CHAPTER 5, IMPACTS OF STATION OPERATION

TABLE OF CONTENTS

Table of Contents (Continued)

Table of Contents (Continued)

Table of Contents (Continued)

CHAPTER 5, IMPACTS OF STATION OPERATION

LIST OF TABLES

List of Tables (Continued)

List of Tables (Continued)

CHAPTER 5, IMPACTS OF STATION OPERATION

LIST OF FIGURES

5.0 ENVIRONMENTAL IMPACTS OF STATION OPERATION

Chapter 5 presents the potential environmental impacts of operation of VCSNS Units 2 and 3. In accordance with 10 CFR 51, impacts are analyzed, and a single significance level of potential impact to each resource (i.e., SMALL, MODERATE, or LARGE) is assigned consistent with the criteria that NRC established in 10 CFR 51, Appendix B, Table B-1, Footnote 3 as follows:

SMALL — Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, NRC has concluded that those impacts that do not exceed permissible levels in NRC's regulations are considered small.

MODERATE — Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource.

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

Mitigation of adverse impacts, if appropriate, is presented. This chapter is divided into 12 sections:

- Land Use Impacts (Section 5.1)
- Water-Related Impacts (Section 5.2)
- Cooling System Impacts (Section 5.3)
- Radiological Impacts of Normal Operations (Section 5.4)
- Environmental Impacts of Waste (Section 5.5)
- Transmission System Impacts (Section 5.6)
- Uranium Fuel Cycle Impacts (Section 5.7)
- Socioeconomic Impacts (Section 5.8)
- Decommissioning Impacts (Section 5.9)
- Measures and Controls to Limit Adverse Impacts During Operations (Section 5.10)
- Transportation of Radioactive Materials (Section 5.11)
- Nonradiological Health Impacts (Section 5.12)

5.1 LAND USE IMPACTS

The following subsections describe the impacts of VCSNS Units 2 and 3 operations on land use at the VCSNS site, the 6-mile vicinity, and associated transmission line corridors, including impacts to historic and cultural resources. Operation of Units 2 and 3 is not anticipated to affect any current or planned land uses.

5.1.1 THE SITE AND VICINITY

5.1.1.1 The Site

Land use impacts from construction are described in Subsection 4.1.1. The only additional impacts to land use from operations would be the impacts of solids deposition from cooling tower drift. Cooling tower design is discussed in Subsection 3.4.2. Impacts of the heat dissipation system, including deposition, are discussed in Subsections 5.3.3.1 and 5.3.3.2. As discussed in Subsection 5.3.3.2, the predicted solids deposition is below the concentrations which could damage sensitive vegetation. SCE&G concludes that impacts to land use from Units 2 and 3 operations would be SMALL and would not warrant mitigation.

5.1.1.2 The Vicinity

As described in Section 2.5, the impact evaluation assumes that the residences of the new units' employees would be distributed across the region in the same proportion as those of the current unit's employees. SCE&G estimates the work force for two AP1000 units would be 800 additional onsite employees (Subsection 3.10.3). Subsection 5.8.2 describes the impact of 800 new employees on the region's housing market and the increases in tax revenues. Understanding tax revenues is important because some land use changes can be driven by increased property taxes.

Approximately 9.7% (77) of the new employees are expected to live in Fairfield County. Relatively few employees live in Fairfield County in the vicinity of VCSNS; the area is rural, with few utilities or amenities. A portion of the land adjacent to the proposed site is part of Parr Hydro (which includes the Monticello and Parr Reservoirs), Broad River, or owned by SCE&G and is unavailable for development. It is likely that the new employees who choose to settle in Fairfield County would purchase homes or acreage in the Winnsboro area, 12 miles from VCSNS. Based on the 24 years of experience of Unit 1, increased tax revenues would not spur development in the vicinity of VCSNS.

Land within the vicinity on the west side of the Broad River is in Newberry County. Development is most likely to occur in this area because of its proximity to the growing populations of Lexington and Richland counties and I-26. However, no SCE&G tax revenues would go to Newberry County.

SCE&G concludes that impacts to land use in the vicinity of VCSNS would be SMALL and not warrant mitigation.

5.1.2 TRANSMISSION CORRIDORS AND OFF-SITE AREAS

Land proposed to be used for transmission corridors is described in Subsection 2.2.2. Land use impacts from the operation of Units 2 and 3 would be identical in nature to impacts from Unit 1. SCE&G acquires transmission line rights-of-way (either by outright purchase of the land or easement) that give it access and control over how the land in the transmission corridor is managed. SCE&G ensures that land use in the corridors is compatible with the reliable transmission of electricity. Vegetation communities in these corridors are kept at an early successional stage by mowing and application of herbicides and growth-regulating chemicals. In some instances, SCE&G allows farmers to grow feed (hay, wheat, and corn) for livestock or graze livestock in these rights-of-way. SCE&G also allows hunt clubs and individuals to plant wildlife foods for quail, dove, wild turkey, and whitetail deer. SCE&G's control and management of these rights-of-way preclude virtually all residential and industrial uses of the transmission corridors. SCE&G and Santee Cooper have established corridor vegetation management and line maintenance procedures that would be used to maintain the new corridors and transmission lines. SCE&G concludes that impacts to land use in transmission corridors or offsite areas would be SMALL and not require mitigation.

Units 2 and 3 would generate low-level radioactive wastes that would require disposal in permitted radioactive waste disposal facilities (Table 3.5-3) and nonradioactive wastes that would require disposal in permitted landfills. Both types of waste are commonly generated, and permitted disposal facilities are located throughout the country. Units 2 and 3 would generate spent fuel, which would be stored on site until such time as DOE constructs, and NRC licenses, a high-level waste disposal facility. SCE&G concludes that impacts to offsite land use due to disposal of wastes generated at Units 2 and 3 would be SMALL and would not warrant mitigation.

5.1.3 HISTORIC PROPERTIES AND CULTURAL RESOURCES

Table 2.5-24 lists 21 properties within 10 miles of the VCSNS site that are on the National Register of Historic Places. As described in Subsection 2.5.3, SCE&G conducted a two-part, Phase I cultural resource survey of the areas that may be impacted by Units 2 and 3, and found 26 archaeological sites. SCE&G has fenced one of these areas, a cemetery, to protect it from potential construction impacts of this proposed project. Impacts to these historic or cultural resources, during the operational phase of the proposed project, would be minimal and far less than any potential impacts during the construction phase described in Subsection 4.1.3.

The precise routes of new transmission corridors have not been determined; however, Subsection 2.5.3 discusses National Register sites in the counties the lines would cross. Because SCE&G's and Santee Cooper's transmission line siting processes (Subsection 2.2.2) evaluate cultural resources in the vicinity of proposed lines, SCE&G has determined that Units 2 and 3 operations would have a SMALL impact on historic or cultural resources and would not require mitigation.

5.2 WATER RELATED IMPACTS

5.2.1 HYDROLOGY ALTERATIONS AND PLANT WATER SUPPLY

VCSNS Unit 2 and 3 closed-cycle cooling systems would require modest amounts of makeup water to replace that lost to evaporation, drift (entrained in water vapor), and blowdown (water released to purge solids). As discussed in Chapter 3 and shown on Figure 5.2-1, water withdrawn for plant operations, including makeup for the mechanical draft cooling towers, would be pumped from the Monticello Reservoir. The expected rate of withdrawal during normal plant operations would be approximately 37,200 gpm (83 cfs) for the proposed two-unit operation and 61,800 gpm (138 cfs) during maximum use operations (see Figure 3.3-1).

Of the total surface water withdrawn, water for makeup to the circulating water system would be supplied at an approximate rate of 36,200 gpm (81 cfs) during normal operations and 58,800 gpm (131 cfs) during maximum use operations. Additional water, withdrawn for Unit 2 and 3 uses at an approximate rate of 970 gpm (2.2 cfs) during normal operations and 2,990 gpm (6.7 cfs) during maximum use operations, would be supplied through a water treatment facility. Of the total additional water withdrawn, makeup water for the service water system would be supplied at an approximate rate of 640 gpm (1.4 cfs) during normal operations and 1,840 gpm (4.1 cfs) during maximum use operations. The remainder of the water would be supplied to other plant uses, including potable water, except for approximately 5% that would be returned to the Monticello Reservoir from the water treatment facility.

Water withdrawn for cooling tower makeup would be returned to the Parr Reservoir as blowdown, lost as evaporation, or lost as drift. Water returned to the Broad River as blowdown discharged to the Parr Reservoir is not lost to downstream users or downstream aquatic communities. Evaporative losses, on the other hand, are not replaced and are considered “consumptive” losses. Even though drift losses are small compared to evaporative losses, they were considered in the analysis.

The assessment that follows is, therefore, focused on water use in the strictest sense, meaning water that is lost via evaporation, drift, and consumptive use, rather than water that is withdrawn from, and later returned to, the Parr Reservoir.

5.2.2 WATER USE IMPACTS

5.2.2.1 Surface Water

Historical daily river flow data (1896–1907 and 1980–2005) for the Broad River at Elastin, located 1.2 miles downstream of Parr Shoals Dam, were used to approximate the monthly and annual average and low flows of the Broad River for VCSNS analyses.

Units 2 and 3 would remove water from the Monticello Reservoir and return water, minus consumptive loss, to the Parr Reservoir. A small amount of water withdrawn for processing through the water treatment facility is returned to the Monticello Reservoir. SCE&G has estimated that current evaporative consumptive loss from the Monticello Reservoir for Unit 1 is 5,800 gpm (13 cfs). However, a more conservative theoretical value of 9,900 gpm (22 cfs) was used as the evaporative consumptive loss in the Environmental Report during relicensing for Unit 1, based on the discharge of heated water to the Monticello Reservoir. The Units 2 and 3 total cooling tower evaporation rates are projected to be 27,640 gpm (62 cfs) and 30,780 gpm (69 cfs) for normal and maximum use operations, respectively (Table 3.3-1). This compares to the long-term, annual mean of the Broad River flow in the vicinity of the VCSNS site at Alston, South Carolina, of 2,829,000 gpm (6,300 cfs). The lowest annual mean flow at Alston is 966,300 gpm (2,150 cfs). The total consumptive water loss rate for Units 2 and 3 is approximately 27,800 gpm (62 cfs) and 31,100 gpm (69 cfs) for normal and maximum use operations. Therefore, approximately 1% (normal and maximum use operations) of the average annual flow and 2.9% (normal operations) to 3.2% (maximum use operations) of the lowest annual mean flow of the Broad River at Alston would be lost, mainly to evaporation from the new units' cooling towers.

The state of South Carolina uses the 7Q10 flow to determine potential impacts. The closest monitoring station with 7Q10 values is the Alston station located just downstream of the Parr Reservoir. The 7Q10 value at the Alston station is 382,800 gpm (853 cfs) (USGS 2007). The evaporative loss of water for Units 2 and 3 is estimated to be 7.2% and 8.0% of the 7Q10 value for normal and maximum use operations. Table 5.2-1 compares consumptive water loss to river flow on a monthly basis and indicates that the impact of consumptive use would be highest in summer and fall and lowest in the winter and spring.

Consumptive losses of this magnitude would, under normal circumstances (typical annual flows), be barely discernible on the flow of the Broad River. During low-flow periods, the impact of this consumptive use on the availability of water downstream of the plant would be mitigated by the reservoirs from which SCE&G could remove water instead of directly removing water from the Broad River. The usable storage inventory of water transferred by the Fairfield Pumped Storage Facility between the two reservoirs is 29,000 acre-feet (1.26×10^9 cubic feet). An additional emergency drawdown inventory of 16,000 acre-feet (6.97×10^8 cubic feet) of water is available in the Monticello Reservoir for a total usable storage inventory of 45,000 acre-feet (1.96×10^9 cubic feet). Based on these storage values and the operation of the Fairfield Pumped Storage Facility maintaining the pool level of the Monticello Reservoir, impacts due to the withdrawal of water from the Monticello Reservoir for operation of the proposed Units 2 and 3 would be SMALL. The cumulative impacts of three operating units (Units 1, 2, and 3) are discussed in Section 10.5.

5.2.2.2 Groundwater

The VCSNS site lies atop a drainage divide bounded by stream channels that have cut down, in some instances, to bedrock. The local rock surface is the boundary between the water table aquifer and the rock aquifer at the site. The streams act as interceptor drains for the groundwater in the water table aquifer (see Subsection 2.3.2) and in some cases even to the underlying rock aquifer. The water table aquifer beneath the plant is, thus, hydraulically isolated on an interfluvial high. The groundwater is replenished by natural precipitation that percolates to the water table and then moves laterally to one of the interceptor streams.

As discussed in Subsection 3.3.1, groundwater would not be withdrawn for operational use by Units 2 and 3. If dewatering is required to maintain dry portions of the new facilities, impacts would be localized to the facility being dewatered. Therefore, impacts from groundwater use would be SMALL and would not warrant mitigation.

5.2.3 WATER QUALITY IMPACTS

5.2.3.1 Surface Water

5.2.3.1.1 Chemical Impacts

Cooling-tower based heat dissipation systems, such as the ones proposed for Units 2 and 3, remove waste heat by allowing water to evaporate to the atmosphere. The water lost to evaporation must be replaced continuously with fresh makeup water to prevent the accumulation of solids and solid scale formation. To prevent buildup of these solids, a small portion of the circulating water stream would be drained or blown down.

Because cooling towers concentrate solids (minerals and salts) and organics that enter the system in makeup water, cooling tower water chemistry must be maintained with anti-scaling compounds and corrosion inhibitors. Similarly, because conditions in cooling towers are conducive to the growth of fouling bacteria and algae, some sort of biocide must be added to the system.

As noted in Subsections 3.3.2 and 3.6.1, Units 2 and 3 would use water from the Monticello Reservoir as does the existing unit’s once-through cooling system and plant operations. Therefore, water treatment methods and technologies would be similar to those in place at Unit 1 for similar applications. Table 3.6-1 lists water treatment chemicals that could be discharged for Units 2 and 3. SCE&G plans to treat raw makeup water to the circulating water and service water cooling towers to prevent biofouling in the intake structure and supply piping to the cooling towers. Additional water treatment would take place in the cooling tower basins, and could include the addition of biocides, algaecides, pH adjusters, corrosion inhibitors, anti-scaling compounds, and silt dispersants (Subsection 3.3.2.1). Treatment would occur through the injection of chemicals into the piping system.

Demineralized water would be produced through filtration and primary and secondary demineralization processes. Reverse osmosis is the primary demineralization treatment process designed to reduce solids, salts, organics, and colloids. The secondary stage would include an electrode ionization system where carbon dioxide and most of the remaining ions would be removed. The demineralized water would then be stored and processed to remove oxygen. Condensate would pass through a polisher resin bed. Wastewater from the polishing process would be discharged to the wastewater collection and treatment system. Chemical corrosion inhibitors would treat the demineralized water to minimize system component corrosion. Potentially contaminated sources would discharge their wastewater to plant sumps that could direct water to either the liquid radwaste system or to the plant discharge. Water for domestic use and human consumption would be treated by filtration and disinfection as needed.

Unit 1 operates under National Pollutant Discharge Elimination System permit (Permit No. SC0030856), issued June 13, 2007. Part V of the permit titled, "Other Requirements," outlines the use of other chemical types and permit requirements. The National Pollutant Discharge Elimination System permit does not allow any addition of chlorine to the condenser cooling water discharged via outfall 001. The cooling towers for Units 2 and 3 could operate between 2 to 4 cycles of concentration, meaning that solids and chemical constituents in makeup water could be concentrated 2 to 4 times before being discharged and replaced with fresh water from the Monticello Reservoir. As a result, levels of solids and organics in cooling tower blowdown could be as much as four times higher than ambient concentrations. Because the blowdown stream would be very small relative to the flow of the Broad River, concentrations of solids and chemicals used in cooling tower water treatment would return to ambient levels almost immediately downstream of the discharge pipe. The projected discharge flow from the blowdown sump of approximately 9,380 gpm (21 cfs) under normal operations and 30,350 gpm (68 cfs) under maximum operations represents 0.33% to 1.1% of the annual mean flow [2,828,000 gpm (6,300 cfs)] and 2.5% to 8.0% of the 7Q10 flow value of 382,800 gpm (853 cfs) for the Alston monitoring station. This equates to a dilution factor of from 58 to 510**,** depending on the time of year based on the monthly annual mean flow of the Broad River and whether operations are occurring under normal or maximum conditions (Table 5.2-1).

Even though the amount of cooling tower blowdown entering the Parr Reservoir would be very small and the chemicals it contains relatively innocuous, the discharge would have to be permitted by SCDHEC and comply with applicable state water quality standards. Impacts of chemicals in the permitted blowdown discharge on the Parr Reservoir water quality would be SMALL and would not warrant mitigation.

Discharge of radionuclides is described in Section 3.5, Radioactive Waste Management System. Radiological impacts from liquid discharges are presented in Section 5.4, Radiological Impacts of Normal Operation.

5.2.3.1.2 Groundwater

Any minor spills of diesel fuel, hydraulic fluid, or lubricants during operations would be cleaned up quickly in accordance with SCE&G's Spill Prevention, Control, and Countermeasures Plan and Facility Response Plan. Although these plans are primarily intended to prevent spilled oil from moving into navigable waters, they also tend to mitigate impacts to local groundwater because spills are quickly attended to and not allowed to penetrate to groundwater.

In the unlikely event small amounts of contaminants escape into the environment, they would have only a small, localized, temporary impact on the water table aquifer. SCE&G believes that any impacts to groundwater quality would be SMALL and would not warrant mitigation beyond those described in this section or required by permit.

Section 5.2 References

1. Cooney et al. 2006. Cooney, T. W., P. A. Drewes, S. W. Ellisor, T. H. Lanier, and F. Melendez. *Water Resources Data South Carolina Water Year 2005,* U.S. Department of the Interior, U.S. Geological Survey, Water-Data Report SC-0501, March 2006.

2. USGS (U.S. Geological Survey) 2007, Letter from Toby D. Feaster, Hydrologist of the USGS South Carolina Water Science Center, Clemson Field Office to Steve Summer of SCE&G, dated March 6, 2007.

Table 5.2-1
Comparison of Broad River Historical Flows and VCSNS Cooling Water Flows

	Broad River Average Flow*(a)	7Q10 Flow*(b)	Maximum Withdrawal for Cooling Tower Makeup (2 units)*(c)	Maximum Cooling Tower Evaporation Rate (2 units)*(c)	Percent of Average Flow Lost to Evaporation	Percent of 7Q10 Flow Lost to Evaporation	Maximum Blowdown Flow*(c)	Blowdown as Percent of Average Flow	Blowdown as Percent of 7Q10 Flow
Jan	3,498,000	382,800	60,640	30,780	0.88	8.0	29,846	0.85	7.8
Feb	4,497,000	382,800	60,640	30,780	0.68	8.0	29,846	0.66	7.8
Mar	4,780,000	382,800	60,640	30,780	0.64	8.0	29,846	0.62	7.8
Apr	3,696,000	382,800	60,640	30,780	0.83	8.0	29,846	0.81	7.8
May	2,481,000	382,800	60,640	30,780	1.24	8.0	29,846	1.20	7.8
June	2,398,000	382,800	60,640	30,780	1.28	8.0	29,846	1.24	7.8
July	1,772,000	382,800	60,640	30,780	1.74	8.0	29,846	1.68	7.8
Aug	2,436,000	382,800	60,640	30,780	1.26	8.0	29,846	1.23	7.8
Sept	1,773,000	382,800	60,640	30,780	1.74	8.0	29,846	1.68	7.8
Oct	1,854,000	382,800	60,640	30,780	1.66	8.0	29,846	1.61	7.8
Nov	1,989,000	382,800	60,640	30,780	1.56	8.0	29,846	1.50	7.8
Dec	2,972,000	382,800	60,640	30,780	1.04	8.0	29,846	1.00	7.8

a) Cooney et al. (2006), p. 223
b) USGS (2007)
c) Table 3.3-1. Evaporation and blowdown values are total values (service water system plus main cooling towers).
* all flows in gallons per minute

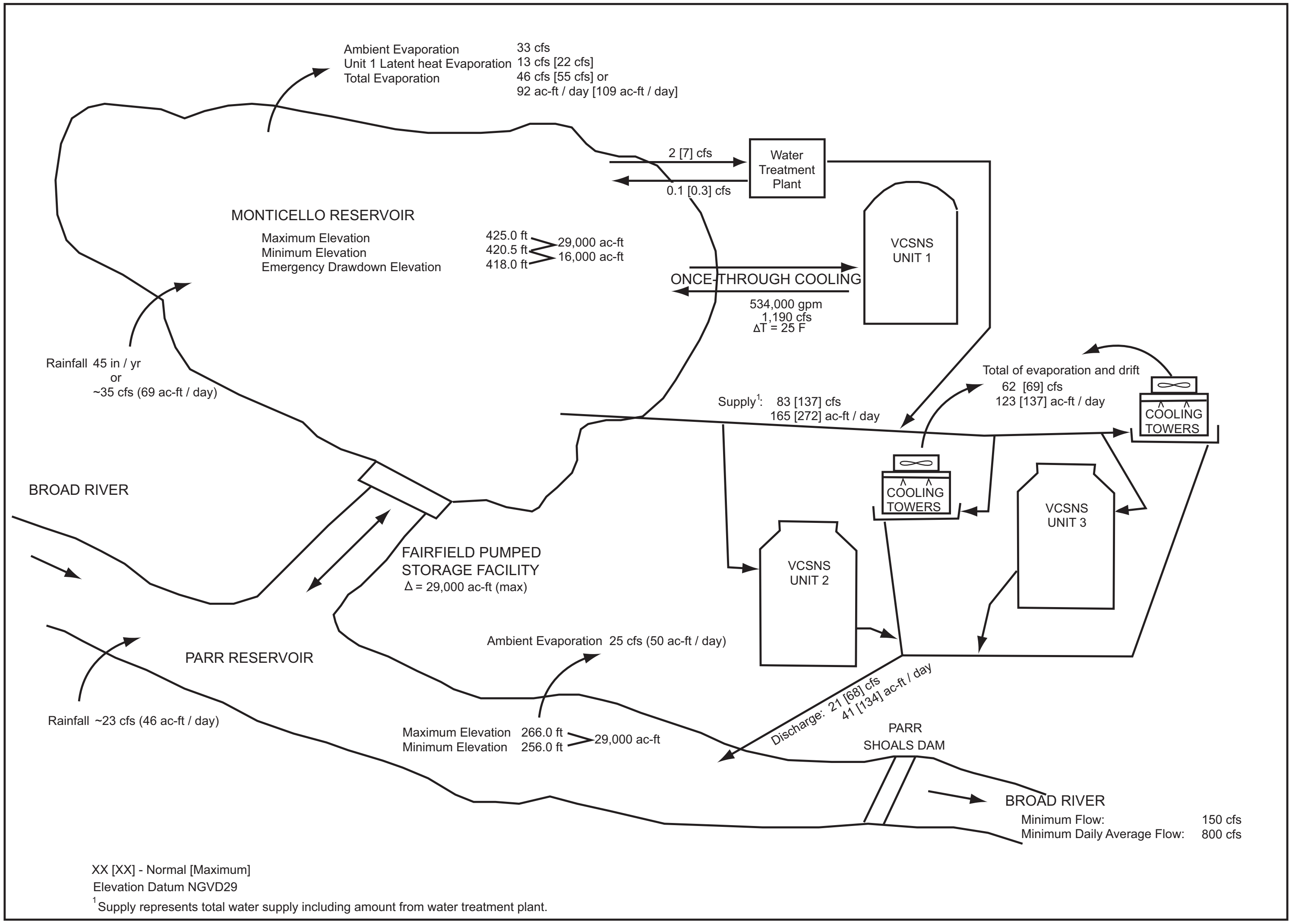

Figure 5.2-1. Diagram of Broad River, Parr Reservoir, and Monticello Reservoir System

5.3 COOLING SYSTEM IMPACTS

5.3.1 INTAKE SYSTEM

Subsection 3.4.2.1 describes the proposed intake system, while Subsection 5.3.1 describes its physical and biological impact on the Monticello Reservoir. VCSNS Units 2 and 3 would use mechanical-draft cooling towers for dissipation of condenser waste heat. Makeup for these cooling towers would be obtained from the Monticello Reservoir at a rate of 36,214 gpm (80 cfs) to 58,800 gpm (131 cfs), depending on water quality in the reservoir. Makeup pumps would be installed in a new raw water intake structure located approximately 1,250 feet west of the existing Unit 1 intake structure.

The EPA promulgated regulations governing the location, design, construction, and capacity of cooling water intake structures at Phase I (new facilities that use waters of the U.S. for cooling) facilities in December 2001 (66 FR 65255) and Phase II (large, existing steam electric plants) facilities in July 2004 (69 FR 41575). SCDHEC may amend or issue the National Pollutant Discharge Elimination System (NPDES) permit for existing Unit 1 to include proposed Units 2 and 3 or issue a new NPDES permit for Units 2 and 3. SCDHEC has not indicated whether the new facility will be subject to the Phase I (new facility) or Phase II (existing facility) regulation. In any case, the cooling water intake structure proposed for Units 2 and 3 will satisfy the requirements for new or existing facilities, by virtue of the fact that it will have a through-trash-rack and through-traveling-screen velocity of less than 0.5 foot per second and an intake flow commensurate with that of a closed-cycle, recirculating cooling water structure. However, EPA has suspended the Phase II Rule as the result of a U.S. Court of Appeals (Second Circuit) decision that remanded several provisions of the rule, including EPA's determination of Best Technology Available (72 FR 37107). Given the regulatory uncertainties, the discussion that follows in Subsection 5.3.1 focuses on potential impacts of circulating water intake system operation and deals only in passing with compliance with the Phase I and Phase II regulations.

5.3.1.1 Hydrodynamic Descriptions and Physical Impacts

Nuclear power plants that use closed-cycle, recirculating cooling systems (cooling towers) withdraw significantly less water for condenser cooling than open-cycle (once-through) units. Depending on the type of cooling tower installed and the quality of the makeup water, power plants with closed-cycle, recirculating cooling towers withdraw only approximately 5% as much water as plants of the same size with once-through cooling systems (Power Scorecard 2000; CATF 2004).

As discussed in Section 3.3, cooling water for plant systems would be withdrawn from the Monticello Reservoir. Under normal operating conditions, Units 2 and 3 would withdraw raw water from the reservoir for cooling tower makeup at a rate of 36,214 gpm; the maximum makeup rate would be 58,800 gpm. Smaller amounts of water would be withdrawn from the Monticello Reservoir at the proposed water treatment plant (see Figure 2.1-1) to supply the proposed water treatment facility, which would be located approximately one mile east of Unit 1. Under normal operating conditions, 969 gpm would be pumped to the water treatment facility for subsequent use in the service water system and several in-plant systems. After treatment at the facility, 640 gpm would be pumped to the service water system and 280 gpm would be pumped to the power plant to supply water for domestic use, fire protection, and the demineralized water system. Under maximum flow conditions, 2,991 gpm of the Monticello Reservoir water would be pumped to the waste treatment facility, after which 1,840 gpm would be directed to the service water system and 1,001 gpm would be directed to various in-plant systems. The conceptual design of the circulating water intake system is described in Subsection 3.4.2 and Figures 3.1-3, 3.4-2, and 3.4-3.

Subsection 3.4.2.1 describes the proposed raw water intake structure, which would be a 60-foot-long by 75-foot-wide concrete structure equipped with six pump bays, three per nuclear unit, each with a raw water (makeup) pump. Each pump bay would have a trash rack and a dedicated traveling screen. With both units operating, the pumps would withdraw makeup water from the Monticello Reservoir at a maximum rate of 58,800 gpm.

Geosyntec (2005) conducted hydraulic surveys in the vicinity of the Unit 1 circulating water intake system as part of a larger 316(b) Comprehensive Demonstration Study for Unit 1 to determine how much of the reservoir was physically affected by cooling water withdrawals. The largest "hydraulic zone of influence" measured, 2.44 acres, was associated with the lowest reservoir elevations (Geosyntec 2005). The hydraulic zone of influence refers to an area within which organisms may be subject to impingement or entrainment. Based on these results, the authors of the study predicted that the maximum area of hydraulic influence was 2.92 acres (Geosyntec 2005). Given that the cooling water withdrawal rate for Units 2 and 3 would be 7% to 12% that of Unit 1 and the intake through-screen velocity would be lower (<0.5 foot per second versus 0.72 foot per second), the area potentially affected by withdrawal of water for Units 2 and 3 would be expected to be much smaller. This has positive implications with respect to impingement and entrainment of aquatic organisms, because reducing the size of the area of the hydraulic zone of influence reduces the area within which fish are at risk of being drawn into the cooling water intake structure.

5.3.1.2 Aquatic Ecosystems

The discussion that follows focuses on impacts of the Units 2 and 3 intake systems on aquatic ecosystems. Impacts of existing Unit 1 are also discussed, but only to provide a historical perspective and context for the assessment of Units 2 and 3 impacts. Cumulative impacts of three units are discussed in Section 10.5.

Dames & Moore evaluated impingement and entrainment at the Unit 1 intake structure in the original *316(b) Demonstration for the Virgil C. Summer Nuclear Station* (Dames & Moore 1985). A total of 5,140 fish weighing 31 kilograms were collected in the impingement study, which the investigators projected/extrapolated to an estimated 85,000 fish per year weighing 515 kilograms. The estimated biomass of fish impinged per year (515 kilograms) represented less than 0.5% of the estimated standing crop of 110,500 kilograms of fish in the Monticello Reservoir (Dames & Moore 1985). Moreover, the 515-kilogram value was assumed to be atypically high, inflated by winter kills of young-of-the-year gizzard shad over the December 1983-February 1984 period (Dames & Moore 1985).

The authors of the original 316(b) study for Unit 1 concluded that "Due to the relatively low percentages of fish being impinged and the apparent stability of Monticello Reservoir, the impingement of organisms appears to have little impact on the aquatic ecosystem of the reservoir." They suggested that losses at the circulating water intake system were similar to losses sustained by predation, "a process to which most natural fish populations are pre-adapted to withstand." They noted also that the bulk of the fish lost to impingement were young-of-the-year and that "the removal of such young is at least partly balanced by increased survival and/or growth of the remainder."

Likewise, the authors of the Dames & Moore (1985) 316(b) study evaluated seasonal distribution and abundance of ichthyoplankton in the Monticello Reservoir and concluded that the two species most susceptible to entrainment were clupeids (gizzard shad and threadfin shad), particularly during the months of May and June when larvae were most abundant. However, they asserted that entrainment losses had "…no apparent ill effects on the fish community of Monticello Reservoir…" (Dames & Moore 1985).

SCDHEC accepted the findings of the 316(b) demonstration and issued the following determination, which appeared in NPDES permits issued to SCE&G for Unit 1 between 1985 and 1997:

> "On April 19, 1985, determination was made, in accordance with Section 316(b) of the Act, that the location, design, construction, and capacity of the VCSNS cooling water intake structure(s) reflects the best technology available for minimizing adverse environmental impact."

The NPDES permit for Unit 1, issued December 3, 2002, contains a similar statement:

> "The South Carolina Department of Health and Environmental Control has determined pursuant to Section 316(b) of the Act that the location, design, construction and capacity of the cooling water intake structure reflect the best technology available for minimizing environmental impact.[a]"

Geosyntec (2006) conducted an impingement mortality characterization study for SCE&G at the Unit 1 intake over the July 2005–June 2006 period as part of a larger 316(b) Comprehensive Demonstration Study required by the U.S. EPA's Phase II rule (69 Federal Register 41576, July 9, 2004). Impingement samples were collected every two weeks over a 52-week period. Annual estimates of impingement mortality were developed from these 26 biweekly samples by a

a. Source: NPDES Permit No. SC0030856, dated December 3, 2002 conventional spreadsheet interpolation and by Monte Carlo simulation. Monte Carlo simulations produced more "robust and unbiased" estimates and higher estimates of impingement mortality than conventional spreadsheet methods and were, therefore, used by SCE&G as the basis for the assessment of impacts of the new raw water intake structure that follows. Tables 5.3-1 and 5.3-2 show estimated annual impingement at the Unit 1 circulating water intake system, based on computer simulations.

Approximately half (50.2% of total) of the 574 fish impinged during the 12-month study were threadfin shad. Smaller percentages of blue catfish (12.2%), channel catfish (11.8%), and white perch (9.4%) were also impinged. These four species comprised 83.6% of all fish impinged. Yellow perch (6.1%), gizzard shad (4.4%), and white catfish (2.6%) were the only other species impinged in meaningful numbers. None of the species impinged were rare, sensitive, or unusual; none were state or federally listed.

Based on the results of the biweekly impingement sampling, as much as 123.4 kilograms (272 pounds) of fish were lost to impingement at the Unit 1 circulating water intake system between July 2005 and June 2006. Of this total, an estimated 45.1 kilograms (99.4 pounds) of fish, or 36.6% of the total, were white perch. Annual impingement losses of gizzard shad, channel catfish, white catfish, and threadfin shad were estimated to be 15.9 kilograms (35 pounds), 15.4 kilograms (34 pounds), 9.2 kilograms (20.3 pounds), and 8.6 kilograms (19.0 pounds), respectively. The Geosyntec report noted that impingement losses at the Unit 1 circulating water intake system were "relatively minor" when compared to standing stocks of fish in the Monticello Reservoir (see Table 2-2 of Geosyntec 2006) or when compared to impingement rates at other southeastern power plants (see Table 6-6 of Geosyntec 2006).

SCE&G used impingement rates from the 2005–2006 Geosyntec study to estimate impingement rates that would be expected at the new circulating water intake system for Units 2 and 3. This approach is believed to be reasonable since the new circulating water intake system would be a short distance from the Unit 1 intake structure, and would withdraw water from the same vicinity of the Monticello Reservoir. The analysis assumed that the number of fish impinged would be proportional to flow (withdrawal rate), all other things being equal.

Depending on the mode of operation (*i.e.,* two or four cycles of concentration) and the statistical confidence level employed, the number of fish impinged annually at the new circulating water intake system for Units 2 and 3, with both units operating, would range from approximately 593 to 1,010 fish (see Table 5.3-3). These fish would weigh an estimated 7.8 to 13.6 kilograms (17.2 to 30 pounds) (see Table 5.3-4).

Focusing on the most extreme case (maximum flow, upper confidence limit), 507 of 1,010 fish impinged at the new circulating water intake system over a typical 12-month period would be threadfin shad. Blue catfish (123 fish), channel catfish (120 fish), and white perch (95 fish) would be the second, third, and fourth most frequently impinged species. This translates into 1.4 (threadfin shad), 0.3 (blue catfish), 0.3 (channel catfish), and 0.3 (white perch) impinged per day. These impingement rates are miniscule when compared to the number of fish (threadfin shad, blue catfish, channel catfish, and white perch) in the reservoir or when compared to the number of catfish and perch removed daily and annually by recreational fishermen. Based on the last creel survey conducted by the South Carolina Department of Natural Resources (Christie and Haines 1998), an estimated 60,434 blue catfish, 52,673 channel catfish, and 14,409 white perch are harvested annually by Monticello Reservoir anglers. This equates to daily harvest rates of 166, 144, and 39 blue catfish, channel catfish, and white perch, respectively.

The species most often impinged in the 2005–2006 study and most likely to be impinged in the future at the new circulating water intake system is the threadfin shad. Threadfin shad are delicate, weak-swimming fish that are sensitive to sudden changes in water temperature and dissolved oxygen (Mettee et al. 1996). They are particularly sensitive to low water temperatures, exhibiting behavioral changes when water temperature fall below 10°C (50°F), and are subject to massive die-offs when water temperatures approach 5°C (41°F) (Griffith 1978).

Threadfin shad have an extremely high reproductive potential because they are capable of spawning as one-year-olds, can spawn more than once per season, and produce relatively large numbers of eggs (up to 25,000 per female) for a small-bodied species (Kilambi and Baglin 1969; Jenkins and Burkhead 1994). A study (computer simulation) of threadfin shad entrainment at a South Carolina pumped-storage hydroelectric power plant suggested that the risk of population-level effects from entrainment was low (maximum risk of 5% above background), even when high rates of entrainment of young and adults were assumed (Oines et al. 1997). The authors of the study attributed the low risk to the species' "robust reproductive potential" that allows threadfin shad populations to rebound quickly from impingement and entrainment losses (Oines et al. 1997).

Threadfin shad have been known to overpopulate small lakes and reservoirs and, when present in high densities, reduce growth and survival of young-of-the-year sport fish (particularly Lepomids), with which they compete for food (DeVries et al. 1991; Armstrong 2001). With their high reproductive rate and efficient filter-feeding, they can, over time, come to make up much of the biomass of a fertile lake or reservoir (Alabama Department of Conservation 2001). Consequently, losses of threadfin shad at power plant intakes, although generally regarded as unfavorable/negative, could actually benefit competing populations of game fish in productive southeastern reservoirs.

As noted earlier in this section, Dames & Moore (1985) evaluated entrainment at Unit 1 in the early 1980s, and concluded that entrainment impacts from operation of the plant's once-through cooling system were small. The state of South Carolina concurred, and has stipulated to this in NPDES permits issued since that time. The EPA published (69 FR 41576) its Phase II 316(b) rule for existing power-producing facilities in July 2004, a rule that applied to Unit 1. The rule requires the use of best technology available to meet performance standards for reducing impingement mortality, and where applicable, entrainment at affected facilities.

Applicable performance standards are determined based on source waterbody type, generating capacity use rate, and/or ratio of water withdrawal to mean annual flow (rivers). Source water body type is the determinant for VCSNS. The applicable performance standard for facilities withdrawing cooling water from lakes or reservoirs under the Phase II regulation would have been a minimum 80% reduction in impingement mortality from a "calculation baseline." Facilities like VCSNS that withdraw cooling water from lakes or reservoirs are not required to address entrainment. As explained in the EPA rule (69 FR 41598), "Performance standards for entrainment do not apply to facilities…that withdraw cooling water from a lake (other than one of the Great Lakes) or reservoir because such facilities have a low propensity for causing significant entrainment impacts…"

As discussed previously in this section, the new circulating water intake system would be designed specifically to mitigate circulating water intake system impacts to fish, with an intake velocity (<0.5 foot per second) that would substantially reduce impingement and entrainment losses. Impingement estimates for new units were based on studies conducted for existing Unit 1, which has a higher intake velocity. Therefore, the impingement rates presented in Table 5.3-3 are inflated, and overstate potential impacts of the new units' circulating water intake system.

In summary, the cooling water intake structure for new Units 2 and 3 would be designed to mitigate impacts to aquatic biota, with intake velocities known to be protective of all life stages of fish and shellfish. The species most likely to be affected by impingement and entrainment is the threadfin shad, a species that is ubiquitous in the Monticello Reservoir and is known to be able to rebound quickly from impingement/entrainment losses or even mass die-offs caused by sudden changes in water temperature or low water temperatures.

Based on the fact that the proposed cooling-tower-based heat dissipation system would withdraw small amounts of water for makeup, the design of the new cooling water intake structure calls for low intake velocities that would reduce impingement and entrainment, the fish species most likely to be affected (threadfin shad) by operation of the circulating water intake structure has a high reproductive potential, and 25 years of operating experience suggests that the Monticello Reservoir fish populations have not been adversely affected by operation of the existing once-through unit, SCE&G concludes that cooling water structure intake impacts from the proposed Units 2 and 3 would be SMALL and would not warrant mitigation measures beyond the design features previously discussed.

