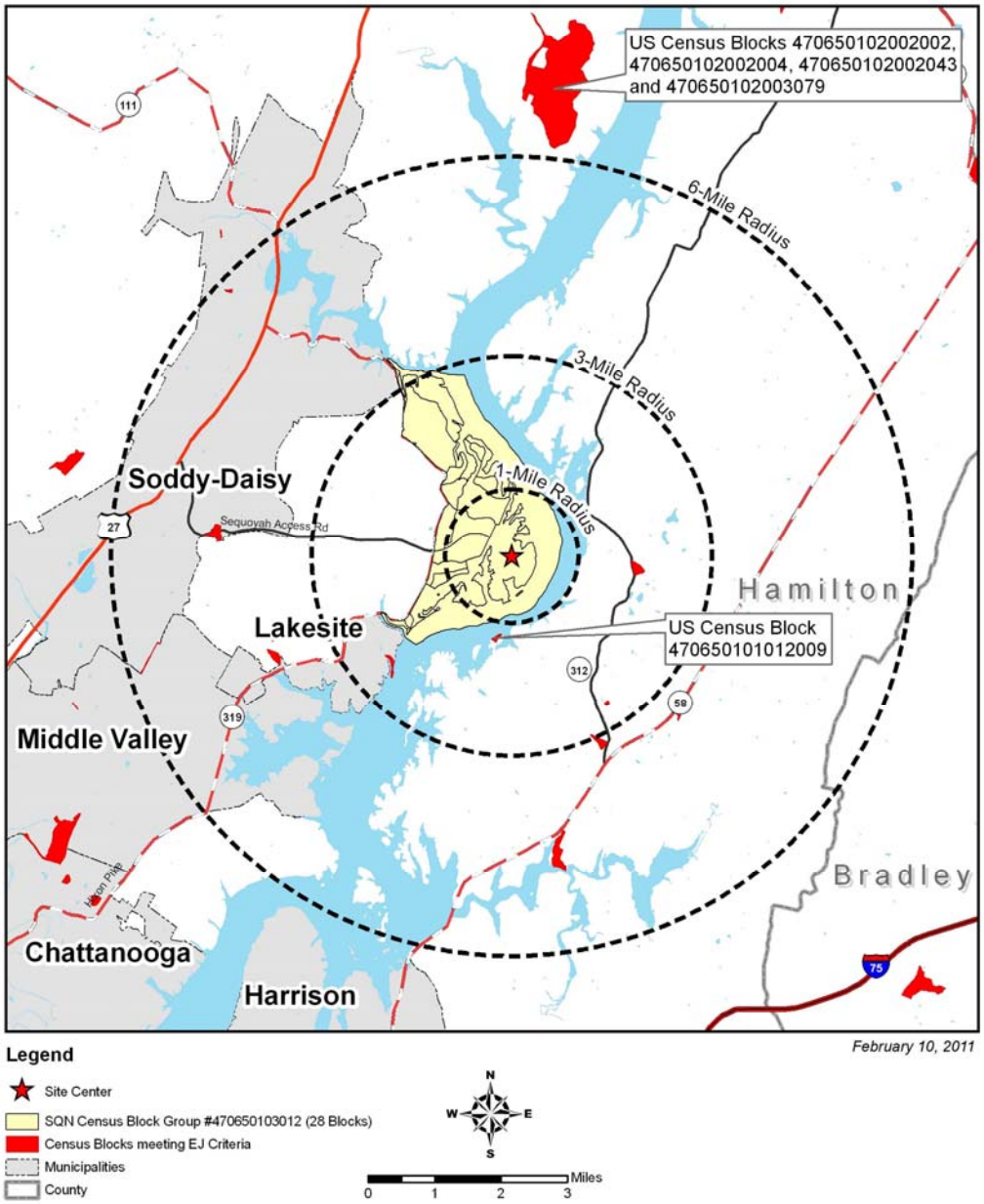

Figure 3-13. Minority Populations Within 6-Mile Radius of SQN

The closest low-income population is approximately 12.6 miles away and located inside the city of Cleveland, Tennessee. It is U.S. Census block group number 470110105003. All of the low-income population block groups are located in or near cities. (NRC 2004a; USCB 2000g)

None of the identified minority and low-income populations meeting the environmental justice criteria are associated with one specific community or geographic area. Instead, they are widely distributed throughout the region.

3.13.3.2. Environmental Consequences

This section addresses impacts to low-income and minority populations from site construction and operation of the Action and No Action Alternatives.

Alternative 1 – License Renewal

Under Alternative 1 – Action Alternative, SQN license renewal would result in no changes in operating employment levels at the plant. In its analysis of current conditions, TVA did not identify any location-dependent, disproportionately high and adverse impacts to minority and low- income populations resulting from operation of SQN. There are beneficial impacts realized, such as taxes paid by TVA and SQN workers. These in turn benefit local public services for the general population, including minority/low-income groups in the community. There should be no new impacts to population through this action.

Alternative 2 – No Action Alternative

Under the No Action Alternative, the loss of operational jobs would not impact disproportionately the minority and low-income populations of Hamilton County, Tennessee. As stated in Subsection 3.13.1, impacts due to a loss of population would have a negligible effect on the permanent population of Hamilton County. Housing costs may slightly decrease, as a result of additional available housing caused by the migration of operational workers. This migration and subsequent reduction in housing costs could have a small temporary beneficial impact on low-income populations. However, these effects would be short-lived if Hamilton County continues to grow as expected, with the overall impact anticipated to be minor.

Alternative 2a or 2b – New Nuclear or Natural Gas-Fired Generation

The impacts of Alternatives 2a and 2b are similar and discussed together below.

Should a new nuclear or a new natural gas facility be constructed, environmental justice issues would depend on the proposed location, and would be analyzed at the appropriate time. Potential impacts that might disproportionately impact minority or low-income communities include, for example, pressure on food and housing prices, or increases in road congestion or noise near residential communities.

3.13.4. Housing

This section addresses impacts to housing in the vicinity of SQN.

3.13.4.1. Affected Environment

To accommodate the increase in population growth as described in Section 3.13.1, the number of total housing units also increased in Hamilton County (Table 3-20). From 1990

to 2000, there was a 9.9 percent increase in total housing units, and an 11.7 percent increase between 2000 and 2008. The vacancy rates fell by 1.2 percent from 1990 to 2000, but rose by 4.2 percent between 2000 and 2008, indicating that more than enough housing was available, even as the county population increased. Median home values for Hamilton County also increased by 52.7 percent between 1990 and 2000, and by 65 percent between 2000 and 2008. Likewise, median rental fees increased in Hamilton County by 78.9 percent between 1990 and 2000. However, the increase in rental rates moderated between 2000 and 2008, with a 33.7 percent increase over the eight-year period. (USCB 1990; USCB 2000h; USCB 2008f)

Hamilton County has land-use and zoning regulations that address county and community priorities, and plans for dealing with the development of subdivisions and housing needs (Section 3.13.8).

Table 3-20. Hamilton County, Tennessee, Housing Statistics 1990, 2000, and 2008

	1990[1]	2000[2]	1990 to 2000 % Change	2008[3]	2000 to 2008 % Change
Total Housing Units	122,588	134,692	9.9	150,476	11.7
Occupied Units	111,799	124,444	11.3	132,773	6.7
Vacant Units	10,789	10,248	-5.0	17,703	72.7
Vacancy Rate (Percent)	8.8%	7.6%	-1.2	11.8%	4.2
Median House Value ($)	62,000	94,700	52.7	156,300	65.0
Median Rent ($/month)	285	510	78.9	682	33.7

1. (USCB 1990)
2. (USCB 2000h)
3. (USCB 2008f) American Community Survey estimates

3.13.4.2. Environmental Consequences

This section addresses impacts to housing from site construction and operation of the Action and No Action Alternatives.

<u>Alternative 1 – License Renewal</u>

Under Alternative 1 – Action Alternative, SQN license renewal would result in no change to operating employment levels at the plant, and no impacts to housing through this action are anticipated.

Alternative 2 – No Action Alternative

Under the No Action Alternative, the SQN operating licenses would not be extended, resulting in shutdown of SQN. Subsequently, the loss of operational jobs could have a dampening effect on the housing market, specifically in Hamilton County. However, the effect would be short-lived if the county continues to grow as expected, with the overall impact likely to be minor.

Alternative 2a or 2b – New Nuclear or Natural Gas-Fired Generation

The impacts of Alternatives 2a and 2b are similar and discussed together below.

Should a new nuclear or a new natural gas facility be constructed, acquiring adequate housing would be necessary for workers during the construction phase for either project, and again during the operational phase.

Depending on a site's proximity to a large labor force and an area's economic characteristics, construction workers might choose to commute from their established residences, seek short-term rental facilities within commuter range, or acquire more permanent housing in a local area near a potential site. Residential locations would depend on the availability of suitable housing facilities and local zoning codes, and could be located anywhere within the labor market area. The strains on localized housing markets could lead to increased prices for some types of housing and/or a potential shortage of accommodations. The demand for housing would begin to diminish after the peak construction employment level is reached and essentially disappear by the end of the construction period. Impacts on local and regional housing markets likely would range from minor to moderate if a proposed facility were located in a highly populated area with readily available housing. Impacts could range to substantial if a potential site were located in a sparsely populated area with little or no available housing. Impacts would be smaller for a natural gas facility than for a nuclear facility, due to the lower number of workers required.

An influx of operational workers at a site would phase in during the time period when construction work is phasing out. It is expected that operational workers migrating to an area would require more permanent housing than temporary construction workers, resulting in little or no competition between the two groups. Again the economic characteristics of the area and vacant housing availability would dictate whether the expansion of a housing market would accommodate the specific needs of an operational work force. Any expansion of the housing market may phase in with the arrival of operations workers to the area. Again, impacts on local and regional housing markets likely would be minor to moderate, depending on proximity to a highly populated area and readily available housing. Impacts could range to substantial, if a potential site were located in a sparsely populated area with little or no available housing. With a smaller number of workers required, impacts would be smaller for a natural gas facility than for a nuclear facility.

3.13.5. Water Supply and Wastewater

This section addresses impacts to water supply and wastewater in the vicinity of SQN.

3.13.5.1. Affected Environment

Most Hamilton County residents receive their potable water from one of 10 major providers active in the county. These utility districts are Hixson, Sale Creek, Savannah Valley, Soddy-Daisy/Falling Water, Tennessee-American, Union Fork-Bakewell, Walden's Ridge,

Signal Mountain, Mowbray, and Eastside. Tennessee-American Water, the major provider of public water services in Hamilton County, draws surface water from the Tennessee River. As of 2005, additional water treatment capacity was not a critical issue for Hamilton County. Over 307,000 people are served through these 10 water districts. (CHCRPA 2005a)

TVA contracts with Hixson Utility District to supply potable water to SQN, where the average daily requirement varies according to plant operation and fluctuations in plant personnel population. In 2007, the Hixson Utility District annual average groundwater withdrawal was over 6.70 MGD. (SDRG 2009) This is approximately the same rate of withdrawal reported in 2000. (TDEC 2000) As of April 2010, SQN's most recent monthly consumption of potable water was 388,660 cubic feet, or approximately 97,000 gallons per day (gpd). (TVA 2010m)

Sanitary sewer service in Hamilton County is provided by four entities: the Hamilton County Wastewater Treatment Authority, City of Chattanooga, City of Collegedale, and Town of Lookout Mountain. Moccasin Bend Treatment Plant is a regional facility that serves a population of approximately 400,000 including Chattanooga, the sewered portions of Hamilton County, and parts of counties and municipalities in both Georgia and Tennessee. Since 2001, the plant has undergone approximately $71 million in upgrades. In addition to Chattanooga, the system serves seven suburban areas, including part of Hixson Utility District and the City of Soddy-Daisy. (CHCRPA 2005a) The plant has a design capacity of 160 MGD and is currently functioning at 75 percent of its capacity. While Moccasin Bend is still under capacity and has had upgrades, other wastewater systems in the region need sewer plant and line improvements associated with their aging and/or outdated infrastructure. (SDRG 2009)

At SQN, the maximum quantity of sanitary water to be handled, treated, disposed of, or pumped off site is approximately 70,000 gpd. Sewage collected on site can be pumped off site to the Moccasin Bend sewage treatment system. (TVA 2008a)

3.13.5.2. Environmental Consequences

This section addresses impacts to water supply and wastewater from site construction and operation of the Action and No Action Alternatives.

Alternative 1 – License Renewal

Under Alternative 1 – Action Alternative, SQN license renewal would result in no new change in operating employment levels at the plant. No new impacts to water and wastewater services infrastructure are anticipated through this action.

Alternative 2 – No Action Alternative

Under the No Action Alternative, the SQN operating licenses would not be extended, resulting in shutdown of SQN. There would be less plant-associated demand on the Hamilton County water and wastewater system. However, because some operational workers and families may choose to remain in the county and utilize provided services, plant closure would have minimal influence with regard to lessening demand on system capacity.

Alternative 2a or 2b – New Nuclear or Natural Gas-Fired Generation

The impacts of Alternatives 2a and 2b are similar and discussed together below.

Should a new nuclear or new natural gas facility be constructed, the new plant water and wastewater infrastructure would need to be connected to existing area systems, or on-site options would need to be developed. Connecting to existing systems might require additional capacity to be developed. This could impact area land use (Section 3.13.8).

The arrival of construction and operational workers, and any family members brought to the area to live, would also make demands on a system. Depending on available water and wastewater infrastructure, if the housing market expands to meet worker needs, as described in Section 3.13.4, upgrading existing or building new infrastructure could be required, particularly with the creation of new housing subdivisions. This impact would be defrayed with the expected expansion of the tax base (Section 3.13.9).

3.13.6. Police, Fire, and Medical Services

This section addresses impacts to police, fire, and medical services in the vicinity of SQN.

3.13.6.1. Affected Environment

Hamilton County has a wide array of public safety agencies providing services to its residents, including a number of municipal police departments, the sheriff's department, volunteer and career community fire departments, emergency medical services, and area hospitals.

The Hamilton County Sheriff's Department covers the largest area in the county, and patrols and services the unincorporated portions, the City of Lakesite, and the Town of Walden. Chattanooga, Collegedale, Lookout Mountain, Red Bank, Soddy-Daisy, Signal Mountain, and East Ridge all provide police protection for their municipalities. Ridgeside contracts with the East Ridge Police Department to provide full police services for its residents. (CHCRPA 2005a) The Hamilton County Sheriff's Department Uniformed Patrol Division has about 56 patrol deputies and 43 reserve deputies, along with 12 sergeants and lieutenants providing law enforcement in the county (HCSO 2010).

Chattanooga, Soddy-Daisy, Red Bank, Signal Mountain, and East Ridge provide fire protection to their incorporated residents. Several volunteer fire departments provide protection to both incorporated and unincorporated area residents, including Dallas Bay, Highway 58, Tri Community, Sale Creek, Walden's Ridge, Sequoyah, Mowbray, and Flat Top Volunteer Fire Departments. (CHCRPA 2005a) Hamilton County has approximately 17 fire departments, 47 stations, and 866 career and volunteer firefighters providing fire emergency services (USFA 2010; CHCRPA 2005a).

If a situation evolves where outside emergency support becomes necessary at SQN, the plant communicates its need to a number of local and state emergency service agencies. Along with having its own emergency response capabilities, SQN has local support agreements with Soddy-Daisy Fire Department, the Erlanger Medical Center, and Memorial North Park Hospital in Chattanooga, and the Hamilton County Emergency Medical Service for ambulance support. (Dennis Lundy, TVA, personal communication, March 11, 2010) Erlanger has five Tennessee-based medical campuses, and is licensed for 819 acute-care beds and 50 long-term care beds serving patients from 50 counties within a 150-mile radius (Erlanger 2010). The Memorial Health Care System has 405 licensed acute inpatient

services beds system-wide, and an 83-bed capacity at Memorial North Park Hospital, located in the suburb of Hixson (Memorial 2010). Both hospital systems have a wide range of associated physicians and staff who serve public needs.

3.13.6.2. Environmental Consequences

This section addresses impacts to police, fire, and medical services from site construction and operation of the Action and No Action Alternatives.

Alternative 1 – License Renewal

Under Alternative 1 – Action Alternative, SQN license renewal would result in no change to operating employment levels at the plant. No new impacts to emergency services infrastructure are anticipated through this action.

Alternative 2 – No Action Alternative

Under the No Action Alternative, there could be a phased drop in the need for public safety services should operational staff choose to relocate out of the county. As described in Sections 3.13.1 and 3.13.2, Hamilton County has a growing population and a number of employment options. It is likely that the reduced need for public safety services would be offset by the increasing demand from future county population growth.

Alternative 2a or 2b – New Nuclear or Natural Gas-Fired Generation

The impacts of Alternatives 2a and 2b are similar and discussed together below.

Should a new nuclear or new natural gas facility be constructed, the arrangement of support from local emergency service providers would become a necessity during the construction and operation phase. Depending on the proximity to population centers and the availability of emergency services, the influx of construction workers could impact the ability of an area's police, fire, and medical facilities to provide support requiring additional resources. With workers leaving at the end of the construction phase, permanent investments made in the expansion of public safety services would support incoming operational staff and families expected to permanently move to the area as well as other further county population growth.

3.13.7. Schools

This section addresses impacts to schools in the vicinity of SQN.

3.13.7.1. Affected Environment

Hamilton County has one public school district. Based on the 2007 – 2008 school year, the Hamilton County School District has 77 schools with 41,230 students. The student-to-teacher ratio is 14.5 to 1. Near SQN, there are six schools in Soddy-Daisy, including three elementary schools, a middle school, and two high schools. Eight schools are located in the nearby Chattanooga suburb of Hixson, including five elementary schools, two middle schools, and a high school. The city of Chattanooga has 43 schools (NCES 2010a). Based on a 2005 report, 42 county schools are 100 students or more under capacity, 23 schools are fewer than 100 students under capacity, and 10 schools are over their enrollment limits. Soddy-Daisy High was deemed one of the five most crowded schools (CHCRPA 2005a). In the decade prior to the 2007 – 2008 school year, overall enrollment in the Hamilton County public school system dropped by 68 students (TACIR 2008). In

addition to the public school system, Hamilton County also has over 12,000 students in approximately 43 private schools (CHCRPA 2005a).

The schools are funded through the Hamilton County Commission by an allocation of the local property tax and half of the local option sales tax (CHCRPA 2005a). The district's budget for 2006 – 2007 was $271 million (HCDE 2009).

In 2008, there were eight 4-year colleges, one community college (2-year), one technology center, and two 2-year private institutions in Hamilton County (TACIR 2008). Nine of those 12 are in Chattanooga, including three 2-year institutions and six 4-year schools. The two public colleges include Chattanooga State Community College and the University of Tennessee at Chattanooga (NCES 2010b).

3.13.7.2. Environmental Consequences

This section addresses impacts to schools from site construction and operation of the Action and No Action Alternatives.

Alternative 1 – License Renewal

Under Alternative 1 – Action Alternative, SQN license renewal would result in no change to operating employment levels at the plant. No new impacts to schools would be anticipated through this action.

Alternative 2 – No Action Alternative

Under the No Action Alternative, the loss of operational jobs could result in a loss of population in Hamilton County where a large percentage of SQN operational workers live (Section 3.13.4). This could have a dampening effect on school attendance, particularly in nearby Soddy-Daisy and Hixson. However, as some operation workers and families could remain in the area and the population in the county is expected to grow, the overall impact is likely to be minor..

Alternative 2a or 2b – New Nuclear or Natural Gas-Fired Generation

The impacts of Alternatives 2a and 2b are similar and discussed together below.

Should a new nuclear or a new natural gas facility be constructed, it is expected that workers with accompanying family members would access available school facilities. For construction workers, the ability to find adequate housing and length of employment are two factors that could dictate whether they opt to have family members present during the construction phase. The arrival of operational workers at a site would phase in during the time period when construction work is phasing out. It is expected that operational workers migrating to an area would be more likely to bring their families, resulting in an increased demand for school facilities.

If a site were located in proximity to a populated metropolitan area with numerous schools, an influx of students would most likely be absorbed into a school system or enrollment would be spread among a number of schools systems, having little impact on resources. Should a plant be sited in a less populated area with fewer educational resources, the influx of new students from construction and operational worker families could cause a strain on a community's educational infrastructure. As described in Section 3.13.9, the arrival of

workers and plant would bring in new monies to a region through direct and indirect spending, and in the long run, the costs of providing education for additional students should be offset by the increase in tax revenues and plant equivalent payments.

3.13.8. Land Use

This section addresses impacts to land use in the vicinity of SQN.

3.13.8.1. Affected Environment

Hamilton County, where SQN is located, is situated in southeast Tennessee and comprises approximately 368,479 acres (542 sq mi). The Tennessee River bisects the county from northeast to southwest and accounts for 6 percent of total county area. (CHCRPA 2005a) The SQN site is located along the Tennessee River, approximately 6 miles from the center of Soddy-Daisy and 18 miles from the center of Chattanooga. Soddy-Daisy has a 2008 estimated population of 12,511, which is an increase of approximately 52 percent since 1990 (Figure 1-2) (USCB 2008e). Chattanooga has a 2008 estimated population of 170,880 and is Hamilton County's largest city (USCB 2008b).

Hamilton County has a well-developed, land-use and zoning plan, with every parcel of land carrying a zoning designation (CHCRPA 2005a). It is one of Tennessee's largest counties, with a 2008 estimated population of 332,848 residents (USCB 2008a). 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), commercial (2.20), special zoning (0.64), and office (0.12). Subdivision of land for residential lots continues to be prevalent in Hamilton County, with 68 percent occurring in unincorporated areas. (CHCRPA 2005a) Soddy-Daisy has experienced considerable residential subdivision growth between 2000 and 2008, with a peak in 2000 of 235 lots. As of 2009, it had the most housing units permitted among the smaller municipalities. Chattanooga's share of residential subdivisions for the same time period increased a total of 159 new major subdivisions, including 4,085 new lots. (CHCRPA 2009a) This accounts for 38 percent of the county's residential building permit activity, and includes a growing residential investment in Chattanooga's downtown, Alton Park, and the North Shore (CHCRPA 2005a; CHCRPA 2009a). SQN is located in Commission District 1, which has had 80 major subdivisions, including 2,193 lots, zoned between 2000 and 2008, accounting for more than 20 percent of the county's newly zoned subdivisions. (CHCRPA 2009a)

Land use is discussed in detail in the UFSAR, Section 2.1.4. Since 2000, there has been a notable increase in commercial growth and residential development, particularly along highway and interstate corridors. Updated land-use estimates for Hamilton County, shown in Table 3-21, indicate that residential (36.54 percent) and farm-agriculture (23.09 percent) are the two primary land-use types. (CHCRPA 2005a)

Table 3-21. 2005 Hamilton County Land Use

Category	Approx. Acres	% of Total
Residential	117,967	36.54
Commercial -Office	6,446	2.00
Industrial	11,110	3.44

Category	Approx. Acres	% of Total
Transportation	2,408	0.75
Institutional	9,648	2.99
Public Utility	1,534	0.48
Park-Open Space	34,428	10.66
Farm-Agriculture	74,567	23.09
Vacant	63,294	19.60
Other-Unknown	1,479	0.46

(CHCRPA 2005a)

3.13.8.2. Environmental Consequences

This section addresses impacts to land use from site construction and operation of the Action and No Action Alternatives.

Alternative 1 – License Renewal

Under Alternative 1 – Action Alternative, SQN license renewal would result in no changes in land use on site. Additional uranium fuel would be required for SQN during the license renewal time period and would result in approximately 2,400 acres of land being affected by uranium mining operations, resulting in minor to moderate off-site land-use impacts.

Alternative 2 – No Action Alternative

Under the No Action Alternative, no on-site change in land-use patterns would be anticipated. While the plant would undergo decommissioning, the site would probably remain developed. Because uranium fuel would no longer be required at SQN, there could be a resulting decrease in land-use impacts at source uranium mining operations due to reduced demand.

Alternative 2a – New Nuclear Generation

Should a new nuclear power facility be constructed, changes to land use would be anticipated. As discussed in Section 2.2, approximately 1,000 acres of land would be required to construct a new nuclear power facility. If a greenfield site were selected for the new facility, it is probable that land-use changes would occur, with the potential for loss of natural habitat and agricultural land. Should the site selected be a brownfield site (previously disturbed), the level of impact would vary. There would be no net change in off-site land-use impacts from the mining of uranium fuel, if supplies destined to be used during an SQN license renewal period were redirected for use at a new nuclear facility.

Alternative 2b – New Natural Gas-Fired Generation

If a new natural gas facility option were chosen, construction- and operation-related land-use impacts would be anticipated. As described in Section 2.2, a new natural gas facility with a capacity equivalent to SQN would require approximately 110 – 132 acres. Additional

land would be required for natural gas wells and collection stations, which could amount to as much as 4,320 acres. Depending on whether the site selected were a greenfield or brownfield site, this could amount to extensive land-use impacts.

For either option, additional land would likely be impacted for transmission, railroad, and pipeline ROWs. Depending on the location of the existing ROWs and the inter-tie connection and rail spur, these alternatives could result in potentially extensive land-use impacts.

3.13.9. Local Government Revenues

This section addresses impacts to local government revenue in the vicinity of SQN.

3.13.9.1. Affected Environment

Section 13 of the TVA Act requires TVA to make in-lieu-of tax payments to states and counties in which TVA conducts power operations or in which TVA has acquired power-producing properties previously subject to state and local taxation. The total amount of these payments is 5 percent of gross revenues from the sale of power during the preceding year, excluding sales or deliveries to other federal agencies and off-system sales with other utilities, with a provision for minimum payments under certain circumstances. (TVA 2009a) The share to each state is apportioned as follows: one half is determined by the percentage of total TVA gross proceeds of power sales within each state; the other half is apportioned by the percentage of book value of TVA power property in each state. Except for certain direct payments that TVA is required to make to counties, distribution of in-lieu-of tax payments within a state is determined by individual state legislation.

TVA tax equivalent payments to the State of Tennessee are distributed according to the Tennessee Code, Title 67, Chapter 9. Under this code, 48.5 percent of the total payments received by the state are distributed to the counties and municipalities of Tennessee. Of this amount, 30 percent is distributed to counties based on county shares of the total state population, 30 percent to counties based on county acreage shares of the state total, and 30 percent to incorporated municipalities based on each municipality's share of the total population of all incorporated municipalities in the state. The remaining 10 percent is allocated to counties on the basis of county shares of TVA-owned land in the state. Thus, only 4.85 percent of the payment to the county varies based on the level of TVA property or facilities in the state. (Tennessee Code 2010)

Total TVA in-lieu-of tax payments for financial year (FY) 2009 were about $505 million, of which Tennessee received $295 million. Estimated payments for FY 2010 are a total of $538 million. (TVA 2009j) This amount would include $320 million to Tennessee.

Hamilton County received $2,677,694 of TVA's in-lieu-of tax payments to the State of Tennessee. Additional money to the cities in Hamilton County totaled $2,091,425, with Chattanooga receiving $1,487,106 and Soddy-Daisy receiving $107,039. (ATVG 2009)

3.13.9.2. Environmental Consequences

This section addresses impacts to local government revenue from site construction and operation of the Action and No Action Alternatives.

Alternative 1 – License Renewal

Under Alternative 1 – Action Alternative, SQN license renewal would result in no new change to operating employment levels at the plant, and no impacts to local governmental revenues are anticipated through this action.

Alternative 2 – No Action Alternative

Under the No Action Alternative, there would be no impact on local government revenues. The amount of payment in lieu of taxes Hamilton County receives is based in part on land ownership, not its usage, so there would be no impact if the SQN plant were closed and the property retains its status as a power system asset. If at some future date TVA were to dispose of the land, the Hamilton County share would decline by a very small percentage. The SQN site is about 3 percent of the total TVA-owned land in Hamilton County. Because only 10 percent of the payment is determined by land ownership, the resulting decrease in the county share of payments from the state would be very small, less than 0.5 percent.

Alternative 2a or 2b – New Nuclear or Natural Gas-Fired Generation

The impacts of Alternatives 2a and 2b are similar and discussed together below.

Should a new nuclear or a new natural gas facility be constructed, revenues for Hamilton County would still be unaffected, unless TVA chose to sell the SQN property, resulting in a very minor decrease as discussed above. If TVA purchased property in Hamilton County for the new nuclear or natural gas facility, local government revenues would increase slightly, as the total amount of TVA-owned land in the county increased. However, the amount of land needed would likely be similar to the SQN site and thus make up only a very small fraction of the total TVA-owned land. Revenue increases would be proportionally small. Should a plant be built outside the state of Tennessee, any TVA in-lieu-of tax payment disbursement to local government would be apportioned based on that state's legislative decision. Whether the local government's existing tax base is small or large, the disbursement would have a positive and beneficial impact.

3.13.10. Transportation

This section addresses impacts to transportation in the vicinity of SQN.

3.13.10.1. Affected Environment

SQN is located in Hamilton County on the western shore of the Tennessee River, outside the cities of Chattanooga, Lakesite, and Soddy-Daisy (Figures 1-2 and 1-3). The major Hamilton County east-west road network on the east side of the river is anchored by I-75 and Interstate-24, both of which pass through Chattanooga. On the west side of the river running north-south, U.S. Highway 27 (US 27) becomes a major expressway in Hamilton County, feeding traffic from Chattanooga to Soddy-Daisy and eastward into Rhea County (Figure 1-3).

SQN personnel access the site from either US 27 or State Road 319 (SR 319) – Hixson Pike, via the Sequoyah Access Road (Figure 1-2). The Sequoyah Access Road runs eastward from US 27 and intersects with SR 319 near the site. In 2008, the average daily traffic volume on US 27, west of the Sequoyah Access Road intersection, was 33,136 vehicles per day. The average daily traffic volume on the Sequoyah Access Road, immediately west of SR 319-Hixson Pike, was 3,526 vehicles per day. Similarly, the 2008

vehicle count on SR 319-Hixson Pike, immediately south of Sequoyah Access Road, was 2,850. (TVA 2009h; TDOT 2008)

Hamilton County's long-range transportation plan forecast for 2030 anticipates greater demand than the currently available capacity on many of the existing roadways, although US 27 is not included in this list. The plan recommends that while increased transit opportunities and other strategies are needed to reduce single-occupancy vehicle travel, capacity additions would still be needed for the most congested roadways. (CHCRPA 2005a)

Chickamauga Reservoir on the Tennessee River is a navigable waterway used by commercial and recreational traffic. Through a series of locks and dams, commercial traffic can travel from Knoxville, Tennessee, located over 100 miles northeast of the site, to the mouth of the Tennessee River at the Ohio River. (TVA 2008a) Commercial and private traffic on the Tennessee River are discussed in detail in the UFSAR, Section 2.2.

