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5.0 Station Operational Impacts at the Proposed Site

This chapter examines environmental issues associated with operation of the proposed new nuclear Units 3 and 4 at the Vogtle Electric Generation Plant (VEGP) site for an initial 40-year period as described by Southern Nuclear Operating Company, Inc. (Southern). As part of this application, Southern submitted an Environmental Report (ER) that discussed the environmental impacts of station operation (Southern 2008a). The ER provides information used as the basis for the environmental review. The parameters included in design documents for the Westinghouse AP1000 advanced light-water reactors at the VEGP site and the values for these parameters are listed in Appendix I of this environmental impact statement (EIS).

The design parameter values that the staff formally evaluated in its EIS for the VEGP ESP are those drawn from Revision 15 of the AP1000 Design Control Document (DCD) (Westinghouse 2005); these are the values proposed in Southern's application (including the ER) and documented in Appendix I of this EIS. However, Southern has indicated that in its combined license (COL) application, it may seek to reference Revision 16 of the AP1000 DCD (Westinghouse 2007), which has been submitted as a proposed design certification amendment for U.S. Nuclear Regulatory Commission (NRC) review. Accordingly, Southern has indicated that some design parameter values may change as part of the design certification amendment. For instances where those values diverge, the staff has discussed in the final EIS how those changes would affect its conclusions, if at all.

This chapter is divided into 13 sections. Sections 5.1 through 5.11 discuss the potential operational impacts on land use, meteorology and air quality, water, terrestrial and aquatic ecosystems, socioeconomics, historic and cultural resources, environmental justice, nonradiological and radiological health effects, postulated accidents, and applicable measures and controls that would limit the adverse impacts of station operation during the 40-year operating period. In accordance with Title 10 of the Code of Federal Regulations (CFR) Part 51, impacts have been analyzed and a significance level of potential adverse impacts (i.e., SMALL, MODERATE, or LARGE) has been assigned to each analysis. In the area of socioeconomics related to taxes, the impacts may be considered beneficial and are stated as such. The staff's determination of significance levels is based on the assumption that the mitigation measures identified in the ER or activities planned by various State and county governments, such as infrastructure upgrades, as discussed throughout this chapter, are implemented. Failure to implement these upgrades might result in a change in significance level. Possible mitigation of adverse impacts is also presented, where appropriate. A summary of these impacts is presented in Section 5.12. The references cited in this chapter are listed in Section 5.13.

5.1 Land-Use Impacts

Sections 5.1.1 and 5.1.2 contain information regarding land-use impacts associated with operation of the proposed VEGP Units 3 and 4 at the VEGP site. Section 5.1.1 discusses land-use impacts at the site and in the vicinity of the site. Section 5.1.2 discusses land-use impacts with respect to transmission line rights-of-way and offsite areas.

5.1.1 The Site and Vicinity

Some offsite land-use changes can be expected as a result of operational activities. Possible changes include the conversion of some land in surrounding areas to housing developments (e.g., recreational vehicles, apartment buildings, single-family condominiums and homes, and manufactured home parks) and retail development to serve plant workers. Property tax revenue from the addition of two new units could also lead to additional growth and land conversions in Burke County as a result of infrastructure improvements (e.g., new roads and utility services). Additional information on operational-related infrastructure impacts is in Section 5.5.4. However, the staff assumes that any growth would be managed because all Georgia counties surrounding the VEGP site have comprehensive land-use plans in place as required by the Georgia Planning Act of 1989.

The principal land-use impact resulting from operation of the cooling towers would be salt deposition. Some leaf damage can occur when salt deposition exceeds 10 kg/ha/mo (8.9 lbs/ac/mo) (NRC 2000a). Salt deposition is discussed in Section 5.4.1.1 of the EIS. The maximum estimated cumulative deposition rate is below 8.9 lbs/ac/mo.

Based on the existence and projected implementation of land-use plans, the information provided by Southern, and the U.S. Nuclear Regulatory Commission's (NRC) own independent review, the staff concludes that the land-use impacts of operation would be SMALL, and further mitigation is not warranted.

5.1.2 Transmission Line Rights-of-Way and Offsite Areas

Most land-use impacts would occur during construction of the planned new 500-kV transmission line. Georgia Power Company (GPC) provides easements to allow agricultural activities under its transmission lines. Therefore, impacts are expected to be SMALL and no mitigation would be required. Transmission line right-of-way management practices are discussed in Section 5.4.1.5.

5.2 Meteorological and Air-Quality Impacts

The primary impacts of operation of two new units on local meteorology and air quality would be from releases to the environment of heat and moisture from the primary cooling system (cooling

towers), operation of auxiliary equipment (generators and boilers), and emissions from workers' vehicles. The potential impacts of releases from operation of the cooling system are discussed in Section 5.2.1. Section 5.2.2 covers potential air-quality impacts from nonradioactive effluent releases at the VEGP site, and Section 5.2.3 covers the potential air-quality impacts of transmission line rights-of-way during plant operation.

5.2.1 Cooling Tower Impacts

The cooling system for the proposed Units 3 and 4 at the VEGP site is a natural draft cooling tower. A total of two cooling towers would be constructed—one for each new nuclear unit. Natural draft cooling towers remove excess heat by evaporating water. Upon exiting the cooling tower, water vapor mixes with the surrounding air and this process can lead to condensation and the formation of a visible plume. Aesthetic impacts from the visible plume as well as land-use impacts from cloud shadowing, fogging, icing, increased humidity, and drift from dissolved salts and chemicals found in the cooling water can result.

The SACTI (Seasonal and Annual Cooling Tower Impacts) computer code was used by Southern to estimate impacts associated with operating the cooling towers. Select engineering data for Revision 15 of the Westinghouse AP1000 DCD (Westinghouse 2005) and 1 year of onsite meteorological data from 1999 were used as input to the SACTI model. Results from the analysis are presented in the ER (Southern 2008a) and are summarized below. NRC staff reviewed the input and output files used in the SACTI analysis and concurs with the results. Southern has since updated the original analysis using Revision 16 of the Westinghouse AP1000 DCD (Westinghouse 2007), which includes revised evaporation and drift rates that are about 4 percent higher than previously analyzed (Southern 2008b). Because the impact level for the Revision 15 values the staff analyzed for was not near a known impact level, the NRC staff does not expect that the 4 percent increase in drift or evaporation rates will appreciably affect results from the SACTI analysis or conclusions.

Results from the SACTI analysis, as reported in the ER (Southern 2008a), indicate that on average the longest plume lengths would occur during the winter and the shortest plume lengths would occur during the summer. For both seasons, the predominant plume direction is to the north, followed by northeast during the winter and north-northeast during the summer. The longest plume length is 9.7 km (6.0 mi), with a frequency of 3.9 percent in the winter and 0.5 percent in the summer. Ground-level fogging or icing is likely to be infrequent because of the height of the cooling towers. Deposition of salts from cooling tower drift would occur in all directions from the towers. The maximum estimated solids deposition rate for each tower is 4.0 kg/ha/mo (3.6 lbs/ac/mo) and occurs 490 m (1600 ft) north of the towers.

An existing pair of cooling towers for VEGP Units 1 and 2 operate at the VEGP site. These cooling towers are located approximately 1219 m (4000 ft) to the east-northeast of the proposed cooling towers for the proposed VEGP Units 3 and 4 (Southern 2008a). This separation

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distance is greater than the distance to the modeled locations of the maximum deposition rate at 490 m (1600 ft) predicted for the new cooling towers (Southern 2008a). Moreover, given the location and orientation of the proposed cooling towers with respect to the existing cooling towers, it is unlikely that plumes would interact appreciably for any extended period of time. Therefore, the NRC staff concludes that there are no significant combined impacts from the cooling towers on air quality.

Diesel generators and boilers currently operate at VEGP for limited periods; generators and boilers that would be associated with the proposed VEGP Units 3 and 4 would similarly operate for limited periods. Interaction between pollutants emitted from these sources and the cooling tower plumes would be intermittent and would not have a significant impact on air quality. Based on the above considerations and the assumption that cooling towers associated with the new units would be similar to existing cooling towers used at nuclear sites, the staff concludes the cooling tower impacts on air quality would be SMALL and that additional mitigation of air-quality impacts would not be warranted.

5.2.2 Air-Quality Impacts

Additional standby diesel generators and auxiliary power systems would be used for emergency power and auxiliary steam purposes. These systems would be used on an infrequent basis and pollutants discharged (e.g., particulates, sulfur oxides, carbon monoxide, hydrocarbons, and nitrogen oxides) would be permitted in accordance with the Georgia Department of Natural Resources (GDNR) and Federal regulatory requirements (Southern 2008a). Because these systems would be used on an infrequent basis (i.e., typically a few hours per month), the staff concludes that the environmental impact of pollutants from these sources would be SMALL and that additional mitigation would not be warranted.

5.2.3 Transmission Line Impacts

Impacts of existing transmission lines on air quality are addressed in the *Generic Environmental Impact Statement for License Renewal* (GEIS) (NRC 1996). Small amounts of ozone and even smaller amounts of oxides of nitrogen are produced by transmission lines. The production of these gases was found to be insignificant for 745-kV transmission lines (the largest lines in operation) and for a prototype 1200-kV transmission line. In addition, it was determined that potential mitigation measures, such as burying transmission lines, would be very costly and would not be warranted.

One new 500-kV transmission line would be constructed to accommodate the new power generating capacity (Southern 2008a). This size is well within the range of transmission lines provided in the GEIS and the staff therefore concludes that air-quality impacts from transmission lines would be SMALL.

5.3 Water-Related Impacts

This section discusses water-related impacts to the surrounding environment from operation of the proposed VEGP Units 3 and 4. Details of the operational modes and cooling water systems associated with operation of the plant can be found in Section 3.2.2 of this EIS.

Managing water resources requires understanding and balancing the tradeoffs between various, often conflicting, objectives. At the VEGP site, these objectives include navigation, recreation, visual aesthetics, a fishery, and a variety of beneficial consumptive domestic, farming, and industrial uses of water. The responsibility for regulating water use and water quality is delegated to the U.S. Army Corps of Engineers (USACE) and the GDNR through Federal and State of Georgia laws, respectively.

Water-use and water-quality impacts involved with operation of a nuclear plant are similar to the impacts associated with any large thermoelectric power generation facility. Accordingly, Southern must obtain the same water-related permits and certifications as any other large industrial facility. These would include:

- Clean Water Act Section 401 Certification. This certification would be issued by the GDNR and would ensure that operation of the plant would not conflict with State water-quality-management programs.
- Clean Water Act Section 402(p) National Pollutant Discharge Elimination System (NPDES) Discharge Permit. This permit would be issued by the GDNR and would regulate limits of pollutants in liquid discharges to surface water.
- Clean Water Act Section 316(a). This section regulates the cooling water discharges to protect the health of the aquatic environment.
- Clean Water Act Section 316(b). This section regulates cooling water intake structures to minimize environmental impacts associated with location, design, construction, and capacity of those structures.
- Surface-Water Withdrawal Permit. This GDNR permit limits the quantity of water withdrawn from surface waterbodies, such as the Savannah River (Georgia Code Title 12, Chapter 5, Article 2).
- Groundwater Water Use Act. This GDNR permit limits the quantity of groundwater withdrawal on the VEGP site (Georgia Code Title 12, Chapter 5, Article 3).

This section discusses the hydrological alterations and the resulting impacts from operation of the proposed VEGP Units 3 and 4. The combined impacts of operating the proposed VEGP Units 3 and 4 along with VEGP Units 1 and 2, as well as other activities in the surrounding environment are discussed in Chapter 7 (Cumulative Effects) of this EIS.

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5.3.1 Hydrological Alterations

Southern states in its ER (Southern 2008a) that water pumped from the Savannah River would be used to makeup water lost by the circulating water system (CWS) to evaporation, blowdown, and drift. Water pumped from groundwater would be used to makeup water lost by the service water system (SWS) to evaporation, blowdown and drift and to satisfy operational demands for demineralized, potable, and fire protection water systems.

Effluent discharge from the plant would be collected into a common sump before being discharged to the river. The arithmetic difference between Savannah River withdrawals and blowdown is not equivalent to the consumptive water use of Savannah River water because systems fed by groundwater would also contribute to the common sump. The maximum consumptive use of Savannah River water was reported by Southern to be 1824 L/s (28,904 gpm) (Southern 2008a). Therefore, approximately 94 percent of the maximum effluent discharge is expected to be composed of water originating from the Savannah River, with the remaining 6 percent originating from groundwater.

Hydrogeological alterations to operate the proposed VEGP Units 3 and 4 would be:

- Groundwater would be withdrawn to provide the water needed for operation of the proposed new units.
- Surface infiltration in the vicinity of the proposed VEGP Units 3 and 4 would be altered by the construction of facilities, including a stormwater drainage system, buildings, and parking lots, and maintaining large, vegetation-free graveled areas.

The expected maximum surface-water rates for operation of the proposed VEGP Units 3 and 4 are as follows:

- The normal and maximum Savannah River withdrawal is 2348 L/s (37,224 gpm) and 3646 L/s (57,784 gpm), respectively (Southern 2008a)
- The normal and maximum Savannah River effluent discharge is 606 L/s (9608 gpm) and 1941 L/s (30,761 gpm), respectively (Southern 2008b)

Following publication of the draft EIS, Southern advised the staff (Southern 2007f) that based on changes between Revision 15 and Revision 16 of the AP1000 DCD, the surface water withdrawal and discharge rates would increase. However, the groundwater use values would decrease, and therefore, the staff determined that the description of hydrogeological alterations set forth above did not change. As revised, the expected maximum surface water rates for operation of the proposed VEGP Units 3 and 4 would be as follows:

- The normal and maximum Savannah River withdrawal is 2449 L/s (38,825 gpm) and 3858 L/s (61,145 gpm), respectively (Southern 2007f)

- The normal and maximum Savannah River effluent discharge would be 606 L/s (9608 gpm) and 2000 L/s (31, 695 gpm), respectively (Southern 2007f)

Accordingly, in the following sections the staff has also discussed what effect these changes would have on the staff's conclusions concerning impact levels.

5.3.2 Water-Use Impacts

The existing VEGP Units 1 and 2 are among the largest water users in the region. Likewise, the proposed Units 3 and 4 at the VEGP site would also become major users of surface water and groundwater. Most of the proposed water demands associated with operation of the proposed VEGP Units 3 and 4 would be satisfied through the use of surface water originating from the Savannah River. The ratio of total groundwater withdrawals to surface-water (consumptive) use would be approximately 9 percent. Groundwater would primarily be used to meet operational water demands associated with systems requiring/producing relatively pure water, such as demineralized and potable water systems (Southern 2008a).

5.3.2.1 Surface Water

J. Strom Thurmond Dam, which lies 113.8 river kilometers (rkm) (70.7 river miles [RM]) upstream of the VEGP site, regulates Savannah River discharge in the vicinity. Discharges released from the dam are a function of Drought Level, which is defined by the USACE to be a function of the water volume impounded at Thurmond Dam and the cascade of upstream reservoirs. The drought conditions of 2002 resulted in a new drought of record for the Savannah River Basin (USACE 2006). Following this period of drought, modifications to the Drought Contingency Plan for the basin were proposed. The releases from Thurmond Dam at each Drought Level in the proposed plan are currently as follows (see Table 2-2 and USACE 2006):

- Level 1: Maximum weekly-average release discharge of 119 m³/s (4200 cfs)
- Level 2: Maximum weekly-average release discharge of 113 m³/s (4000 cfs)
- Level 3: Maximum daily-average release discharge of 108 m³/s (3800 cfs)
- Level 4: Inflow to Thurmond Dam equals release discharge.

The Drought Contingency Plan has not been finalized at the time of the writing this EIS. However, the staff has presented the reservoir release policies described in the draft Drought Plan in this EIS, as it represents the most current understanding of future operation. The Savannah River Basin is currently in a severe and multiple-year drought. The Corps is presently operating in a manner similar to the draft Drought Plan except that the Thurmond Dam discharge has been at 102 m³/s (3600 cfs) and not the 108 m³/s (3800 cfs) minimum currently prescribed in the draft plan. Based on the draft plan, the Savannah River Basin is at Drought Level 2 and has never reached Drought Level 3 or 4. However, in recent consultation the Corps

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stated that without a reprieve in the drought, Drought Level 3 is likely during the summer of 2008. Additionally, the Corps is considering revising the minimum releases in the December to April period downward to 88 m³/s (3100 cfs).

The magnitude of the impact of surface-water withdrawals associated with operating the proposed VEGP Units 3 and 4 would fluctuate with discharge in the Savannah River. The staff evaluated the magnitude of the surface-water withdrawals against a range of river discharges. Results presented in Table 5-1 show that at the normal withdrawal rate of 2.35 m³/s (83 cfs, 37,224 gpm), the proposed VEGP Units 3 and 4 would withdraw 1 percent of the average river discharge. At the maximum withdrawal rate of 3.65 m³/s (129 cfs, 57,784 gpm), the proposed VEGP Units 3 and 4 would withdraw between 1.5 and 3.4 percent of the total flow of the Savannah River as the river fluctuates between average and Drought Level 3.

A water surface elevation versus discharge relationship was developed by the U.S. Geological Survey (USGS) to monitor discharge near the VEGP site (USGS 2007). Using this relationship and the maximum withdrawal rate of 3.65 m³/s (129 cfs), the resulting decrease in river stage as a result of operating the proposed VEGP Units 3 and 4 would be approximately 5 cm (2 in.) at Drought Level 3 and approximately 2.5 cm (1 in.) under average discharge conditions.