5.3.2 DISCHARGE SYSTEMS

Cooling tower blowdown from Units 2 and 3 would be discharged into the Parr Reservoir by means of a new discharge structure with a diffuser line beginning 30 feet from the shoreline and extending 70 additional feet into the reservoir (Section 3.4). Other waste streams would also be routed through the discharge structure, but most of the flow would be cooling tower blowdown. The discussion of discharge system impacts is limited to the new units. Cumulative impacts of three units are discussed in Section 10.5.

5.3.2.1 Thermal Description and Physical Impacts

5.3.2.1.1 Conceptual Blowdown Thermal Model

The blowdown thermal model concentrates its analysis on the near-field, where plume temperature excess is greatest and in which mixing-zone definitions (temperatures and ΔT above ambient) apply. The ambient is defined as the flow and temperature condition of the Parr Reservoir, the body of water receiving the blowdown, before the proposed construction and operation of Units 2 and 3. Ambient temperatures and flows are defined by long-term measurements; discharge conditions are defined by concurrent long-term meteorological conditions (which affect the cooling tower blowdown temperature and flow).

The analysis first considers the reservoir as a natural river, with flow rates based on run of the river conditions. The 7-day 10-year low river flow (7Q10) is among the river conditions specified for the temperature analysis. The analysis then considers the effect that operation of the existing Fairfield Pumped Storage Facility, which uses the Parr Reservoir as its lower pool, has on the thermal plume. Flow reversals imposed by the Fairfield Pumped Storage Facility pumping water up from the Parr Reservoir to the upper pool, Monticello Reservoir, are analyzed.

5.3.2.1.2 Modeling of Blowdown Temperatures

As noted in Subsection 5.2.3, discharges from Units 2 and 3 would be permitted under the state of South Carolina's NPDES program, which regulates the discharge of pollutants into waters of the state. In this context, waste heat is regarded as thermal pollution and is regulated in much the same way as chemical pollutants. SCE&G used the CORMIX (Jirka, Doneker and Hinton 1996) Version 4.3 model to simulate the temperature distribution in the Parr Reservoir resulting from discharge of blowdown from proposed Units 2 and 3. CORMIX is a U.S. EPA-supported mixing zone model that emphasizes the role of boundary interactions to predict steady-state mixing behavior and plume geometry. It is widely used and recognized as a state-of-the-art tool for discharge mixing zone analyses (CORMIX 2007a). The model has been validated in numerous applications (CORMIX 2007b).

Five years (2001–2005) of hourly data from the Unit 1 meteorological station and the National Weather Service (Columbia Airport, approximately 26 miles southeast of the site) were evaluated for possible use in computer simulations of cooling tower thermal performance. Because the National Weather Service data (dry bulb temperature, dew point temperature) was more complete, and data from the two sites was similar, the National Weather Service data was used in the simulations. This region-specific meteorological data was used in conjunction with cooling tower design curves (supplied by the manufacturer) and historic reservoir temperatures to generate minimum, maximum, and mean blowdown temperatures and temperature differences (blowdown temperature minus reservoir temperature) for Units 2 and 3.

River temperature data from a U.S. Geological Survey water quality monitoring station at Parr Shoals Dam from the period October 1, 1996 through September 30, 2005 was used to characterize existing water temperatures in the Parr Reservoir. Long-term Broad River flows in the vicinity of VCSNS were synthesized from flows measured at upstream (Carlisle) and downstream (Alston) U.S. Geological Survey gaging stations and were conservative, as they were lower than flows estimated from the difference in drainage areas (ratio of downstream to upstream). Reservoir temperatures, blowdown temperatures, natural river flows, blowdown flows, the configuration of the discharge structure (*i.e.,* its orientation, length, number/spacing of ports), and the Parr Reservoir bathymetry data was used as inputs to the CORMIX model to simulate the distribution of water temperatures in the Parr Reservoir that would be expected across a range of plant operating conditions. These simulated temperature distributions were used to estimate the size (dimensions, surface area, and volume) of mixing zones that would be associated with a ΔT of 5°F (5°F higher than ambient) and river temperature of greater than 90°F, the two SCDHEC thermal standards that apply (SCDHEC 2004).

As discussed in Section 3.4 and elsewhere in this section, the normal operating mode would be four cycles of concentration. Should there be periods when the Monticello Reservoir contains high levels of dissolved and suspended solids, the plant may operate at two cycles of concentration in order to maintain circulating water concentrations within design limits. Discharge (blowdown) flow rates were simulated for each hour of the data period for both two- and four-cycle operation, however.

Tables 5.3-5 and 5.3-6 give the range of blowdown parameters for each month of the year, based on hourly simulations over a 5-year period. The right-hand columns show the range for the entire 5-year period.

Based on the 5-year hourly simulation, the maximum blowdown temperature is expected to be 91.8°F, in late summer (Table 5.3-5); the blowdown temperature is expected to exceed 90°F for less than nine hours per year (Toblin 2007). The maximum ΔT (blowdown temperature minus river temperature) would be 38.0°F, and would occur in winter (Table 5.3-6). A ΔT of 20°F was exceeded 24% of the hours during the 5-year period (Toblin 2007). Simulated ΔT values were highest in winter months, when river temperatures are lowest and cooling tower approach (cold water temperature – wet bulb temperature) is highest. The minimum ΔT of -6.1°F occurred in August. Negative ΔTs were seen 3% of the time; ΔTs less than -2.2°F were seen 0.5% of the time (Toblin 2007). Blowdown flows for four (normal discharge flow) and two (maximum discharge flow) cycles of concentrations are presented in Table 5.3-7 and 5.3-8.

The cooling water discharge conditions for which thermal plume calculations were performed were maximum blowdown temperature (max-T), maximum blowdown ΔT (max-ΔT), minimum ΔT (min-ΔT), and 5-year average (average). Two subcases were considered for max-ΔT: winter (November-April) and summer (May-October). Table 5.3-9 summarizes the discharge parameters modeled.

5.3.2.1.3 South Carolina Thermal Standards and Mixing Zone Regulations

The Broad River and its tributaries from the Tyger River to the Parr Shoals Dam are classified as "Freshwaters" (SCDHEC 2001). By regulation, the temperature of all free-flowing waters classified as freshwaters may not be increased more than 5°F (2.8°C) above natural temperature conditions and may not exceed a maximum of 90°F (32.2°C) as a result of the discharge of heated effluent unless a different site-specific temperature standard or mixing zone has been established or a Section 316(a) determination (variance) has been granted (SCDHEC 2004).

SCDHEC regulations allow mixing zones, areas where water quality standards for surface waters may be exceeded, but has a policy of limiting their use (SCDHEC 2004, Section C.10). Mixing zones are prohibited in freshwater areas when they would endanger public health, promote an undesirable or nuisance species, adversely affect a federally listed species, or interfere with the protection and propagation of a balanced indigenous community. The regulations do not provide specifics on mixing zone size(s), they simply state that the size of a mixing zone shall be kept to a minimum. SCDHEC has issued guidance, entitled "Whole Effluent Toxicity Implementation Guidance as Relates to the South Carolina Aquatic Life Protection Act of 2005," that provides more specific information on acceptable methods for establishing mixing zones and boundary zone conditions. This guidance suggests that boundary conditions for "chronic mixing permit conditions" be determined based on a boundary of one half the width of the stream (width) and a distance downstream of twice the width of the river (SCDHEC 2005).

5.3.2.1.4 Mixing Zones Analysis

Having established the SCDHEC requirements for thermal mixing zones, SCE&G conducted a mixing zone analysis, focusing on the portion of the discharge area that would have temperatures more than five degrees Fahrenheit above ambient and the area that would have temperatures greater than 90°F. The modeling assumed severe conditions: maximum ΔT, maximum discharge flows (two cycles of concentration), 7Q10 river flows, and Fairfield Pumped Storage Facility not operating. Discharge structure design and the Parr Reservoir bathymetry figured prominently in the mixing zone analysis and are touched on briefly in the paragraphs that follow.

5.3.2.1.5 Discharge Design

Subsection 3.4.2.2 describes the proposed discharge design. The unusual hydraulics of Parr Reservoir—flow is downstream when the Fairfield Pumped Storage Facility is generating and upstream when the Fairfield Pumped Storage Facility is pumping back—imposed constraints on discharge/diffuser design. The CORMIX manual (Jirka, Doneker, and Hinton, 1996) suggests an alternating diffuser design for fluctuating current flow (more typically tidal flow but imposed by

FPSF in this case), with alternate discharge nozzles pointed upstream and downstream.

5.3.2.1.6 Bathymetry

Subsection 2.3.1 describes bathymetric surveys of the Parr Reservoir that were conducted in 2006. Figure 2.3-7 shows bathymetric contours in the area proposed for the discharge structure. The proposed discharge structure would extend 100 feet into a relatively deep portion of the reservoir that appears to be associated with the old river channel.

Figure 5.3-1 shows the reservoir cross section at the proposed discharge location, with a closeup of the deepest part of the cross section where the diffuser line would be placed. Note that the figure is drawn with the vertical scales exaggerated so that details are clearly delineated. Figure 5.3-2 shows the cross sections 50 and 100 feet downstream from the proposed discharge location; the corresponding upstream cross sections look roughly the same. This reach of the reservoir encompasses the proposed mixing zone.

As depicted in Figure 5.3-1, the reservoir width is 600 feet and reaches a maximum depth of approximately 14 feet in the immediate area of the proposed discharge at minimum pool elevation. However, that depth decreases a foot within about 20 feet of the maximum in the cross-stream direction; a discharge depth of 13 feet was specified in CORMIX to simulate this near field geometry. The far field river depth was specified as 10 feet because CORMIX requires that the near field discharge depth be no more than 130% of the far field depth. Note that, for average reservoir elevation, the water surface is 5.8 feet higher than for normal minimum elevation as shown in Figure 5.3-1. The average elevation discharge depth was specified as 18 feet.

5.3.2.1.7 Discharge Mixing Zone

As discussed previously, the mixing zone is defined in terms of the 5°F temperature excess and 90°F river temperature. The temperature excess is taken relative to present reservoir conditions (Parr Shoals Dam and Fairfield Pumped Storage Facility operating). The proposed discharge 90°F isotherm is only applicable for the Max-T case. Linear, areal, and volume characteristics of the mixing zone for the proposed discharge are given in Table 5.3-10.

The two-cycle, Max-ΔT (winter) case, which corresponds to the maximum heat discharge to the reservoir, produced the largest mixing zone. Even for this case, the mixing zone is only 11% of the 1,200-foot length and 45% of the 300-foot width criteria imposed by the minimum reservoir width of 600 feet (Toblin 2007). Approximately 42% of the bank-to-bank cross-sectional area is impacted by the mixing zone for these conditions, while only 0.3% is impacted for average conditions. The volume of water affected by the mixing zone under the maximum heat discharge, 2.29×10^5 cubic feet, is 0.6% of the volume of water downstream of the mixing zone and above Parr Shoals Dam (Toblin 2007).

Figure 5.3-3 shows the Max-ΔT (winter) mixing zone in the reservoir for two-cycle operation. Note that the vertical axis is exaggerated in order to depict greater plume detail. Figure 5.3-4 provides a plan view of the plume in relation to the Parr Reservoir. The more typical four-cycle operation mixing zone would be smaller, as shown in Table 5.3-10, owing to the lesser flow and, thus, lesser heat being discharged.

The Fairfield Pumped Storage Facility is in generating mode for an average of 11.3 hours per day and in pumping mode for 9.6 hours per day (Toblin 2007). During the former, an average of 16,511 cfs passes through the facility with 2,614 cfs of that passing through the discharge cross section. During the latter, an average of 19,225 cfs passes through the facility with 3,004 cfs of that passing through the discharge cross section. Both pumping and generating mode flows at the discharge exceed the low flows used in the mixing zone analysis. Thus, the discharge mixing zone size during the average 20.9 hours per day of Fairfield Pumped Storage Facility operation would generally be bounded by the above results (Toblin 2007).

The mixing zone analysis, by assuming no Fairfield Pumped Storage Facility operation and 7Q10 flows, essentially represents a slack time in the fluctuating reservoir flow direction. These “slack” conditions result in unstable recirculation regions over the reservoir depth and include upstream intrusion of the discharge plume; the presented mixing zone sizes are a result of these hydrodynamics. However, there still could be short periods of time when flows are reversing, that ambient conditions are such that the effective dilution of the plume would be reduced below that of the conditions previously analyzed.

5.3.2.1.8 Discharge Mixing Zone During Flow Reversal

As discussed previously, the two-cycle Max-T (winter) case produced the largest discharge mixing zone. That case, which includes no Fairfield Pumped Storage Facility operations with 7Q10 downstream flows, was investigated with the additional condition of flow reversal imposed by average Fairfield Pumped Storage Facility pumping (3,004 cfs upstream flow) followed by downstream low flow. The reservoir temperatures preceding the flow reversal were calculated by assuming complete mixing of the discharge and reservoir flow. Such complete mixing would result from both the discharge-reservoir mixing and the turbulence of the flow reversal. Those pre-reversal temperatures were used as the reservoir temperature in CORMIX, with the allowable mixing zone temperature excess being decremented from 5°F by the completely mixed temperature excess. Table 5.3-11 gives the linear, areal, and volume characteristics of the mixing zone for the proposed discharge during these current reversal conditions.

Table 5.3-11 shows that the mixing zone 1,200-foot-long and 600-foot-wide criteria is met for these flow reversal conditions. The mixing zone criteria would continue to be met for the Max T (winter) case for upstream flows past the discharge as low as 1,620 cfs. That is, the discharge mixing zone criteria would be met during flow reversal from upstream flow at roughly half of the average

Fairfield Pumped Storage Facility pumping power for the very restrictive case of Max T (winter).

5.3.2.1.9 Bottom Scour

The cooling water system would typically be operating at four cycles of concentration. The discharge velocity for such operation would be in the range of 2.3 to 3.8 feet per second (fps) (minimum and maximum blowdown flow from Table 5.3-7 divided by the discharge port area). This compares to typical current velocities in the Parr Reservoir of 0.2 to 0.6 fps for low and average flow periods, respectively (Toblin 2007). During periods of two-cycle operation, discharge velocities would range from 6.9 to 11.3 fps (see Table 5.3-8 for blowdown flow range). In either case, the net downstream discharge momentum is zero because of the alternating (upstream and downstream) discharge port orientation. The discharge momentum would be dissipated in the near field recirculation region within which scouring is expected because of the vertical mixing in this region. The size of the near field recirculation region would be about 135 feet wide with lengths ranging from about 40 to 100 feet (Toblin 2007). Scouring would not be expected to be an issue because the Broad River has a relatively high sediment load and sediment is continually deposited in the Parr Reservoir upstream of the Parr Shoals Dam.

5.3.2.2 Aquatic Ecosystems

5.3.2.2.1 Thermal Effects

The CORMIX simulation indicates that the heated discharge (cooling tower blowdown) from the proposed new units would affect a small portion of the Parr Reservoir in the immediate area of the discharge structure. Discharge effects were evaluated in terms of both maximum allowable temperature (the 90°F state standard) and maximum allowable temperature increase (the 5°F state standard). The CORMIX simulation indicated that the >90°F plume would occupy a surface area less than 13,200 square feet (<0.30 acre) and a cross-sectional area of less than 1,757 square feet when cooling towers are employing two cycles of concentration, and a surface area of less than 12,500 square feet (<0.29 acre) square feet and a cross-sectional area of less than 1,757 square feet when cooling towers are employing four cycles of concentration. The corresponding volume of heated water for the two cases was less than 171,000 and 162,000 cubic feet, respectively. The CORMIX simulation indicated that the >5°F maximum T plume would occupy a surface area of 17,700 square feet (0.41 acre) and a cross-sectional area of 1,757 square feet when cooling towers are employing two cycles of concentration and a surface area of no greater than 7,260 square feet (0.17 acre) and a cross-sectional area of less than 1,757 square feet when cooling towers are employing four cycles of concentration. The corresponding volume of heated water for the two cases would be 229,000 and 94,300 cubic feet, respectively. As discussed previously in Subsection 5.3.2.1, the two-cycle, maximum ΔT case corresponds to the maximum heat discharge to the river and produced the largest thermal plume.

As shown in Tables 5.3-10 and 5.3-11, the thermal plume (as represented by the mixing zone) is expected to extend a relatively short distance across the Parr Reservoir, which is approximately 600 feet wide at the location of the proposed discharge structure at minimum pool elevation. Under two cycles of concentration and the maximum ΔT (winter) case, the thermal plume extends 135 feet across the reservoir and 133 feet downstream of the discharge structure. Even for this case, the thermal plume is relatively small: less than 25% of the reservoir's width at low pool is involved. Under the maximum ΔT (summer) temperature case, the thermal plume extends less than 135 feet across the reservoir and less than 97.5 feet downstream from the discharge.

Because most of the reservoir would be unaffected by the blowdown, even under extreme (worst-case) conditions, the thermal plume would not create a barrier to upstream or downstream movement of fish. As discussed in Subsection 2.4.2, there are no diadromous fish species in the Broad River upstream of the Parr Shoals Dam. There would be no thermal impacts beyond some thermally sensitive species possibly avoiding the immediate area of the discharge opening. Impacts to aquatic communities would be SMALL and would not warrant mitigation.

5.3.2.2.2 Chemical Impacts

As discussed in Subsection 5.2.2, operation of the new cooling towers would be based on four cycles of concentration, meaning that solids and chemical constituents in makeup water would be concentrated four times before being discharged. As a result, levels of solids and organics in cooling tower blowdown would be approximately four times higher than the Monticello Reservoir concentrations. However, because the blowdown stream would be very small relative to the flow of the Broad River, concentrations of solids and chemicals used in cooling tower water treatment would return to near-ambient levels almost immediately downstream of the discharge pipe. The projected maximum blowdown flow of 30,347 gpm (which corresponds to two-cycle operation, i.e., solids and chemicals would be concentrated two times rather than four) is 0.63 to 1.71% of the average flow and 7.9% of the 7Q10 flow for the Broad River at Alston, South Carolina, 1.2 miles downstream of the Parr Shoals Dam (see Section 5.2, Table 5.2-1). This equates to a dilution factor of 58 to 157 when compared to average monthly Broad River flows and a dilution factor of 12.6 when compared to 7Q10 flow. The discharge would be permitted by SCDHEC and comply with applicable state water quality standards (SCDHEC Water Classifications and Standards, Regulation 61-68). Any impacts to aquatic biota from solids and chemicals in cooling tower blowdown would be SMALL and would not warrant mitigation.

5.3.2.2.3 Physical Impacts

When operating at four cycles of concentration, the discharge velocity would be in the range of 2.3 to 3.8 fps. Because of these relatively low discharge velocities and rapid plume dilution, only minor scouring of the river bottom is expected.

During periods of two-cycle operation, discharge velocities would range from 6.9 to 11.3 fps and somewhat more scouring could be expected.

The size of the area affected would be approximately 135 feet wide by 100 feet long, or 0.3 acre. Other than a local reduction in numbers of benthic organisms, there would be no effect on the Parr Reservoir macrobenthos or fish. No important aquatic species or its habitat would be affected. Physical impacts to aquatic communities would therefore be SMALL and would not warrant mitigation.

5.3.3 HEAT DISSIPATION SYSTEMS

5.3.3.1 Heat Dissipation to the Atmosphere

SCE&G would use two circular mechanical draft cooling towers for each AP1000 unit to remove excess heat from the circulating water system. Cooling towers evaporate water to dissipate heat to the atmosphere. The evaporation is followed by partial recondensation which creates a visible mist or plume. The plume creates the potential for shadowing, fogging, icing, localized increases in humidity, and possibly water deposition. In addition to evaporation, small water droplets drift out of the tops of the cooling towers. The drift of water droplets can deposit dissolved solids on vegetation or equipment.

For Units 2 and 3, SCE&G modeled the impacts from fogging, icing, shadowing, and drift deposition using EPRI's Seasonal/Annual Cooling Tower Impact prediction code. This code incorporates the modeling concepts presented by Policastro et al. (1994), which were endorsed by NRC in NUREG-1555 (U.S. NRC 1999). The model provides predictions of seasonal and annual cooling tower impacts from mechanical or natural draft cooling towers. It predicts average plume length, rise, drift deposition, fogging, icing, and shadowing, providing results that have been validated with experimental data (Policastro et al. 1994).

Engineering data for the AP1000 was used to develop input to the Seasonal/Annual Cooling Tower Impact model. As described in Section 3.4, the model assumed four identical cooling towers, each with a heat rejection rate of 3.8×10^9 Btu's per hour and circulating water flows of 300,000 gpm. The tower height was set at 70 feet. Although the cooling towers could operate from two to four cycles of concentration, four cycles of concentration were assumed for the analysis. The meteorological data were from the Unit 1 meteorological tower for the year 2004, which had the most complete data set, and from the National Climatic Data Center for the Columbia Metropolitan Airport.

5.3.3.1.1 Length and Frequency of Elevated Plumes

The Seasonal/Annual Cooling Tower Impact code calculated the expected plume lengths for each season by direction for the combined effect of four mechanical draft cooling towers. The plumes would occur in all compass directions. The average plume length and height was calculated from the frequency of occurrence for each plume by distance from the tower. The median plume length and height is the distance where half of all the plumes would be expected to be shorter than that distance. The average plume length would range from 1.0 miles in the summer season to 2.8 miles in the winter season. The annual prediction for the average plume length is 1.8 miles from the cooling towers. The median plume length would range from one-fifth of a mile during the summer and spring seasons to 2.5 miles in the winter season. The annual prediction for the median plume length is 0.37 miles. The average plume height is consistent throughout the year and ranges from 970 feet to 2,000 feet. The median plume height would range from 360 feet in the spring and summer seasons to 3,300 feet for the winter. The annual prediction for the median plume height would be 560 feet. The average plume height or length is different from the median height or length and reveals characteristics of the plumes. When the median is smaller than the average, as in the case of the plume length and height, it reveals that the majority of the visible plumes are shorter than the average length.

The cooling tower plumes would occur in each direction of the compass and would be spread over a wide area, reducing the time that the plume would be visible from a particular location. The average plume lengths would be relatively short and would not leave the site boundary during the spring and summer seasons. The visible plume would resemble clouds from a distance, and would not be distinguishable from existing clouds during overcast weather conditions. Due to the varying directions and short average plume lengths, impacts from elevated plumes would be SMALL and not warrant mitigation.

Modeled plumes from proposed cooling towers would be as follows:

	Winter	Spring	Summer	Fall	Annual
Predominant direction	East	North	East-northeast	West-southwest	East
Average plume length (miles)	2.8	1.2	1.0	2.1	1.8
Median plume length (miles)	2.5	0.19	0.19	0.43	0.37
Average plume height (feet)	2,000	1,100	970	1,500	1,400
Median plume height (feet)	3,300	360	360	660	560

5.3.3.1.2 Ground-Level Fogging and Icing

Fogging from the mechanical draft cooling towers occurs when the visible plume intersects with the ground, appearing like fog to an observer. Fogging is only predicted to occur in the winter. The fogging is predicted to last between 6 and 45 minutes and would be to the southwest and west-southwest on SCE&G land from 1,300 to 4,600 feet from the towers. Natural fogging occurs approximately 31 to 35 days per year in the vicinity and approximately 26 days per year at the Columbia, South Carolina National Weather Service station.

Icing from the mechanical draft cooling towers is the result of ground-level fogging when ambient temperatures are below freezing. The accumulation of ice on trees could cause limbs to bend and break. Icing is not predicted to occur from the operation of the cooling towers.

Because fogging would occur so infrequently and in remote areas and icing is not predicted to occur, impacts from fogging or icing would be SMALL and not warrant mitigation.

5.3.3.1.3 Solids Deposition

Water droplets drifting from the cooling towers would have the same concentration of dissolved and suspended solids as the water in the cooling tower basin. As these droplets evaporate, either in the air or on vegetation or equipment, they deposit these solids. The water in the cooling tower basin is assumed to have solid concentrations four times that of the Monticello Reservoir, the source of cooling water makeup. All solids deposited are assumed to be composed of salt, for comparison with the NUREG-1555 significance level for visible impacts to vegetation of 8.9 pounds of salt deposition per acre per month.

The maximum predicted salt deposition rate from the towers would be as follows:

Maximum deposition (lbs/acre-month)	0.012
Distance to maximum deposition (feet)	980
Direction to maximum deposition	Northeast
Maximum deposition at the Unit 2 and 3 switchyard (lbs/acre-month)	0.00027
Maximum deposition at the Unit 1 switchyard (lbs/acre-month)	0.00036

The maximum predicted salt deposition is 0.012 pounds per acre per month. This is much less than the NUREG-1555 significance level for possible visible effects to vegetation of 8.9 pounds per acre per month. NRC (U.S. NRC1996) reports that visible damage from salt deposition to terrestrial vegetation at operating nuclear power plants with mechanical draft cooling towers has not been observed. The impacts from the proposed cooling towers are not expected to be different from the impacts of the currently operating nuclear power plants.

The switchyard for Units 2 and 3 is located to the northwest, approximately 3,500 feet from the proposed location of the cooling towers. A maximum predicted salt deposition of 0.00027 pounds per acre per month would be expected at this location during the fall season. The switchyard for Unit 1 is located to the north, approximately 4,000 feet from the proposed location of the cooling towers. The salt deposition at this location, 0.00036 pounds per acre per month in the spring season, is slightly larger than the salt deposition at the Units 2 and 3 switchyard, although it is farther away. This is due to the cooling tower alignment in a north-south direction, allowing impacts from cooling towers to sum in those directions. An existing transmission line parallels the cooling towers approximately 600 feet to the east. The code predicted minimal salt deposition at this location.

The predicted salt deposition from the operation of the cooling towers would be much less than the NUREG-1555 significance level where visible effects may be observed. Salt deposition in other areas, including at the Unit 1 switchyard, and Units 2 and 3 switchyard are not expected to impact these facilities. The impact from salt deposition from the cooling towers would be SMALL and would not require mitigation.

5.3.3.1.4 Cloud Shadowing and Additional Precipitation

Vapor from cooling towers can create clouds or contribute to existing clouds. Rain and snow from vapor plumes are known to have occurred. The Seasonal/Annual Cooling Tower Impact code predicted the precipitation expected from the proposed cooling towers. The maximum precipitation would occur during the fall, with a seasonal total of less than an inch of precipitation at 1,600 feet west-southwest of the towers. This value is very small compared to the annual precipitation of 38 inches from the year of meteorological data used in this analysis. The average annual rainfall at Columbia is 47 inches (for the period 1948-2005) (SCSCO 2006). Impacts from precipitation would be SMALL and would not require mitigation.

The formation of clouds could also prevent sunlight from reaching the ground, or cloud shadowing. This is especially important for agricultural fields or other sensitive areas. As shown in Figure 2.2-2, the closest agricultural area is approximately 1 mile to the southeast; the most extensive agricultural area in the vicinity of the proposed site is approximately 2 miles to the west-northwest; and a large wetland is present approximately 4 miles to the west of the proposed cooling towers. The Seasonal/Annual Cooling Tower Impact code predicted that shadowing at the closest agricultural area would occur for a maximum of 7 hours per month during the winter season and 19 hours annually. The predicted shadowing at the most extensive agricultural area is approximately 8 hours per month during the fall season with 15 hours annually. Shadowing at the large wetland would occur for a maximum of 6 hours during the winter season and 12 hours annually. The impacts from cloud shadowing at other agricultural areas within the site vicinity would be less than the shadowing for the three areas discussed above. Due to the limited amount of agricultural areas and short duration of the shadowing at those and other sensitive areas, the impacts from cloud shadowing would be SMALL and would not require mitigation.

5.3.3.1.5 Interaction with Existing Pollution Sources

The closest significant pollution sources to the cooling towers are combustion turbines located at the Parr Reservoir. These are simple cycle combustion turbines used for peaking or off-normal system conditions. These combustion turbines are more than 1.25 miles from the closest cooling tower.

Several small intermittently operated pollution sources are located at the existing Unit 1. An auxiliary boiler located at Unit 1 has been abandoned in place. A rented portable oil fired boiler is brought in to supply steam for startups following refueling outages. Two 6000-horsepower emergency diesel generators are run for testing and to supply AC power if normal offsite power is lost. A small incinerator is used periodically to dispose of contaminated used oil. Impacts would be SMALL and would not require mitigation.

5.3.3.1.6 Ground-Level Humidity Increase

Potential increases in the absolute and relative humidity could result from the operation of the proposed cooling towers. Most of the water evaporated in the cooling tower is buoyant and dissipates into the atmosphere. A small fraction of this evaporated water may not be as buoyant and could increase the ground level humidity. Specific meteorological conditions could also limit the dissipation into the atmosphere, but would be infrequent. The ground level increases in humidity would occur in the immediate vicinity of the cooling towers, on developed land. The impacts from increases in absolute and relative humidity would be SMALL and mitigation would not be warranted.

5.3.3.2 Terrestrial Ecosystems

Heat dissipation systems associated with nuclear power plants have the potential to impact terrestrial ecosystems through salt drift, vapor plumes, icing, precipitation modifications, noise, and bird collisions with structures (e.g., cooling towers). Each of these topics is discussed below.

5.3.3.2.1 Salt Drift

Vegetation near the cooling towers could be subjected to salt deposition attributable to drift from the towers. Salt deposition could potentially cause vegetation stress, either directly by deposition of salts onto foliage or indirectly from accumulation of salts in the soil.

An order-of-magnitude approach was used to evaluate salt deposition on plants, since some plant species are more sensitive to salt deposition than others, and tolerance levels of most species are not known with precision. Deposition of sodium chloride at rates of approximately 1 to 2 pounds per acre per month is generally not damaging to plants, while deposition rates approaching or exceeding 8.9 pounds per acre per month in any month during the growing season could cause leaf damage in many species (NUREG-1555). An alternate approach for evaluating salt deposition is to use 8.9 to 18 pounds per acre per month of sodium chloride deposited on leaves during the growing season as a general threshold for visible leaf damage (NUREG-1555).

As presented in Subsection 5.3.3.1.3, the maximum expected salt deposition rate from the combination of all four towers would be 0.012 pounds per acre per month. This maximum rate is less than 1% of the 8.9 pounds per acre per month rate that is considered a threshold value for leaf damage in many species. Any impacts from salt drift on the local terrestrial ecosystems would therefore be SMALL and would not warrant mitigation. Cumulative impacts are discussed in Section 10.5.

5.3.3.2.2 Vapor Plumes and Icing

As concluded in Subsection 5.3.3.1.1, the expected average plume length would range from 1.0 to 2.8 miles, and the expected median plume length would range from 0.19 to 2.5 miles. As discussed in Subsection 5.3.3.1.2, ground level fogging is expected only during winter, and the predicted total duration would be between 6 and 45 minutes. Therefore, the impacts of fogging and icing on terrestrial ecosystems would be SMALL and would not warrant mitigation.

5.3.3.2.3 Precipitation Modifications

As discussed in Subsection 5.3.3.1.4, the predicted maximum precipitation from the cooling towers would be less than an inch. This amount is very small compared to the average annual precipitation of approximately 47 inches at Columbia (26 miles southeast of the site) over the 1948 to 2005 period (SCSCO 2006). Thus, additional precipitation resulting from operation of the proposed units on local terrestrial ecosystems would be SMALL and would not warrant mitigation.

5.3.3.2.4 Noise

Noise from the operation of each cooling tower would be about 71 dBA at 200 feet from the tower. Each cooling tower would be about 285 feet from the adjacent cooling tower. This level is below the 80 to 85 dBA threshold at which birds and small mammals are startled or frightened (Golden et al. 1980). Thus, it is likely that noise from each tower would not disturb wildlife beyond 200 feet from the tower. Furthermore, the closest natural habitat would be beyond the transmission corridor running parallel to the cooling towers, which is more than 600 feet away. Therefore, noise impacts to terrestrial ecosystems would be SMALL and would not warrant mitigation.

5.3.3.2.5 Avian Collisions

As discussed in Subsection 5.3.3.1, the mechanical draft cooling towers associated with Units 2 and 3 would be 70 feet high. Although natural draft cooling towers have been associated with bird kills, the relatively low height of mechanical draft cooling towers cause negligible mortality (U.S. NRC 1996). Therefore, impacts to bird species from collisions with the cooling towers would be SMALL and would not warrant mitigation.

5.3.4 IMPACTS TO MEMBERS OF THE PUBLIC

This section describes the potential health impacts associated with the cooling system for the proposed Units 2 and 3. Specifically, impacts to human health from thermophilic microorganisms and from noise resulting from operation of the cooling system are addressed.

As described in Section 3.4, a closed-cycle cooling system would be used for the new units. Because the system would use mechanical draft cooling towers, thermal discharges would be to the atmosphere.

5.3.4.1 Thermophilic Microorganism Impacts

Consideration of the impacts of thermophilic microorganisms on public health are important for facilities using cooling ponds, lakes, canals, or small rivers, because use of such water bodies may significantly increase the presence and numbers of thermophilic microorganisms. Organisms of concern include the 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. These microorganisms are the causative agents of potentially serious human infections, the most serious of which is attributed to *Naegleria fowleri*.

Pathogenic bacteria has evolved to survive in the digestive tracts of mammals and, accordingly, have optimum temperatures of around 99°F (Joklik and Smith 1972). Many of these pathogenic microorganisms (e.g., Pseudomonas, Salmonella, and Shigella) are ubiquitous in nature, occurring in the digestive tracts of wild mammals and birds (and thus in natural waters), but are usually only a problem when the host is immunologically compromised. Thermophilic bacteria generally occur at temperatures of 77°F to 176°F, with maximum growth at 122°F to 140°F (Joklik and Smith 1972, pg. 65).

Naegleria fowleri is a free-living amoeba that occurs worldwide. It is present in soil and virtually all natural surface waters such as lakes, ponds, and rivers. *Naegleria fowleri* grows and reproduces well at high temperatures (104° to 113°F) and has been isolated from waters with temperatures as low as 79.7°F. (TtNUS 2001)

It should also be noted that waterborne-disease outbreaks are generally rare and depend on specific exposure conditions. The Centers for Disease Control and Prevention (CDC) reports on waterborne-disease outbreaks throughout the United States. From 1977 to 1998, 18 states reported 32 outbreaks associated with recreational water, which includes both thermophilic and non-thermophilic microorganisms as confirmed etiological agents (CDC 2000). Most of the outbreaks associated with thermophilic microorganisms involved swimming and wading pools, hot tubs, and springs. Fecal contamination was frequently a contributing factor. In 1998, only four cases of disease attributable to *Naegleria* were confirmed in the entire United States (CDC 2000). *Naegleria* infection usually only occurs in warm weather environments, when water near the bottom of a lake is forced up the nasal passage of a swimmer, and when pollution appears to be a factor (U.S. EPA 1979). However, studies have shown the absence of *Naegleria* infection and related diseases among swimmers in lakes with relatively high numbers of the pathogenic organisms present (U.S. EPA 1979).

Subsection 5.3.2 describes the thermal plume expected from cooling tower blowdown to the Parr Reservoir. Theoretically, thermal additions to the Parr Reservoir from cooling tower blowdown could support *Naegleria fowleri* and other thermophilic microorganisms. However, the thermal charge would have maximum temperatures in the range of 91.8°F (Table 5.3-5) with a very small mixing zone (Table 5.3-10), thus limiting the conditions necessary for optimal growth. The maximum recorded temperature in the Parr Reservoir in 2004 was 84.6°F (Table 2.3-19). Parr Reservoir temperatures are not optimal for *Naegleria fowleri* reproduction. Therefore, the risk to public health from thermophilic microorganisms would be SMALL and would not warrant mitigation.

As part of license renewal activities for Unit 1, SCE&G wrote SCDHEC requesting information on any studies the agency might have conducted of thermophilic microorganisms in the Monticello Reservoir and any concerns the agency might have relative to these organisms. SCDHEC's response indicated that public health hazards from thermophilic microorganisms are largely theoretical and do not represent a significant health threat to offsite users of the Monticello Reservoir's waters. (SCE&G 2002)

Fecal coliform bacteria are regarded as indicators of other pathogenic microorganisms, and are the organisms normally monitored by state health agencies. The NPDES permit for Unit 1 requires monitoring of fecal coliforms in sewage treatment plant effluent (after discharge from the chlorine contact chamber and before mixing with other waste streams). Samples are collected for fecal coliform analysis and other parameters twice per month. The NPDES permit specifies a maximum 30-day average of 200 organisms per 100 milliliter sample (200/100 ml), and a daily maximum of 400/100 ml. Based on NPDES discharge monitoring reports from 1995 through 2005, neither of these limits was exceeded during any sampling event.

5.3.4.2 Noise Impacts

Units 2 and 3 would produce noise from the operation of pumps, cooling towers, transformers, turbines, generators, switchyard equipment, and loudspeakers. NUREG-1555 notes that the principal sources of noise include cooling towers and pumps that supply the cooling water. The exclusion area boundary is at least 3,390 feet in all directions from the center of the Units 2 and 3 footprint and 1,300 feet from the closest of the planned cooling towers. This distance and vegetation would attenuate any noise. SCE&G has not received complaints about the noise of Unit 1. Subsection 2.7.7 describes the existing noise environment at VCSNS.

Most equipment would be located inside structures, reducing the outdoor noise level. Fishermen, canoeists and kayakers on the Monticello Reservoir would hear the makeup water pumps. However, this noise would be further attenuated by the one mile distance from the intake pumps to the exclusion area boundary. The diesel generators (which would operate intermittently) and the cooling towers could have noise emissions as high as 55 dBA at distances of 1,000 feet (Westinghouse 2003). As described in Subsection 5.8.1, the nearest residence is about 5,800 feet away from the planned cooling towers location.

Neither the state of South Carolina nor Fairfield County has regulations or guidelines on environmental noise. As reported in NUREG-1437, and referenced in NUREG-1555, noise levels below 60 to 65 dBA are considered of small significance. Therefore, the noise impact at the nearest residence would be SMALL and no mitigation would be warranted.

Commuter traffic would be controlled by speed limits. The access road to the Units 2 and 3 site would be paved. Good road conditions and appropriate speed limits would minimize the noise level generated by the work force commuting to the VCSNS site.

Section 2.7 of Regulatory Guide 4.2 (U.S. NRC 1976) suggests an assessment of the ambient noise level within 5 miles of the proposed site; particularly noises associated with high-voltage transmission lines. No noise assessment has been done due to the rural character of the area. However, as presented in Subsection 5.6.3.3. SCE&G has not received any reports of nuisance noise from the existing transmission lines. It is unlikely any new lines would generate more noise than existing lines.

Section 5.3 References

1. Alabama Dept. of Conservation (Alabama Department of Conservation and Natural Resources) 2001. *So What Good is a Shad, Anyway?* From Outdoor Alabama, online edition. Available at http://www.outdooralabama.com/education/publications/fnashad.cfm.

2. Armstrong, D. 2001. *Relationship of shad to largemouth bass in Alabama.* From Outdoor Alabama, online edition. Available at http://www.outdooralabama.com/education/publications/fnashad-lmb.cfm.