The nearest airport is the Dallas Bay Sky Park, which is a general aviation airport located approximately 5.5 miles west southwest of the plant. The Chattanooga Airport is a full-service commercial airport located about 14.5 miles south southwest of the plant. (TVA 2008a) SQN has a private use helipad associated with the plant (Pilot Outlook 2010).

There is no Amtrak service associated with Chattanooga, and there is no local intercity passenger rail service. Two of the nation's largest rail networks currently 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 site through Soddy-Daisy. A railroad spur runs from the Norfolk Southern line to SQN just outside the EAB. (USDOT 2008; Norfolk Southern Corporation 2010)

3.13.10.2. Environmental Consequences

This section addresses impacts to transportation from site construction and operation of the Action and No Action Alternatives.

Alternative 1 – License Renewal

Under Alternative 1 – Action Alternative, the license renewal program would not require major new construction, alterations, or refurbishment to SQN to maintain consistency with the current licensing basis. In addition, no change to operation at the plant or addition of operation personnel is anticipated. Any future plans to increase capacity of the spent fuel storage capacity at SQN would require a minimal number of construction workers on site for a short duration of time. No resulting impacts to transportation are anticipated due to this action.

Alternative 2 – No Action Alternative

Under the No Action Alternative, the loss of operation jobs would result in a noticeable decline of traffic on SR 319 and other minor arterial and collector roads that feed south off of US 27. This could create an increase of available capacity for these area roads. Overall, any decline in traffic due to plant closure would be offset should future housing subdivisions

increase along these road sets and should the anticipated population increases continue for Hamilton County (Sections 3.13.1 and 3.13.8).

Alternative 2a or 2b – New Nuclear or Natural Gas-Fired Generation

The impacts of Alternatives 2a and 2b are similar and discussed together below.

Construction and operation of a new nuclear power facility or new natural gas facility would potentially impact the transportation infrastructure and traffic load on the roadways associated with a site. It is expected that a larger construction and operations work force would be required for a new nuclear facility than would be required for a new natural gas plant. Factors that help determine transportation and traffic impacts from construction and operation of a new facility include:

- Number of construction and/or operational workers and expected vehicles on the road.
- Number of shift changes for construction and/or operational work force.
- Projected population growth rate in the region during the construction and operation period.
- Capacity and condition of existing roads.

Should a new power facility be constructed, the facility could be sited in a manner that would reduce or avoid transportation and traffic impacts. However, mitigation of potential transportation impacts due to the location of a facility may be necessary because of expected increases in construction and operation traffic. This mitigation may include a need for extensive improvements to roadways and intersections (e.g., roadway widening, ramp improvements, and traffic signal installation) on state and local roads. Other mitigation actions could include employee car pooling or off-site parking with organized transportation, such as buses, to the site. Traffic generated as an outcome of construction activities would be temporary and short term. Scheduling for certain construction activities to occur during off-peak hours could also be an option to reduce conflict with normal traffic use on area roads. Traffic related to operation and maintenance at a potential site would utilize any mitigation improvements established during the construction phase. Impacts could range from minor to moderate, depending on project and site-specific conditions.

3.13.11. Cumulative Effects

Potential future area development and construction projects were assessed to determine if in combination with the SQN license renewal action, there would be any cumulative impacts that would affect socioeconomic resources in the SQN area. Two license renewal alternatives were evaluated with the proposed projects. Alternative 1, the Action Alternative, addressed the potential impacts associated with license renewal and the continued operation of SQN. Alternative 2, the No Action Alternative, identified and evaluated any potential impacts associated with the closure of SQN and the construction and operation of either a new nuclear facility or a new natural gas turbine facility elsewhere.

One of the proposed projects is the potential production of tritium at SQN for the DOE. The DOE has identified the purchase of irradiation services from the Watts Bar and Sequoyah reactor facilities as preferred for the production of tritium. Tritium production could require

the addition of employees (fewer than 10 per unit) as well as additional plant modifications. It is expected that irradiated fabricating TBPAR assemblies, nonradioactive waste, and some additional LLRW would be transported off site for processing and disposal. (DOE 1999) To date, SQN has not produced tritium for the DOE, but the option remains open.

The second proposed project includes the potential construction of a Tennessee River toll bridge in north Hamilton County, using the Sequoyah Access Road on the west as the connection from US 27 to the river crossing, with the new bridge and toll road connecting to I-75 on the east side of the river. Two proposed routing options branch off the Sequoyah Access Road and would cross the TVA Sequoyah Reservation peninsula either to the east or to the west of the SQN industrial plant. This project is in the feasibility stage and no preferred routing scenarios have been selected.

Cumulative Impacts – Alternative 1 – License Renewal

As discussed in Sections 3.13.1 through 3.13.10, should this alternative be chosen, no socioeconomic impacts are anticipated due to renewal of the SQN license. Most of the impacts described in these sections are driven by changes in population. With no changes anticipated at SQN with current operating practices or employment levels, the possibility of impact is negligible. The only socioeconomic factor not driven by population is land use. There would be minor off-site land-use impacts resulting from the continuation of uranium mining operations supplying fuel to SQN. No changes are anticipated to on-site land use, and no other land-use-related impacts are predicted.

Regarding the potential cumulative impacts of the SQN license renewal action combined with the on-site production of tritium for the DOE, again, no combined socioeconomic impacts from the two actions are anticipated. Because few if any new employees would be hired at SQN due to tritium production, there would be no resulting population growth in the Hamilton County area or negative impact to any community resources. Likewise, neither SQN nor the surrounding area would see any land-use change brought about by the production of tritium.

While employee transportation habits are not expected to change due to license renewal or tritium production, there would be additional transportation of radiological and nonradiological materials off site with the production of tritium. Because of the limited number of shipments, impacts from an increase in traffic near the plant and resulting vehicle emissions would be minor. DOE takes many precautions to ensure the safe transportation of radioactive materials (DOE 1999), and SQN follows all rules and regulations from the U.S. Department of Transportation (USDOT) to transport non-radioactive materials. Because license renewal is not expected to bring about any new impacts to local roads, and the effects of tritium production transportation would be minor, it is anticipated that overall cumulative transportation impacts from these two actions would also be minor.

Regarding environmental justice concerns, no negative impacts were identified that would result from the proposed SQN license renewal. The production of tritium at SQN would also cause no adverse environmental effects to the general population, or to any of the area's socioeconomic resources. Neither is it expected that tritium production would have any effect on particular groups within the general population, including minority and low-income populations. (DOE 1999)

Should construction of the new toll road and bridge proceed, this action on its own would impact the environment and affect the socioeconomic resources of the community at large. To meet anticipated county population growth, the project would promote the efficient movement of vehicles in Hamilton County and increase economic development opportunities along the transportation corridor. Planners would take into consideration likely effects to the environment that may develop, including land-use change, population and business displacement, and the potential for environmental justice issues, etc. It would be expected that the environment and population in the vicinity of the proposed road could experience substantial impacts.

SQN license renewal and tritium production at SQN would not play a role in impacting community socioeconomic resources in combination with the construction and operation of the proposed road. There would be no cumulative effects expected due to the combination of the three actions. It should be noted that because of SQN proximity to the proposed toll road routing options, and the potential crossing of the SQN reservation, it is likely SQN plant operations would experience some of the described toll road impacts, particularly land-use change.

Cumulative Impacts – Alternative 2 – No Action Alternative

Alternative 2, the No Action Alternative, is divided into two options, Alternative 2a and Alternative 2b. Both options entail the end of operations at the SQN site.

The socioeconomic impacts of plant closure would be varied and minor, as discussed in Sections 3.13.1 through 3.13.10. Regarding the cumulative effects of SQN not being able to produce tritium for the DOE, there are alternative options for production at other TVA nuclear facilities. The cumulative impact of this action would be minor. The potential cumulative impacts of the proposed toll road and its proximity to SQN, as described in "Cumulative Impacts – Alternative 1," would no longer be a consideration. TVA would have the option of making the property available for other use.

Alternative 2a is the new nuclear generation option. This option identified any associated socioeconomic impacts related to the construction and operation of a new nuclear facility. Alternative 2b is the new natural gas-fired generation option. As discussed in Sections 3.13.1 through 3.13.10, should these alternatives be chosen, impacts would vary with proximity to associated populated areas and the availability of amenities, housing, and services. Land-use impacts would be site specific. There would likely be moderate to substantial socioeconomic impacts to the communities closest to a site.

There are no socioeconomic cumulative effects of tritium production to consider under Alternative 2a or 2b. The DOE agreement with TVA for the production of tritium is unique to the SQN nuclear facility. Should TVA opt to construct a new nuclear plant elsewhere, reassessment of DOE tritium production need and site specific environmental evaluations would be undertaken at that time. A natural gas facility would not be involved in tritium production.

With Alternative 2a or 2b, should TVA decide to construct and operate an energy facility elsewhere, there could be combined cumulative effects associated with the proposed toll road in Hamilton County. Ultimately, proximity of any proposed facility site to the toll road would be the determining factor. Cumulative effects on socioeconomic factors could be positive in some categories and negative in others, including the creation of new jobs,

increased demand for skilled construction workers, wage increases, new economic opportunities, housing demand and subsequent shortages, elevated pricing for commodities and food, overuse of social services, and increased tax revenues, etc.

3.14. Solid and Hazardous Waste

Solid wastes generated in conjunction with operation of SQN, or construction and operation of new alternatives, can be subdivided into seven general categories:

- Construction and demolition debris associated with site activities.
- Municipal solid waste consisting of paper, plastics, garbage, and other items.
- Waste generated from transmission line clearing and maintenance.
- Hazardous wastes and universal wastes as defined under the Resource Conservation and Recovery Act (RCRA) (40 CFR §141.25 Parts 260–273).
- Special wastes as regulated by TDEC.
- Hazardous low-level radioactive solid wastes that consist of spent resins and DAW (i.e., contaminated protective clothing, paper, rags, glassware, and trash).
- Hazardous spent fuel (high-level radioactive waste).

Hazardous low-level radioactive solid waste and hazardous spent fuel are discussed in Section 3.18, not in this section. The first five general categories of solid and hazardous waste are discussed below.

Nonradiological solid wastes are managed in accordance with applicable federal environmental regulations, as well as state and county regulations. Solid wastes are properly stored and disposed of in approved and licensed disposal facilities in accordance with federal, state, and county requirements.

TVA's 1974 FES for SQN addressed expected waste generation resulting from plant construction, normal plant operation activities, hazardous waste generation, transmission line clearing and vegetation control practices, LLRW, spent fuel, and the proposed temporary on-site storage and plans for final permanent disposal of those various wastes (TVA 1974a). Since the FES was written, there have been many improvements to the methods used to reduce solid waste volumes at SQN, and the programs that control these wastes are continually improved. All activities involving handling of waste follow approved procedures, and are performed by trained and qualified personnel.

Construction/Demolition Debris

TVA operates a construction/demolition landfill (Tennessee permit number DML 33-105-0021) within the confines of the SQN site. This landfill is permitted to accept nonhazardous, nonradioactive solid wastes including scrap lumber, bricks, sandblast grit, crushed metal drums, glass, wiring, non-asbestos insulation, roofing materials, building siding, scrap metal, concrete with reinforcing steel and similar construction, and demolition wastes from the SQN site. The landfill is approximately 18 acres in size (TVA 2008b), but has not received any waste for at least 10 years (Michael Browman, TVA, personal

communication, January 27, 2010). The landfill permit is still active, but there is currently no intention to use the landfill. Instead, SQN construction/demolition wastes are disposed of in a state-permitted landfill. In the past, construction/demolition wastes have been sent to the Bradley County and Rhea County landfills. Future construction/demolition wastes from SQN will most likely be sent to state-permitted landfills owned/managed by Republic Services National Accounts, LLC (Republic Services) instead, in accordance with the new contracts, as discussed further in the paragraph below.

Municipal Solid Waste (General Plant Trash)

MSW is collected in dumpsters and transported to a state-licensed regional landfill permitted to accept the solid wastes. General trash at SQN typically consists of garbage, paper, plastic, packing materials (metal retaining bands, excelsior, and cardboard), rubber, glass, soft drink and food cans, dead animals and fish, floor sweepings, wood, and textiles. SQN has a waste management contract for the collection and transportation of MSW from SQN to a state-permitted landfill and for the processing of recyclable waste. Until recently (2011), MSW was sent to the Bradley County Landfill (remaining capacity for 48 more years) (Michael Browman, TVA, personal communication, January 27, 2010) and the Rhea County Landfill (Michael Browman, TVA, personal communication, April 25, 2011). Table 3-22 provides the total yearly amounts for MSW collected and shipped for disposal, as well as the annual amounts of recyclable waste processed each year from 1995 through 2009 (Michael Browman, TVA, personal communication, February 26, 2010). MSW is the largest type of nonradiological solid waste generated on site.

The new SQN waste disposal contract with Republic Services will dispose of SQN MSW at a state-licensed, Republic Services owned/managed landfill. It is proposed that all of SQN MSW be sent to the Sand Valley Landfill in Collinsville, Alabama. Republic Services landfills have an average lifespan of 30 years. Republic Services will also be responsible for the majority of the recyclables from SQN. (Michael Browman, TVA, personal communication, April 22, 2011) Recycling of scrap metal at SQN is currently managed by PSC Metals, Inc., of Chattanooga, Tennessee (Michael Browman, TVA, personal communication, April 22, 2011).

Table 3-22. SQN Municipal Solid Waste Yearly Total and Recycle Yearly Total

Year	MSW Yearly Total (Tons)	Recycle Yearly Total (Tons)
1995	854.8	179.1
1996	1305.5	293.7
1997	1432.2	182.6
1998	1826.0	116.4
1999	1918.5	118.9
2000	1857.2	335.5
2001	1745.0	243.3
2002	1462.6	266.7

Year	MSW Yearly Total (Tons)	Recycle Yearly Total (Tons)
2003	1395.0	386.9
2004	1302.3	338.3
2005	2497.1	455.9
2006	3294.3	299.0
2007	862.5	134.0
2008	922.9	134.3
2009	778.1	59.2

(Michael Browman, TVA, personal communication, February 26, 2010)

Waste Generated From Transmission Line Clearing and Maintenance

TVA owns and operates the majority of transmission lines within the TVA system. TVA has developed a comprehensive environmental procedure for the vegetation management of transmission ROWs (TVA 2010n). The procedure provides guidelines regarding maintenance of solid wastes such as tree trimmings and brush from transmission line ROWs and border areas, and roads for maintenance and routine access. For Alternative 1 – License Renewal, TVA would not be required to provide any new transmission lines or structures. Routine maintenance and management would continue to be conducted in accordance with developed guidelines and BMPs (TVA 2010n).

Hazardous Waste

SQN is an industrial facility that generates a variety of wastes classified as hazardous under the RCRA. These wastes typically include paint-related materials, spent solvents used for cleaning and degreasing, as well as universal wastes such as spent batteries and spent mercury-containing lighting. SQN's site designation as a small quantity generator (SQG) or as a conditionally exempt small quantity generator (CESQG) changes based on routine operating conditions and episodic waste generating activities at the site. SQN was a CESQG for the years 2006 and 2007, when it generated 220 pounds or less of waste in any calendar month within the particular year. SQN was classified as an SQG for the years 2008, 2009, and 2010, when it generated more than 220 pounds but less than 2,200 pounds in any calendar month within the particular year. (TVA 2011c). SQN holds an RCRA permit for hazardous waste (TN 5640020504).

TVA operates the hazardous waste storage facility (HWSF) in Muscle Shoals, Alabama, and holds an RCRA Part B permit (AL2640090005) for temporary storage of hazardous wastes. The HWSF serves as a central collection point for most of the SQN-generated hazardous wastes, and maintains contracts with waste treatment and disposal facilities through TVA's Environmental Restricted Awards List process to permanently dispose of wastes.

The majority of hazardous waste generated at SQN is shipped to the HWSF for consolidation, storage, and disposal through approved and licensed facilities. Universal

wastes are collected for recycling and shipped to recycling firms listed on the TVA's Environmental Restricted Awards List. Hazardous waste generated by SQN during the years 2004 – 2009 is listed in Table 3-23.

Used oil is generated at SQN as a result of maintenance activities on plant equipment. It is collected, stored on site, and shipped to an approved recycling center for recovery.

Table 3-23. SQN Hazardous Waste Generation for the Years 2004 – 2009

Year	Hazardous Waste Generated (Pounds)
2004	413.6
2005*	10,764.6
2006	444.4
2007	550
2008	880
2009	1062.6

* Increase due to surplus chemical disposal (TVA 2010o)

Special Waste

Special waste is placed in dumpsters and includes materials such as asbestos waste, sandblast grit, alum sludge, resin, and sand from water treatment. The contents of these dumpsters are transported to the Rhea County Landfill (remaining capacity until the year 2027). (Michael Browman, TVA, personal communication, January 27, 2010) It is expected that SQN will continue to use the Rhea County landfill as an alternative for special waste disposal (Michael Browman, TVA, personal communication, April 25, 2011).

Special waste placed in drums is predominantly oily debris, but may include materials such as desiccant, resin, nondestructive examination chemicals, and nonhazardous batteries. These special waste drums are sent to the TVA HWSF permitted by the State of Alabama and located in Muscle Shoals, Alabama. The HWSF stores hazardous waste prior to final disposal in a hazardous waste landfill or incineration at an approved and licensed facility. (Michael Browman, TVA, personal communication, April 22, 2010)

3.14.1. Affected Environment

A review of various types of waste generation at SQN as compared to the TVA 1974 FES shows a reduction in the generation of annual plant solid wastes predicted. It should be noted that solid waste generation follows plant activities. For example, during the Unit 1 steam generator replacement project, waste increased as expected. Similarly, this increase is expected during the Unit 2 steam generator replacement project.

Solid wastes generated in conjunction with operation of SQN include MSW (general plant trash), waste generated from transmission line clearing and maintenance, hazardous wastes, and universal wastes as defined under the RCRA, and special wastes as regulated by TDEC. SQN has in place programs, procedures, and training that ensure the volumes of all solid waste types generated would be as low as practicable.

General plant trash is handled by following a formal program that allows all general trash to be collected, sorted as appropriate for recycling, and disposed of off site in licensed landfills. Transmission line clearing and maintenance follows TVA directions and allows for the proper disposal of the wastes associated with vegetation management and control. SQN is a large industrial facility and generates several types of hazardous waste. These hazardous wastes are controlled by a chemical traffic control program, material safety data sheet (MSDS) training, and formal procedures that help minimize the generation of waste and the proper handling of used chemicals and other hazards.

The hazardous waste generated would be minor, commensurate with the level of activity at the plant. As previously stated, SQN's classification as an SQG or CESQG fluctuates, based on routine operating conditions and episodic plant activities. These hazardous wastes include paints, paint-related materials, solvents, corrosive liquids, leather gloves, discarded chemicals, and parts washer solutions. Just as for the solid waste, the TVA HWSF manages a number of waste management contracts that provide TVA with a variety of hazardous waste disposal options approved by local, state, and federal regulators.

3.14.2. Environmental Consequences

The types and relative amounts of solid wastes generated by the viable alternatives during construction and operation are described below. Recycling of potential waste materials such as water, oils, wood and lumber, plastics, and scrap metal, would potentially reduce the pressure on landfill capacity, mitigating any potential adverse disposal effects.

Because the disposal of solid and hazardous wastes would be in accordance with the applicable regulations at permitted facilities, the new facilities would need to be located in areas with adequate capacity to serve the potential building and operation of the viable alternatives. TVA expects that any adverse effects from the generation, management, and disposal of solid wastes are likely to be minor for Alternative 1 – License Renewal, No Action Alternative 2a – New Nuclear Generation, and No Action Alternative 2b – New Natural Gas-Fired Generation.

Alternative 1 – License Renewal

Construction

For this alternative, there would be no major construction activity. Solid waste generation would continue as currently generated at SQN, and there would be no change in impact from the current level of minor impact. Any construction and demolition waste would be minimal as a result of normal plant operation, and would be disposed of in a state-approved landfill. The future expansion of the spent fuel storage capacity by the addition of a separate concrete storage pad would be expected to result in minor quantities of construction debris and potentially the generation of paint-related hazardous waste that would be sent to the TVA HWSF for eventual disposal elsewhere in a permitted facility. The spent fuel storage capacity would probably be constructed at a different location than the current ISFSI, but would still be constructed on site, and the impact would be expected to be minor.

If Alternative 1 – License Renewal were not chosen, SQN would go into decommissioning at the end of the current license period or before. If the alternative of license renewal were approved, the decommissioning of SQN would be delayed for an additional 20 years. Regardless of which alternative is chosen, decommissioning will occur in the future. Once

the decommissioning process is started, the amount of waste generated would change. Use of many of the hazardous chemicals normally used at the plant would cease.

Starting the decommissioning process would shift the waste generated to more demolition-type wastes. Buildings and structures that are not radioactive can be dismantled and recycled or disposed of. The generation of general trash would potentially increase along with soils, concrete rubble, and construction debris. All handling of wastes during the decommissioning phase would be in accordance with applicable rules, regulations, and requirements of local, state, and federal laws. All waste would be properly disposed of in licensed landfills or processed by licensed vendors to recover as much waste as practicable. The impact on the environment from waste during the period of decommissioning would be expected to be minor. Special chemicals used for decontamination would be in accordance with all applicable permits, and personnel would be trained in handling hazardous materials.

Operation

Under Alternative 1 – License Renewal, solid waste would be generated at approximately the same current rates. SQN would most likely vary between CESQG and SQG status for hazardous waste generation. However, in accordance with its Hazardous Waste Minimization Plan, SQN would strive to limit the quantities of hazardous waste generated. Therefore, impacts would be expected to remain minor for hazardous wastes. All solid wastes as discussed would be handled in accordance with applicable rules, regulations, and permits. All wastes would be removed from site and properly disposed of in licensed landfills or recycled and reused. The impacts from solid and hazardous wastes would be expected to be minor.

As previously discussed, solid wastes generated include oily debris (absorbent, floating boom barriers, rags from cleanup, oily gravel, and dirt), spent resin, desiccant, and nonhazardous alkaline batteries. These wastes are shipped to the TVA HWSF for eventual disposal by a contractor in a permitted landfill. Scrap metal is recycled, and any wood waste that cannot be recycled also goes to a permitted landfill.

Types of hazardous waste generated by TVA nuclear plants include paint, paint thinners, paint solids, discarded laboratory chemicals, spent fixer (X-ray solution), parts washer solutions, hydrazine, rags from hydrazine cleanup, and sulfuric acid and sodium hydroxide waste from demineralizer beds and makeup water treatment.

Hazardous wastes are shipped to the TVA HWSF in Muscle Shoals, Alabama, for interim storage prior to disposal at a permitted facility. The TVA HWSF has contracts for hazardous waste disposal by a number of methods with companies that have significant disposal capacity.

TVA evaluated the potential impacts from the construction and operation of the ISFSI and found there would be no significant impact (TVA 2002c). Expansion of the spent fuel storage capacity at SQN is not expected to result in significant impacts.

Alternative 2a – New Nuclear Generation

Construction

The quantities and types of solid waste generated by this option would be determined primarily by the number of acres, the initial condition of the selected site, and the location and type of nuclear technology chosen. Depending on previous land use, forested areas may need to be cleared and old buildings demolished or renovated to make the area suitable for construction. During construction, there would be large volumes of dirt, concrete, wood, metal, and packing materials to dispose of in appropriate landfills. Any construction and demolition wastes generated during the building and renovation process would be managed through the TVA waste disposal contracts to access the permitted disposal capacity or recycling facilities, as needed.

Typical hazardous wastes generated during the construction phase would include paint wastes, paint thinners, dried paint, and cleaning liquids. These hazardous wastes would be sent to the TVA HWSF for disposal elsewhere in a permitted facility.

If Alternative 2a – New Nuclear Generation were chosen for implementation, potentially extensive new transmission lines would need to be installed. The need for new transmission lines, structures, and ROWs has a potential to produce large volumes of solid waste; however, TVA-established management practices would ensure minor impacts.

The likely implementation of a chemical traffic control program early in the construction phase of the Alternative 2a – New Nuclear Generation project would minimize the discarded chemical hazardous waste stream, reducing the pressure on hazardous waste disposal landfill capacity and ultimately mitigating any potential adverse disposal effects.

If Alternative 2a – New Nuclear Generation were chosen, SQN would be shut down by the expiration date of the current licenses and begin the process of decommissioning. Starting the decommissioning process would shift the waste generated to more demolition-type waste. Buildings and structures that are not radioactive could be dismantled and recycled, or disposed of. The amount of general trash would potentially increase along with the amount of soils, concrete rubble, and construction debris. All handling of wastes during the decommissioning phase would be in accordance with applicable rules, regulations and requirements of local, state, and federal laws. All waste would be properly disposed of in licensed landfills or processed by licensed vendors to recover as much waste as practicable. The impact on the environment from waste during the period of decommissioning would be expected to be minor. Special chemicals used for decontamination would be in accordance with all applicable permits, and personnel would be trained in handling hazardous materials.

Operation

Depending on the type of nuclear technology chosen, generation of solid wastes would continue to be similar to SQN. The impacts would be minor.

Alternative 2b – New Natural Gas-Fired Generation

Construction

Site preparation for a new natural gas-fired plant would be similar to Alternative 2a and would result in the generation of some wood and other vegetative waste from clearing and grubbing. Because a new natural gas-fired plant would require the smallest amount of land for construction, it would produce a smaller amount of solid waste and would have a minor impact, as long as appropriate landfills and BMPs are used.

Typical hazardous waste generated during construction would include paint wastes, paint thinners, dried paint, and cleaning liquids.

If Alternative 2b – New Natural Gas-Fired Generation were chosen for implementation, there would potentially need to be extensive new transmission lines and natural gas pipelines installed. Impacts would be expected to be similar to Alternative 2a.

Operation

Anticipated nonradioactive waste for the operation of a new natural gas-fired plant would include small volumes of industrial wastes such as metal, wood, and paper, as well as process wastes such as nonradioactive resins, filters, and sludge from maintenance activities and water processing. General trash would be produced in small quantities due to the small work force. Solid waste from a new natural gas-fired plant would be expected to be minor.

3.14.3. Conclusion

Solid wastes are produced at all power generating facilities and would be a minor impact during construction and operation for all alternatives described. No direct impacts would be expected at the proposed operating sites from removal of waste from the sites. Indirect impacts or cumulative effects would also be expected to be minor when waste is disposed of in approved and licensed landfills. These licensed facilities would provide substantive barriers to separate the waste from at-risk groundwater, and would be capped to minimize the cumulative effect of migration or transportation of waste to the surrounding areas over long periods of time. Impacts from solid wastes would be minor.

3.15. Seismology

3.15.1. Affected Environment

The known seismic history of the southeastern United States suggests that the earthquake hazard is relatively minor at the SQN site. There are no active faults in the vicinity of the site, and there is no physical evidence of any seismic activity at the site.

The site lies in the Southern Appalachian Tectonic Province. This province is bounded on the east by the western edge of the Piedmont Province, on the west by the western limits of the Cumberland Plateau, on the south by the overlap of the Gulf Coastal Plain Province, and on the north by the reentrant in the Valley and Ridge Province near Roanoke, Virginia. (TVA 2008a)

The maximum historic quake reported in the Southern Appalachian Tectonic Province occurred in Giles County, Virginia, in 1897, and was assigned an intensity of modified

Mercalli (MM) VIII. Although this earthquake occurred 285 miles northeast of the site, this intensity is assumed to have occurred at the site for the purpose of defining the safe shutdown earthquake (SSE). (TVA 2008a)

The SQN plant is designed so that all structures, systems, and components important to safety will remain functional when subjected to an SSE with maximum horizontal acceleration of 0.18 g and maximum vertical ground acceleration of 0.12 g. The half-SSE for SQN was therefore 0.09 g (i.e., half of the 0.18 g maximum horizontal ground acceleration) and 0.06 g vertical acceleration (1/2 of the 0.12 g vertical acceleration). (TVA 2008a)

In the course of its review for the original operating license, NRC requested additional information concerning the SQN seismic design basis. This culminated in the development of a site-specific response spectrum. This spectrum represents the 84th percentile of 13 actual earthquake recordings and has a peak acceleration of 0.22 g. This site-specific spectrum was used for evaluation of present designs and not as a design basis. (TVA 2008a)

As a result of the development of the site-specific response spectrum, an SSE of 0.22 g has been considered. 10 CFR Part 100, Appendix A, 1973, regulations no longer require a half SSE; however, applicants are required to select an operating-basis earthquake (OBE) equal to at least half the SSE unless supporting data are presented to clearly justify otherwise. TVA presented such data and justified an OBE of 0.09 g, less than half the present site-specific SSE of 0.22 g and the same as the half-SSE used in earlier seismic analyses. (TVA 2008a)

Section 2.5 of the SQN UFSAR describes the geology and seismicity in the vicinity of SQN and contains a summary of significant regional earthquakes through 1980 (TVA 2008a). The seismic history of the region around SQN from November 1776 through July 1980 is contained in Table 2.5.2-1 of the SQN UFSAR (TVA 2008a). Additional information on surrounding areas can be found in Subsection 2.5.2.3 Seismic History (TVA 2008a). From 1980 to 2010, there have been 246 recorded earthquakes with an average magnitude of 2.9 within a 200-mile radius of SQN (ANSS 2010). Table 3-24 lists the recent seismic history from January 2005 through March 2010 for earthquakes with magnitudes of 2.5 or greater within 200 miles of SQN. The data are based on the earthquake catalog maintained by the Advanced National Seismic System (ANSS 2010).