Approximately 150 m (500 ft) downstream of the existing VEGP Units 1 and 2 intake, an outfall pipe discharges effluent from Units 1 and 2 to the Savannah River. Approximately 120 m (400 ft) downstream of this outfall pipe, the proposed outfall pipe would discharge additional effluent from operation of the proposed VEGP Units 3 and 4. The magnitude of the surface-water withdrawals associated with operation of the proposed VEGP Units 3 and 4 downstream of the site was evaluated by staff by comparing consumptive use relative to Savannah River discharge. Results presented in Table 5-2 show that at normal river discharge, the maximum consumptive use of the proposed VEGP Units 3 and 4 would represent less than 1 percent of

Table 5-1. Savannah River Discharge and Surface-Water Withdrawals for Units 3 and 4

Case	River Discharge		Normal Withdrawal			Maximum Withdrawal		
	m ³ /s	(cfs)	m ³ /s	(cfs)	as % of river	m ³ /s	(cfs)	as % of river
Average Conditions	250	8830	2.35	83	0.9	3.65	129	1.5
Drought Level 1	119	4200	2.35	83	2.0	3.65	129	3.1
Drought Level 2	113	4000	2.35	83	2.1	3.65	129	3.2
Drought Level 3	108	3800	2.35	83	2.2	3.65	129	3.4

Withdrawal source: Southern 2008a

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Table 5-2. Consumptive Use of Savannah River Water for Units 3 and 4

Case	River Discharge		Normal Consumptive Use			Maximum Consumptive Use		
	m ³ /s	(cfs)	m ³ /s	(cfs)	as % of river	m ³ /s	(cfs)	as % of river
Average Conditions	250	8830	1.76	62	0.7	1.81	64	0.7
Drought Level 1	119	4200	1.76	62	1.5	1.81	64	1.5
Drought Level 2	113	4000	1.76	62	1.6	1.81	64	1.6
Drought Level 3	108	3800	1.76	62	1.6	1.81	64	1.7

Withdrawal source: Southern 2008a

the river discharge. During periods when the proposed VEGP Units 3 and 4 would be consuming the maximum quantity of water, the consumptive use of the proposed units would increase to 1.7 percent of the total flow in the Savannah River.

The implementation of Drought Level 4 in the draft Drought Contingency Plan currently does not provide explicit flows. The Corps, the State of Georgia and the State of South Carolina are presently clarifying the operational implementation of Drought Level 4. Without explicit flow levels (and the likelihood that any such flow levels would change based on the ongoing development of the Draft Drought Contingency Plan) and because a Drought Level 4 would be an extremely rare event, the staff determined that it was still conservative to base its analysis in this EIS on Drought Level 3. However, to provide additional context for its conclusions, the staff did evaluate the fractional decline in the river discharge resulting from normal consumptive use at the lower flowrates of 85 m³/s (3000 cfs) and 57 m³/s (2000 cfs), beyond the 108 m³/s (3800 cfs) minimum for Drought Levels 1, 2, and 3 in the current draft Drought Contingency Plan. The staff determined that the maximum consumptive use at 85 m³/s (3000 cfs) and 57 m³/s (2000 cfs) would be 2.1 % and 3.2 % of river flow, respectively.

Values in Table 5-2 represent Savannah River water consumed by the cooling water system only; all other plant operation system demands are satisfied from groundwater. Blowdown from these groundwater systems is commingled with cooling water system blowdown before being discharged to the Savannah River. Therefore, from a mass balance perspective relative to the Savannah River, the values shown in the table are conservative, because under normal operations, 0.02 m³/s (0.7 cfs) of additional effluent would be added from groundwater-fed systems. This additional effluent lowers the normal consumptive use by 0.02 percent of the river discharge at Drought Level 3.

As noted in Chapter 2, the accuracy of the Savannah River stream gages ranges from approximately 5 to 10 percent of true. Since the maximum withdrawal and consumptive use values are less than 5 percent, the staff concludes that surface-water-use impacts of the

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proposed VEGP Units 3 and 4 would be difficult to detect. In any event, the staff considers the maximum consumptive use of 1.7 percent of the river flow would not have the potential to destabilize the resource. Even under lower flow conditions, which would likely be only temporary, maximum consumptive use would not exceed 3.2 percent of the river flow, which the staff similarly considers would not destabilize the resource. Therefore, the staff concludes the impacts would be SMALL, and mitigation not warranted.

Following publication of the draft EIS, Southern advised the NRC staff (Southern 2007f) that, based on changes between Revision 15 and Revision 16 of the AP1000 DCD, the maximum surface water consumptive use for Vogtle Units 3 and 4 would increase by approximately 0.11 m³s (4 cfs). The staff evaluated the effect of this change on the staff analysis presented above, which uses the DCD Revision 15 surface water withdrawal values currently in Southern's ER (Southern 2008a). The staff determined that this change would result in an increase in the maximum surface water consumptive use from approximately 1.7 percent in the present analysis to 1.8 percent of the river flow at Drought Level 3. Because the change identified by Southern would result in only a 0.1 percent increase in the maximum consumptive water use under Drought Level 3 conditions, the staff determined that these changes would not affect the staff's conclusion that surface water use impacts would be SMALL.

Even assuming the lower river flows of 3000 cfs and 2000 cfs that the staff analyzed, maximum surface water consumptive use would increase from 2.1 % to 2.3 % and from 3.2 % to 3.4 %, respectively. Thus, the changes identified by Southern would result in a 0.2 percent increase in consumptive water use under low flow conditions of 3000 cfs, or a 0.2 percent increase in consumptive water use even under conditions of 2000 cfs. Because the impacts previously analyzed were not near any known impact threshold, the staff determined that these changes would not affect the staff's conclusion that surface water use impacts would be SMALL.

5.3.2.2 Groundwater

The potential impacts from groundwater use are described in Section 5.2.2.2 of the ER (Southern 2008a) and in Southern's response to Requests for Additional Information (Southern 2007a,b). The existing VEGP Units 1 and 2 are among the largest users of groundwater in the region. The proposed VEGP Units 3 and 4 at the VEGP site would use groundwater to supply make-up water for the SWS, the fire protection system, the plant demineralized water system, the potable water supply, and other miscellaneous water uses.

Wells at the VEGP site are permitted currently by the State of Georgia Environmental Protection Division to withdraw an annual average rate of 20,800 m³/d (5.5 MGD, 3819 gpm) with a maximum monthly average of 22,700 m³/d (6 MGD, 4167 gpm). Records for 2005 (Southern 2008a) indicate that only 0.245 L/s (3.89 gpm) was withdrawn from the Tertiary aquifer while 36.72 L/s (582 gpm) was withdrawn from the Cretaceous aquifer. Thus, the

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majority of the groundwater resource used by the VEGP site is withdrawn from the Cretaceous aquifer, and the rate of withdrawal is well below the permitted level.

Three of the VEGP site's existing nine groundwater wells at the VEGP site are completed in the confined Cretaceous aquifer and are used now to supply make-up water for the operation of Units 1 and 2. The six additional wells are completed in the confined Tertiary aquifer and provide water for site-specific operations.

A potential offsite impact during the operation of the proposed VEGP Units 3 and 4 from projected water use is related to the water budget of the aquifer system. Impacts are the withdrawal of groundwater that would not be available to others, as well as the physical drawdown of the hydraulic head of the confined aquifer that implies pumping cost increases for neighboring groundwater users.

Projected annual average groundwater resource use for the operation of the existing and proposed units at normal and maximum operating conditions are shown in Table 5-3. Groundwater use under normal long-term demand for the operation of the proposed VEGP Units 3 and 4 is 47.4 L/s (752 gpm). This demand flow rate compares to a deep aquifer baseflow estimated to range from 5210 to 9550 L/s (119 to 218 MGD) (see Section 2.6.1.2). Because at the VEGP location the deep aquifer flows toward erosional windows that permit discharge to the Savannah River, any use of deep aquifer groundwater acts to decrease discharge to the river. The normal demand of 47.4 L/s represents at most 0.9 percent of the baseflow of the deep aquifer.

The normal operating groundwater demand for both existing and proposed units would be 93.5 L/s (1482 gpm) and the maximum operating groundwater demand would be 343.2 L/s (5440 gpm). Six cases of groundwater withdrawal are presented in Table 5-3. They quantify aquifer drawdown in the year 2025 and 2045 for normal operation, drawdown after 30 days for several maximum water withdrawal examples, and a drawdown after 2 days for the maximum withdrawal case.

To evaluate the potential offsite impacts of groundwater use by the proposed units, drawdown calculations have been completed using conservative analysis methods. The existing Cretaceous aquifer well closest to the VEGP site property boundary has been selected as a representative location for water withdrawal, and the shortest distance to the boundary has been chosen as the distance to the nearest future offsite groundwater user. Analyses by Southern employed a well 1740 m (5700 ft) from the facility boundary; however, Southern also identifies proposed locations for new wells and one is approximately 1070 m (3500 ft) from the boundary. The staff has analyzed both cases.

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Table 5-3. Drawdown Resulting from Groundwater Withdrawal During Operation of the Proposed VEGP Units 3 and 4

Water Withdrawal Scenario	Time Period	Pumping Rate		Drawdown at 1740 m (5700')		Drawdown at 1070 m (3500')	
		L/s	(gpm)	m	(ft)	m	(ft)
Aquifer response 2025							
Units 1 and 2 normal	39 yr	46.1	(730)	1.80	(5.89)	1.95	(6.40)
Units 3 and 4 normal	11 yr	<u>47.4</u>	<u>(752)</u>	<u>1.64</u>	<u>(5.37)</u>	<u>1.80</u>	<u>(5.91)</u>
		93.5	(1482)	3.44	(11.26)	3.75	(12.31)
Aquifer response 2045							
Units 1 and 2 normal	59 yr	46.1	(730)	1.86	(6.11)	2.02	(6.62)
Units 3 and 4 normal	31 yr	<u>47.4</u>	<u>(752)</u>	<u>1.81</u>	<u>(5.94)</u>	<u>1.97</u>	<u>(6.47)</u>
		93.5	(1482)	3.67	(12.05)	3.99	(13.09)
Unit 1 or 2 maximum 30 days							
Unit 1 or 2 max		72.5	(1150)	1.26	(4.13)	1.51	(4.94)
Unit 2 or 1 normal	30 d	23.1	(365)	0.40	(1.31)	0.48	(1.57)
Units 3 and 4 normal		<u>47.4</u>	<u>(752)</u>	<u>0.83</u>	<u>(2.70)</u>	<u>0.99</u>	<u>(3.24)</u>
		2.49	(8.14)	2.98	(9.75)		
Unit 3 or 4 maximum 30 days							
Units 1 and 2 normal	30 d	46.1	(730)	0.80	(2.62)	0.96	(3.14)
Unit 3 or 4 normal		23.7	(376)	0.41	(1.35)	0.49	(1.62)
Unit 4 or 3 max		<u>99.1</u>	<u>(1570)</u>	<u>1.72</u>	<u>(5.65)</u>	<u>2.06</u>	<u>(6.75)</u>
				2.93	(9.61)	3.51	(11.51)
Four units maximum 30 days							
Units 1 and 2 max	30 d	145	(2300)	2.50	(8.19)	2.99	(9.80)
Units 3 and 4 max		<u>198</u>	<u>(3140)</u>	<u>3.41</u>	<u>(11.19)</u>	<u>4.08</u>	<u>(13.38)</u>
		343	(5440)	5.91	(19.38)	7.07	(23.19)
Four units maximum 2 days							
Units 1 and 2 max	2 d	145	(2300)	1.16	(3.82)	1.63	(5.36)
Units 3 and 4 max		<u>198</u>	<u>(3140)</u>	<u>1.59</u>	<u>(5.21)</u>	<u>2.23</u>	<u>(7.32)</u>
		343	(5440)	2.75	(9.03)	3.87	(12.69)

Conservative models are employed by Southern and the NRC staff to estimate drawdown in the confined Cretaceous aquifer as a result of groundwater withdrawal from the Cretaceous aquifer. A simplified form of the Theis equation for estimating drawdown in a confined aquifer (Theis 1935; Cooper and Jacob 1946) was used to estimate drawdown in the Cretaceous aquifer. This analysis assumes the aquifer is homogeneous, isotropic, has negligible recharge and gradient, as well as negligible boundary impacts. The water is assumed to be released from storage within the aquifer in response to declining hydraulic head. This is a conservative representation because not all of the water withdrawn by pumping comes from storage because there are recharge and gradients. The analysis is also conservative because it focuses the cumulative withdrawal from multiple wells at one point nearest to a hypothetical offsite groundwater user. Several groundwater wells completed in the Cretaceous aquifer would be used to withdraw groundwater. Groundwater users of the Cretaceous aquifer are several miles away.

Cretaceous Aquifer

Data on the hydraulic properties of the Cretaceous aquifer are published in the Final Safety Analysis Report for VEGP Units 1 and 2 (Southern 2003) and were gathered during the installation and testing of the deep production wells. The transmissivity of $0.0227 \text{ m}^2/\text{s}$ ($158,000 \text{ g/d/ft}$) is identified by Southern (2008a) as a mid-range value for use in analyses.

The storativity value of 3.1×10^{-4} (dimensionless) is the arithmetic mean of values reported in the Final Safety Analysis Report.

Estimated drawdowns for the normal and maximum withdrawal rates are shown in Table 5-3. The normal withdrawal case with a well-to-boundary distance of 1740 m (5700 ft) for all units operating and a cumulative rate of 93.5 L/s (1482 gpm), yields approximately 3.44 m (11.3 ft) of drawdown through 2025 (approximately 39 years of operation for Units 1 and 2, approximately 11 years of operation for the proposed VEGP Units 3 and 4). The same rates yield approximately 3.67 m (12.1 ft) of drawdown through 2045 (approximately 59 years of operation for VEGP Units 1 and 2, approximately 31 years of operation for the proposed VEGP Units 3 and 4). From VEGP Units 1 and 2 operation alone, these represent differences of approximately 1.6 m (5.4 ft) and 1.8 m (5.9 ft) for the water withdrawal associated with proposed VEGP Units 3 and 4. If either Units 1 or 2 were to require maximum groundwater withdrawal, the difference in drawdown after 30 days would be approximately 0.86 m (2.8 ft). If either of the new units were to require maximum groundwater withdrawal, the difference in drawdown after 30 days would be approximately 1.3 m (4.3 ft). If all four units were to require maximum off-normal groundwater withdrawal, the difference in drawdown (i.e., maximum rate drawdown minus normal rate drawdown) after 30 days would be less than 4.3 m (14 ft) at the property boundary.

In a recent study undertaken for the USGS, Cherry and Clarke (2007) studied groundwater pumping scenarios for the proposed VEGP Units 3 and 4. They simulated existing and potential future conditions in the aquifer underlying the VEGP site using an existing USGS MODFLOW groundwater model of a $11,538.4\text{-km}^2$ (4455-mi^2) area (Cherry 2006). The model provides estimates of drawdown as a result of long-term, steady-state stresses, including the incremental increases proposed for VEGP Units 3 and 4. It simulates the response of a three-dimensional system of aquifers comprised of six separate aquifers separated by confining units and overlain by the Water Table aquifer. For the case examining the incremental increase of long-term average pumping rate of 47.8 L/s (757 gpm, 1.09 MGD) for operation of proposed VEGP Units 3 and 4, the USGS model forecasts an incremental increase in drawdown of 0.61 m (~2 ft) in the upper and lower Midville aquifers. Aquifers overlying the Midville aquifers in the deep regional aquifer and the tertiary aquifer were found to exhibit lesser drawdown impacts. The drawdown response of the shallower aquifers is a result of simulated leakage through confining zones in response to deep aquifer pumping. This is a moderating influence neglected in the simplified model of drawdown employed by Southern. The 0.61 m (~2 ft) forecast compares with the

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1.6-m (5.4-ft) and 1.8-m (5.9-ft) forecasts for the years 2025 and 2045 provided by the simplified and conservative model described above.

In addition to confirming Southern's calculations of drawdown, the staff used the proposed well locations that are approximately 1070 m (3500 ft) from the property boundary to calculate drawdown. Estimates of drawdown increased roughly 10 percent for multiyear estimates for all normal pumping rates and roughly 20 percent for 30-day estimates involving maximum pumping rates.

The estimates above reflect the potential impact at the property boundary. The closest users of the Cretaceous aquifer are a municipal well 23.3 km (14.5 mi) away, an industrial well 13.7 km (8.5 mi) away and Savannah River Site wells located in D-Area 6.4 km (4 mi) away. At these distances the change in drawdown resulting from the production of water during operation of the proposed VEGP Units 3 and 4 through 2045 (approximately 30 years after startup of the proposed units) is estimated as less than 1.5 m (5 ft) for these users.

The original water level of the Cretaceous aquifer prior to Units 1 and 2 operations was approximately 56.1 m (184 ft) above mean sea level (MSL) in the vicinity of the VEGP site. The base of the upper confining strata for the Cretaceous aquifer is at an elevation of approximately -77.4 m (-254 ft) MSL; therefore, the original confining hydraulic head was approximately 133.5 m (438 ft) above the aquifer sediments. Based on recent submittals by Southern to the State of Georgia (Southern 2006a), since VEGP Units 1 and 2 operations began in 1987 and 1989, the hydraulic head of the Cretaceous aquifer has dropped approximately 4.6 m (15 ft) in the vicinity of well MU-1 and 7 m (23 ft) in the vicinity of MU-2A in 2004 (Southern 2003; Southern 2007a, b). Clearly, the pumping stress to support the proposed Units 3 and 4 would not dewater an aquifer with an excess of 120 m (400 ft) of confining hydraulic head, and does not substantially alter drawdown at offsite well locations.