3. Jenkins, R. E. and N. M. Burkhead. 1994. *Freshwater Fishes of Virginia*. American Fisheries Society, Bethesda, Maryland, 1994.

4. CATF (Clean Air Task Force) 2004. *Regulating Cooling Water Use at Existing Power Plants: an Overview of the Decision Before EPA,* Fact sheet prepared by Clean Air Task Force, Boston, Massachusetts, 2004.

5. CDC (Centers for Disease Control and Prevention) 2000. *Surveillance for Waterborne-Disease Outbreaks United States, 1977 1998*. Volume 49, No. SS-4, Atlanta, Georgia, 2000.

6. Christie, W. W. and R. M. Stroud 1998. *Fisheries Investigations in Lakes and Streams, District IV. Annual Program Report F-63*, S.C. Department of Natural Resources, Columbia, South Carolina, 1998.

7. CORMIX 2007a. *CORMIX Mixing Zone Applications,* Available at http://www.cormix. info/applications.php.

8. CORMIX 2007b. *Independent CORMIX Validation Studies,* Available at http://www.cormix.info/validations.php.

9. Dames & Moore, 1985. 316(b) *Demonstration for the Virgil C. Summer Nuclear Station for the South Carolina Department of Health and Environmental Control and the Nuclear Regulatory Commission*. Prepared by for SCE&G by Dames & Moore Environmental Consultants, Atlanta, Georgia, March 1985.

10. DeVries, D. R., R. A. Stein, J. G. Miner, and G. G. Mittelbach. 1991. *"Stocking Threadfin Shad: Consequences for Young-of-the-Year Fishes,* Transactions of American Fisheries Society 120: 368-381, 1991.

11. Geosyntec (Geosyntec Consultants) 2005. *Source Water Physical Data Characterization of the Cooling Water Source Waterbody for the Virgil C. Summer Nuclear Station,* Prepared for SCE&G by Geosyntec Consultants, Kennesaw, Georgia, September. 2005.

12. Geosyntec (Geosyntec Consultants) 2006. *Preliminary Report of Fish Impingement Mortality at the V.C. Summer Nuclear Station,* Prepared for SCE&G by Geosyntec Consultants, Kennesaw, Georgia, October 2006.

13. Golden, J., R. P. Ouellette, S. Saari, and P. N. Cheremisinoff 1980. Chapter 8: "Noise" in *Environmental Impact Data Book*. Second Printing. Ann Arbor Science Publishers, Inc. Ann Arbor, Michigan, 1980.

14. Griffith, J.S. 1978. *Effects of Low Temperature on the Survival and Behavior of Threadfin Shad, Dorosoma Petenense,* Transactions of American Fisheries Society 107(1): 63-70, 1978.

15. Grumbles, B. 2007. *Implementation of the Decision in Riverkeeper, Inc. v. EPA, Remanding the Cooling Water Intake Structures Phase II Regulation*, Memorandum to Regional Administrators, March 20, 2007.

16. Jirka, Doneker, and Hinton, 1996. *"User's Manual for Cormix: A Hydrodynamic Mixing Zone Model and Decision Support System for Pollutant Discharges into Surface Waters,"* Office of Science and Technology, U.S. EPA, Washington, D.C. September 1996.

17. Joklik, W. K. and D. T. Smith (eds.). 1972. *Microbiology,* 15th edition. Appleton-Century-Crofts. New York, New York, 1972

18. Kilambi, R.V. and R.E. Baglin 1969. "Fecundity of the Threadfin Shad, *Dorosoma petenense*, in Beaver and Bull Shoals Reservoirs," Transactions of American Fisheries Society 98(2): 320-322.

19. Mettee, M. F., P. E. O'Neil, and J.M. Pierson, 1996. *Fishes of Alabama and the Mobile Basin*. Oxmoor House, Birmingham, Alabama, 1996.

20. Oines, G., K. V. Root, L. Ginzburg, and S. Ferson, 1997. *Assessment of Population-Level Threat from Entrainment at Russell Dam on Thurmond Reservoir Fishes*, Prepared by Applied Biomathematics under contract to U.S. Army Corps of Engineers, Abstract available at http://www.ramas.com/russdam.htm.

21. Policastro, A. J., W. E. Dunn, and R. A. Carhart 1993,.*A Model for Seasonal and Annual Cooling Tower Impacts*. Atmospheric Environment Volume 28, No. 3. Pages 379-395. Elsevier Science Ltd., Great Britain, 1993.

22. Power Scorecard 2000. *Consumption of Water Resources, Fact Sheet prepared by Power Scorecard*, a publication of Pace University, White Plains, NY. CORMIX 2007a. CORMIX Mixing Zone Applications. Available at http://www.cormix.info/applications.php.

23. SCDHEC (South Carolina Department of Health and Environmental Control) 2001. *Watershed Water Quality Assessment, Broad River Basin,* Technical Report No. 001-01. June 2001.

24. SCDHEC (South Carolina Department of Health and Environmental Control) 2004. *Water Classifications and Standards,* Regulation 61-68, South Carolina Department of Health and Environmental Control, June 25.

25. SCDHEC 2005. *Whole Effluent Toxicity (WET) Implementation Guidance As Relates to the South Carolina Aquatic Life Protection Act of 2005,* South Carolina Department of Health and Environmental Control, July 2005.

26. SCE&G 2002. *Applicant's Environmental Report, Operating License Stage*, *Virgil C. Summer Nuclear Station*. August 2002.

27. SCSCO (South Carolina State Climatology Office) 2006. *Monthly Climate Summary, Columbia Airport.* Available at http://cirrus.dnr.state.sc.us/cgi-bin/sercc/cliRECtM.pl?sc1939, accessed November 2, 2006.

28. TtNUS (Tetra Tech NUS, Inc.) 2001. *Review of Scientific Literature on Thermophilic Microorganisms, With Emphasis on Factors Limiting Their Distribution and Abundance,* Tetra Tech NUS Reference Report, TtNUS-01-02-23. February 2001.

29. Toblin, 2007. *Temperature Distribution in Parr Reservoir on the Broad River as a Result of Blowdown from Proposed 2-Unit AP1000 Operation at V.C. Summer Station,* prepared by Tetra Tech NUS for SCE&G, 2007.

30. U.S. EPA 1979. *Pathogenic Naegleria – Distribution in Nature*, EPA-622/1-79-018, Health Effects Research Laboratory, Cincinnati, Ohio., 1979.

31. U.S. NRC 1976. *Preparation of Environmental Reports for Nuclear Power Stations,* NUREG-099, Regulatory Guide 4.2, Revision 2. Office of Nuclear Reactor Regulation. Washington, D.C. July 1976.

32. U.S. NRC 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants,* NUREG-1437, Volume 1, Office of Nuclear Regulatory Research, U.S. NRC, Washington, D.C. May 1996.

33. U.S. NRC 1999. *Environmental Standard Review Plans for Environmental Reviews for Nuclear Power Plants*, NUREG-1555, Washington, D.C. October 1999.

34. Westinghouse 2003. *AP1000 Siting Guide: Site Information for an Early Site Permit Application*, APP-0000-XI-001, Revision 3. April. 2003.

Table 5.3-1
Estimated Annual Impingement at the Existing Unit 1 Circulating Water Intake System

Species	Actual Number of Organisms Impinged	Relative Abundance of Impinged Organisms	Extrapolated Values[a]	
			Annual Estimate	"Upper Confidence Limit"
gizzard shad	25	4.4%	380	399
threadfin shad	288	50.2%	4,377	4,593
snail bullhead	2	0.3%	30	32
white catfish	15	2.6%	228	239
flat bullhead	3	0.5%	46	48
blue catfish	70	12.2%	1,064	1,116
channel catfish	68	11.8%	1,033	1,084
white perch	54	9.4%	821	861
flier	1	0.2%	15	16
warmouth	1	0.2%	15	16
bluegill	6	1.0%	91	96
hybrid sunfish	1	0.2%	15	16
yellow perch	35	6.1%	532	558
grass shrimp	1	0.2%	15	16
crayfish	4	0.7%	61	64
Total	574	100%	8,723	9,154

a) Based on Monte Carlo simulations (Geosyntec 2006)

Table 5.3-2
Estimated Biomass (weight) of Fish Impinged Annually at Unit 1 Circulating Water Intake System

Species	Actual Weight of Organisms Impinged (*kg*)	Relative Abundance	Extrapolated Numbers[a]	
			Annual Estimate (*kg*)	"Upper Confidence Limit" (*kg*)
gizzard shad	1.022	12.9%	14.9	15.9
threadfin shad	0.549	6.9%	8.0	8.6
snail bullhead	0.050	0.6%	0.7	0.8
white catfish	0.589	7.4%	8.6	9.2
flat bullhead	0.084	1.1%	1.2	1.3
blue catfish	1.272	16.1%	18.5	19.9
channel catfish	0.985	12.5%	14.4	15.4
white perch	2.893	36.6%	42.1	45.1
flier	0.001	0.0%	<0.1	<0.1
warmouth	0.005	0.1%	0.1	0.1
bluegill	0.116	1.5%	1.7	1.8
hybrid sunfish	0.052	0.7%	0.8	0.8
yellow perch	0.271	3.4%	3.9	4.2
grass shrimp	0.001	0.0%	<0.1	<0.1
crayfish	0.017	0.2%	0.2	0.3
Total	7.9	100%	115.1	123.4

a) Based on Monte Carlo simulations (Geosyntec 2006).

Table 5.3-3
Number of Fish Projected to be Impinged Annually at Units 2 and 3 Cooling Water Intake Structure

Species	Normal flow	Normal flow (Upper Confidence Limit)	Maximum flow	Maximum flow (Upper Confidence Limit)
gizzard shad	25.8	27.1	41.9	44.0
threadfin shad	297.3	312	482.8	506.6
snail bullhead	2.0	2.2	3.3	3.5
white catfish	15.5	16.2	25.1	26.4
flat bullhead	3.1	3.3	5.1	5.3
blue catfish	72.3	75.8	117.4	123.1
channel catfish	70.2	73.6	113.9	119.6
white perch	55.8	58.5	90.6	95.0
flier	1.0	1.1	1.7	1.8
warmouth	1.0	1.1	1.7	1.8
bluegill	6.2	6.5	10.0	10.6
hybrid sunfish	1.0	1.1	1.7	1.8
yellow perch	36.1	37.9	58.7	61.5
grass shrimp	1.0	1.1	1.7	1.8
crayfish	4.1	4.3	6.7	7.1
Total	592.6	621.8	962.1	1009.7

Table 5.3-4
Biomass of Fish Projected to be Impinged Annually at Units 2 and 3 Cooling Water Intake Structure (Kilograms)

Species	Normal flow	Normal flow (Upper Confidence Limit)	Maximum flow	Maximum flow (Upper Confidence Limit)
gizzard shad	1.0	1.1	1.6	1.8
threadfin shad	0.5	0.6	0.9	0.9
snail bullhead	0.0	0.1	0.1	0.1
white catfish	0.6	0.6	0.9	1.0
flat bullhead	0.1	0.1	0.1	0.1
blue catfish	1.3	1.4	2.0	2.2
channel catfish	1.0	1.1	1.6	1.7
white perch	2.9	3.1	4.6	5.0
flier	0.0	0.0	0.0	0.0
warmouth	0.0	0.0	0.0	0.0
bluegill	0.1	0.1	0.2	0.2
hybrid sunfish	0.1	0.1	0.1	0.1
yellow perch	0.3	0.3	0.4	0.5
grass shrimp	0.0	0.0	0.0	0.0
crayfish	0.0	0.0	0.0	0.0
Total	7.8	8.4	12.7	13.6

Table 5.3-5
Monthly and Five-Year Blowdown Temperatures (°F)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Five Year
Min	61.1	62.3	63.1	67.3	71.4	75.6	80.2	77.3	72.1	65.3	64.5	62.1	61.1
Average	70.8	71.9	74.8	77.9	81.6	85.1	86.6	86.2	83.5	79.3	75.5	71.1	78.7
Max	83.9	83.9	84.6	87.1	88.3	89.7	91.3	91.8	89.7	88.3	87.5	83.9	91.8

Source: Toblin (2007)

Table 5.3-6
Monthly and Five-Year T (Blowdown Temperature Excess Above Ambient Reservoir, °F)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Five Year
Min	12.4	10.1	6.2	-2.7	-2.5	-5.5	-4.9	-6.1	-4.4	-2.2	3.1	8.3	-6.1
Average	24.0	22.7	20.0	14.1	9.9	6.2	3.9	3.2	4.7	9.6	15.4	20.7	12.8
Max	36.7	38.0	34.0	26.3	20.8	19.1	13.2	10.3	14.2	20.9	31.5	35.8	38.0

Source: Toblin (2007)

Table 5.3-7
Blowdown Flow for Four Cycles of Concentration Operation (gpm Per Unit)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Five Year
Min	2,916	2,954	2,970	3,181	3,377	3,597	3,767	3,638	3,397	3,036	3,007	2,948	2,916
Average	3,455	3,523	3,692	3,881	4,003	4,098	4,153	4,142	4,057	3,852	3,689	3,466	3,836
Max	4,229	4,244	4,484	4,561	4,630	4,720	4,788	4,799	4,681	4,479	4,381	4,231	4,799

Source: Toblin (2007)

Table 5.3-8
Blowdown Flow for Two Cycles of Concentration Operation (gpm Per Unit)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Five Year
Min	8,748	8,862	8,911	9,544	10,131	10,791	11,300	10,915	10,191	9,108	9,022	8,843	8,748
Average	10,366	10,568	11,075	11,644	12,008	12,295	12,459	12,426	12,170	11,556	11,066	10,398	11,507
Max	12,686	12,732	13,453	13,683	13,889	14,160	14,365	14,398	14,042	13,437	13,143	12,693	14,398

Source: Toblin (2007)

Table 5.3-9
Discharge Parameters For Blowdown Modeling

Case	Discharge Temperature (°F)	Discharge T (°F)	Normal Discharge Flow (4 Cycles of Concentration, gpm per unit)	Maximum Discharge Flow (2 Cycles of Concentration, gpm per unit)
Max-T	91.75	5.21	4,352	13,057
Max-ΔT (winter)	82.37	37.95	3,993	11,980
Max-ΔT (summer)	79.05	20.90	4,113	12,340
Min-ΔT	77.25	–6.05	3,638	10,915
Average	78.72	12.83	3,836	11,507

Source: Toblin (2007)

Table 5.3-10
Proposed Discharge Mixing Zone Statistics

Case	Furthest Downstream Extent, ft from Discharge	Furthest Cross-Stream Extent, ft from Discharge	Surface Area (Horizontal Projection), ft^2	Cross-Sectional Area (vertical Projection Perpendicular to flow), ft^2	Volume, ft^3
5°F Temperature Increase Above Intake Temperature, 2 Cycles of Concentration					
Max-T (winter)	133.3	135.2	1.77×10^4	1757.0	2.29×10^5
Max-T (summer)	<97.5	<135.2	$<1.32\times10^4$	<1757.0	$<1.71\times10^5$
Min-T	<97.5	<135.2	$<1.32\times10^4$	<1757.0	$<1.71\times10^5$
Average	1.6	70.3	116.0	27.9	27.7
5°F Temperature Increase Above Intake Temperature, 4 Cycles of Concentration					
Max-T (winter)	42.3	<135.2	$<5.72\times10^3$	<1757.0	$<7.44\times10^4$
Max-T (summer)	<53.7	<135.2	$<7.26\times10^3$	<1757.0	$<9.43\times10^4$
Min-T	<76.9	<135.2	$<1.04\times10^4$	<1757.0	$<1.35\times10^5$
Average	1.3	70.3	89.9	22.9	18.3
90°F River Temperature					
Max-T (2 Cycles of Concentration)	<97.5	<135.2	$<1.32\times10^4$	<1757.0	$<1.71\times10^5$
Max-T (4 Cycles of Concentration)	<92.1	<135.2	$<1.25\times10^4$	<1757.0	$<1.62\times10^5$

Source: Toblin (2007)

Table 5.3-11
Proposed Discharge Mixing Zone Statistics During Flow Reversal
(Max ΔT Winter Condition)

Case	Furthest Downstream Extent, ft from Discharge	Furthest Cross-Stream Extent, ft from Discharge	Surface Area (Horizontal Projection), ft^2	Cross-Sectional Area (Vertical Projection Perpendicular to Flow), ft^2	Volume, ft^3
5°F Temperature Increase Above Intake Temperature, 2 Cycles of Concentration					
Flow Reversal (Fairfield Pumped Storage Facility pumping followed by low downstream flow)	233	185	3.28×10^4	1,757	3.55×10^5

Source: Toblin (2007)

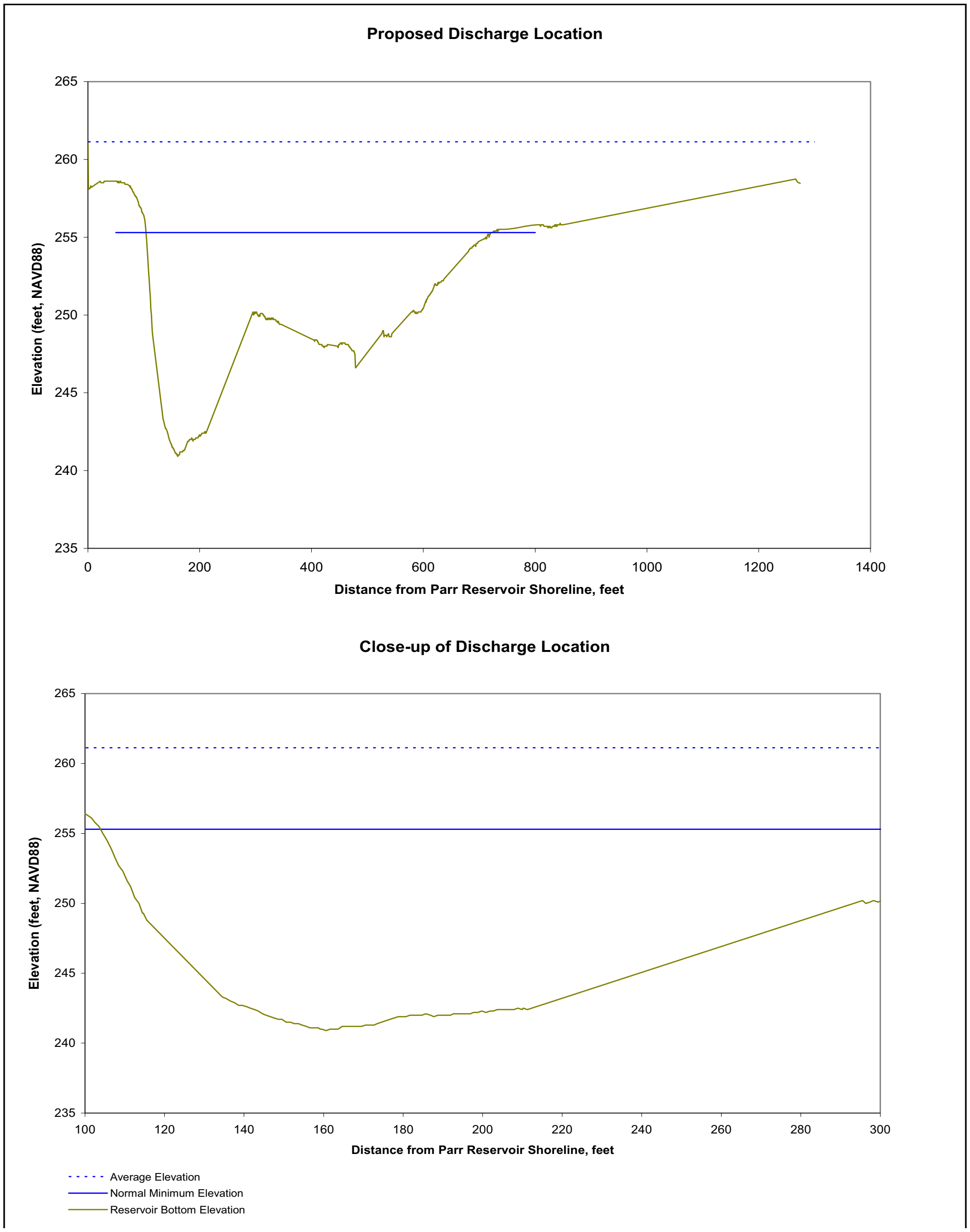

Figure 5.3-1. Reservoir Cross Sections at Proposed Discharge Location

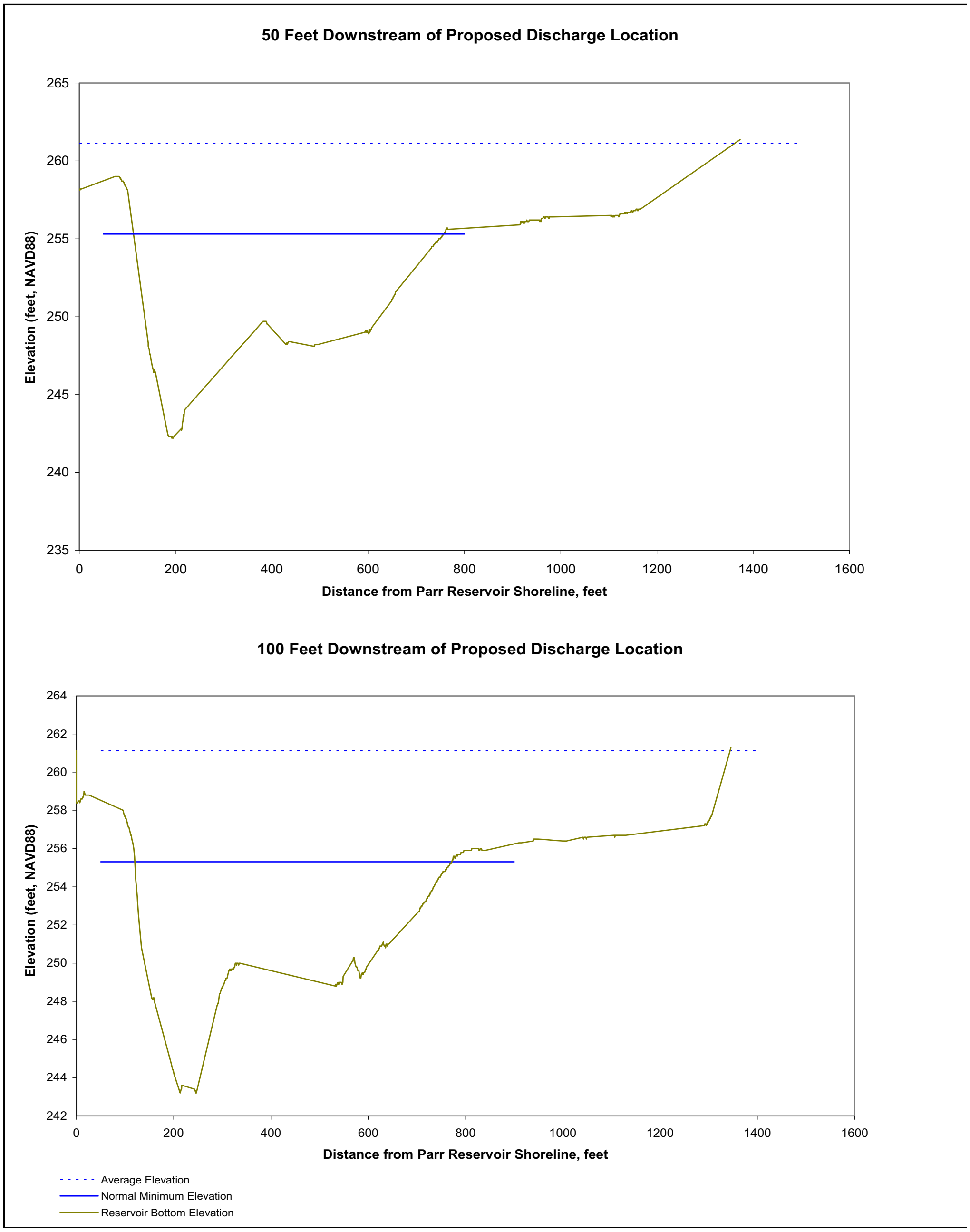

Figure 5.3-2. Reservoir Cross Sections Downstream of Discharge Location

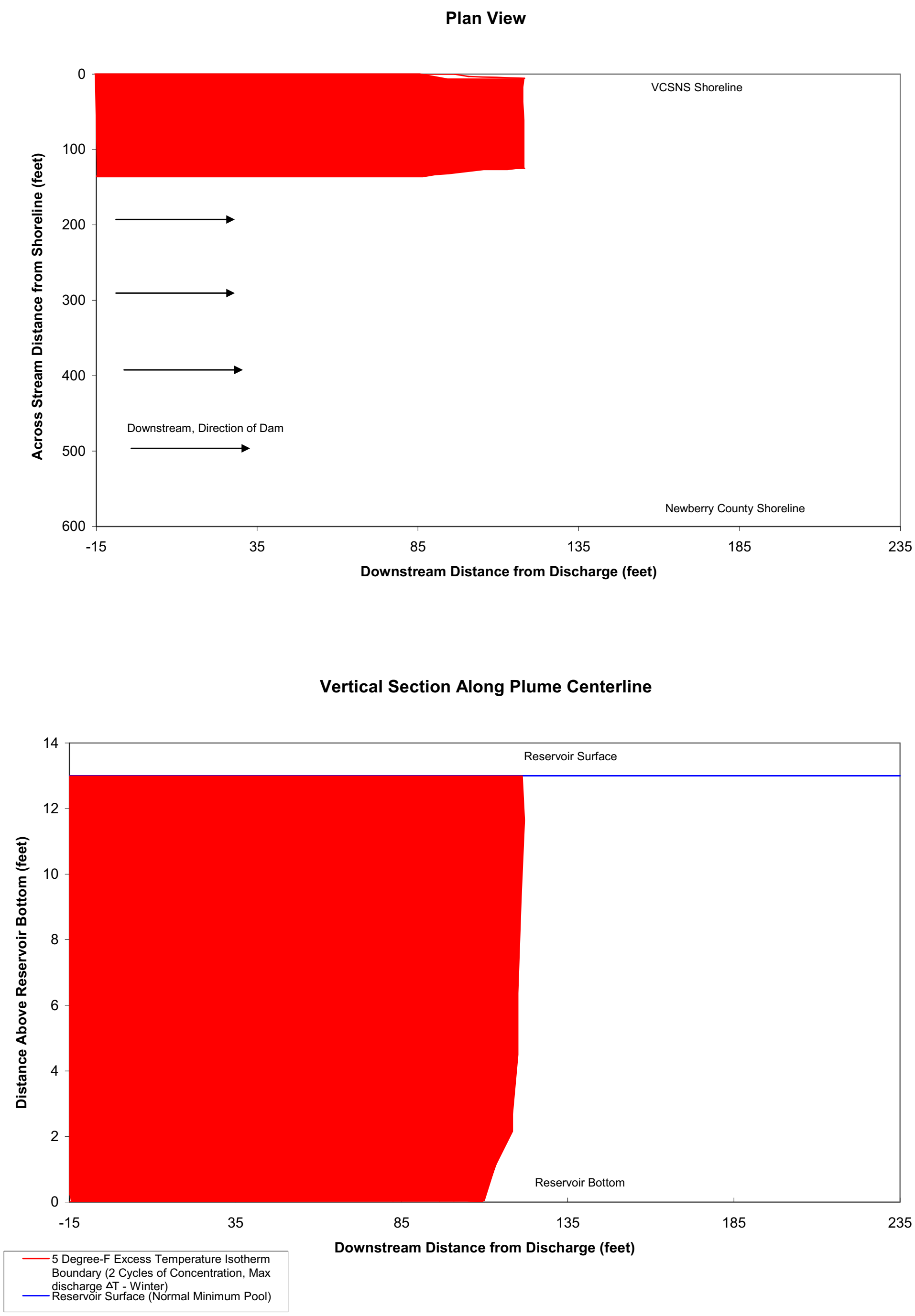

Figure 5.3-3. Mixing Zone for Two Cycles of Concentration and Maximum Discharge ΔT

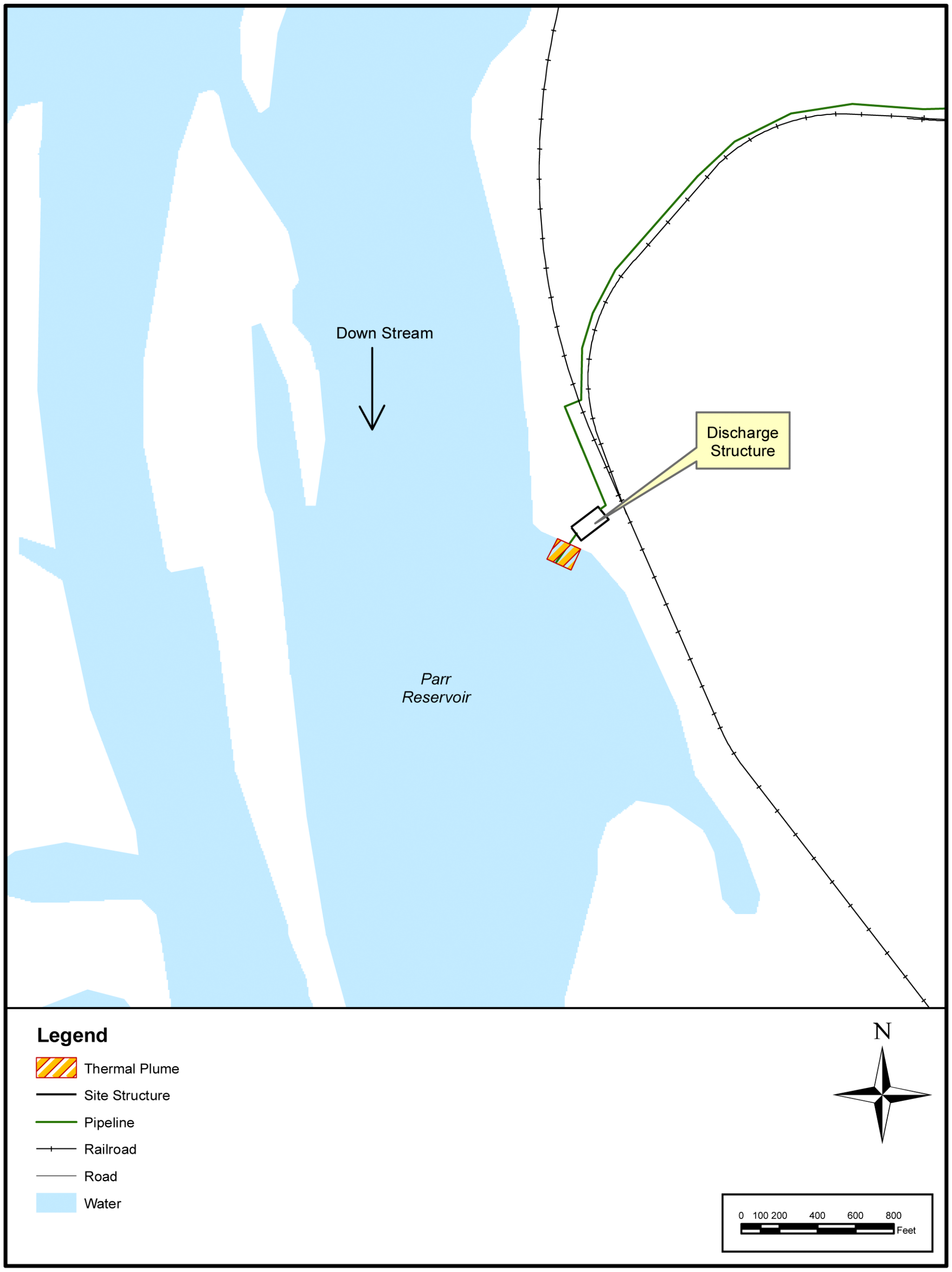

Figure 5.3-4. Plan View of the Thermal Plume in Parr Reservoir

5.4 RADIOLOGICAL IMPACTS OF NORMAL OPERATION

This section describes the radiological impacts of normal plant operation on members of the public, plant workers, and biota. Subsection 5.4.1 describes the exposure pathways by which radiation and radioactive effluents could be transmitted from VCSNS Units 2 and 3 to organisms living near the plant. Subsection 5.4.2 estimates the maximum doses to the public from the operation of one new unit, either Unit 2 or Unit 3. Subsection 5.4.3 evaluates the impacts of these doses by comparing them to regulatory limits for one unit. In addition, the impact of Units 2 and 3 in conjunction with the existing Unit 1 is evaluated against the corresponding regulatory limit. Subsection 5.4.4 considers the impact to nonhuman biota. Subsection 5.4.5 describes the radiation doses to plant workers from the new units.

5.4.1 EXPOSURE PATHWAYS

Small quantities of radioactive liquids and gases would be discharged to the environment during normal operation of Units 2 and 3. The impact of these releases and any direct radiation to individuals, population groups, and biota in the vicinity of the new units was evaluated by considering the most important pathways from the release to the receptors of interest. The major pathways are those that could yield the highest radiological doses for a given receptor. The relative importance of a pathway is based on the type and amount of radioactivity released, the environmental transport mechanism, and the consumption or usage factors of the receptor.

The exposure pathways considered and the analytical methods used to estimate doses to the maximally exposed individual and to the population surrounding the new units are based on 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 50*, Appendix I (Rev.1, October 1977) and Regulatory Guide 1.111, *Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors* (Revision 1, July 1977). A maximally exposed individual is a hypothetical member of the public who receives the maximum calculated dose. Use of the maximally exposed individual concept allows dose comparisons with established criteria for the public.

5.4.1.1 Liquid Pathways

Units 2 and 3 would release effluents to the Parr Reservoir. The NRC-endorsed LADTAP II computer program was used to calculate these doses, with parameters specific to the Parr Reservoir and downstream locations. This program implements the radiological exposure models described in Regulatory Guide 1.109 for radioactivity releases in liquid effluent. The following important exposure pathways are considered in LADTAP II:

- Consumption of fish

- Consumption of drinking water
- Consumption of meats, vegetables, and milk (assumes irrigation with contaminated water)

Although less important, shoreline usage and swimming and boating exposure pathways are also considered in LADTAP II. The input parameters for the liquid pathway are presented in Table 5.4-1. The discharge from the units is assumed to be fully mixed with the river flow.

5.4.1.2 Gaseous Pathways

The GASPAR II computer program was used to calculate the doses to offsite receptors from normal atmospheric releases from Units 2 and 3. This program implements the radiological exposure models described in Regulatory Guide 1.109 to estimate the doses resulting from radioactive releases in gaseous effluent. The atmospheric dispersion component of the analysis was calculated with the NRC-sponsored program, XOQDOQ (U.S. NRC 1982). Dispersion and deposition factors, presented in Section 2.7, were calculated from onsite meteorological parameters (wind speed, wind direction, and stability class) for July 2003 through June 2006.

The following exposure pathways are considered in GASPAR II:

- External exposure to contaminated ground
- External exposure to gases in air
- Inhalation of airborne activity
- Consumption of contaminated meat and milk
- Consumption of contaminated garden vegetables

5.4.1.3 Direct Radiation from Units 2 and 3

Contained sources of radiation at the new units would be shielded. The AP1000 is expected to provide shielding that is at least as effective as existing light water reactors. An evaluation of all operating plants by the NRC states that:

> "…because the primary coolant of an LWR is contained in a heavily shielded area, dose rates in the vicinity of light water reactors are generally undetectable and are less than 1 mrem/year at the site boundary. Some plants [mostly BWRs] do not have completely shielded secondary systems and may contribute some measurable off-site dose." (U.S. NRC 1996)

Thus, the direct radiation from normal operation would result in small contributions at site boundaries. Furthermore, Units 2 and 3 would be pressurized water reactors, not boiling water reactors. Therefore, the impact from direct dose from the new units would be SMALL and would not warrant additional mitigation. No further consideration of direct radiation is provided.

5.4.2 RADIATION DOSES TO MEMBERS OF THE PUBLIC

In this subsection, doses to the maximally exposed individual (MEI) from liquid and gaseous effluents from one unit, either Unit 2 or Unit 3, are estimated using the methodologies and parameters specified in Subsection 5.4.1.

5.4.2.1 Liquid Pathway Doses

Based on the parameters shown in Table 5.4-1, the LADTAP II computer program was used to calculate the important doses to the MEI via the following activities:

- Consuming fish caught in the Parr Reservoir and the Broad River
- Consuming drinking water from the Parr Reservoir and the Broad River
- Consuming meats, vegetables, and milk (assumes irrigation with contaminated water)

Doses from shoreline activities were also calculated but found to be much smaller than those from fish and drinking water consumption. The liquid activity releases (source terms) for each radionuclide are shown in Table 3.5-1. The calculated annual doses to the total body, the thyroid, and the maximally exposed organ are presented in Table 5.4-2. The maximum annual organ dose from liquid releases of 0.17 millirem per unit would be to the GI tract of the MEI (adult).

5.4.2.2 Gaseous Pathway Doses

Based on the parameters in Tables 5.4-3 and 5.4-4, the GASPAR II computer program was used to calculate doses from Units 2 and 3 to the MEI (child), who represents the bounding age group for total body and organs other than the thyroid. The location of this individual is given in Table 5.4-5. The gaseous activity releases (source terms) for each radionuclide are shown in Table 3.5-2. The calculated annual pathway components for the total body, thyroid, and other organ doses for this individual are presented in Table 5.4-6 per unit. The total body MEI (annual total body dose of 0.455 millirem per unit) is the child of a resident gardener that would be exposed through plume, ground, vegetation, meat, greater value of cow or goat milk, and inhalation pathways. The maximum annual dose to an organ, 9.1 millirem per unit, would be to the thyroid of an infant, taking into account inhalation, plume, ground deposition, and drinking goat milk pathways shown in Table 5.4-6. Based on experience at Unit 1, these calculations are conservative and do not represent actual doses to individuals near the VCSNS site.

5.4.3 IMPACTS TO MEMBERS OF THE PUBLIC

In this subsection, the radiological impacts to individuals and population groups from liquid and gaseous effluents are presented using the methodologies and parameters specified in Subsection 5.4.1. Table 5.4-7 estimates the single-unit total body and organ doses to the MEI from liquid effluents and gaseous releases for analytical endpoints prescribed in 10 CFR 50, Appendix I. As the table indicates, the single-unit doses are below Appendix I limits.

The total liquid and gaseous effluent doses from Unit 1 plus Units 2 and 3 would be well within the regulatory limits of 40 CFR 190 (Table 5.4-8). As indicated in NUREG-1555, demonstration of compliance with the limits of 40 CFR 190 is considered to be in compliance with the 0.1 rem regulatory limit of 10 CFR 20.1301. Table 5.4-9 shows the collective total body dose to the population within 50 miles of the VCSNS site that would be attributable to the new units. Impacts to members of the public from operation of the new units would be SMALL and would not warrant additional mitigation.

5.4.4 IMPACTS TO BIOTA OTHER THAN MEMBERS OF THE PUBLIC

Radiation exposure pathways to biota were examined to determine if the pathways could result in doses to biota significantly greater than those predicted for humans. This assessment used species that provide representative information about the various dose pathways potentially affecting broader classes of living organisms. The liquid pathway doses to these species are calculated by the LADTAP II computer program. The gaseous pathway doses were taken as equivalent to adult human doses for the inhalation, vegetation ingestion, plume, and twice the ground pathways. Neither muskrats nor heron normally ingest terrestrial vegetation and that pathway was deleted for those species. The doubling of doses from ground deposition reflects the closer proximity of these organisms to the ground.