Table 3-24. Earthquakes Within 200 Miles of SQN (January 2005 – November 2009)*

Date	Time	Latitude (Degrees North)	Longitude (Degrees West)	Depth (km)	Magnitude	Magnitude Type
03/18/2005	01:02:16.3	35.723	-84.164	9.1	2.7	Md
04/05/2005	20:37:42.6	36.147	-83.693	10.0	2.9	Md
04/14/2005	15:38:15.7	35.468	-84.091	15.5	2.8	Md
06/07/2005	16:33:36.7	33.531	-87.304	5.0	2.8	ML
08/25/2005	03:09:41.8	35.880	-82.795	7.9	3.7	Md
08/25/2005	12:56:31.5	35.876	-82.810	8.10	2.5	Md

Date	Time	Latitude (Degrees North)	Longitude (Degrees West)	Depth (km)	Magnitude	Magnitude Type
10/12/2005	06:27:30.1	35.509	-84.544	8.1	3.3	Md
10/25/2005	05:18:10.5	34.429	-85.315	9.1	2.6	Md
04/11/2006	03:29:20.8	35.362	-84.480	19.6	3.3	Md
05/10/2006	12:17:29.2	35.533	-84.396	24.7	3.2	Md
06/16/2006	00:57:26.8	35.512	-83.203	1.37	3.4	Md
07/11/2006	13:45:40.7	33.606	-87.146	1.0	2.8	ML
08/07/2006	08:44:27.7	34.937	-85.461	14.2	2.9	Md
09/05/2006	04:32:42.6	33.705	-82.992	10.2	2.5	Md
10/02/2006	19:56:19.2	35.468	-84.984	8.7	2.5	Md
12/18/2006	08:34:26.5	35.356	-84.351	17.7	3.3	Md
01/03/2007	23:05:45.0	35.916	-83.955	15.3	2.7	Md
01/30/2007	21:20:29:4	33.664	-87.107	1.00	2.6	ML
02/07/2007	00:34:53.6	34.607	-85.308	10.7	2.6	Md
03/23/2007	14:15:33.3	33.652	-87.067	5.0	2.6	ML
05/04/2007	16:16:28.2	33.797	-87.299	5.0	3.0	ML
06/19/2007	18:16:26.8	35.793	-85.362	1.2	3.5	Md
07/27/2007	17:16:39.8	33.834	-87.329	1.0	2.6	ML
10/23/2007	05:16:11.6	35.591	-84.104	21.3	2.8	Md
11/17/2007	19:22:55.7	37.393	-83.087	1.0	2.5	ML
01/23/2008	22:22:13.8	33.739	-87.180	1.0	2.8	ML
02/23/2008	17:03:18.5	33.864	-87.165	1.0	2.6	ML
05/07/2008	16:44:35.1	33.691	-87.211	1.0	2.7	ML
06/23/2008	23:30:20.0	34.925	-84.841	8.8	3.1	Md
06/28/2008	01:40:36.5	33.276	-87.396	5.0	3.1	ML
10/25/2008	23:47:17.3	36.052	-83.604	15.8	2.5	Md
10/31/2008	16:37:34.0	35.768	-84.000	7.6	2.9	Md
11/10/2008	02:29:00.8	35.766	-84.591	25.1	2.5	Md
12/18/2008	00:05:07.1	36.050	-83.592	9.5	3.3	Md
01/27/2009	11:20:12.7	36.773	-84.131	26.1	3.2	Md

Date	Time	Latitude (Degrees North)	Longitude (Degrees West)	Depth (km)	Magnitude	Magnitude Type
01/30/2009	20:32:38.2	33.663	-87.351	1.0	2.9	ML
03/14/2009	22:16:18.6	35.444	-84.127	21.3	2.6	Md
03/16/2009	23:16:29.9	33.689	-87.284	1.0	2.9	ML
03/17/2009	23:27:55.2	33.745	-86.211	7.5	2.5	Md
04/04/2009	20:45:33.7	33.215	-83.202	0.0	3.1	Md
05/23/2009	01:03:31.3	35.592	-84.156	7.8	2.7	Md
08/01/2009	13:38:26.1	35.064	-84.292	5.4	3.2	Md
08/31/2009	14:07:10.2	35.778	-84.124	14.3	3.3	Md
10/02/2009	15:28:47.1	36.048	-83.567	14.5	2.5	Md
10/27/2009	19:13:21.0	33.796	-87.290	1.0	2.9	ML
11/01/2009	17:01:26.3	35.137	-84.854	24.5	3.0	Md
11/06/2009	18:30:10.4	33.748	-87.158	1.0	2.5	ML
ML – Local magnitude						
Md – Duration magnitude						
* - taken from Advanced National Seismic System Earthquake Catalog (ANSS 2010)						

The most significant earthquake near SQN since 1973 was the Fort Payne earthquake that occurred on April 29, 2003, in northeastern Alabama, near the Georgia border (USGS 2009). This earthquake had a measured Lg wave magnitude (mbLg) of 4.9 and a moment magnitude (M) of 4.6 (John Fouke, USGS, personal communication, April 19, 2011). The Fort Payne earthquake caused minor damage, including damage to chimneys, cracked walls and foundations, broken windows, and collapse of a 29-ft wide sinkhole near the epicenter (GSA 2009). Based on reconnaissance in the epicentral area, no landslides were reported, and damage to chimneys was observed only for chimneys with masonry in poor/weakened condition. Other masonry, including chimneys in good condition and several old masonry buildings, did not appear to be damaged. The earthquake occurred at a depth of about 8 to 15 km (5.0 to 9.3 mi). (EC 2009; USGS 2009) There was no noticeable effect on SQN from this earthquake.

Utilizing the USGS's Community Internet Intensity Map, the observed MM intensity at SQN would have been IV to V (USGS 2009). The Fort Payne earthquake magnitude is still lower than that of the maximum historical earthquake in the southern Appalachians, which was the 1897 Giles County, Virginia, earthquake. The 1897 earthquake had a maximum MM of VIII and an estimated body-wave magnitude of 5.8. Therefore, the 2003 Fort Payne earthquake is well within the known historical maximum magnitude earthquake in the southern Appalachian region and is consistent with the earthquake history of the region described in the SQN UFSAR (TVA 2008a).

3.15.2. Environmental Consequences

Given the historic record of seismic activity in the SQN region described above, TVA believes the basis for the SSE described in Section 2.5 of the SQN UFSAR (TVA 2008a) is still valid. The largest historical earthquake in the Southern Appalachian Tectonic Province remains the 1897 Giles County, Virginia, earthquake.

Alternative 1 – License Renewal

For this alternative, there would be no major construction activity. SQN is in compliance with current NRC regulations related to seismic evaluation requirements; therefore, no change regarding any potential impact from the current level of minor impact would be anticipated. The future expansion of the spent fuel storage capacity may result in additional seismic evaluation if required by the NRC.

Alternative 2 – No Action Alternative

The No Action Alternative is the result of the decision not to extend operation of the SQN units past the current expiration dates of the operating licenses. No impacts from potential minor seismic event(s) are expected during shutdown activities. However, shutdown of SQN could lead TVA to replace the resulting loss of the approximately 2,400 MWe base load generation. Given the need for adequate replacement power generation, TVA has evaluated in detail two alternative means of doing so.

Alternative 2a – New Nuclear Operation

A new nuclear plant would be required to meet or exceed the current federal regulations for seismic performance (10 CFR Part 50, Appendix S and Regulatory Guide 1.208). Therefore, the impacts related to seismic activity would be minor.

Alternative 2b – New Natural Gas-Fired Generation

The site chosen for a new natural gas-fired plant would have been evaluated for potential seismic impacts during the site-selection process; however, those impacts would likely be less than those considered for new nuclear construction and operation.

3.15.3. Conclusion

Impacts from a seismic event would be expected to be very minimal during the construction and operational life of the plant for each alternative. Indirect impacts or cumulative effects would also be expected to be minor.

3.16. Climatology, Meteorology, and Air Quality

The TVA 1974 FES for SQN contains a discussion of the climatology, meteorology, and air quality for the SQN site. This section contains information from the FES, the SQN UFSAR, on-site data from 1971, and more recent climatological records from the National Weather Service and the National Climatic Data Center (NCDC), as appropriate.

3.16.1. Affected Environment – Climatology and Meteorology

This section discusses the affected environment consisting of the regional climate and local meteorology. The regional climate section includes the general discussion of the regional climate along with GCC, GHG emissions, and a special focus on the regional climate

change in the southeast and the Tennessee River Valley (Valley). Severe weather conditions and the effects on the local environment, as well as the local meteorological characteristics in the SQN area, are also discussed.

3.16.1.1. Regional Climatology

The regional climate and meteorology of the SQN site was first characterized in the TVA 1974 FES for SQN (TVA 1974a). More extensive regional climate information and detailed data summaries, especially for on-site meteorological data, can be found in the SQN UFSAR (TVA 2008a). This section describes the current regional climate, as well as changes that may be expected to the regional climate of the southeast and the Valley. A discussion of the current understanding of GCC, GHG emissions relevant to SQN, and potential alternatives for replacement power generation is also included in this section.

Regional Climate

The Sequoyah site is in the eastern Tennessee portion of the southern Appalachian region which is dominated much of the year by the Azores-Bermuda anticyclonic circulation shown in the annual normal sea level pressure distribution. This circulation over the southeastern United States is most pronounced in the fall and is accompanied by extended periods of fair weather and widespread atmospheric stagnation. In winter, the normal circulation pattern becomes more varied as the eastward-moving migratory high and low pressure systems, associated with the midlatitude westerly current, bring alternating cold and warm air masses into the area with resultant changes in wind direction, wind speed, atmospheric stability, precipitation, and other meteorological elements. In summer, the migratory systems are less frequent and less intense, and the area is under the dominance of the western edge of the Azores-Bermuda anticyclone with a warm moist air influx from the Atlantic Ocean and the Gulf of Mexico. (TVA 2008a)

The terrain features of the region have some effect on the general climate. With the mountain ridge and valley terrain aligned northeast-southwest over eastern Tennessee, there is a definite bimodal upvalley-downvalley wind flow in the lower 500 to 1,000 feet during much of the year. A detectable lake breeze circulation resulting from discontinuities in differential surface heating between land and water is not expected because of the relatively narrow width of the Tennessee River as it flows southwestward through the valley area. (TVA 2008a)

Regional Climate Change in the Southeast and the Valley

Compared to the rest of the United States, the climate of the southeast is warm and wet, with high humidity and mild winters. Average annual temperature across the southeastern United States did not change significantly over the last century; however, since 1970, annual average temperature has risen about 2°F. The greatest seasonal increase in temperature has been during the winter months. Since the 1970s, the number of freezing days in the southeast has declined by four to seven days per year for most of the region. Average autumn precipitation has increased by 30 percent for the region since 1901. There has been an increase in heavy downpours in many parts of the region, while at the same time, the percentage of the region experiencing moderate-to-severe drought increased over the past three decades. (TVA 2010b)

In order to understand future climate scenarios in the TVA region better, TVA contracted with the EPRI to prepare a report on the impacts of GCC on various resources throughout

the Valley, including water and air, that could be reasonably anticipated to occur over the 21st century. Emphasis was placed on the near future (through 2050), as high uncertainty exists for longer-range predictions. The basis for this report is the United Nations Intergovernmental Panel on Climate Change's (IPCC's) Fourth Assessment Report, published in 2007, that assumes a medium GHG emissions projection, which does not reflect additional efforts to reduce GHG emissions. In addition to this report, TVA received and reviewed comments on the 2009 EPRI report. The 2009 EPRI report forecasts temperatures to increase as much as +0.8°C between 1990 and 2020, and +4°C by the end of the 21st century in the TVA region. Researchers presented two arguments regarding these estimates. First, based on historical climate records, a change of +0.8°C in 30 years is within the natural climate variations of the region. Second, the +4°C estimate is an "up to" result that is the least likely to occur. Furthermore, evidence suggests that climate models are often too sensitive to CO_2 and overestimate temperature rise.

Precipitation forecasts are more uncertain and vary depending on location in the Valley and time of year. According to the EPRI report, precipitation is forecast to increase in the winter across the Valley as a whole, while in the western portion of the Valley, summers may be drier, and in the eastern portion of the Valley, summers may remain unchanged. Changes in water resource practices may become necessary to adapt to changes in the temporal distribution of precipitation across the region. It is important to emphasize that the current scientific knowledge of climate change is improving, but still contains a great amount of uncertainty. (TVA 2010b)

3.16.1.2. Global Climate Change and Greenhouse Gas Emissions

GCC and its relationship to GHG is an item of intense study and is important to TVA. The topic of GHG and GCC was not discussed in the original 1974 FES for SQN. In common usage, global warming often refers to the warming of the earth that may occur as a result of emissions of GHG in the atmosphere. Global warming can occur from a variety of both natural and anthropogenic causes. Climate change refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). The two terms are often used interchangeably, but climate change is broader as it conveys that there are other changes in addition to rising atmospheric temperature. (TVA 2010b)

It is believed that certain substances present in the atmosphere act like the glass in a greenhouse to retain a portion of the heat that is radiated from the surface of the earth. The common term for this phenomenon is the "greenhouse effect," and it is essential for sustaining life on earth. Water vapor and, to a lesser extent, water droplets in the atmosphere are responsible for 90 to 95 percent of the greenhouse effect. The most abundant long-lived GHG are CO_2, methane, and nitrous oxide (N_2O). Both man-made and natural processes produce GHG. According to some sources, increases in the earth's average surface temperatures are linked in part to increasing concentrations of GHG, particularly CO_2, in the atmosphere. This has been a cause for concern among scientists and policymakers. On the international level, this phenomenon has been studied since 1992 by the United Nations Framework Convention on Climate Change, IPCC. (TVA 2010b)

The global carbon cycle is made up of large carbon sources and sinks. Billions of tons of carbon in the form of CO_2 are absorbed by oceans and living biomass (i.e., sinks) and are emitted to the atmosphere annually through natural and man-made processes (i.e., sources). When in equilibrium, carbon fluxes among these various reservoirs are roughly

balanced. According to the IPCC (2007), since the Industrial Revolution (i.e., about 1750), global atmospheric concentrations of CO_2 have risen about 36 percent, principally due to the combustion of fossil fuels. (TVA 2010b)

The primary GHG emitted by electric utilities is CO_2 produced by the combustion of coal and other fossil fuels. Worldwide man-made annual CO_2 emissions from utilities are estimated at 29 billion tons, with the United States responsible for 20 percent. U.S. electric utilities, in turn, emit 2.5 billion tons, roughly 39 percent of the U.S. total. TVA's power generation plants are responsible for approximately 114 million tons of annual CO_2 emissions from energy production. (TVA 2010b)

On April 17, 2009, the EPA declared CO_2, methane, N_2O, hydrofluorocarbons, perifluorocarbons, and sulfur hexafluoride to be "pollutants." In July 2011, the EPA expects to propose standards under the Clean Air Act (CAA) for regulating GHG emissions from power generating plants. The volume of GHG emissions results from the efficiency of the technologies utilized to produce and deliver the energy and from the carbon content of the fuel being used.

Table 3-25 demonstrates the differences of CO_2 emissions for various fuels that are used for electricity generation. Considering just the electrical generation process, nuclear and renewable sources (excludes bio-fuels) do not directly produce any measurable CO_2 during generation.

Table 3-25. CO_2 Direct Emissions From Electricity Generation for Various Sources

Fuel	Pounds CO_2 per Million BTU
Sub-bituminous coal	212.7
Bituminous coal	205.3
#6 fuel oil	173.9
Natural gas	117.1
Nuclear	0
Renewable sources	0

(DOE 2007)

3.16.1.3. Local Meteorology

This section discusses the meteorology found in the area of the SQN site including meteorological characteristics of wind direction, wind speed, precipitation, atmospheric stability, and dispersion. Meteorological data have been collected at the site since April 1971 and selected data have been used for the description of the local weather and for the calculation of the dispersion factors. (TVA 2008a) Dispersion factors are important for determining the effects from routine and accident releases of radioactive effluents from SQN. This section provides a discussion of those effects.

Most of the data used in this meteorological description were collected at the on-site meteorological facility (environmental data station) in the four-year period from January 1, 1972 through December 31, 1975. Additional data from the on-site system for the years

2000 – 2009 were included as a comparison, ensuring that the described local meteorological conditions were still valid. Location of this facility with respect to SQN is shown in Figure 1-4. (TVA 2008a)

Wind Direction

Wind rose data and wind frequency data are provided in Appendix F. Data from the 33-foot high wind instruments at the permanent meteorological facility for the January 1972 through December 1975 period represent reasonably well the expected wind conditions in the plant site area. The annual and monthly patterns show the predominant directions from the northeast and southwest quadrants that reflect the orographic channeling effects of the northeast-southwest aligned valley-ridge terrain. (TVA 2008a) Wind rose data for the years 2000 – 2009 from the SQN on-site meteorological data clearly show the same annual and monthly patterns for predominant wind directions as the earlier data sited above (see Appendix F). Wind direction frequency data for the years 1972 – 2009 also confirm the presence of the channeling effects of the valley-ridge terrain (see Appendix F).

For most months, but especially the cooler months of the year, there is a weak secondary maximum of wind frequency from the northwest quadrant. This is most likely associated with post-cold-frontal winds that are most common during the optimum seasons (winter and early spring) for frequent migratory low pressure systems. (TVA 2008a)

The greatest persistence is from the north-northeast, and includes the maximum of 33 hours. Persistence of 24 hours or more occurs with winds from the southwest, north, and northeast. The analysis shows that the occurrence of persistence periods lasting three hours or more is about 59 percent. For persistence of 12 hours or more, the occurrence is about 4 percent. (TVA 2008a) As a confirmation of the earlier data, the persistence data for the years 2000 – 2009 were analyzed and the persistence lasting 3 hours or more had an occurrence of 60.61 percent of the time, and the persistence lasting 12 hours or more had an occurrence of 4.34 percent. Recent on-site data are consistent with earlier data used in the SQN UFSAR. Persistence data are provided in Appendix F.

Wind Speed

The preponderance of winds from the northeast within the 0.6 to 3.4 mph wind speed range is most likely attributable to the anticyclonic circulation that dominates the eastern Tennessee region in the late summer and fall. Also, the identification of wind speeds less than 3.5 mph with stable anticyclonic flow is reflected in the high frequency of occurrence of this range in late summer and early fall, a period during which stable anticyclonic conditions are most common. These low wind speeds occur least often in winter and early spring, a period frequented by the passage of migratory low pressure systems. (TVA 2008a)

Wind speeds 7.5 mph and greater occur most frequently with upvalley winds from the southwest. These wind speeds occur very infrequently with winds from the east-northeast, east, east-southeast, and southeast. The predominance of strong winds from the southwest may be attributable to the channeling of the southerly and southwesterly flow preceding the passage of cold fronts through the area. Winds greater than 7.5 mph are more frequent from November through April, with a maximum of about 32 percent in April; they occur least often in July and August. (TVA 2008a)

Precipitation

Precipitation patterns, based on a 20-year period (1948-1967) of data collection at the TVA rain gauge station #685, 2.5 miles north-northeast of the plant site, show that there are an average of 117 days annually with 0.01 inches or more of precipitation. The average monthly precipitation is 4.81 inches, with the maximum monthly average, 6.76 inches, occurring in March and the minimum monthly average, 2.86 inches, occurring in October. The extreme monthly maximum and minimum is 16.58 inches in November and 0.09 inches in October, respectively. This station was discontinued after 1972, but examination of records for 1968 – 1972 show no changes in extremes. (TVA 2008a)

Precipitation data are provided in Appendix F. On-site precipitation data for the years 1998 – 2009 were analyzed and indicated the annual average rainfall at SQN was 44.90 inches. Rainfall is consistent throughout the year; January and December averaged 4.53 inches each and are the months with the highest average monthly precipitation. October is the month that averages the least precipitation with 2.33 inches. (See Appendix F.)

Snowfall does not occur often in the Sequoyah site area. The average annual snowfall is 4.4 inches and occurs mostly in December through March. The maximum 24-hour snowfall reported at Chattanooga was 20.0 inches in March 1993; the next highest was 10.2 inches in January 1988. (NWS 2010; TVA 2008a)

Severe Weather

Wind storms may occur several times a year, particularly during winter, spring, and summer, with winds exceeding 35 mph and on occasion exceeding 60 mph. The records show the highest wind speed recorded in Chattanooga, Tennessee, prior to 1950 was 82 mph in March 1947. (TVA 2008a) Between 1950 and 2009, the highest wind recorded in Chattanooga, Tennessee, was 63 mph recorded on June 11, 2009. Records of high winds (>57.54 mph) and thunderstorms for Hamilton County, Tennessee, for the years 1950 – 2009 indicated 145 high wind and thunderstorm events taking place during those years (NCDC 2010a). High wind may accompany moderate-to-strong cold frontal passages about 20 to 30 times a year, with the maximum frequency in March and April. (TVA 2008a)

High wind may accompany thunderstorms that occur about 56 days a year with a maximum frequency in July. The distribution of average monthly thunderstorm occurrences recorded during 1931 – 1979 at the Chattanooga National Weather Service Office is as follows.

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1	2	4	5	7	10	11	9	4	1	1	1	56

Severe storm data for 1955 – 1967 show 10 occurrences of hail 0.75 inches or greater in diameter, 20 occurrences of wind storms with speeds of 57.54 mph or greater, and 15 occurrences of tornadoes in the 1-degree latitude-longitude square containing the site. If these severe storm occurrences are assumed to be exclusive of one another, it can be assumed that about 45 severe thunderstorms occurred in the 1-degree square in this 13-year period. The annual occurrence for the square would be about 3.5. A smaller annual occurrence would be expected for the immediate site area, which is much smaller than the 1-degree square for which these statistics apply. (TVA 2008a)

The probability of a tornado occurrence at the site is estimated to be about once in 6,000 years. Despite this low probability, the design of plant Category I structures, those structures that are safety-related and built to withstand natural phenomenon, included consideration of the effects of tornadic winds. (TVA 2008a) Statistics show that during the 49-year period, 1916 – 1964, no tornadoes were reported in Hamilton County, where the Sequoyah site is located. During 1955 – 1967, a total of 15 tornadoes were recorded for the 1-degree latitude-longitude square containing the site, for an annual occurrence of 1.15. Using the principles of geometric probability described by H.C.S. Thom, his frequency data for that 1-degree square, and a tornado path size of 0.284 mi^2, the probability of a tornado striking any point in the plant site area is 4.4×10^{-5}. (TVA 2008a) During the years 1950 – 2009, the number of tornadoes recorded in Hamilton County, Tennessee, was just seven, consisting of two F0s, three F1s, one F2, and one F3 (F = Fujita tornado scale ranges from 1 to 5) magnitude tornadoes (NCDC 2010b).

Hamilton County, Tennessee, was significantly impacted by the April 27, 2011, tornado outbreak in the southeastern United States. Based on preliminary information, several tornadoes, including at least one EF-4 level storm struck the county. However, only three tornadoes (one F/EF-1 and two F/EF-0) appeared to have tracks within 10 miles of SQN (Kenneth Wastrack, TVA, personal communication, May 27, 2011).

The National Severe Storms Forecast Center in Kansas City, Missouri, calculated the tornado return probability for the Sequoyah site based on tornado occurrences within a 30-nautical mile (nm) radius during 1950 – 1986. A circle with a 30-nm radius has an area comparable to a 1-degree latitude-longitude square. Based on the 29 tornado occurrences with path size estimates in the 37-year period, the return probability is 1.635×10^{-4} and the mean return interval is 6,115 years. The annual tornado occurrence in the 30-nm radius circle was 0.84, based on 31 tornadoes reported during that period. During the subsequent period spanning 1987 through October 2002, 23 tornadoes were reported in the same circle. Thus, for the period spanning 1950 through October 2002, 54 tornadoes occurred for an annual occurrence of 1.02. Given the typically small path size of these tornadoes, the return probability and return interval given above would still be representative. (TVA 2008a)

The highest monthly average rainfall near the site area occurs during the winter and early spring months, with March usually having the greatest amount. The maximum 24-hour rainfall reported near the plant site was 7.56 inches in August. High precipitation is also observed in July when air mass thunderstorm activity is common. Minimum precipitation occurs normally in October. (TVA 2008a)

Lightning strike density in the vicinity of the plant is computed at an average of about eight ground strikes per square kilometer per year. These are defined as cloud-to-ground strikes of lightning. (TVA 2008a)

Using NCDC data for Chattanooga, Tennessee, the all-time highest temperature was 106ºF recorded on July 28, 1952, while the all-time lowest temperature was recorded as -10ºF on January 21, 1985. The highest rainfall in a 24-hour period was recorded in Chattanooga, Tennessee, measuring 7.61 inches in March 29-30, 1886. The most rain in one year measured 73.70 inches in 1994, while the average precipitation for Chattanooga is 54.5 inches for the period 1971 – 2000. (NWS 2010)

Meteorological data provided in Appendix F indicate that there has been a slight drop in the maximum temperatures as recorded at SQN. The average temperature has increased slightly, and the minimum temperature has increased noticeably.

Atmospheric Stability

Ten years (January 1, 2000 – December 31, 2009) of on-site temperature difference data from the 30-foot and 150-foot tower levels of the permanent meteorological facility are categorized into seven atmospheric stability groups (Pasquill stability classes A through G). Table 3-26 shows that the Pasquill stability classes E, F, and G occur about 49 percent of the time. The most stable class, G, occurs about 3.5 percent of the time. The total occurrence of the least stable classes, A, B, and C, was about 16.9 percent, while the neutral stability class, D, occurred about 34.1 percent of the time. (See Appendix F.)

Table 3-26. Atmospheric Stability Data Collected at SQN (Percent Occurrence)

Pasquill Stability Class	Vertical Temperature Difference	Percent Occurrence
A (very unstable)	ΔT < -1.9ºC/100m	6.62
B	-1.9ºC < ΔT to -1.7ºC/100m	4.56
C	-1.7ºC < ΔT to -1.5ºC/100m	5.72
D (neutral)	-1.5ºC < ΔT to -0.5ºC/100m	34.10
E	-0.5ºC < ΔT to 1.5ºC/100m	32.11
F	1.5ºC < ΔT to 4.0ºC/100m	13.37
G (very stable)	ΔT > 4.0ºC/100m	3.52
Total of all Classes		100.00

(See Appendix F.)

Dispersion

The transport and dispersion of radioactive materials in the form of aerosols, vapors, or gasses released into the atmosphere from a nuclear power station are a function of the state of the atmosphere along the plume path, the topography of the region, and the characteristics of the effluents themselves. The downwind concentrations of released materials are estimated by atmospheric dispersion models and analysis. Atmospheric dispersion analysis considers two categories of radiological releases: routine and accident. In all cases, the atmospheric dispersion characteristics of the SQN site result in off-site doses within the regulatory limits established by the NRC (10 CFR Part 100) for short-term accident diffusion estimates for effluent releases and regulatory limits established by the NRC (10 CFR Part 20) for normal long-term diffusion estimates for routine effluent releases. Low or small atmospheric dispersion (X/Q) values are indicative of better transport and better dilution of released airborne effluents. Section 3.17 further discusses the relationship of dispersion and estimated radiological dose to the public.

Routine Releases

During normal operation of SQN, all radioactive effluents released to the environment are controlled, sampled, and maintained as low as reasonably achievable (ALARA) in

accordance with the *Sequoyah Nuclear Plant Offsite Dose Calculation Manual* (ODCM). This document provides the methodologies, calculations, dose factors, monitor setpoints, limits, and controls for liquid and gaseous effluent releases. This document is reviewed and updated as needed to provide the best possible program to protect the public and monitor and control radioactive effluents. SQN uses annual average data for atmospheric dispersion factors for gaseous effluents based on 40 quarters of recent meteorological data and maximum sector and receptor distances for those sectors. Table 7.1 of the latest ODCM provides the current annual average X/Q factor based on quarterly meteorological data from the on-site meteorological system. The current X/Q factor is based on meteorological data from the years 1986 – 1995 and is determined to be 6.94 E-6 seconds per cubic meter (sec/m^3). (SQN 2009)

Based on the original analysis from the SQN UFSAR, the average annual atmospheric dispersion factors are calculated for locations along 16 radial lines corresponding to the major compass points drawn from the center of the nuclear plant complex. Calculations in each of the 16 sectors are made for the site boundary and for the distances 1, 2, 3, 4, 5, 10, 15, 20, 30, 40, and 50 miles. (TVA 2008a)

SQN calculates atmospheric dispersion factors at the EAB and at the outer boundary of the low population zone (LPZ) boundary (Figure 3-14). In calculating the average annual atmospheric dispersion factors, it is assumed that gaseous effluents are released from a single point. (TVA 2008a)

The favorable atmospheric dispersion characteristics at SQN result in annual gaseous effluent doses within the regulatory limits established by the NRC (Appendix I of 10 CFR Part 50) for any individual (member of the public) in unrestricted areas. Because of favorable atmospheric dispersion at the SQN site, the radioactive doses due to routine gaseous effluents, when added to the radioactive doses due to radioactive liquid effluent releases, meet the regulatory requirements established by the NRC (10 CFR §20.1301) and are minor.