The proposed VEGP Units 3 and 4 would use 47.4 L/s (1.08 MGD, 752 gpm) for normal operation and 198.1 L/s (4.52 MGD, 3140 gpm) for maximum operation demand (Southern 2008a). These groundwater use rates compare to the deep aquifer baseflow estimates of 5210 to 9570 L/s (119 to 218.4 MGD). Water requirements for the proposed plant represent 0.90 (normal) and 3.8 (maximum) percent of the lower estimate of deep aquifer baseflow. The normal and maximum operational demands for the proposed VEGP Units 3 and 4 are within the groundwater-use permit held by Southern, provided existing VEGP Units 1 and 2 are operating under normal demand. If both the existing two units and two new units (i.e., all four units) were at maximum demand, the incremental increase in the groundwater-use permit for maximum monthly average flow rate would be 80.2 L/s (1.83 MGD), or 1.5 percent of the lower estimate of deep aquifer baseflow. Thus, the groundwater resource use at these rates for the proposed plants could be sustained for the life of the facility. The average long-term demand 47.4 L/s (752 gpm) also represents recharge to the regional groundwater system from an area approximately 2.4 times the size of the VEGP site based on the 1.9 in./yr recharge rate

estimated by the USGS. Thus, groundwater resource use at rates required for the proposed plants could be sustained for the life of the facility.

Tertiary Aquifer

A review of hydraulic head contour plots for the Tertiary aquifer during 1971 and 1984 (Southern 2003) and June 2005 to June 2006 (Southern 2008a) reveals a gradual decline in the hydraulic head of the Tertiary aquifer during the period covering construction and operation of VEGP Units 1 and 2. In the vicinity of VEGP Units 1 and 2, where the record is longer, the decline is as much as 4.6 m (15 ft) since 1971 and 1.5 m (5 ft) since 1984, (i.e., hydraulic head of 35.1 m [115 ft] in 1971, 32.0 m [105 ft] in 1984, and 30.5 m [100 ft] in June of 2006). Most of this change occurred prior to Unit 1 coming online in 1987. Since 1971, the data set has undergone substantial change in spatial coverage and temporal continuity; and, consequently, there is not a long-term record of change in the immediate vicinity of the proposed VEGP Units 3 and 4. However, the rate of pumping documented in 2005, 0.25 L/s (4 gpm), would result in a undetectable drawdown in the Tertiary aquifer at the VEGP site boundary as a result of groundwater withdrawals from the Tertiary aquifer.

The hydraulic heads of the Cretaceous aquifer and Tertiary aquifer in the vicinity of the VEGP site are approximately 49 m (160 ft) and 37 m (120 ft) above MSL, respectively. Thus, there is an upward gradient driving groundwater from the Cretaceous toward the Tertiary aquifer. Further, records submitted by Southern to the State of Georgia reveal that pumping the Cretaceous aquifer results in drawdowns less than 12 m (40 ft). Accordingly, an upward gradient is maintained during pumping of the Cretaceous and negligible impact on the Tertiary aquifer is anticipated.

Water Table Aquifer

The Water Table aquifer appears to be hydraulically isolated from the underlying confined Tertiary aquifer by the Blue Bluff Marl; however, some isolated data suggest the potential for local communication between the two aquifers. The hydraulic head of the Water Table aquifer ranges from 50.3 to 43 m (165 to 140 ft) above MSL in the vicinity of the power block. The head in the Tertiary aquifer ranges from 38.1 to 32 m (125 to 105 ft) above MSL in the same vicinity. A downward gradient exists between these two aquifers, driving groundwater from the Water Table aquifer toward the Tertiary aquifer (Southern 2008a). In the vicinity of the VEGP site, the Blue Bluff Marl separating these two aquifers is believed to be a high-integrity confining unit; this is supported by the hydraulic head difference observed between the two aquifers at all but one location. The anomalous data indicate a Water Table aquifer hydraulic head of 35.7 to 36.0 m (117 to 118 ft) MSL in the vicinity of monitoring wells OW-1001 and B-1004 at the eastern edge of the power block. Thus, water from the Water Table aquifer could flow downward into the Tertiary aquifer at this location. Hydraulic isolation of the Water Table aquifer from the underlying confined aquifer systems implies no impact or a negligible impact to the Water Table

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aquifer from pumping the Tertiary or Cretaceous aquifers. If there is localized communication between the Water Table and Tertiary aquifers, flow would occur from the Water Table aquifer into the Tertiary aquifer, and hydraulic isolation of the Water Table aquifer would be maintained.

As a result of construction of the proposed VEGP Units 3 and 4 the Water Table aquifer in the vicinity of the VEGP site would experience a change in net infiltration (i.e., recharge from precipitation) during operation of the units because of the construction of buildings, paving parking lots, maintenance of a large area as vegetation free, and construction of a stormwater discharge system. Data provided for wells in the immediate vicinity of VEGP Units 1 and 2 (Southern 2008a) illustrate water table change over the period of record is variable, but all changes appear to range between 1.5 and 2.4 m (5 and 8 ft) in magnitude.

Summary

Groundwater supplies for normal and maximum operational scenarios have been evaluated using a conservative conceptual model. Drawdown levels forecast for normal withdrawals are less than 2.1 m (7 ft) after approximately 30 years of operation. Drawdown levels forecast for maximum withdrawal for a period of 30 days are short-term impacts for which the aquifer would recover. These short-term drawdowns are also less than 2.1 m (7 ft) at the site boundary for single unit maximum demand. These incremental drawdown levels are small in comparison to the 120 m (400 ft) of confining hydraulic head in the Cretaceous aquifer. In their study for the U.S. Geological Survey using a regional groundwater model that accounts for the interactions among the multiple aquifers underlying the VEGP site, Cherry and Clarke (2007) found the incremental increase in drawdown for the deep aquifer was 0.61 m (2 ft).

A review of work by the U.S. Geological Survey revealed an estimated range of deep aquifer baseflow from 5210 to 9550 L/s (119 to 218 MGD) (see Section 2.6.1.2). Long-term normal demand for operation of the proposed VEGP Units 3 and 4 would be 47.4 L/s (752 gpm). Using the low estimate of baseflow, this represents less than 1 percent of the baseflow of the deep aquifer.

Southern would not use Tertiary aquifer wells to supply groundwater for proposed VEGP Units 3 and 4. Data provided by Southern (2008a) when supplemented with regional data in U.S. Geological Survey reports (Clarke and West 1997, 1998; Cherry 2006), indicate an upward gradient is maintained between the Cretaceous and Tertiary aquifers. Thus, impacts to the Tertiary aquifer from groundwater withdrawals from the Cretaceous aquifer are small. This was confirmed by the regional groundwater model (Cherry and Clarke 2007). Southern would also not use the Water Table aquifer to supply groundwater for proposed VEGP Units 3 and 4. The Water Table aquifer appears hydraulically isolated from both confined aquifers by the Blue Bluff Marl. Hydraulic head in the Water Table aquifer is higher than that of the Tertiary aquifer. During VEGP Unit 3 and 4 operation, recharge to the Water Table aquifer would be altered locally by the facility as constructed. However, alteration to hydraulic head in response to changed recharge rates would be localized.

Based on the foregoing, the staff concludes that groundwater-use impacts of the proposed VEGP Units 3 and 4 would be SMALL, and mitigation is not warranted.

Following publication of the draft EIS, Southern advised NRC staff (Southern 2007f) that, based on changes between Revision 15 and Revision 16 of the AP1000 DCD, the maximum groundwater demand for Vogtle Units 3 and 4 would be expected to decrease by about 11 percent. Because the impacts of this decrease in groundwater demand are bounded by the present analysis, the staff determined that its conclusions regarding groundwater use would not change.

5.3.3 Water-Quality Impacts

5.3.3.1 Savannah River

The GDNR classified the Savannah River at the VEGP site for fishing water use (GDNR 2007a). The water-quality standards for temperature are not to exceed 32.2°C (90°F), and at no time is the temperature of the receiving waters to be increased more than 2.8°C (5°F) above the intake temperature. A provision is included that allows for use of a reasonable and limited mixing zone; however, evidence must be provided that such a zone would not create an objectionable or damaging pollution condition.

Southern states in its ER that the discharge outfall would enter the Savannah River 123.1 m (404 ft) downstream from the existing outfall (Southern 2008a) and on the same (Georgia) bank of the river (see Figure 5-1). The effluent from the proposed outfall would enter the river from a single submerged port angled 70 degrees from the shoreline (pointing toward the center of the channel and slightly downstream) (see Figures 3-6 and 3-7).

For purposes of determining the bounding water temperature impacts, the staff examined the variable effluent and river discharge conditions. As noted by Southern in its ER, and corroborated by the staff's analysis, the extent of the 2.8°C (5°F) above ambient mixing zone would be largest when the following conditions simultaneously occur: river discharge is the lowest, the outfall discharge is the largest, and the maximum temperature difference exists between the ambient river and the effluent. The independent assessment performed by the staff assumed flow in the Savannah River was consistent with the Draft Drought Contingency Plan (USACE 2006) releases in Drought Level 3. Thus, the Savannah River discharge was assumed to be 108 L/s (3800 cfs) with a corresponding stage elevation of 23.59 m (77.4 ft) above MSL. At the location of the discharge outfall, the Savannah River would be approximately 95.1 m (312 ft) wide with an average depth of 2.50 m (8.2 ft) and have a cross-sectional average velocity of 0.457 m/s (1.50 ft/s). The local water depth near the outfall, which is located near the deepest point in the cross-section, is 3.05 m (10.0 ft).

The distance between the existing outfall and the proposed outfall was a factor in Southern's analysis. A larger distance between the outfalls provides greater opportunity for the ambient

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river water to mix with effluent from VEGP Units 1 and 2 before encountering effluent from proposed VEGP Units 3 and 4. Likewise, a shorter distance between the two outfalls would raise the ambient river temperature, and a larger mixing zone for the downstream VEGP Units 3 and 4 would be produced.

The staff made a bounding assumption that discharge from VEGP Units 1, 2, 3, and 4 was combined into a single discharge pipe instead of specifying a set distance between the two outfalls. The diameter of the pipe governs the effluent velocity and mixing as the effluent leaves the discharge pipe. It is important under this assumption to alter the diameter of the pipe so that the exit velocity is equivalent when the effluents are combined. Southern states in its ER that at the outfall terminus, the discharge pipe would be 0.6 m (2 ft) in diameter (Southern 2008a), resulting in an effluent velocity of 6.64 m/s (21.8 ft/s) at the maximum design discharge of 1941 L/s (68.5 cfs, 30,761 gpm) from VEGP Units 3 and 4 (Southern 2008a). The effluent discharge from VEGP Units 1 and 2 was 631.5 L/s (22.3 cfs or 10,000 gpm) based on an average value at 4 cycles of concentration (Southern 2008a). The combined effluent used in the analysis was 2572 L/s (90.8 cfs), and the modified pipe diameter was increased to 0.70 m (2.3 ft) to maintain the VEGP Units 3 and 4 effluent velocity in the simulation. Although the CWS blowdown mixes with SWS blowdown, sanitary waste, and other effluents in the common sump before being discharged through the outfall, the staff made an assumption that all waste issuing from the outfall was at the cooling water system maximum blowdown temperature of 32.8°C (91°F) (Southern 2008a).

The largest 2.8°C (5°F) above ambient mixing zone would occur when the temperature difference is the greatest between the ambient river and the discharging effluent, assuming fixed river and effluent discharge rates. Therefore, the maximum temperature difference would occur when the ambient river temperature was a minimum. Monthly water temperature data collected near Shell Bluff Landing were analyzed for the period between January 1973 and August 1996. Minimum river temperatures were approximately 5°C (41°F) on both February 1, 1977 and January 31, 1978. The temperature difference between the ambient river and the discharge effluent was therefore calculated to be 28°C (50°F).

The staff performed an independent assessment of the effluent plume extent using CORMIX version 5.0 (Jirka et al. 2004), and assumed the conservative river conditions described above (e.g., minimum river temperatures, maximum discharge temperatures, and combining total effluent from VEGP Units 1 through 4 into the proposed VEGP Units 3 and 4 discharge pipe). The extent of the 5°F above ambient isotherm is shown in Figure 5-1. The maximum downstream extent of the 5°F above ambient isotherm was 29.6 m (97 ft) downstream of the outfall pipe. As shown in the figure, the plume curves after leaving the pipe and turns downstream following the river flow. The maximum width of the curved isotherm was 4.6 m (15 ft).

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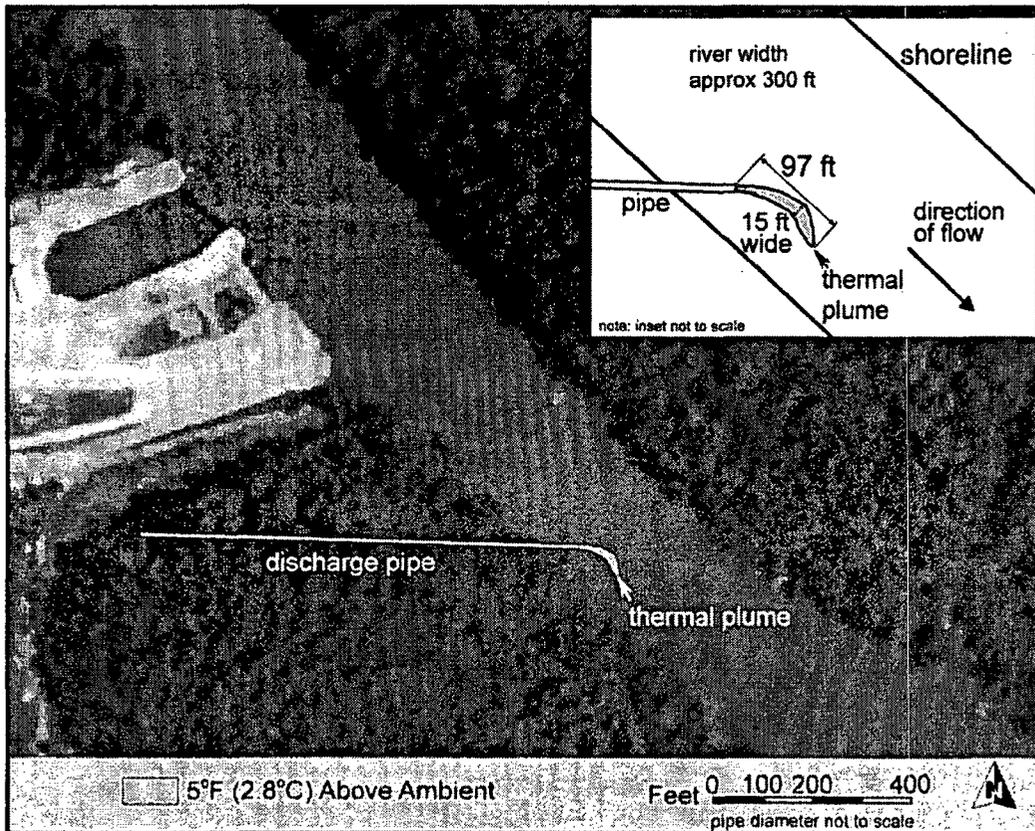


Figure 5-1. Extent of the 2.8°C (5°F) Above Ambient Isotherm Created by the Proposed VEGP Units 3 and 4 Discharge Pipe in the Combined Effluent Analysis

The staff performed a second analysis to identify the maximum downstream and lateral location of the 90°F isotherm, which is 1°F below the effluent release temperature. The same release conditions were assumed for this analysis (e.g., maximum discharge temperatures and combining total effluent from VEGP Units 1 through 4 into the proposed VEGP Units 3 and 4 discharge pipe). However, the maximum extent of the 90°F isotherm would occur whenever the ambient river temperature is as close to the release temperature as possible, and maximum river temperature near Shell Bluff Landing was approximately 81°F. As with the analysis above, the river discharge was assumed to be at 108 m³/s (3800 cfs). Results generated by CORMIX indicate the maximum downstream extent of the 90°F isotherm would occur at a distance of 0.9 m (3 ft) downstream of the outfall pipe. Because of the proximity of the 90°F isotherm to the pipe terminus, the plume had not yet been significantly influenced by the river discharge, and the lateral extent of the isotherm was greater than the downstream extent. The maximum lateral extent of the 90°F isotherm from the outfall pipe terminus toward the river centerline was 2.21 m (7 ft).

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The analysis performed by Southern and described in the ER (Southern 2008a) investigated two river discharge levels: 261 m³/s (9229 cfs) (average discharge) and 112 m³/s (3967 cfs) (low-flow discharge). The largest 5°F above ambient isotherm was computed for the scenario with the lowest river discharge, largest effluent discharge, and the greatest temperature difference between the effluent and the ambient river. However, unlike the staff's analysis, Southern assumed that the outfall pipe for the proposed VEGP Units 3 and 4 was located 123 m (404 ft) downstream of the existing VEGP Units 1 and 2 outfall pipe (note: the staff performed a similar analysis, which is presented in Chapter 7, Cumulative Impacts, of this EIS). The distance between the outfall pipes influences the size of the plume resulting from operation of the proposed VEGP Units 3 and 4. To understand the change in ambient river conditions at the VEGP Units 1 and 2 outfall, Southern first developed a CORMIX model of the VEGP Units 1 and 2 plume. Along the centerline of the plume path the water temperatures are the greatest, and Southern applied the computed water temperatures 123 m (404 ft) downstream as the ambient river temperatures for the proposed VEGP Units 3 and 4 outfall analysis. The largest 5°F above ambient isotherm resulting from the proposed VEGP Units 3 and 4 outfall extended 17.4 m (57 ft) downstream and 6.7 m (22 ft) laterally across the river from the proposed outfall pipe terminus (Southern 2007a). The Savannah River would be approximately 95.1 m (312 ft) wide at drought level 3 flow rate.