Doses to biota from liquid and gaseous effluents from Units 2 and 3 are shown in Table 5.4-10. The total body dose is taken as the sum of the internal and external dose. Annual doses to all of the surrogates are well below the limits of 40 CFR 190 (Table 5.4-10).

Use of exposure guidelines, such as 40 CFR 190, which apply to members of the public in unrestricted areas, is considered very conservative when evaluating calculated doses to biota. The International Council on Radiation Protection states that "...if man is adequately protected, then other living things are also likely to be sufficiently protected," and uses human protection to infer environmental protection from the effects of ionizing radiation (ICRP 1977, 1991). This assumption is appropriate in cases where humans and other biota inhabit the same environment and have common routes of exposure. It is less appropriate in cases where human access is restricted or pathways exist that are much more important for biota than for humans. Conversely, it is also known that biota with the same environment and exposure pathways as man can experience higher doses without adverse effects.

Species in most ecosystems experience dramatically higher mortality rates from natural causes than man. From an ecological viewpoint, population stability is considered more important to the survival of the species than the survival of individual organisms. Thus, higher dose limits could be permitted. In addition, no biota have been discovered that show significant changes in morbidity or mortality due to radiation exposures predicted from nuclear power plants.

An international consensus has been developing with respect to permissible dose exposures to biota. The International Atomic Energy Agency (IAEA 1992) evaluated available evidence including the *Recommendations of the International Commission on Radiological Protection* (ICRP 1977). The IAEA found that appreciable effects in aquatic populations will not be expected at doses lower than 1 rad per day and that limiting the dose to the maximally exposed individual organisms to less than 1 rad per day will provide adequate protection of the population. The IAEA also concluded that chronic dose rates of 0.1 rad per day or less do not appear to cause observable changes in terrestrial animal populations. The assumed lower threshold occurs for terrestrial rather than for aquatic animals primarily because some species of mammals and reptiles are considered more radiosensitive than aquatic organisms. The permissible dose rates are considered screening levels and higher species-specific dose rates could be acceptable with additional study or data.

The calculated annual total body doses in Table 5.4-10 can be compared to the 1 rad per day (aquatic) and 0.1 rad per day (terrestrial) dose criteria evaluated in the *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards* (IAEA 1992). The biota doses meet the dose guidelines by a large margin. In these cases, the annual dose to biota is much less than the daily allowable doses to aquatic and terrestrial organisms. Impacts to biota other than members of the public from exposure to sources of radiation would be SMALL and would not warrant mitigation.

5.4.5 OCCUPATIONAL RADIATION DOSES

The AP1000 DCD estimates a collective annual occupational dose from each of the new units of 67 rem. This is similar to the dose received by workers on Unit 1. Using data from 2003 to 2005 in Table 2.9-1, the average annual collective dose to Unit 1 workers is approximately 51 rem. The annual total body dose to a construction worker during the construction of the new units is 1.1 millirem, as shown in Table 4.5-1. Impacts to workers from occupational radiation doses would be SMALL and would not warrant additional mitigation.

Section 5.4 References

1. IAEA (International Atomic Energy Agency) 1992. *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*, Report Series No. 332, 1992.

2. ICRP (International Commission on Radiological Protection) 1977. *Recommendations of the International Commission on Radiological Protection*. Publication 26, 1977.

3. ICRP 1991. *Recommendations of the International Commission on Radiological Protection*. Publication 60, 1991.

4. SCE&G 2002. *Appendix E, Applicant's Environmental Report, Operating License Renewal Stage*, *Virgil C. Summer Nuclear Station.* NUREG-1437, Supplement 15. Jenkinsville, South Carolina, August 2002.

5. SCE&G 2006. *Radiological Environmental Monitoring Report, Virgil C. Summer Nuclear Station, for the operating period January 1, 2005 – December 31, 2005*, Jenkinsville, South Carolina, April 2006.

6. U.S. NRC 1982. XOQDOQ: *Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations*. NUREG/ CR-2919. Office of Nuclear Reactor Regulation, Washington, D.C., September 1982.

7. U.S. NRC 1986. LADTAP II – *Technical Reference and User Guide, NUREG/ CR-4013. Office of Nuclear Reactor Regulation*. Washington, D. C. April 1986.

8. U.S. NRC 1987. GASPAR II – *Technical Reference and User Guide*, NUREG CR-4653, Office of Nuclear Reactor Regulation, Washington, D.C., March 1987.

9. U.S. NRC 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, Office of Nuclear Regulatory Research, Washington, D.C., May 1996.

Table 5.4-1
Liquid Pathway Parameters

Parameter	Value
Freshwater site	Selected
Release source terms	Table 3.5-1
Discharge rate = river flow rate	4,811 cubic feet per second[(a)]
Dilution factor for discharge	1[(a)]
Transit time to receptor	0.1, 96 hours[(b)]
Impoundment reconcentration model	None
50-mile population	2,131,394[(c)]
Shore width factor	0.2
Fish consumption	21 kg per year[(d)]
Drinking water consumption	730 liters per year[(d)]
Sport fishing harvest	3.77×10^5 kg per year[(e)]
50-mile drinking water population	299,930[(f)]
50-mile shoreline usage	3.59×10^6 person-hours per year[(g)]
50-mile swimming usage	3.59×10^5 person-hours per year[(h)]
50-mile boating usage	3.59×10^6 person-hours per year[(i)]
Fraction of SC crops irrigated[(j)]	0.0696
Fraction of population using contaminated water for drinking and food production[(k)]	0.141
Fraction of SC agricultural products within 50 mi radius	0.258
Irrigation rate for food products[(l)]	102 liters per square meter per month
Fraction of contaminated water not used for feed or drinking water	0
Total production of vegetables within 50 mi radius[(m)]	6.86×10^7 kg per year
Production rate for irrigated vegetables[(n)]	6.71×10^5 kg per year
Total production of leafy vegetables within 50 mi radius[(o)]	1.80×10^7 kg per year
Production rate for irrigated leafy vegetables[(n)]	1.76×10^5 kg per year
Total production of milk within 50 mi radius[(p)]	6.78×10^7 liters per year
Production rate for irrigated milk[(n)]	6.63×10^5 liters per year
Total production of meat within 50 mi radius[(q)]	9.15×10^8 kg per year
Production rate for irrigated meat[(n)]	8.96×10^6 kg per year

a) Assumed fully mixed model with annual average Broad River flow rate at Alston, SC for 1981–1982 and 1997–2006, United States Geological Survey, 2007
b) 0.1 hours assumed for maximally exposed individual (MEI) at the Parr Reservoir. 96 hours for downstream users reflecting reservoir retention time (SCE&G 2002)
c) Table 2.5-1 2060 Population Projection
d) Table values are for adult MEI. For population doses 6.9 kilograms and 370 liters per year average (adult population) fish and water consumption, respectively (USNRC 1986) are assumed.
e) Boating population x 21 kg per year (adult MEI fish ingestion rate)
f) 2060 population projection

g) Assumed same as boating usage
h) Assumed 10% of shoreline usage
i) Assumed 10% of boats registered in Fairfield, Lexington, Newberry, and Richland counties, 2 persons per boat, 200 hours per year
j) USDA, National Agricultural Statistics Service, 2002 Census of Agriculture
k) Fraction of contaminated water users (144,671) divided by the 50-mile population (1,028,075) in 2000
l) 1 inch of water applied to the crops per week
m) USDA, National Agricultural Statistics Service, 2005 and 2006, with apples and peaches included but leafy vegetables excluded, and projected to 2060
n) Food product production rate multiplied by fraction of irrigated crops and fraction of contaminated water users
o) USDA, Integrated Pest Management Center for leafy vegetables — 2001, and projected to 2060
p) *Milk Production, Disposition, and Income, 2006 Summary*, USDA, National Agricultural Statistics Service, April 2007, and projected to 2060. Density of producer milk is 1.03 kg l^{-1}
q) *South Carolina Agricultural Statistics, Crops, Livestock, and Poultry, 2005-2007*, USDA, National Agricultural Statistics Service. The total meat production in SC consists of broilers, turkey, commercial red meat, and young chickens. Projected to 2060

Table 5.4-2
Liquid Pathway Doses for Maximally Exposed Individual – 1 Unit

(millirem per year)							
Skin	**Bone**	**Liver**	**Total Body**	**Thyroid**	**Kidney**	**Lung**	**GI Tract[a]**
0.00014[b]	0.041[c]	0.083[c]	0.051[d]	0.070[c]	0.059[c]	0.044[c]	0.17[d]

a) Gastrointestinal lining of lower intestine
b) teenager
c) child
d) adult

Table 5.4-3
Gaseous Pathway Parameters

Parameter	Value
Release Source Terms	Table 3.5-2.
Population distribution	Table 2.5.1-1[a]
Dispersion and deposition factors (X/Q and D/Q)	Section 2.7
50-Mile Milk Production (l/yr)	6.78×10^7 [b]
50-Mile Meat Production (kg/yr)	9.15×10^8 [c]
50-Mile Vegetable Production (kg/yr)	8.66×10^7 [d]

a) Projected to year 2060.
b) South Carolina milk production for 2006 from USDA (U.S. Department of Agriculture) projected to 2060. Proportioned by land area within 50-miles of site to state land area.
c) South Carolina meat production for 2005 from USDA projected to 2060. Includes broilers, turkey, commercial red meat, and young chickens. Proportioned by land area within 50-miles of site to state land area.
d) South Carolina vegetable production for 2006 from USDA projected to 2060. Includes apples and peaches. Proportioned by land area within 50-miles of site to state land area.

Table 5.4-4
Gaseous Pathway Consumption Factors for Maximally Exposed Individual

Consumption Factor	Annual Rate			
	Infant	Child	Teen	Adult
Milk consumption (liters per year)	330	330	400	310
Meat consumption (kilograms per year)	0	41	65	110
Leafy vegetable consumption (kilograms per year)	0	26	42	64
Vegetable consumption (kilograms per year)	0	520	630	520

Source: U.S. NRC (1987). Leafy vegetables are assumed grown in the MEI's garden for 58% of the year; the garden is assumed to supply 76% of the other vegetables ingested annually. Average population consumption of milk, meat and vegetables is 131 l/yr, 81 kg/yr, and 197 kg/yr, respectively.

Table 5.4-5
Gaseous Pathway Receptor Locations

Receptor	Direction	Distance (miles)
Site boundary	NE	0.50
Maximally exposed individual	E	1.23

Table 5.4-6
Gaseous Pathway Doses for Total Body Maximally Exposed Individual — Per Unit (millirem per year)

PATHWAY		TOTAL BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
PLUME		0.0676	0.0676	0.0676	0.0676	0.0676	0.0676	0.0725	0.363
GROUND		0.0376	0.0376	0.0376	0.0376	0.0376	0.0376	0.0376	0.0441
VEGETABLE									
	ADULT	0.0633	0.0649	0.333	0.0634	0.0597	0.832	0.0539	0.0531
	TEEN	0.0930	0.0948	0.517	0.0977	0.0917	1.12	0.0831	0.0816
	CHILD	0.201	0.194	1.19	0.211	0.201	2.16	0.187	0.184
MEAT									
	ADULT	0.0185	0.0230	0.0801	0.0186	0.0181	0.0479	0.0177	0.0176
	TEEN	0.0149	0.0174	0.0674	0.0151	0.0147	0.0363	0.0145	0.0144
	CHILD	0.0267	0.0278	0.126	0.0272	0.0267	0.0593	0.0263	0.0262
COW MILK									
	ADULT	0.0281	0.0235	0.0973	0.0309	0.0285	0.876	0.0225	0.0218
	TEEN	0.0449	0.0398	0.177	0.0535	0.0495	1.39	0.0390	0.0376
	CHILD	0.0955	0.0886	0.431	0.114	0.107	2.77	0.0891	0.0870
	INFANT	0.189	0.178	0.822	0.232	0.209	6.70	0.180	0.176
GOAT MILK									
	ADULT	0.0438	0.0289	0.114	0.0505	0.0397	1.17	0.0291	0.0269
	TEEN	0.0620	0.0469	0.205	0.0855	0.0667	1.85	0.0487	0.0442
	CHILD	0.115	0.0996	0.495	0.167	0.134	3.67	0.104	0.0975
	INFANT	0.214	0.194	0.914	0.330	0.253	8.89	0.204	0.192
INHALATION									
	ADULT	0.00821	0.00830	0.00123	0.00839	0.00853	0.0748	0.0106	0.00797
	TEEN	0.00830	0.00838	0.00149	0.00861	0.00881	0.0933	0.0119	0.00804
	CHILD	0.00735	0.00725	0.00181	0.00766	0.00782	0.109	0.0103	0.00710
	INFANT	0.00424	0.00414	0.000913	0.00457	0.00456	0.0974	0.00634	0.00409
SUM OF VIABLE PATHWAYS (CHILD)		0.455	0.434	1.92	0.518	0.475	6.10	0.438	0.722

NOTE: Maximally exposed total body individual is the child of resident gardener at 1.23 miles east of Units 2 and 3. The sum of viable pathways is plume, ground, vegetables, meat, greater value of cow or goat milk, and inhalation. Adult, teen, and infant doses are presented as additional information. Ground level releases assumed.

GI Tract = Gastrointestinal lining of the lower stomach

Table 5.4-7
Comparison of Annual Doses with 10 CFR 50, Appendix I Criteria

Type of Dose	Location	Annual Dose Unit 2 or 3	Annual Dose Limit
Liquid effluent[a]			
Total body (millirem)	Parr Reservoir	0.051	3
Maximum organ – liver (millirem)	Parr Reservoir	0.17	10
Gaseous effluent[b]			
Gamma air (millirad)	Site boundary	0.58	10
Beta air (millirad)	Site boundary	2.4	20
Total external body (millirem)	Site boundary	0.55	5
Skin (millirem)	Site boundary	2.0	15
Iodines and particulates[c] (gaseous effluents)			
Maximum organ – thyroid (millirem)	1.23 miles, E	9.0[d]	15

a) Total body dose is for an adult using the Parr Reservoir. The liver dose is for a child using the Parr Reservoir.
b) Northeast Site Boundary. Ground Level releases assumed.
c) Includes Tritium and Carbon-14 Terrestrial food chain dose (and inhalation dose for calculation ease and conservatism), consistent with Table 1 of Regulatory Guide 1.109.
d) Infant drinking home-produced goat milk. Difference between Tables 5.4-7 and 5.4-8 thyroid dose is 0.07 millirem (from each unit) from noble gases in the plume.

Table 5.4-8
Comparison of Maximally Exposed Individual Doses with 40 CFR 190 Criteria (millirem per year)

	Units 2 and 3			Unit 1[c]		
	Liquid	Gaseous	Total	Total	Site Total	Regulatory Limit
Total body[a]	0.10	0.91	1.0	1.2	2.2	25
Thyroid[b]	0.14	18.2[c]	18.3	0.04	18.4	75
Other organ - bone[a]	0.082[d]	3.84	3.9	0.04	4.0	25

a) Residence with garden, dose to child, 1.23 miles E of new units.
b) Residence with goat, infant drinking goat milk, 1.23 miles E of new units.
c) At location of new units maximally exposed individual.
d) Maximum other organ doses for liquid pathway is 0.34 mrem/yr to the GI-LLI. (two new units)

Table 5.4-9
Collective Total Body Doses within 50 Miles (person-rem per year)

	Units 2 and 3	
	Liquid	Gaseous
Noble gases	0	0.87
Iodines and particulates	0.86	0.36
Tritium and C-14	3.3	1.4
Total	4.2	2.6
Natural background[a]	7.7×10^5	

a) Natural background dose is based on a dose rate of 360 millirem/person/yr and a projected 2060 population of 2,131,394 (Table 2.5 -1).

Table 5.4-10
Doses to Biota from Liquid and Gaseous Effluents — Units 2 and 3

	Dose (millirad per year)		
Biota	Liquid effluents[a]	Gaseous effluents[b]	Total
Fish	0.30	0	0.30
Muskrat	0.90	1.6	2.5
Raccoon	0.35	2.2	2.5
Heron	4.1	1.6	5.7
Duck	0.86	2.2	3.1

a) Using Parr Reservoir water.
b) Assumed residing at site boundary. Adult pathway doses from GASPAR for plume, vegetation ingestion (except herons and muskrats) and inhalation; ground exposure taken as twice adult. Relative Biological Effectiveness equals one.

5.5 ENVIRONMENTAL IMPACT OF WASTE

Operation of a nuclear power plant produces nonradioactive waste, mixed waste, and radioactive waste. This section describes the environmental impacts that could result from the management of these wastes.

5.5.1 NONRADIOACTIVE WASTE SYSTEM IMPACTS

All nonradioactive wastes generated at the VCSNS site, including those from VCSNS Units 2 and 3 (i.e., solid wastes, liquid wastes, air emissions) would be managed in accordance with applicable federal, state, and local laws and regulations, and permit requirements. Management practices would be the same as those currently used for Unit 1 (see Section 3.6) and would include the following (SCE&G undated):

- Nonradioactive solid waste (e.g., office waste, recyclables) would be collected and stored temporarily on the VCSNS site and disposed or recycled locally.
- Organic debris collected on trash racks and screens at the water intake structures would be disposed of onsite.
- Scrap metal, universal wastes, used oil, and antifreeze would be collected and stored temporarily on the VCSNS site and recycled or recovered at an offsite permitted recycling or recovery facility, as appropriate.
- Activated carbon from the water treatment system would be transferred to McMeekin Station, a coal-fired power plant, to be burned for energy recovery, subject to SCDHEC approval.
- Water from cooling and auxiliary systems would be discharged to the Parr Reservoir/Broad River through permitted outfalls.
- Wastewater treatment sludges would be disposed onsite by land application, subject to SCDHEC approval or disposed in a landfill.

No site-specific waste disposal activities would be unique to the new units.

5.5.1.1 Impacts of Discharges to Water

Nonradioactive wastewater discharges to surface water from Units 2 and 3 operations would include cooling tower blowdown, permitted wastewater from auxiliary systems, sanitary wastewater (Subsection 5.5.1.4), and storm water runoff from impervious surfaces. Subsection 3.6.1 lists water treatment chemicals that could be used in the new units. SCE&G maintains engineering controls that prevent or minimize the release of harmful levels of constituents to surface water. Concentrations of constituents in the cooling water discharge would be limited by National Pollutant Discharge Elimination System permit requirements and would be minimal or non-detectable in the river (see Subsection 5.3.2.2). Smaller-volume discharges associated with plant auxiliary systems would be discharged in accordance with applicable National Pollutant Discharge Elimination System requirements. The National Pollutant Discharge Elimination System permit limits for cooling tower blowdown discharges are based on effluent guidelines for the steam electric power generating point source category (40 CFR 423) which limit the free available chlorine concentration to 0.2 milligrams per liter (monthly average) and 0.5 milligrams per liter (daily maximum). The discharge of chlorine would be limited to not more than two hours per day per unit and not more than one generating unit discharging at any one time, unless the utility can demonstrate that the units in a particular location cannot operate below these levels of chlorination. Dechlorination of the effluent would be performed if required to meet National Pollutant Discharge Elimination System permit limits. This dechlorination could be accomplished by means such as the addition of sodium bisulfite to the blowdown sump before discharge.The estimated blowdown discharge for Units 2 and 3 ranges from approximately 9,400 gpm (normal operations) to approximately 30,500 gpm (maximum operations). These discharge flow rates equate to between 300 and 1,000 kilograms of chlorine discharged per month at the maximum average concentration. In accordance with 40 CFR 423.13 (d)(1), there should be no detectable discharge of the 126 priority pollutants associated with the cooling tower blowdown discharge as a result of maintenance chemicals. Therefore, potential impacts from constituents in the cooling water and plant auxiliary systems' discharges would be SMALL and would not warrant mitigation.

SCE&G would implement a Storm Water Pollution Prevention Plan to prevent or minimize the discharge of harmful quantities of pollutants with the storm water discharge associated with the addition of new paved areas and facilities and changes in drainage patterns. Impacts from increases in volume or pollutants in the storm water discharge would be SMALL and would not warrant mitigation.

5.5.1.2 Impacts of Discharges to Land

Operation of Units 2 and 3 would result in an increase in the total volume of nonradioactive solid waste generated at the VCSNS site. Anticipated volumes of nonradioactive wastes are discussed in Section 3.6. However, there would be no fundamental change in the characteristics of these wastes or the way in which they are managed currently at Unit 1. All applicable federal, state, and local requirements and standards would be met for handling, transporting, and disposing of the solid waste. Solid wastes would be reused or recycled to the extent possible. Solid wastes appropriate for recycling or reclamation (e.g., used oil, antifreeze, scrap metal, universal wastes) would be managed using approved and licensed contractors. Sludges collected from the wastewater treatment units and basins would be sampled and analyzed before disposal onsite by land application, subject to SCDHEC approval. The proposed site for Units 2 and 3 was previously used for land application of sludges from Unit 1 operations. A new sludge land application area was designated in consultation with SCDHEC. This area is currently designated in the Unit 1 National Pollutant Discharge Elimination System permit as preapproved for disposal of alum sludges from Unit 1 operations. SCE&G would need to seek authorization for disposal of other wastewater sludges in that location. The area is not expected to provide sufficient disposal capacity for sludges associated with Units 2 and 3 operations. An alternate site for land application of sludges would be identified as part of the detailed plant design for Units 2 and 3. Organic debris that collects on the water intake screens would be removed periodically and disposed onsite. All other nonradioactive solid waste would be transported to approved and licensed offsite commercial waste disposal sites. Therefore, potential impacts from land disposal of nonradioactive solid wastes would be SMALL and would not warrant mitigation.

5.5.1.3 Impacts of Discharges to Air

Operation of Units 2 and 3 would increase gaseous emissions to the air by a small amount, primarily from equipment associated with plant auxiliary systems (e.g., emergency diesel generators). Emissions from the diesel-fueled equipment are described in Subsection 3.6.3.1. Cooling tower impacts on terrestrial ecosystems are addressed in Section 5.3.

All air emission sources associated with Units 2 and 3 would be managed in accordance with federal, state, and local air quality control laws and regulations. Impacts to air quality would be SMALL and would not require mitigation.

5.5.1.4 Sanitary Waste

A new sanitary waste treatment system (see Subsection 3.6.2) would be constructed to process sanitary wastes associated with Units 2 and 3. Sanitary wastes would be managed in compliance with applicable laws, regulations, and permit conditions imposed by federal, state, and local agencies.

Potential impacts associated with sanitary wastes from operation of Units 2 and 3 would be SMALL and would not warrant mitigation.

5.5.2 MIXED WASTE IMPACTS

The term “mixed waste” refers to waste that contains both hazardous waste as defined by the Resource Conservation and Recovery Act, as amended (42 USC 6901 et seq.), and source, special nuclear, or byproduct material subject to the Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.). Radioactive materials at nuclear power plants are regulated by the NRC under the Atomic Energy Act. Hazardous wastes are regulated by the state of South Carolina as an EPA-authorized state under the Resource Conservation and Recovery Act.

Nuclear power plants are not large generators of mixed waste. Proper chemical handling techniques and pre-job planning ensures that only small quantities of mixed waste would be generated by the new units. Westinghouse estimates that each AP1000 reactor would generate less than 3 drums (about 17 cubic feet) per year of liquid mixed waste and approximately 7.5 cubic feet per year of solid mixed waste (see Table 3.5-3). The wastes would be collected in suitable containers and brought to the radwaste building before being shipped offsite for processing. The liquid mixed waste would be stored on containment pallets in the waste accumulation room of the radwaste building.

SCE&G would manage the mixed wastes generated at Units 2 and 3 in the same manner as the existing procedures for mixed waste generated at Unit 1. SCE&G has contingency plans, emergency preparedness plans, and spill prevention procedures that would be implemented in the unlikely event of a mixed waste spill. Personnel who are designated to handle mixed waste or to respond to mixed waste emergency spills have appropriate training to enable them to perform their work properly and safely. The emergency procedures would limit any onsite impacts.

SCE&G believes that any impacts from the treatment, storage, and disposal of mixed wastes generated by the new units would be SMALL and would not warrant mitigation beyond what has been described in the previous paragraphs.

5.5.3 WASTE MINIMIZATION PLAN

SCE&G's existing pollution prevention and waste minimization program for Unit 1 would apply to the new units. The previous sections have incorporated components of the Unit 1 waste minimization program in their discussions.

5.5.4 RADIOACTIVE WASTE

Low-level radioactive waste management is described in Section 3.5. Westinghouse estimates that one AP1000 would generate approximately 5,760 cubic feet of low-level radioactive waste (excluding the mixed low-level radioactive waste discussed in Subsection 5.5.2) annually. Following volume reduction and compaction, the estimated low-level radioactive waste disposal volume is 1,960 cubic feet per year for each new unit.

Low-level radioactive waste would be stored onsite on an interim basis before being shipped offsite for permanent disposal. Onsite storage facilities would be designed to minimize personnel exposures. High-dose-rate low-level radioactive waste would be isolated in a shielded storage area and be easily retrievable. The lower-dose-rate low-level radioactive waste would be stacked or stored to maximize packing efficiencies. NRC requirements and guidelines ensure that low-level radioactive waste is stored in facilities that are designed and operated properly and that public health and safety and the environment are adequately protected. The requirements and guidelines include:

- The amount of material allowed in a storage facility and the shielding used should be controlled by dose rate criteria for both the site boundary and any adjacent offsite areas. Direct radiation and effluent limits are restricted by 10 CFR Part 20 and 40 CFR Part 190. The exposure limits given in 10 CFR 20.1301 apply to unrestricted areas.
- Containers and their waste forms should be compatible to prevent significant corrosion within the container. After a period of storage, the

subsequent transportation and disposal should not cause a container breach.

- Gases generated from organic materials in waste packages should be evaluated periodically with respect to container breach. After a period of storage, the subsequent transportation and disposal should not cause a container breach.
- High-activity resins should not be stored more than one year unless they are in containers with special vents.
- A program of at least quarterly visual inspection should be established.
- A liquid drainage collection and monitoring system should be in place. Routing of the drain should be to a radwaste processing system. (U.S. NRC 1996)

Commercial low-level radioactive waste disposal facilities are sited and operated consistent with 10 CFR 61 and other appropriate regulations, ensuring minimal environmental impact. Waste generators must meet the waste acceptance criteria established for the facility and adhere to packaging requirements.

SCE&G maintains procedures for shipping and handling low-level radioactive waste generated at Unit 1. SCE&G currently sends low-level radioactive waste to Duratek in Erwin, Tennessee, for processing and to the disposal facility operated by Chem-Nuclear Systems in Barnwell, South Carolina.

The environmental impacts of onsite low-level radioactive waste management activities, including interim storage, at existing nuclear power plants are described in NUREG-1437 (U.S. NRC 1996). Any impacts would result principally from exposure to radioactivity. Workers receive external doses from exposure to radiation while handling and packaging the waste materials and from periodic inspections of the packaged materials and any other handling operations required during interim storage. Such doses account for a small fraction of the total radiation dose commitment to workers and, as discussed in Section 5.4, the total dose commitment is well within regulatory limits. Radiation doses to offsite individuals and biota from interim low-level radioactive waste storage would be insignificant (U.S. NRC 1996).

SCE&G determined that the environmental impacts of low-level radioactive waste generation by the new units would be SMALL and would not warrant mitigation.

5.5.5 CONCLUSIONS

Minimal chemical constituents would be discharged to the water or air from operation of the new units. Waste minimization programs would reduce the amount of wastes, including mixed wastes, generated by operation of the new units. All radioactive wastes would be managed according to established laws, regulations, and exposure limits. No new types of waste streams would be generated. There is a disposition path for each waste stream and the anticipated quantities would not challenge the commercially available treatment and disposal capacities. Therefore, impacts of waste generation would be SMALL and would not warrant mitigation.

Section 5.5 References

1. SCE&G undated. *Solid Waste Management and Waste Minimization Plan for Virgil C. Summer Nuclear Station*, Rev. 1.

2. U.S. NRC 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. NUREG-1437, Volume 1, Office of Nuclear Regulatory Research, May. 1996.

5.6 TRANSMISSION SYSTEM IMPACTS

This section discusses the environmental impacts of the transmission system described in Section 3.7, during operation of the new units. Subsection 5.6.1 and Subsection 5.6.2 discuss the terrestrial and aquatic impacts associated with maintenance activities that would be performed on the transmission corridors; however, the specific routes for the transmission lines have not been determined. Subsection 5.6.3 discusses the potential impacts to members of the public.

5.6.1 TERRESTRIAL ECOSYSTEMS

Existing transmission corridors pass through forested and agricultural lands typical of central South Carolina (Subsections 2.2.2 and 2.4.1.2).

SCE&G and Santee Cooper have established maintenance procedures for transmission systems (SCE&G 2006, Santee Cooper 2006). Aerial inspections to support routine maintenance activities are typically conducted once each year by SCE&G and twice each year by Santee Cooper. Noise from the flyovers and from aerial tree-trimming by helicopters (see following paragraph) could startle or frighten birds, small mammals, and whitetail deer foraging in transmission corridors or using them as travel routes. Reactions to low-flying aircraft could, depending on noise levels and distance, range from simply being startled or alarmed (showing an alert body posture) to fleeing from the area into adjoining woods. Normal behavior (e.g., feeding, foraging, and breeding) would be disrupted briefly, but animals would resume normal behavior within minutes or hours. Impacts associated with aerial inspections would, therefore, be SMALL.

The transmission corridors are managed to prevent woody growth from encroaching on the transmission lines and potentially disrupting service or creating a safety hazard. Trees along the periphery of the corridor are side-trimmed by ground crews or by helicopters carrying hydraulically operated saws. The maintenance cycle for tree trimming depends on specific conditions, and varies from 3 to 12 years for SCE&G (2006) and from 1 to 7 years for Santee Cooper (Santee Cooper 2006).

The transmission corridor “ground floors” are recleared on a three- to five-year maintenance cycle or as needed, depending on public concerns, local ordinances, line maintenance, or environmental considerations (SCE&G 2006, Santee Cooper 2006). As part of the maintenance cycle, transmission lines and corridors are inspected from the ground and monitored for clearance. Corridor vegetation management involves the use of light equipment (e.g., saws, mowers), herbicides, and hand tools. These same vegetation management practices would be applied to new corridors.

The use of light equipment (e.g., pickup trucks, tractors with mower attachments, small-engine hand tools) in transmission corridors could result in incidental spills of fuel and/or lubricants. Whenever these materials are taken into the field, adequate spill response materials are available for immediate cleanup of any spills. Additionally, personnel are trained in how to respond to, clean up, and report a spill. Contaminated material is managed and disposed of in accordance with federal and state laws and regulations.

No areas designated by the U.S. Fish and Wildlife Service as "critical habitat" for endangered species exist on or adjacent to existing VCSNS transmission corridors. The existing transmission corridors do not cross state or federal parks. The VCSNS-Newberry transmission line and the VCSNS-Ward transmission line cross the Parr Reservoir Waterfowl Management Area in a single shared corridor. Otherwise, the transmission corridors do not cross any state or federal parks, wildlife refuges or preserves, or wildlife management areas.

Transmission line corridor management was evaluated in NUREG-1437 (U.S. NRC 1996). The impacts were found to be of small significance at operating nuclear power plants. Based on SCE&G and Santee Cooper procedures and the NRC analysis of the impacts of corridor management, SCE&G concludes that the effects of transmission corridor maintenance on the new transmission line corridors would be SMALL.

The effects of transmission line maintenance and vegetation management on floodplains and wetlands were evaluated in NUREG-1437. The impacts were found to be of small significance at operating nuclear power plants. Based on SCE&G and Santee Cooper procedures and the NRC analysis, SCE&G concludes that the effects of new transmission corridor maintenance on floodplains and wetlands will be SMALL.

Avian mortality resulting from collisions with transmission lines was evaluated in NUREG-1437. The impacts were found to be of small significance at operating nuclear power plants. Transmission line and corridor maintenance personnel have not reported dead birds from collisions or contact with VCSNS transmission lines. Any additional transmission lines would not be expected to cause significant avian mortality, and overall impacts would be SMALL.

Potential impacts associated with routine corridor maintenance activities would be SMALL.

As discussed in Subsection 2.2.2, SCE&G and Santee Cooper estimate that three additional 230kV lines would be needed for Unit 2 and three additional 230kV lines would be needed for Unit 3. The specific routes would be determined after the decision to construct the new units is made, using siting procedures developed by SCE&G and Santee Cooper that address land use, environmental impacts, and cultural resource impacts. In general, the 230kV transmission lines for Unit 2 could follow portions of existing SCE&G or Santee Cooper corridors. The corridors could require constructing new structures, moving existing structures, or widening existing rights-of-way and/or portions of new corridors. The 230kV lines for Unit 3 would generally require new corridors, but could follow existing corridors where practicable and as determined by the SCE&G and Santee Cooper siting processes. Until the new transmission corridors are sited, the specific environmental impacts can not be quantified. SCE&G and Santee Cooper have a history of working with regulatory agencies to protect ecological resources along existing lines. Impacts of transmission lines on terrestrial resources during operations would be SMALL and would not warrant mitigation.

5.6.2 AQUATIC ECOSYSTEMS

Operation and maintenance of the transmission system has the potential to affect important aquatic habitats and species. Impacts of building, operating, and maintaining the existing transmission facilities for VCSNS were assessed in the Final Environmental Statements for construction (U.S. AEC 1973) and operation (U.S. NRC 1981) of Unit 1. Impacts of operating the existing transmission facilities for VCSNS were also addressed in Supplement 15 to the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (U.S. NRC 2004) for Unit 1. Subsection 2.2.2 describes the eight SCE&G and two Santee Cooper transmission lines that connect the Unit 1 switchyard to the regional electric grid; it also describes the lines that have been proposed to connect Units 2 and 3 to the regional transmission system. Subsection 4.3.2 addresses potential impacts to aquatic ecosystems of constructing the new transmission lines.

5.6.2.1 Important Habitats

As discussed in Subsection 2.2.2.2, the specific routes for the new lines would be determined after the decision to construct the new units is made, using siting procedures discussed in Section 4.1. Based on termination points that have been identified (see Figure 2.2-4), it appears unlikely that any of the new lines would cross any state parks, national parks, state conservation areas, state or national wildlife refuges, or critical habitat for any federally listed species. Aside from the fact that relatively few parks, refuges, and conservation areas are in the areas that would be crossed by new lines, SCE&G and Santee Cooper have transmission siting procedures (SCE&G 2000; Santee Cooper 1996) that ensure locations of state and federal lands and ecologically sensitive areas are factored into siting of new lines. Furthermore, once possible routes (the “study area”) of lines have been identified, SCE&G and Santee Cooper solicit input of state and federal resource agencies to ensure agency concerns are considered in selection of final route(s). Under normal circumstances, this means that new transmission lines are routed around state and federal parks, state conservation areas, and wildlife refuges.

Although it appears unlikely that any new line would cross any state or national park, wildlife refuge, or conservation area, proposed new lines could cross perennial or intermittent streams and associated floodplains or wetlands. SCE&G and Santee Cooper both have right-of-way vegetation management programs/procedures intended to prevent impacts to water quality and be protective of wetlands and stream crossings. Both companies restrict the use of heavy equipment around wetlands and stream crossings to prevent erosion and sedimentation. Both companies use approved herbicides around wetlands and waterways and take measures to ensure that fuel and lubricants are not spilled in or around these wetlands and waterways. The Generic Environmental Impact Statement for License Renewal of Nuclear Plants (U.S. NRC 1996) observes that impacts of transmission system operation and maintenance to surface water quality and aquatic communities is of small significance when utilities employ "proper management practices" with respect to vegetation management, soil erosion, and application of herbicide impacts.

Programs already in place for the transmission lines associated with Unit 1 provide controls to ensure protection of important habitats, including wetlands and stream crossings. These programs or similar programs would be implemented for the new transmission lines and would provide an equivalent level of protection for aquatic resources. Impacts of transmission lines on important aquatic habitats during operations would, therefore, be SMALL and would not warrant mitigation.

5.6.2.2 Important Species

As discussed in Subsection 2.4.2, several state and federally listed aquatic species are found in counties crossed by existing VCSNS transmission lines. SCE&G and Santee Cooper transmission maintenance and vegetation management practices have been designed to minimize impacts to water quality of downgradient streams, ponds, and impoundments and, thus, to aquatic populations, including sensitive populations that inhabit these streams, ponds, and impoundments.

Three state and federally listed aquatic species are known to exist in the counties that would be crossed by the new transmission lines (SCDNR 2006). These include one fish, the shortnose sturgeon (*Acipenser brevirostrum*), one freshwater mussel, the Carolina heelsplitter (*Lasmigona decorata*), and one sea turtle, the loggerhead (*Caretta caretta*). The federally listed Carolina heelsplitter is found in two of the Piedmont counties (Chester and Lancaster) that would be crossed by new transmission lines. The federally listed shortnose sturgeon exists in the Santee River drainage (Congaree River, Santee River, and Lake Marion) and is listed by SCDNR as existing in several of the counties that border these water bodies. The loggerhead sea turtle nests on Colleton and Charleston County beaches (SCDNR 2006), but terminations for new lines in these counties are well inland, more than 45 miles away from any beaches that might be used by nesting turtles.

As discussed throughout this section, SCE&G and Santee Cooper have procedures in place to ensure that erosion and sedimentation are controlled along transmission corridors and to prevent any fuels or lubricants used in vehicles or heavy equipment from polluting waterways adjacent to transmission corridors. Because SCE&G and Santee Cooper have adopted practices and procedures to prevent impacts to surface waters and wetlands, impacts to aquatic communities from operation and maintenance of transmission lines would be SMALL and would not warrant mitigation measures beyond the actions already identified in this section.

5.6.3 IMPACTS TO MEMBERS OF THE PUBLIC

5.6.3.1 Electrical Shock

Objects located near transmission lines can become electrically charged due to their immersion in the lines' electric field. This charge results in a current that flows through the object to the ground. The current is called "induced" because there is no direct connection between the line and the object. The induced current can also flow to the ground through the body of a person who touches the object. An object that is insulated from the ground can actually store an electrical charge, becoming what is called "capacitively charged." A person standing on the ground and touching a vehicle or a fence receives an electrical shock due to the sudden discharge of the capacitive charge through the person's body to the ground. After the initial discharge, a steady-state current can develop, the magnitude of which depends on several factors, including:

- The strength of the electric field which, in turn, depends on the voltage of the transmission line as well as its height and geometry.
- The size of the object on the ground.
- The extent to which the object is grounded

The National Electrical Safety Code has a provision that describes how to establish minimum vertical clearances to the ground for electric lines having voltages exceeding 98 kilovolts. The clearance must limit the induced current due to electrostatic effects to 5 milliamperes if the largest anticipated truck, vehicle, or equipment were short-circuited to ground. By way of comparison, the setting of ground fault circuit interrupters used in residential wiring (special breakers for outside circuits or those with outlets around water pipes) is 4 to 6 milliamperes.