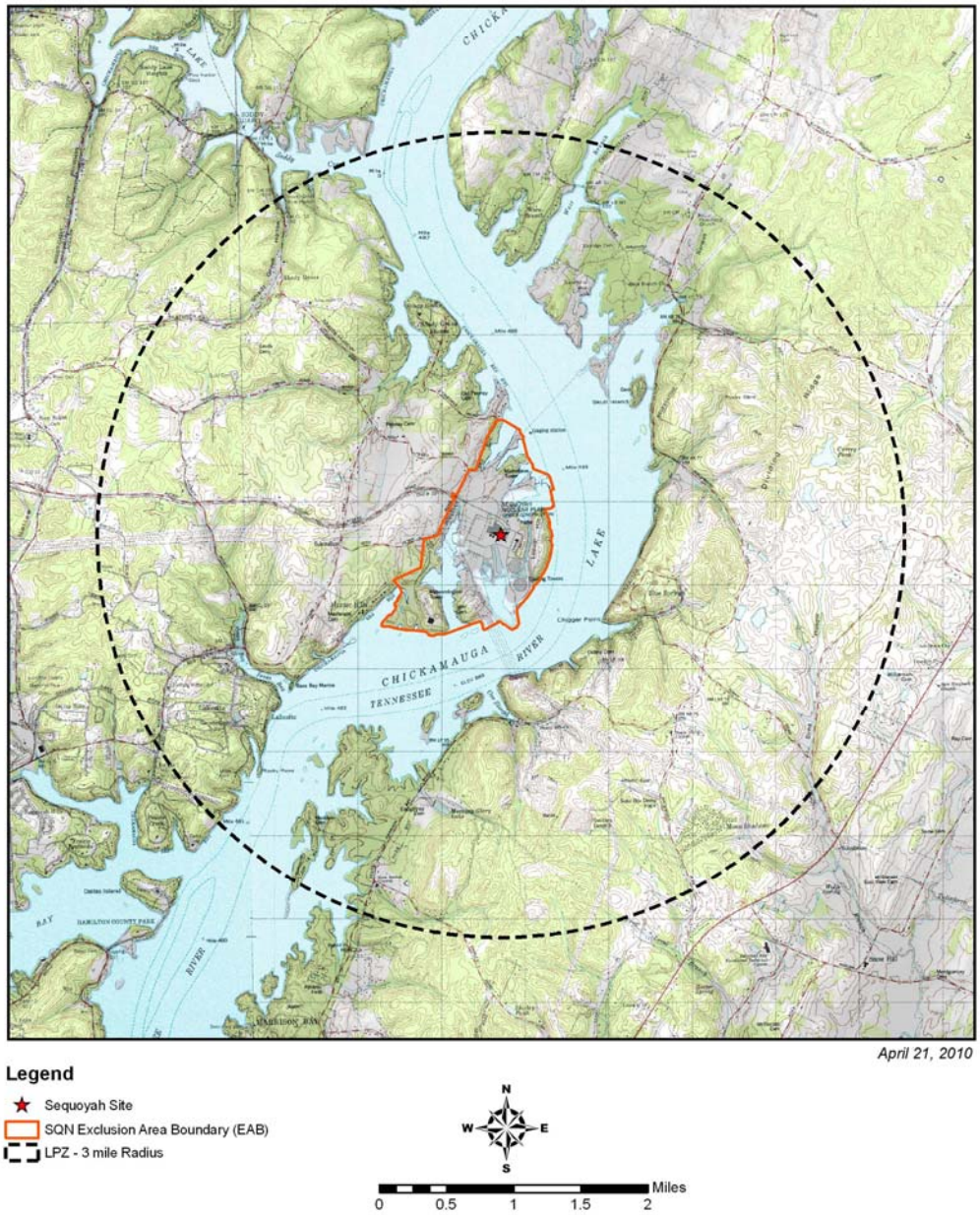

Figure 3-14. SQN Exclusion Area Boundary and Low Population Zone

Accident Releases

The accident X/Q values are determined for time periods of one hour, eight hours, 16 hours, three days, and 26 days after a hypothetical release of radioactive gaseous effluents. The releases are considered ground-level releases because the highest release location, the plant vent, is less than 2.5 times the height of adjacent buildings.

For accident releases, calculations use a release boundary to encompass all release locations and results in higher accident X/Q values at the EAB. Table 3-27 provides the one-hour atmospheric dilution factors at the EAB as an example.

Table 3-27. One-Hour Atmospheric Dilution Factors At EAB (sec/m3)

Release Zone	Distance	5th Percentile	50th Percentile	Average
1	556 meters	0.147 E-2	0.234 E-3	0.369 E-3
2	600 meters	0.130 E-2	0.215 E-3	0.365 E-3
3	509 meters	0.162 E-2	0.258 E-3	0.435 E-3

(TVA 2008a)

For accidental releases to the LPZ, a set distance of 4,828 meters from the SQN site center is used. In accordance with Regulatory Guide 1.145, the 50th percentile probability X/Q values are determined to provide more realistic radioactive doses (Table 3-28). (TVA 2008a)

Table 3-28. Atmospheric Dilution Factors At Outer Boundary of LPZ (sec/m^3)

Average Time	Distance	5th Percentile	50th Percentile	Average
1-hour	4828 meters	0.139 E-3	0.142 E-4	0.319 E-4
8-hour	4828 meters	0.539 E-4	0.980 E-5	0.169 E-4
16-hour	4828 meters	0.717 E-5	0.236 E-5	0.299 E-5
3-day	4828 meters	0.434 E-5	0.176 E-5	0.201 E-5
26-day	4828 meters	0.271 E-5	0.153 E-5	0.148 E-5

(TVA 2008a)

The favorable accident condition atmospheric dispersion characteristics presented in the above tables result in accident radioactive doses at the EAB and LPZ well within the regulatory limits established by the NRC (10 CFR Part 100); therefore, the hypothetical radioactive doses due to accidental releases are minor.

3.16.2. Environmental Consequences – Climatology and Meteorology

This section addresses impacts to climatology and meteorology from site construction and operation of the Action and No Action Alternatives.

The CEQ recently issued draft guidance (CEQ 2010) on how agencies should consider the effects of climate change and GHGs when they describe the environmental impacts of proposed actions in NEPA documents. With the purpose of informing decision-making, CEQ indicated that the NEPA process should incorporate consideration of both the impact

of an agency action on the environment through the mechanism of GHG emissions and the impact of changing climate on the agency action.

The guidance includes tools for agency reporting, including that if a proposed action would be reasonably anticipated to cause direct emissions of 25,000 metric tons or more of CO_2-equivalent GHG emissions on an annual basis, agencies should consider this an indicator that a quantitative and qualitative assessment may be meaningful to decision-makers and the public. The reference point of 25,000 metric tons of direct CO_2-equivalent GHG is not a standard for indicating significant or insignificant effects.

For long-term actions with annual direct emissions of less than that amount, CEQ encourages agencies to consider whether the action's long-term emissions should still receive similar analysis. The draft guidance proposes that an agency analysis of GHG emissions should, when possible, include quantification of cumulative emissions over the lifetime of the project, a discussion of measures to reduce emissions, including consideration of reasonable alternatives; and a qualitative discussion of the potential link between such emissions and climate change. The guidance, however, notes that it is not currently useful for the NEPA analysis to attempt to link specific climatological change to particular project emissions, as such direct linkage is difficult to isolate and understand.

The guidance also instructs agencies on appropriate ways to assess the effects of climate change on proposed actions. It does not apply to land and resource management actions and does not propose to regulate GHGs.

Alternative 1 – License Renewal

This section addresses the consequences of implementing the Action and No Action alternatives on the climate, as well as the possible effects of climate change on the implementation of either alternative. Additionally, effects to meteorological conditions are addressed.

As noted above, there are primarily two ways in which SQN would potentially interact with GHG and GCC. The first is the emissions of GHG resulting from the continued operation of SQN; as noted above, these emissions would occur through the life cycle of the plant, including the uranium fuel cycle (UFC). The second is the manner in which GCC could affect operation of the SQN facility itself.

Life-Cycle Nuclear Greenhouse Gas Production and Mitigation Potential

Although nuclear generation does not emit GHGs in large quantities during the normal course of operations, there are GHG emissions involved with the construction of the plant; mining, processing and transportation of nuclear fuels; waste disposal; and decommissioning. Fossil fuels are typically used as part of the infrastructure needed to operate a nuclear power facility, primarily for the manufacture of the fuel used in the nuclear facility. The largest variables in life-cycle GHG emissions of a nuclear plant, aside from the operating lifetime, electrical output, and capacity factor, are the type of uranium enrichment process and the source of power for enrichment facilities. Current enrichment facilities use the energy-intensive gaseous diffusion process largely powered by fossil fuels. New enrichment facilities will use much less energy-intensive processes resulting in reduced nuclear plant life-cycle emissions. The use of nuclear fuel from dismantled nuclear weapons also reduces GHG emissions. While the life-cycle GHG emissions of TVA's

nuclear plants have not been determined, estimates of life-cycle GHG emissions of U.S. nuclear plants range from 12 to 61 tons CO_2-equivalent/GWh and average 22.2 tons CO_2-equivalent/GWh (Meier 2002, Fthenakis and Kim 2007, Sovacool 2008).

On a life-cycle-based comparison, nuclear-generated electricity emits far less GHG per kilowatt hour (kWh) than fossil-fueled sources, and according to estimates of GHG emissions from various generation sources (Table 3-29) by the World Nuclear Association (WNA 2009), compares favorably to renewable energy sources. Considering all CO_2 direct and indirect sources in terms of the number of grams of CO_2 equivalent produced per kWh of electricity, nuclear electricity production of CO_2 is a low production source of GHGs when compared to coal, natural gas, hydroelectric, solar, and wind. In a meta-analysis of worldwide data, Sovacool (2008) reported higher emissions of GHGs for the nuclear energy fuel cycle (a mean of 66 gCO_2-equivalent per kWh (range 1.4 to 288 gCO_2 equivalent per kWh) than those reported in WNA 2009. However, a reasonable approximation for GHG emissions for an existing, relicensed U.S.-based reactor is better represented by a mid-point estimate of 39 (short) tons of CO_2-equivalent per GWh (about 35 gCO_2 equivalent per kWh) derived from the U.S.-based reactors in that comparison study. Inherent limitations of applying such broad-based data to license renewal of an existing U.S-based reactor include that it appears to accrue a substantive portion (~18 percent) of reported totals for nuclear from activities associated with new construction; includes cases for GHG contributions from milling and mining processes that assume 40-60 year-out times when the known reserves of uranium are assumed to require much greater mining of low quality ores with a many-fold increase in associated CO_2 emissions; and assumes no production or includes no cases of fuel derived from sources surplus to weapons programs.

Even considering life-cycle emissions, the resulting emissions of GHG (in CO_2 equivalents) would be substantially less (several million tons) overall for SQN operating under a 20-year license renewal than that of a comparable coal- or natural gas-fired plant supplying the equivalent base load power. As such, SQN license renewal would be an effective alternative to help TVA maintain the flexibility to offset those greater amounts of GHG emissions from its generation portfolio. The nuclear option overall leads to substantially lower emissions of GHG than other major sources of new replacement generation in the Tennessee Valley and adjoining service areas in the southeast and central United States. SQN is not expected to be a significant contributor to GHGs or GCC.

Actively reducing carbon emissions through cleaner energy options and energy efficiency initiatives is a central principle in TVA's Environmental Policy. To accomplish the greatest benefit, TVA's efforts focus upon reducing GHG emissions from its portfolio of generating plants. As noted in the SEIS, increasing the proportion of energy generated by TVA nuclear plants is one of the primary strategies for offsetting GHG emissions, as well as providing the flexibility to increase energy production from other non- or low-emitting sources.

Additionally, in accordance with the requirements of EO 13514, *Federal Leadership in Environmental, Energy and Economic Performance*, TVA developed a Strategic Sustainability Performance Plan (TVA 2010r) that establishes aggressive goals for reductions of GHG, as well as overall pollution prevention. Among TVA's climate change mitigation initiatives are purchasing energy efficient fleet vehicles, reducing the number of high-fuel-consumption fleet vehicles, and improving the efficiency of fleet vehicle use. TVA is implementing energy-saving improvements in many of its facilities, and new building designs incorporate modern energy efficiency technologies. Additionally, TVA is enhancing

its sustainable acquisition program (currently, the Green Procurement Plan initiated in 2007) to ensure the purchase of environmentally preferable materials and services. Finally, in the Sustainability Plan, TVA establishes goals for minimizing and diverting debris from construction sites and decreasing use of chemicals that increase GHG emissions. As additional technological innovations are developed, TVA will consider their application in activities such as construction of new generation facilities.

Table 3-29. Comparison of CO_2 Life-Cycle (Direct and Indirect) Production for Various Sources

Electricity Source	Direct Emissions (grams/kWh)	Indirect Emissions (grams/kWh)
Coal	1,017 max – 790 min range	289 max – 176 min range
Natural Gas	575 max – 362 min range	113 max – 77 min range
Hydroelectric	NA	236 max – 4 min range
Solar Photovoltaic	NA	280 max – 100 min range
Wind	NA	48 max – 10 min range
Nuclear	NA	21 max – 9 min range

(WNA 2009)

Potential for Effects of Climate Change on SQN Operations

Higher air and water temperatures and altered frequency of precipitation that could result from GCC can influence processes for maintaining compliance with environmental and safety standards at nuclear (and fossil) plants, as well as the efficiency of plant operations. SQN would continue to withdraw cooling water from the Tennessee River to operate the plant condenser cooling water system. Regulatory requirements for environmental compliance prescribe the maximum temperature of water that could be released from SQN into the Tennessee River. Additional information concerning the SQN requirements for water temperature and the expected impact of the plant releases on the river are discussed in Section 3.16.1 and Section 3.1.

The impacts from the GCC and GHG emissions upon SQN would be expected to be minor. Because the duration of license renewal is only 20 years, the permanent changes expected would be very minor and for normal fluctuations in temperature of the water and air, SQN would be expected to continue to operate within all thermal limits.

Effects of SQN Operations on Meteorology

The presence and operation of SQN has been shown to have no noticeable effects on the local meteorology, with the exception of a slight increase in frequency, duration, and intensity of steam fogs forming at the river surface due to heated water released through the diffusers. These fogs develop as a result of elevation of the dew point by the addition of moisture to the air from the water surface. Once this shallow fog moves on shore, the moisture source is cut off, and the fog dissipates. Thus, the increased fogging would be confined within the boundaries of the Chickamauga Reservoir and would not affect long-

term fog patterns in the surrounding area. This phenomenon is observed frequently over the extended river and reservoir system within the Tennessee Valley region. (TVA 2008a)

SQN's cooling towers are not in operation for the majority of the year (operation averaged 112.7 days of cooling tower operation per year for the years 2006 – 2009), but some minor effects may include increased atmospheric moisture, decreased solar radiation, and increased concentrations of aerosols related to the drift during the brief periods of operation. (TVA 2008a)

Alternative 2 – No Action Alternative

Under Alternative 2, termination of the SQN operating license and shutdown of the plant would have little or no impact on GHG emissions, as the plant emits relatively small quantities of GHG. Because uranium fuel would not be needed to continue SQN operations, the GHG associated with the UFC for SQN would not be emitted. However, the necessary adjustments to TVA's power generation system could result in GHG emissions, as described below.

Alternative 2a – New Nuclear Generation

A new nuclear facility utilizing closed-cycle cooling would typically use less than 5 percent of the volume of water that would be required for a once-through system. The new nuclear plant operation would be less susceptible to climate change influences because it is equipped with a closed-cycle cooling system. Air and water temperature increases would cause a decrease in plant efficiency and plant design, and would include potential changes that would appropriately handle the potential increases in temperatures. Plants can be derated to reduce power and thermal heat loads if needed. Impacts from GCC and GHG emissions would be expected to be minor for new nuclear generation.

Prior to construction of a new generating plant (nuclear or natural gas-fired), local meteorological conditions would be evaluated to model dispersion characteristics as well as the potential impact on the local air quality from the operation of the new facility. Neither a new nuclear nor a new natural gas-fired plant is expected to adversely affect local meteorological conditions.

Alternative 2b – New Natural Gas-Fired Generation

GCC impacts related to a new natural gas-fired generation plant would be similar to Alternative 2a and planned designs would address this issue prior to construction. A new natural gas-fired plant would contribute a substantial amount of GHG emissions for the life of the plant, but substantially less the GHG emissions from a comparably sized coal plant. The impacts are direct and indirect as well as potentially cumulative in the environment. The air emissions would meet all required regulations and would be expected to be minor to moderate.

3.16.3. Affected Environment – Air Quality

Air quality is an important environmental characteristic and this section discusses the federal and state air quality standards, limits, and requirements that are applicable to the continued operation of SQN or potential alternatives. Uniform national ambient air quality standards (NAAQS) established by the EPA under the authority of the CAA restrict ambient

levels of criteria pollutants to protect the public health (primary standards) and the public welfare (secondary standards).

NAAQS establish concentration limits in the outside air for six pollutants: PM, SO_2, CO, ozone (O_3), nitrogen dioxide (NO_2), and lead. The primary NAAQS standards are to protect humans, including sensitive individuals such as children, people with asthma, and the elderly, from health risks. The secondary standards protect against impacts to the public welfare, such as unacceptable damage to crops and vegetation, buildings and property, and ecosystems. An area where any air quality standard is violated is designated as a nonattainment area for that pollutant, and emissions of that pollutant from new or expanding sources are carefully controlled. Air quality in the TVA region has steadily improved over the past 30 years.

The EPA promulgated new, more restrictive standards for O_3 and PM in July 1997. In 2008, EPA lowered the 8-hour O_3 standard to 0.075 parts per million (ppm). The original implementation schedule for this standard required that states send their recommended designations to the EPA in March 2009 with the EPA finalizing designations in March 2010. However, the EPA is now reconsidering the ground-level O_3 standards set in 2008. EPA is proposing to strengthen the 8-hour "primary" O_3 standard to a level within the range of 0.060-0.070 ppm and to establish a distinct cumulative, seasonal "secondary" standard within the range of 7-15 ppm-hours. EPA plans to issue final standards by July 2011. These standards and their applicability to continued operation of SQN and potential replacement alternatives are being considered as necessary and would be included in future TVA resource planning. Table 3-30 provides a summary of the NAAQS limits used to evaluate any new alternatives.

Hamilton County, where SQN is located, is a nonattainment area for annual $PM_{2.5}$ (very fine) based on 1997 NAAQS (EPA 2008) and is recommended as a nonattainment area for 8-hour O_3 based on 2008 NAAQS (TDEC 2009). SQN is a very small source of PM_{10} (fine) and $PM_{2.5}$. Only indirect sources of particulates are produced in support of SQN operation. Local air quality is affected by operation of SQN, but that impact is far below the impact that would be expected from replacement generation from fossil-fueled plants depending on the new site location. Personal vehicles of the plant workers, trucks, and equipment used to support routine operations, occasional operation of the emergency diesels, and refueling outage personnel and activities contribute low levels of GHG. It is reported that a 1,300-MW nuclear power plant would avoid annual emissions of about 8.5 million tons of CO_2 when compared to a similar-sized coal plant (NRC 1996); therefore, SQN avoids approximately 16 million tons of CO_2 annually (2,400 MW/1,300 MW X 8.5 million tons = 15.69 million tons) compared to a replacement coal-fired plant. Nuclear plant routine operations are virtually free of all air pollutants and are of trivial impact in the local area.

In addition, the prevention of significant deterioration (PSD) regulations restrict emissions and any significant reduction in ambient air quality. PSD regulations include protection of national parks and wilderness areas designated PSD Class I air quality areas. A new or expanding major air pollutant source must estimate the potential impact of its emissions on the air quality of any nearby Class I area, as specified by the state or local air regulatory agency, with input from the federal land manager(s) having jurisdiction over the given Class I area(s). The closest PSD Class I areas are the Sipsey Wilderness Area in Alabama, the Cohutta Wilderness Area in Georgia, the Great Smoky Mountains National Park, and the Joyce Kilmer-Slickrock Wilderness Area located within both Tennessee and North Carolina (EPA 2009). Extending the operational period of SQN is not a new or expanding major

source of air pollutants; therefore, no evaluation of the potential impact to these Class I areas is required. See Figure 3-15 for a map of the nearest Class I areas. Any clean air area not designated as a PSD Class I area is a PSD Class II area with less stringent standards (increments), and extended operation of SQN would not create or modify any air emission source and would not affect any PSD Class II resource.

Table 3-30. National Ambient Air Quality Standards

	Primary Standards		Secondary Standards	
Pollutant	**Level**	**Averaging Time**	**Level**	**Averaging Time**
Carbon Monoxide (CO)	9 ppm (10 mg/m^3)	8-hour [1]	None	
	35 ppm (40 mg/m^3)	1-hour [1]		
Lead	0.15 µg/m^3 [2]	Rolling 3-Month Average	Same as Primary	
Nitrogen Dioxide (NO_2)	53 ppb [3]	Annual (Arithmetic Average)	Same as Primary	
	100 ppb	1-hour [4]	None	
Particulate Matter (PM_{10})	150 µg/m^3	24-hour [5]	Same as Primary	
Particulate Matter ($PM_{2.5}$)	15.0 µg/m^3	Annual [6] (Arithmetic Average)	Same as Primary	
	35 µg/m^3	24-hour [7]	Same as Primary	
Ozone (O_3)	0.075 ppm (2008 std)	8-hour [8]	Same as Primary	
	0.08 ppm (1997 std)	8-hour [9]	Same as Primary	
	0.12 ppm	1-hour [10]	Same as Primary	
Sulfur Dioxide (SO_2)	0.03 ppm	Annual (Arithmetic Average)	0.5 ppm	3-hour [1]
	0.14 ppm	24-hour [1]		
	75 ppb [11]	1-hour	None	

[1] Not to be exceeded more than once per year.

[2] Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m^3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978 standard, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

[3] The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

[4] To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb (effective January 22, 2010).

[5] Not to be exceeded more than once per year on average over three years.

[6] To attain this standard, the three-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m^3.

(7) To attain this standard, the three-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 $\mu g/m^3$ (effective December 17, 2006).

(8) To attain this standard, the three-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm (effective May 27, 2008).

(9) (a) To attain this standard, the three-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
(b) The 1997 standard—and the implementation rules for that standard—will remain in place for implementation purposes as EPA undertakes rulemaking to address the transition from the 1997 ozone standard to the 2008 ozone standard.
(c) EPA is in the process of reconsidering these standards (set in March 2008).

(10) (a) EPA revoked the 1-hour ozone standard in all areas, although some areas have continuing obligations under that standard ("anti-backsliding").
(b) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is $\leq$ 1.

(11) (a) Final rule signed June 2, 2010. To attain this standard, the three-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 ppb.

Source: <http://www.epa.gov/air/criteria.html> (accessed April 20, 2011).

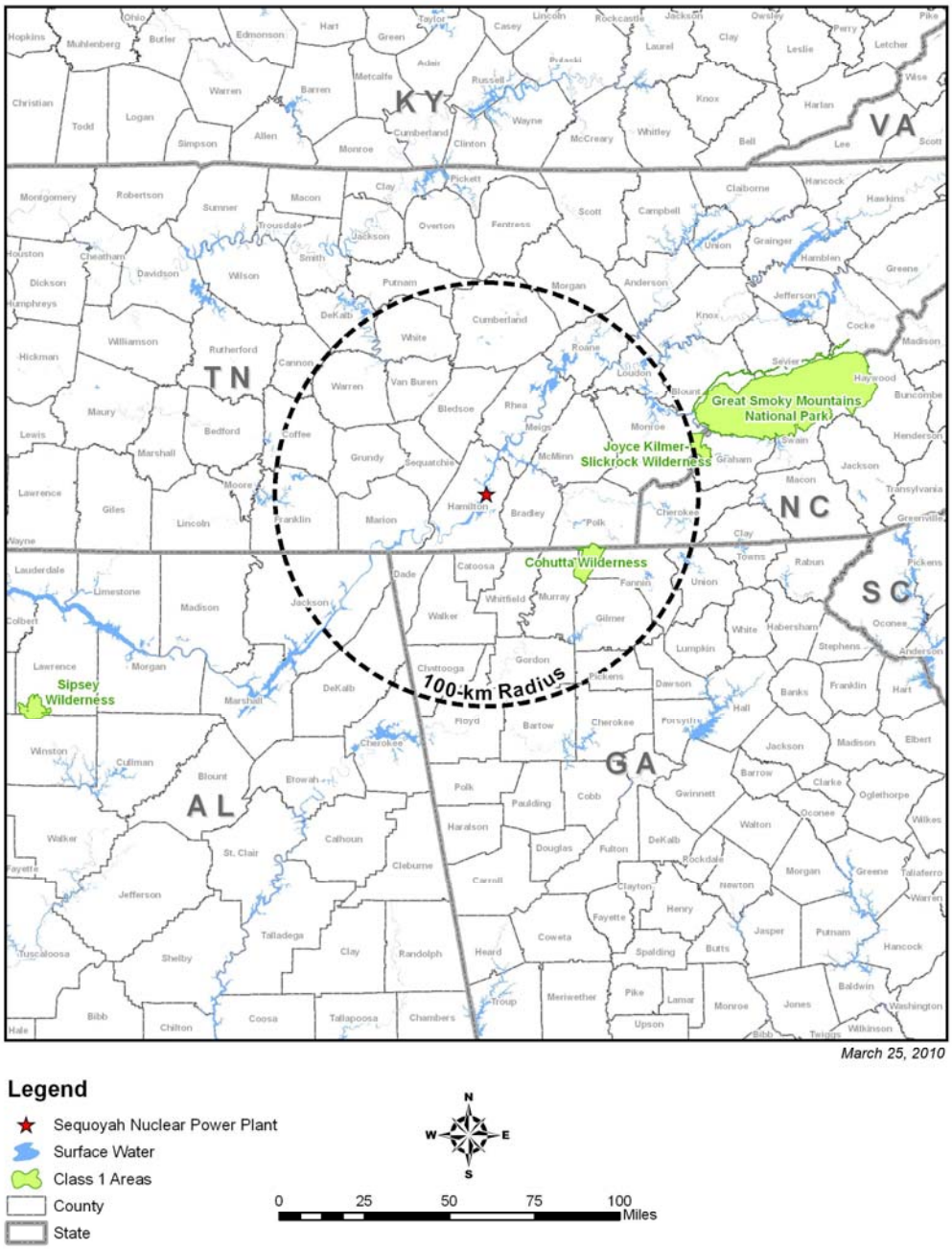

Figure 3-15. PSD Class I Air Quality Areas

Existing Air Emission Sources

There are virtually no air emissions from the nuclear reaction that releases the energy used to generate electricity. Existing sources of air emissions include: minor emissions from vehicular traffic, including both personal and commercial transportation, minor PM_{10} emissions from dust produced from travel over unpaved roads, and small volumes of emissions from auxiliary boilers, cooling towers during operation, testing of stand-by emergency diesel generators, and some heavy machinery used during normal operations and planned refueling outages. Nuclear energy life-cycle emissions include emissions associated with construction of the plant (Alternative 2a only), mining and processing the fuel, routine operation of the plant, waste disposal, and decommissioning. Numerous studies demonstrate that over the life cycle of the fuel, electricity generated from nuclear power results in emissions of about the same amount of GHG per kWh as renewable energy sources and far less than fossil fuel sources (Section 3.16.1). The largest variables in life-cycle GHG emissions of a nuclear plant, aside from the operating lifetime, electrical output, and capacity factor, are the type of uranium enrichment process and the source of power for enrichment facilities. Current enrichment facilities use the energy-intensive gaseous diffusion process largely powered by fossil fuels. New enrichment facilities currently under construction will use much less energy-intensive processes resulting in reduced nuclear plant life-cycle GHG emissions. The relevant emissions would occur over a period of 20 years of the license renewal and would be consistent with the very low level of emissions produced by the currently operating SQN. Nuclear power is an effective alternative to help TVA reduce GHG emissions.

Current air emissions from the operation of SQN are minor amounts of NO_x, CO, SO_x, PM_{10}, and reactive organic gases (ROG). Air emissions from SQN during the time frame of the license renewal, 2020 to 2041, are expected to be similar to current emissions. Air emissions would also be generated in the form of fugitive dust emissions (PM_{10}) and equipment exhaust emissions (NO_x, SO_x, CO, ROG, and PM_{10}). Operation of heavy equipment and vehicles during transportation and routine operations would generate exhaust emissions resulting from fuel combustion, and fugitive dust emissions would be generated by mobile equipment and vehicles traveling on unpaved roads. However, vehicle exhaust emissions and fugitive dust impacts from the operation of SQN on the local air quality are expected to be minor.

Equipment used for activities such as the transport of outage equipment on unpaved surfaces would generate fugitive dust. These dust emissions would consist primarily of large particles that generally settle on nearby surfaces, rather than becoming airborne for any great distance. These types of emissions are not permanent emissions; they occur with short duration and infrequency, and are scattered over different times of the day and throughout the year. Fugitive dust would not cause air quality standards to be exceeded, nor would they delay the attainment of ambient air quality standards in the area. There would be no substantial adverse impacts on air quality.

Air emissions from specific sources at SQN include the following sources that require air permits from the Chattanooga/Hamilton County Air Pollution Control Bureau: the hyperbolic natural draft cooling towers, the auxiliary steam boilers for heating and other uses, the generators and diesel-powered auxiliary (emergency) generators, and other small sources such as insulation saws and abrasives operations (Chapter 4).

Actual operating experience under the thermal regulations in effect, the reservoir conditions, and the plant's cooling requirements have shown that closed-mode operation of the cooling towers has been unnecessary and is not expected to be used in the future. Cooling tower operation is conducted only in the warmer months of the year.

The plant operates under the air quality permit category of a “minor source” of air pollutants as approved by TDEC and the Chattanooga/Hamilton County Air Pollution Control Bureau. All industry with the potential to emit any air pollutant operating in Hamilton County is required to obtain an air pollution permit. The Air Pollution Control Bureau conducts annual inspections, tracks air emissions, and develops special operating conditions to ensure compliance with the applicable rules and regulations. (CHCAPCB 2009) Various air permits are required for operation of SQN and would be maintained during the period of license renewal given their respective renewal schedules (Section 1.5 and Chapter 5).

Hazardous Air Pollutants

Hydrazine and lead are reported annually to the Tennessee Emergency Management Agency (TEMA) as hazardous air pollutants (HAPs) released from SQN, but technically reported as Toxic Release Inventory (TRI) chemicals and submitted as part of the TRI reporting to TEMA. Both of these chemicals are released to the air in very small amounts, and the impacts from these chemicals are considered insignificant HAPs at SQN. Hydrazine is a corrosion inhibitor and provides pH control in the cooling water system. It is controlled in accordance with the NPDES permit and is released in the cooling water returned to the Tennessee River (see Section 3.1.4 and 3.14). A small fraction of the hydrazine used on site is estimated to be released to the air. Lead is present at SQN mainly from the use of ammunition at the on-site security gun range. A small fraction of the lead (0.37 lbs/year) (TVA 2009k) from the ammunition becomes airborne and is released. There is no significant source of HAPs at SQN.

3.16.4. Environmental Consequences – Air Quality

Alternative 1 – License Renewal

Under the Action Alternative, SQN would continue to operate under the current conditions. SQN is not a significant source of pollutants, and the impact of operation for an additional 20-year period would be minor. The nuclear fission process produces substantially less air pollutants when compared to replacement fossil-fueled generation sources. The vehicular traffic of personnel commuting to work would produce small amounts of pollutants, and fugitive dust would occur from vehicles traveling on unpaved roads.