The staff extended its thermal impact assessment using the CORMIX model to consider the potential impacts of chemical pollutants in the discharge to the Savannah River. Dilution was defined as the ratio between the initial concentration at discharge to the concentration at some given location away from the outfall. The calculations performed by Southern estimate dilution ratios range between 60 and 120 during periods of average Savannah River discharge. For the analysis performed by staff and at the edge of the 5°F above ambient isotherm described above, the dilution ratio was computed to be 10. For example, if the dilution ratio were 10 at the edge of the mixing zone and the discharge concentration was 20 ppm, then the concentration at the mixing zone edge would be 2 ppm. The dilution ratio was smaller under the more conservative conditions used by the staff.

Discharge limits to the Savannah River for the proposed VEGP Units 3 and 4 would be established by GDNR through the NPDES permitting process. Based on the computed size of the proposed VEGP Units 3 and 4 discharge plume, computed by both the staff and by Southern, and the relatively high levels of dilution at the mixing zone boundary, the NRC staff concludes that the impacts of the effluent plume on the Savannah River would be SMALL and localized. The staff assumes that the types and concentrations of potential chemical pollutants discharged from Units 3 and 4 would be similar to those from Units 1 and 2.

5.3.3.2 Groundwater

There are no potential impacts on groundwater quality from the operation of the proposed VEGP Units 3 and 4. However, cumulative impacts to which the proposed VEGP operation may contribute (i.e., salt water intrusion, tritium in the Water Table aquifer, and contaminants underlying the Savannah River Site) are addressed in Chapter 7 of this EIS.

5.4 Ecological Impacts

This section describes the potential impacts to ecological resources from operation of two new units at the VEGP site, transmission line operation, and transmission line right-of-way maintenance. The impacts are discussed for terrestrial ecosystems, aquatic ecosystems, and threatened and endangered species.

5.4.1 Terrestrial Impacts

The proposed cooling system for the proposed VEGP Units 3 and 4 at the VEGP site is a closed-cycle system that would employ natural draft cooling towers. The heat would be transferred to the atmosphere in the form of water vapor and drift. Vapor plumes and drift may affect crops, ornamental vegetation, and native plants, and water losses could affect shoreline habitat. In addition, bird collisions and noise-related impacts are possible with natural draft cooling towers.

Electric transmission systems have the potential to affect terrestrial ecological resources through right-of-way maintenance, bird collisions with transmission lines, and electromagnetic fields (EMFs). Southern estimates that one additional 500-kV transmission line would be required to distribute the additional generation from proposed VEGP Units 3 and 4 (Southern 2008a). The proposed new transmission line right-of-way would likely connect the VEGP site with the Thomson-Vogtle substation west of Augusta. The transmission line would cross Burke, Jefferson, McDuffie, and Warren Counties. It is anticipated it would be a 46-m (150-ft)-wide right-of-way approximately 97 km (60 mi) long. Maintenance activities on the new transmission right-of-way would be the responsibility of GPC (Southern 2008a). Each of these topics is discussed in the following paragraphs.

5.4.1.1 Impacts on Vegetation

Impacts on crops, ornamental vegetation, and native plants may result from cooling tower drift, icing, fogging, or increased humidity. No row crop agricultural land exists on the VEGP site. However, forests and forested wetlands occur both onsite and offsite in the vicinity of the VEGP site.

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Through the process of evaporation, the total dissolved solid concentration in the CWS increases. A small percentage of the water in the CWS is released into the atmosphere as fine droplets containing elevated levels of Total Dissolved Solids (TDS) that can be deposited on nearby vegetation. Operation of the CWS would be based on four-cycles of concentration, which means the TDS in the make-up water would be concentrated approximately 4 times before being released. CWS water losses from drift are minor in comparison to evaporation and blowdown discharge losses, and the maximum drift rate reported by Southern is 1.5 L/s (24 gpm) when both towers are operating (Southern 2008a).

Depending on the make-up source waterbody, the TDS concentration in the drift can contain high levels of salts which under certain conditions and for certain species can be damaging. Vegetation stress can be caused from drift with high levels of TDS deposition, either directly by deposition onto foliage or indirectly from the accumulation in the soils. Southern estimates a single cooling tower's plume to have a maximum deposition rate of 4.0 kg/ha/mo (3.6 lbs/ac/mo) (Southern 2008a), and that maximum deposition would occur 490 m (1600 ft) from the tower. Regardless of the plume direction, maximum deposition would occur on the VEGP site. The drift from the proposed VEGP Units 3 and 4 towers would overlap because the towers are only 340 m (1100 ft) apart. Therefore, the maximum estimated cumulative deposition rate is 8.0 kg/ha/mo (7.2 lbs/ac/mo) at 490 m (1600 ft) north of the towers (4.0 kg/ha/mo [3.6 lbs/ac/mo] per tower). These estimates are based on a cooling tower characteristics described in the ER (Southern 2008a). Southern (2008b) has since updated the original analysis using Revision 16 of the Westinghouse AP1000 DCD (Westinghouse 2007), which includes an increase in drift and evaporation rates of about 4 percent, thus resulting in increases in the the maximum salt deposition by about 0.3 kg/ha/mo (0.2 lbs/ac/mo) for each tower. The location of the maximum deposition rate is in the vicinity of the proposed Units 3 and 4 switchyard, more than 1.6 km (1 mi) from the northern site boundary. General guidelines for predicting effects of drift deposition on plants suggest that many species have thresholds for visible leaf damage in the range of 10 to 20 kg/ha/mo (9 to 18 lbs/ac/mo) on leaves during the growing season (NRC 1996). Since the maximum deposition for the proposed VEGP Units 3 and 4 is below the level which could cause visible leaf damage in many common species, even if the higher Revision 16 value is used the impacts would be negligible. The impact of drift on crops, ornamental vegetation, and native plants was evaluated for existing nuclear power plants in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* NUREG-1437 (GEIS) and was found to be of minor significance (NRC 1996). This determination also included existing nuclear power plants with more than one cooling tower.

Southern expects the longest vapor plume associated with the new towers would be 10 km (6 mi), but would only occur 3.9 percent of the time (Southern 2008a). The longest plume length would occur in the winter months and the shortest in the summer months. Ground-level fogging and icing do not occur currently at the cooling towers for VEGP Units 1 and 2 and are

not expected to occur at the new cooling towers associated with proposed VEGP Units 3 and 4. Therefore, impacts associated with fogging and icing would be negligible.

The potential impact on crops, ornamental vegetation, and native plants from the operation of cooling towers for the proposed VEGP Units 3 and 4 at the VEGP site would be minimal and mitigation would not be warranted.

5.4.1.2 Bird Collisions with Cooling Towers

The natural draft cooling towers associated with the proposed VEGP Units 3 and 4 would be 180 m (600 ft) high (Southern 2008a). The VEGP site is located adjacent to the Savannah River, and though migratory birds pass through the vicinity of the VEGP site, it is not located on a major American flyway. No formal bird collision surveys have been conducted at the VEGP site. However, the Environmental Protection Plan for VEGP Units 1 and 2 stipulates that any excessive bird-impact events be reported to NRC within 24 hours (Southern 1989). No excessive bird-impact events have been reported onsite. Bird collision events that have been investigated by Southern have been determined to be of no significance due to their infrequent occurrence (Southern 2006b). The conclusion presented in the GEIS for license renewal is that bird collisions with natural draft cooling towers are of small significance at all operating nuclear power plants, including those with multiple cooling towers (NRC 1996). Consequently, the incremental number of bird collisions, if any, associated with the operation of the two new natural draft cooling towers for the proposed VEGP Units 3 and 4 at the VEGP site, would be minimal and mitigation would not be warranted.

5.4.1.3 Noise

The effects of noise on most wildlife species are poorly understood partly because noise disturbance cannot be generalized across species or genera, and there may be response differences among individuals or groups of individuals of the same species (Larkin et al 1996; AMEC Americas Limited 2005). An animal's response to noise can depend on a variety of factors including the noise level, frequency distribution, duration, existence of background noise, time of year, animal activity, age, and sex (AMEC Americas Limited 2005). The potential effects of noise on wildlife include acute or chronic physiological damage to the auditory system, increased energy expenditure, physical injury incurred during panicked responses, and interference with normal activities, such as feeding, impaired communication among individuals and groups (AMEC Americas Limited 2005). The impacts of these effects might include habitat loss through avoidance, reduced reproductive success, and mortality. Long term noise thresholds are not established for wildlife, evidence for habituation is limited, long-term effects are generally unknown, and how observed behavioral and physiological response might be manifested ecologically and demographically are poorly understood (AMEC Americas Limited 2005).

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The noise levels from natural draft cooling tower operation and diesel generators are estimated to be approximately 55 decibels (dBA) SPL (Sound Pressure Level) at 300 m (1000 ft) (Southern 2008a). Researchers have found that dBA measurements contain frequencies out of the hearing bandwidth of birds and some mammals and are not inclusive of the total hearing range for other animals. Because of this, the dBA weighting system does not accurately characterize sound exposure or hearing response for wildlife (Dooling 2002; AMEC Americas Limited 2005). Natural-draft cooling towers emit broadband noise spectrally very similar to environmental (wind) noise. In the case of relatively flat spectra, the spectrum level of cooling tower and diesel generator noise given the estimated dBA SPL would be approximately 15 dB SPL. Cooling tower noise does not change appreciably with time (steady state) and the estimated noise level at 300m is well below the 80-85-dBA SPL threshold at which birds and small mammals are startled or frightened (Golden et al. 1980). Using the startle criterion reported by Golden et al.(1980), the noise level expected to be generated by cooling tower and diesel generator operations would only approach startle levels in the immediate vicinity (within 5m for noise with approximately 60 dBA SPL at 300 m) of the tower or generator. In addition, birds and other animals show habituation to acoustic deterrents (complex sounds designed with spectral components to be within the hearing band of the target animal). Thus, noise generated by natural draft cooling towers would be unlikely to disturb transient wildlife beyond the VEGP site perimeter fence, which is over 300 m (1000 ft) from the towers. Seasonally or long-term resident wildlife could be expected to habituate to cooling tower and generator noise.

Wildlife may also be affected by noise "masking" hearing of important sounds to which the animal would react if they were heard. The approach of a predator would be one such sound. In general, masking of signals in the frequency range of greatest sensitivity of an animal is probably more important to the well being of the animal than are sounds which evoke a behavioral (startle) response causing the animal to move away from the sound source (Dooling 2002).

Impacts (startle to avoidance) within the distance of the VEGP perimeter fence, if any, would be considered negligible owing to the large expanses of open habitat available into which mobile wildlife species could move if disturbed. In addition, the new towers would be near the current VEGP Unit 1 and 2 facilities, where wildlife have likely acclimated to typical operating facility noise levels. Consequently, the potential for startle and avoidance responses by wildlife posed by the incremental noise resulting from the operation of the two new natural draft cooling towers for the proposed VEGP Units 3 and 4 and other facilities at the VEGP site would be minimal. Less clear is the potential for masking of critical sounds within and external to the VEGP perimeter fence. The potential for some level of masking, particularly at frequencies above 2 or 3 kHz, is likely within and external to the VEGP perimeter. Nevertheless, the loss of individuals due to this phenomenon would be localized and would be expected to have a minimal impact on overall population health.

5.4.1.4 Shoreline Habitat

Because of the small quantity of water withdrawn and discharged during operation relative to the flow in the Savannah River, adverse impacts on the river shoreline are unlikely. Based on NRC's own independent review (see Section 5.3.2.1), at the normal withdrawal rate of 2.35 m³/s (83 cfs, 37,224 gpm), proposed VEGP Units 3 and 4 would withdraw up to 2.2 percent of the total river flow at Drought Level 3. At the maximum withdrawal rate of 3.65 m³/s (129 cfs, 57,784 gpm), the Units 3 and 4 would withdraw between 1.5 and 3.4 percent of the total flow of the Savannah River as the river fluctuates between the average flow rate and Drought Level 3.

A water surface elevation versus discharge relationship was developed by the USGS to monitor discharge near the VEGP site (USGS 2007). Using this relationship and the maximum withdrawal rate of 3.65 m³/s (129 cfs), the resulting decrease in river stage as a result of operating the proposed VEGP Units 3 and 4 is approximately 5 cm (2 in.) at Drought Level 3 and approximately 2.5 cm (1 in.) under average discharge conditions.

As described in Section 5.3.2, the staff determined that it was still conservative to base its analysis in this EIS on Drought Level 3. However, the staff did evaluate the fractional decline in the river discharge resulting from maximum withdrawal at the flow rates of 85 m³/s (3000 cfs) and 57 m³/s (2000 cfs) in addition to the 108 m³/s (3800 cfs) minimum for Drought Level 1, 2 and 3 from the current Drought Contingency Plan. The fractional maximum withdrawal rates at 85 m³/s (3000 cfs) and 57 m³/s (2000 cfs) are 4.3 percent and 6.5 percent respectively. At these flow levels and using the maximum withdrawal rate for both Units 3 and 4, the decrease in river stage would only be a matter of inches. Shoreline habitat is preadapted to survive fluctuations in river levels. River flows below Drought Level 3 are expected to occur infrequently and would be temporary in duration. Consequently, the staff anticipates that impacts to shoreline habitat would be minor even under these conditions. Nevertheless, changes in shoreline habitat could occur if the flows in the river are maintained at extremely low levels for an extended period of time, without any appreciable flow variation.

Following publication of the draft EIS, Southern advised the NRC staff (Southern 2007f) that based on changes between Revision 15 and Revision 16 of the AP1000 DCD, the maximum surface water withdrawal for Vogtle Units 3 and 4 would increase by approximately 0.21 m³/s (7.5 cfs). The staff evaluated the effect of this change on the analysis presented above, which uses DCD Revision 15 maximum surface water withdrawal values currently in Southern's ER (Southern 2008a). The staff determined that this change would result in an increase in the consumptive loss to the river of 0.2 percent at 3800 cfs. Such a change would result in an insignificant reduction in river stage. Even assuming the lower river flow values of 85 m³/s (3000 cfs) and 57 m³/s (2000 cfs), the water consumption between Revision 15 and 16 would be from 4.3 percent (Rev 15) to 4.5 percent (Rev 16) for 85 m³/s (3000 cfs) and from 6.5 percent (Rev 15) to 6.8 percent (Rev 16) for 57 m³/s (2000 cfs). Thus the changes identified by Southern would result in a 0.2 to 0.3 percent increase in water consumption under low flow

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conditions. Because this is a very small increase in consumptive water loss, the staff determined that the change in water withdrawal due to Revision 16 of the DCD would not affect the staff's conclusion that surface water use impacts on shoreline habitat would be minor.

In summary, the staff analyzed the potential effects on terrestrial ecology from the drawdown of the Savannah River at Drought Level 3 resulting from the maximum withdrawal rate due to the operation of two additional natural draft cooling towers for the proposed VEGP Units 3 and 4 at the VEGP site. The staff concluded that these effects would be negligible and mitigation would not be warranted. Even at river flow rates of 85 m³/s (3000 cfs) and 57 m³/s (2000 cfs), any impact to downstream shoreline habitat would result principally from the extremely low river flows, and not the additional consumptive water loss due to Units 3 and 4. Furthermore, any impact is expected to be infrequent, temporary, and largely reversible.

5.4.1.5 Transmission Line Right-of-Way Management (Cutting and Herbicide Application)

Southern stated that the same vegetation management practices currently employed by GPC for the existing VEGP Units 1 and 2 transmission line rights-of-way (such as hand-cutting on an as-needed basis) would be applied to the proposed new 500-kV transmission line right-of-way (Southern 2008a).

GPC performs aerial inspections of the transmission corridors five times each year to support routine maintenance activities. These surveys are normally conducted using a helicopter. The noise may startle and temporarily displace wildlife. However, these impacts are short term and occur in a very local area. Woody growth is cleared from transmission line rights-of-way on a 5-year maintenance cycle. This cycle may vary based on public concerns, local ordinances, line maintenance or environmental considerations. Vegetation management includes using herbicides, hand tools, and light equipment. Hand cutting or herbicides are used in areas that cannot be mowed either because it is impractical or because of environmental concerns. Herbicide use is conducted in accordance with manufacturer specifications and by licensed applicators. Any spills of fuel and/or lubricants that occur as a result of equipment use in the transmission line right-of-way are immediately cleaned up and reported. GPC cooperates with the GDNR to manage known sites considered environmentally sensitive within the transmission line rights-of-way (Southern 2008a). GPC has developed recommendations for maintenance practices for the protection of pitcher plants, caves, nests, rookeries, and habitat such as rock outcrops that occur within GPC rights-of-way (Southern 2007b).

Transmission line right-of-way maintenance was evaluated in the GEIS (NRC 1996), and the impact was found to be of small significance at operating nuclear power plants with associated transmission line rights-of-way of variable widths (NRC 1996). Consequently, the potential effects on terrestrial ecology from transmission line maintenance in the new transmission line rights-of-way would be negligible, and mitigation would not be warranted.

5.4.1.6 Bird Collisions with Transmission Lines

Section 4.1 of the Environmental Protection Plan for VEGP Units 1 and 2 stipulates that any excessive bird-impact events be reported to NRC within 24 hours (Southern 1989).

Transmission line and right-of-way maintenance personnel have not reported dead birds from collisions or contact with the Unit 1 and 2 transmission lines (Southern 2008a). GPC has an Avian Protection Plan in place to monitor and address the impacts of transmission lines on birds. Any impact events would be coordinated with GPC's Environmental Field Services and, if necessary, coordination would also involve the FWS (GPC 2006). The conclusion presented in the GEIS is that bird collisions with transmission lines are of small significance at operating nuclear power plants, including transmission line rights-of-way with variable numbers of transmission lines (NRC 1996). Thus, the addition of the proposed transmission line would likely present few new opportunities for bird collisions. The additional number of bird collisions, if any, would not be expected to cause a measurable reduction in local bird populations. Consequently, the incremental number of bird collisions posed by the operation of the new transmission line for the proposed VEGP Units 3 and 4 at the VEGP site would be negligible and mitigation would not be warranted.