As described in Subsection 2.2.2, SCE&G and Santee Cooper have proposed six new 230kV lines to service VCSNS Units 2 and 3. The routing of these proposed transmission lines has not yet been determined. To assess the impacts of these proposed lines on induced current shock, SCE&G examined the impacts of currently used 230kV lines connected to the Unit 1 switchyard. These existing lines were designed and constructed to the same standards that SCE&G and Santee Cooper would apply to their respective proposed lines for Units 2 and 3. The induced current from existing transmission lines is reported in the license renewal environmental report and is a maximum of 3.5 milliamperes for SCE&G lines and 3.9 milliamperes for Santee Cooper lines (SCE&G 2002).

Should a new transmission line be constructed in the same corridor as an existing line, it is possible that the induced current beneath the two lines could exceed the reported values calculated for a single line alone. The same is true for the double-circuit lines for Unit 3 (Subsection 2.2.2). However, due to vector summing, the cumulative impact could also be less than for a single line. SCE&G and Santee Cooper commit to design any new transmission lines to ensure compliance with the 5-milliamp standard for multiple lines acting in concert. Consequently, impacts would be SMALL, and no mitigation measures would be needed.

5.6.3.2 Electromagnetic Field Exposure

In 1992, the U.S. Congress established a research and educational program designed to determine if exposure to extremely low frequency electric and magnetic fields (ELF-EMF) was harmful to humans. The research and information compilation effort was conducted by the National Institute of Environmental Health Sciences, the National Institutes of Health, and the DOE. Their findings (NIEHS 1999) state, "The scientific evidence suggesting that ELF-EMF exposures pose any health risk is weak." The National Institute of Environmental Health Sciences concluded that such exposure could not be ruled as entirely safe, but that the evidence was insufficient to warrant aggressive regulatory concern. SCE&G and Santee Cooper concur with this finding, and continue to monitor industry research on this subject. Accordingly, SCE&G does not expect impacts from electromagnetic field exposure; no mitigation measures would be needed.

5.6.3.3 Noise

High-voltage transmission lines can emit noise when the electric field strength surrounding them is greater than the breakdown threshold of the surrounding air, creating a discharge of energy. This noise, known as corona discharge, is affected by ambient weather conditions such as humidity, air density, wind, and precipitation and by irregularities on the energized surfaces. SCE&G and Santee Cooper transmission lines are designed and constructed with hardware and conductors that have features to eliminate corona discharge. Nevertheless, during wet weather, the potential for corona loss increases, and nuisance noise could occur if insulators or other hardware have any defects. Corona-induced noise along the existing transmission lines is very low or inaudible, except possibly directly below the line on a quiet, humid day. Such noise does not pose a risk to humans. SCE&G and Santee Cooper seldom receive complaints on noise from transmission lines. Should such complaints occur, SCE&G and Santee Cooper would investigate the cause and, if necessary, take action to correct the problem. SCE&G does not expect any increase in complaints on nuisance noise from the proposed transmission lines and concludes impacts would be SMALL.

5.6.3.4 Radio and Television Interference

Generally, the cause of radio or television interference from transmission lines is from corona discharge from defective insulators or hardware. SCE&G and Santee Cooper seldom receive complaints on electromagnetic interference with radio or television reception. Should such complaints occur, SCE&G and Santee Cooper would investigate the cause and, if necessary, replace the defective component to correct the problem. As described in Subsection 5.6.3.3, SCE&G and Santee Cooper transmission lines are designed to be corona-free up to their maximum operating voltage. SCE&G expects that radio and television interference from any new lines would be SMALL.

5.6.3.5 Visual Impacts

New transmission lines constructed for Units 2 and 3 would be sited in accordance with long-standing procedures that take into consideration environmental and visual values (Subsection 4.1.2). SCE&G and Santee Cooper would attempt to maintain important viewscapes. Accordingly, the visual impacts to members of the public from the transmission system would be SMALL.

Section 5.6 References

1. NIEHS (National Institute of Environmental Health Sciences) 1999. *NIEHS Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields,* Publication No. 99-4493, Research Triangle Park, North Carolina, 1999.

2. Santee Cooper 1996. *Transmission Line Location, Engineering Survey, and Right-of-Way Activities,* Transmission Line Standards Reference Manual, Section 3, June. 1996.

3. Santee Cooper 2006. *Santee Cooper Transmission Vegetation Management Program,* February 17, 2006.

4. SCDNR (South Carolina Department of Natural Resources) 2006. *Rare, Threatened, & Endangered Species Inventory (by county)*. Available at https://www.dnr.sc.gov:4443/pls/heritage/county_species.select_county_map, accessed December 21.

5. SCE&G 2000. *Transmission Line and Substation Siting Processes*, Columbia, South Carolina, January 2000.

6. SCE&G 2002. *Appendix E, Applicant's Environmental Report, Operating License Renewal Stage*, *Virgil C. Summer Nuclear Station*, Columbia, South Carolina. August 2002.

7. SCE&G 2006. *230 kV Electric Transmission Right-of-Way Vegetation Management Program,"* Revision 2. January 3, 2006.

8. U.S. AEC (U.S. Atomic Energy Commission) 1973. *Final Environmental Statement related to the operation of Virgil C. Summer Nuclear Station Unit 1*. SCE&G. Directorate of Licensing. Washington, D.C., 1973.

9. U.S. NRC 1981. *Final Environmental Statement related to the operation of Virgil C. Summer Nuclear Station Unit 1*. NUREG-0719, SCE&G. Washington, D.C., May. 1981.

10. U.S. NRC 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, Volume 1, Office of Nuclear Regulatory Research, U.S. NRC, Washington, D.C., May 1996.

11. U.S. NRC 2004. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, *Supplement 15 Regarding Virgil C. Summer Nuclear Station*, NUREG-1437, Office of Nuclear Reactor Regulation, U.S. NRC, Washington, D.C,. February 2004.

5.7 URANIUM FUEL CYCLE IMPACTS

This section discusses the environmental impacts from the uranium fuel cycle for the AP1000. The uranium fuel cycle is defined as the total of those operations and processes associated with provision, use, and ultimate disposal of fuel for nuclear power reactors.

The regulations in 10 CFR 51.51(a) state that

> Every environmental report prepared for the construction permit stage of a light-water-cooled nuclear power reactor, and submitted on or after September 4, 1979, shall take Table S-3, Table of Uranium Fuel Cycle Environmental Data, as the basis for evaluating the contribution of the environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low level wastes and high level wastes related to uranium fuel cycle activities to the environmental costs of licensing the nuclear power reactor. Table S-3 shall be included in the environmental report and may be supplemented by a discussion of the environmental significance of the data set forth in the table as weighed in the analysis for the proposed facility.

Table S-3 is used to assess environmental impacts. Its values are normalized for a reference 1000-MWe light water reactor at 80% capacity factor. The 10 CFR 51.51(a) Table S-3 values are reproduced as the “Reference Reactor” column in Table 5.7-1. SCE&G has analyzed a 1,150 MWe AP1000 unit operating at 93% capacity factor in this section. The results of this analysis are also included in Table 5.7-1.

Specific categories of natural resource use are included in Table S-3 (and duplicated in Table 5.7-1). These categories relate to land use, water, and fossil fuel consumption, chemical and thermal effluents, radiological releases, disposal of transuranic, high-level, and low-level wastes, and radiation doses from transportation and occupational exposure. In developing Table S-3, NRC considered two fuel cycle options, which differed in the treatment of spent fuel removed from a reactor. “No recycle” treats all spent fuel as waste to be stored at a federal waste repository; “uranium only recycle” involves reprocessing spent fuel to recover unused uranium and return it to the system. Neither cycle involves the recovery of plutonium. The contributions in Table S-3 resulting from reprocessing, waste management, and transportation of wastes are maximized for both of the two fuel cycles (uranium only and no recycle); that is, the identified environmental impacts are based on the cycle that results in the greater impact.

During the Carter administration, the Nuclear Nonproliferation Act of 1978, Pub. L. No. 95-242 (22 USC 3201 et seq.), was enacted; it significantly impacted the disposition of spent nuclear fuel by deferring indefinitely the commercial reprocessing and recycling of spent fuel produced in the U.S. commercial nuclear power program. While the ban on the reprocessing of spent fuel was lifted during the Reagan administration, economic circumstances changed, reserves of uranium ore increased, and the stagnation of the nuclear power industry provided little incentive for industry to resume reprocessing. During the 109th Congress, the Energy Policy Act of 2005, Pub. L. No. 109-58 (119 Stat. 594 [2005]), was enacted. It authorized DOE to conduct an advanced fuel recycling technology research and development program to evaluate proliferation-resistant fuel recycling and transmutation technologies that minimize environmental or public health and safety impacts. Consequently, while federal policy does not prohibit reprocessing, additional DOE efforts would be required before commercial reprocessing and recycling of spent fuel produced in the U.S. commercial nuclear power plants could commence.

Because the United States does not currently reprocess spent fuel, only the no-recycle option is considered here. Natural uranium is mined from either open-pit or underground mines or by an in situ leach solution process. In situ leach mining, the primary form used in the United States today, involves injecting a lixiviant solution into the uranium ore body to dissolve uranium and then pumping the solution to the surface for further processing. The ore in situ leach solution is transferred to mills where it is processed to produce uranium oxide (UO_2) or “yellowcake.” A conversion facility prepares the UO_2 from the mills for enrichment by converting it to uranium hexafluoride, which is then processed to separate the relatively nonfissile isotope uranium-238 from the more fissile isotope uranium-235. At a fuel fabrication facility, the enriched uranium, which is approximately 5% uranium-235, is converted to UO_2. The UO_2 is pelletized, sintered, and inserted into tubes to form fuel assemblies. The fuel assemblies are placed in the reactor to heat water to steam which turns turbines which produce power. The nuclear reaction reduces the amount of uranium-235 in the fuel. When the uranium-235 content of the fuel reaches a point where the nuclear reaction becomes inefficient, the fuel assemblies are withdrawn from the reactor. After onsite storage for a time sufficient to allow the short-lived fission products to decay, thus, reducing the heat generation rate, the fuel assemblies will be transferred to a permanent waste disposal facility for internment. Disposal of spent fuel elements in a repository constitutes the final step in the no-recycle option.

The following assessment of the environmental impacts of the fuel cycle for an AP1000 at the VCSNS site is based on the values in Table S-3 and NRC’s analysis of the radiological impacts from radon-222 and technetium-99 in NUREG-1437, which SCE&G has reviewed and updated for this analysis. NUREG-1437 and Addendum 1 to the Generic Environmental Impact Statement for License Renewal (U.S. NRC 1999) provide a detailed analysis of the environmental impacts from the uranium fuel cycle. Although NUREG-1437 is specific to impacts related to license renewal, the information is relevant to this review because the AP1000 design considered here uses the same type of fuel.

The fuel cycle impacts in Table S-3 are based on a reference 1000-MWe light water reactor operating at an annual capacity factor of 80% for an electrical output of 800 MWe. SCE&G is considering operating two AP1000 units at the VCSNS site. The standard configuration (a single unit) will be used to evaluate uranium fuel cycle impacts relative to the reference reactor. In the following evaluation of the environmental impacts of the fuel cycle for the AP1000, SCE&G assumed an 1150-MWe reactor with a capacity factor of 93% for an electrical output of approximately 1070 MWe. The AP1000 output is approximately 34% greater than the output used to estimate impact values in Table S-3 (reproduced here as the first column of Table 5.7-1) for the reference reactor. Analyses presented here are scaled from the reference reactor impacts to reflect the output of one AP1000.

Recent changes in the fuel cycle may have some bearing on environmental impacts; however, as discussed below, SCE&G is confident that the contemporary fuel cycle impacts are bounded by values in Table S-3. NRC calculated the values in Table S-3 from industry averages for the performance of each type of facility or operation associated with the fuel cycle. NRC chose assumptions so that the calculated values will not be underestimated. This approach was intended to ensure that the actual values will be less than the quantities shown in Table S-3 for all light water reactor nuclear power plants within the widest range of operating conditions. Changes in the fuel cycle and reactor operations have occurred since Table S-3 was promulgated. For example, the estimated quantity of fuel required for a year's operation of a nuclear power plant can now reasonably be calculated assuming a 60-year lifetime (40 years of initial operation plus a 20-year license renewal term). This was done in NUREG-1437 for both boiling water reactors and pressurized water reactors, and the highest annual requirement (35 metric tonnes of uranium made into fuel for a boiling water reactor) was used in NUREG-1437 as the basis for the reference reactor year. A number of fuel management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel and enrichment requirements, reducing annual fuel requirements. For example, an AP1000 requires about 23 metric tonnes of uranium per year. Therefore, Table S-3 remains a conservative estimate of the environmental impacts of the fuel cycle fueling nuclear power reactors operating today.

Another change is the elimination of the U.S. restrictions on the importation of foreign uranium. The economic conditions of the uranium market now and in the foreseeable future favor full use of foreign uranium at the expense of the domestic uranium industry. These market conditions have forced the closing of most U.S. uranium mines and mills, substantially reducing the environmental impacts in the United States from these activities. However, the Table S-3 estimates have not been adjusted accordingly so as to ensure that these impacts, which will have been experienced in the past and may be fully experienced in the future, are considered. Factoring in changes to the fuel cycle suggests that the environmental impacts of mining and milling could drop to levels below those in Table S-3. Subsection 6.2.3 of NUREG-1437 discusses the sensitivity of these changes in the fuel cycle on the environmental impacts.

5.7.1 LAND USE

The total annual land requirements for the fuel cycle supporting an AP1000 will be about 150 acres. Approximately 17 acres will be permanently committed land, and 130 acres will be temporarily committed. A "temporary" land commitment is a commitment for the life of the specific fuel cycle plant (e.g., a mill, enrichment plant, or succeeding plants). Following decommissioning the land could be released for unrestricted use. “Permanent” commitments represent land that may not be released for use after decommissioning because decommissioning does not result in the removal of sufficient radioactive material to meet the limits of 10 CFR 20, Subpart E for release of an area for unrestricted use.

In comparison, a coal-fired plant with the same MWe output as the AP1000 using strip-mined coal requires the disturbance of about 270 acres per year for fuel alone. The impacts on land use would be SMALL and would not warrant mitigation.

5.7.2 WATER USE

Principal water use for the fuel cycle supporting this COL application would be that required to remove waste heat from the power stations supplying electricity to the enrichment process. Scaling from Table S-3, of the total annual water use of 1.52 x 10^{10} gallons for the AP1000 fuel cycle, about 1.48 x 10^{10} gallons is required for the removal of waste heat. Evaporative losses from fuel cycle process cooling is about 2.1 x 10^{8} gallons per year and mine drainage accounts for 1.7 x 10^{8} gallons per year. Impacts on water use would be SMALL and would not warrant mitigation.

5.7.3 FOSSIL FUEL IMPACTS

Electric energy and process heat are required during various phases of the fuel cycle process. The electric energy is usually produced by the combustion of fossil fuel at conventional power plants. Electric energy associated with the fuel cycle represents about 5% of the annual electric power production of the reference reactor. Process heat is primarily generated by the combustion of natural gas. This gas consumption, if used to generate electricity, represents less that 0.4% of the electrical output of the reference reactor. The direct and indirect consumption of electric energy for fuel cycle operations would be small relative to the power production of the proposed units. Therefore, impacts from fossil fuels are expected to be SMALL and would not warrant mitigation.

5.7.4 CHEMICAL EFFLUENTS

The quantities of liquid, gaseous, and particulate discharges associated with the fuel cycle processes are given in Table S-3 (Table 5.7-1) for the reference 1000 MWe light water reactor. The quantities of effluents for an AP1000 would be approximately 34% greater than those in Table S-3 (Table 5.7-1). The principal gaseous effluents are SO_x, NO_x, and particulates. Based on the U.S. EPA’s National Air Pollutant Emissions Estimates (U.S. EPA 2006), these emissions constitute less than 0.1% of all SO_2 emissions in 2005, and less than 0.01% of all NO_X emissions in 2005.

Liquid chemical effluents produced in the fuel cycle processes are related to fuel enrichment and fabrication and may be released to receiving waters. All liquid discharges into navigable waters of the United States from facilities associated with fuel cycle operations are subject to requirements and limitations set by an appropriate federal, state, regional, local or tribal regulatory agency. Tailing solutions and solids are generated during the milling process and are not released in quantities sufficient to have a significant impact on the environment. Impacts from chemical effluents would be SMALL and would not warrant mitigation.

5.7.5 RADIOACTIVE EFFLUENTS

Radioactive gaseous effluents estimated to be released to the environment from waste management activities and certain other phases of the fuel cycle are set forth in Table S-3 (Table 5.7-1). Using Table S-3 data, Subsection 6.2.2.1 of NUREG-1437 estimates the 100-year environmental dose commitment to the U.S. population from the fuel cycle (excluding reactor releases and dose commitments due to radon-222 and technetium-99) to be about 400 person-rem per reference reactor year. The estimated dose commitment to the U.S. population is approximately 530 person-rem per year of operation for the AP1000.

Subsection 6.2.2.1 of NUREG-1437 estimates the additional whole body dose commitment to the U.S. population from radioactive liquid wastes effluents due to all fuel cycle operations (other than reactor operation) to be approximately 200 person-rem per reference reactor year. The estimated dose commitment to the U.S. population is approximately 270 person-rem per year of operation for the AP1000. Thus, the estimated 100-year environmental dose commitment to the U.S. population from radioactive gaseous and liquid releases from fuel cycle operations is approximately 800 person-rem to the whole body per reactor-year for the AP1000.

The radiological impacts of radon-222 and technetium-99 releases are not included in Table S-3. Principal radon releases occur during mining and milling operations and as emissions from mill tailings. Principal technetium-99 releases occur as releases from the gaseous diffusion enrichment process. NRC provided an evaluation of these technetium-99 and radon-222 releases in NUREG-1437. SCE&G has reviewed the evaluation, considers it reasonable, and has provided it as part of this COL application.

Section 6.2 of NUREG-1437 estimates radon-222 releases from mining and milling operations, and from mill tailings for a year of operation of the reference 1000 MWe light water reactor. The estimated releases of radon-222 for one AP1000 reactor year are 6,900 curies. Of this total, about 78% will be from mining, 15% from milling, and 7% from inactive tails before stabilization. Radon releases from stabilized tailings were estimated to be 1.3 curies per year for the AP1000; that is, approximately 34% greater than the NUREG-1437 estimate for the reference reactor year. The major risks from radon-222 are from exposure to the bone and lung, although, there is a small risk from exposure to the whole body. The organ-specific dose weighting factors from 10 CFR 20 were applied to the bone and lung doses to estimate the 100-year dose commitment from radon-222 to the whole body. The 100-year estimated dose commitment from mining, milling, and tailings before stabilization for the AP1000 is approximately 1,200 person-rem to the whole body. From stabilized tailing piles, the same estimated 100-year environmental dose commitment is approximately 23 person-rem to the whole body.

NUREG-1437 considered the potential health effects associated with the releases of technetium-99 for the reference reactor. The estimated technetium-99 releases for the AP1000 are 0.0094 curie from chemical processing of recycled uranium hexafluoride before it enters the isotope enrichment cascade and 0.0067 curie into groundwater from a high-level waste repository. The major risks from technetium-99 are from exposure of the gastrointestinal tract and kidneys, and a small risk from whole-body exposure. Applying the organ-specific dose-weighting factors from 10 CFR 20 to the gastrointestinal tract and kidney doses, the total-body 100-year dose commitment from technetium-99 is estimated to be 130 person-rem for the AP1000.

Although radiation can cause cancer at high doses and high dose rates, no data unequivocally establish a relationship between cancer and low doses or low dose rates, below about 10,000 millirem. However, to be conservative, radiation protection experts assume that any amount of radiation may pose some risk of cancer, or a severe hereditary effect, and that higher radiation exposures create higher risks. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detrimental effects. Simply stated, any increase in dose, no matter how small, results in an incremental increase in health risk. A recent report by the National Academy of Sciences (NAS 2006) supports the linear, no-threshold dose response model.

Based on this model, risk to the public from radiation exposure can be estimated using the nominal probability coefficient (730 fatal cancers, non-fatal cancers, or severe hereditary effects per 1 x 10^6 person-rem) from the International Commission on Radiological Protection Publication 60 (ICRP 1991). This coefficient, multiplied by the sum of the estimated whole-body population doses estimated above for the AP1000, approximately 2,200 person-rem per year, estimates that the U.S. population could incur a total of approximately 1.6 fatal cancers, non-fatal cancers, or severe hereditary effects from the annual fuel cycle for the AP1000. This risk is small compared to the number of fatal cancers, nonfatal cancers and severe hereditary effects that will be estimated to occur in the U.S. population annually from exposure to natural sources of radiation using the same risk estimation methods.

Based on these analyses, SCE&G concludes that the environmental impacts of radioactive effluents from the fuel cycle would be SMALL and would not warrant mitigation.

5.7.6 RADIOACTIVE WASTE

The quantities of radioactive waste (low-level, high-level, and transuranic wastes) associated with fuel cycle processes are presented in Table S-3 (Table 5.7-1). For low-level waste disposal, NRC notes in 10 CFR 51.51(b) that there will be no significant radioactive releases to the environment. For high-level and transuranic wastes, NRC notes that these wastes are to be disposed at a repository, such as the candidate repository at Yucca Mountain, Nevada. No release to the environment is expected to be associated with such disposal because all of the gaseous and volatile radionuclides contained in the spent fuel are released to the atmosphere prior to disposal of the waste.

There is some uncertainty associated with the high-level waste and spent fuel disposal component of the fuel cycle. The regulatory limits for offsite releases of radionuclides for the current candidate repository site have not been finalized. However, NRC has assumed that limits would be developed along the line of the 1995 National Academy of Sciences report, *Technical Bases for Yucca Mountain Standards* (NAS 1995), and that in accordance with the Commission's Waste Confidence Decision (10 CFR 51.23), a repository can and likely will be developed at some site, that will comply with such limits, with peak doses to virtually all individuals of 100 millirem per year or less (U.S. NRC 1996). Despite any uncertainty with respect to these regulations, it is reasonable to conclude that the offsite radiological impacts of spent fuel and high-level waste disposal would not be sufficiently great to preclude construction of new units at the VCSNS site.

For the reasons stated above, SCE&G concludes that the environmental impacts of radioactive waste disposal would be SMALL and would not warrant mitigation.

5.7.7 OCCUPATIONAL DOSE

The estimated occupational dose attributable to all phases of the fuel cycle is approximately 800 person-rem per year for the AP1000. This is based on a 600 person-rem per year occupational dose estimate attributable to all phases of the fuel cycle for the reference reactor (U.S. NRC 1996). The dose to any individual worker would be maintained within the dose limit of 10 CFR Part 20, which is 5 rem per year. The environmental impacts from this occupational dose would be SMALL.

5.7.8 TRANSPORTATION

The transportation dose to workers and the public totals about 2.5 person-rem per year for the reference reactor as presented in Table S-3 (Table 5.7-1). This corresponds to a dose of 3.3 person-rem per year for the AP1000. For comparative purposes, the estimated collective dose from natural background radiation to the population within 50 miles of the VCSNS site is 335,000 person-rem per year. On this basis of this comparison, SCE&G concludes that environmental impacts of transportation from the fuel cycle would be SMALL and would not warrant mitigation.

5.7.9 SUMMARY

SCE&G evaluated the environmental impacts of the uranium fuel cycle as given in Table S-3 and considered the effects of radon-222 and technetium-99 releases based on the information presented in NUREG-1437. Based on this evaluation, SCE&G concludes that the impacts would be SMALL, and mitigation would not be warranted.

Section 5.7 References

1. ICRP (International Commission of Radiological Protection) 1991, *1990 Recommendations of the International Commission of Radiological Protection*, ICRP Publication 60, Annals of the ICRP 21(1-3), Pergammon Press, New York, New York, 1991.

2. NAS (National Academy of Sciences) 2006, *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII – Phase 2,* Committee to Assess Health Risks From Exposure to Low Levels of Ionizing Radiation, Board on Radiation Effects Research, Division of Earth and Life Studies, National Research Council, National Academy Press, Washington D.C, 2006. Available at http://www.nap.edu/books/030909156X/html.

3. U.S. EPA 2006, *National Air Pollutant Emissions Estimates for Major Pollutants,* Office of Air and Radiation, Washington D.C., Available online at http://www.epa.gov/airtrends/2006/pdfs/Table3.pdf. Accessed July 14, 2006.

4. U.S. NRC 1996, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, Section 6.2, “Impacts of the Uranium Fuel Cycle,” NUREG-1437, Volume 1, Office of Nuclear Regulatory Research, Washington D.C., May 1996.

5. U.S. NRC 1999, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, Section 6.3, “Transportation,” and Table 9-1, “Summary of findings on NEPA issues for license renewal of nuclear power plants,” NUREG-1437, Volume 1, Addendum 1, Office of Nuclear Regulatory Research, Washington D.C., August 1999.

Table 5.7-1 (Sheet 1 of 3)
Uranium Fuel Cycle Environmental Data[(a)]

Environmental Considerations	Reference Reactor	AP1000
Natural Resource Use		
Land (acres)		
Temporarily committed[(b)]	100	130
Undisturbed area	79	110
Disturbed area	22	29
Permanently committed	13	17
Overburden moved (millions of metric tonnes)	2.8	3.7
Water (millions of gallons)		
Discharged to air	160	210
Discharged to water bodies	11,090	14,800
Discharged to ground	127	170
Total	11,377	15,200
Fossil fuel		
Electrical energy (thousands of MW-hour)	323	430
Equivalent coal (thousands of metric tonnes)	118	160
Natural gas (millions of standard cubic foot)	135	180
Effluents - Chemical (metric tonnes)		
Gases (including entrainment)[(c)]		
SO_x	4,400	5,900
NO_x[(d)]	1,190	1,600
hydrocarbons	14	19
CO	29.6	40
particulates	1,154	1,500
Other gases		
F	0.67	0.90
HCl	0.014	0.019
Liquids		
SO_4^-	9.9	13
NO_3^-	25.8	34
fluoride	12.9	17
Ca^{++}	5.4	7.2

Table 5.7-1 (Sheet 2 of 3)
Uranium Fuel Cycle Environmental Data[(a)]

Environmental Considerations	Reference Reactor	AP1000
Effluents - Chemical (metric tonnes) (cont.)		
Cl^-	8.5	11
Na^+	12.1	16
NH_3	10	13
Fe	0.4	0.53
Tailings solutions (thousands of metric tonnes)	240	320
Solids	91,000	120,000
Effluents – Radiological (curies)		
Gases (including entrainment)		
^{222}Rn	(e)	(e)
^{226}Ra	0.02	0.027
^{230}Th	0.02	0.027
U	0.034	0.045
^{3}H (thousands)	18.1	24
^{14}C	24	32
^{85}Kr (thousands)	400	530
^{106}Ru	0.14	0.19
^{129}I	1.3	1.7
^{131}I	0.83	1.1
^{99}Tc	(e)	(e)
Fission products and transuranic	0.203	0.27
Liquids		
U and daughters	2.1	2.8
^{226}Ra	0.0034	0.0045
^{230}Th	0.0015	0.0020
^{234}Th	0.01	0.013
fission and activation	5.90×10^{-6}	7.9×10^{-6}
Solids buried		
not high-level waste (shallow)	11,300	15,000
Transuranic and high-level waste (deep)	1.10×10^{7}	1.5×10^{7}

Table 5.7-1 (Sheet 3 of 3)
Uranium Fuel Cycle Environmental Data[(a)]

Environmental Considerations	Reference Reactor	AP1000
Effluents – Thermal (billions of Btu)	4063	5400
Transportation (person rem)		
exposure of workers and the general public	2.5	3.3
occupational exposure	22.6	30

a) In some cases where no entry appears in Table S-3 it is clear from the background documents that the matter was addressed and that, in effect, the table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at all in the table. Table S-3 does not include health effects from the effluents described in the table, or estimates of releases of radon-222 from the uranium fuel cycle or estimates of technetium-99 released from waste management or reprocessing activities. Radiological impacts of these two radionuclides are addressed in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," (U.S. NRC 1996) and it was concluded that the health effects from these two radionuclides posed a small significance. Data supporting Table S-3 is given in the "Environmental Survey of the Uranium Fuel Cycle," WASH-1248 (April 1974); the "Environmental Survey of Reprocessing and Waste Management Portion of the LWR Fuel Cycle," NUREG-0116 (Supplement 1 to WASH-1248); the "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0216 (Supp. 2 to WASH-1248); and in the record of final rule making pertaining to "Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management, Docket RM-50-3." The contributions from reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and fuel recycle). The contribution from transportation excluded transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in Table S-4 of § 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A-E of Table S-3A of WASH-1248.

b) The contributions to temporarily committed land from reprocessing are not prorated over 30 years, since the complete temporary impact accrues regardless of whether the plant services one reactor for one year or 57 reactors for 30 years.

c) Estimated effluents based upon combustion of coal for equivalent power generation.

d) 1.2% from natural gas use and processes.

e) Radiological impacts of radon-222 and technetium-99 are addressed in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," (U.S. NRC 1996). The Generic Environmental Impact Statement concluded that the health effects from these two radionuclides pose a small risk.

5.8 SOCIOECONOMIC IMPACTS

5.8.1 PHYSICAL IMPACTS OF STATION OPERATION

This subsection assesses the potential physical impacts due to operation of the new units on the nearby communities or residences. Potential impacts include noise, odors, exhausts, thermal emissions, and visual intrusions. These physical impacts would be managed to comply with applicable federal, state, and local environmental regulations and would not significantly affect the VCSNS site and its vicinity.

There are no residential areas located within the site boundary. The area within 10 miles of the VCSNS site is estimated to be populated by approximately 12,200 people (Table 2.5-1). This area is predominately rural and characterized by farmland and wooded tracts. No significant industrial or commercial facilities other than VCSNS exist or are planned for this area. Population distribution details are given in Subsection 2.5.1.

5.8.1.1 Noise

As presented in Section 2.2, Fairfield County is predominantly farmland and wooded tracts. Areas that are subject to farming are prone to seasonal noise-related events such as planting and harvesting. Wooded areas provide natural noise abatement control to reduce noise propagation.

The new units would produce noise from the operation of pumps, cooling towers, transformers, turbines, generators, switchyard equipment, and loud speakers. As described in Subsection 5.3.4, neither the state of South Carolina nor Fairfield County has regulations or guidelines regarding environmental noise limits.

Most equipment would be located inside structures reducing the outdoor noise level. Noise would be further attenuated by distance to the VCSNS site boundary. The exclusion area boundary is at least 3,400 feet in all directions from the center of the Unit 2 and 3 footprint and 1,300 feet from the closest of the planned cooling towers. No major roads, public buildings, or residences are located within the exclusion area. The noise level generated by the towers would be about 55 dBA at 1,000 feet from the towers (Westinghouse 2003) and lower at the exclusion area boundary (Subsection 5.3.4).

The nearest residence is about 5,800 feet to the east of the nearest of the planned cooling towers which would be located on the eastern side of the Units 2 and 3 site (see Figure 5.8-1). Noise levels below 60 to 65 dBA are considered to be of small significance (U.S. NRC 1996). Therefore, the noise impact at the nearest residence would be SMALL and no mitigation would be warranted.

Commuter traffic would be controlled by speed limits. The access roads to the proposed site would be paved. Good road conditions and appropriate speed limits would minimize the noise level generated by the work force commuting to the site.

Impacts from the noise of operations activities would be SMALL and would not require mitigation.

5.8.1.2 Air Quality

VCSNS is located in Fairfield County, South Carolina, which is part of the Columbia Intrastate Air Quality Control Region (40 CFR 81.108 and 81.341). The Clean Air Act establishes National Ambient Air Quality Standards, which include the following criteria pollutants:

- Sulfur dioxide (SO_2)
- Particulate matter with aerodynamic diameters of 10 microns or less (PM_{10})
- Particulate matter with aerodynamic diameters of 2.5 microns or less ($PM_{2.5}$)
- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Ozone (O_3)
- Lead (Pb)

Areas of the United States having air quality as good as or better than the National Ambient Air Quality Standard are designated by EPA as attainment areas. Fairfield County is classified as an attainment area under the National Ambient Air Quality Standard criteria. Areas having air quality that is worse than the National Ambient Air Quality Standard are designated by EPA as non-attainment areas. The nearest non-attainment areas to VCSNS are Richland and Lexington Counties (the Columbia, South Carolina metropolitan area), which are classified as non-attainment areas due to exceedances of the 8-hour ozone standard. These counties are approximately 4 miles and 7.4 miles southeast of the proposed site, respectively.

The new units would have standby diesel generators. Emissions from those sources are described in Subsection 3.6.3. The standby diesel generators would be operated under air permits issued by the state of South Carolina. The generators would be operated periodically on a limited short-term basis. As discussed in Section 5.12, the impact of the operation of the new units on air quality would be SMALL, and would not warrant mitigation.

Good access roads and appropriate speed limits would minimize the amount of dust generated by the commuting work force.

5.8.1.3 Aesthetics

The nearest residence is 1.1 miles from the site of the proposed new units and is shielded by forested land. Given this distance, residents would not have a clear view of the new units. The viewscape would be similar to the existing viewscape.

The visual impacts of the operation of the cooling towers would be the towers themselves and plumes resembling lines of clouds. The plumes would be most noticeable in the winter months. A plume could extend several miles from the VCSNS site. As described in Subsection 5.3.3.1, due to the varying directions and low frequency of the longest plumes and the short average plume lengths, impacts from elevated plumes would be SMALL and not warrant mitigation.

5.8.1.4 Traffic

Roads within the vicinity of the VCSNS site would experience a temporary increase in traffic at the beginning and the end of the workday. However, the current road network has sufficient capacity to accommodate the increase, as detailed in Subsection 5.8.2.2.4. Therefore, no significant traffic congestion would result from operation of the new units.

5.8.1.5 Other Impacts

Heat dissipation to the atmosphere from operation of the cooling towers is described in Subsection 5.3.3.1. Because there is no residential area within the site boundary, there would be no heat impacts on nearby communities.

5.8.1.6 Conclusion

Physical impacts to the surrounding population as a result of operation of the new units would be SMALL and would not warrant mitigation.

5.8.2 SOCIAL AND ECONOMIC IMPACTS

This subsection evaluates the demographic, economic, infrastructure, and community impacts to the region as a result of operating two AP1000 units at the VCSNS site, and the demands that the workforce places on the region. Operation of Units 2 and 3 could continue for 60 years (a potential 40-year initial operating license, plus 20 additional years of operation under a renewed license). Operations impacts were evaluated for the initial 40-year license term. SCE&G estimates a two-unit facility would require approximately 800 onsite employees.

It is likely that operation of Units 2 and 3 would overlap with the continued operation of Unit 1, which employs 635 onsite employees. The refueling outages for Unit 1 last approximately four to six weeks and require approximately 800 additional workers. For the AP1000 units, refueling outages are expected to last three to five weeks and employ as many as 1,000 additional workers.

5.8.2.1 Demography

The 2000 population within 50 miles of the site was approximately 1,028,075 and is projected to be approximately 2,131,394 by 2060 (see Table 2.5-1), for an average annual growth rate of 1.22%. SCE&G anticipates employing 800 onsite operations workers at Units 2 and 3. To be conservative, SCE&G assumes that all of the Unit 2 and 3 employees would migrate into the region, and that each operations worker would bring a family. The largest average household size for each of the four counties, 2.6 people per household (USCB 2000), was used to estimate the total population increase of 2,080 people associated with the incoming operations workforce. This represents a 0.35% increase in the four-county region of influence year 2000 population of 596,253, and a 0.28% increase over the projected 2020 region of influence population of 738,240 (see Table 2.5-3).

SCE&G assumes that the residential distribution of the Units 2 and 3 operations workforce would resemble the residential distribution of the current Unit 1 workforce that live within the four-county region. Of the total population increase due to the operations workforce, 201 people would settle in Fairfield County, 758 people would settle in Lexington County, 398 people would settle in Newberry County, and 723 people would settle in Richland County. These numbers constitute 0.85%, 0.35%, 1.1%, and 0.23% of the 2000 populations of Fairfield, Lexington, Newberry and Richland counties, respectively (USCB 2000).

The operations employees and their families would represent SMALL increases in total population within the region of influence.

The in-migration of approximately 800 operations workers would create new indirect jobs in the area because of the “multiplier” effect. Under the multiplier effect, each dollar spent on goods and services by an operations worker becomes income to the recipient, who saves some but re-spends the rest. In turn, this re-spending becomes income to someone else, who in turn saves part and re-spends the rest. The final multiplier indicates the amount of turnover from the initial dollar spent. The Economic and Statistics Division of the U.S. Department of Commerce Bureau of Economic Analysis uses an economic model, RIMS II, to calculate multipliers for industry jobs and earnings by incorporating buying and selling linkages among regional industries. RIMS II was used to estimate the employment multiplier for new nuclear plant-related expenditures in the four-county region of influence at 3.13 (U.S. BEA 2006). For every operations worker, an additional 2.13 jobs would be created, resulting in a total of approximately 2,500 new jobs in the region of influence.

SCE&G assumes that most indirect jobs would be service-related, not highly specialized, and filled by the existing workforce in the region; therefore, the increase in population in the region of influence, if any, as a result of the indirect jobs would be SMALL.

5.8.2.2 Impacts to the Community

5.8.2.2.1 Economy

The impacts of the new units' operation on the local and regional economy depend on the region's current and projected economy and population. The economic impacts of a potential 40-year period of operation are discussed below.

SCE&G assumes, conservatively, that all new operating personnel would come from outside of the region of influence. The employment of the operations workforce for such an extended period of time would have economic and social impacts on the surrounding region. Fairfield County would likely be the most affected county in the region of influence because it is the most rural of the four counties impacted by VCSNS, and because it would receive property tax revenues assessed on the new units, in addition to tax revenues generated by the operations workforce that would settle in the county. Thus, the net economic benefits of Units 2 and 3 to the total economy of Fairfield County would be greater than for the other counties in the region of influence.

The wages and salaries of the operating workforce would have a multiplier effect that could result in an increase in business activity, particularly in the retail and service industries. This would be most evident in Fairfield and Newberry Counties with their smaller populations. Since employment in indirect jobs is expected to be pulled from the current resident workforce, unemployment could decrease. This would have a positive impact on the economy by providing new business and job opportunities for local residents. In addition, these businesses and employees would generate additional profits, wages, and salaries, which would be taxed.

SCE&G concludes that the impacts of Units 2 and 3 operations on the economy would be beneficial and MODERATE in Fairfield and Newberry Counties, and beneficial and SMALL in Lexington and Richland Counties, and that mitigation would not be warranted.

5.8.2.2.2 Taxes

<u>Personal and Corporate Income Taxes</u>

South Carolina has a personal and corporate income tax. SCE&G would pay South Carolina a corporate income tax on the profits received from the sale of electricity generated by Units 2 and 3. While the exact amount of tax payable to South Carolina is not known, taxes collected over the potential 40-year license period would likely be small when compared to the total amount of taxes the state collects in any given year or over the 40-year period.

New businesses created through the multiplier effect would pay income taxes and would hire workers who would be taxed on wages. Thus, the tax base in the region would expand, particularly in the four counties most affected by the influx of new workers.