License renewal would help TVA meet the goal of reducing carbon emissions from electrical generation facilities, and provide a potentially positive indirect impact to the air quality. By using nuclear power, the amount of pollutants released into the air would be substantially reduced from what may have been released from alternative fossil fueled sources as described earlier.

Alternative 2 – No Action Alternative

Under the No Action Alternative, the impact on air quality from shutting down SQN would be a slightly positive impact. SQN would start decreasing the work force, which would reduce the emissions from the vehicles. There would be less mobile and stationary equipment in

use, which would decrease emissions. Once the destruction and recycling of site structures and facilities began, there would be a brief period of increased particulate emissions from construction-type activities.

Alternative 2a – New Nuclear Generation

Constructing a new nuclear plant is similar to many large construction projects. Construction impacts to air quality come from several sources such as fugitive dust emissions, vehicular traffic emissions, heavy equipment emissions, and concrete batch plant emissions.

BMPs would be used to control the sources of emissions, and the impacts would be minor and of short duration. There would be minor indirect impacts off site and no cumulative impacts due to construction.

Under the No Action Alternative, operation of a new nuclear plant would not create a significant source of pollutants including GHG, because the nuclear fission process produces considerably less air pollutants when compared to fossil-fueled generation sources. The vehicular traffic of personnel commuting to work would produce small amounts of pollutants, and fugitive dust would occur from vehicles traveling on unpaved roads. Therefore, the environmental impact of a new nuclear plant on air quality would be minor. With an operational work force of approximately 650 to 1,000 workers, the traffic due to commuting workers would be a minor impact. Occasional trucks, diesel engines, and small-source engines would be used, but the impacts would be minor. Fugitive dust would be a minor impact.

The quantities of air pollutants released from the nuclear fission process are essentially zero for NO_2, SO_2, CO, and CO_2.

Under Alternative 2a, new nuclear units would not be operational until 2025 – 2027. Between 2020 (when SQN would begin to shut down) and 2027 (when the second new nuclear unit would become operational), a combination of TVA-owned and purchased natural gas-fired capacity, and increased production of existing coal and natural-gas fired units could be used to meet demand. Increased use of fossil fuel plants would increase air emissions during that time period. Between 2020 and 2024, the average annual emissions of SO_2, NO_x, CO_2, and mercury would be less than 2010, but still greater than under Alternative 1. Between 2027 and 2029, when operation of the new nuclear units begin, operation of the fossil fuel plants providing necessary energy during the interim period would decrease and emissions would be similar to those under Alternative 1. Under Alternative 2a, TVA would maintain air emissions in compliance with regulatory limits, but overall quantities of emissions would be greater than under Alternative 1.

Alternative 2b – New Gas Natural Gas-Fired Generation

Activities associated with construction of a new natural gas-fired plant would be similar but on a smaller scale than Alternative 2a. Under Alternative 2b, operation of a new natural gas-fired turbine plant would increase some air pollutants. The amount of pollutants released is determined by the type of control equipment used in the plant design. The typical quantities of air pollutants released from a modern natural gas-fired turbine, such as the JSF gas turbine project, are small enough (for SO_2, NO_2, CO, and CO_2 emissions) that they would be operated with a minor impact to air quality (TVA 2010c). Depending on the

chosen location, typical combined-cycle combustion turbine gas-fired generation plants have minor to moderate impacts on air quality, but would be designed and operated to meet all air quality standards. New processes are being developed to continue the decrease in pollutants released or sequestered. With the smallest work force, the vehicular emissions would be minor due to commuting activities.

Table 3-31 presents pollutant air emission estimates for the JSF project operating in the combined-cycle mode to provide base load capacity. The table also provides the SQN equivalent gas-fired plant pollutant air emissions estimates based on the twofold increase in capacity. As a rule of thumb, natural gas combined-cycle generation produces about 1,000 pounds of CO_2 per MWh. (TVA 2010c)

Table 3-31. Air Emissions From JSF Combined-Cycle Base Load and SQN Equivalent Alternative

Pollutant	JSF Combined-Cycle Base Load – Tons per Year	Two JSF Plants Equivalent – Tons per Year (JSF times 2 increase in capacity)
SO_x	109.65	219.30
NO_x	564.00	1128.00
CO	288.00	576.00
Lead	0.0373	0.0746
PM_{10}	137.00	274.00
$PM_{2.5}$	137.00	274.00
VOC	91.60	183.20

SO_x= sulfur oxides, VOC = volatile organic compounds
(TVA 2010c)

Operating new natural gas-fired plants would result in direct and indirect impacts on air quality, but they would be minor in the short term as well as the long term. A PSD analysis may be required to verify the impact to nearby PSD Class I areas.

Under Alternative 2b, new natural gas-fired units would not be operational until 2025 – 2029. Between 2020 and 2029, a combination of TVA-owned and purchased natural gas-fired capacity and increased production of existing coal and natural-gas fired units would be used. Increased use of fossil fuel plants would increase air emissions during that time period. Furthermore, TVA's system-wide generation planning study indicated that under Alternative 2b, although new natural gas-fired plants would be available, the energy needed to replace SQN generation would be obtained primarily by increasing operation of existing coal and natural gas-fired plants. The interim need to provide energy from these alternative generation resources to replace SQN would cease, as would any associated emissions after the new combined-cycle units started operating. Under Alternative 2b, emissions would be greater than under Alternative 1.

Conclusion

Impacts from air emissions would be expected to be minor from the continued operation of SQN during the period of license renewal. Air emissions would be a minor to moderate impact from the construction and operation of either of the alternative new replacement plants. TVA would obtain appropriate permits and maintain air emissions in compliance with regulatory limits.

3.17. Radiological Effects of Normal Operations

This section discusses the potential radiological dose exposure to the public during normal operations of SQN. The impact of SQN is assessed in TVA's 1974 FES and it was concluded that environmental radioactivity levels due to releases to unrestricted areas from SQN will be so low that the radiation doses to man will be less than the variations in the natural background radiation dose (TVA 1974a).

3.17.1. Affected Environment

The estimated total dose to the public within 50 miles of SQN is approximately 95,400 person-rem/year natural background dose. The natural background dose is based on an individual person dose of approximately 90 millirem (mrem)/year and a population of 1,060,000 people within the 50 miles. (TVA 2009i) The estimated dose to the public within 50 miles due to the operation of SQN is about 1.2 person-rem/year, less than the normal fluctuations in the 95,400 person-rem/year natural background radiation dose this population would receive from background sources. Background radiation comes from a variety of sources such as cosmic radiation, soils and rocks, radon, weapons testing, medical X-rays, smoke detectors, and smoking.

Although TVA's 1974 FES for SQN predated the issuance of the federal regulation of the NRC (Appendix I of 10 CFR Part 50), when compared to the federal regulations (Appendix I values), SQN demonstrates full compliance. Recent calculations confirm that earlier assessments and doses to the public resulting from the discharge of radioactive effluents from SQN are a small fraction of the (Appendix I) federal regulation. TVA determined that the doses to the public resulting from the discharge of radioactive effluents from SQN are within applicable limits for dose exposure during normal operations. Alternative 1 – License Renewal would be a continuation of the current SQN operation, and the radiological effects of normal operations during the period of license renewal would be similar to the discussion in this section. Alternative 2a – New Nuclear Generation would result in radiological effects similar to the operation of SQN, with changes based on the nuclear technology chosen and potential improvements based on new reactor designs. Construction and operation of a replacement Alternative 2b – New Natural Gas-Fired Generation plant would have no direct radiological effects. Discussion of the shutdown of SQN at the end of the current license periods or at the end of the license renewal period is presented within this section also.

Exposure Pathways

Evaluation of the potential impacts to the public from normal operational releases is based upon the probable pathways to individuals, populations, and biota near SQN. The exposure pathways, described in federal regulations of the NRC (Regulatory Guides 1.109 and 1.111) (NRC 1977a; NRC 1977b) are shown in Figure 3-16. The critical pathways to humans for routine radiation releases from SQN are direct exposure from radionuclides in the air (submersion), inhalation of contaminated air, ingesting milk from a cow that feeds on

open pasture near the site, ingesting vegetables from a garden near the site, ingestion of liquids, immersion in liquid, shoreline direct irradiation, and ingesting fish caught in the Tennessee River (TVA 1974a).

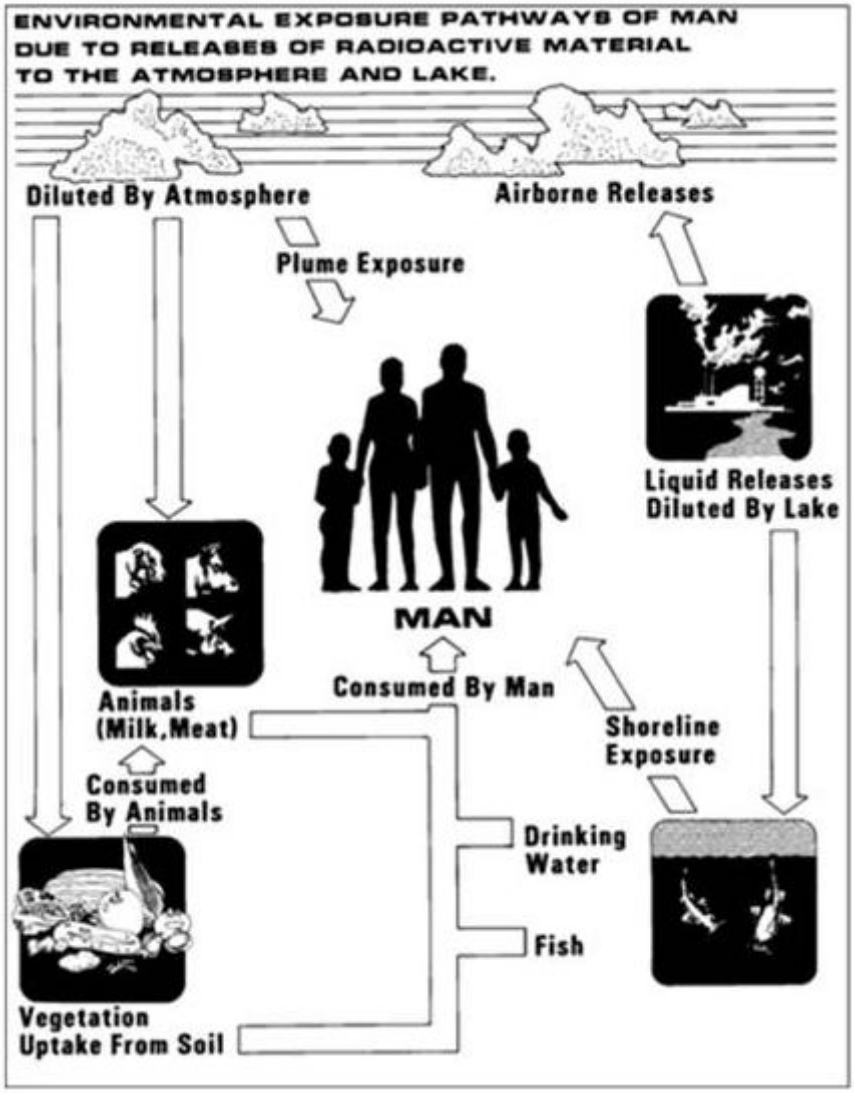

Figure 3-16. Exposure Pathways

The ODCM specifies the requirements for monitoring specific exposure pathways. The ODCM is based on current conditions at the site and in the surrounding community so that monitoring and sampling can be altered as necessary. Dose calculations to members of the public are based on the guidance of the ODCM. The ODCM can be modified to include new pathways if needed or to exclude pathways if the conditions warrant. (SQN 2009)

Radiation exposure pathways to biota other than members of the public were assessed to determine if the pathways could result in radiation doses to biota greater than those predicted for humans. This assessment used surrogate species that provide representative information on the various dose pathways potentially affecting broader classes of living organisms.

Surrogates are used because important attributes are well defined and accepted as a method for judging doses to biota. Surrogate biota used include algae (surrogate for aquatic plants), invertebrates, fish, aquatic animals, muskrat, and duck. (TVA 1974a)

The exposure pathways to humans that were used in the 1974 FES for SQN (TVA 1974a) analyses for liquid effluents remain valid and include:

- External exposure to contaminated water by way of swimming, boating, or walking on the shoreline.
- Ingestion of contaminated water.
- Ingestion of aquatic animals exposed to contaminated water.

Exposure pathways considered include external radiation doses due to noble gases, internal doses from particulates due to inhalation, and the ingestion of milk, meat, and vegetables (including grains) within a 50-mile radius area around SQN.

Exclusion Area Boundary

As defined in federal regulations of the NRC (10 CFR Part 100), the EAB is the area surrounding the reactor in which TVA has the authority to determine all activities, including exclusion or removal of personnel and property from the area. The boundary on which limits for the release of radioactive effluents are based is the EAB as shown in Figure 3-14. There are no residents living in this exclusion area. Access within the EAB is controlled, and no restricted areas within the EAB are accessible to members of the public. Areas outside the EAB are unrestricted in the context of federal regulations of the NRC (10 CFR Part 20) and open to the public. The nearest resident lives 0.5 miles away from the plant in a north-northwesterly direction (TVA 2009i).

Radiation Doses to Members of the Public

This section provides an estimate of doses to the maximally exposed individual (MEI) and the general population during routine operations for both the radioactive liquid and gaseous effluent pathways. The MEI is a hypothetical individual member of the public who would live continuously at the location that would allow him to receive the maximum dose by being exposed to the plant radioactive effluents.

Radiological Doses Due to Liquid Effluents

The release of small amounts of radioactive liquid effluents is permitted for SQN as long as releases comply with the requirements specified in federal regulations of the NRC (10 CFR Part 20) and the ODCM (SQN 2009). The liquid effluent exposure pathways given in Subsection 3.17.1 were considered in the evaluation of radiation doses to the public resulting from radioactive liquid effluent releases. Current analyses of potential radioactive doses to members of the public due to releases of radioactivity in liquid effluents are calculated using the methodology provided in the ODCM.

The resulting calculated doses to an individual due to liquid effluents released from SQN for the years 2004 through 2008 are given in Table 3-32. The dose controls and limits of the ODCM, based on federal regulations of the NRC (10 CFR Part 20, Appendix B, Table 2,

Column 2 for concentrations of effluent releases and 10 CFR Part 50 Appendix I for any individual) are annual limits of 3 mrem or less to the total body and 10 mrem or less to any organ while the quarterly limits are 1.5 mrem or less to the total body and 5 mrem or less to any organ (SQN 2009). The annual and quarterly limits are designed to assure that doses due to releases of radioactive material from nuclear power reactors to unrestricted areas are kept as low as practicable during normal conditions.

Table 3-32. Calculated Dose to Individuals From Liquid Effluents, 2004 – 2008

Year	Qtr	Age Group	Total Body Dose	Qtr Limit	% of Limit
2004	1	Adult	9.60e-4 mrem	1.5 mrem	<1
2004	2	Child	3.90e-3 mrem	1.5 mrem	<1
2004	3	Child	2.40e-3 mrem	1.5 mrem	<1
2004	4	Child	2.10e-3 mrem	1.5 mrem	<1
2005	1	Child	1.50e-3 mrem	1.5 mrem	<1
2005	2	Child	4,20e-3 mrem	1.5 mrem	<1
2005	3	Child	2.10e-4 mrem	1.5 mrem	<1
2005	4	Child	1.40e-3 mrem	1.5 mrem	<1
2006	1	Child	8.00e-3 mrem	1.5 mrem	<1
2006	2	Child	3.90e-3 mrem	1.5 mrem	<1
2006	3	Child	3.30e-3 mrem	1.5 mrem	<1
2006	4	Child	2.50e-3 mrem	1.5 mrem	<1
2007	1	Child	8.20e-4 mrem	1.5 mrem	<1
2007	2	Child	1.10e-2 mrem	1.5 mrem	<1
2007	3	Child	1.00e-2 mrem	1.5 mrem	<1
2007	4	Child	6.70e-3 mrem	1.5 mrem	<1
2008	1	Child	3.20e-3 mrem	1.5 mrem	<1
2008	2	Child	4.70e-3 mrem	1.5 mrem	<1
2008	3	Child	1.80e-3 mrem	1.5 mrem	<1
2008	4	Child	5.40 e-3 mrem	1.5 mrem	<1

(TVA 2005c; TVA 2006c; TVA 2007e; TVA 2008c; TVA 2009i)

SQN submits annual reports to the NRC detailing the release of radioactive liquid effluents for the previous year. These annual radioactive effluent release reports (ARERR) include summations of all radioactive liquid releases and the resulting doses for individuals and the total population, as well as the quantities of radioactive nuclides released. It is evident from these reports that the release of radioactive liquid effluents from SQN has a minor impact on the environment and people in the surrounding the area. Based on these reports (TVA 2005c; TVA 2006c; TVA 2007e; TVA 2008c; TVA 2009i), the overall results expected from normal operations of SQN are as follows:

- Each unit meets the dose guidelines given in 10 CFR Part 50, Appendix I.
- The dose estimates to the public are a small fraction of the Appendix I guidelines.
- The analyses of the radiological impact to humans from liquid releases in TVA's 1974 FES for SQN continue to be valid.
- The population doses are low.
- The impact to members of the public resulting from normal liquid effluent releases is minor.

Table 3-33 provides the calculated quarterly total body doses to the total population in the 50-mile radius of SQN for the years 2004 – 2008 from liquid and gaseous effluents released. The natural background radiation causes an estimated dose of 95,400 person-rem/year to the population within the 50-mile radius of SQN. Therefore, SQN is contributing a dose so minor that it cannot be distinguished from the variations in the natural background radiation dose, as was expected in TVA's 1974 FES for SQN.

If Alternative 2a – New Nuclear Generation is pursued, the design would ensure the effluent liquid releases would be within applicable rules and regulations. The new plant would be required to develop a REMP, which would contain adequate sampling and analysis guidance to monitor the environment. Based on design criteria and operational procedures, the normal operation of a new nuclear plant would present minimal risk to the health and safety of the public from radioactive liquid releases. Advanced reactor design would be expected to provide better protection to the workers and the public depending on the technology chosen. All new nuclear plants would be required to meet all applicable liquid release limits and thereby ensure the health and safety of the public, or they would not be allowed to operate.

Table 3-33. Calculated Quarterly Total Population Doses (Liquid and Gaseous) to the Total Population in a 50-Mile Radius of SQN, 2004 – 2008*

Year	Qtr	Total Population Dose by Quarter (person-rem) Liquids	Total Population Dose by Quarter (person-rem) Gases
2004	1	3.80e-2	7.41e-3
2004	2	2.50e-1	2.65e-2
2004	3	1.60e-1	1.58e-2
2004	4	1.30e-1	9.64e-2
2005	1	1.20e-1	2.67e-2
2005	2	3.50e-1	4.26e-2
2005	3	1.90e-2	1.53e-2
2005	4	1.10e-1	2.01e-2
2006	1	5.20e-1	1.58e-2

Year	Qtr	Total Population Dose by Quarter (person-rem) Liquids	Total Population Dose by Quarter (person-rem) Gases
2006	2	2.60e-1	6.16e-2
2006	3	2.30e-1	2.77e-2
2006	4	1.60e-1	6.20e-2
2007	1	5.00e-2	1.79e-1
2007	2	6.80e-1	1.25e-1
2007	3	7.10e-1	1.48e-1
2007	4	4.30e-1	1.60e-1
2008	1	2.00e-1	1.88e-2
2008	2	3.10e-1	5.28e-2
2008	3	1.20e-1	9.09e-2
2008	4	3.60e-1	4.76e-2

*Based on a population of 1,060,000 people within the 50-mile radius.

(TVA 2005c; TVA 2006c; TVA 2007e; TVA 2008c; and TVA 2009i)

Radiological Impact of Gaseous Effluents

Gaseous effluents refers to the release of small quantities of gaseous aerosols and particulates associated with the normal operation of SQN. Gaseous radioactive effluents are released to the atmosphere through vents on the shield building, auxiliary building, turbine building, and service building (TVA 2008a).

The current analyses of potential doses to members of the public due to releases of radioactivity in gaseous effluents are performed using the methodologies described in the SQN ODCM. The methods described are based on NRC guidance for determining the doses for releases of radioactive effluents from nuclear power plants into the atmosphere as provided in Regulatory Guide 1.109, *Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, Revision 1* (NRC 1977a). The ODCM provides the limits for gaseous effluent doses to members of the public. Those limits are that during any calendar quarter, the dose due to noble gases must be less than or equal to 5 millirad (mrad) for gamma radiation and less than or equal to 10 mrad for beta radiation, and that during any calendar year, the dose must be less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation (SQN 2009). Additionally, limits are that during any calendar quarter, the dose due to tritium and radionuclides must be less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation, and that during any calendar year, the dose must be less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation (SQN 2009). Tables 3-34 through 3-38 provide the gaseous doses calculated from the gaseous releases during the years 2004 – 2008.

Table 3-34. Doses From Gaseous Effluents, 2004

Year	Qtr	Pathway	Dose	QTR Limit	% of Limit
2004	1	Gamma air	2.69e-3 mrad	5 mrad	<1
	1	Beta air	1.22e-3 mrad	10 mrad	<1
	1	Total body	2.00e-3 mrad	10 mrad	<1
	1	Skin	3.03e-3 mrad	10 mrad	<1
	1	Child/thyroid	6.52e-3 mrem	7.5 mrem	<1
	1	Child/total body	6.52e-3 mrem	7.5 mrem	<1
2004	2	Gamma air	4.72e-3 mrad	5 mrad	<1
	2	Beta air	2.01e-3 mrad	10 mrad	<1
	2	Total body	2.67e-3 mrad	10 mrad	<1
	2	Skin	4.01e-3 mrad	10 mrad	<1
	2	Child/thyroid	1.90e-2 mrem	7.5 mrem	<1
	2	Child/total body	1.90e-2 mrem	7.5 mrem	<1
2004	3	Gamma air	3.11e-3 mrad	5 mrad	<1
	3	Beta air	1.37e-3 mrad	10 mrad	<1
	3	Total body	2.38e-3 mrad	10 mrad	<1
	3	Skin	3.58e-3 mrad	10 mrad	<1
	3	Child/thyroid	1.25e-2 mrem	7.5 mrem	<1
	3	Child/total body	1.25e-2 mrem	7.5 mrem	<1
2004	4	Gamma air	6.08e-3 mrad	5 mrad	<1
	4	Beta air	2.79e-3 mrad	10 mrad	<1
	4	Total body	3.50e-3 mrad	10 mrad	<1
	4	Skin	5.30e-3 mrad	10 mrad	<1
	4	Child/thyroid	4.78e-2 mrem	7.5 mrem	<1
	4	Child/total body	4.77e-2 mrem	7.5 mrem	<1

(TVA 2005c)

Table 3-35. Doses From Gaseous Effluents, 2005

Year	Qtr	Pathway	Dose	QTR Limit	% of Limit
2005	1	Gamma air	5.38e-3 mrad	5 mrad	<1
	1	Beta air	2.63e-3 mrad	10 mrad	<1
	1	Total body	3.23e-3 mrad	10 mrad	<1
	1	Skin	4.93e-3 mrad	10 mrad	<1
	1	Child/thyroid	9.75e-3 mrem	7.5 mrem	<1
	1	Child/total body	9.36e-3 mrem	7.5 mrem	<1
2005	2	Gamma air	4.30e-3 mrad	5 mrad	<1
	2	Beta air	2.80e-3 mrad	10 mrad	<1
	2	Total body	2.70e-3 mrad	10 mrad	<1
	2	Skin	4.25e-3 mrad	10 mrad	<1
	2	Child/thyroid	1.61e-2 mrem	7.5 mrem	<1
	2	Child/total body	1.55e-2 mrem	7.5 mrem	<1
2005	3	Gamma air	2.18e-3 mrad	5 mrad	<1
	3	Beta air	1.57e-3 mrad	10 mrad	<1
	3	Total body	1.65e-3 mrad	10 mrad	<1
	3	Skin	2.68e-3 mrad	10 mrad	<1
	3	Child/thyroid	1.08e-2 mrem	7.5 mrem	<1
	3	Child/total body	1.08e-2 mrem	7.5 mrem	<1
2005	4	Gamma air	4.91e-3 mrad	5 mrad	<1
	4	Beta air	1.36e-2 mrad	10 mrad	<1
	4	Total body	3.34e-3 mrad	10 mrad	<1
	4	Skin	7.74e-3 mrad	10 mrad	<1
	4	Child/thyroid	1.01e-2 mrem	7.5 mrem	<1
	4	Child/total body	1.01e-2 mrem	7.5 mrem	<1

(TVA 2006c)

Table 3-36. Doses From Gaseous Effluents, 2006

Year	Qtr	Pathway	Dose	QTR Limit	% of Limit
2006	1	Gamma air	2.62e-3 mrad	5 mrad	<1
	1	Beta air	3.31e-3 mrad	10 mrad	<1
	1	Total body	1.55e-3 mrad	10 mrad	<1
	1	Skin	2.81e-3 mrad	10 mrad	<1
	1	Child/thyroid	7.81e-3 mrem	7.5 mrem	<1
	1	Child/total body	7.79e-3 mrem	7.5 mrem	<1
2006	2	Gamma air	1.67e-2 mrad	5 mrad	<1
	2	Beta air	3.82e-2 mrad	10 mrad	<1
	2	Total body	9.78e-3 mrad	10 mrad	<1
	2	Skin	2.09e-2 mrad	10 mrad	<1
	2	Child/thyroid	5.02e-2 mrem	7.5 mrem	<1
	2	Child/total body	3.88e-2 mrem	7.5 mrem	<1
2006	3	Gamma air	3.20e-3 mrad	5 mrad	<1
	3	Beta air	2.13e-3 mrad	10 mrad	<1
	3	Total body	2.17e-3 mrad	10 mrad	<1
	3	Skin	3.43e-3 mrad	10 mrad	<1
	3	Child/thyroid	2.91e-2 mrem	7.5 mrem	<1
	3	Child/total body	2.91e-2 mrem	7.5 mrem	<1
2006	4	Gamma air	1.90e-2 mrad	5 mrad	<1
	4	Beta air	8.15e-3 mrad	10 mrad	<1
	4	Total body	1.15e-2 mrad	10 mrad	<1
	4	Skin	1.73e-2 mrad	10 mrad	<1
	4	Child/thyroid	3.56e-2 mrem	7.5 mrem	<1
	4	Child/total body	3.56e-2 mrem	7.5 mrem	<1

(TVA 2007e)

Table 3-37. Doses From Gaseous Effluents, 2007

Year	Qtr	Pathway	Dose	QTR Limit	% of Limit
2007	1	Gamma air	4.23e-3 mrad	5 mrad	<1
	1	Beta air	1.98e-3 mrad	10 mrad	<1
	1	Total body	2.42e-3 mrad	10 mrad	<1
	1	Skin	3.66e-3 mrad	10 mrad	<1
	1	Child/thyroid	1.92e-2 mrem	7.5 mrem	<1
	1	Child/total body	1.92e-2 mrem	7.5 mrem	<1
2007	2	Gamma air	3.56e-3 mrad	5 mrad	<1
	2	Beta air	1.69e-3 mrad	10 mrad	<1
	2	Total body	2.13e-3 mrad	10 mrad	<1
	2	Skin	3.19e-3 mrad	10 mrad	<1
	2	Child/thyroid	1.38e-2 mrem	7.5 mrem	<1
	2	Child/total body	1.38e-2 mrem	7.5 mrem	<1
2007	3	Gamma air	5.25e-3 mrad	5 mrad	<1
	3	Beta air	2.95e-3 mrad	10 mrad	<1
	3	Total body	3.37e-3 mrad	10 mrad	<1
	3	Skin	5.24e-3 mrad	10 mrad	<1
	3	Child/thyroid	2.29e-2 mrem	7.5 mrem	<1
	3	Child/total body	2.25e-2 mrem	7.5 mrem	<1
2007	4	Gamma air	8.06e-3 mrad	5 mrad	<1
	4	Beta air	4.24e-3 mrad	10 mrad	<1
	4	Total body	5.95e-3 mrad	10 mrad	<1
	4	Skin	9.10e-3 mrad	10 mrad	<1
	4	Child/thyroid	1.81e-2 mrem	7.5 mrem	<1
	4	Child/total body	1.76e-2 mrem	7.5 mrem	<1

(TVA 2008c)

Table 3-38. Doses From Gaseous Effluents, 2008

Year	Qtr	Pathway	Dose	QTR Limit	% of Limit
2008	1	Gamma air	5.14e-3 mrad	5 mrad	<1
	1	Beta air	1.86e-3 mrad	10 mrad	<1
	1	Total body	2.96e-3 mrad	10 mrad	<1
	1	Skin	4.37e-3 mrad	10 mrad	<1
	1	Child/thyroid	7.12e-2 mrem	7.5 mrem	<1
	1	Child/total body	7.12e-3 mrem	7.5 mrem	<1
2008	2	Gamma air	3.75e-3 mrad	5 mrad	<1
	2	Beta air	1.46e-3 mrad	10 mrad	<1
	2	Total body	2.15e-3 mrad	10 mrad	<1
	2	Skin	3.22e-3 mrad	10 mrad	<1
	2	Child/thyroid	9.01e-3 mrem	7.5 mrem	<1
	2	Child/total body	9.01e-3 mrem	7.5 mrem	<1
2008	3	Gamma air	8.14e-4 mrad	5 mrad	<1
	3	Beta air	3.24e-4 mrad	10 mrad	<1
	3	Total body	6.16e-4 mrad	10 mrad	<1
	3	Skin	9.18e-4 mrad	10 mrad	<1
	3	Child/thyroid	1.62e-2 mrem	7.5 mrem	<1
	3	Child/total body	1.62e-2 mrem	7.5 mrem	<1
2008	4	Gamma air	5.21e-4 mrad	5 mrad	<1
	4	Beta air	2.30e-4 mrad	10 mrad	<1
	4	Total body	3.91e-4 mrad	10 mrad	<1
	4	Skin	5.89e-4 mrad	10 mrad	<1
	4	Child/thyroid	6.63e-3 mrem	7.5 mrem	<1
	4	Child/total body	6.63e-3 mrem	7.5 mrem	<1

(TVA 2009i)

SQN submits annual reports to the NRC detailing the release of radioactive gaseous effluents for the previous year as part of the ARERR. These reports include summations of all radioactive gaseous releases and the resulting doses as well as the quantities of radioactive nuclides released. (TVA 2005c; TVA 2006c; TVA 2007e; TVA 2008c; TVA 2009i)

Federal regulations (10 CFR Part 50, Appendix I) define design objective limits for radioactive material in gaseous effluents for any nuclear power plant. Meeting the limits presented in the federal regulations also conforms to the ALARA criterion for radioactive material in gaseous effluents. If Alternative 2a – New Nuclear Generation is pursued, the design would ensure the effluent releases would be within applicable rules and regulations. Based on these design criteria, normal operation of a new nuclear plant would present minimal risk to the health and safety of the public.