5.4.1.7 Impact of EMFs on Flora and Fauna

EMFs are unlike other agents that have an adverse impact (e.g., toxic chemicals and ionizing radiation) in that dramatic acute effects cannot be demonstrated and long-term effects, if they exist, are subtle (NRC 1996). As discussed in the GEIS for license renewal (NRC 1996), a careful review of biological and physical studies of EMFs did not reveal consistent evidence linking harmful effects with field exposures. Thus, the conclusion presented in the GEIS for license renewal (NRC 1996) was that the impacts of EMFs on terrestrial flora and fauna were of small significance at operating nuclear power plants, including transmission systems with variable numbers of transmission lines. Since 1997, over a dozen studies have been published that looked at cancer in animals that were exposed to EMFs for all or most of their lives (Moulder 2003). These studies have found no evidence that EMFs cause any specific types of cancer in rats or mice (Moulder 2003). Therefore, the staff concludes that the incremental EMF impact posed by the operation of the proposed transmission line at the VEGP site would be minimal and mitigation would not be warranted.

5.4.1.8 Floodplains and Wetlands on Transmission Line Rights-of-Way

The effects of transmission line right-of-way maintenance on floodplains and wetlands was evaluated in the GEIS for license renewal (NRC 1996). The impacts were found to be of small significance at operating nuclear power plants with transmission line rights-of-way of variable widths. The incremental effects of transmission line right-of-way maintenance on floodplains and wetlands posed by the addition of the proposed transmission line for the proposed VEGP Units 3 and 4 at the VEGP site would be negligible, and mitigation beyond use of best management practices (BMPs) would not be warranted.

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5.4.1.9 State-Listed Species

The Georgia State-listed threatened bay star-vine (*Schisandra glabra*) is the only State-listed plant species known to occur on the VEGP site. It was recorded on the wooded bluffs above the floodplain in the vicinity of the proposed cooling water intake structure during the 2005 threatened and endangered species survey (TRC 2006). Its habitat preferences are such that it could occur in the floodplain forest as well. In addition, mounds suggestive of the Southeastern pocket gopher have been recorded just north of the VEGP site (Southern 2008a). Southern would likely work with GDNR during operation to ensure species of concern are protected. No other Georgia or South Carolina State-listed plant or animal species are known to occur within 3.2 km (2 mi) of the VEGP site (GDNR 2007b; SCDNR 2007). The potential impacts from VEGP Units 3 and 4 operation on State-listed species at the VEGP site are considered negligible.

Three State-listed species have been documented by the GDNR as occurring within the RDC: the bald eagle (*Haliaeetus leucocephalus*), silky camellia (*Stewartia malacodendron*), and sandhill rosemary (*Ceratiola ericoides*). A proposed 180-m (600-ft) buffer around the known bald eagle nest site would minimize any potential impacts from transmission line construction and maintenance. The impact on State-listed wildlife within the proposed transmission line right-of-way, from noise, EMFs, and bird collisions is expected to be negligible. The impact on State-listed species in the right-of-way due to right-of-way maintenance activities is not known due to the uncertainty of the final routing of the transmission line. However, based on Southern's past performance and established maintenance practices and procedures, the staff has determined the impacts to State-listed species would likely be minimal.

5.4.1.10 Summary of Terrestrial Ecosystem Impacts

The potential impacts of operating the proposed VEGP Units 3 and 4 and two natural draft cooling towers at the VEGP site on vegetation, birds, shoreline habitat, and any related impacts on State-listed species are considered negligible. The potential impacts of transmission line right-of-way maintenance (cutting and herbicide application) and similar impacts on floodplains and wetlands, birds, and biota because of noise, EMFs, and bird collisions on State-listed species are considered negligible, assuming BMPs are followed and State agencies are consulted, as appropriate.

The staff reviewed the potential terrestrial ecological impacts of operating new generation facilities at the VEGP site including the associated heat dissipation system, transmission lines, and associated right-of-way maintenance. The staff concludes the impacts from operation of the new facilities and associated transmission line right-of-way would be SMALL, and additional mitigation beyond that mentioned in the text would not be warranted.

5.4.2 Aquatic Impacts

This section discusses the potential impacts of the operation of the proposed VEGP Units 3 and 4 on the aquatic ecosystem in the Savannah River, onsite streams, and ponds, and water courses crossed by the Thomson-Vogtle transmission rights-of-way.

5.4.2.1 Onsite Streams and Ponds

The only impacts to the onsite streams and ponds during the period of operation of the proposed VEGP Units 3 and 4 would result from stormwater drainage. Southern has an extensive stormwater drainage system and retention ponds for the VEGP site and this system would be modified during construction of Units 3 and 4 to manage stormwater discharges prior to discharge to the Savannah River (Southern 2008a). Southern would revise the existing VEGP Stormwater Pollution Prevention Plan to reflect the addition of new paved areas and facilities and changes in drainage patterns (Southern 2008a). The staff concludes that, based on the use of a stormwater system comparable to that currently used for the VEGP site, the impacts to onsite streams and ponds from operation of the additional VEGP Units 3 and 4 would be minimal.

5.4.2.2 Savannah River

The potential impacts to the Savannah River from the operation of the proposed VEGP Units 3 and 4 would include the consumption of water from the Savannah River, the impingement and entrainment of fish and aquatic organisms, the discharge of heated effluents, the discharge of chemicals, and the physical impact of bottom scouring from the discharge.

Water Intake and Consumption

For aquatic resources, the primary concern related to water consumption is whether there is ample water to operate the facility without a detrimental impact to the aquatic organisms living in the Savannah River downstream of the facility. As shown in Table 5-2, at a normal consumptive use rate for average conditions, the consumptive use of water by both Units 3 and 4 would result in a reduction of 0.7 percent of the river flow. At the maximum consumptive use rate, the two new units would consumptively use between 0.7 and 1.7 percent of the total flow of the Savannah River depending on the drought level (average conditions to drought level 3) in the Savannah River.

Potential impacts to aquatic organisms also are caused by impingement on the intake screens or entrainment into the cooling water system. Impingement occurs when organisms are trapped against the intake screens by the force of the water passing through the CWIS (66 FR 65256). Impingement can result in starvation and exhaustion, asphyxiation (water velocity forces may prevent proper gill movement or organisms may be removed from the water for prolonged

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periods of time), and descaling (66 FR 65256). Entrainment occurs when organisms are drawn through the CWIS into the proposed VEGP Units 3 and 4 cooling system. Organisms that become entrained are normally relatively small benthic, planktonic and nektonic (organisms in the water column) forms, including early life stages of fish and shellfish, which often serve as prey for larger organisms (66 FR 65256). As entrained organisms pass through a plant's cooling system, they are subject to mechanical, thermal, and toxic stresses that are, in most cases, lethal.

A number of factors, such as the type of cooling system, the design and location of the intake structure, and the amount of water withdrawn from the source waterbody greatly influence the degree to which impingement and entrainment affect the aquatic biota.

First, Southern stated in its ER that a closed-cycle wet cooling tower system would be used for the proposed VEGP Units 3 and 4. The proposed cooling system would be similar to the one employed by VEGP Units 1 and 2 (Southern 2008a). Closed-cycle recirculating cooling water systems can, depending on the quality of the makeup water, reduce water withdrawals by 96 to 98 percent of the amount that the facility would use if it employed a once-through cooling system (66 FR 65256). This significant reduction in water withdrawal rate results in a corresponding reduction in impingement and entrainment.

A second factor, the intake design through-screen velocity, greatly influences the rate of impingement of fish at a facility. The higher the through-screen velocity, the greater the number of fish impinged. EPA has established a national standard for the maximum design through-screen velocity of no more than 0.5 ft/sec (66 FR 65256). EPA determined that species and life stages evaluated in various studies could endure a velocity of 1.0 ft/sec, and then applied a safety factor of two to derive the threshold of 0.5 ft/sec. Southern has stated that the proposed Unit 3 and 4 intake structure would have a design through-screen velocity of less than 15 cm/sec (0.5 ft/sec) at a minimum river water level of 23.8 m (78 ft) above MSL (Southern 2008a).

Another factor affecting impingement and entrainment losses is the percentage of the flow of the source waterbody past the site that is withdrawn by the station. EPA determined that limiting withdrawal to 5 percent of the source water body mean flow was technically achievable and economically practicable and that larger withdrawals may result in greater levels of entrainment (66 FR 65256). At a normal withdrawal rate of 2.35 m³/s (83 cfs), proposed VEGP Units 3 and 4 would withdraw between 0.9 and 2.2 percent of the river flow during conditions ranging from average to drought level 3. At the maximum withdrawal rate of 3.65 m³/s (129 cfs) the two new units would withdraw between 1.5 and 3.4 percent of the total flow of the Savannah River depending on the drought level in the Savannah River. Thus, the planned design and operation of the proposed VEGP Units 3 and 4 CWIS meets the standard of withdrawing no greater than 5 percent of the source water body mean annual flow.

A fourth factor is the use of design and construction technologies for minimizing impingement mortality and entrainment if specific conditions exist where the cooling water intake structure is located. EPA indicated (66 FR 65256) that the optimal design for the intake location is to place the inlet of the CWIS in an area of the source water body away from areas with the potential for high productivity, where impingement and entrainment of organisms are minimized. As discussed in Section 2.7.2.1, larval densities are significantly greater in the oxbows of the river, indicating that these are areas of higher productivity, as opposed to the straighter stretches of the river, such as in the vicinity of the VEGP site, where the CWIS would be located.

As discussed in Section 4.4.2, Southern has stated in its ER (Southern 2008a) that the intake canal would be built so that the river flow is almost perpendicular to the intake canal flow. Southern has also stated that, at the minimum river operating level (23.8 m [78 ft] above MSL), the flow velocity along the intake canal would be about 3 cm/s (0.1 fps), based on the site maximum make-up water demand of 3646 L/s (57,784 gpm, 129 cfs) (Southern 2008a). A weir wall would extend upward approximately 0.3 m (1 ft) from the bottom of the intake canal near its entrance. This would further serve to reduce entrainment mortality by selecting a portion of the water column that could move into the intake canal.

As indicated in Section 2.7.2.3, entrainment monitoring was initiated in March 2008 at the VEGP Units 1 and 2 CWIS to estimate the species composition and density of ichthyoplankton entrained by the cooling water withdrawals (Southern 2008d). Background river samples are being collected with plankton net tows upstream and beyond the influence of the intake in order to develop site specific background ichthyoplankton values for comparison. The results of this study will not be available until late 2008.

Because the data collection is ongoing, the staff analyzed two other assessments conducted in the vicinity of VEGP Units 3 and 4. The first assessment was summarized in the Final Environmental Statement (FES) for the licensing of VEGP Units 1 and 2, published in 1985 (NRC 1985). The second assessment was performed for the Department of Energy to estimate the entrainment rates determined for the Savannah River Site facilities that are located across the river from the VEGP site (Paller et al. 1986; Specht 1987).

The staff's evaluation of entrainment in the Final Environmental Statement (FES) (NRC 1985) assumed a uniform distribution of drift organisms and a maximum of 2 percent of the river flow passing through the plant in 1985. The NRC staff determined that under average flow conditions (292 m³/s [10,300 cfs]) and maximum withdrawal (3.4 m³/s [120 cfs]), the removal rate would be 1 percent of the drift organisms, for a maximum of 2 percent for both units. The staff concluded that this would have an insignificant effect on the drift organisms, aquatic community, and resident fish in the vicinity of VEGP Units 1 and 2 (NRC 1985). A similar estimate could be applied to entrainment for the proposed VEGP Units 3 and 4 CWIS because of the similarity in design for the CWISs. The assumption of a uniform distribution can be compared to data from Paller et al. (1986), which found a uniform distribution of larvae in

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relation to depth in the Savannah River, although egg densities were higher at the bottom of the water column than they were at the top. Because of the presence of a wier wall in the intake canal, the assumptions of a uniform distribution of drift organisms and 100 percent mortality of entrained biota are conservative and appropriate for Units 3 and 4. Based on the surface-water withdrawals for only VEGP Units 3 and 4 given in Table 5-1, an estimate of 0.9 to 3.4 percent removal would be appropriate depending on the flow conditions and removal rate.

Studies have been performed that looked at entrainment rates for reactor facilities at the Savannah River Site. Between 1982 and 1985, ichthyoplankton studies occurred between rkm 47.2 and 301.1 (RM 29.3 and 187.1) and in intake canals and mouths of three creeks along the Savannah River Site (Paller et al. 1986). During these four years, it was estimated that between 8.3 percent and 12.3 percent of the ichthyoplankton that drifted past the canals were entrained. However, there are significant differences between the Savannah River Site intakes and the existing and proposed intakes at the VEGP site. First, the volume of water withdrawn is greater at the Savannah River Site, 11.2 m³/s (395 cfs) each for K-reactor and L-reactor intakes at full power (Paller 1992). This is about three times the anticipated water withdrawal rate of the proposed VEGP Units 3 and 4. Second, the intake velocity at the Savannah River Site intakes is calculated at 38 cm/s (1.25 ft/s) (McFarlane et al. 1978), which is 2.5 times as great as for the proposed VEGP Units 3 and 4.

Based on the small percentage of water withdrawn, the design of the cooling intake canal and structure, the significantly greater larval densities in the oxbows, as opposed to the straighter part of the river at the location of the VEGP site, the typically high fecundity of most species inhabiting rivers, and the high natural mortality rates of eggs and larvae, the staff finds that the impacts to the fish of the Savannah River from entrainment due to the operation of the proposed VEGP Units 3 and 4 would be minor.

As indicated in Section 2.7.2.3, impingement studies are currently being conducted at the VEGP Units 1 and 2 intake structures to qualitatively identify and enumerate fish impingement rates. Impingement monitoring was initiated in March of 2008 at the VEGP Units 1 and 2 and is anticipated to continue for a year. The study consists of sampling for two 12-hour sampling periods (night and day) every two weeks. One hundred percent of the material washed from the intake screens over one full day is examined. Preliminary results based on 6 days of sampling of the impingement monitoring program for VEGP Units 1 and 2 collected a total of 25 aquatic organisms, representing 15 species in 9 taxonomic families. The rate of impingement from this small sample is approximately four aquatic organisms per day for the combined operation of both units (Southern 2008c).

In addition, a site visit to the VEGP Units 1 and 2 on March 8, 2007 included an investigation of the VEGP intake and involved an examination of the traveling screens, the screen wash system, the debris trough that collects and channels debris washed from the screens, and the collection debris basket as documented in a trip report (NRC 2007a). Southern staff indicated that the

screen wash collection basket had been cleaned about 2-3 times each of the past two years and no fish were seen. Section 4.1, entitled Unusual or Important Environmental Events, of the VEGP Units 1 and 2 Environmental Protection Plan, Appendix B to VEGP Units 1 and 2 operating licenses NPF 68 and NPF 81, requires NRC notification of any unusual environmental events, citing specifically fish kills or impingement events at the plant. To date, no such report has been submitted for VEGP Units 1 and 2.

Based on the planned low-through-screen intake velocity, the use of closed-cycle cooling, the design of the intake canal, and the preliminary data from the impingement study at VEGP Units 1 and 2, the staff concludes that impacts from impingement of fish for the proposed VEGP Units 3 and 4 would be minor.

5.4.2.3 Aquatic Thermal Impacts

The effluent discharge from the proposed VEGP Units 3 and 4 would be directly into the Savannah River. Section 5.3.3.1 discusses the location and design of the discharge piping. It also discusses the results of the staff's thermal impact assessment using the CORMIX model to estimate the size and temperature of the thermal plume from the existing VEGP Units 1 and 2 as well as the proposed VEGP Units 3 and 4. Assuming conservative river conditions (e.g., minimum river temperatures, maximum discharge temperatures), the maximum width of the curved 2.8°C (5°F) isotherm is 4.6 m (15 ft). At the location of the discharge outfall, the river is approximately 95.1 m (312 ft) wide at Drought Level 3 flow rate. The maximum distance that the 2.8°C (5°F) above ambient isotherm was estimated to occur was 29.6 m (97 ft) downstream of the outfall pipe. Under average flow conditions, the plume is significantly smaller. Based on the calculations, the staff has determined that the size of the thermal plume from the proposed effluent discharge is small in comparison to the width of the Savannah River at the VEGP site (see Figure 5-1). The location and design of the discharge would not impede fish passage up and down the river. Fish and other organisms in the river would likely avoid the elevated temperatures. They can move through this part of the river unencumbered by any structures or physical features that would retain them in the plume.

Another factor related to thermal discharges that may affect aquatic biota is cold shock. Cold shock occurs when aquatic organisms that have been acclimated to warm water, such as fish in a power plant's discharge canal, are exposed to a sudden temperature decrease. This sometimes occurs when single-unit power plants shut down suddenly in winter. Cold shock mortalities at U.S. nuclear power plants are relatively rare and typically involve small numbers of fish (NRC 1996). It is less likely to occur at a multiple-unit plant, because the temperature decrease from shutting down one unit is moderated by the heated discharge from the units that continue to operate. It also is less of a factor when the discharge is to a river where the volume of the discharge in comparison to the flow of the river is very small, as is the case at the VEGP site.

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Neither Asiatic clams (*Corbicula fluminea*), nor any other invasive species has been observed to have increased in numbers in the vicinity of the thermal plume operated by VEGP Units 1 and 2. Therefore, no large growths of invasive nuisance organisms are anticipated from the thermal plume for the proposed units.

Based on this analysis of the potential for thermal impacts to the aquatic ecosystem of the Savannah River, the staff has reviewed the impacts to the aquatic environment in the vicinity of the site. The staff concludes that the impacts to aquatic organisms from thermal discharges from the proposed VEGP Units 3 and 4 would be minor.