<u>Sales and Use Taxes</u>

South Carolina and the counties surrounding the VCSNS site would experience an increase in the amount of state and local option sales and use taxes collected. Additional sales and use taxes would be generated by retail expenditures of the operating workforce and by increases in retail expenditures by indirect workers.

Currently, it is difficult to assess which counties and local jurisdictions would be most impacted by sales and use taxes collected from the new workforce. Fairfield County, which has a 1% local sales tax, (the state has a 5% sales tax) is rural, with limited shopping or entertainment options, although this could change over the estimated 40-year license period. The retail center of the 50-mile region is the Columbia metropolitan area. Thus, it is likely that the Columbia metropolitan area would realize the greatest increase in and derive the greatest benefit from sales and use taxes.

In absolute terms, the amount of state and local sales and use taxes collected over a potential 40-year operating period could be large, but small when compared to the total amount of taxes collected by South Carolina and the affected counties.

<u>Property Taxes</u>

One of the main sources of economic impact related to the operation of Units 2 and 3 would be property taxes assessed on the facility. SCE&G's current annual utility property tax payments to Fairfield County for Unit 1 total approximately 12.7 million dollars (see Subsection 2.5.2.3).

South Carolina recently enacted legislation to allow counties to use tax-incentive financing to attract power generation facilities. Consequently, Fairfield County has offered an inducement for the construction of two units at VCSNS, consisting of a fee-in-lieu-of-taxes agreement. This agreement includes several provisions, including an assessment ratio of 4.0% and a special revenue credit of 20.0% of the fee-in-lieu-of-taxes payments on the project during the first 20 years that fee-in-lieu-of-taxes payments are made. The agreement also provides SCE&G with a fixed millage rate for 30 years (based on meeting an investment minimum) (SCANA 2007). In Fairfield County, property taxes for Unit 2 and Unit 3 are not due until the January after each unit has been in service for one year.

Table 5.8-1 provides SCE&G estimates of property taxes that the new nuclear units could provide annually to Fairfield County during the 40-year period of operation. This is based on the range of estimated costs of the new units. The table shows decreasing tax payments over time due to the effect of depreciation.

Santee Cooper pays a "sums in lieu" of property tax to Fairfield County associated with their ownership share of VCSNS. A portion of the payment is based on the value of the land at the time of purchase. The amount is not subject to reassessment so long as Santee Cooper owns the land. The annual payment has been approximately 1,300 to 1,600 dollars. Santee Cooper also pays a "sums in lieu" of property tax to Fairfield County based on their generation in that county. These payments are made semiannually and the recent payments to Fairfield County ranged from about 70,000 to 75,000 dollars.

Another source of property taxes would be on housing owned by the new workforce. To be conservative, SCE&G anticipates that the entire operations workforce would relocate from outside the region. New workers could construct new housing or increase the demand for existing housing, resulting in increases in home values and property tax assessments. In the larger municipalities in the region, the increase in property taxes paid, though large when aggregated over time, would be small compared to the total property taxes collected in those jurisdictions. In the less populated jurisdictions, such as Fairfield and Newberry Counties, the effects could be SMALL and positive.

<u>Summary of Tax Impacts</u>

SCE&G believes that the impact of additional taxes would be beneficial and SMALL in the region of influence, except for Fairfield County where they would be MODERATE to LARGE, and mitigation would not be warranted.

5.8.2.2.3 Land Use

In the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437, U.S. NRC 1996), NRC presents an analysis of offsite land use during license renewal (*i.e.,* operations) that is based on the size of plant-related population growth compared to the area's total population, the size of the plant's tax payments relative to the community's total revenue, the nature of the community's existing land use patterns, and the extent to which the community already has public services in place to support and guide development. In the same document, NRC presents an analysis of offsite land use during refurbishment (*i.e.,* large construction activities) that is based on population changes caused by refurbishment activities. SCE&G reviewed the criteria and methodology in the Generic Environmental Impact Statement and determined that NRC's criteria and methodology are appropriate to evaluate socioeconomic impacts of operation of Units 2 and 3.

Fairfield County is the focus of the land use analysis because the new units would be located there and a percentage of the workforce would reside there. A larger percentage of the workforce would live in Newberry, Lexington, and Richland Counties, but in these counties, distance and other socioeconomic forces would dilute potential land use impacts created by the operation of Units 2 and 3, especially in the more densely populated Lexington and Richland Counties.

Based on the case study analysis of refurbishment, NRC concluded that all new land use changes at nuclear plants would be:

SMALL — if population growth results in very little new residential or commercial development compared with existing conditions and if the limited development results only in minimal changes in the area's basic land use pattern.

MODERATE — if plant-related population growth results in considerable new residential and commercial development and the development results in some changes to an area's basic land use pattern.

LARGE — if population growth results in large-scale new residential or commercial development and the development results in major changes in an area's basic land use pattern.

Second, NRC defined the magnitude of refurbishment-related population changes as follows:

SMALL — if plant-related population growth is less than 5% of the study area's total population, especially if the study area has established patterns of residential and commercial development, a population density of at least 60 people per square mile, and at least one urban area with a population of 100,000 or more within 50 miles.

MODERATE — if plant-related growth is between 5 and 20% of the study area's total population, especially if the study area has established patterns of residential and commercial development, a population density of 30 to 60 people per square mile, and one urban area within 50 miles.

LARGE — if plant-related population growth is greater than 20% of the area's total population and density is less than 30 people per square mile.

Third, NRC defined the magnitude of license renewal-related tax impacts as:

SMALL — if the payments are less than 10% of revenue.

MODERATE — if the payments are between 10 and 20% of revenue.

LARGE — if the payments are greater than 20% of revenue.

Finally, NRC determined that, if the plant's tax payments are projected to be a dominant source of the community's total revenue, new tax-driven land use changes would be large. This would be especially true where the community has no preestablished pattern of development or has not provided adequate public services to support and guide development in the past.

Offsite Land Use in Fairfield County

The land area of Fairfield County is 686 square miles (Fairfield County 1997). The county includes two small incorporated municipalities, Winnsboro and Ridgeway, with the remaining area unincorporated. As described in Subsection 2.2.3, the predominant land use is forestry (87% of the unincorporated area in the county in 1990). In 1990, developed areas represented approximately 13% of the total land area in the county. Most industry is related to forestry or manufacturing, and no new industries have located in the area as a result of the VCSNS site.

As stated in Subsections 2.2.3 and 2.5.2.4, Fairfield County and municipalities within the county use comprehensive land use planning to guide development. From 1990 to 2000, the Fairfield County population increase was only about 0.5% per year (Table 2.5-3). The county encourages growth in areas where public facilities, such as water and sewer systems, exist or are scheduled to be built in the future. Fairfield County promotes an arrangement of land use, circulation, and services that would contribute to the economic, social and physical health, safety, welfare, and convenience to the county (Fairfield County 1997).

Operations-Related Population Growth

The 2000 population of Fairfield County was approximately 23,454, with a population density of 34 people per square mile. Fairfield County could gain about 77 new families, with an estimated population increase of 201 people, about 0.85% of the total 2000 population of Fairfield County.

According to NRC guidelines, operations-related population changes would be considered small if plant-related population growth would be less than 5% of the study area's total population, the area has an established pattern of residential and commercial development, a population density of at least 60 people per square mile, and at least one urban area with a population of 100,000 or more within 50 miles. With the exception of population density, Fairfield County meets the NRC criteria, and SCE&G concludes that changes to the population of Fairfield County due to operation of Units 2 and 3 would be SMALL. Anticipated population increases attributable to the operations workforce would represent 0.35% of the 2000 Lexington County population, 1.1% of the 2000 Newberry County population, 0.23% of the 2000 Richland County population, and an even smaller percentage of the population of other counties in the region. SCE&G concludes that impacts would be SMALL.

Tax Revenue-Related Impacts

SCE&G's utility property tax payments for Unit 1 represent approximately 40% of the total property taxes received by the Fairfield County (Table 2.5-14). Using NRC's criteria, SCE&G's tax payments are of LARGE significance to Fairfield County. As described in Subsection 5.8.2.2.2, SCE&G expects that Units 2 and 3 would generate similar property tax revenue for Fairfield County and that taxes from SCE&G would be the overwhelming dominate source of property tax revenue in the county.

Conclusion

Fairfield County is still predominantly rural, and land in the county would likely continue to be used for forestry into the foreseeable future. Commercial and residential development is minimal and has experienced little change over 25 years of Unit 1 operations. Fairfield County has approximately 1,600 vacant housing units (Table 2.5-16). Therefore, the influx of operations workers and their families is unlikely to spur residential development, particularly since the operations workforce would arrive as the much larger construction workforce is leaving the area. The county's infrastructure and public services are sufficient to support the existing populations and would not be significantly impacted by the in-migration of the new operations workers and their families, taken within the context of the departing construction workers. SCE&G concludes that Fairfield County is capable of meeting the needs of the anticipated workforce without additional housing, infrastructure, or public utilities, and impacts to other counties would be less than those in Fairfield County.

Although SCE&G property tax payments would continue to be of large significance, the population and land use in Fairfield County have not changed significantly since the construction of Unit 1, indicating that the tax revenues would not lead to significant land-use changes. Therefore, by NRC criteria, offsite land use changes would be SMALL and would not warrant mitigation.

5.8.2.2.4 Transportation

Impacts of Units 2 and 3 operations on transportation and traffic would be most obvious on the rural roads of Fairfield County, particularly SC 215, a two-lane highway that provides access to Unit 1 from the north and south, and SC 213, which provided access from the east and west. Impacts on traffic are determined by four elements: the number of operations workers and their vehicles on the roads, the number of shift changes for the operations workforce, the projected population growth rate in Fairfield County, and the capacity of the roads.

SCE&G estimates it would employ an operations workforce of 800 workers at Units 2 and 3. This analysis conservatively assumes one worker per vehicle. The Unit 1 workforce of 635 would access the site via SC 215. SCE&G has not determined the access route for the operations workforce for Unit 2 while Unit 3 is under construction and for the combined operating staffs once both units are in service. Traffic impacts were assessed assuming the workforce for all three units as well as any outage personnel would reach the VCSNS site via SC 215. Other options, such as Units 2 and 3 personnel continuing to use the new access road (see Subsection 4.4.2.2.4) or establishing a loop traffic flow to separate the incoming shifts entering from SC 215 from workers exiting the plant via the new access road, may be considered. The impacts of the options would be bounded by the analysis of all incoming and outgoing vehicles using the current entrance that intersects SC 215 approximately 1.5 miles north of Jenkinsville.

Traffic congestion would be most noticeable during shift changes, which occur three times a day. Roadway traffic is classified by the ability of drivers to maneuver, and the maintenance of the traffic flow. Movement on roads with a Level of Service A is described as free-flowing at or above the posted speed limit. Level of Service B may limit lane changes, but does not reduce speed. Level of Service C and D are progressively more congested. Level of Service E provides marginal service, and usually occurs on roads servicing traffic beyond their design capacity. Traffic flow is irregular, speed varies rapidly, but the speed limit is rarely reached.

The South Carolina Department of Transportation (SCDOT 2006) assumes the maximum road capacity on a two-lane rural minor arterial such as SC 215 to be 5,292 passenger cars per day with Level of Service A. The same road with Level of Service E would have as many as 14,472 vehicles per day. SC 213 is considered a rural major collector with a Level of Service design capacity of 4,214 cars per day at Level of Service A. As a rule of thumb, SCDOT engineers use 10% of the vehicle daily count as the number of vehicles per maximum hour of traffic when they plan road improvements.

Traffic on SC 215, as measured by the 2005 Average Annual Daily Traffic, was 1,700 vehicles per day (see Table 2.5-12 and Figure 2.5-3; location 1). Traffic on SC 213, south of VCSNS, as measured by the 2005 Average Annual Daily Traffic, was 2,400 vehicles. Based on the SCDOT planning rule of thumb, the average number of vehicles on SC 215 during the hour of the day with maximum usage is 170 and the road is designed to support 529 vehicles per hour at Level of Service A. For SC 213, the average number of vehicles during the hour of the day with maximum usage is 240 and the road is designed to support 421 vehicles per hour at Level of Service A.

For this analysis, SCE&G assumed that 60% of the Unit 1 employees work the day shift, 30% work the night shift, and 10% work the graveyard shift, and that all workers on a shift arrive and leave during the same hour. Therefore, the afternoon shift change results in the highest traffic count, with approximately 381 (635 × 0.6) day-shift workers leaving and 191 (635 × 0.3) night-shift workers arriving, for a total of 572 vehicles during the hour of shift change. SCE&G also assumed that 50% (286 vehicles) of the traffic comes from the south on SC 215 and 50% (286 vehicles) comes from the west on SC 213. Most of the current workforce lives to the southwest of VCSNS.

Applying these same assumptions to the Units 2 and 3 operations workforce results in approximately 480 (800 × 0.6) day-shift workers leaving and 240 (800 × 0.3) night-shift workers arriving for a total of 720 vehicles during the afternoon shift change hour. Approximately 360 vehicles (50%) of the traffic would come from the south on SC 215 and 360 vehicles (50%) would come from the west on SC 213.

The Fairfield County population was 23,454 in 2000 (Table 2.5-3) and is expected to increase by approximately 6% by 2010, the approximate decade SCE&G estimates operations can begin. Because most of the traffic on SC 215 and 213 during shift change is plant-related and because of the conservative assumptions SCE&G has made regarding the timing of VCSNS traffic flow on SC 215 and 213, local traffic was not factored into the analysis.

The SCDOT rates the capacity of SC 215 at 5,292 vehicles per day (or 529 vehicles per hour during the hour of greatest usage) at Level of Service A, with a maximum capacity of 14,472 vehicles per day (or 1,447 vehicles per hour) at Level of Service E. During shift change of the current unit as described in this analysis, with 286 cars on the road, SC 215 would maintain a Level of Service of A (529 cars per hour). SC 213, with 286 cars on the road would maintain a Level of Service of A (421 cars per hour). An additional 360 cars on SC 215 would decrease the Level of Service to B for the afternoon commuting hour. An additional 360 cars on SC 213 would decrease the Level of Service to C for the afternoon commuting hour. Using these conservative estimates, road capacity on SC 215 and 213 would not be exceeded during the operations period.

The Level of Service A capacity of SC 215 is 5,292 vehicles per day, so there is adequate capacity for an additional 3,592 passenger cars or equivalent beyond the current 1,700 vehicles per day use now. Conservatively assuming that all VCSNS traffic would use SC 215, new operations at VCSNS would increase daily traffic on SC 215 by approximately 1,600 vehicles (800 × 2, counting once for traffic going to work and once for traffic leaving work). Adding this to the current use (1,700), the estimated total daily traffic on SC 215 is 3,300 vehicles per day. Thus, traffic from new operations at VCSNS would not exceed capacity of SC 215.

SC 213 has a design capacity of 4,214 cars per day at Level of Service A. If all VCSNS traffic used SC 213, new operations at VCSNS would increase daily traffic on SC 215 also by approximately 1,600 vehicles. Adding this to the current use (2,400), the estimated total daily traffic on SC 213 is 4,000 vehicles per day. Traffic from new operations at VCSNS would not exceed the capacity of SC 213.

During outages, SCE&G estimates an increase in the workforce of 1,000 people (worst-case analysis for Unit 1, 2, or 3). Assuming each has their own vehicle, daily traffic would increase by 2,000 vehicles (1,000 × 2). Adding this to the estimate of daily traffic with operations of all three VCSNS units, the total daily traffic on SC 215 could reach 5,300 (3,300 + 2,000), slightly exceeding the Level of Service A capacity. Under the same scenario, daily traffic could reach 6,000 (4,000 + 2000) on SC 213, exceeding the Level of Service A capacity. SCE&G would stagger outage schedules so only one unit would be down at a time.

The combined operations workforce for all three units would have a SMALL to MODERATE impact on the two-lane highways in Fairfield and Newberry County, specifically SC 215 and 213 and the highways that feed into them. Mitigation would be necessary to accommodate the additional vehicles on SC 215 and 213.

Mitigation measures would be included in an operations management traffic plan developed before the start of Unit 2 operation. Potential mitigation measures could include establishing a centralized parking area away from the site and shuttling workers to the site in buses or vans, encouraging carpools, and staggering shifts so they do not coincide with operational shifts for the other units. SCE&G could also establish a shuttle service from the Columbia area, where a significant portion of the operations workforce would likely settle. The Unit 1 operations workforce would continue to enter the plant at the current entrance on County Road 311 from SC 215. Units 2 and 3 personnel may continue to use the new access road (see Subsection 4.4.2.2.4) or SCE&G may establish a loop traffic flow to separate the incoming shifts entering from SC 215 from workers exiting the plant via the new access road. Outage shifts could be similarly staggered so as not to coincide with the work shifts of the other units, or outage workers could be shuttled from remote locations to the job site.

5.8.2.2.5 Aesthetics and Recreation

Units 2 and 3 and their support facilities would not be visible from offsite roads, although the intake and discharge structures would be visible from the reservoirs. SCE&G would work to minimize the visual impact of the structures through use of topography, design, materials and color. People boating on the Monticello Reservoir are accustomed to seeing the Unit 1 structures. The additional shoreline structures (water intakes, water treatment plant) associated with Units 2 and 3 would not appreciably alter the plant's appearance as viewed from the Monticello Reservoir. The discharge structure would be visible from the Parr Reservoir. However, the aesthetic impacts would be localized and the reservoirs are not popular for recreational boating except by fishermen.

With the exception of plumes associated with the cooling towers, trees would screen Units 2 and 3 and their support facilities from view from the river and from SC 213 and 215. The plumes associated with the cooling towers would resemble clouds when seen from a distance. SCE&G has determined that impacts of operations on aesthetics would be SMALL and would not warrant mitigation.

The Parr Hydro Wildlife Management Area is immediately north and west of the SCE&G property. The Wildlife Management Area is used by hunters and the boat landing by fishermen during the appropriate seasons. Use of the Wildlife Management Area/boat landing is seasonal. Additionally, it is unlikely that hunters and fishermen would be using SC 213 and 215 at the same time as the operations shifts. Operation of Units 2 and 3 at the existing VCSNS site would not affect any other recreational facilities in the 50-mile region. Impacts on aesthetics and recreation would be SMALL and would not warrant mitigation.

5.8.2.2.6 Housing

While there is no way of accurately estimating the number of available housing units at the start of operations, Subsection 2.5.2.6 reviews the year 2000 availability of housing in the region.

In 2000, there were approximately 22,000 vacant housing units in Fairfield, Lexington, Newberry, and Richland Counties. It is likely that adequate housing would be available, especially in the larger Columbia metropolitan area, at the time the operations workforce is needed. While there is currently enough housing to accommodate all the new families expected in Fairfield County, housing style, price, and location preferences are difficult to predict. Therefore, a percentage of the operations workforce that could be expected to reside in Fairfield County could choose to live elsewhere in the region or to construct new homes in Fairfield County.

The average income of the new workforce is expected to be higher than the average income in the region of influence. Therefore, the new workforce could exhaust the higher-end housing market and some new construction could result. This is most likely in the two more rural counties, Fairfield and Newberry, but the impact would be lessened to the extent that higher-end housing is already available. With time, market forces would increase the housing supply to meet demand. The more urban Lexington and Richland County housing markets are rapidly expanding, as is evidenced by double-digit increases in housing units of 34.7 and 18.5%, respectively, between 1990 and 2000 (Table 2.5-16).

Refueling outages would occur approximately every 18 months for each unit. Refueling outages for the three units would be staggered when Unit 1, Units 2, and 3 are all operational. SCE&G estimates that the maximum increase in workforce would be 1,000 outage workers. These workers would need temporary (three to five weeks) housing. Most of the outage workers would stay in local motels that offer weekly/monthly rates, rent rooms in local homes or bring their own housing in the form of campers and mobile homes. The outage workforce would not affect the permanent housing market in the region.

SCE&G concludes that the potential operations impacts on housing would be SMALL in all counties. Because the lead time for operating a nuclear facility is several years, mitigation beyond self-adjusting market conditions would not be warranted.

5.8.2.2.7 Public Services

Water Supply Facilities

SCE&G considered both plant demand and plant-related population growth demands on local water resources. Subsection 2.5.2.7 describes the public water supply systems in the area, their permitted capacities, and current demands. The average per capita water usage in the U.S. is 90 gpd per person for all activities, including bathing, laundry, and cooking (EPA 2003).

VCSNS does not use water from a municipal system. The Monticello Reservoir provides potable water for Unit 1, and would provide the water for Units 2 and 3 as well. Therefore, water usage at the VCSNS site would not impact municipal water suppliers. As described in Subsection 4.4.2.2.7, the VCSNS potable water system serving Unit 1 uses an average of 27,800 gpd of surface water. Conservatively assuming that each new worker would require 30 gallons of potable water (1/3 of the daily average) per work day, a total of 24,000 additional gallons would be required to support the operations workforce for Units 2 and 3. The availability of surface water from the Monticello Reservoir, which is maintained with water from the Broad River, is adequate to meet this demand. Operations impacts on surface water supplies would be SMALL and would not warrant mitigation.

The impact to the local water supply systems from operations-related population growth can be estimated by calculating the amount of water that would be required by these individuals. The operation-related population increase of 2,080 people could increase water consumption by approximately 187,200 gpd in the four counties. The excess public water supply capacity from surface water in Fairfield County alone is approximately 1.4 million gpd, and all four counties have excess surface water capacity (see Table 2.5-18). Impacts to municipal water suppliers from the operations related population increase would be SMALL and not warrant mitigation.

Wastewater Treatment Facilities

VCSNS operates a wastewater treatment facility for Unit 1. A new wastewater treatment system would be constructed to serve the Units 2 and 3 operations workforce. Therefore, operations would not impact municipal wastewater treatment facilities.

Subsection 2.5.2.7 describes the public wastewater treatment systems in the region of influence, their permitted capacities, and current demands. Wastewater treatment facilities in the region of influence have excess capacity (see Table 2.5-19). The impact to local wastewater treatment systems from operations-related population increases can be determined by calculating the amount of water that would be used and disposed of by these individuals. To be conservative, SCE&G estimates that 100% of the assumed water consumption of 90 gpd per person would be disposed of through the wastewater treatment facilities. The operations-related population increase of 2,080 people could require 187,200 gpd of additional wastewater treatment capacity in the four-county area, currently, the four counties have excess wastewater treatment capacity of more than 40 million gpd, including 25 million gpd of excess capacity in the system serving the Columbia metropolitan area. Impacts of the operations-related population increase on wastewater treatment facilities in the region would be SMALL and would not warrant mitigation.

Police Services

In 2005, Fairfield, Lexington, Newberry, and Richland Counties' ratios of persons-per-police-officer were 321:1, 504:1, 457:1, and 376:1, respectively. Ratios are, in part, dependent on population density, as fewer officers are necessary for the same population if the population resides in a smaller area. SCE&G does now and would continue to employ its own security force at VCSNS.

Fairfield County would see an influx of approximately 201 new residents because of the operation of Units 2 and 3. Approximately 758 new residents would move into Lexington County, 398 new residents would move into Newberry County, and approximately 723 would move into Richland County. These population changes would increase the persons-per-police-officer ratios (Table 5.8-2) by 0.35%, 1.1%, and 0.23% in Lexington, Newberry, and Richland Counties, respectively. Fairfield County's person-per-police-officer ratio would increase 0.86%, but the county would still have the lowest person-to-officer ratio in the region of influence.

Based on the percentage increase in persons-per-police-officer ratios, operations-related population increases would not adversely affect existing police services in Fairfield, Lexington, Newberry, or Richland Counties.

SCE&G concludes that the potential impacts of operations on police services in Fairfield, Lexington, Newberry or Richland Counties would be SMALL and would not warrant mitigation.

Fire Protection Services

In 2004, Fairfield, Lexington, Newberry and Richland Counties' persons-per-firefighter ratios were 215:1, 893:1, 182:1, and 593:1, respectively.

For Unit 2 and 3 operations, Fairfield County would see an influx of approximately 201 new residents. Approximately 758 new residents would move into Lexington County, 398 new residents would move into Newberry County, and approximately 723 would move into Richland County. The rest of the workforce would live in other counties in the region of influence. These population changes would increase the persons-per-firefighter ratios (Table 5.8-3) by 0.35%, 1.1%, and 0.23% in Lexington, Newberry and Richland Counties, respectively. Fairfield County's persons-per-firefighter ratio would increase 0.86%.

Based on the percentage increase in persons-per-firefighter ratios, operations-related population increases would not have a significant impact on existing fire suppression services in Fairfield, Lexington, Newberry, or Richland Counties.

SCE&G concludes that the potential impacts of the operations-related population increase on fire protection services in Fairfield, Lexington, Newberry, or Richland Counties would be SMALL and mitigation would not be warranted.

Medical Services

Information on medical services in the region of influence is provided in Subsection 2.5.2.7. Minor injuries to operations workers would be assessed and treated by onsite medical personnel. Other injuries would be treated at one of the hospitals in the four-county region, depending on the severity of the injury. SCE&G has agreements with local medical providers to support emergencies at Unit 1. SCE&G would revise the agreements to include emergency medical services for the additional workforce. Operations activities are not expected to burden existing medical services.

The region of influence's medical facilities provide medical care to much of the population within the area. The operations workforce and their families would increase the population in the region of influence by approximately 0.35%. The potential impacts of operations on medical services would be SMALL and mitigation would not be warranted.

5.8.2.2.8 Social Services

Operations could be viewed as economically beneficial to the disadvantaged population served by the South Carolina Department of Human Resources. Substantial increases in property tax revenues would flow to Fairfield County, the state, and other region of influence counties would also receive additional income and sales taxes. The direct operations jobs would lead to additional indirect jobs that could be filled by currently unemployed workers, thus removing them from social services client lists or reducing their need for services. Many of these benefits would accrue to Fairfield County, where, because of the smaller economic base, they might have a more noticeable impact. Impacts would be SMALL and positive and not require mitigation.

5.8.2.2.9 Education

SCE&G has negotiated agreements with three area two-year, associated degree granting technical colleges to participate in a credit earning, cooperative work experience for students. SCE&G expects to recruit some of its operational workforce from these programs. In addition, SCE&G is working with the state higher education authorities to ensure that area technical college programs include curriculum designs such as an Associate Degree in Radiation Protection, Industrial Maintenance Technology, Electronic Instrumentation Technology, and Industrial Maintenance Technology that can support the operations of three units.

Approximately 20.9 to 22.3% of the population in the four counties is between 5 and 19 years old (USCB 2000). Table 5.8-4 applies these population distribution percentages to the operations workforce population to estimate the number of operations workforce-related school-aged children in each of the four counties. SCE&G estimates that in an operations-workforce related population of 2,080, roughly 452 would be school-aged. The school districts in all four counties have student-teacher ratios below the state-mandated maximum of 28:1, and the operations workforce would not push any district's ratios higher than the state mandate.

Newberry County would see the largest change with an estimated 83 students, representing a 1.1% increase in public school enrollment. The increase in Fairfield County would be 44 students, for a 0.86% increase. However, when spread over K-12 grades, it is unlikely that either of these increases would affect class size, teacher ratios, or facility capacity, particularly since these children would attend schools that are losing the children of the departing construction workers. Increases of 0.23 to 0.35% would occur in the two more urban counties, Richland and Lexington.

SCE&G would provide the local communities with timely information regarding the proposed units, giving schools several years to make accommodations for the additional influx of students.

SCE&G concludes that impacts to the four counties school systems and school systems within the region would be SMALL and would not warrant mitigation.

5.8.3 ENVIRONMENTAL JUSTICE

Environmental justice refers to a federal policy under which each federal agency identifies and addresses, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority or low-income populations. The NRC has a policy on the treatment of environmental justice matters in licensing actions (69 FR 52040). Figures 2.5-6 through 2.5-11 (Subsection 2.5.4) locate minority and low-income populations within 50 miles of Units 2 and 3. VCSNS is in a predominantly Black races census block group, and adjacent census block groups on the east side of the Broad River also have predominantly Black races populations.

SCE&G evaluated whether the health or welfare of minority and low-income populations could be disproportionately affected by potential impacts of operations. SCE&G identified the most likely pathways through which adverse environmental impacts associated with operation of Units 2 and 3 could affect human populations.

Land use impacts caused by operations could potentially include impacts from salt deposition from cooling towers, new employment, new transmission lines, and disposal of wastes. The predicted solids deposition on site is below the concentrations that would damage sensitive vegetation, and therefore impacts would be SMALL and would not warrant mitigation Subsection 5.3.3.1). Changes in population to Fairfield, Newberry, Richland, and Lexington Counties would be approximately 1% or less, and would be an even smaller percentage of the population in other counties in the region. SCE&G concludes that land use impacts caused by new operations employees would be SMALL and would not warrant mitigation (Subsection 5.8.2.2.3). SCE&G has established corridor vegetation management and line maintenance procedures that would be used to maintain the new corridors and transmission lines. Any wastes transported offsite for disposal would go to permitted and licensed disposal facilities (Subsection 5.5.1.2). Therefore, SCE&G concludes that land use impacts to transmission corridors and offsite areas associated with waste disposal would be SMALL and would not warrant mitigation (Subsection 5.1.2).

Impacts to surface water (including the Monticello Reservoir, Parr Reservoir, and the Broad River) from withdrawal of water from the Monticello Reservoir for operation of Units 2 and 3 would be SMALL (Subsection 5.2.2.1), because of the usable storage available from Parr Reservoir and the operation of Fairfield Pumped Storage Facility. Cooling tower blowdown entering Parr Reservoir would be permitted by the South Carolina Department of Health and Environmental Control and comply with applicable state water quality standards. Therefore, impacts would be SMALL and would not warrant mitigation (Subsection 5.2.3). Groundwater would not be withdrawn for operational use for Units 2 and 3. If dewatering is required to maintain dry portions of the new facilities, impacts would be localized to the facility being dewatered. Therefore, impacts from groundwater use would be SMALL and would not warrant mitigation (Subsection 5.2.2.2). Groundwater quality could only be affected by accidental spills which would be cleaned quickly in accordance with SCE&G's Spill Prevention, Control, and Countermeasures Plan and Facility Response Plan. Any spills would have a small, localized, temporary impact on groundwater. Therefore, any impacts to groundwater quality would be SMALL and would not warrant mitigation (Subsection 5.2.3).

There is a potential for health impacts to members of the public from operation of the cooling system, including impacts from thermophilic microorganisms and from noise. However, Parr Reservoir temperatures are not optimal for *Naegleria fowleri* reproduction. Therefore, risk to public health from thermophilic microorganisms would be SMALL and would not warrant mitigation (Subsection 5.3.4.1). Boaters and fisherman on the Monticello Reservoir would hear the makeup water pumps, but this noise would be attenuated by the 1-mile distance from the intake pumps to the exclusion area boundary. The nearest residence is far enough from the planned cooling towers location that noise would be of SMALL significance (Subsection 5.3.4.2).

Radiological impacts from normal operation could affect members of the public, plant workers, and biota. However, SCE&G assessed potential radiation doses to these receptors from all pathways and determined that potential impacts to these receptors would be SMALL and would not warrant mitigation (Subsections 5.4.3, 5.4.4, and 5.4.5).

Minimal chemical constituents would be discharged to the water or air from operation of the new units. Waste minimization programs would reduce the amount of wastes, including mixed wastes, generated by operation of the new units. All radioactive wastes would be managed according to established laws, regulations, and exposure limits. No new types of waste streams would be generated. There is a disposition path for each waste stream, and the anticipated quantities would not challenge the commercially available treatment and disposal capacities. Therefore, impacts of waste generation would be SMALL and would not warrant mitigation (Subsection 5.5.5).

The addition of new transmission lines to support operation of Units 2 and 3 could impact terrestrial communities. In general, the 230kV transmission lines for Unit 2 would follow existing SCE&G or Santee Cooper corridors. The corridors could require construction of new towers, moving of existing towers, or widening. The 230kV lines for Unit 3 would generally require new corridors, but would tend to follow existing corridors where practicable. Although impacts cannot be quantified until new corridors are sited (after receipt of the COL), SCE&G and Santee Cooper have a history of working with regulatory agencies to protect ecological resources along existing lines, and impacts are expected to be SMALL and would not warrant mitigation (Subsection 5.6.1). Aquatic habitats and species could also be affected by operation and maintenance of the proposed transmission system. SCE&G and Santee Cooper have right-of-way vegetation management programs/procedures intended to prevent impacts to water quality and be protective of wetlands and stream crossings. These programs would provide a level of protection for aquatic resources and communities, and impacts from operation and maintenance of transmission lines would be SMALL, and would not warrant mitigation (Subsection 5.6.2.2).

In the general region, impacts of operations on the economy would be beneficial and SMALL. Impacts to the economies of Fairfield and Newberry counties would also be beneficial, but would be MODERATE because of their rural nature and because of the significant impacts that operations would have on the tax base of Fairfield County (Subsection 5.8.2.2.1).

The proposed units would affect the tax base of the region of influence through personal and corporate income taxes, sales and use taxes, and property taxes. SCE&G would pay South Carolina a corporate income tax on the profits received from the sale of electricity generated by Units 2 and 3 and new business created through the multiplier effect would pay income taxes and hire workers who would be taxed on wages and salaries. Because Columbia, South Carolina is the retail center of the 50-mile region, this metropolitan area would most likely realize the greatest increase in and derive the greatest benefit from sales and use taxes. One of the main sources of economic impact would be property taxes assessed on the facility. A second source of property taxes would be on housing owned by the new workforce. SCE&G believes that the impact of these additional taxes would be beneficial and SMALL in the region of influence, except Fairfield and Newberry Counties, where the effects would be MODERATE and positive (Subsection 5.8.2.2.2).

Operations of Units 2 and 3 would not cause traffic to exceed road capacities in the area. SCE&G would stagger outage schedules so only one unit would be down at a time, preventing road capacities from being exceeded during outages. SCE&G concludes that impacts to traffic would be SMALL at most times and MODERATE during shift changes and outages, and that mitigation would not be warranted (Subsection 5.8.2.2.4).

Units 2 and 3 and their support facilities would not be visible from offsite roads, although the intake and discharge structures would be visible from the reservoirs. People boating on the Monticello Reservoir are accustomed to seeing the Unit 1 structures. The discharge structure would be visible from the Parr Reservoir. However, the aesthetic impacts would be localized and the Parr Reservoir is not popular for recreational boating except by fishermen. With the exception of plumes associated with the cooling towers, trees would screen Units 2 and 3 and their support facilities from view from the Parr Reservoir and from SC 213 and 215. SCE&G has determined that impacts of operations on aesthetics would be SMALL and would not warrant mitigation. Use of the Parr Hydro Wildlife Management Area/boat landing is seasonal, and it is unlikely that hunters and fishermen would be using SC 213 and 215 at the same time as the operations shifts. Operation of Units 2 and 3 at the existing VCSNS site would not affect any other recreational facilities in the 50-mile region. Impacts on aesthetics and recreation would be SMALL and would not warrant mitigation (Subsection 5.8.2.2.5).

SCE&G concludes that the potential operations impacts on housing would be SMALL in Lexington and Richland Counties and the 50-mile region and SMALL in Fairfield and Newberry counties. Because the lead time for constructing and operating a nuclear facility is several years, and because the community would be aware of this construction project, people would recognize the opportunity for additional housing and construct new homes in anticipation of the arrival of the operations workforce. Additional mitigation beyond self-adjusting market conditions would not be warranted (Subsection 5.8.2.2.6).

Impacts to public services in the area (water supply facilities, wastewater treatment facilities, police services, fire protection services, and medical services) would be SMALL because the operations workforce would not stress existing infrastructure capacities (Subsection 5.8.2.2.7), and operations could be viewed as economically beneficial to the disadvantaged population served by the South Carolina Department of Human Services. Many of these benefits would accrue in Fairfield County. Overall impacts to social services would be SMALL and positive and would not require mitigation (Subsection 5.8.2.2.8).

Within the region of influence, Newberry County would see the largest increase in student enrollment (1.1%) resulting from the new units' operation. Fairfield County's education system would increase by 0.86%. Lexington and Richland counties would experience increases of 0.35% and 0.23%, respectively. Increased property and special option sales tax revenues as a result of the increased population, and in the case of Fairfield County, property taxes on the new reactors, could fund any needed additional teachers and facilities. Therefore, impacts to the school systems within the four-county region of influence and within the region would be SMALL and would not warrant mitigation (Subsection 5.8.2.2.9).

SCE&G also contacted local government officials and the staff of social welfare agencies concerning unusual resource dependencies or practices that could result in potentially disproportionate impacts to minority and low-income populations. No agency reported such dependencies or practices, as subsistence agriculture, hunting, or subsistence fishing through which the populations could be disproportionately adversely affected by plant operations (TtNUS 2007). While fishing and hunting definitely occur in the vicinity of VCSNS, these activities are mostly recreational.

As discussed throughout Chapter 5 and summarized here, impacts to most resource areas would be SMALL, indicating that the effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. As such, there would be no disproportionate impacts to minority or low-income populations. Several socioeconomic impacts would be more significant, including the local economy, the tax base, transportation, and housing, but are not expected to disproportionately affect minority or low-income populations. In fact, most impacts to the local economy and tax base are expected to be beneficial.

SCE&G did not identify any location-dependent disproportionately high and adverse impacts affecting minority and low-income populations. No operations-related disproportionately high or adverse health or environmental effects impacting minority or low-income populations' health or welfare were found. Therefore, SCE&G concludes that impacts of operation of Units 2 and 3 to minority and low-income populations would be SMALL.

Section 5.8 References

1. Fairfield County 1997. *Fairfield County Comprehensive Plan Update*. Winnsboro, South Carolina. April 1997.

2. FBI (Federal Bureau of Investigation) 2005. *Crime in United States, Table 80 South Carolina Full-time Law Enforcement Employees by State and by Metropolitan and Nonmetropolitan Counties,"* Available at www.fbi.gov/ucr/05cius, accessed October 2, 2006.

3. Fire Department Net Undated. Available at http://www.firedepartment.net/, accessed May 21, 2007.

4. SCANA 2007. Communication with Mr. Barry Burnette (SCANA) regarding property tax information, January 11, 2007.

5. SCDOT (South Carolina Department of Transportation) 2006. *Maximum ADT by Level of Service for Urban Facilities for SCDOT Travel Demand Models,"* Available from Ron Patton, SCDOT Engineer, December 4, 2006.

6. TtNUS (Tetra Tech NUS) 2007. *Subsistence Living in the Vicinity of VCSNS,* Prepared by Emily H. McRee. Aiken, South Carolina, January. 2007.

7. U.S. BEA (U.S. Bureau of Economic Analysis) 2006. *RIMS II Multipliers for Columbia, SC Region 2*, Regional Economic Analysis Division, Economic and Statistics Administration, Washington, D.C., 2006.

8. USCB (U.S. Census Bureau) 2000. *American Factfinders. DP-1 Profile of General Demographic Characteristics: 2000*. Available at http://factfinder.census/gov.

9. U.S. EPA 2003. *Water on Tap: What You Need to Know,* EPA 816-K-03-007, Office of Water, Washington, D.C. Available at http://www.epa.gov/safewater/wot/index.html.

10. U.S. NRC 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, Volume 1, Office of Nuclear Regulatory Research, U.S. NRC, Washington, D.C. May 1996.