Total Dose (Liquid and Gaseous) From All Sources

Dose limits for individual members of the public are given in the ODCM Control 1.2.3. The annual (calendar year) dose or dose commitment to any member of the public, beyond the site boundary due to releases of radioactivity from UFC sources, shall be limited to less than or equal to 25 mrem to the total body or any organ (except the thyroid, which shall be limited to less than or equal to 75 mrem). Table 3-39 provides results of the calculated cumulative total dose (total body or any other organ) from all sources for the years 2004 – 2008. Table 3-40 provides results of the calculated cumulative total dose (thyroid) from all sources for the years 2004 – 2008. These calculated doses are well within the limits specified in the ODCM. Therefore, it is concluded that normal operation of SQN presents minimal risk to the health and safety of the public.

Individual doses due to normal liquid and gaseous effluent releases from SQN are less than 1 percent of the applicable limits. The doses are well below the federal regulatory guidelines and standards (Appendix I of 10 CFR Part 50 and 10 CFR Part 20).

Table 3-39. Cumulative Annual Total Dose (Total Body or Any Organ) From All Sources, 2004 – 2008

Year	Cumulative Total Dose	Annual Limit	% of Limit
2004	1.16e-1 mrem	25 mrem	0.46
2005	1.35e-1 mrem	25 mrem	0.54
2006	2.29e-1 mrem	25 mrem	0.92
2007	1.50e-1 mrem	25 mrem	0.60
2008	7.56e-2 mrem	25 mrem	0.30

(TVA 2005c; TVA 2006c; TVA 2007e; TVA 2008c; and TVA 2009i)

Table 3-40. Cumulative Annual Total Dose (Thyroid) From All Sources, 2004 – 2008

Year	Cumulative Total Dose	Annual Limit	% of Limit
2004	1.15e-1 mrem	75 mrem	0.15
2005	7.23e-2 mrem	75 mrem	0.10
2006	1.84e-1 mrem	75 mrem	0.25
2007	1.44e-1 mrem	75 mrem	0.19
2008	7.53e-2 mrem	75 mrem	0.10

(TVA 2005c; TVA 2006c; TVA 2007e; TVA 2008c; and TVA 2009i)

If Alternative 2a – New Nuclear Generation is pursued, the design would ensure the effluent gaseous releases would be within applicable rules and regulations. The new plant would be required to develop a REMP, which would contain adequate sampling and analysis guidance to monitor the environment. Based on design criteria and operational procedures, the normal operation of a new nuclear plant would present minimal risk to the health and safety of the public from radioactive gaseous releases. Advanced reactor design would be expected to provide better protection to the workers and to the public depending on the technology chosen. All new nuclear plants would be required to meet all applicable gaseous release limits and thereby ensure the health and safety of the public, or they would not be allowed to operate.

Population Dose

Population dose calculations determined the cumulative dose to the population within 50 miles of SQN. The estimated radiological impact from the normal gaseous releases from SQN is presented in Table 3-34 for comparison with the 50-mile regional population, resulting in 95,400 person-rem/year from natural background radiation. For perspective, the total body dose from normal background radiation to individuals within the United States averages 300 mrem per year (NRC 2004b). The annual total body dose due to normal background radiation for a population of 1,060,000 persons currently within a 50-mile radius of SQN is approximately 95,400 person-rem, assuming 90 mrem/year for each individual. By comparison, the same general population would receive a calculated total body dose of less than 1.2 person-rem/year from both liquid and gaseous effluents released from SQN. (TVA 2009i)

Based on the calculated results, normal operation of SQN presents minimal risk to the health and safety of the public. The annual doses to the public from Alternative 1 – License Renewal continued operation of SQN during the period of license renewal or No Action Alternative 2a – New Nuclear Generation would be well within all regulatory limits, and there would be no observable health impacts on the public from construction and operation of a new nuclear plant.

Radiological Impact on Biota Other Than Man

Radiation exposure pathways to biota other than man (i.e., animals) are examined to determine if the pathways could result in doses to biota greater than those predicted for man. This assessment uses surrogate species that provide representative information on

the various dose pathways potentially affecting broader classes of living organisms. Surrogates are used because important attributes are well defined and accepted as a method for judging doses to biota. Surrogate biota used for gaseous effluent exposure from SQN include muskrat, fish, and duck. (TVA 1974a)

Liquid radioactive effluents from SQN are mixed with other wastewater and subsequently discharged into the Tennessee River. Other non-radioactive discharges may be combined with cooling water discharges, but they are small in comparison and are ignored as a source of dilution. Release of radioactive materials in liquid effluents results in minimal radiological exposure to biota. Impacts on aquatic life from radiological releases are minor. Calculated values for doses to plants, invertebrates, and fish were performed for the TVA 1974 FES for SQN and produced results that support the impacts being classified as minor (Table 3-41). (TVA 1974a)

Doses from gaseous effluents contribute to terrestrial total body doses. External doses occur due to immersion in a plume of noble gases and deposition of radionuclides on the ground. The inhalation of radionuclides followed by the subsequent transfer from the lung to the rest of the body contributes to the internal total body doses. Immersion and ground deposition doses are largely independent of organism size, and the total body doses calculated for man can be applied.

Table 3-41. Annual Doses to Biota Living Near SQN

Biota Type	2.0 Curie Mixture	1.0 Curie Mixture
Ducks and Muskrat		
Internal Dose	2.7E+02 mrad	6.1E-05 mrad
External Dose	8.7E-04 mrad	0.0E+00 mrad
Total Dose	2.7E+02 mrad	6.1E-05 mrad
Plants		
Internal Dose	6.2 mrad @ 3-cm	1.3E-05 mrad
External Dose	1.7E-03 mrad	NA
Invertebrates		
Internal Dose	2.9 mrad @ 3-cm	1.3E-05 mrad
External Dose	1.7E-03 mrad	NA
Fish		
Internal Dose	0.3 mrad @ 3-cm	1.3E-05 mrad
External Dose	1.7E-03 mrad	

NA = not applicable
(TVA 1974a)

The NRC conducted a review of all operating nuclear power plants to evaluate the potential impacts of radionuclides on terrestrial biota from continued operations. Site-specific radionuclide concentrations in water, sediment, and soils were obtained from REMP reports for 15 nuclear plants. SQN was not one of the plants selected in the group of 15. These 15 plants were selected to represent sites with a range of radionuclide concentrations in the media, including plants with high annual worker total effective dose equivalent (TEDE) values for both BWR and PWRs. The RESRAD-BIOTA dose evaluation model was used to calculate estimated dose rates for terrestrial biota by using the media concentrations presented in the REMP reports. Results of the RESRAD-BIOTA dose modeling presented in Table 4.6.1.1–1 of the 2009 draft GEIS show the total dose estimates for three different terrestrial ecological receptors: riparian animal (an animal assumed to spend approximately 50 percent of its time in aquatic environments and 50 percent of its time in terrestrial environments), terrestrial animal, and terrestrial plant. The maximum estimated dose rate calculated for any of the nuclear power plants is 35.4 mrad/day, which is below the guideline value of 100 mrad/day for a riparian animal receptor. It is unlikely that the normal operations of these power plants would have adverse effects on terrestrial biota resulting from radionuclide releases, because the calculated doses are below protective guidelines and thus would not significantly affect populations. (NRC 2009b)

Use of federal exposure guidelines (40 CFR Part 190) that apply to members of the public in unrestricted areas is considered very conservative when evaluating calculated doses to biota. The calculated biota doses are well below those specified in the federal guidelines (40 CFR Part 190) and well below any dose expected to have any acute effects.

Radiological Monitoring

The REMP is described in the ODCM and was established to provide preoperational and operational monitoring of the area surrounding SQN, along with any new nuclear alternative. Preoperational monitoring was conducted prior to the start of SQN operations, and monitoring has continued during all the years of current operations. The SQN REMP is designed to provide the environmental monitoring necessary to document compliance with applicable regulations. All results obtained in the performance of the REMP are reported to the NRC on an annual basis in the *Annual Radiological Environmental Operating Report* (AREOR), and the dose results from the release of radioactive effluents are reported each year in the ARERR. The ODCM specifies the requirements of the annual reports. (SQN 2009)

The REMP is designed to monitor the pathways between the plant and the general public in the immediate vicinity of the plant. Sampling locations, sample types, collection frequency, and sample analyses are chosen so that the potential for detection of radioactivity in the environment is maximized. For a new nuclear plant, the REMP would be designed based on federal guidance (NUREG-1301, *Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors*). Quality assurance and quality control procedures and processes would be implemented in accordance with federal requirements (NRC Regulatory Guide 4.15, *Quality Assurance for Radiological Monitoring Programs (Normal Operations) -- Effluent Streams and the Environment*).

New nuclear plants, if built, would meet applicable federal requirements (10 CFR §20.1302, *Compliance with Dose Limits for the Individual Members of the Public* and the requirements established by NRC Regulatory Guide 4.1, *Radiological Environmental Monitoring for Nuclear Power Plants*). A formal REMP would be required for the facility.

Radiological Environmental Monitoring Program for Alternative 1 or 2a

An operating nuclear plant may release liquid and gaseous radioactive effluents into the environment in accordance with all applicable regulations. Exposure pathways to the public from plant effluents consist of direct radiation, immersion, inhalation, and ingestion. The types of samples collected are specified in the SQN ODCM, and the resulting SQN's REMP is designed to monitor these pathways. If the choice of Alternative 1 – License Renewal were approved, the SQN REMP would continue to be used during the 20-year license renewal period. Table 3-42 provides REMP minimum required sampling as per the SQN ODCM. (SQN 2009)

Table 3-42. SQN Minimum Required REMP

Exposure Pathway And/or Sample	Number and Location of Samples*	Sampling and Collection Frequency	Type and Frequency of Analysis
Gaseous			
Radioiodine and Particulates	Minimum of five locations.	W (Weekly) Continuous sampler**	Radioiodine canister: Weekly I-131 Particulate sampler: Analyze for gross beta activity ≥ 24 hours following filter change. Perform gamma isotopic analysis on each sample when gross beta activity is > 10 times the yearly mean of control samples. Q: Perform gamma isotopic analysis on composite (by location) sample.
Direct Radiation			
	35 to 40 locations with ≥ 2 dosimeters for continuously measuring and recording dose rate at each location.	Q (Quarterly)	Q: Gamma Dose
Waterborne			
Surface	Two locations.	M (Monthly) Composite***sample	Gamma Isotopic Each composite sample Tritium analysis

Exposure Pathway And/or Sample	Number and Location of Samples*	Sampling and Collection Frequency	Type and Frequency of Analysis
Ground	Two locations.	Q	Gamma isotopic and tritium Analyses of each sample. Gross beta and gamma Isotopic analysis.
Drinking	Minimum of one location. Two locations.	M Composite*** sample M Grab sample	Q Tritium analysis Gross beta and gamma isotopic analysis.
Shoreline sediment locations	Minimum of two locations.	S (Semi-annually)	Gamma isotopic analysis from each sample.
Ingestion			
Milk	Milk from three locations. Samples of broad leaf vegetation at off-site locations of highest D/Q if no milk samples are available.	B**** (Bi-weekly)	Gamma isotopic and I-131 analysis of each sample.
Fish	Two locations.	One sample in season, or at least once per 184 days if not seasonal. One sample representing a commercially important species and one sample representing a recreationally important species.	Gamma isotopic analysis on edible portions.

Exposure Pathway And/or Sample	Number and Location of Samples*	Sampling and Collection Frequency	Type and Frequency of Analysis
Food Products	Minimum of two locations.	At time of harvest. One sample of each of the following or similar classes of food products, as available. 1. Lettuce and/or cabbage 2. Corn 3. Beans 4. Tomatoes	Gamma isotopic analysis on edible portions.

* Sample locations are given in Table 9.1 (ODCM)
** Continuous sampling with sample collection as required by dust loading, but at least once per seven days.
*** Composite samples shall be collected by collecting an aliquot at intervals not exceeding two hours.
**** When animals are on pasture, at least once per 31 days at other times.

If Alternative 2a – New Nuclear Generation were approved, a new REMP would be developed for the new plant and would include the following minimum monitoring activities.

Direct Radiation Monitoring

Monitoring direct radiation would be performed utilizing a network of environmental monitoring stations. Two or more dosimeters in an inner ring would be placed at monitoring locations near the site boundary in each of the 16 meteorological sectors. A second outer ring of dosimeters would be located in each sector at the 4- to 5-mile range from the site. Environmental dosimeter monitoring stations would be placed at a minimum of eight other special interest locations, including at least two control stations. (NRC 1991)

Gaseous Pathway Monitoring

Sampling for air particulates and radioiodine would be performed at three locations: in different sectors; near the site boundary at one location near area population centers; and one control location greater than 10 miles from the site and in the least prevalent wind direction. The gaseous pathway monitoring would be performed with continuous operating air samplers. (NRC 1991)

Waterborne Pathway Monitoring

Surface water sampling would be performed at a control location upstream of the plant and at one location downstream of the plant discharge, beyond but near the mixing zone. (NRC 1991)

Drinking water sampling would be performed at the first potable water supply downstream from the plant. The sampling method and collection frequency utilized for surface water sampling would also be applied to this first downstream drinking water location. The

upstream surface water control location would also serve as the control location for monitoring drinking water. Monthly grab samples would be collected from at least two additional water supply systems downstream of the plant. (NRC 1991)

Groundwater sampling would be conducted at one location on-site down gradient from the plant and at a control location up gradient from plant. If site groundwater hydrology data indicate that leaks or spills at the site might impact off-site groundwater, sampling of private wells could be added to the REMP. (NRC 1991)

Samples of shoreline sediment would be collected from the first downstream shoreline recreational use area and possibly from a control location upstream of the plant. (NRC 1991)

Ingestion Pathway

Monitoring for the ingestion pathway would include milk sampling, sampling of fish from the water source, and sampling of vegetables from local gardens identified in the land-use survey. Samples of milk produced for human consumption would be collected in each of three areas within a 5-mile radius identified by the land-use survey to have the highest potential doses and from at least one control location at 10 to 20 miles from the site in the least prevalent wind direction. Sampling of pasture vegetation would be performed at milk producing locations when milk sampling cannot be performed. (NRC 1991)

Fish sampling would be performed on the plant discharge reservoir or river and at a control location. Sampling would consist of one sample of commercially important species and one sample of recreationally important species. (NRC 1991) Sampling of the principal garden vegetables grown in the area would be performed at private gardens identified by the annual land-use survey. Sampling would be performed once during the normal growing season. (NRC 1991)

Land-Use Survey

A land-use survey would be conducted annually. The purpose of the survey is to identify changes in land use within a 5-mile radius of the plant that would require modifications to the REMP or the ODCM. The survey would identify the nearest resident, nearest animal milked for human consumption, and nearest garden of greater than 500 square feet with broadleaf vegetation in each of the 16 meteorological sectors. The results of the annual land-use survey would be documented in the AREOR. (NRC 1991)

Interlaboratory Comparison Program

The laboratory performing the analyses of the REMP samples would participate in an interlaboratory comparison program providing radiological environmental cross-checks representative of the types of samples and analyses in the REMP. The results of the analysis of the comparison program cross-checks would be included in the AREOR. (NRC 1991)

3.17.2. Environmental Consequences

Alternative 1 – License Renewal

For this alternative, there would be no major construction activity. The future expansion of the spent fuel storage capacity for SQN would result in minor additional radioactive dose to construction workers and no measurable radioactive dose to the public. Therefore, the impacts would be expected to be minor.

Operating SQN for the additional 20-year period of license renewal would not cause an increase in annual radioactive effluent releases. The impact of the additional years of operation would be expected to be minor because the releases would be in compliance with federal regulations. The REMP would continue to monitor levels of radiation in the environment around SQN throughout the license renewal period. The health and safety of the public would be ensured. Indirect and cumulative impacts would be expected to be minor. The impact to the public due to operation of SQN would be considered minor. Based on the postulated biota doses presented above and the new studies performed by the NRC, the impact due to operation of SQN for the period of license renewal would be expected to be minor.

SQN controls the release of radioactive liquids and gases in accordance with applicable regulations, and the resulting impacts on biota other than humans are minor. There are no expected direct, indirect, or cumulative impacts from SQN.

Uranium mining and production in off-site areas is a minor impact, but over the long term can result in potential contamination and destruction of geological resources and pollution of lakes, streams, underground aquifers, and the soil.

Under Alternative 1, the shutdown and decommissioning of SQN would be delayed for an additional 20 years. Regardless of which option is chosen, decommissioning will take place in the future. Once the decommissioning process is started, the radioactive effects would change. The shutdown of SQN would stop the generation of new radioactive effluents being released to the environment. Decommissioning activities associated with the dismantlement of the site structures would produce temporary radioactive air emissions and air emissions from dust, concrete, vehicle exhaust, and equipment. All releases of radioactive effluents would be in accordance with applicable regulations, and the impact from those effluent releases would be minor.

Alternative 2 – No Action Alternative

Under the No Action Alternative, SQN would go into shutdown and begin decommissioning at or before the end of the current license expiration dates. The shutdown of SQN would stop the generation of new radioactive effluents being released to the environment. Decommissioning activities associated with the dismantlement of the site structures would produce temporary radioactive air emissions and air emissions from dust, concrete, vehicle exhaust, and equipment. All releases of radioactive effluents would be in accordance with applicable regulations, and the impact from those effluent releases would be minor.

Alternative 2a – New Nuclear Generation

There would be no radioactive effects during the construction of a new nuclear plant unless the construction takes place at the location of another operating nuclear plant, or there are multiple units being built and one unit becomes operational before the other. The radiological impacts from the construction of a new nuclear plant would be of minor significance to the construction workers. Workers who would be in close proximity to the operating nuclear plant would be tracked and monitored (radiation badge) as necessary to meet NRC requirements.

Depending on the type of nuclear technology chosen, the radioactive effects of a new operating nuclear plant would be expected to be potentially less than the SQN current effects. However, because the current effluent releases are already well below all limits and regulations, the impact would remain minor. There would be no expected observable direct or indirect impacts from radioactive liquid or gaseous releases from a new nuclear facility during normal operations. The REMP would be set up for the new nuclear plant to ensure there are no measurable indirect or cumulative effects to the environment off site of the new location or to the public.

Alternative 2b – New Natural Gas-Fired Generation

There would be no radioactive impacts from the operation of the new natural gas-fired plant. There would be no radioactive impacts from the construction of a new natural gas-fired plant.

3.18. Uranium Fuel Effects

Nuclear power plants fueled by uranium produce radioactive wastes in various forms. This section discusses the management, storage, and transportation of radioactive wastes associated with the operation of SQN, including the handling and storage of spent fuel. The potential production of tritium at SQN is also described in this section.

3.18.1. Radioactive Waste

3.18.1.1. Affected Environment

Radioactive waste (radwaste) sources and treatment systems for SQN were described in TVA's 1974 FES for SQN. Section 2.4 states that TVA's policy is to keep the discharge of all wastes from its facilities, including nuclear plants, at the lowest practicable level by using the best and highest degree of waste treatment available under existing technology within reasonable economic limits (TVA 1974a). While this statement is still true, current practices for managing radioactive waste have evolved since the start of commercial operations of SQN.

This section describes the current radwaste systems and practices at SQN along with data showing current volumes and program results. Operation of SQN radwaste is handled by TVA-approved procedures, and the current methods of handling the waste would be continued during the period of license renewal.

The following information also updates and compares the potential for environmental effects from plant construction and operations regarding radwaste for actions of the viable alternatives; Alternative 1 – License Renewal and No Action Alternative 2a – New Nuclear

Generation. For the No Action Alternative 2b – New Natural Gas-Fired Generation, no radwaste would be generated during construction or operation activities.

Liquid Radioactive Waste Treatment Systems

The liquid waste processing system (LWPS) is designed to receive, segregate, process, recycle for further processing, and discharge liquid wastes. The system design considers potential personnel exposure and assures that quantities of radioactive releases to the environment are as low as practicable. Under normal plant operation, the activity from radionuclides leaving the discharge canal is a small fraction of the federal NRC limits (10 CFR Part 20 and Appendix I to 10 CFR Part 50). (TVA 2008a)

All liquids are now routinely processed as necessary for release to the environment. A separate subsystem is provided for handling laboratory samples that may be tritiated and may contain chemicals. The capability for handling and storage of spent demineralizer resins is also provided. Parts of the LWPS are shared by the two plant units. (TVA 2008a)

The LWPS consists of numerous tanks, pumps, sumps, filters, a demineralizer system, and the associated piping, valves, and instrumentation. All tritiated and nontritiated liquid wastes are processed for discharge to the environment. (TVA 2008a)

The LWPS is also designed to process blowdown liquid from the steam generators if a unit has a primary-to-secondary leak coincident with significant fuel defects. The blowdown from the steam generators is passed through the condensate demineralizer or directly to the cooling tower blowdown line. (TVA 2008a)

The radwaste demineralizer system, located in the railway bay, is a portable vendor-owned system that recycles, reprocesses, discharges or removes soluble and suspended radioactive materials from the waste stream via ion exchange and filtration. After the resin and filter media are expended, they are processed for disposal. Filters are air-dried and placed into containers for disposal. (TVA 2008a)

Spent resin is stored in the spent resin storage tank (SRST). To remove spent resins from the storage tank for packaging, the resin is agitated by bubbling nitrogen through the tank. The resin is slurried from the SRST by nitrogen pressure to the railroad bay, where it is received in liners and dewatered prior to shipment off site or prior to storage in the SQN LLRW on-site storage facility. (TVA 2008a)

Radioactive liquid wastes are released from the plant through the cooling tower blowdown line and through the diffuser pond system. (TVA 2008a)

Table 3-43 provides a summary of radioactive liquid releases for the years 2004 – 2008. The resulting total dose for each year is less than 1 percent of the allowed dose limit.

Table 3-43. Annual Radioactive Liquid Releases, 2004 – 2008

Year	Fission and Activation Products (Curies)	Tritium (Curies)	Dissolved and Entrained Gases (Curies)	Total Volume Released (Liters)	Total Body Dose From Liquids (mrem)
2004	2.39e-01	1.45e+03	2.34e-02	1.75e+08	9.36e-03
2005	2.88e-01	1.48e+03	6.99e-01	2.02e+08	7.31e-03
2006	1.87e-01	2.19e+03	2.54e+00	2.39e+08	1.77e-02
2007	1.23e-01	1.87e+03	1.49e-01	3.83e+08	2.85e-02
2008	8.16e-02	1.27e+03	1.04e-02	2.36e+08	1.51e-02

(TVA 2005c; TVA 2006c; TVA 2007e; TVA 2008c; TVA 2009i)

Gaseous Radioactive Waste Treatment Systems

The gaseous waste processing system (GWPS) is designed to remove fission product gases from the reactor coolant and permit operation with periodic discharges of small quantities of fission gases through the monitored plant vent. This is accomplished by internal recirculation of radioactive gases and holdup in the nine gas decay tanks to reduce the concentration of radioisotopes in the released gases. (TVA 2008a)

The GWPS consists of waste-gas compressor packages, nine gas decay tanks, and the associated piping, valves, and instrumentation. The equipment serves both SQN plant units. (TVA 2008a)

The auxiliary services portion of the GWPS consists of an online waste gas analyzer (WGA) and its instrumentation, valves, tubing, a nitrogen supply, and a hydrogen supply manifold with the necessary instrumentation, valves, and piping (TVA 2008a).

The WGA determines the quantity of oxygen and hydrogen in the waste gas tank that is in service. The volume control tank (VCT), pressurizer relief tank (PRT), holdup tanks, and SRST may be analyzed by grab sample as plant conditions require. (TVA 2008a)

The nitrogen and hydrogen supply packages are designed to provide a supply of gas to the nuclear steam supply system. Nitrogen is supplied to the SRST, reactor coolant drain tank, PRT, VCT, gas decay tanks and the holdup tanks. Hydrogen is supplied to the VCT. (TVA 2008a)

Gaseous wastes consist primarily of hydrogen stripped from the reactor coolant during boron dilution and degassing operations, and nitrogen from the closed cover gas system. The components connected to the vent header are limited to those which contain no air or aerated liquids to prevent formation of a combustible mixture of hydrogen and oxygen. (TVA 2008a)

Waste gases discharged to the vent header are pumped to a waste gas decay tank by one of the two waste gas compressors. The compressors may also be used to transfer gas between gas decay tanks. Normal operation of either compressor is in the manual mode. (TVA 2008a)

The decay tank being filled is normally sampled by the WGA, and an alarm alerts the operator to high oxygen content. On the high oxygen signal, the tank must be isolated and operator action is required to direct flow to the standby tank and select a new standby tank. (TVA 2008a)

Before a gas decay tank is discharged to the atmosphere via the plant vent, a gas sample is taken to determine activity concentration of the gas in the tank. The curie content versus change in tank pressure is used to quantify the activity released along with time to determine the off-site dose for the release. To release the gas, the appropriate local manual stop valve is opened to the plant vent, and the gas discharge modulating valve is opened at the GWPS control panel. If there should be a high radioactivity level in the 2-inch discharge line during release, the modulating valve closes. (TVA 2008a)

Gaseous wastes consist primarily of hydrogen stripped from the coolant. During normal gaseous radwaste processing, the gas holdup tank capacity permits at least 60 days decay for radioactive waste gases before discharge. (TVA 2008a)

Gaseous radioactive wastes are released to the atmosphere through vents on the shield building, auxiliary building, turbine building, and service building (TVA 2008a).

Waste gases from the gas decay tanks are discharged to the environment through a shield building vent. Each shield building has one vent. All gases released from the shield building vent, except for the air that passes through the containment purge air exhaust radiation monitors, are processed through high efficiency particulate air (HEPA) filters and charcoal adsorbers prior to release. (TVA 2008a)

Waste gases in the auxiliary building are discharged through the auxiliary building exhaust vent. Under normal operating conditions, gases are continuously discharged through the vent. Under accident conditions the auxiliary building is isolated, and the auxiliary building gas treatment system discharges at a rate of 9,000 cfm to the reactor building exhaust vent. Ventilation air is exhausted from the turbine building through the turbine building vents. (TVA 2008a)

Gaseous wastes from the condenser are discharged through the condenser vacuum exhaust vent. The vent, which is a 12-inch diameter pipe, is located on the turbine building roof and discharges approximately 96 feet above grade. Under normal operating conditions, the discharge flow rate is less than 20 cfm. (TVA 2008a)

Potentially radioactive waste gases from the radiochemical laboratory, titration room, and radiologically controlled area access control area are exhausted to the service building vent. The service building vent is on the service building roof. The vent discharges to the atmosphere approximately 24 feet above grade. Air from the radiochemical laboratory and titration room is exhausted via fume hoods through HEPA filters. (TVA 2008a)

Excess air inside lower containment is exhausted through the reactor building purge vent valves directly into the annulus, where the annulus vacuum control system would discharge the effluent through the auxiliary building exhaust vent (TVA 2008a).

All releases are assumed to be continuous. Releases known to be periodic, e.g., those during containment purging and waste gas decay tank venting, are treated as continuous releases. Releases from the reactor building, turbine building, and auxiliary building vents

are treated as ground level. (TVA 2008a) Individuals are exposed to gaseous effluents via the following pathways:

- External radiation from radioactivity in the air and on the ground.
- Inhalation.
- Ingestion of beef, vegetables, and milk.
- Tritium transpiration.

No other additional exposure pathway has been identified that would contribute 10 percent or more to either individual or population doses. (TVA 2008a) Table 3-44 provides a summary of quarterly gaseous total body dose for the years 2004 – 2008. The resulting quarterly total dose for each year is less than 1 percent of the allowed dose limit.

Table 3-44. Quarterly Gaseous Total Body Dose, 2004 – 2008

Year	Total Body 1st QTR (mrem) (Limit = 7.5 mrem/qtr)	Total Body 2nd QTR (mrem)	Total Body 3rd QTR (mrem)	Total Body 4th QTR (mrem)
2004	6.52e-03	1.90e-02	1.25e-02	4.77e-02
2005	9.36e-03	1.55e-02	1.06e-02	1.01e-02
2006	7.79e-03	3.88e-02	2.91e-02	3.56e-02
2007	1.92e-02	1.38e-02	2.25e-02	1.76e-02
2008	7.12e-03	9.01e-03	1.62e-02	6.63e-03

(TVA 2005c; TVA 2006c; TVA 2007e; TVA 2008c TVA 2009i)

Table 3-45 provides a summary of total (individual) annual dose from all sources (liquids and gases) for the years 2004 – 2008. The resulting total annual dose for each year is less than 1 percent of the allowed dose limit. Therefore, the impact from all radioactive effluent releases released from SQN is minor and would continue to be minor during the period of license renewal.

Table 3-45. Total Dose From All Sources, 2004 – 2008

Year	Total Dose (mrem)	% of Limit (limit = 25 mrem)
2004	1.16e-01	0.46
2005	1.35e-01	0.54
2006	2.29e-01	0.92
2007	1.50e-01	0.60
2008	7.56e-02	0.30

(TVA 2005c; TVA 2006c; TVA 2007e; TVA 2008c; TVA 2009i)

The off-site exposure to individuals from gaseous effluents released during normal operation of SQN is limited by 10 CFR Part 50 Appendix I and 40 CFR Part 190 (TVA 2008a).