5.4.2.4 Chemical Impacts

Another discharge-related impact involves the chemical treatment of the cooling water. The ER indicates that chemicals, including biocides, would be added to the cooling tower basins to control scaling, corrosion and solids (Southern 2008a). Biocides would not be injected at the intake structure (NRC 2007b). Biofouling would be controlled using chlorination and/or other treatment methods in the cooling water system cooling tower basin. This decision was based on the operational experience of the existing VEGP Units 1 and 2 intake structure. The biofouling control in the make-up water pipeline is handled by maintaining an appropriate velocity to prevent the attachment of the biofouling species of concern to the piping (Southern 2007a).

Operation of the cooling towers would be based on four cycles of concentration, which means that the total dissolved solids in the make-up water would be concentrated four times before being discharged. Thus, the levels of solids and organics in the cooling tower blowdown would be approximately four times higher than ambient or upstream concentrations. The CWS chemical treatment would be similar to that for the existing units. The final plant discharge from the proposed VEGP Units 3 and 4 would be composed of circulating and service water blowdown and other site wastewater streams, including sanitary waste, miscellaneous low-volume waste, and treated liquid radwaste (Southern 2008a). Blowdown from the cooling towers would be discharged to a common blowdown sump to provide retention time for settling of solids or to be treated, if required to remove biocide residuals before the water is discharged to the river (Southern 2008a). Calculations performed by Southern and confirmed by the staff (Section 5.3.3.1) give an estimated in-river dilution factor of 60 to 120 during periods of average Savannah River discharge, depending on the time of the year and river flow rate. The dilution rate calculated by the staff under more conservative conditions for the edge of the 2.8°C (5°F) above ambient isotherm was 10, as discussed in Section 5.3.3.1.

Table 5-4 provides a list of the water treatment chemicals, their use, the concentration that is anticipated to be discharged from proposed VEGP Units 3 and 4, and the toxicity data from the Material Safety Data Sheets for each of the chemicals that will be discharged to the Savannah River. This list is the same as those present in the final discharge for VEGP Units 1 and 2.

Table 5-4. Chemical discharges to the Savannah River from Proposed VEGP Units 3 and 4

Chemical ^(a)	Use ^(a)	Concentration at Discharge Point ^(a)	Toxicity ^(b)
Nalco Sure-Cool 1336 (hazardous substance - sodium tolytriazole)	Corrosion control for yellow metals	2 ppm	23.7 ppm LC50(c)
Nalco 3DT177 (polymer) (hazardous substance - phosphoric acid)	Corrosion control for mild steel	10-11 ppm	> 5000 ppm LC50 for inland silverside (<i>Minidia beryllina</i>)
Nalco 3DT190 (polymer)	Dispersant	6-7 ppm	948 ppm LC50 for fathead minnow (<i>Pimephales promelas</i>) with similar product
Nalco 7905 (hazardous substance - ammonium bisulfite)	Dechlorination agent	25% excess to halogen radical, so max is (0.75 ppm × 0.25) = 0.1875 ppm	No toxicity studies have been conducted. This product is not a sensitizer or listed as a carcinogen.
Oxidizing biocide as either <ul style="list-style-type: none"> • Liquid sodium hypochlorite • Liquid sodium bromide activated with sodium hypochlorite • Stabilized bromine 	Control algae and general biofouling (Asiatic clams) – Twice per week to achieve 0.2-0.75 ppm free available oxidant and continuously over a period of 120 hours at 0.5 ppm free available oxidant to control Asiatic clams	Neutralized prior to discharge – Concentration effectively is zero.	Not applicable
Sodium hypochlorite (liquid)	Sanitary waste disinfection	Unknown (held in 325,000 gallon wastewater retention basin prior to discharge so that no chlorine residual remains in the final effluent).	Not applicable

(a) NRC 2007d

(b) Southern 2007c

(c) LC50 – Lethal Concentration 50 is the concentration of a chemical that kills 50% of the sample population.

These chemicals include those that are used in the cooling towers, the heat exchangers, cooling systems, and sewage treatment. The concentrations in the discharge are significantly lower than the LC50 (the concentration that kills 50% of the sample population) obtained from the Material Safety Data Sheets (Southern 2007c). The water flow from the Savannah River would further dilute the concentration of these chemicals.

The use of chemicals in the existing VEGP Units 1 and 2 is regulated by the GDNR, as set forth in an NPDES permit, which is granted by. The chemical concentrations at the outfall for the existing units would meet the NPDES limits (Southern 2008a). No impacts to the aquatic ecology of the Savannah River from these chemicals have been observed. Southern would be required to obtain an NPDES permit from GDNR prior to operation of VEGP Units 3 and 4. The NPDES permit will specify discharge limits for the various water treatment chemicals that are

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protective of the aquatic environment. The staff has determined that the impacts from the chemical discharges to the Savannah River would be minimal.

5.4.2.5 Physical Impacts from Discharge

Some localized bottom scouring is anticipated in the immediate vicinity of the end of the discharge pipe (Southern 2008a). A bathymetric study (Southern 2008a) demonstrated that there was a 0.9- to 1.5-m- (3- to 5-ft)-deep trough immediately downstream of the existing VEGP Units 1 and 2 discharge structure, which is presumed to have been caused by the discharge scouring the river bottom. The bathymetric study shows no evidence of this depression 22.9 m (75 ft) further downstream; thus indicating that the scouring is restricted to a small area. Southern assumed that the extent of bottom scouring associated with the operation of the new discharge would be similar to that for the existing units, resulting in an area of several hundred square feet that is unsuitable for benthic organisms such as larval aquatic insects or mussels (Southern 2008a). Southern has committed to the placement of rip-rap around the discharge point to reduce potential erosion from the discharge jet pipe (Southern 2008a). This would result in impacts to a very small fraction of the entire benthic habitat of the Savannah River, thus there would be a minimal, if any, impact on benthic organisms.

Based on this analysis of the potential for physical impacts to the aquatic ecosystem from the discharge of cooling water to the Savannah River, the staff reviewed the impacts to the aquatic environment in the vicinity of the site. The staff concludes that the physical impacts from thermal discharges from the proposed VEGP Units 3 and 4 would be minor.

5.4.2.6 State-Listed Species

Two Georgia State-listed species occur in the vicinity of the VEGP site. The robust redhorse (*Moxostoma robustum*) is found in the Savannah River. Spawning areas for this species have only been reported upstream of the VEGP site. The nearest known spawning area is at rkm 284 (RM 176) located about rkm 40 (25 RM) upstream of the VEGP site (Grabowski and Isely 2007). The description of the spawning area (a mid-channel gravel bar) discussed in Section 2.7.2.1 does not fit the description of the river bottom adjacent to the VEGP site. The eggs of the robust redhorse develop within the gravel and the larval fish remain there for approximately 7 days after hatching. The adults are observed to stay primarily within the main channel as they move upstream or downstream. High-water events were the only times that radio-tagged fish were located outside the main river channel (Grabowski and Isely 2006). As a result, the potential for impact to the State Listed robust redhorse from entrainment, impingement, and thermal or chemical discharges would be minor.

The Georgia state endangered Atlantic pigtoe mussel (*Fusconaia masoni*), tentatively identified in surveys by the USFWS (The Catena Group 2007) as being in the Savannah River, were located at a considerable distance upstream of the VEGP site (84 rkms (52 RMs) and thus, would not be adversely affected by operational activities at the VEGP site.

The Savannah darter (*Etheostoma fricksium*), a Georgia species of concern with no legal protected status may at times enter the Savannah River; however, its preferred habitat is shallow creeks such as Beaverdam Creek. As a result, it is unlikely to be affected by operation of VEGP Units 3 and 4.

Nine South Carolina mussel species of concern are known to occur in the Savannah River near the VEGP site (Table 2-9). Potential impacts during operations could include entrainment of glochidia (larval form), entrainment or impingement of the host fish larvae, and impact to individuals that are in the discharge plume from thermal discharges or chemicals. A portion of the glochidia along the stretch of the Savannah River near the VEGP site may be entrained along with river water into the Units 3 and 4 intake structure. However, the glochidia of most freshwater mussels are obligate parasites of fish, and once they attach to the gills or fins of a fish they are less susceptible to the impacts of entrainment. As discussed in Section 5.3.3.1, the thermal plume encompasses a small part of the river. Thus, the area of impact for thermal or chemical discharges in the cooling water to any mussels in the vicinity of the intake is small in comparison to the remainder of the river. The staff has determined that the impacts to the mussels in the vicinity of the VEGP site as a result of entrainment, and of chemical and thermal discharges would be minor.

5.4.2.7 Transmission Line Right-of-Way Maintenance Activities

Maintenance activities along the Thomson-Vogtle 500-kV transmission project could lead to periodic temporary impacts on the waterways being crossed. However, it is assumed that the same vegetation management practices currently employed by GPC for the existing VEGP Units 1 and 2 facility transmission line rights-of-way would be applied to the proposed new 500-kV Thomson-Vogtle transmission line right-of-way (Southern 2008a). GPC practices and procedures were developed to prevent impacts to surface waters and wetlands, so that impacts to aquatic ecosystems from operation and maintenance of transmission lines would be small. GPC's Routine Line Maintenance Procedures call for GPC personnel to check transmission line rights-of-way at least three times a year for encroachment, erosion problems or evidence of unauthorized logging or construction activity adjacent to the transmission lines. Identifying and correcting these problems would benefit aquatic communities in down-gradient streams and wetlands. GPC has also directed its maintenance crews to avoid environmentally sensitive areas, including spawning areas and endangered species habitats (Southern 2008a). However, no Federal or State-listed aquatic organisms are anticipated to be in the transmission line rights-of-way, thus there are no impacts anticipated to important aquatic species. The staff concludes that the impacts of transmission line right-of-way maintenance activities on aquatic resources

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would not adversely impact aquatic ecosystems and that no mitigation beyond that described above is warranted.

5.4.2.8 Aquatic Monitoring During Operation

Southern does not plan to perform any formal monitoring of the aquatic ecosystems during operations. Its basis for this decision is that "...the operation of the new intake and discharge structures would have small impacts on the water quantity or quality" (Southern 2007b).

5.4.2.9 Summary of Aquatic Impacts

Based on a number of factors given in Section 5.4.2.2, including the use of a closed-cycle cooling system and an intake with a design velocity through the screens of less than 15 cm/s (0.5 ft/s), the staff concludes that impacts on aquatic ecosystems due to impingement and entrainment would likely be minor.

The staff concludes that the impacts to the aquatic ecosystem from the thermal discharge from proposed VEGP Units 3 and 4 are also likely to be minor based on the size of the thermal plume in relationship to the size of the Savannah River. The staff concludes that the chemical impacts from the discharge would be minor based on the dilution factors and experience with VEGP Units 1 and 2. The staff also concludes that the physical impacts of the discharge would be minor based on experience with the existing units and Southern's commitment to place rip-rap around the discharge point to reduce potential erosion from the discharge pipe. Impacts of transmission line right-of-way maintenance activities on aquatic ecosystems would also be minor.

For additional conservatism, the staff also considered the impacts to aquatic biota in the Savannah River at two river flow rates below the Drought Level 3 values analyzed above. Even assuming river flows of 3000 cfs and 2000 cfs, rather than the Drought Level 3 case of 3800 cfs river flow, the percentage of water withdrawn based on the maximum withdrawal rate from the Savannah River due to the operation of VEGP Units 3 and 4 would be 4.3% at 3000 cfs and 6.5% at 2000 cfs.

At river flows of 3000 and 2000 cfs, the river stage and available habitat for aquatic organisms would be reduced, which would concentrate aquatic biota populations, and through-screen velocities at the intake would increase, likely resulting in some minimal increase in impingement. The lower flows of 3000 and 2000 cfs would result in an increased fraction of water flowing past the site being drawn into the cooling water system. Accordingly, entrainment would increase proportionately for both the 3000 and 2000 cfs river flow cases. However, both the increased percentage of organisms entrained and the possible increase in impingement mortality are unlikely to have any persistent long term impacts on populations in the river, because the low flow conditions would likely be temporary and the characteristics of the river in the vicinity of the

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site are not biologically unique. Because of the small amount of water discharged in relation to the river flow and the resulting dilution of the discharge plume, the effects on aquatic biota in the river from the thermal and chemical discharges from VEGP Units 3 and 4 at the 3000 and 2000 cfs river flow rates, even at maximum withdrawal rates, would not result in impacts to aquatic biota that are significantly different from those analyzed for VEGP operation at Drought Level 3.

Following publication of the draft EIS, Southern advised the NRC staff (Southern 2007f) of updates to its original analysis based on changes in flow rates between Revision 15 and Revision 16 of the AP1000 DCD. These changes included revised, increased estimates of evaporative loss and make-up flow. The maximum surface water withdrawal for Vogtle Units 3 and 4 would increase by approximately 0.21 m³s (7.5 cfs).

The staff evaluated the effect of this change on the staff's analysis presented above, which uses the DCD Revision 15 surface water withdrawal values currently in Southern's ER (Southern 2008a). The staff determined that this change would result in an increase in the maximum withdrawal from approximately 3.4 percent in the present analysis to 3.6 percent of the river flow at Drought Level 3. Similarly, at a river flow rate of 3000 cfs, the revised maximum withdrawal rate would be 4.5 percent, and for 2000 cfs it would be 6.8 percent. Accordingly, because the changes identified by Southern would result in only a minor increase in consumptive water use under Drought Level 3 conditions – with only minor increases expected in the entrainment and impingement rates, the size of the thermal plume, and chemical impacts – and because the impact level analyzed for the Revision 15 values was not near a known impact threshold, the staff determined that these changes would not adversely affect the aquatic community inhabiting the Savannah River. Furthermore, even under low flow conditions of 3000 and 2000 cfs, the increased withdrawals identified by Southern in Revision 16 would result in sufficiently small increases in maximum water withdrawal and in associated thermal and chemical impacts, that it similarly would not alter the staff's impact assessment.

Therefore, the staff determined that neither the low flows of 3000 and 2000 cfs, nor the potential increased surface water withdrawals associated with Revision 16 of the AP1000 DCD, would affect the staff's conclusion that impacts to aquatic biota from operation of proposed Units 3 and 4 would be minor.

Therefore, the staff concludes that the overall impact on aquatic resources of operating the proposed VEGP Units 3 and 4 and the new transmission line would be SMALL and that no mitigation beyond that described above is warranted.

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5.4.3 Federally Listed Species

5.4.3.1 Terrestrial Species

The VEGP Site

No Federally listed threatened and endangered species are known to occur at the VEGP site, with the exception of the American alligator (*Alligator mississippiensis*). There are no areas designated as critical habitat for threatened and endangered species in the vicinity of the VEGP site.

The American alligator is classified as "threatened based on the similarity of appearance" to the American crocodile (52 FR 21059). The alligator is no longer biologically imperiled in Georgia. Alligators appear to be relatively common in the Savannah River near the VEGP site and currently occur onsite. The alligator population near the VEGP site is not expected to be adversely affected by operation of VEGP Units 3 and 4.

The wood stork (*Mycteria americana*) has been seen within 3.2 km (2 mi) of the VEGP site in the Savannah River Swamp. However, the closest wood stork colony is about 45 km (27 mi) from the site. The wood stork may occasionally use suitable habitat on the VEGP site for foraging or could use it for roosting. However, this species is highly mobile, and any impacts associated with the operation of Units 3 and 4 on the VEGP site would be negligible.

The red-cockaded woodpecker (*Picoides borealis*), relict trillium (*Trillium reliquum*), and the flatwoods salamander (*Ambystoma cingulatum*) are not known to occur within 16 km (10 mi) of the VEGP site. Though suitable habitat may exist for these species on the VEGP site, this habitat is not likely to be affected by operation activities. It is unlikely there is suitable habitat for the smooth coneflower (*Echinacea laevigata*) and Canby's dropwort (*Oxypolis canbyi*) onsite. Therefore, there are no anticipated impacts on these species associated with operation of the proposed VEGP Units 3 and 4.

Operation of VEGP Units 3 and 4 would have minimal impacts on the red-cockaded woodpecker, wood stork, relict trillium, smooth coneflower, Canby's dropwort, American alligator, or the flatwoods salamander. Based on this review, the staff concluded the impacts on terrestrial Federally listed threatened and endangered species from operation of the proposed VEGP Units 3 and 4 would be SMALL, and no mitigation is warranted.

Proposed 500-kV Transmission Line

The exact route of the proposed 500-kV transmission line has not yet been determined. However, the proposed transmission line would be located within the RDC. Routing alternatives within this right-of-way are currently being evaluated by GPC and Southern (GPC 2007). No Federally listed species have been documented to occur within the RDC. Populations of

Canby's dropwort and Georgia aster are within 16 km (10 mi) of the RDC. The wood stork, red-cockaded woodpecker, relict trillium, smooth coneflower, and flatwoods salamander are not known to occur within 16 km (10 mi) of RDC, but have the potential to occur in counties that may be crossed by the transmission line. GPC maintenance practices include identifying all red-cockaded woodpecker colony areas within 3.2 km (2 mi) of maintenance work around the activity areas during non-breeding periods. GPC maintenance practices include identifying all active nesting wood stork colony locations in the State with a focus on the rookeries that are within 1.6 km (1 mi) of a transmission line. In areas within 230 m (750 ft) of an active rookery, GPC conducts mowing during the non-nesting season (Southern 2007a).

Based on Southern's past performance and established maintenance practices and procedures, the staff has determined the impacts to Federally listed species would be SMALL. Any additional mitigative actions or BMPs would be dependent on the species, exact location and nature of the environmental impacts associated with operation of the transmission line right-of-way.