11. U.S. NRC 1999. *Standard Review Plan for Environmental Reviews for Nuclear Power Plants*, NUREG-1555, Washington, D. C., October 1999.

12. Westinghouse 2003. *AP1000 Siting Guide: Site Information for an Early Site Permit*, APP-0000-X1-001, Revision 3, April 24, 2003.

Table 5.8-1
Estimated Property Taxes Generated by Units 2 and 3

	Range of Average Annual Tax Payments to Fairfield County for Units 2 and 3	
Years of Operation	Low Estimate	High Estimate
2017-2019	$10.1 Million	$12.4 Million
2020-2034	$13.7 Million	$24.6 Million
2035-2044	$9.7 Million	$15.3 Million
2045-2056	$6.4 Million	$10.8 Million

Table 5.8-2
Police Protection in the Four-County Region of Influence, Adjusted for the Operations Workforce and Associated Population Increase

County	Total Population in 2000	Additional Population Due to Operation	Total Population with Operation	Police Protection in 2005[(a)]	Persons per Police Officer with Operations	Percent Increase from Current Persons per Police Officer
Fairfield	23,454	201	23,655	73	324	0.86
Lexington	216,014	758	216,772	429	505	0.35
Newberry	36,108	398	36,506	79	462	1.1
Richland	320,677	723	321,400	852	377	0.23

a) FBI (2005)

Table 5.8-3
Fire Protection in the Four-County Region of Influence, Adjusted for the Operation Workforce and Associated Population Increase

County	Total Population in 2000	Additional Population Due to Operations	Total Population with Operation	Firefighters (Full time and Volunteer)[(a)]	Estimated Persons per Firefighter	Percent Increase from Current Persons per Firefighter
Fairfield	23,454	201	23,655	109	217	0.86
Lexington	216,014	758	216,772	242	896	0.35
Newberry	36,108	398	36,506	198	184	1.1
Richland	320,677	723	321,400	541	594	0.23

a) Fire Department New (updated)

Table 5.8-4
Estimated Additional Public School Students in the Four-County Area as a Result of Operations Workforce and Associated Population Increase

County	Operations-Related Population Increase	Population between ages 5 and 18	Percentage Increase in Public School Children per County
Fairfield	201	44	0.9
Lexington	758	164	0.4
Newberry	398	83	1.1
Richland	723	161	0.2

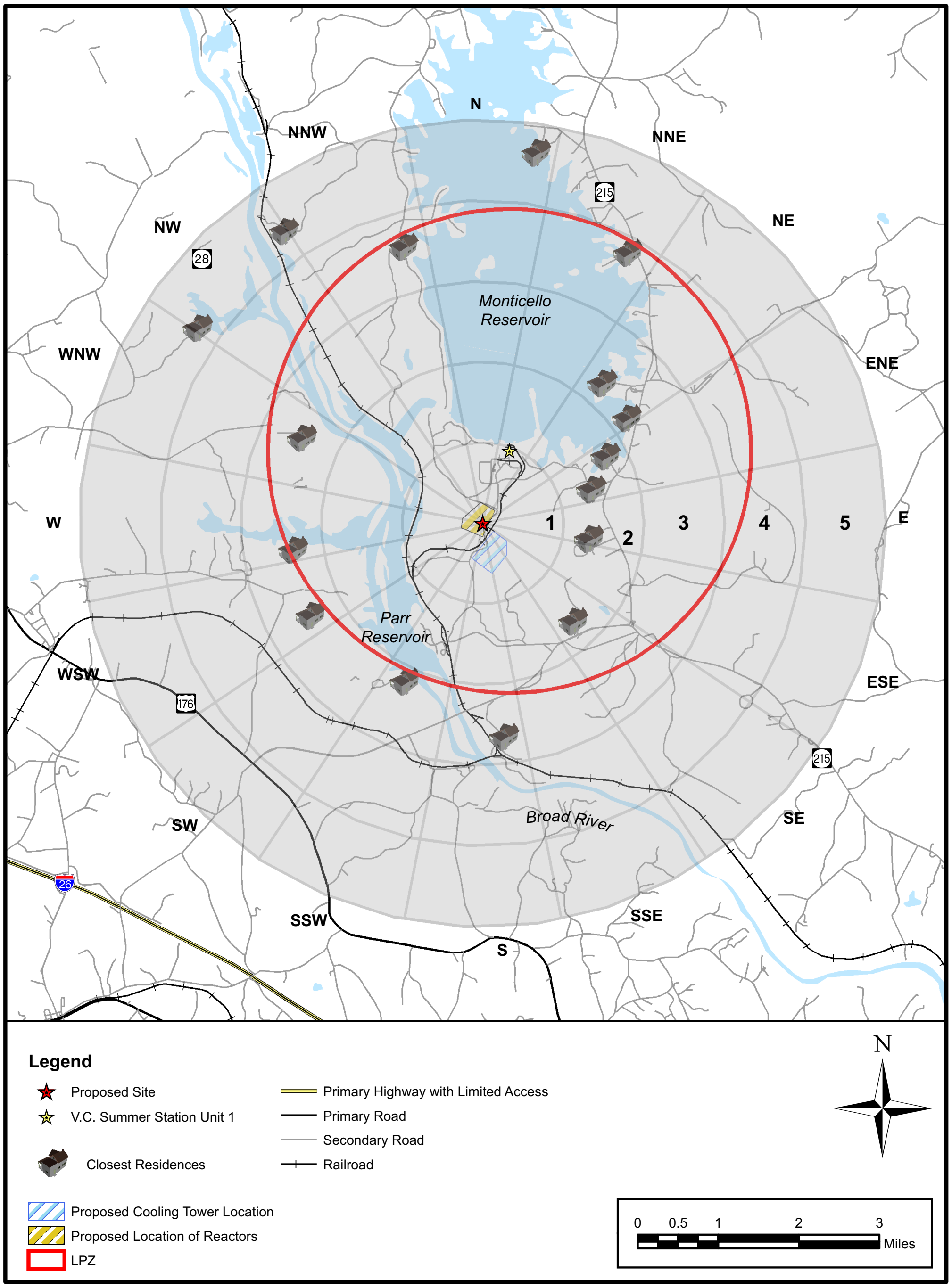

Figure 5.8-1. Closest Residences In Each of 16 Directions

5.9 DECOMMISSIONING

NRC defines decommissioning as the permanent removal of a nuclear facility from service and the reduction of residual radioactivity to a level that permits release of the property and termination of the license (10 CFR 50). NRC regulation 10 CFR 50.82 specifies the regulatory actions that NRC and a licensee must take to decommission a nuclear power facility. NRC regulation 10 CFR 20, Subpart E identifies the radiological criteria that must be met for license termination. These requirements apply to the existing fleet of power reactors and to advanced reactors such as the AP1000.

Decommissioning must occur because NRC regulations do not permit an operating license holder to abandon a facility after ending operations. However, NRC prohibits licensees from performing decommissioning activities that result in significant environmental impacts not previously reviewed [10 CFR 50.82(a)(6)(ii)]. Therefore, NRC has indicated that licensees for existing reactors can rely on the information in a Generic Environmental Impact Statement (GEIS) on the environmental impacts of decommissioning the existing fleet of domestic nuclear power reactors (NRC 2002).

The U.S. DOE funded a study that compares activities required to decommission existing reactors to those required for advanced reactors, including the AP1000 (U.S. DOE 2004). In addition, SCE&G used the formula delineated in 10 CFR 50.75(c)(1) to estimate the minimum amount of decommissioning funds needed for the AP1000 at VCSNS. SCE&G has concluded that the DOE-funded study and the SCE&G cost estimate form a basis for concluding that the environmental impacts that the decommissioning GEIS identifies are representative of impacts that can be reasonably expected from decommissioning the AP1000. The following subsections summarize the decommissioning GEIS, the DOE-funded study, the SCE&G cost estimates, and the SCE&G conclusion.

5.9.1 NRC GEIS REGARDING DECOMMISSIONING

The decommissioning GEIS (U.S. NRC 2002) describes decommissioning regulatory requirements, the decommissioning process, and environmental impacts of decommissioning. Before presenting impacts, the GEIS describes the NRC process for evaluating impacts. Activities and impacts that NRC considered to be within the scope of the GEIS include:

- Activities performed to remove the facility from service once the licensee certifies that the facility has permanently ceased operations, including organizational changes and removal of fuel from the reactor.
- Activities performed in support of radiological decommissioning, including decontamination and dismantlement of radioactive structures, systems, and components (SSCs) and any activities required to support the decontamination and dismantlement process such as isolating the spent fuel pool to reduce the scope of required safeguards and security systems

so decontamination and dismantlement can proceed on the balance of the facility without affecting the spent fuel

- Activities performed in support of dismantlement of nonradiological SSCs, such as diesel generator buildings and cooling towers

- Activities performed up to license termination and their resulting impacts as provided by the definition of decommissioning, including shipment and processing of radioactive waste

- Nonradiological impacts occurring after license termination from activities conducted during decommissioning

- Activities related to release of the facility

- Human health impacts from radiological and nonradiological decommissioning activities.

According to NRC studies of social and environmental effects of decommissioning, there are no significant impacts for large commercial power generating units beyond those considered in the final GEIS (U.S. NRC 1999). The GEIS evaluates the environmental impact of the following three decommissioning methods:

- DECON – The equipment, structures, and portions of the facility and site that contain radioactive contaminants are removed or decontaminated to a level that permits termination of the license shortly after cessation of operations.

- SAFSTOR – The facility is placed in a safe stable condition and maintained in that state (safe storage) until it is subsequently decontaminated and dismantled to levels that permit license termination. During SAFSTOR, a facility is left intact, but the fuel is removed from the reactor vessel and radioactive liquids are drained from systems and components and then processed. Radioactive decay occurs during the SAFSTOR period, thus reducing the quantity of contaminated and radioactive material that must be disposed of during the decontamination and dismantlement of the facility at the end of the storage period.

- ENTOMB – This alternative involves encasing radioactive structures, systems, and components 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.

NRC regulations do not require a COL applicant to select one of these decommissioning alternatives or to prepare definite plans for decommissioning. These plans are required (10 CFR 50.82) after a decision has been made to cease operations. The general environmental impacts are summarized in this subsection, because decommissioning plans and reports (and consequently detailed analyses of alternatives) are not prepared until cessation of operations.

According to the NRC, decommissioning a nuclear facility that has reached the end of its useful life generally has a positive environmental impact. The air quality, water quality, and ecological impacts of decommissioning are expected to be substantially smaller than those of power plant construction or operation because the level of activity and the releases to the environment are expected to be smaller during decommissioning than during construction and operation. The major environmental impact, regardless of the specific decommissioning option selected, is the commitment of small amounts of land for waste burial in exchange for the potential reuse of the land where the facility is located. Socioeconomic impacts of decommissioning will result from the demands on, and contributions to, the community by the workers employed to decommission a power plant. (U.S. NRC 2002)

Experience with decommissioned power plants has shown that the occupational exposures during the decommissioning period are comparable to those associated with refueling and plant maintenance when it is operational (U.S. NRC 2002). Each potential decommissioning alternative will have radiological impacts from the transport of materials to their disposal sites. The expected impact from this transportation activity will not be significantly different from normal operations (U.S. NRC 1999).

5.9.2 DOE-FUNDED STUDY ON DECOMMISSIONING COSTS

The total cost of decommissioning depends on many factors, including the sequence and timing of the various stages of the program, location of the facility, current radioactive waste burial costs, and plans for spent fuel storage. So that a lack of funds does not result in delays in or improper conduct of decommissioning that may adversely affect public health and safety, 10 CFR 50.75 requires that operating license applicants and licensees provide reasonable assurance that adequate funds for performing decommissioning will be available at the end of operation. To provide this assurance, the regulation requires that two factors be considered—the amount of funds needed for decommissioning and the method used to provide financial assurance. At its discretion, an applicant may submit a certification based either on the formulas provided in 10 CFR 50.75 or, when a higher funding level is desired, on a facility-specific cost estimate that is equal to or greater than that calculated using the formula in 10 CFR 50.75. (NRC 2003)

The U.S. DOE commissioned the *Study of Construction Technologies and Schedules, O&M Staffing and Cost, and Decommissioning Costs and Funding Requirements for Advanced Reactor Designs* (U.S. DOE 2004) to support development of advanced reactors for production of electric power and to establish the requirements for providing reasonable assurance that adequate funds for performing decommissioning will be available at the end of plant operations. The study presents estimates of the costs to decommission the advanced reactor designs following a scheduled cessation of plant operations. Four reactor types were evaluated in this report: the Toshiba and General Electric

Advanced Boiling Water Reactor, the GE Economic Simplified Boiling Water Reactor, the Westinghouse Advanced Passive pressurized water reactor (AP1000), and the Atomic Energy of Canada, Limited's Advanced CANDU Reactor (ACR-700). The cost analysis described in the study is based on the prompt decommissioning alternative, or DECON, as defined by the NRC. The DECON alternative is also the basis for the NRC funding regulations (10 CFR 50.75) and the use of the DECON alternative for the advanced reactor designs facilitates the comparison with NRC's own estimates and financial provisions.

DECON comprises four distinct periods of effort:

- Pre-shutdown planning/engineering
- Plant deactivation and transition (no activities are conducted during this period that will affect the safe operation of the spent fuel pool)
- Decontamination and dismantlement with concurrent operations in the spent-fuel pool until the pool inventory is zero
- License termination

Each of the decommissioning activities evaluated in the GEIS is performed during one or more of the periods identified above. Because of the delays in development of the federal waste management system, it may be necessary to continue operation of a dry fuel storage facility on the reactor site after the reactor systems have been dismantled and the reactor nuclear license terminated. However, these latter storage costs are considered operations costs under 10 CFR 50.54(bb) and are not considered part of decommissioning (U.S. NRC 2002).

The cost estimates described in the DOE study were developed using the same cost estimating methodology used by NRC and consider the unique features of a generic site located in the southeast, including the nuclear steam supply systems, power generation systems, support services, site buildings, and ancillary facilities; and are based on numerous fundamental assumptions, including labor costs, low-level radioactive waste disposal costs and practices, regulatory requirements, and project contingencies. The primary cost contributors identified in the study are either labor-related or associated with the management and disposition of the radioactive waste. These are the same primary cost contributors that NRC identified in its *Revised Analysis of Decommissioning for the Reference Pressurized Water Reactor Power Station* (U.S. NRC 1995). Overall, the DOE study concluded that with consistent operating and management assumptions, the total decommissioning costs projected for the advanced reactor designs are comparable to those projected by NRC for operating reactors with appropriate reductions in costs due to reduced physical plant inventories. (DOE 2004)

5.9.3 SCE&G DECOMMISSIONING COST ESTIMATE

In accordance with NRC regulations [10 CFR 50.33(k); 10 CFR 50.75(b); 10 CFR 52.77] that require the establishment of decommissioning financial assurances to support a COL application, SCE&G used the formula delineated in 10 CFR 50.75(c)(1) and escalation indices provided in NUREG-1307 (NRC 2007) to calculate the minimum amount of funds needed for the eventual decommissioning of the Westinghouse AP1000 advanced reactor assuming one is constructed on the VCSNS site. The funding levels calculated for the AP1000, in 2007 dollars, are $365,610,000 per unit, totaling $731,220,000 for the two-unit facility.

SCE&G would be responsible for 55% of the facility decommissioning costs ($402,171,000) and Santee Cooper would be responsible for 45% of the facility decommissioning costs ($329,049,000). Both SCE&G and Santee Cooper would use an external sinking fund in the form of a trust to provide their respective share of funds to decommission the facility. The costs of decommissioning would be recovered through electric rates.

5.9.4 CONCLUSIONS

SCE&G compared the activities analyzed in the GEIS on the environmental impacts of decommissioning the existing fleet of domestic nuclear power reactors (U.S. NRC 2002) with the activities that form the basis for decommissioning cost estimates prepared by DOE (U.S. DOE 2004) for advanced reactor designs and determined that the scope of activities are the same. Projected physical plant inventories associated with advanced reactor designs will generally be less than those for currently operating power reactors due to advances in technology that simplify maintenance, and benefit decommissioning. Based on this comparison, SCE&G has concluded that the environmental impacts identified in the GEIS are representative of impacts that can be reasonably expected from decommissioning the AP1000.

SCE&G projected total site-specific decommissioning costs for an AP1000 at VCSNS using the formula delineated in 10 CFR 50.75(c)(1) and escalation indices provided in NUREG-1307 (U.S. NRC 2007). The estimated cost to decommission the AP1000 is $365,610,000 per unit, as reported in 2007 dollars. External sinking funds in the form of trusts would be used to provide funds to decommission the facility.

Section 5.9 References

1. U.S. DOE 2004. *Study of Construction Technologies and Schedules, O&M Staffing and Cost, and Decommissioning Costs and Funding Requirements for Advanced Reactor Designs*, prepared by Dominion Energy Inc., Bechtel Power Corporation, TLG, Inc., and MPR Associates for United States Department of Energy Cooperative Agreement DE-FC07-03ID14492, Contract DE-AT01-020NE23476, May. 2004.

2. U.S. NRC 1995. *Revised Analysis of Decommissioning for the Reference Pressurized Water Reactor Power Station*, NUREG/CR-5884, November 1995.

3. U.S. NRC 1999. *Environmental Standard Review Plans for Environmental Reviews for Nuclear Power Plants*, NUREG-1555, Washington D.C,. October 1999.

4. U.S. NRC 2002. *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities,* NUREG-0586, Supplement 1, Office of Nuclear Reactor Regulation, Washington, D.C,. November 2002.

5. U.S. NRC 2003. *Assuring the Availability of Funds for Decommissioning Nuclear Reactors*, Regulatory Guide 1.159, Revision 1. October 2003.

6. U.S. NRC 2007. *Report on Waste Burial Charges, Changes in Decommissioning Waste Disposal Costs at Low-Level Waste Burial Facilities*. NUREG-1307, Revision 12, Office of Nuclear Material Safety and Safeguards, Washington, D.C., November 2007.

5.10 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATIONS

The following measures and controls would limit adverse environmental impacts of operations:

- Compliance with applicable local, state, and federal, ordinances, laws, and regulations intended to prevent or minimize adverse environmental effects
- Compliance with the applicable requirements of all environmental permits and licenses
- Compliance with SCE&G or Santee Cooper procedures and processes

Table 5.10-1 lists the potential impacts due to operation of VCSNS Units 2 and 3 and mitigation measures to be implemented beyond those identified above and any existing or planned monitoring program that is applicable to the potential impacts.

Table 5.10-1 (Sheet 1 of 9)
Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Section Reference		Impact Description or Activity	Feasible and Adequate Measures/Controls
5.1 Land-Use Impacts			
5.1.1	The Site and Vicinity	• Low level of deposition of solids on SCE&G property from operation of the cooling towers. • Potential to spur development, if any, in Newberry County due to its proximity to VCSNS and availability of land that could be developed.	• No mitigation would be required.
5.1.2	Transmission Corridors and Offsite Areas	• Land use would be changed to transmission of electricity, precluding the land within the transmission corridors from being developed as residential or industrial properties. • Units 2 and 3 would generate nonradioactive and low-level radioactive waste that would require disposal in offsite permitted facilities.	• No mitigation would be required.
5.1.3	Historic Properties	• Identified cultural sites wholly or partially within the site boundary of Units 2 and 3, all of which were previously disturbed. Potential for unidentified sites within the site boundary.	• Continue to have a fence barrier around Pearson Cemetery. • Conduct earth-disturbing activities under existing procedures that prescribe actions to be taken in the event that significant archaeological or paleontological artifacts are encountered.
5.2 Water-Related Impacts			
5.2.1	Hydrologic Alterations and Plant Water Supply	• Water would be withdrawn from the Monticello Reservoir at a rate of approximately 37,200 gpm during normal operations to 61,800 gpm during maximum operations. • The consumptive loss of water is projected to be 27,600 gpm during normal operations and 30,800 gpm during maximum use operations.	• No mitigation would be required.
5.2.2	Water Use Impacts	• Maximum consumptive surface water use would be 8% of 7Q10 flow at the Alston Station.	• Monitor hydrological impacts as required by NPDES permit.

Table 5.10-1 (Sheet 2 of 9)
Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Section Reference		Impact Description or Activity	Feasible and Adequate Measures/Controls
5.2.3	Water Quality Impacts	• Discharges to surface water would be under an NPDES permit. • Discharge of solids in water from cooling towers blowdown. Lowest dilution factor would be 58, which could occur during the combination of maximum blowdown and low flow conditions. • Potential for minor spills of petroleum products.	• Monitor constituent emissions as required by NPDES permit. • Implement SCE&G's Spill Prevention, Control, and Countermeasure Plan. • Conduct storm water monitoring as required by storm water permit.
5.3 Cooling System Impacts			
5.3.1	Intake System		
5.3.1.1	Hydrodynamic Descriptions and Physical Impacts	• Water would be withdrawn from the Monticello Reservoir at a rate of approximately 37,200 to 61,800 gpm at the velocity of 0.5 feet per second or less through intake structures that would comply with Clean Water Act provisions designed to minimize impingement and entrainment impacts to aquatic organisms. • The water withdrawal rate and velocity intake for Units 2 and 3 would be less than for the existing unit, so the proposed withdrawal would physically affect much less than 2.92 acres (the maximum area of hydraulic influence from Unit 1) of the Monticello Reservoir.	• Design and operate intake structures based on best available technology.
5.3.1.2	Aquatic Ecosystems	• Estimated impingement rates for Units 2 and 3 based on a 2005–2006 study at Unit 1 were less than that removed daily by fisherman and natural mortality rates.	• Continue voluntary monitoring program for water quality in the Monticello Reservoir.
5.3.2	Discharge System		
5.3.2.1	Thermal Description and Other Physical Impacts	• Based on modeling to predict the mixing zone required for the thermal discharge that would have the maximum impact on the Parr Reservoir, the mixing zone required was within criteria established by SCDHEC. Under maximum heat discharge, the plume would be only 11% of the length and 45% of width that would be allowable under the SCDHEC criteria. • The momentum of the discharge would be dissipated near the discharge point.	• Implement planned design that alternates discharge orientation.

Table 5.10-1 (Sheet 3 of 9)
Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Section Reference		Impact Description or Activity	Feasible and Adequate Measures/Controls
5.3.2.2	Aquatic Ecosystem	• Based on modeling using extreme (worst-case) conditions, most of the reservoir would be unaffected by the thermal discharge. The thermal plume would not create a barrier to upstream or downstream movement of fish. Also, there would be no thermal impacts beyond some thermally sensitive species possibly avoiding the immediate area of the discharge opening. • The discharge will be very small relative to the flow of the Broad River, allowing concentrations of solids and chemicals used in cooling tower water treatment to return to near-ambient levels almost immediately downstream of the discharge pipe. • The discharge would result in minor bottom scour affecting approximately 0.3 acres, leading to a local reduction in numbers of benthic organisms. No important aquatic species or its habitat would be affected.	• No mitigation would be required.
5.3.3	Heat Dissipation Systems		
5.3.3.1	Heat Dissipation to the Atmosphere	• Based on modeling, the expected effects from Units 2 and 3 cooling towers are as follows: average plume length 1.0 miles (summer) to 2.8 miles (winter), average plume height 970 to 2,000 feet, fogging only on site, no icing, shadowing on closest agricultural area of 19 hours per year, increases in humidity onsite only, less than 1 inch of precipitation per season, and salt deposition would be a fraction of the level needed to have visible effects on vegetation.	• No mitigation would be required.
5.3.3.2	Terrestrial Ecosystems	• Maximum expected salt deposition rate from the combination of all four towers would be significantly less than the rate that is considered a threshold value for leaf damage in many species. • Noise level from a cooling tower beyond 200 feet would be lower than the level that startles or frightens birds and small mammals and due to spacing of the towers the noise from more than one operating at a time would not lead to significant incremental increases in noise level. • Cooling towers would be 70 feet high, a height that is expected to cause negligible mortality.	• No mitigation would be required.

Table 5.10-1 (Sheet 4 of 9)
Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Section Reference		Impact Description or Activity	Feasible and Adequate Measures/Controls
5.3.4	Impacts to Members of the Public	• Cooling tower noise would be less than 60 dBA at 1,000 feet away, which is given in NRC guidance as being of small significance. • The thermal plume in the Parr Reservoir from cooling tower blowdown would have maximum temperatures in the range of 92°F with a very small mixing zone, limiting the conditions necessary for optimal growth of thermophilic microorganisms.	• No mitigation will be required.
5.4 Radiological Impacts of Normal Operation			
5.4.1	Exposure Pathways	• Small discharges of radioactive liquids and gases to the environment. • Direct radiation would result in small increases at the site boundary.	• Implement radiological monitoring program as required.
5.4.2	Radiation Doses to Members of the Public	• Potential liquid pathway doses would be 0.058 millirem per year for total body for the maximally exposed individual and 1.64 person-rem per year for collective total body doses to the public within 50 miles.	• Conduct radiological monitoring program as required.
5.4.3	Impacts to Members of the Public	• Potential gaseous pathway doses would be 0.63 millirem for total body for the maximally exposed individual and 1.86 person-rem per year for the collective total body dose to the public within 50 miles. Estimated doses to the public are within the design objectives of 10 CFR 50 Appendix I and within regulatory limits of 40 CFR 190.	• Conduct meteorological monitoring.
5.4.4	Impacts to Biota Other than Members of the Public	• Potential doses to biota from liquid and gaseous effluents. Although there are no acceptance criteria specifically for biota, there is no scientific evidence that chronic doses below 100 millirad/day are harmful to plants or animals. The annual biota doses are much less than the 100 millirad/day.	• Conduct radiological monitoring program as required.
5.4.5	Occupational Radiation Doses	• Maximum annual occupational dose expected to be similar to or less than that for Unit 1, which averages 51 person-rem per year based on the years 2003–2005.	• Conduct radiological monitoring program as required.

Table 5.10-1 (Sheet 5 of 9)
Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Section Reference		Impact Description or Activity	Feasible and Adequate Measures/Controls
5.5 Environmental Impact of Waste			
5.5.1	Nonradioactive Waste System Impacts	• Increase to total volume of water and total amount of chemical and other pollutants in the NPDES permitted discharge. • Increase in storm water discharge over current Unit 1 volume. • Increase in air emissions from VCSNS primarily from auxiliary systems such as emergency diesel generators. • Increase in total volume of nonradioactive solid waste generated and subsequent increase in amount of waste disposed of onsite and offsite. • Operation of a new sanitary waste treatment system for sanitary wastewater.	• Implement existing VCSNS waste minimization program at new units.
5.5.2	Mixed Waste Impacts	• Expected annual generation of 17 cubic feet of liquid mixed waste and 7.5 cubic feet of solid mixed waste for each AP1000 unit.	• Implement existing VCSNS waste minimization program at new units.
5.5.4	Radioactive Waste	• Expected annual generation of uncompacted low-level radioactive waste of 5,760 cubic feet for each AP1000 unit.	• Implement existing VCSNS waste minimization program at new units.
5.6 Transmission System Impacts			
5.6.1	Terrestrial Ecosystems	• Noise from low-flying aircraft conducting aerial surveys of and tree trimming in transmission corridors would temporarily disrupt animal behavior. • Vegetation growth in corridors would be kept in check including eliminating woody growth by periodic maintenance including mowing and applying herbicides.	• Train personnel in the handling of fuel and lubricants and the cleanup and reporting of any incidental spills. • Have adequate spill response equipment on hand during maintenance activities in the corridors.
5.6.2	Aquatic Ecosystems	• Maintenance activities would be conducted in transmission corridors at or nearby water bodies and wetlands that could potentially impact water quality and subsequently important species.	• Implement existing SCE&G and Santee Cooper procedures intended to prevent impacts to water quality and be protective of wetlands and stream crossings including restriction of heavy equipment to prevent erosion, use of approved herbicides only, and spill prevention practices when fueling or lubricating equipment.

Table 5.10-1 (Sheet 6 of 9)
Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Section Reference		Impact Description or Activity	Feasible and Adequate Measures/Controls
5.6.3	Impacts to Members of the Public	• New lines built in new corridors may induce shock in vehicles parked beneath lines. • Transmission lines could emit corona-induced noise at very low or inaudible levels. • New transmission lines could have visual impacts.	• Build new transmission lines to national electrical standards to limit shock from induced currents.
5.7 Uranium Fuel Cycle Impacts			
5.7	Uranium Fuel Cycle Impacts (i.e., relative to the reference Light Water Reactor)	• Permanent commitment of 17 acres of land per year. • Water loss from process cooling would be 210 million gallons per year and water use attributed to mine drainage would be 170 million gallons per year. • Consumption of fossil fuels during the fuel cycle process would be small relative to the power production of the 1000 MW reference reactor (<0.04%). • Units 2 and 3 would have liquid, gaseous, and particulate effluents. Air releases per unit would be <0.1% of the US 2005 SO_2 emissions and <0.01% of the US 2005 NO_x emissions. Liquid effluents would comply with regulatory and permit requirements. • Estimated 100-year environmental dose commitment to the U.S. population from radioactive gaseous and liquid releases would be approximately 800 person-rem to the whole body per reactor-year each year. The 100-year estimated dose commitment from radon-222 due to mining of uranium would be approximately 1,200 person-rem to the whole body per AP 1000 reactor unit and the 100-year estimated dose commitment from technetium-99 due to uranium enrichment would be 130 person-rem per unit. These doses are estimated to potentially result in 1.6 cancer/birth defects cases in the U.S. per year per unit.	• No mitigation would be required.

Table 5.10-1 (Sheet 7 of 9)
Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Section Reference		Impact Description or Activity	Feasible and Adequate Measures/Controls
5.8 Socioeconomic Impacts			
5.8.1	Physical Impacts of Station Operation	• Noise and dust would result from commuting. • Noise from generators, towers, switchyard, and public address system. • Roads in the vicinity would experience temporary increases in traffic at the beginning and end of the workday. • Air emissions would result from standby diesel generators that would be operated periodically on a limited short-term basis.	• Pave access roads and set speed limits for vehicle traffic to minimize noise impacts.
5.8.2	Social and Economic Impacts of Station Operation	• Increase the population by approximately 0.35% in 4-county (i.e., Fairfield, Lexington, Newberry, and Richland) region of influence. Maximum increase in any one county is estimated at approximately 1.1%. • Employ approximately 800 onsite workers and up to an additional 1,000 temporary workers during outages. Housing impacts would be small due to availability in the region and existing of the construction workforce. • An estimated 2,500 additional jobs would be created in the 4-county region as a result of the in-migration of approximately 800 operations workers. • South Carolina would collect additional tax revenue from corporate taxes paid by SCE&G, income taxes paid by employees in newly created jobs (indirect employees) and operations workers (direct employees), and sales taxes from purchases made by direct and indirect employees. • Increased local sales and use tax revenues where applicable and increased property tax revenues from housing owned by the operations workers. • Annual payments of fee-in-lieu of taxes are estimated to range from \$6.4 to \$24.6 million to Fairfield County.	• Stagger outage schedules to minimize traffic congestion. • Before the start of Unit 2 operation, develop an operations management traffic plan. • Minimize the visual impact of the structures through use of topography, design, materials and color.

Table 5.10-1 (Sheet 8 of 9)
Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Section Reference		Impact Description or Activity	Feasible and Adequate Measures/Controls
5.8.2	Social and Economic Impacts of Station Operation (continued)	• Increased traffic on rural roads, especially SC 213 and 215, would remain within the road's capacity during normal operations. Additional traffic during outages would further increase traffic on SC 213 and 215 and could exceed the LOS A (free-flowing traffic) capacity. • Units 2 and 3 intake and discharge structures would be visible from the reservoirs. Cooling tower plumes would be visible for some distance from VCSNS. • Increased demand for water and wastewater treatment by operations workforce residences, but within available capacity of the 4-county region. • Slight increase in ratio of resident to police and firefighter staff in the 4-county region. • Increased demand for medical services, but within available capacity of the 4-county region • Influx of estimated 452 school-age children, an increase in student population that would not push any school district in the 4-county region pass the state-mandated maximum classroom size.	
5.8.3	Environmental Justice Impacts	• SCE&G did not identify any location-dependent disproportionately high and adverse impacts affecting minority and low-income populations. No operations-related disproportionately high and adverse health or environmental effects impacting minority or low-income populations' health or welfare were found.	• No mitigation would be required.
5.9 Decommissioning			
5.9	Decommissioning	• Decommissioning methods are expected to produce occupational exposures comparable to those associated with refueling and plant maintenance. • Radiological impacts of transportation will be similar to those of operations. • Adequate funding for decommissioning at the end of the reactors operational period would have to be assured.	• Continue applicable mitigation measures employed during the operations period for decommissioning activities or for transportation of waste and materials to disposal sites. • SCE&G would assure that adequate funding for decommissioning would be available.

Table 5.10-1 (Sheet 9 of 9)
Summary of Impacts and Measures and Controls to Limit Adverse Impacts During Operations

Section Reference		Impact Description or Activity	Feasible and Adequate Measures/Controls
5.11 Transportation of Radioactive Waste			
5.11	Transportation of Radioactive Waste	• Normalized average annual shipments of unirradiated fuel would be 4.9. Dose was estimated to transportation workers, onlookers, and persons along the route. The largest estimated dose was 0.033 person-rem per AP1000 reactor year to onlookers. • Normalized annual shipments of spent fuel to a repository by truck would be 39 per AP1000 reactor. Dose was estimated to crew, onlookers, and persons along the route per reactor year. The largest dose was 13 person-rem to onlookers. • Normalized annual shipments of radioactive waste by truck for each AP1000 reactor would be 21.	• No mitigation would be required.
5.12 Nonradiological Health Impacts			
5.12	Nonradiological Health Impacts	• The total recordable cases of occupational injuries and illnesses estimated per year for the onsite worker population of Units 2 and 3 based on Unit 1's incident rate would less than the national and SC rates.	• Implement existing SCE&G industrial safety program at Units 2 and 3.

NPDES = National Pollutant Discharge Elimination System
SCDHEC = South Carolina Department of Health and Environmental Control

5.11 TRANSPORTATION OF RADIOACTIVE MATERIALS

Transport of radioactive materials is an important activity associated with operating new reactors at the VCSNS site. The analysis in this section is based on the AP1000 reactor characteristics described in Section 3.2 and radioactive waste management systems described in Section 3.5. Information regarding preparation and packaging of the radioactive materials for transport offsite can be found in Section 3.8.

5.11.1 TRANSPORTATION ASSESSMENT

The NRC regulations in 10 CFR 51.52 state that:

> "Every environmental report prepared for the construction permit stage of a light-water-cooled nuclear power reactor, and submitted after February 4, 1975, shall contain a statement concerning transportation of fuel and radioactive wastes to and from the reactor. That statement shall indicate that the reactor and this transportation either meet all of the conditions in paragraph (a) of this section or all of the conditions in paragraph (b) of this section."

NRC evaluated the environmental effects of transportation of fuel and waste for light water reactors in *Environmental Survey of Transportation of Radioactive Materials to and From Nuclear Power Plants* (U.S. AEC 1972) and Supplement 1 (U.S. NRC 1975) and found the impacts to be SMALL. These NRC analyses provided the basis for Table S-4 in 10 CFR 51.52 (Table 5.11-1), which summarizes the environmental impacts of transportation of fuel and radioactive wastes to and from a reference reactor. The table addresses two categories of environmental considerations: normal conditions of transport and accidents in transport.

To analyze the impacts of transporting AP1000 fuel and radioactive waste for comparison to Table S-4, the characteristics for the AP1000 were normalized to a reference reactor-year. The reference reactor is an 1,100 MWe reactor that has an 80% capacity factor, for an electrical output of 880 MWe per year. The advanced light water reactor technology being considered for the VCSNS site is the AP1000 assumed to be a 1,115 MWe reactor with a 93% capacity factor. The proposed configuration for the new plant is two units. The standard configuration (a single unit) for the AP1000 will be used to evaluate transportation impacts relative to the reference reactor.

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 report. For reactors not meeting all of the conditions in paragraph (a) of 10 CFR 51.52, paragraph (b) of 10 CFR 51.52 requires a further analysis of the transportation effects.

The conditions in paragraph (a) of 10 CFR 51.52 establishing the applicability of Table S-4 are 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, and mode of transport for radioactive waste other than irradiated fuel. The following subsections describe the characteristics of the AP1000 relative to the conditions of 10 CFR 51.52 for use of Table S-4. Information for the AP1000 is taken from the AP1000 DCD (Westinghouse 2005, Whiteman 2006, INEEL 2003).

5.11.1.1 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. The AP1000 has a thermal power rating of 3,400 MWt and meets this condition.

The core power level was established as a condition because, for the light water reactors being licensed when Table S-4 was promulgated, higher power levels typically indicated the need for more fuel and, therefore, more fuel shipments than was evaluated for Table S-4. This is not the case for the new light water reactor designs due to the higher unit capacity and higher burnup for these reactors. The annual fuel reloading for the reference reactor analyzed in WASH-1238 (U.S. AEC 1972) was 30 metric tons of uranium while the annual fuel loading for the AP1000 is 23 metric tons of uranium. When normalized to equivalent electric output, the annual fuel requirement for the AP1000 is approximately 20 metric tons of uranium or two-thirds that of the reference light water reactor.

5.11.1.2 Fuel Form

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel be in the form of sintered uranium dioxide (UO_2) pellets. The AP1000 uses a sintered UO_2 pellet fuel form.

5.11.1.3 Fuel Enrichment

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel have a uranium-235 enrichment not exceeding 4% by weight. For the AP1000, the enrichment of the initial core varies by region from 2.35 to 4.45% and the average for reloads is 4.54%. The AP1000 fuel exceeds the 4% U-235 condition.

5.11.1.4 Fuel Encapsulation

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel pellets be encapsulated in Zircaloy rods. Paragraph 10 CFR 50.46 also allows use of ZIRLO™[a]. License amendments approving use of ZIRLO rather than Zircaloy have not involved a significant increase in the amounts or significant change in the types of any effluents that may be released offsite, or significant increase in

a. ZIRLO is a trademark of the Westinghouse Electric Company individual or cumulative occupational radiation exposure. The AP1000 fuel uses either Zircaloy or ZIRLO cladding and meets this subsequent evaluation condition.

5.11.1.5 Average fuel Irradiation

Subparagraph 10 CFR 51.52(a)(3) requires that the average burnup not exceed 33,000 MW days per metric tons of uranium. The average burnup is 50,553 MW days per metric tons of uranium for the AP1000, which exceeds this condition.

5.11.1.6 Time after Discharge of Irradiated Fuel before Shipment

Subparagraph 10 CFR 51.52(a)(3) requires that no irradiated fuel assembly be shipped until at least 90 days after it is discharged from the reactor. The original analysis for Table S-4 assumes 150 days of decay time before shipment of any irradiated fuel assemblies (U.S. AEC 1972). The updated analysis (Ramsdell et al. 2001) extends Table S-4 to burnups of up to 62,000 MW days per metric tons of uranium, assumes a minimum of five years between removal from the reactor and shipment. Five years is the minimum decay time expected before shipment of irradiated fuel assemblies. The U.S. DOE’s contract for acceptance of spent fuel, as set forth in 10 CFR 961, Appendix E, requires a five-year minimum cooling time. 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 (U.S. NRC 1999). As described in Section 3.5, Units 2 and 3 would have storage capacity exceeding that needed to accommodate five-year cooling of irradiated fuel prior to transport off site.