Solid Radioactive Wastes

The slurries and solid radwaste, including resin and evaporator concentrates, produced by SQN are prepared for shipment or for temporary on-site storage in compliance with the requirements in 10 CFR Part 61, 10 CFR Part 71, and 49 CFR Parts 170 through 178. Solid wastes would be processed by the solid waste system. (TVA 2008a)

Waste inputs are divided into two categories: DAW and wet active waste (WAW). DAW and WAW inputs are products of the plant operation and maintenance. DAW is further subdivided into compressible and noncompressible wastes. Solid compressible wastes include paper, clothing, rags, mop heads, rubber boots, and plastic. Noncompressible wastes include tools, mop handles, lumber, glassware, pumps, motors, valves, and piping. WAWs are primarily composed of spent resins. The sources for spent resins are the SRST and the radwaste demineralizer. (TVA 2008a)

When sufficient spent resin is accumulated in the SRST, the appropriate valves necessary to transfer spent resin to the liner filling area in the railroad access bay are opened except for the liner fill valves. The SRST is then pressurized with nitrogen. The liner filling valves are then opened, and the resin is forced into the liner. Loading is accomplished with the casks mounted on a truck or trailer bed. The truck or trailer is located in the auxiliary building railroad bay. The cask with a disposable liner is filled from the spent resin tank. The spent resins are dewatered to meet the free-standing water limitations at licensed disposal facilities. Several types of shipping casks may be used. All casks have been licensed pursuant to the general license provisions of paragraph 71.12(b) of 10 CFR Part 71. (TVA 2008a)

Spent resins from the radwaste demineralizer system are sluiced to a transportable liner or high integrity container (HIC) inside a shipping container within the auxiliary building railroad bay area and dewatered to meet the disposal facilities' free-standing water limitations. The dewatered resins and disposable liners are prepared for shipment or temporary on-site storage. (TVA 2008a)

Spent resins from the condensate polishing system are transferred directly to a disposal liner (radwaste) or suitable container (non-radwaste) from the resin storage tank. The disposal liner or container is adjacent to the condensate polishing system building. After transfer of the resins is complete, the liner or container is dewatered and prepared for shipment or temporary on-site storage. (TVA 2008a)

The waste packaging area is provided for receiving, sorting, and compacting DAW. Bagged and/or boxed DAW collected throughout the plant is brought to the waste packaging area for final packaging into 55-gallon drums or metal boxes. Compressible trash like paper, clothing, rags, plastic, etc., is collected and compacted or maybe transported to a contracted broker/processor for processing, packaging, and/or subsequent disposal. Items such as tools, mop handles, valves, motors, piping, lumber, and some compressible materials are packaged, sealed, and stored until shipped for off-site disposal. Collected waste may also be sent to a contracted broker/processor. Active waste filters are packaged when necessary in HICs. If the radiation levels of the containers are high enough

to require shielding, the containers are transported in shielded truck trailers or casks similar to those used to transport liners containing bulk quantities of dewatered resins. (TVA 2008a)

The mobile solidification system (MSS) is a portable solidification unit provided under a vendor service contract. The MSS combines and mixes radioactive wastes (concentrates and liquid wastes) with solidification agents and needed additives to solidify the waste. The solidification is done in accordance with a process control program to ensure that each batch of waste is properly solidified. Only solidification agents (such as cement) that have been approved by licensed disposal facilities are used. The waste is solidified in a disposable liner and prepared for shipment or temporary on-site storage. The disposable liners are equipped with internal mixers to provide uniform mixing. The mobile solidification system is in the auxiliary building railroad bay area when the MSS is utilized. Necessary service connections have been provided in the railroad bay to support the MSS. (TVA 2008a)

Radioactive plant filters are usually packaged in HICs or 55-gallon drums. The filter elements are remotely or manually removed from the filter housing. In-plant transportation shielding is provided as required. Radioactive filter elements are drummed and stored in a shielded transportation cask or drum shield prior to shipment for disposal. The low activity level filter elements may be handled as intermediate activity level elements, or they may be stored prior to shipment for disposal. (TVA 2008a)

In order to provide storage for LLRW that cannot be shipped, an on-site storage facility (OSF) has been constructed. This facility is located on a 16-acre site within the SQN site. The grade elevation is approximately 730 feet, which is above the probable maximum flood elevation. The facility is comprised of individual buildings called modules. Each module is designed to contain packaged radwaste generated at SQN and WBN Unit 1, and is segmented into four compartments. All of the modules are above-ground, safety-related structures of reinforced concrete. The modules are designed to resist loads resulting from extreme environmental events, such as high winds, tornadoes, and seismic events. The structural characteristics of the OSF meet or exceed the criteria applicable to SQN. The entire OSF is enclosed within an access-controlled security fence. (TVA 2008a)

Most radwaste is classified as Class A, Class B, or Class C (minor volumes are classified as greater than Class C). Class A includes both DAW and WAW. Classes B and C are normally WAW. The majority of LLRW generated would be Class A waste and can be shipped to Oak Ridge, Tennessee, for reduction, packaging, and shipping to a Class A disposal facility such as Energy Solutions LLC in Clive, Utah. Class B and C wastes constitute a low percentage by volume of the total LLRW and are currently stored in the OSF at SQN. The OSF has sufficient capacity to store the anticipated volume of Class B and C wastes that would be produced at SQN and WBN during the license renewal period. Shipment of solid waste from SQN for the years 2004 – 2008 is tabulated in Table 3-46.

Table 3-46. Total Volume of Shipped Solid Waste, 2004 – 2008

Year	Waste Type	Annual Volume Shipped (m^3)
2004	Spent Resins, Filter Sludges, Evaporator Bottoms	6.19E+01
	DAW, Compressible Waste, Contaminated Equipment	5.56E+01

Year	Waste Type	Annual Volume Shipped (m^3)
	Irradiated Components, Control Rods	None
	Other: Mechanical Filters and Tank Residue	1.70E+01
2005	Spent Resins, Filter Sludges, Evaporator Bottoms	6.81E+00
	DAW, Compressible Waste, Contaminated Equipment	2.87E+01
	Irradiated Components, Control Rods	None
	Other: Mechanical Filters and Tank Residue	3.41E+00
2006	Spent Resins, Filter Sludges, Evaporator Bottoms	2.21E+01
	DAW, Compressible Waste, Contaminated Equipment	1.57E+01
	Irradiated Components, Control Rods	None
	Other: Mechanical Filters and Tank Residue	3.41E+00
2007	Spent Resins, Filter Sludges, Evaporator Bottoms	8.98E+00
	DAW, Compressible Waste, Contaminated Equipment	1.45E+02
	Irradiated Components, Control Rods	None
	Other: Mechanical Filters and Tank Residue	None
2008	Spent Resins, Filter Sludges, Evaporator Bottoms	8.98E+00
	DAW, Compressible Waste, Contaminated Equipment	1.21E+02
	Irradiated Components, Control Rods	None
	Other: Mechanical Filters and Tank Residue	3.41E+00

(TVA 2005c; TVA 2006c; TVA 2007e; TVA 2008c; TVA 2009i)

3.18.1.2. Environmental Consequences

Alternative 1 – License Renewal

Under Alternative 1, during the license renewal period, radwaste would continue to be produced in the manner and annual volumes currently generated at SQN, as described above. There would be no change in the types or rates of liquid, gaseous, or solid wastes generated during the license renewal period. The total volumes of each type of radioactive waste would increase because there would be an additional 20 years of operation. The management, handling, storage, and shipping of radwaste would remain consistent with current practice. All applicable federal regulations would be followed.

SQN would continue to release radioactive liquids and gases to the environment in accordance with, and below the limits of, federal regulation. Impacts to the environment

from releases of radioactive liquids and gases are minor and would continue to be minor during the license renewal period.

Solid radwaste would continue to be handled in accordance with TVA-approved procedures, which ensure that all federal regulations and limits pertaining to solid radwaste are met. During the license renewal period, SQN would continue to be available to accept the same types of radwaste currently transported from WBN Unit 1. Additionally, the SQN OSF would have sufficient capacity throughout the license renewal period to accept radwaste from WBN Unit 2, at similar annual volumes as currently generated at WBN 1, should TVA decide to transport WBN Unit 2 radwaste to SQN. Radwaste placed in the SQN OSF from SQN and WBN would be managed to comply with annual and lifetime curie and dose rate limitations. Therefore, impacts to the public and the environment resulting from processing, storage, and transportation of solid radwaste, including cumulative effects of waste storage from WBN are minor, and would continue to be minor during the license renewal period.

The increased volume of radwaste generated during the 20-year period of license renewal would result in a greater volume disposed of in a licensed landfill. The additional volume would remain a minor impact on the available landfill capacity, and would not result in substantial cumulative impacts on licensed landfills.

When SQN finally shuts down at end of the current license or the end of the license renewal period, generation of radwaste would cease. During decommissioning, the plant would ship all stored radioactive material to be processed or to its final disposal. The volume of stored radwaste shipped would be larger at the end of the 20-year license renewal period than it would be should the licenses not be renewed. The radioactive waste from activated components (piping, valves, reactor vessel, etc.) and structures (activated rebar, concrete, etc.) that would be removed during decommissioning would be approximately the same whether it were at the end of the current license or the end of the license renewal period.

Alternative 2a – New Nuclear Generation

Under Alternative 2a, SQN would be shut down at the end of the current license period. The effects of removing stored radwaste would be as described above. However, the volume of radwaste to be removed would be less.

Under Alternative 2a, a new nuclear power plant would produce radwaste in the same basic processes as SQN currently does. Depending upon the specific technology selected for a potential new facility, the radwaste systems would be constructed to the approved design requirements. Those design requirements ensure the system would be able to handle and process all the radwaste in accordance with all applicable federal regulations and would be expected to be similar to the processes described for SQN. Similar to SQN, the environmental impacts of radwaste handling, storage, and transportation are expected to be minor. In fact, those impacts may be less from a new facility than from SQN, if radioactive waste volumes were to decrease due to advanced design, equipment, and programs in the new facility.

Alternative 2b – New Natural Gas-Fired Generation

There are no impacts from radwastes during construction of this type of power generation facility, and there are no impacts from radwastes during operation of this type of power generation facility.

3.18.2. Spent Fuel Storage

3.18.2.1. Affected Environment

SQN has constructed an on-site ISFSI facility at SQN. SQN needed the ISFSI to continue operation of the units because the on-site spent fuel pools were to reach maximum capacity in 2004. The additional on-site storage capacity was needed due to delays in a licensed DOE facility becoming available; DOE is mandated to take possession of spent fuel and provide a permanent disposal facility for all spent fuel. The need to expand on-site spent fuel storage at TVA nuclear plants was addressed when DOE prepared the tritium production FEIS (DOE 1999). That DOE FEIS analyzed spent fuel storage needs at Watts Bar Nuclear Unit 1, SQN, and BLN Units 1 and 2, and included a thorough review of the environmental effects of constructing and operating an on-site ISFSI.

The existing ISFSI was constructed on approximately 4.5 acres of previously graded site (TVA 2000b) within the SQN protected area. SQN uses concrete cask systems for storage. The ISFSI pad site has a maximum capacity of 90 HOLTEC Hi-Storm 100 (S) B casks with an effective capacity of 86 casks (four spaces are left empty to allow for cask shuffling). The HOLTEC-designed MPC-32 is currently used with the HOLTEC casks. (TVA 2000b)

Based on TVA's review of the existing SQN ISFSI, the following environmental issues were identified:

- Radioactive dose to workers.
- Radioactive dose to the public.
- Management and disposal of solid and hazardous waste.
- Transportation.
- Design, siting, and construction of the ISFSI cask storage pads.

TVA determined there were no significant adverse impacts to the environment associated with construction and operation of the existing ISFSI (TVA 2000b).

Industry experience with spent fuel storage, coupled with supplemental studies of the integrity of pool and dry storage systems, indicates that spent fuel can be stored safely on site with minimal environmental impacts (NRC 1996). NRC has made a generic determination that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impact for at least 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of that reactor at its spent fuel storage basin or at either on-site or off-site ISFSIs (10 CFR 51.23 (a)).

Alternative 1 – License Renewal

Under Alternative 1, spent fuel assemblies would continue to be produced in the manner and volumes currently generated at SQN and described above. The SQN ISFSI would continue to be operated in accordance with all applicable regulations, which are designed to protect the public and the environment. Operation of the ISFSI results in negligible impacts to the public.

If SQN is approved for license renewal and DOE still is not taking possession of spent fuel, the current capacity for storage of spent fuel is expected to be reached in 2026. Figure 3-17 shows the capacity projections for spent fuel storage and the resulting need for additional storage, based on the approval of the SQN's LRA. At that time, SQN would need to expand the spent fuel storage capacity, and it is likely that TVA would add a separate concrete storage pad. This storage pad construction would be started in approximately 2021 to ensure additional space is available when needed. (Dennis Lundy, TVA, personal communication, March 11, 2010) Dose limits would be maintained in compliance with federal regulations.

Like the construction and operation of the current ISFSI, construction and use of an additional concrete storage pad is expected to have only minor impacts. There would be minor direct impacts from the radiation doses from the ISFSI for the on-site workers and for the people in the surrounding area. The indirect and cumulative dose impacts would be minor.

3.18.2.2. Environmental Consequences

Alternative 2a – New Nuclear Generation

Under Alternative 2, generation of spent fuel at SQN would be stopped. However, the operation of the SQN ISFSI would continue under its separate general license until the DOE takes possession of the spent fuel at the SQN ISFSI facility and it can be decommissioned in a separate project.

For a new nuclear generating facility, spent fuel typically would be stored in a spent fuel pool. It is not expected that an ISFSI would be included in the initial construction.

Once a new nuclear power plant is operating, it would produce spent fuel in the same basic processes as described for SQN. The environmental impacts of a new facility may potentially be less than SQN due to advanced design, equipment, and programs from the new facility. The environmental impacts are expected to be minor for spent fuel storage.

Alternative 2b – New Natural Gas-Fired Generation

No radwaste or spent fuel would be generated during construction or operation of this type of facility. Therefore, there would be no impacts from radwastes or spent fuel.from construction or operation of this type of power generating facility. If SQN is shut down, generation of spent fuel at SQN would be stopped. However, the operation of the SQN ISFSI would continue under its separate general license until the DOE takes possession of the spent fuel at the SQN ISFSI facility and it can be decommissioned in a separate project.

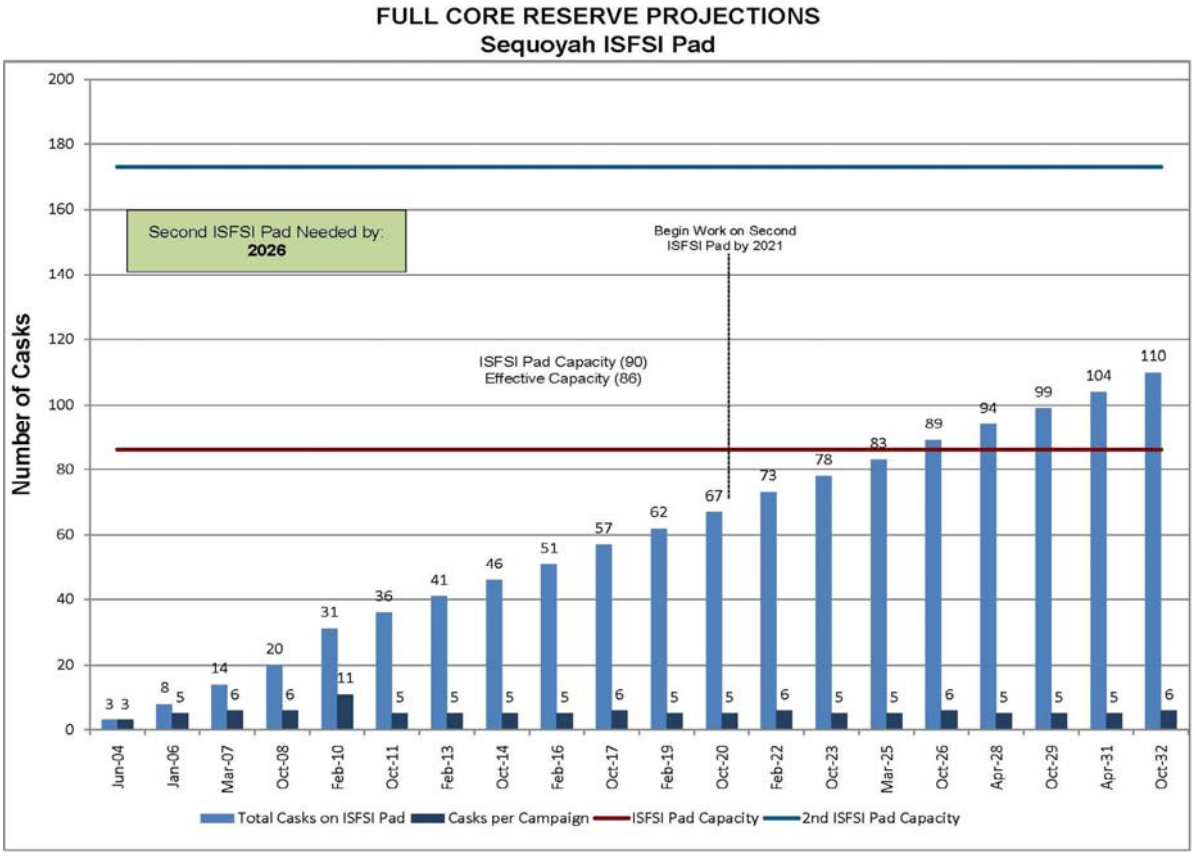

Figure 3-17. Spent Fuel Projections

3.18.3. Transportation of Radioactive Materials

3.18.3.1. Affected Environment

Transportation of radioactive materials is required to operate any nuclear facility. SQN transports radioactive materials currently and would continue to do so during the license renewal period if license renewal is approved by the NRC. This section would also apply to Alternative 2a – New Nuclear Generation (based on the type of nuclear technology chosen) if it were to be constructed and operated. This section is not applicable to the Alternative 2b – New Natural Gas-Fired Generation.

Table S-4 in 10 CFR §51.52 includes the NRC evaluation of the environmental effects of transportation of fuel and waste to and from LWRs. Note "a" of Table S-4 states that data for the table come from the *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Plants* in WASH-1238, December 1972, and Supplement 1 NUREG-75/038, April 1975, *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants*, and the table states that the radiological risk due to effects of accidents in transportation was determined to be minor.

The table addresses two categories of environmental considerations: (1) normal conditions of transport and (2) accidents in transport. (10 CFR Part 51) Subparagraphs 10 CFR §51.52(a) (1) through (5) delineate specific conditions the reactor licensee must meet to

use Table S-4 as part of its environmental evaluation to determine impacts. The conditions in paragraph (a) of 10 CFR §51.52 establishing the applicability of Table S-4 relate to:

- Reactor core thermal power.
- Fuel form, fuel enrichment.
- Fuel encapsulation.
- Average fuel irradiation.
- Time after discharge of irradiated fuel before shipment.
- Mode of transport for unirradiated fuel.
- Mode of transport for irradiated fuel.
- Radioactive waste form and packaging.
- Mode of transport for radioactive waste other than irradiated fuel.

Transportation of Unirradiated Fuel

Subparagraph 10 CFR §51.52(a) (5) requires that unirradiated fuel be shipped to the reactor site by truck. Table S-4 includes a condition that the truck shipments not exceed 73,000 pounds as governed by federal or state gross vehicle weight restrictions. New fuel assemblies are transported to the SQN site by truck, in accordance with USDOT and NRC regulations.

The details of the new fuel container designs, shipping procedures, and transportation routes depends on the requirements of the suppliers providing the fuel fabrication and support services. Truck shipments do not exceed the applicable federal or state gross vehicle weight restrictions.

Transportation of Irradiated Fuel

Spent fuel assemblies are removed from the reactor and placed into the spent fuel pool during each refueling outage. It is expected that the spent fuel would remain on site for a minimum of five years between removal from the reactor and shipment off site. Packaging of the fuel for off-site shipment would comply with applicable USDOT and NRC regulations for transportation of radioactive material. If transportation is to a DOE repository, by law, DOE is responsible for the transportation of spent fuel from reactor sites to a repository, as shown in the Nuclear Waste Policy Act of 1982, Section 302, and DOE makes the decision on the transport mode.

The following subsections compare the SQN site with federal requirements (10 CFR §51.52[a]).

Reactor Core Thermal Power

Subparagraph 10 CFR §51.52(a)(1) requires that the reactor have a core thermal power level not exceeding 3,800 MW. SQN has a thermal design reactor core heat output rating of 3,455 MW and meets this condition (TVA 2008a).

Fuel Form

Subparagraph 10 CFR §51.52(a)(2) requires that the reactor fuel be in the form of sintered UO_2 pellets. SQN uses a sintered UO_2 pellet fuel form and would meet this requirement. (TVA 2008a)

Fuel Enrichment

Subparagraph 10 CFR §51.52(a)(2) requires that the reactor fuel have a uranium-235 enrichment not exceeding 4.0 weight percentage. SQN's reactor fuel is assumed to be enriched to 5.0 weight percentage of U-235 for standard fuel (TVA 2008a), which exceeds the 4.0 weight percentage U-235 requirement. The NRC has generically considered the environmental impacts of spent nuclear fuel with U-235 enrichment levels up to 5.0 weight percent and determined that the environmental impacts of spent nuclear fuel transport are bounded by the impacts listed in Table S-4 provided that more than five years has elapsed between removal of the fuel from the reactor and any shipment of the fuel off site. (NRC 1999b)

Five years is the minimum decay time expected before shipment of irradiated fuel assemblies from SQN. In addition, NRC specifies five years as the minimum cooling period when it issues certificates of compliance for casks used for shipment of power reactor fuel as stated in NUREG-1437, Addendum 1 (NRC 1999b). SQN has sufficient land to expand the ISFSI if needed and provide storage capacity to accommodate five-year cooling of irradiated fuel prior to any transport off site even with a 20-year extension of operations. Therefore, SQN meets the requirements of Subparagraph 10 CFR §51.52(a)(2).

Fuel Encapsulation

Subparagraph 10 CFR §51.52(a)(2) requires that the reactor fuel pellets be encapsulated in Zircaloy rods. SQN's reactor fuel is encapsulated in ZIrcaloy fuel rods. Therefore, SQN would meet this requirement. (TVA 2008a)

Average Fuel Irradiation

Subparagraph 10 CFR §51.52(a)(3) requires that the average fuel assembly burnup not exceed 33,000 megawatt-day (MWD)/metric ton uranium (MTU). The average fuel assembly burnup for SQN exceeds this requirement with a design burnup of 48,000 MWD/MTU (TVA 2008a). The NRC has generically considered the environmental impacts of irradiation levels up to 62,000 MWD/MTU and found that the environmental impacts of spent nuclear fuel transport are bounded by the impacts listed in Table S-4 provided that more than five years has elapsed between removal of the fuel from the reactor and any shipment of the fuel off site. SQN would meet this requirement.

Transportation

Subparagraph 10 CFR §51.52(a) (5) allows for truck, rail, or barge transport of irradiated fuel. This requirement can be met for SQN. DOE is responsible for spent fuel transportation from reactor sites to the repository and makes decisions on transport mode as stated in 10 CFR §961.1. Should an off-site repository be established, the heat load of the spent fuel shipping casks and the doses to the general public would be bounded by the conditions of Table S-4. Should a TVA-shared facility or a reprocessing plant be established, transportation would comply with applicable USDOT and NRC regulations for transportation of radioactive material.

3.18.3.2. Environmental Consequences

The risks of transporting radioactive materials are bound by Table S-4. Because SQN meets the requirements of Table S-4, the environmental impact of any transportation of irradiated fuel would be minor.

Transportation impacts of all types of radioactive waste would be expected to be minor for Alternative 1 – License Renewal. No Action Alternative 2a – New Nuclear Generation would be bound by the same transportation criteria for radioactive wastes as SQN. A new nuclear facility would be designed to meet all federal regulations to protect the health and safety of the public and keep potential impacts minor.

3.18.4. Potential Tritium Production by SQN for the DOE

SQN's operating licenses for Units 1 and 2 have provisions for the production of tritium in the reactor units. Tritium production could be performed at just one reactor or at both reactors as needed. SQN has not actually produced tritium for the DOE, but it is possible that the demand for tritium would increase to the point that it would become necessary to begin production in the future. The production of tritium was evaluated in detail by the DOE in its tritium production FEIS. (DOE 1999) TVA was a cooperating agency in development of that FEIS, and adopted it in May 2000.

The production of tritium in a CLWR is technically straightforward and requires no elaborate, complex engineering development and testing program. The entire nation's supply of tritium has been produced in reactors. Most existing commercial PWRs utilize 12-foot-long rods containing an isotope of boron (boron-10) in ceramic form in the reactor fuel assemblies. These rods are sometimes called burnable absorber rods. The rods are inserted into reactor fuel assemblies to absorb excess neutrons produced by the uranium fuel in the fission process for the purpose of controlling power in the core at the beginning of an operating cycle. DOE's tritium program has developed another type of burnable absorber rod in which neutrons are absorbed by a lithium aluminate ceramic rather than boron ceramic. These TPBARs would be placed in the same locations in the fuel assemblies as the standard burnable absorber rods. There is no fissile material (uranium or plutonium) in the TPBARs. (DOE 1999)

When neutrons strike the lithium aluminate ceramic material in a TPBAR, tritium is produced. This tritium is captured almost instantaneously in a solid zirconium material in the rod, called a "getter." The solid material that captures the tritium as it is produced in the rod is so effective that the rod would have to be heated in a vacuum at much higher temperatures than normally occur in the operation of a light water reactor to extract the tritium for eventual use in the nuclear weapons stockpile. The TPBARs containing tritium would be removed and processed off site. (DOE 1999)

Some tritium is expected to permeate through the TPBARs during normal operation, which would increase the quantity of tritium in the reactor's coolant water system. Because tritium is a type, or isotope, of the hydrogen atom, once tritium is in the reactor's coolant water system, it could combine with oxygen to become part of a water molecule and eventually be released to the environment. (DOE 1999) Actual experience at WBN has shown that permeation is greater than that predicted by DOE in its tritium production FEIS. Consequently, TVA has managed the number of TPBARs per reload at WBN to ensure that actual effluent releases and subsequent off-site dose consequences were bounded by the DOE tritium production FEIS for these parameters. Should TVA use TPBARs at SQN, TVA would similarly manage the number of TPBARs to ensure effluents and off-site dose consequences were bounded by the DOE tritium production FEIS.

The following modifications have been implemented or planned at SQN: (1) four rod cluster control assemblies (RCCAs) were relocated from core periphery control rod drive mechanism position to provide improved reactivity control, (2) improved monitoring instrumentation was installed in the waste disposal system, (3) a new sampling system was provided in the auxilary and shield buildings' exhaust vents, (4) additional grab sampling capability, and (5) installed TPBAR consolidation equipment in the spent fuel pool cask loading area. Additional modifications may be needed to support future production, if the decision is made to do so.

In a tritium production mode, SQN would continue to comply with all federal, state, and local requirements. There would be some incremental impacts in the following areas: radiation exposure (worker and public), spent fuel generation, and LLRW generation, but any exposure would remain well below NRC limits. Tritium production could also change the accident and transportation risks associated with these reactors. (DOE 1999) Each of these incremental impacts is discussed below.

Radiation Exposure

Tritium production could increase average annual worker radiation exposure by approximately 0.82 – 1.1 mrem per year. The resultant dose would be well within regulatory limits. Radiation exposure to the public from normal operations could also increase, but would still remain well within regulatory limits. Considering tritium production at either SQN Unit 1 or Unit 2, the total dose to the population within 50 miles could increase by a maximum of 1.9 person-rem per year. Statistically, this equates to one additional fatal cancer approximately every 1,000 years from the operation of SQN Unit 1 or Unit 2. (DOE 1999)

Spent Fuel Generation

The impacts of tritium production on the quantity of spent fuel generated have been addressed in the 1999 DOE FEIS for tritium production. Additional spent fuel would be generated at SQN Unit 1 or Unit 2, or both units. In the average 18-month fuel cycle, spent fuel generation could increase from approximately 80 spent fuel assemblies up to a maximum of 140, a 71 percent increase in spent fuel generation. Spent fuel would continue to be handled and stored at SQN in the spent fuel pool and ISFSI. Storing the additional spent fuel should have minor impacts. The impacts of accidents associated with dry cask spent fuel storage would be small. If fewer than approximately 2,000 TPBARs were irradiated, there would be no change in the amount of spent fuel produced by the reactors. (DOE 1999) Should TVA decide to produce tritium at SQN, the potential increase in spent

fuel generation and any necessary adjustment in the timing of the ISFSI expansion would be assessed at that time.

Low-Level Radioactive Waste Generation

Tritium production at SQN Unit 1 or Unit 2 would generate approximately 0.43 additional cubic meters per year of LLRW. This would be a 0.1 percent increase in LLRW generation per reactor unit. Such an increase would amount to less than 1 percent of the LLRW to be disposed of at the Clive, Utah, disposal facility. (DOE 1999)

Accident Risks

Tritium production could change the potential risks associated with accidents at SQN Unit 1 or Unit 2. These changes would be small. Potential impacts from accidents were determined using computer modeling. If a limiting DBA occurred, tritium production at the 3,400 TPBAR level would increase the individual risk of a fatal cancer by 2.1×10^{-9} to an individual living within 50 miles of SQN Unit 1 or Unit 2. Statistically, this equates to a risk to an individual of one additional fatal cancer approximately every 490 million years from tritium production. For a beyond-DBA (an accident that has a probability of occurring approximately once in a million years or less), tritium production would result in small changes in the consequences of an accident. This is due to the fact that the potential consequences of such an accident would be dominated by radionuclides other than tritium. (DOE 1999)

Transportation

Tritium production at SQN Unit 1 or Unit 2 would necessitate additional transportation to and from the reactor plants. Most of the additional transportation would involve nonradiological materials. Impacts would be limited to toxic vehicle emissions and traffic fatalities. At each of these reactors, the transportation risks would be less than one fatality per year. Radiological materials transportation impacts would include routine and accidental doses of radioactivity. The risks associated with radiological materials transportation would be less than one fatality per 100,000 years. (DOE 1999)

Table S-2 of the DOE FEIS, *Summary of Environmental Consequences for the CLWR Reactor Alternatives*, provided the following analysis. The FEIS concluded that there would be no operational changes and no change in environmental impacts associated with the production of tritium by SQN. Given 1,000 TPBARs, the maximum potential increase in annual gaseous radioactive emissions of tritium would be 100 curies; given 3,400 TPBARs, 340 curies. Given 1,000 TPBARs, the maximum potential increase in annual liquid radioactive effluents of tritium would be 900 curies; given 3,400 TPBARs, 3,060 curies. There would be a less than a 1.0 percent impact on regional economy. Workers annual dose increase (1,000 TPBARs vs. 3,400 TPBARs) ranges from 0.24 mrem to 0.82 mrem, while the maximally exposed individual would increase in the range of 0.017 mrem to 0.057 mrem. The 50-mile population dose would increase in the range of 0.60 person-rem to 1.9 person-rem. (DOE 1999)

Conclusion on Tritium Production

Depending on events, SQN may be used to produce tritium for the DOE although no decision has been made to do so. Plant licenses already have been amended.