5.4.3.2 Aquatic Federally Listed Species

This section describes the potential impacts that operation of the proposed VEGP Units 3 and 4 could have on the shortnose sturgeon (*Acipenser brevirostrum*), the only Federally listed aquatic species occurring in the vicinity of the VEGP site. This species was identified through correspondence with the National Marine Fisheries Service (NMFS) (NMFS 2006). A Biological Assessment describing the staff's findings was prepared and sent to the National Oceanic and Atmospheric Administration (NOAA) under Section 7 of the Endangered Species Act. Impacts to shortnose sturgeon could occur as a result of entrainment, impingement, thermal discharges, or chemical discharges.

As discussed in Section 2.7.2.2, shortnose sturgeon are known to be in the Savannah River in the vicinity of the site. Suspected spawning grounds are located downstream of the VEGP site at rkm 179 to 190 (RM 111 to 120) (Hall et al. 1991) and rkm 208 to 228 (RM 129 to 142) (Collins and Smith 1993), or upstream of the site at rkm 275 to 278 (RM 171 to 173) (Hall et al. 1991). Twelve larval shortnose sturgeon were collected in the vicinity of the Savannah River Site during ichthyoplankton surveys conducted between 1982 and 1985 (Paller et al. 1986), indicating that they are present in the Savannah River adjacent to the VEGP site. However, the only shortnose sturgeon eggs or larvae that potentially could be subject to entrainment at the VEGP Units 3 and 4 intake are those from the upstream spawning location.

Because sturgeon eggs are demersal, and adhere to hard substrate such as rocks or submerged logs (Dadswell et al. 1984), they are less likely to be entrained into the cooling water system than eggs of other species. In addition, as discussed in Section 2.7.2.2, larvae and early juveniles tend to initially stay near the bottom and seek cover. NMFS (1998) reported that larvae collected in rivers were found in the deepest water, usually within the channel (NMFS 1998). These larvae would be less likely to enter the intake canal and become entrained. Collins et al. (2002) indicates the nursery habitat for juvenile shortnose sturgeon in the

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Savannah River is in the lower river approximately from rkm 31.5 to 47.5 (RM 19.57 to 29.52), well distant from the VEGP site.

The design and operation of the CWIS (as discussed in Section 5.4.2.2) including the low-through-screen intake velocity, are not likely to adversely impact shortnose sturgeon. The area affected by thermal discharge is small in comparison to the width of the Savannah River at the VEGP site, thus not providing a barrier to the up- or down-river migration of shortnose sturgeon. In addition, the quantities of chemicals to be discharged into the Savannah River from proposed VEGP Units 3 and 4 are of low enough concentration and would be significantly diluted so as to not cause an adverse impact to nearby sturgeon.

No impacts are anticipated to the shortnose sturgeon from maintenance of the transmission lines, because the lines do not cross the Savannah River. Consequently, operation of the proposed VEGP Units 3 and 4 is not likely to adversely affect the shortnose sturgeon. The impacts to the sturgeon would be considered SMALL and there is no need for additional mitigation.

For reasons described in Section 5.4.2.9, even under conditions of lower river flow (3000 cfs or 2000 cfs) than was analyzed for Drought Level 3 (3800 cfs), the staff does not foresee long term adverse impacts to the Savannah River shortnose sturgeon population due to VEGP water withdrawals. It is unlikely that the lower river flows would result in increased sturgeon mortality due to impingement or thermal or chemical discharges. The low river flows could marginally increase the loss of sturgeon larvae produced upstream of VEGP due to increased entrainment and could affect the suspected downstream spawning area by further reducing the already low river flows. However, as noted in Section 5.4.2.9, such low flow conditions are expected to be only temporary and flows in the river could be increased during the spawning period. The staff does not anticipate adverse impacts in connection with potential small increases in river withdrawals associated with Revision 16 of the AP1000 DCD. The changes in water use and effluent discharge values associated with Revision 16 would be small in proportion to those already analyzed. Accordingly, impacts to shortnose sturgeon should not significantly differ from those described above.

5.5 Socioeconomic Impacts

The socioeconomic impacts from operating two new Westinghouse AP1000 reactors at the VEGP site and from the activities and demands of the operating workforce on the surrounding region include the potential impacts on individual communities, the surrounding region, and minority and low-income populations. Unless otherwise specified, the primary source for information in this section is provided by Southern's ER (Southern 2008a).

5.5.1 Physical Impacts

Potential physical impacts include noise, odors, exhausts, thermal emissions, and visual intrusions. The NRC staff believes these impacts would be mitigated through operations of the facility in accordance with all applicable Federal, State, and local environmental regulations and therefore would not significantly affect the region surrounding VEGP. The following sections assess the potential operations-related physical impacts of two new units on specific segments of the population, the plant, and nearby communities.

5.5.1.1 Workers and the Local Public

There are no residential areas located within the site boundary. The area within 16 km (10 mi) of the VEGP site is predominately rural and characterized by agricultural and forested land, with only 3500 residents (see Section 2.8.1 of this EIS). No significant industrial or commercial facilities other than VEGP exist or are planned for this area.

Burke County is part of the Augusta-Aiken Interstate Air Quality Control Region, which is classified as in attainment with all National Ambient Air Quality Standards (NAAQS)^(a) (40 CFR 81.114). Once the two new reactors have begun operation, they would not produce any known air pollutant, except for (1) the periodic testing and operation of VEGP's standby diesel generators and auxiliary power systems, (2) commuter vehicle dust and exhaust, (3) odors from operations, and (4) operations-based noise. Certificates to operate the diesel generators require that air emissions comply with all applicable regulations and the staff expects the impact of the operations of the proposed VEGP Units 3 and 4 on air quality would be small. Access road maintenance and speed limit enforcement would reduce the amount of dust generated by the commuting workforce. Southern uses a staggered shift schedule for its operations workforce, which also helps mitigate the effects of vehicle exhaust. During normal plant operation, the new units would not use chemicals in amounts that would generate odors exceeding Federal and State limits. Southern plans to use BMPs to control the odors emitted by chemicals and other sources during routine outages and therefore the staff believes the addition of two new reactors to the site would have only a SMALL impact on workers and the local public and would not require additional mitigation. Air-quality impacts of plant operation are discussed in more detail in Section 5.2 of this EIS.

The proposed VEGP Units 3 and 4 would produce noise from the operation of pumps, transformers, turbines, generators, and switchyard equipment. The noise levels would be controlled in accordance with applicable local regulations. Most equipment would be located inside structures, reducing the outdoor noise level. Southern would use single natural draft cooling towers for each Westinghouse AP1000 reactor at the VEGP site to remove excess heat

(a) Areas of the United States having air quality as good as or better than the NAAQS are designated by the U.S. Environmental Protection Agency (EPA) as "attainment areas."

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from the CWS. Natural and mechanical draft cooling towers emit broadband noise, which Southern expects to be greater than background levels. Noise levels below 60 to 65 dBA are not considered to be significant because these levels are not sufficient to cause hearing loss (NRC 1996). Ambient noise heard by recreational users on the Savannah River or nearby Yuchi Wildlife Management Area (WMA) under normal conditions includes some noise from the operation of VEGP Units 1 and 2. The maximum sound level generated by the operation of the proposed VEGP Units 3 and 4 at the site boundary would be approximately 30 to 40 dBA and would not affect the usage of nearby recreational areas and would not require mitigation. Therefore, the staff determined the noise-related effect on workers, residents, and recreational users of nearby areas would be SMALL and no mitigation would be required.

5.5.1.2 Buildings

Operations activities would not affect offsite buildings. Except for VEGP site structures, no other industrial, commercial, or residential structures would be affected by the operation of VEGP Units 3 and 4. Consequently, the staff determined the operations impacts to onsite and offsite buildings would be SMALL and not require mitigation.

5.5.1.3 Roads

Roads within the vicinity of the VEGP site would experience an increase in traffic at the beginning and the end of each operations shift and the beginning and end of each outage support shift. Commuter traffic would be controlled by speed limits. The access roads to the VEGP site would be paved. Maintaining good road conditions and enforcing appropriate speed limits would reduce the noise level and particulate matter generated by the workforce commuting to and from the VEGP site. Therefore, the staff determined the road-related impacts from noise and dust to workers, residents, and other users of the roads within the vicinity of the proposed site would be SMALL and would not require mitigation.

5.5.1.4 Aesthetics

The nearest residence is more than 1.6 km (1 mi) from the site of the proposed new units, separated by forested land such that the proposed units would not be clearly visible from its location. The proposed intake structure would be clearly visible from the Savannah River, and the new 180-m (600-ft) towers and the top of the new containment domes would be visible from some locations on the river, as well as their vapor plumes, which would resemble cumulus clouds. The plumes would be most noticeable in the winter months and may extend more than 10 km (6 mi) from the site. Section 5.2 of this EIS describes these impacts in more detail. Given the site has already been affected by the presence of two reactors and cooling towers, the staff believes the marginal aesthetic impact of the new reactors and cooling towers would be SMALL and would not require mitigation.

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Once the new units are operational, the power would be transmitted via new 500-kV transmission lines. The new transmission line right-of-way would be routed northwest of the VEGP site to the Thomson-Vogtle Substation northwest of Augusta, Georgia. The new right-of-way would be approximately 46 m (150 ft) wide and 100 km (60 mi) long (Southern 2007a), and would require approximately 390 metal-lattice towers (Southern 2007a). MODERATE aesthetic impacts are expected due to the presence of this new transmission line and right-of-way.

5.5.1.5 Summary of Physical Impacts

Based on the information provided by Southern, staff interviews with local public officials, and NRC's own independent review, the staff concludes that the physical impacts of operation of the proposed new units would be SMALL, except for aesthetics, which would be MODERATE along the transmission lines. Thus, additional mitigation measures beyond those identified by Southern are not warranted.

5.5.2 Demography

Based on U.S. Census bureau estimates, approximately 670,000 people lived within an 80-km (50-mi) radius of the VEGP site in 2000 and this population is estimated to grow annually by an average rate of 2.1 percent between 2000 and 2090, increasing the population to approximately 4.5 million in 2090 (see Table G-3 in Appendix G).^(a) Southern anticipates employing 812 operations workers at the new units (Southern 2008b). Although it is likely that some employees would already reside within a reasonable commuting distance to the plant, to estimate the maximum demographic impacts from operations, the staff assumed all of the new operations employees and their families would migrate into the region from other locations. The average household size in Georgia and South Carolina are 2.65 and 2.53, respectively. The staff used the average Georgia household size (2.65 persons) to determine that the increase in the operational workforce of 812 would increase the population in the 80-km (50-mi) region by approximately 2152 people.

The staff assumed the distribution of new operations workers and their families would resemble the residential distribution of employees operating VEGP Units 1 and 2. Therefore, approximately 80 percent would likely reside in Burke (about 350 people), Columbia (732 people), and Richmond Counties (560 people) (see Table 2-15). For each of these counties, the increase in population would constitute less than 2 percent of the 2000 populations. The staff assumes the remaining 20 percent of operations employees and their families would be scattered throughout the other 23 counties within the 80-km (50-mi) radius of the VEGP site, and would represent a small fraction of each community's population. Table 5-5 displays the assumed distribution of new workers in tabular form.

(a) Further detail regarding the population projection methodology used for the sector population analysis is provided in Section 2.5 of Southern's ER (Southern 2008a).

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Based on the information provided by Southern, NRC staff interviews with local public officials, and NRC's own independent review, the staff concludes that the demographic impacts of operation of the new unit or units at the VEGP site would be SMALL.

5.5.3 Economic Impacts to the Community

The impacts of station operation on the local and regional economy are dependent on the region's current and projected economy and population. Although future impacts cannot be predicted with certainty, some insight can be obtained for the projected economy and population by consulting with county planners and population data. The economic impacts over a 40-year period of station operation are qualitatively discussed. The primary economic impacts from employing 812 new workers to operate the proposed VEGP Units 3 and 4 would be related to taxes, housing, and increased demand for goods and services, with the largest impact associated with plant property tax revenues (discussed in 5.5.3.2).

Table 5-5. Potential Increase in Resident Population Resulting from Operating the Proposed VEGP Units 3 and 4

County	Percent of Current VEGP Site Workforce by Location	VEGP Units 3 and 4-Related Increase in Population	Year 2000 U.S. Census Population	Percentage Increase in Resident Population
Columbia	34	732	89,288	0.82
Richmond	26	560	199,775	0.28
Burke	20	430	22,243	1.93
Screven	7	151	15,374	0.98
Aiken	4	86	142,552	0.06
Jenkins	2	43	8,575	0.50
Jefferson	2	43	17,266	0.25
Emanuel	1	21	21,837	0.10
Bulloch	1	21	55,983	0.04
Other 19 Counties	3	65	97,107	0.07
Total	100.0	2152		

Source of resident locations: Southern 2008a

Source of Year 2000 U.S. Census Population: USCB 2007

5.5.3.1 Economy

The staff estimated the potential social and economic impacts on the surrounding region as a result of operating the proposed two new reactors at the VEGP site, assuming a 40-year operating license. Social and economic impacts would occur from additional operation workforce jobs, tax revenue impacts, and increased population because of in-migrating workers and their families.

Section 2.8 of this EIS presents a detailed description of local and regional employment trends. The 80-km (50 mi) region of interest has a relatively diverse and stable economy, with a steady

growth in the number of jobs for Burke, Columbia, and Richmond Counties in the last decade. The 812 new jobs at VEGP would represent less than 1 percent of the total current workforce in the three county region (Burke-Columbia-Richmond). However, in Burke County, where the plant is located, the 812 additional jobs currently represents a 8.7 percent increase in the total number of jobs. Burke County would be the most impacted, as it would likely receive the largest population and workforce increase as a percentage of its base population and workforce, and it would also receive the substantial property tax benefits (discussed in 5.5.3.2 of this chapter). Outside of Burke County, the impacts become diffuse as a result of interacting with the larger economic base of the surrounding counties and the city of Augusta.

The operation of two new units at the VEGP site would also result in roughly doubling the workforce needed for scheduled outages. VEGP Units 1 and 2 each undergo a scheduled refueling outage every 18 months. Once the proposed VEGP Units 3 and 4 are operational, the refueling outages would occur at least annually, and sometimes semiannually, which would require as many as 1000 (maximum estimate) additional short-term (3- to 5-week) contract employees to perform equipment maintenance, refueling, and special outage projects at the VEGP site. Most of the outage workers would stay in local hotels, rent rooms in local homes, or bring travel trailers so they can stay as close as possible to the VEGP site. In the town of Waynesboro, which is the closest town to the VEGP site, all available hotel rooms are filled to capacity during outages. This would now likely occur twice as often, increasing hotel and restaurant revenues, as well as other retail establishments that provide services to these temporary workers. Outside of Burke County, the impacts become more diffuse because of each area's larger economic base with more available hotel rooms and temporary housing.

The overall impact on the economy of the region from operating two new units at the VEGP site would be positive. The most pronounced economic impacts would occur in Burke County, where impacts could be MODERATE, while SMALL positive economic impacts may occur in other nearby counties within commuting distance of the plant.

5.5.3.2 Taxes

Sales, Use, Income, and Corporate Taxes

To the extent the new operations employees would move into the area surrounding the proposed site from other states, the counties within the 80-km (50-mi) radius of the plant in Georgia and South Carolina would experience an increase in sales and use tax, and income tax revenues; however, these tax payments go to general State funds, and the marginal tax revenue impact at the regional level would be negligible.

GPC would also pay the State of Georgia a corporate income tax on the profits received from the sale of electricity generated by the new units, and the tax revenue impact on the region from increased sales, use, income, and corporate taxes would not be noticeable at a regional level.

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Property Taxes

One of the primary sources of economic impact related to the operation of new units would be property taxes assessed on the facility. Currently Southern's tax payments represent 80 to 82 percent of the total property taxes received by Burke County (see Table 2-16). Property taxes that would be paid by the co-owners for the two new units during operations depend on many factors, most of which are unknown at this time, including future millage rates. Southern made simplifying assumptions to develop an estimate of tax payments based on the estimated value of the reactors. Table 5-6^(a) provides an estimate of the tax payments for the proposed VEGP Units 3 and 4 throughout the life of the plant.

Table 5-6. Range of Estimated Annual Property Taxes Paid to Burke County Generated by the Proposed VEGP Units 3 and 4

Years of Operation	Estimated Range	
	Lower Range (\$)	Upper Range (\$)
2015-2024	20,000,000	29,000,000
2025-2034	16,000,000	23,000,000
2035-2044	10,000,000	14,000,000
2045-2054	3,500,000	5,000,000

Source: Southern 2008a

In addition to the property taxes paid on the value of the plant itself, Burke, Columbia, and Richmond Counties could experience an increase in property tax revenues on new homes, if the influx of workers results in any new residential construction and/or increases in existing home prices; however, this overall impact would likely be small, since the operations workforce and their families would only make up a small percentage of the existing population in the region (see Section 5.5.4.3 of this EIS).

Summary of Tax Impacts

The NRC staff expects tax revenue increases in the form of sales, use, income, and corporate taxes, because of the operation of the proposed VEGP Units 3 and 4 and the influx of operations workforce into the region. This impact, however, is likely to be SMALL at a regional level. Burke County would experience a LARGE beneficial property tax revenue increase.

(a) These assumptions used to calculate future property taxes on VEGP Units 3 and 4 are detailed in Southern's ER, Section 5.8.2.2.2. The taxable value is assumed to depreciate throughout the life of the plant (Southern 2008a)

5.5.3.3 Summary of Economic Impacts

Based on the information provided by Southern, NRC staff interviews with local public officials, and NRC's own independent review of data on the regional economy and taxes, the staff concludes that the impacts on the regional economy of operating the proposed units at the VEGP site would be SMALL and beneficial for all counties except Burke County, which would experience a LARGE beneficial impact under current Georgia tax law.

5.5.4 Infrastructure and Community Services

Infrastructure and community services include transportation, recreation, housing, public services, and education. The operation of two new units at the VEGP site would impact the transportation network as the additional workforce uses the local roads to commute to and from work and possibly additional truck deliveries are made to support operation of the new units. These same commuters could also potentially impact recreation in the area. As the workforce in-migrates and settles in the region, there may be impacts on housing, education, and public sector services.