5.11.1.7 Transportation of Unirradiated Fuel

Subparagraph 10 CFR 51.52(a)(5) requires that unirradiated fuel be shipped to the reactor site by truck. Fuel is currently transported to the reactor at Unit 1 by truck. SCE&G would receive fuel via truck shipments for Units 2 and 3.

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. The fuel shipments to the VCSNS site will comply with federal or state weight restrictions.

5.11.1.8 Transportation of Irradiated Fuel

Subparagraph 10 CFR 51.52(a)(5) allows for truck, rail, or barge transport of irradiated fuel. This condition would be met for the AP1000. For the impacts analysis described in Subsection 5.11.2, SCE&G assumed that all spent fuel shipments would be made using legal weight trucks. DOE is responsible for spent fuel transportation from reactor sites to the repository and will make the decision on transport mode (10 CFR 961.1).

5.11.1.9 Radioactive Waste Form and Packaging

Subparagraph 10 CFR 51.52(a)(4) requires that, with the exception of spent fuel, radioactive waste shipped from the reactor be packaged and in a solid form. As described in Subsection 3.5.3, SCE&G would solidify and package the radioactive waste. Additionally, SCE&G would comply with NRC (10 CFR 71) and DOT (49 CFR 173 and 178) packaging and transportation regulations for the shipment of radioactive material.

5.11.1.10 Transportation of Radioactive Waste

Subparagraph 10 CFR 51.52(a)(5) requires that the mode of transport of low-level radioactive waste be either truck or rail. SCE&G would ship radioactive waste from the AP1000 units by truck.

Radioactive waste shipments are subject to a weight limit of 73,000 pounds per truck and 100 tons per cask per rail car. Radioactive waste from the AP1000 is capable of being shipped in compliance with Federal or state weight restrictions.

5.11.1.11 Number of Truck Shipments

Table S-4 limits traffic density to less than one truck shipment per day or three rail cars per month. SCE&G has estimated the number of truck shipments that would be required assuming that all radioactive materials (fuel and waste) are received at the site or transported offsite via truck.

Table 5.11-2 summarizes the number of truck shipments of unirradiated fuel. Table 5.11-2 also normalizes the number of shipments to the electrical output for the reference reactor analyzed by NRC (U.S. AEC 1972). When normalized for electrical output, the number of truck shipments of unirradiated fuel for the AP1000 is less than the number of truck shipments estimated for the reference light water reactor.

For the AP1000, the initial core load is estimated at 84.5 metric tons of uranium per unit and the annual reload requirements are estimated at 23 metric tons of uranium per year per unit. This equates to about 157 fuel assemblies in the initial core (assuming 0.5383 metric tons of uranium per fuel assembly) and 43 fuel assemblies per year for refueling. The vendor is designing a transportation container that will accommodate one 14-foot fuel bundle. Due to weight limitations, the number of such containers will be limited to seven to eight per truck shipment. For the initial core load, the trucks are assumed to carry seven containers to allow for shipment of core components along with the fuel assemblies. Truck shipments will be able to accommodate eight containers per shipment for refueling.

The numbers of spent fuel shipments were estimated as follows. For the reference light water reactor analyzed in WASH-1238 (U.S. AEC 1972), NRC assumed that 60 shipments per year will be made, each carrying 0.5 metric tons of uranium of spent fuel. This amount is equivalent to the annual refueling requirement of 30 metric tons of uranium per year for the reference light water reactor. For this transportation analysis, SCE&G assumed that for the AP1000, it would also ship spent fuel at a rate equal to the annual refueling requirement. The shipping cask capacities used to calculate annual spent fuel shipments were assumed to be the same as those for the reference light water reactor (0.5 metric tons of uranium per legal weight truck shipment). This results in 46 shipments per year for one AP1000. After normalizing for electrical output, the number of spent fuel shipments is 39 per year for the AP1000. The normalized spent fuel shipments for the AP1000 would be less than the reference reactor that was the basis for Table S-4.

Table 5.11-3 presents estimates of annual waste volumes and numbers of truck shipments. The values are normalized to the reference light water reactor analyzed in WASH-1238 (U.S. AEC 1972). The normalized annual waste volumes and waste shipments for the AP1000 would be less than the reference reactor that was the basis for Table S-4.

The total numbers of truck shipments of fuel and radioactive waste to and from the reactor are estimated at 65 per year for the AP1000. These radioactive material transportation estimates are well below the one truck shipment per day condition given in 10 CFR 51.52, Table S-4. Doubling the estimated number of truck shipments to account for empty return shipments still results in number of shipments well below the one-shipment-per-day condition.

5.11.1.12 Summary

Table 5.11-4 summarizes the reference conditions in paragraph (a) of 10 CFR 51.52 for use in Table S-4 and the values for the AP1000. The AP1000 does not meet the conditions for average fuel enrichment or average fuel irradiation. Therefore, Subsection 5.11.2 and Section 7.4 present additional analyses of fuel transportation effects for normal conditions and accidents, respectively. Transportation of radioactive waste meets the applicable conditions in 10 CFR 51.52 and no further analysis is required.

5.11.2 INCIDENT-FREE TRANSPORTATION IMPACTS ANALYSIS

Environmental impacts of incident-free transportation of fuel are discussed in this subsection. Incident-free transportation refers to transportation activities in which the shipments reach their destination without releasing any radioactive cargo to the environment.Transportation accidents are discussed in Section 7.4.

NRC analyzed the transportation of radioactive materials in its assessments of environmental impacts for the proposed ESP sites at North Anna, Clinton, and Grand Gulf (U.S. NRC 2006a, 2006b, 2006c). SCE&G reviewed the NRC analyses for guidance in assessing transportation impacts for Units 2 and 3 at the VCSNS site.

5.11.2.1 Transportation of Unirradiated Fuel

Table S-4 of 10 CFR 51.52 includes conditions related to radiological doses to transport workers and members of the public along transport routes. These doses, based on calculations in WASH-1238 (U.S. AEC 1972), are a function of the radiation dose rate emitted from the unirradiated fuel shipments, the number of exposed individuals and their locations relative to the shipment, the time of transit (including travel and stop times), and the number of shipments to which the individuals are exposed. In its assessments of environmental impacts for proposed ESP sites, NRC calculated the radiological dose impacts of unirradiated fuel transportation using the RADTRAN 5 computer code. The RADTRAN 5 calculations estimated worker and public doses associated with annual shipments of unirradiated fuel.

One of the key assumptions in WASH-1238 (U.S. AEC 1972) for the reference light water reactor unirradiated fuel shipments is that the radiation dose rate at 1 meter from the transport vehicle is about 0.1 millirem per hour. This assumption was also used by NRC to analyze advanced light water reactor unirradiated fuel shipments for the proposed ESP sites. This assumption is reasonable for all of the advanced light water reactor types because the fuel materials will all be low-dose-rate uranium radionuclides and will be packaged similarly (inside a metal container that provides little radiation shielding). The per-shipment dose estimates are “generic” (*i.e.,* independent of reactor technology) because they were calculated based on an assumed external radiation dose rate rather than the specific characteristics of the fuel or packaging. Thus, the results can be used to evaluate the impacts for any of the advanced light water reactor designs. Other input parameters used in the NRC radiation dose analysis for advanced light water reactor unirradiated fuel shipments are summarized in Table 5.11-5. The results for this “generic” fresh fuel shipment based on the RADTRAN 5 analyses are as follows:

Population Component	Dose
Transport workers	0.00171 person-rem/shipment
General public (Onlookers – persons at stops and sharing the highway)	0.00665 person-rem/shipment
General public (Along Route – persons living near a highway)	1.61 x 10^{-4} person-rem/shipment

SCE&G reviewed the NRC analysis and concluded these unit dose values could be used to estimate the impacts of transporting unirradiated fuel to the VCSNS site. Based on the parameters used in the analysis, these per-shipment doses are expected to conservatively estimate the impacts for fuel shipments to a site in the SCE&G region of influence. For example, the average shipping distance of 2000 miles used in the NRC analyses is likely to exceed the shipping distance for fuel deliveries to the VCSNS site. The fuel shipments are expected to originate at a fabrication facility located in Columbia, South Carolina, and travel less than 60 miles to the VCSNS site.

The unit dose values were combined with the average annual shipments of unirradiated fuel to calculate annual doses to the public and workers that can be compared to Table S-4 conditions. The numbers of unirradiated fuel shipments were normalized to the reference reactor analyzed in WASH-1238 (U.S. AEC 1972). The numbers of shipments per year were obtained from Table 5.11-2. The results are presented in Table 5.11-6. As shown, the calculated radiation doses for transporting unirradiated fuel to the VCSNS site are within the Table S-4 conditions.

Although radiation may cause cancers at high doses and high dose rates, currently there is no data that unequivocally establish the occurrence of cancer following exposures to low doses, below about 10 rem. However, radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. Simply stated, any increase in dose, no matter how small, results in an incremental increase in health risk. This theory is accepted by the NRC as a conservative model for estimating health risks from radiation exposure, recognizing that the model may overestimate those risks. A recent review by the National Academy of Sciences Committee to Assess Health Risks from Low Levels of Ionizing Radiation supports the linear no-threshold model (NAS 2005).

Based on this model, the risk to the public from radiation exposure is estimated using the nominal probability coefficient for total detriment (730 fatal cancers, nonfatal cancers, and severe hereditary effects per million person-rem) from International Commission on Radiological Protection Publication 60 (ICRP 1991). All the public collective doses presented in Table 5.11-6 are less than 0.1 person-rem per year. Therefore, the total detriment estimates associated with these doses will all be less than 1×10^{-4} fatal cancers, nonfatal cancers, and severe hereditary effects per year. These risks are very small compared to the fatal cancers, nonfatal cancers, and severe hereditary effects that the same population will incur annually from exposure to natural sources of radiation.

5.11.2.2 Transportation of Spent Fuel

This subsection provides the environmental impacts of transporting spent fuel from the VCSNS site to a spent fuel disposal facility, using Yucca Mountain, Nevada, as a possible location for a geologic repository. The impacts of the transportation of spent fuel to a potential repository in Nevada provide a reasonable bounding estimate of the transportation impacts to a monitored retrievable storage facility because of the distances involved and the representative exposure of members of the public in urban, suburban, and rural areas (U.S. NRC 2006a, 2006b, 2006c).

Incident-free transportation refers to transportation activities in which the shipments reach their destination without releasing any radioactive cargo to the environment. Impacts from these shipments will be from the low levels of radiation that penetrate the heavily shielded spent fuel shipping cask. Radiation doses would occur to people residing along the transportation corridors between the VCSNS site and the proposed repository, people in vehicles passing a spent-fuel shipment, people at vehicle stops for refueling, rest, and vehicle inspections, and transportation crew workers.

This analysis is based on shipment of spent fuel by legal-weight trucks in casks with characteristics similar to casks currently available (*i.e.,* massive, heavily shielded, cylindrical metal pressure vessels). Each shipment is assumed to consist of a single shipping cask loaded on a modified trailer. These assumptions are consistent with assumptions made by NRC in evaluating the environmental impacts of spent fuel transportation (U.S. NRC 1999). As discussed in NRC (U.S. NRC 1999), these assumptions are conservative because the alternative assumptions involve rail transportation or heavy-haul trucks, which will reduce the overall number of spent fuel shipments.

SCE&G estimated the environmental impacts of spent fuel transportation using the RADTRAN 5 computer code (Neuhauser et al. 2003). This analysis assumed the spent fuel will be transported by legal weight trucks to the potential Yucca Mountain repository over designated highway route-controlled quantity routes. The route used for this analysis of the VCSNS site differs from the VCSNS - Yucca Mountain legal weight truck route evaluated in the Yucca Mountain environmental impact statement (U.S. DOE 2002a). The VCSNS-Yucca Mountain route analyzed in the Yucca Mountain environmental impact statement traveled a total of 2,704 miles (U.S. DOE 2002). SCE&G evaluated a more direct route that was consistent with highway route-controlled quantity routes requirements but that traveled a total of 2,568 miles.

Although shipping casks have not been designed for the advanced light water reactor fuels, the advanced light water reactor fuel designs will not be significantly different from existing light water reactor designs. Current shipping cask designs were used for analysis.

Radiation doses are a function of many parameters, including vehicle speed, traffic count, dose rate at 1 meter from the vehicle, packaging dimensions, number in the truck crew, stop time, and population density at stops. The values of the key variables used in this analysis are presented in Table 5.11-7. Most of the variables are extracted from the literature and are considered to be standard values used in many RADTRAN applications, including environmental impact statements and regulatory analyses.

The transportation route selected for a shipment determines the total potentially exposed population and the expected frequency of transportation-related accidents. For truck transportation, the route characteristics most important to the risk assessment include the total shipping distance between each origin-destination pair of sites and the population density along the route.

Representative shipment routes for the proposed VCSNS site and alternative sites were identified using the TRAGIS (Version 1.5.4) routing model (Johnson and Michelbaugh 2000). The highway data network in TRAGIS is a computerized road atlas that includes a complete description of the interstate highway system and of all U.S. highways. The TRAGIS database version used was Highway Data Network 4.0. The population densities along a route are derived from 2000 census data from the U.S. Census Bureau. This transportation route information is summarized in Table 5.11-8.

Based on the transportation route information shown in Table 5.11-8, the impacts of spent fuel shipments originating at the VCSNS site are expected to be similar to the impacts for the alternative sites (Savannah River Site, Cope Generating Station). The impacts of transportation of spent fuel from a green field site (assumed to be in Saluda County) located in the SCE&G region of interest will also be similar to the transportation impacts for the VCSNS site.

The radiation dose estimates to the transport workers and the public for spent fuel shipments from the VCSNS site and alternative sites are as follows:

	Population Dose (person-rem per shipment)		
Site	**Transport Workers**	**General Public (Onlookers)**	**General Public (Along Route)**
VCSNS	0.054	0.34	0.0082
SRS	0.054	0.34	0.0089
Cope	0.056	0.34	0.0088
Saluda County	0.054	0.34	0.0081

These per-shipment dose estimates are independent of reactor technology because they were calculated based on an assumed external radiation dose rate emitted from the cask, which was fixed at the regulatory maximum of 10 millirem per hour at 2 meters. For the purpose of this analysis, the transportation crew consists of two drivers. Stop times were assumed to accrue at the rate of 30 minutes per 4 hours of driving time. TRAGIS output was used to determine the number of stops.

The numbers of spent fuel shipments for the transportation impacts analysis were derived as described in Subsection 5.11.1. The normalized annual shipments values and corresponding population dose estimates per reactor-year are presented in Table 5.11-9. The population doses were calculated by multiplying the number of spent fuel shipments per year by the per-shipment doses. For comparison to Table S-4, the population doses were normalized to the reference light water reactor analyzed in WASH-1238.

As shown in Table 5.11-9, population doses to the onlookers for both the AP1000 and the reference light water reactor exceed Table S-4 values. Two key reasons for these higher population doses relative to Table S-4 are the number of spent fuel shipments and the shipping distances assumed for these analyses relative to the assumptions used in WASH-1238.

- The analyses in WASH-1238 used a “typical” distance for a spent fuel shipment of 1,000 miles. The shipping distance used in this assessment is about 2,600 miles.
- The numbers of spent fuel shipments are based on shipping casks designed to transport shorter-cooled fuel (*i.e.,* 150 days out of the reactor).

This analysis assumed that the shipping cask capacities are 0.5 metric tons of uranium per legal-weight truck shipment. Newer cask designs are based on longer-cooled spent fuel (*i.e.,* 5 years out of reactor) and have larger capacities. For example, spent fuel shipping cask capacities used in the Yucca Mountain environmental impact statement (U.S. DOE 2002a) were approximately 1.8 metric tons of uranium per legal-weight truck shipment. Use of the newer shipping cask designs will reduce the number of spent fuel shipments and decrease the associated environmental impacts (since the dose rates used in the impacts analysis are fixed at the regulatory limit rather than based on the cask design and contents).

If the population doses were adjusted for the longer shipping distance and larger shipping cask capacity, the population doses from incident-free spent fuel transportation from the VCSNS site will fall within Table S-4 requirements.

Other conservative assumptions in the spent fuel transportation impacts calculation include:

- Use of the regulatory maximum dose rate (10 millirem per hour at 2 meters) in the RADTRAN 5 calculations. The shipping casks assumed in the Yucca Mountain environmental impact statement (U.S. DOE 2002a) transportation analyses were designed for spent fuel that has cooled for five years. In reality, most spent fuel will have cooled for much longer than five years before it is shipped to a possible geologic repository. NRC developed a probabilistic distribution of dose rates based on fuel cooling times that indicates that approximately three-fourths of the spent fuel to be transported to a possible geologic repository will have dose rates less than half of the regulatory limit (Sprung et al. 2000). Consequently, the estimated population doses in Table 5.11-9 could be divided in half if more realistic dose rate projections are used for spent fuel shipments from the VCSNS site.

- Use of 30 minutes as the average time at a truck stop in the calculations. Many stops made for actual spent fuel shipments are short duration stops (*i.e.,* 10 minutes) for brief visual inspections of the cargo (checking the cask tie-downs). These stops typically occur in minimally populated areas, such as an overpass or freeway ramp in an unpopulated area. Based on data for actual truck stops, NRC concluded that the assumption of a 30-minute stop for every four hours of driving time used to evaluate potential ESP sites will overestimate public doses at stops by at least a factor of two (U.S. NRC 2006a, 2006b, 2006c). Consequently, the doses to onlookers given in Table 5.11-9 could be reduced by a factor of two to reflect more realistic truck shipping conditions.

5.11.2.3 Maximally Exposed Individuals Under Normal Transport Conditions

SCE&G also considered incident-free radiation doses to maximally exposed individuals (MEIs) for fuel and waste shipments to and from the VCSNS site. An MEI is a person who may receive the highest radiation dose from a shipment to and/or from the VCSNS site. The radiological doses to the workers who would load casks, drive trucks, and inspect vehicles in transit would be higher than doses to individuals in the general public. Radiological protection programs would manage and limit doses to workers whose jobs would cause them to receive the greatest exposures.

Truck crew members would receive the highest radiation doses because of their proximity to the loaded shipping container for an extended period of time. SCE&G assumed that crew member doses would be limited to 2 rem per year, which is the DOE administrative control level (DOE 2005). DOE will take title to the spent fuel at the reactor site. Consequently, the DOE administrative control level is expected to apply to spent fuel shipments from the VCSNS site to a disposal facility. Spent fuel represents the majority of the radioactive materials shipments to and from reactor sites, and comprises those shipments with the highest radiation dose rates. Crew doses from unirradiated fuel and radioactive waste shipments will be lower than the spent fuel shipments. SCE&G assumed a maximally exposed individual worker on the truck crew could receive a dose as high as 2 rem per year for each of the 40 years of reactor operation, for a total of 80 rem for one AP1000 over the 40-year license term.

The dose received by members of the public would be less than that described for the truck crew due to decreases in the exposure times, dose rates, and number of times an individual may be exposed to an offsite shipment. For example:

- Inspectors. Radioactive shipments are inspected by Federal or State vehicle inspectors at State ports of entry. DOE (2002a) assumed that inspectors would be exposed for 1 hour at a distance of 1 meter from the shipping containers. The dose rate at 1 meter is about 14 millirem per hour, assuming the dose rate from the shipping containers is 10 millirem per hour at 2 meters from the side of the transport vehicle. (This is the maximum dose rate allowed by U.S. Department of Transportation (DOT) regulations.) Therefore, the dose per shipment is about 14 millirem. Based on this conservative value, the maximum annual dose to vehicle inspectors would be approximately 1,400 millirem per year, assuming the same person inspects all shipments of fuel and waste to and from the reactor site in a year. This is less than the 2 rem per year DOE administrative control level on individual doses

- Resident. A resident living along the transportation route could be exposed to each shipment that passes their residence. Given the distance separating the residence from the radioactive material transport vehicle on the roadway and the short duration of each exposure, the potential radiation doses to maximally exposed residents would be much less than those of the truck crew or inspectors.

- Individual stuck in traffic. Potential traffic interruptions could lead to a person being exposed to a loaded radioactive material shipment for some period of time. Because this exposure scenario would occur only one time to any individual and their exposure is relatively short (on the order of an hour), the dose to these members of the public sharing the route would be much less than those of the truck crew or inspectors.

- Person at a truck service station. An employee at a service station could be exposed when truck shipments to and from the reactor stop. DOE (2002a) assumed this person could be exposed for 49 minutes at a distance of 52 feet from the loaded shipping container. This results in a dose of about 0.07 millirem per shipment for an annual dose of approximately 7 millirem, assuming that a single individual services all unirradiated fuel, spent fuel, and radioactive waste shipments to and from the site in a year. This dose is much less than those of the truck crew or inspectors.

5.11.2.4 Conclusion

SCE&G has evaluated incident free transportation of unirradiated and spent fuel to and from the VCSNS site, including potential impacts to MEIs. The impacts of accident free transportation would be SMALL and do not warrant additional mitigation.

Section 5.11 References

1. ICRP (International Commission on Radiological Protection) 1991. *Recommendations of the International Commission on Radiological Protection*, ICRP Publication 60, Pergammon Press, Oxford, United Kingdom, 1991.

2. INEEL (Idaho National Engineering and Environmental Laboratory) 2003. *Early Site Permit Environmental Report Sections and Supporting Documentation*, Engineering Design File Number 3747, Idaho Falls, Idaho, 2003.

3. Johnson, P. E. and R. D. Michelhaugh, 2000. *Transportation Routing Analysis Geographic Information System (WebTRAGIS) User's Manual*, ORNL/TM-2000/86, Oak Ridge National Laboratory, Oak Ridge, Tennessee. Available at http://www.ornl.gov/~webworks/cpr/v823/rpt/106749.pdf.

4. NAS (National Academy of Sciences) 2005. *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII – Phase 2,* Committee to Assess Health Risks From Exposure to Low Levels of Ionizing Radiation, Board on Radiation Effects Research, Division of Earth and Life Studies, National Research Council, National Academy Press, Washington D.C., 2005. Available at http://www.nap.edu/books/030909156X/html.

5. (Neuhauser et al. 2003) Neuhauser, K. S., F. L. Kanipe, and R. F. Weiner. *RADTRAN 5 User Guide*. SAND2003-2354, Sandia National Laboratories, Albuquerque, New Mexico. Available at http://infoserve.sandia.gov/sand_doc/2003/032354.pdf.

6. Ramsdell, J. V., C. E. Beyer, D. D. Lanning, U. P. Jenquin, R. A. Schwarz, D. L. Strenge, P.M. Daling, and R. T. Dahowski, 2001. *Environmental Effects of Extending Fuel Burnup Above 60 GWd/MTU*, NUREG/CR-6703, Office of Nuclear Reactor Regulation, U.S. NRC, Washington D.C., January 2001.

7. Sprung, J. L., D. J. Ammerman, N. L. Breivik, R. J. Dukart, F. L. Kanipe, J. A. Koski, G. S. Mills, K. S. Neuhauser, H. D. Radloff, R. F. Weiner, and H. R. Yoshimura, 2000. *Reexamination of Spent Fuel Shipment Risk Estimates*, NUREG/CR-6672, Volume 1, Office of Nuclear Material Safety and Safeguards, U.S. NRC, Washington D.C., March 2000.

8. U.S. AEC (U.S. Atomic Energy Commission) 1972. *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants*, WASH-1238, Washington D.C., December 1972.

9. U.S. DOE 2002a. *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250, Office of Civilian Radioactive Waste Management, U.S. DOE, Washington D.C., February 2002.

10. U.S. DOE 2002b. *A Resource Handbook on DOE Transportation Risk Assessment*, DOE/EM/NTP/HB-01, Washington D.C., 2002.

11. U.S. DOE 2005. *DOE Standard, Radiological Control*, DOE-STD-1098-99, Washington D.C., March 2005. Available at http://www.hss.energy.gov/NuclearSafety/techstds/standard/std1098/doe-std-1098-99cn1a.pdf.

12. U.S. NRC 1975. *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants*, Supplement 1, NUREG-75/038, Office of Standards Development, Washington D.C., April 1975.

13. U.S. NRC 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, Section 6.3, “Transportation” and Table 9, “Summary of findings on NEPA issues for License Renewal of Nuclear Power Plants,” NUREG-1437, Volume 1, Addendum 1, Washington D.C., August 1999.

14. U.S. NRC 2006a. *Environmental Impact Statement for an Early Site Permit (ESP) at the North Anna ESP Site*, NUREG-1811, Office of New Reactors, Washington D.C., December 2006.

15. U.S. NRC 2006b. *Environmental Impact Statement for an Early Site Permit (ESP) at the Exelon ESP Site*, NUREG-1815, Office of Nuclear Reactor Regulation, U.S. NRC, Washington D.C., July 2006.

16. U.S. NRC 2006c. *Environmental Impact Statement for an Early Site Permit (ESP) at the Grand Gulf ESP Site*, NUREG-1817, Office of Nuclear Reactor Regulation, Washington D.C., April 2006.

17. Westinghouse 2007. *AP1000 Design Control Document*, Revision 16, Pittsburgh, Pennsylvania, May 2006.

18. Whiteman, J., 2006. Electronic mail to A. Paglia (SCE&G) regarding SCANA’s Fuel Reload-Related Request for Confirmation, June 15, 2006.

Table 5.11-1
Summary of Environmental Impacts of Transportation of Fuel and Waste to and from One Light Water Reactor, Taken from 10 CFR 51.52 Table S-4[(a)]

Normal Conditions of Transport	
	Environmental Impact
Heat (per irradiated fuel cask in transit)	250,000 Btu/hour
Weight (governed by federal or state restrictions)	73,000 lbs per truck; 100 tons per cask per rail car
Traffic density:	
Truck	Less than 1 per day
Rail	Less than 3 per month

Exposed Population	Estimated Number of Persons Exposed	Range of Doses to Exposed Individuals[(b)] (per reactor year)	Cumulative Dose to Exposed Population (per reactor year)[(c)]
Transportation workers	200	0.01 to 300 millirem	4 man-rem.
General public:			
Onlookers	1,100	0.003 to 1.3 millirem	3 man-rem.
Along Route	600,000	0.0001 to 0.06 millirem	

Accidents in Transport	
Types of Effects	**Environmental Risk**
Radiological effects	Small[(d)]
Common (nonradiological) causes	1 fatal injury in 100 reactor years; 1 nonfatal injury in 10 reactor years; $475 property damage per reactor year.

(a) Data supporting this table are given in the Commission's "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," WASH-1238, December 1972, and Supp. 1 NUREG-75/038, April 1975.
(b) The Federal Radiation Council has recommended that the radiation doses from all sources of radiation other than natural background and medical exposures should be limited to 5,000 millirem per year for individuals as a result of occupational exposure and should be limited to 500 millirem per year for individuals in the general population. The dose to individuals due to average natural background radiation is about 130 millirem per year.
(c) Man-rem is an expression for the summation of whole body doses to individuals in a group. Thus, if each member of a population group of 1,000 people were to receive a dose of 0.001 rem (1 millirem), or if 2 people were to receive a dose of 0.5 rem (500 millirem) each, the total man-rem dose in each case will be 1 man-rem.
(d) Although the environmental risk of radiological effects stemming from transportation accidents is currently incapable of being numerically quantified, the risk remains small regardless of whether it is being applied to a single reactor or a multi-reactor site.

Table 5.11-2
Number of Truck Shipments of Unirradiated Fuel

Reactor Type	Number of Shipments per Unit			Unit Electric Generation, MWe[(c)]	Capacity Factor[(c)]	Normalized Shipments Total[(d)]	Normalized Shipments Annual[(e)]
	Initial Core[(a)]	Annual Reload	Total (b)				
Reference LWR	18[(f)]	6.0	252	1,100	0.8	252	6.3
AP1000	23	5.3	231	1,115	0.93	196	4.9

a) Shipments of the initial core have been rounded up to the next highest whole number.
b) Total shipments of fresh fuel over 40-year plant lifetime (i.e., initial core load plus 39 years of average annual reload quantities).
c) AP1000 unit generating capacity from Westinghouse (2007) and capacity factor from Westinghouse (2006).
d) Normalized to electric output for WASH-1238 reference plant (*i.e.,* 1100 MWe) plant at 80% or an electrical output of 880 MWe.
e) Annual average for 40-year plant lifetime.
f) The initial core load for the reference BWR in WASH-1238 was 150 metric tons of uranium The initial core load for the reference PWR was 100 metric tons of uranium. Both types result in 18 truck shipments of fresh fuel per reactor.

Table 5.11-3
Number of Radioactive Waste Shipments

Reactor Type	Waste Generation, ft^3/yr, per unit	Annual Waste Volume, ft^3/yr, per site	Electrical Output, MWe, per site	Capacity Factor	Normalized Waste Generation Rate, ft^3/ reactor-year[(a)]	Normalized Shipments/ reactor-year[(b)]
Reference LWR	3,800	3,800	1,100	0.80	3,800	46
AP1000	2,000	3,900	2,230[(c)]	0.93	1,700	21

a) Annual waste generation rates normalized to equivalent electrical output of 880 MWe for reference LWR analyzed in WASH-1238.
b) The number of shipments was calculated assuming the average waste shipment capacity of 82.6 square feet per shipment (3800 square feet/yr divided by 46 shipments/yr) used in WASH-1238.
c) The VCSNS site includes two AP1000 units assumed to be 1115 MWe per unit.

Table 5.11-4
AP1000 Comparisons to Table S-4 Reference Conditions

Characteristic	Table S-4 Condition	AP1000
Thermal Power Rating (MWt)	Not exceeding 3,800 per reactor	3,400
Fuel Form	Sintered UO2 pellets	Sintered UO2 pellets
U235 Enrichment (%)	Not exceeding 4	Initial Core Region 1: 2.35; Region 2: 3.40; Region 3: 4.45 Reload Average 4.54
Fuel Rod Cladding	Zircaloy rods; NRC has also accepted ZIRLO™ per 10 CFR 50.46	Zircaloy or ZIRLO™
Average burnup (MWd/metric tons uranium)	Not exceeding 33,000	50,553
Unirradiated Fuel		
Transport Mode	truck	truck
No. of shipments for initial core loading[(a)]		23
No. of reload shipments per year[1]		5.3
Irradiated Fuel		
Transport mode	truck, rail or barge	truck, rail
Decay time before shipment	Not less than 90 days is a condition for use of Table S-4; 5 years is per contract with DOE	10 years
No. of spent fuel shipments by truck[(a)]		46 per year
No. of spent fuel shipments by rail		not analyzed
Radioactive Waste		
Transport mode	truck or rail	truck
Waste form	solid	solid
Packaged	yes	yes
No. of waste shipments by truck[1]		24 per year
Traffic Density		
Trucks per day[(b)] (normalized total)	Less than 1	<1 (65 per year)
Rail cars per month	Less than 3	not analyzed

a) Table provides the total numbers of truck shipments of fuel and waste for the AP1000. These values are then normalized based on electric output and summed for comparison to the traffic density condition in Table S-4.

b) Total truck shipments per year calculated after normalization of estimated fuel and waste shipments for equivalent electrical output to the reference reactor analyzed in WASH-1238.

Table 5.11-5
RADTRAN 5 Input Parameters for NRC Analysis of Unirradiated Fuel Shipments

Parameter	RADTRAN 5 Input Value
Shipping distance, miles[(a)]	2,000
Travel Fraction – Rural	0.90
Travel Fraction – Suburban	0.05
Travel Fraction – Urban	0.05
Population Density – Rural, persons/square miles	25.9
Population Density – Suburban, persons/square miles	904
Population Density – Urban, persons/square miles	5,850
Vehicle speed – Rural, miles/hour	55
Vehicle speed – Suburban, miles/hour	55
Vehicle speed – Urban, miles/hour	55
Traffic count – Rural, vehicles/hour	530
Traffic count – Suburban, vehicles/hour	760
Traffic count – Urban, vehicles/hour	2,400
Dose rate at 1 meter from vehicle, mrem/hour	0.1
Packaging length, feet	22
Number of truck crew	2
Stop time, hour/trip	4.5
Population density at stops, persons/square miles	166,500

a) WASH-1238 had a range of shipping distances between 25 and 3,000 miles for unirradiated fuel shipments. A 2,000-mile “average” shipping distance was used in NRC analyses of ESP sites.

Source: U.S. NRC (2006a, 2006b, 2006c).

Table 5.11-6
Radiological Impacts of Transporting Unirradiated Fuel to the VCSNS Site by Truck

		Cumulative Annual Dose, Person-Rem per Reference Reactor Year		
Reactor Type	Normalized Average Annual Shipments	Transport Workers	General Public - Onlookers	General Public - Along Route
Reference LWR	6.3	0.011	0.042	0.0010
AP1000	4.9	0.0084	0.033	7.9×10^{-4}
10 CFR 51.52 Table S-4 condition[(a)]	365 (<1 per day)	4	3	3

a) Table S-4 conditions apply to all types of radioactive material transportation. The impacts of unirradiated fuel shipments constitute a small fraction of the overall cumulative annual dose limit.

Table 5.11-7
RADTRAN 5 Incident-Free Exposure Parameters

Parameter	RADTRAN 5 input value	Source
Vehicle speed – Rural (miles/hour)	55	Based on average speed in rural areas given in DOE (2002b). Because most travel is on interstate highways, the same vehicle speed is assumed in rural, suburban, and urban areas. No speed reductions were assumed for travel at rush hour.
Vehicle speed – Suburban (miles/hour)	55	
Vehicle speed – Urban (kilometers/hour)	55	
Traffic count – Rural (vehicles/hour)	530	U.S. DOE (2002b)
Traffic count – Suburban (vehicles/hour)	760	
Traffic count – Urban (vehicles/hour)	2,400	
Dose rate at 1 m from vehicle (mrem/hour)	13	Approximate rate at 1 m that is equivalent to maximum dose rate allowed by federal regulations (*i.e.,* 10 mrem/hour at 2 m from the side of a transport vehicle)
Packaging dimensions, m	Length = 5.2 Diameter = 1.0	U.S. DOE (2002a)
Number of truck crew	2	U.S. DOE (2002b)
Stop time (hour/trip)	5	Route specific
Population density at Stops (person/square kilometers)	30,000	Sprung et al. 2000
Min/Max Radii of Annular Area Surrounding Vehicle at Stops (m)	1 to 10	Sprung et al. 2000
Shielding Factor Applied to Annular Area Surrounding Vehicle at Stops	1 (no shielding)	Sprung et al. 2000
Population Density Surrounding Truck Stops (persons/square kilometers)	340	Sprung et al. 2000
Min/Max Radii of Annular Area Surrounding Truck Stop (m)	10 to 800	Sprung et al. 2000
Shielding Factor Applied to Annular Area Surrounding Truck Stop	0.2	Sprung et al. 2000

Table 5.11-8
Transportation Route Information for Spent Fuel Shipments to the Potential Yucca Mountain Disposal Facility[(a)]

Reactor Site	One-Way Shipping Distance, Miles				Population Density People per Square Mile			Stop Time per trip, hr
	Total	Rural	Suburban	Urban	Rural	Suburban	Urban	
VCSNS	2,568	2,043	477	49	25.2	798	5,725	5
SRS	2,562	2,006	489	68	24.8	857	5,883	5
Cope	2,638	2,070	517	52	25.5	814	5,726	5.5
Saluda County	2,541	2,021	471	49	25.1	802	5,725	5

a) Transportation route information obtained from TRAGIS. Routing of legal weight truck shipments differs from that analyzed in the Yucca Mountain environmental impact statement (U.S. DOE 2002a) and U.S. NRC (2006a, 2006b, 2006c).

Table 5.11-9
Population Doses from Spent Fuel Transportation, Normalized to Reference Light Water Reactor

Exposed Population	Cumulative Dose Limit Specified in Table S-4, Person-Rem per Reactor Year	Reactor Type	
		Reference LWR	AP1000
		Normalized Number of Spent Fuel Shipments per year	
		60	39
		Environmental Effects, person-rem per reactor year	
Crew	4	3.3	2.1
Onlookers	3	20	13
Along route	3	0.49	0.32

5.12 NONRADIOLOGICAL HEALTH IMPACTS

5.12.1 PUBLIC HEALTH

The operation of new generating units could potentially have nonradiological health impacts on the public. Nonradiological air emissions can move offsite to nearby residences or businesses. Noise may be heard offsite. The electrical transmission system can produce induced currents in metal fences and vehicles beneath the transmission lines. Pathogenic organisms could exist due to the heated effluent from the plant. Subsection 5.3.4, "Impacts to Members of the Public" (from cooling system operation), addresses the impacts to the public from pathogenic organisms and concludes that the risk to the public is SMALL. Subsection 5.6.3, "Impacts to Members of the Public" (from transmission line operation), examines the risk from electric shock from induced currents under transmission lines. The magnitude of the shock is shown to be within the limits established by the National Electrical Safety. Subsection 5.8.1, "Physical Impacts," describes the risks from noise and air pollution and concludes that the risks are SMALL.

5.12.2 OCCUPATIONAL HEALTH

Workers at new nuclear units could be susceptible to industrial accidents (*e.g.,* falls, electric shock, burns), or occupational illnesses because of noise exposure, exposure to toxic or oxygen replacing gases, caustic agents, or other industrial hazards. SCE&G has a Safety Services Department at VCSNS that oversees an industrial safety program that addresses these risks, and the new units would be subject to the same safety requirements. VCSNS also has a safety strategic plan that is used to pursue improvement in safety performance and has both short- and long-term goals. The VCSNS Safety Training Advisory Committee oversees the scheduling and effectiveness of training on industrial safety topics.

The Safety Services Department maintains records of a statistic known as total recordable cases. Total recordable cases include work-related injuries or illnesses that include death, days away from work, restricted work activity, medical treatment beyond first aid, and other criteria. The incidence rate of recordable cases at Unit 1 between 2002 and 2005, as calculated from OSHA Form 300A data, averaged 0.9 cases per 100 workers, or 0.9%. This compares favorably to the nationwide total recordable cases rate for electrical power generation workers of 3.3% (BLS 2006a) and of 1.3% for South Carolina for electrical power generation, transmission, and distribution (BLS 2006b). SCE&G estimates that the AP1000 would employ 800 workers onsite (Subsection 3.10.3). During outages, these numbers could increase significantly for short durations (Subsection 5.8.2).

The number of total recordable cases per year for the new units can be estimated as the number of workers multiplied by the total recordable cases rate. Therefore, the estimated total recordable cases incidence would be:

Number of Workers	TRC Incidence at U.S. Rate	TRC Incidence at SC Rate	TRC Incidence at Unit 1 Rate
800	26	10	7

Given that SCE&G projects a total recordable incidence below national and state averages, occupational health impacts would be SMALL and not warrant mitigation.

Section 5.12 References

1. BLS (Bureau of Labor Statistics) 2006a. *Table 1. Incidence rates of nonfatal occupational injuries and illnesses by industry and case types, 2005,* Available at http://www.bls.gov/iif, accessed April 26, 2007.

2. BLS 2006b. *Table 6. Incidence rates of nonfatal occupational injuries and illnesses by industry and case types, 2005, South Carolina,* Available at http://www.bls.gov/iif, accessed April 26, 2007.