Environmental analyses show there would be only minor impacts from the production of tritium.

SQN could produce tritium until the time of license expiration for the current license or until the end of the license renewal period. The impacts would be minor for either option. Tritium production would end with the shutdown of SQN. Tritium production from Alternative 2a – New Nuclear Generation would not normally be considered as part of licensing a new nuclear facility. There would be no expected impact from tritium production at a new nuclear facility. Tritium production from Alternative 2b – New Natural Gas-Fired Generation would not be applicable.

3.19. Nuclear Plant Safety and Security

This section assesses the environmental impacts of postulated accidents involving radioactive materials at SQN and plant security, including protection against intentional destructive acts. It is divided into three subsections that address DBAs, severe accidents, and plant security.

- DBAs (Section 3.19.1)
- Severe accidents (Section 3.19.2)
- Plant security (Section 3.19.3)

3.19.1. Design-Basis Accidents

3.19.1.1. Affected Environment

The potential consequences of postulated accidents are determined based on the use of a set of DBAs that are representative of the reactor designs. The set of DBAs considered for SQN covers the following:

- Postulated loss of A.C. power to the plant auxiliaries (TVA 2008a).
- Postulated waste gas decay tank rupture (TVA 2008a).
- Postulated loss of coolant accident (TVA 2008a).
- Postulated steam line break (TVA 2008a).
- Postulated steam generator tube rupture (TVA 2008a).
- Postulated fuel handling accident (TVA 2008a).
- Postulated rod ejection accident (TVA 2008a).

A high degree of protection against the occurrence of postulated accidents is provided through quality design, manufacture, and construction, which ensure the high integrity of the reactor system and associated safety systems. Deviations from normal operations are handled by protective systems and design features that place and hold the plant in a safe condition. It is conservative to postulate that serious accidents may occur, even though they are extremely unlikely. Engineered safety features are installed to prevent and

mitigate the consequences of postulated events that are judged credible. The probability of occurrence of accidents and the spectrum of their consequences to be considered from an environmental impact standpoint have been analyzed using best estimates of probabilities, realistic fission product releases, and realistic transportation assumptions.

Personnel with specific duties and responsibilities in the SQN radiological emergency plan program receive instruction in the performance of their duties and responsibilities during accidents and emergencies. Drills and exercises are conducted regularly to develop and maintain the key skills required for emergency response by these highly trained personnel. Drills are performed regularly for such accident conditions as fire, medical emergencies, radiological protection, and emergency communications.

Selection of Accidents

The evaluations presented in the SQN UFSAR (TVA 2008a) use conservative assumptions for the purpose of comparing calculated site-specific doses resulting from a hypothetical release of fission products. Realistically computed doses that would be received by the population from the postulated accidents would be significantly less than those presented in the SQN UFSAR. The DBAs cover a spectrum of events, including those of relatively greater probability of occurrence and those that are less probable but with greater consequences. DBAs are postulated accidents that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components necessary to ensure public health and safety.

Evaluation Methodology

The basic scenario for each accident is that radioactivity is released at the accident location inside a building and eventually released to the environment. Chapter 15 of the SQN UFSAR presents conservative radiological consequences for the accidents identified.

Among the conservative assumptions is the use of time-dependent X/Q values and conservative assumptions for the radionuclide activity in the core and coolant, the types of radioactive materials released, and the release paths to the environment in order to calculate conservative dose estimates. Details on the methodologies and assumptions pertaining to each of the accidents, such as activity release pathways and credited mitigation features, are provided in Chapter 15 of the UFSAR. The X/Q values used to calculate conservative design-basis EAB and LPZ doses for SQN are obtained from Chapter 15 of the UFSAR.

3.19.1.2. Environmental Consequences

Alternative 1 – License Renewal

SQN site-specific radiological consequences of DBAs are shown in Tables 3-47 through 3-54. For each accident, the EAB dose shown is for a two-hour period, and the LPZ dose shown is the integrated dose for the duration of the accident. SQN doses are presented as thyroid and whole-body doses (calculated in rem) and as the TEDE as well. The TEDE is the sum of the committed effective dose equivalent (CEDE) and the effective dose equivalent (EDE). (TVA 2008a)

The results presented in Tables 3-46 through 3-53 provide realistically estimated radiological consequences of the postulated accidents for SQN. In all cases, the doses to an assumed individual at the EAB and LPZ are a fraction of the dose limits specified. It is concluded from the results of this realistic analysis that the environmental risks due to postulated radiological accidents are minor. (TVA 2008a) Continued operation of SQN during the period of license renewal does not change the analysis of accidents and the potential impacts of postulated accidents would remain minor. Design analysis of an NRC-approved alternative new nuclear plant would also ensure the health and safety of the public, and if a new nuclear plant were to be built, it would be within the design requirements for all dose limits.

Under Alternative 1, impacts from DBAs would be expected to be as described above. If a DBA occurred, the impacts would be expected to be minor and limited by plant design and the trained emergency actions of SQN personnel.

If SQN were not allowed to extend the licenses for the additional 20-year period, SQN would be shut down and the potential impacts from a DBA would no longer be applicable.

Under Alternative 2a, the new plant design would integrate the requirements to design against and protect from a series of potential DBAs. The new nuclear plant would be designed specifically for the new technology TVA would choose and that technology would meet all DBA criteria and be approved by the NRC.

Under Alternative 2b, there would be no impact applicable for DBAs.

Table 3-47. Loss of A.C. Power With an Accident-Initiated Iodine Spike

	Thyroid	Whole Body	Skin	TEDE
EAB	0.69 rem	0.085 rem	0.18 rem	0.11 rem
LPZ	0.21 rem	0.013 rem	0.026 rem	0.02 rem
Public Limit	300 rem	25 rem	NA	NA

(TVA 2008a)

Table 3-48. Loss of A.C. Power With a Pre-Existing Iodine Spike

	Thyroid	Whole Body	Skin	TEDE
EAB	0.73 rem	0.078 rem	0.17 rem	0.10 rem
LPZ	0.18 rem	0.012 rem	0.024 rem	0.017 rem
Public Limit	300 rem	25 rem	NA	NA

(TVA 2008a)

Table 3-49. Loss-of-Coolant Accident*

	Thyroid	Gamma Dose	Beta Dose	TEDE
Site Boundary 0 – 2 hours	83.1 rem	7.68 rem	4.52 rem	9.80 rem
LPZ 0 – 30 days	16.5 rem	1.50 rem	1.40 rem	1.90 rem
Public Limit	300 rem	25 rem (whole body)	NA	NA

*The loss-of-coolant accident analysis bounds the rod ejection accident.
(TVA 2008a)

Table 3-50. Waste Gas Decay Tank Rupture

	Thyroid	Whole Body	Skin	TEDE
EAB	0.039 rem	1.80 rem	4.7 rem	1.80 rem
LPZ	0.005 rem	0.22 rem	0.56 rem	0.22 rem
Public Limit	300 rem	25 rem	NA	NA

(TVA 2008a)

Table 3-51. Steam Line Break With an Accident-Initiated Iodine Spike*

	Thyroid	Whole Body	Skin	TEDE
EAB	5.40 rem	0.073 rem	0.11 rem	0.25 rem
LPZ	0.69 rem	0.01 rem	0.014 rem	0.053 rem
Control Room	0.22 rem	0.046 rem	0.009 rem	0.053 rem
Public Limit	300 rem	25 rem	NA	NA
Control Room Limit	30 rem	5 rem	30 rem	NA

*The steam line break with accident-initiated iodine spike bounds the steam line break with pre-existing iodine spike. (
TVA 2008a)

Table 3-52. Steam Line Break With Alternate Steam Generator Tube Plugging With an Accident-Initiated Iodine Spike*

	Thyroid	Whole Body	Skin	TEDE
EAB	30.0 rem	0.67 rem	0.97 rem	1.1 rem
LPZ	5.0 rem	0.09 rem	0.14 rem	0.16 rem
Control Room	2.1 rem	0.52 rem	0.064 rem	0.59 rem

	Thyroid	Whole Body	Skin	TEDE
Public Limit	300 rem	25 rem	NA	NA
Control Room Limit	30 rem	5 rem	30 rem	NA

*The steam line break with alternate steam generator tube plugging with accident-initiated iodine spike bounds the steam line break with alternate steam generator tube plugging with pre-existing iodine spike.

(TVA 2008a)

Table 3-53. Steam Generator Tube Rupture With Accident-Initiated Iodine Spike

	Thyroid	Whole Body	Skin	TEDE
EAB	18.50 rem	1.60 rem	2.80 rem	2.20 rem
LPZ	2.30 rem	0.19 rem	0.40 rem	0.26 rem
Public Limit	300 rem	25 rem	NA	NA
Control Room Limit	30 rem	5 rem	30 rem	NA

(TVA 2008a)

Table 3-54. Fuel Handling Accident (FHA)

	FHA in Auxiliary Building	FHA inside Primary Containment
EAB	4.5 rem TEDE	4.5 rem TEDE
LPZ	0.8 rem TEDE	0.8 rem TEDE
Control Room	4.1 rem TEDE	4.2 rem TEDE
Public Limit	6.3 rem TEDE for off-site doses	5.0 rem TEDE for the control room

(TVA 2008a)

3.19.2. Severe Accidents

3.19.2.1. Affected Environment

The term “accident” refers to any unintentional event (i.e., outside the normal or expected plant operation envelope) that results in a release or the potential for a release of radioactive material to the environment. The NRC categorizes accidents as either design basis or severe. DBAs, described in Subsection 3.19.1, are those for which the risk is great enough that the NRC requires plant design features and procedures to prevent unacceptable accident consequences. Severe accidents are defined as accidents with substantial damage to the reactor core and degradation of containment systems. Because the probability of a severe accident is very low, the NRC considers them too unlikely to warrant normal design controls to prevent or mitigate the consequences. Severe accident analyses consider both the frequency of a severe accident and the off-site consequences to determine the public risk.

The risk of nuclear power plant severe accidents is normally determined by a plant-specific probabilistic safety assessment (PSA) that provides a systematic and comprehensive methodology for determining the risks associated with severe accidents due to the operation of the nuclear power plant. Such assessments have been performed on SQN as a response to Generic Letter 88-20. Even though an update of the SQN PSA is currently underway, not all elements of the SQN PSA have been updated sufficiently to provide complete risk information.

Because a complete PSA for SQN was not available, the severe accident risk analysis for SQN is based on the Level 1 and 2 PSA results from the WBN Unit 2 FSEIS. WBN and SQN are very similar in design so the WBN PSA results are representative of SQN. Severe accidents that result in core damage and containment bypass or containment failure are considered. Three modes of containment failure or release categories were evaluated: containment bypass, early containment failure, and late containment failure. The environmental and health consequences of severe accidents that do not result in containment bypass or failure are significantly less and, therefore, would not substantially change the calculated risk of severe accidents at SQN.

The radiological consequences for each release category are from the surplus plutonium disposition (SPD) SEIS (DOE 2011), which used the MELCOR Accident Consequence Code System (MACCS2) computer code (Version 1.13.1) to perform analyses of radiological impacts. The generic MACCS2 input parameters used in the NRC's severe accident analysis (NUREG-1150) (NRC 1990) formed the basis for the analysis. These generic data values were supplemented with parameters specific to SQN and the surrounding area. Site-specific data included population distribution, economic parameters, and agricultural production. Plant-specific release data included nuclide release, release duration, release energy (thermal content), release frequency, and release category (i.e., early release, late release). The behavior of the population during a release (evacuation parameters) was based on declaration of a general emergency and the emergency planning zone (EPZ) evacuation time.

The SQN PSA is currently being upgraded to meet current NRC requirements. The upgraded SQN PSA will provide the basis for the severe accident mitigation alternatives analysis performed in support of the SQN LRA. The overall SQN severe accident environmental consequence conclusions presented in this SEIS will not be impacted by the updated SQN PSA model.

3.19.2.2. Environmental Consequences

<u>Alternative 1 – License Renewal</u>

The consequences of a beyond-DBA (severe) to the maximally exposed off-site individual and the average individual in the population residing within an 80-kilometer (50-mile) radius of the reactor site are summarized in Table 3-55. The SQN analysis assumed that a site emergency would have been declared early in the accident sequence and that all nonessential site personnel would have evacuated the site in accordance with site emergency procedures before any radiological releases to the environment occurred. In addition, the analysis conservatively assumes that 95 percent of the public within 16 kilometers (10 miles) of the plant would participate in the initial evacuation, and the remaining 5 percent of the population would be relocated 12 to 24 hours after passage of the plume.

Table 3-55. Severe Accident Risks

Release Category (frequency per reactor year)	Maximally Exposed Off-Site Individual		Average Individual Member of Population Within 80 Kilometers (50 miles)	
	Dose Risk [a] (rem/year)	Cancer Fatality [b]	Dose Risk [a] (rem/year)	Cancer Fatality [b]
I - Early Containment failure (3.4E-7)	9.5E-03	3.4E-07	5.6E-07	3.4E-10
II - Containment Bypass (1.4E-6)	6.3E-02	1.4E-06	4.4E-06	2.7E-09
III - Late Containment Failure (3.0E-6)	2.5E-03	3.0E-06	3.0E-06	1.7E-09
Cumulative Individual Risk		4.74E-06		4.73E-09

[a] Includes the likelihood of occurrence of each release category.
[b] Likelihood of cancer fatality per year.

The results presented in this table indicate that the risk to the maximally exposed off-site individual is one fatality every 200 thousand years (or 4.74 x 10^{-6} per year), and the risk to an average individual member of the public is one fatality every 200 million years (or 4.73 x 10^{-9} per year). These results vary somewhat from those presented in the draft SEIS for SQN license renewal, which was developed based upon the WBN Unit 2 model. Availability of the SPD SEIS data for SQN provided updated risk calculations. Overall, consistent with conclusions presented in the draft SEIS for SQN license renewal, the risk results presented above are small. This conclusion is consistent with previous studies on SQN, such as NUREG/CR-4551, *Evaluation of Severe Accident Risks: Sequoyah, Unit 1 Main Report* (NRC 1990). That study concluded that the consequences of a severe accident at SQN are well within NRC safety goals. The NRC's GEIS (NRC 1996), which was intentionally conservative, concluded that the probability-weighted consequences of severe accidents are of minor significance for all plants, because they represent only a small fraction of the risk to which the public is exposed from other sources. Thus, the probability-weighted consequences and impacts of severe accidents during the period of extended operation would be expected to be a minor impact for SQN. For Alternative 1 – License Renewal, the impacts from potential severe accidents would be expected to be minor. These impacts are within the requirements specified for SQN. Severe accident analyses considered both the risk of a severe accident occurring and the on-site and off-site consequences if the accident did occur to determine the significance. Overall, the risk results presented above for SQN Units 1 and Unit 2 are not significant.

Alternative 2a – New Nuclear Generation

Under Alternative 2a, the new plant would be analyzed for the risk of a severe accident occurring, and the consequences on the on-site and off-site environment if a severe accident did occur. The impacts would necessarily need to be minor and of no significance for the plant to be allowed to be constructed and operated. The new nuclear plant would be analyzed specifically for the selected technology, and that technology would have to be approved by the NRC prior to construction and operation. The impacts would be expected to be minor and of no significance.

Alternative 2b – New Nuclear Generation

Under Alternative 2b, there would be no impact applicable for severe accidents.

3.19.3. Plant Security

Some nongovernmental entities and members of the public have expressed concern about the risks posed by nuclear generating facilities in light of the threat of terrorism. TVA believes that the possibility of a terrorist attack affecting operation of one or more units at SQN is very remote, and postulating potential health and environmental impacts from a terrorist attack involves substantial speculation.

TVA has in place detailed sophisticated security measures to prevent physical intrusion into all its nuclear plant sites, including SQN, by hostile forces seeking to gain access to plant nuclear reactors or other sensitive facilities or materials. TVA security personnel are trained and retrained to react to and repel hostile forces threatening TVA nuclear facilities. TVA's security measures and personnel are inspected and tested by the NRC. It is highly unlikely that a hostile force could successfully overcome these security measures and gain entry into sensitive facilities, and even less likely that they could do this quickly enough to prevent operators from putting plant reactors into safe shutdown mode. However, the security threat that is more frequently identified by members of the public or in the media are not hostile forces invading nuclear plant sites, but attacks using hijacked jet airliners, the method used on September 11, 2001, against the World Trade Center and the Pentagon. The likelihood of this now occurring is equally remote in light of today's heightened security at airports, but this threat has been carefully studied.

The NEI commissioned EPRI to conduct an impact analysis of a large jet airliner being purposefully crashed into sensitive nuclear facilities or containers including nuclear reactor containment buildings, spent fuel storage pools, spent fuel dry storage facilities, and spent fuel transportation containers. Using conservative analyses, EPRI concluded that there would be no release of radionuclides from any of these facilities or containers because they are already designed to withstand potentially destructive events. Nuclear reactor containment buildings, for example, have thick concrete walls with heavy reinforcing steel and are designed to withstand credible earthquakes, overpressures, and hurricane force winds. The EPRI analysis used computer models in which a Boeing 767-400 was crashed into containment structures representative of all U.S. nuclear power containment types. The containment structures suffered some crushing and chipping at the maximum impact point, but were not breached. The results of this analysis are summarized in an NEI paper titled "Deterring Terrorism: Aircraft Crash Impact Analyses Demonstrate Nuclear Power Plant's Structural Strength" (NEI 2002).

The EPRI analysis is fully consistent with research conducted by the NRC. When the NRC considered such threats, Commissioner McGaffigan observed:

> Today the NRC has in place measures to prevent public health and safety impacts of a terrorist attack using aircraft that go beyond any other area of our critical infrastructure. In addition to all the measures the Department of Homeland Security and other agencies have put in place to make such attacks extremely improbable (air marshals, hardened cockpit doors, passenger searches, etc.), NRC has entered into a Memorandum of Understanding with NORAD/NORTHCOM to provide realtime information to potentially impacted sites by any aircraft diversion.

> As NRC has said repeatedly, our research showed that in most (the vast majority of) cases an aircraft attack would not result in anything more than a very expensive industrial accident in which no radiation release would occur. In those few cases where a radiation release might occur, there would be no challenge to the emergency planning basis currently in effect to deal with all beyond-design-basis events, whether generated by mother nature, or equipment failure, or terrorists. (NRC 2007)

Notwithstanding the very remote risk of a terrorist attack affecting operations, TVA increased the level of security readiness, improved physical security measures, and increased its security arrangements with local and federal law enforcement agencies at all of its nuclear generating facilities after the events of September 11, 2001. These additional security measures were taken in response to advisories issued by NRC. TVA continues to enhance security at its plants in response to NRC regulations and guidance. The security measures TVA has taken at its sites are complemented by the measures taken throughout the United States to improve security and reduce the risk of successful terrorist attacks. This includes measures designed to respond to and reduce the threats posed by hijacking large jet airliners.

In the very remote likelihood that a terrorist attack would successfully breach the physical and other safeguards at SQN resulting in the release of radionuclides, the consequences of such a release are reasonably captured by the consideration of the impacts of severe accidents discussed above in this section.

Nuclear plant security is applicable to SQN until it is decommissioned and all spent fuel is removed from the site, regardless of the date of the decommissioning. For Alternative 2a – New Nuclear Generation, any new nuclear plant would be designed and constructed to meet all nuclear security design considerations and regulations. Nuclear security rules and regulations have no relevance to Alternative 2b – New Natural Gas-Fired Generation.

3.20. Decommissioning

Regulatory guidance for the consideration of environmental impacts associated with decommissioning is provided in Section 8.4, Termination of Nuclear Power Plant Operations and Decommissioning, of NUREG-1437 (NRC 1996), and Section 7.3, No Action Alternative, of Draft Regulatory Guide 4015, Proposed Revision 1 of Supplement 1 to Regulatory Guide 4.2 (NRC 2009a). The regulatory options and environmental impacts associated with decommissioning SQN are discussed below.

Regulatory Options for Decommissioning

Under all of the alternatives, TVA is required to begin decommissioning each SQN unit no later than the expiration of its operating license. Decommissioning decisions and actions would have to be made sooner under the No Action Alternatives (New Nuclear Construction and New Natural Gas-Fired Construction to replace power lost when the SQN units are decommissioned) than under the Action Alternative.

The same decommissioning options apply to the Action and No Action Alternatives. When TVA proposes a decommissioning option, appropriate environmental reviews would be conducted. A description of decommissioning options is provided below. TVA currently has no preference among decommissioning options and is not proposing one now.

To decommission a nuclear power plant, radioactive material on the site must be reduced to levels that would permit termination of the NRC license. This involves removing the spent fuel, dismantling any systems or components containing activation products (such as the reactor vessel and primary loop piping), and cleaning up or dismantling contaminated materials. Activated materials generally have to be removed from the facility and shipped to a waste processing, storage, or disposal facility. Contaminated materials may either be cleaned of contamination on site, or the contaminated sections may be detached and removed (leaving most of the component intact in the facility), or the contaminated sections may be completely removed and shipped to a waste processing, storage, or disposal facility. The licensee decides how to decontaminate material, and the decision is usually based on the amount of contamination, the ease with which it can be removed, and the cost to remove the contamination versus the cost to ship the entire structure or component to a waste-disposal site.

The NRC has evaluated the environmental impacts of three methods for decommissioning nuclear power facilities: DECON, SAFSTOR, and ENTOMB (see definitions below) (NRC 1996). TVA would decide how to decommission the SQN site, but NRC regulations state that decommissioning must be completed within 60 years of permanent cessation of operations. The choice of decommissioning options is influenced by potential uncertainties in low-level waste disposal costs. NRC regulations provide for the equipment, structures, and portions of the facility and site that contain radioactive contaminants to be removed or decontaminated to a level that permits termination of the license shortly after cessation of operations.

DECON calls for relatively prompt removal of radioactive material to permit restricted or unrestricted access. All fuel assemblies, nuclear source material, radioactive fission and corrosion products, and all other radioactive and contaminated materials above NRC-restricted release levels are removed from the plant. The reactor pressure vessel and internals would be removed, along with removal and demolition of the remaining systems, structures, and components with contamination control employed as required.

The advantages of DECON include the following (NRC 2000):

- The operating license is terminated and the facility and site become available for other purposes more quickly than with the other options.
- Availability of the operating reactor work force that is knowledgeable of the facility.
- Elimination of the need for long-term security, maintenance, and surveillance of the facility, which would be required for the other decommissioning options.
- Greater certainty about the availability of low-level waste disposal facilities to accept the LLRW.
- Lower estimated costs compared to the SAFSTOR alternative, largely as a result of future price escalation. Most activities that occur during DECON would also occur during the SAFSTOR period, only at a later date. (It is anticipated that the later the date for completion of decommissioning, the greater the cost.) Some of these increases may be offset by technological advances during the SAFSTOR period.

The disadvantages of DECON include the following (NRC 2000):

- Higher worker and public doses (because there is less benefit from radioactive decay that would occur in the SAFSTOR option).
- A larger potential commitment of disposal-site space than the SAFSTOR option.
- The potential for complications if spent fuel must remain on the site until a federal repository becomes available.

SAFSTOR is a deferred decontamination strategy that takes advantage of the natural decay of a significant portion of the radiation. After all fuel assemblies, nuclear source material, radioactive liquid, and solid wastes are removed from the plant, the remaining structure would then be secured and mothballed. Monitoring systems would be used throughout the SAFSTOR period and a full-time security force would be maintained. The facility would be decontaminated to NRC release levels after a period of up to 60 years, and the site would be released. This option makes the site unavailable for alternate uses for an extended period, but there would be a reduced need for radioactive waste disposal. The benefits of SAFSTOR include the following (NRC 2000):

- A substantial reduction in radioactivity as a result of the radioactive decay during the storage period.
- A reduction in worker dose (compared to DECON).
- A reduction in public exposure because of fewer shipments of radioactive material to the low-level waste site (compared to DECON).
- A potential reduction in the amount of waste disposal space required (compared to DECON).
- Lower cost during the years immediately following permanent cessation of operations.
- A storage period compatible with the need to store spent fuel on site.
- More time to benefit from growth in the decommissioning trust fund prescribed by NRC regulations (10 CFR Part 50).

Disadvantages of SAFSTOR include (NRC 2000):

- Shortage of personnel familiar with the facility at the time of deferred dismantlement and decontamination.
- Site unavailable for alternate uses during the extended storage period.
- Uncertainties regarding the availability of sites and cost of disposal of low-level radioactive sites in the future.
- Continuing need for maintenance, security, and surveillance.
- Higher total cost for the subsequent decontamination and dismantlement period (assuming typical price escalation during the time the facility is stored); however,

this will be partially offset by reduced radioactive waste disposal volumes resulting from radioactive decay.

For the ENTOMB option, radioactive structures, systems, and components are encased in a structurally long-lived substance, such as concrete. The entombed structure is appropriately maintained, and continued surveillance is carried out until the radioactivity decays to a level that permits termination of the license. The main benefits of the ENTOMB option are (NRC 2000):

- Reduced amount of work to encase the facility in a structurally long-lived substance.
- Reduced worker dose while decontaminating and dismantling the facility.
- Public exposure from waste transported to the low-level waste site would be minimized.
- The ENTOMB option may have a relatively low cost compared to the DECON and SAFSTOR options.

Disadvantages of ENTOMB include the following (NRC 2000):

- Because most power reactors will have radionuclides in concentrations exceeding the limits for site release even after 100 years, this option may not be feasible under current regulations. This option may be acceptable for reactor facilities that can demonstrate that radionuclide levels will decay to levels that will allow release of the site.
- Although three small demonstration reactors have been entombed, no licensees have proposed the ENTOMB option for any power reactors undergoing decommissioning. Therefore, there is virtually no industry experience to provide a source of lessons learned regarding this option for decommissioning commercial nuclear power plants.

Environmental Impacts Associated with Decommissioning

Discontinuing operation of SQN and the initiation of decommissioning may allow some other commercial or industrial use of part of the site in the future. This would ameliorate to some extent the negative socioeconomic impacts of loss of employment. This may include use of the site for electric power generation. Any such future use would require its own environmental review. New, improved decommissioning technologies and efficiencies may be approved by the NRC by the time TVA considers making a decommissioning decision.

Environmental issues associated with decommissioning that result from continued plant operation during the license renewal period are discussed in the GEIS (NRC 1996). Issues were assigned a Category 1 or a Category 2 designation.

For all Category 1 issues, no additional plant-specific analysis is required by the NRC, unless new and significant information is identified. Category 2 issues are those that do not meet one or more of the criteria of Category 1; therefore, additional plant-specific review for these issues is required. There are no Category 2 issues related to decommissioning at SQN.

Category 1 issues applicable to SQN decommissioning are listed in Table 3-56. For all of those issues, the NRC staff concluded in the GEIS that the impacts are minor, and plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 3-56. Category 1 Issues Applicable to the Decommissioning of SQN Following the Renewal Term

ISSUE – 10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
DECOMMISSIONING	
Radiation Doses	7.3.1; 7.4
Waste Management	7.3.2; 7.4
Air Quality	7.3.3; 7.4
Water Quality	7.3.4; 7.4
Ecological Resources	7.3.5; 7.4
Socioeconomic Impacts	7.3.7; 7.4

A brief description of the NRC staff review and the GEIS conclusions, as codified in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, for each of the issues follows.

- Radiation Doses: Based on information in the GEIS, NRC found doses to the public would be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem [0.01 person-Sv] caused by buildup of long-lived radionuclides during the license renewal term. During its review and evaluation, TVA has not identified any significant new information that would indicate any additional radiation dose would be experienced by either the public or workers. Therefore, TVA concludes there would be no radiation doses associated with decommissioning following license renewal beyond those discussed in the GEIS.

- Waste Management: Based on information in the GEIS, NRC found decommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected. During its review and evaluation, TVA has not identified any significant new information relevant to environmental concerns that leads to a different conclusion. Therefore, TVA concludes there would be no solid waste impacts from decommissioning following the license renewal term beyond those discussed in the GEIS.

- Air Quality: Based on information in the GEIS, the NRC found air quality impacts of decommissioning are expected to be negligible either at the end of the current operating term or at the end of the license renewal term. During its review and evaluation, TVA has not identified any significant new information relevant to environmental concerns that leads to a different conclusion. Therefore, TVA

concludes there would be no air quality impacts from license renewal during decommissioning beyond those discussed in the GEIS.

- Water Quality: Based on information in the GEIS, NRC found the potential for significant water quality impacts from erosion or spills is no greater whether decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts. During its review and evaluation, TVA has not identified any significant new information relevant to environmental concerns that leads to a different conclusion. Therefore, TVA concludes there would be no water quality impacts from license renewal term during decommissioning beyond those discussed in the GEIS.

- Ecological Resources: Based on information in the GEIS, NRC found decommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts. During its review and evaluation, TVA has not identified any significant new information relevant to environmental concerns that leads to a different conclusion. Therefore, TVA concludes there would be no ecological resources impacts from license renewal during decommissioning beyond those discussed in the GEIS.

- Socioeconomic Impacts: Based on information in the GEIS, NRC found decommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year relicense period, but they might be decreased by population and economic growth. During its review and evaluation, TVA has not identified any significant new information relevant to environmental concerns that leads to a different conclusion. Therefore, TVA concludes there would be no socioeconomic impacts from license renewal during decommissioning beyond those discussed in the GEIS.

In summary, none of the alternatives would result in foreclosing any decommissioning options, or result in any environmentally unacceptable conditions. A No Action Alternative would not allow an additional 20-year period for decommissioning technology and the licensing framework to evolve and mature. Similarly, a No Action Alternative would not allow an additional 20-year period to increase the likelihood that a permanent spent fuel repository would be available prior to the completion of decommissioning. The availability of a spent fuel repository would further reduce the potential for adverse environmental effects from decommissioning.