5.5.4.1 Transportation

Similar to the impacts discussed in Section 4.5.4, the impacts of the two new units' operations on transportation and traffic would be greatest on the roads of Burke County, particularly River Road, a two-lane highway that provides the only access to the VEGP site. Beyond River Road, traffic is disbursed in several directions and capacity increases as the roads approach Richmond and Columbia Counties; thus, the focus of the impact analysis is on River Road. To enter the plant, the workforce would use the current access road that has a left turn lane from River Road.

As discussed in Section 4.5.3 of this EIS, the staff assumed current peak traffic on River Road is 1200 cars per hour, both directions. The current capacity of River Road is 3200 cars per hour and there is enough capacity for an additional 2000 passenger cars per hour. The existing workforce of 890 for VEGP Units 1 and 2 also accesses the VEGP site via River Road. Traffic congestion would be most noticeable during shift-change, which would occur three times a day. The number of new operations workers per shift is assumed to be similar, in percentage, to the current operations workforce. Therefore, during the afternoon shift change, approximately 60 percent of the 812 operations workers would leave the VEGP site while 30 percent would arrive. Including both existing workforce (operating VEGP Units 1 and 2), and the additional workforce employed to operate the proposed VEGP Units 3 and 4, the peak level number of vehicles per hour would be approximately 2000 vehicles in both directions (assuming baseline of 1200 cars per hour), which is still well within the 3200-vehicles-per-hour capacity (Southern 2008a; 2008d).

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During outages, there could also be as many as 1000 outage workers per unit (divided between two shifts) for approximately 1 month annually or semiannually, increasing the vehicles on River Road by approximately 600. During outages, traffic on River Road could be as high as 2600 vehicles per hour, which would noticeably increase congestion on the road, but still remain within the road's capacity.^(a)

To reduce congestion on River Road during the construction phase, Southern would already have implemented several permanent transportation mitigation measures that would minimize most bottlenecks, and because the current road network has sufficient capacity to accommodate the expected increase in traffic, the estimated workforce of 812 persons is expected to have a SMALL effect on the transportation network in the vicinity.

5.5.4.2 Recreation

A detailed description of local tourism and recreation is provided in Section 2.8. The primary impacts on recreation would be similar to, but smaller than, those impacts described for the construction of two new units in Section 4.5.4.2. The impacts on recreation within 80 km (50 mi) of the VEGP Site are expected to be SMALL.

5.5.4.3 Housing

Section 2.8.2 states there were 4466 vacant rental units and 1997 vacant housing units for sale in Burke, Richmond, and Columbia Counties in 2000. There is currently enough available housing to support the maximum influx of workers and their families (2152 total people) into the region, particularly in Burke, Richmond, and Columbia Counties where most of the workers are expected to reside. Burke County, which would likely receive the highest percentage of in-migrating workers relative to the available housing stock, may experience a noticeable increase in housing demand as well as a possible shift in demand toward relatively higher-value houses.^(b) A number of new housing developments currently in the works, however, could alleviate some of this short-term pressure on housing demand. The overall impact on housing demand and prices from plant operations over the expected 40-year operation of the plant in the region would likely be SMALL.

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- (a) VEGP Units 1 and 2 each have a scheduled outage every 18 months. There would be four as many outages every 18 months once Units 3 and 4 become operational (Southern 2006b). During outages plant operation staff and outage workforce are on 12-hour shifts, 24-hours per day and 7 days per week. The outage shifts are staggered with start/end times between 6-7:00 am and 6-7:00 pm (Southern 2006a)
- (b) General housing outlook based on an interview with Cathy Hawkins of Cox Real Estate, 259 S. Liberty Street, Waynesboro, Georgia, where the housing market in Burke County was described as "tight," especially for newer, higher-value homes (October 19, 2006).

The VEGP site would need as many as 1000 additional outage workers for a period of 30 to 40 days during each outage to maintain the two new reactors. The outages for the new units would be staggered with the other units. The temporary outage workers for the existing VEGP reactors typically stay in area hotels or recreational vehicles dispersed throughout the region; therefore, no single community would be overburdened by the influx of temporary workers. In the town of Waynesboro, however, all available hotel rooms are filled to capacity during the current outages and once the proposed VEGP Units 3 and 4 become operational, this would occur twice as often. This influx of temporary workers would not be expected to impact the permanent housing stock or housing market in the region.

5.5.4.4 Public Services

Water Supply Facilities

The VEGP site does not use water from a municipal system. Instead, the VEGP site relies on a series of onsite wells to provide potable water to support the operational workforce and operations of its existing two units. The VEGP site has permits to extract up to 20.8 million L/d (5.5 MGD) from these wells, but has typically drawn an average of 3.7 million L/d (1.05 MGD). As discussed in its ER, Southern expects those wells to provide the additional potable water demand for operation of the two proposed units, as well (Southern 2007a). Section 5.4.2 of this EIS provides more detail on plant water usage.

The average per capita water usage in the United States is 340 L/d (90 gal/d) per person, 98 L (26 gal) for personal use and the rest for bathing, laundry, and other household uses (EPA 2003). Therefore, the new operations workforce and their families would require an additional 731,680 L/d (193,290 gpd) of potable water. Section 2.8 describes the public water supply systems in the analytical area, their permitted capacities, and current demands. Municipal water suppliers in the region have excess capacity (see Table 2-20; 2-21) with the excess public water capacity in Burke County at approximately 15 million L/d (4 MGD). Therefore, the expected impact on potable water demand in the analytical area from the in-migration of operations workers and their families would be SMALL and not require mitigation.

Waste Water Treatment Facilities

The VEGP site has a private wastewater treatment facility for the two existing units. As part of the new units' construction project, the facility would be expanded to support the increased capacity of the additional units. Therefore, operations would not impact the VEGP site wastewater treatment facility.

Section 2.8 describes the public wastewater treatment systems in the three counties, their permitted capacities, and current demands. Wastewater treatment facilities in the three counties have excess capacity (see Table 2-21). Assuming 100 percent of the water consumed would be disposed of through the wastewater treatment facilities, the proposed VEGP Units 3

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and 4 plant operations-related population increase of 2152 people would require 731,680 L/d (193,290 gpd) of additional wastewater treatment capacity in an area where the excess treatment capacity is approximately 72 million L/d (19 mgd). Therefore, the staff determined the impact on wastewater treatment from the in-migration of operations workers and their families would be SMALL and not require mitigation.

Police and Fire Services

Given the staff expects the increase in population for any given county to be less than 2 percent (see Section 5.5.2), the impact of new operations workers and their families on police and fire services would fall well within the expected population growth planned by their local governments. Therefore, the in-migration of operations workers would have a SMALL impact and not need mitigation.

Medical, Health and Human Services

Section 4.5.4.4 describes the level of medical and human services within the region of interest, which the staff determined is sufficient to absorb the operations-related influx of workers. New jobs created to operate and maintain the proposed new reactors would benefit the disadvantaged population served by the state health and human resources offices by adding some additional jobs to the region which may go to people who are currently under employed or unemployed, removing them from social services client lists. While the influx of new workers and their families may also create additional pressure on those same social services, the NRC staff believes the net effect of the new permanent operations workforce on local and state welfare and social services would be SMALL and beneficial.

5.5.4.5 Education

Section 5.5.2 discusses the staff's underlying assumptions about the distribution of workers' families within the 80-km (50-mile) radius area around the proposed site. These assumptions indicate the expected increase in population for any given county within the analytical area would be less than 2 percent. This rate is well within the planned growth rate for each county government and would, therefore, have a SMALL impact that the NRC staff does not believe would require mitigation.

For the counties expected to have the largest increase in population, the Burke County School District currently operates with an excess capacity that could support up to an additional 800 students.^(a) Although the Richmond and Columbia County school districts do not operate with excess capacity, the number of potential new students from the proposed VEGP site expansion, relative to the total enrollment in their districts is relatively small. Columbia County school capacity is driven by the rapid residential growth in the area. For the 2004 to 2006

(a) Information provided by Wilbert Roberts, Burke County School District Assistant Superintendent, in e-mail message, March 6, 2007.

school years, enrollment has increased by more than 800 students each year. Therefore, all of the school-aged children that might move to the area as a result of the proposed VEGP Units 3 and 4 operations at the VEGP site would be absorbed as part of Columbia County's rapid growth rate. The Richmond School District is the largest of the three districts and the increase in the total number of students expected to enroll due to VEGP operations would be insignificant relative to total enrollment levels.

5.5.4.6 Summary of Infrastructure and Community Services

Based on information supplied by Southern, staff interviews conducted with and information solicited from public officials in Burke, Screven, Columbia and Richmond Counties, and staff review of data concerning the current availability of services and current State and community planning efforts, the staff concludes that the operation impacts on the regional infrastructure and community services would be SMALL throughout the region. The estimated workforce of 812 persons would have a SMALL effect on the local transportation network. The site is relatively isolated, industrial in nature, and well masked by forest in most directions so the impacts on aesthetics would be SMALL, as would the impacts on recreation. The impacts on public services and infrastructure would be SMALL.

5.5.5 Summary of Socioeconomic Impacts

Based on information supplied by Southern, staff interviews conducted with public officials in Burke, Screven, and Richmond Counties concerning the current availability of services, and additional taxes that would likely compensate for the need for additional services, the staff concludes that the operations impacts on the local economy would be beneficial and SMALL in most of the region and probably MODERATE and beneficial in Burke County. The estimated workforce of 812 would have a SMALL effect on the transportation network in the vicinity and region because permanent transportation mitigation measures proposed for the construction of the new unit or units would also result in much reduced transportation-related impacts during operation of the new unit or units. The effect on tax revenues would be beneficial and SMALL except for property tax receipts in Burke County, which could be beneficial and LARGE. The impacts on public services and infrastructure would be SMALL throughout the region.

5.6 Historic and Cultural Resource Impacts from Operations

The National Environmental Policy Act of 1969, as amended (NEPA) requires Federal agencies to take into account the potential effects of their undertakings on the cultural environment, which includes archaeological sites, historic buildings, and traditional places important to local populations. The National Historic Preservation Act of 1966, as amended through 2000 (NHPA), also requires Federal agencies to consider impacts to those resources if they are eligible for listing on the National Register of Historic Places (such resources are referred to as "Historic Properties" in NHPA). As outlined in 36 CFR 800.8(c), "Coordination with the National

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Environmental Policy Act of 1969," the NRC coordinated Section 106 compliance with NEPA compliance.

The NRC has determined that evaluating suitability of the existing VEGP site for construction, operation, and decommissioning of two new units is an undertaking that could possibly affect either known or potential historic properties that may be located at the site. Therefore, in accordance with the provisions of NHPA and NEPA, the NRC is required to make a reasonable and good faith effort to identify historic properties in the areas of potential effect and, if present, determine if any significant impacts are likely to occur. Identification is to occur in consultation with the State Historic Preservation Officer (SHPO), American Indian tribes, interested parties, and the public. If significant impacts are possible, efforts should be made to mitigate them. As part of the NEPA/NHPA integration, if no historic properties (i.e., places eligible for listing on the National Register of Historic Places) are present or affected, the NRC is required to notify the SHPO before proceeding. If it is determined that historic properties are present, the NRC is required to assess and resolve adverse effects of the undertaking.

For specific historic and cultural information on the VEGP site, see Section 2.9.2.

The staff does not expect any significant impacts on historic and cultural resources during operation of the new units. Any new ground-disturbing activities that might occur during operation would follow Southern procedures, which would require further evaluation to determine if additional archaeological review is necessary (Southern 2008a). Therefore, the staff concludes that the impacts from operations would be SMALL. Mitigation might be warranted in the event of an unexpected discovery.

5.7 Environmental Justice

Environmental justice refers to a Federal policy under which each Federal agency identifies and addresses disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority or low-income populations. On August 24, 2004, the Commission issued its policy statement on the treatment of environmental justice matters in licensing actions (69 FR 52040). Section 2.10 discusses the locations of minority and low-income populations around the VEGP site and within the 80-km (50-mi) radius.

The scope of the review as defined in NRC guidance (NRC 2001, 2004a; 69 FR 52040) should include an analysis of the impacts on minority and low-income populations, the location and significance of any environmental impacts during operations on populations that are particularly sensitive, and any additional information pertaining to mitigation. The descriptions to be provided by this review should state whether the impacts are likely to be disproportionately high and adverse. The review should also evaluate the significance of such impacts.

The staff evaluated whether the health or welfare of minority and low-income populations at those census blocks identified in Section 2.10 of this EIS could be disproportionately affected by

the potential impacts of operating two new reactors at the proposed site. To perform this assessment, the staff used the same process employed in Section 4.7.

5.7.1 Health and Environmental Impacts

The results of the normal operation dose assessments presented in Section 5.9 indicate that the maximum individual dose for these pathways was found to be insignificant, well below the regulatory guidelines in Appendix I of 10 CFR Part 50 and the regulatory standards of 10 CFR Part 20.

The evaluation of postulated accidents is provided in Section 5.10 and demonstrates that radiological consequences of these accidents would meet the site acceptance criteria of 10 CFR 50.34 and 10 CFR Part 100 for the exclusion area boundary and low population zone boundary. In demonstrating compliance with these criteria, an adequate level of protection would be provided. There would be no significant adverse health impacts on members of the public, and, therefore, there would be only minimal negligible health impacts on minority and low-income members of the public.

Environmental Impacts

Soil: As discussed in Section 5.8, the staff does not believe there would be any operations-related environmental effects to soils at the VEGP site that would impact nearby residents. Therefore, the staff believes there can be no disproportionate impact on any minority or low-income population. Similarly, while the proposed new units would generate low-level radioactive and non-radioactive wastes, these are currently generated and there are existing facilities located throughout the country permitted for disposing of these materials. Consequently, the staff determined the marginal impact to soils from the proposed new units would be SMALL and not require mitigation.

Water: As discussed in Sections 5.3.3 and 5.4.2, the staff determined the two proposed units at the VEGP site would operate with a very small thermal plume in the Savannah River and that concentrations of biocides, anti-scaling compounds and dispersants would be very small and greatly diluted by the volume of flow in the Savannah River. Consequently, the concentration of these chemicals in the river should quickly return to near-background levels (Southern 2008a). Therefore, the impact to aquatic biota would be negligible.

Under normal plant operation, consumptive losses of the proposed VEGP Units 3 and 4 would account for less than 2 percent of the flow of the Savannah River, even under drought conditions (see Table 5-2), and are too small to affect recreational activities on the river.

The VEGP site has three groundwater wells drawing from the Cretaceous aquifer, each of which are capable of producing 63 to 126 L/s (1000 to 2000 gpm), and under normal operating

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conditions for the two existing units and the two proposed units, the total pumping rate would be about 93.5 L/s (1482 gpm). The closest of the existing Cretaceous aquifer wells is 1737 m (5700 ft) from the facility boundary. Southern has stated that two new wells may be drilled and completed to supply groundwater, and the proposed well location closest to the facility boundary is 1067 m (3500 ft). The pumping rate would drawdown the level of the Cretaceous aquifer by slightly more than 1.8 m (6 ft) at the 1737-m (5700-ft) distance and nearly 2 m (6.5 ft) at the 1067-m (3500-ft) distance by 2045 for the proposed two new reactors. There are an additional six wells completed in the Tertiary aquifer that currently provide a small amount of water for ground site support purposes.

The staff determined that given the relatively small impact on water quantity and quality in the Savannah River, and the small consumptive water use and the drawdown on the Cretaceous aquifer, there would be no operations-related environmental effects that need to be mitigated and, therefore, there cannot be any disproportionate adverse impacts on minority and low-income populations.

Air: The total liquid and gaseous effluent doses from all four units (the two existing units plus the two proposed units) would be well within the regulatory limits of 40 CFR 190. As described in Section 5.5.2, the staff concurs with Southern's findings that the potential impacts from all potential air medium sources would be small. Furthermore, the staff believes that because these impacts would be small, there would be no disproportionate and adverse impacts felt by minority or low-income populations within the analytical area.

5.7.2 Socioeconomic Impacts

The staff determined that once the proposed new units are operational at the VEGP site, any adverse socioeconomic impacts felt by any group within the region of interest would either stop or significantly diminish when the construction workforce leaves the region. However, offsetting the departure of the construction workforce would be the in-migration of the permanent operations workforce that would operate and maintain the two new reactors. While the addition of these new employees would place pressure on local infrastructures (schools, hospitals, etc.), the staff believes any adverse impact the in-migration might create would be overwhelmed by the positive contributions of that workforce to their new local communities through income and taxes. Furthermore, the staff's interviews of surrounding communities revealed a high level of preparedness with regard to any potential influx of temporary construction or permanent operations workers.

5.7.3 Subsistence and Special Conditions

This segment of the staff's environmental justice analysis was performed under the same authority and requirements as that performed in Section 4.7 of this EIS.

Subsistence

Fish advisories from the States of Georgia and South Carolina indicate that consumption of some species, especially predatory species, can carry levels of radioactive contamination that could be harmful if ingested. However, an extensive investigation by the Institute for Energy and Environmental Research indicates only a small amount of the radiological contamination (primarily tritium) in the Savannah River and its organisms can be attributed to the existing VEGP (Makhijani et al. 2004). The addition of the proposed VEGP Units 3 and 4 is not expected to significantly increase the level of radioactive contamination in the Savannah River. Therefore, the staff has identified no reason to believe that subsistence consumption of fish species from the Savannah River would present a health problem for minority and low-income populations, but even if that were the case, it would not be attributable to the existing reactors and cannot be reasonably projected to be exacerbated by the addition of two more reactors at the site. The staff determined there were no operations-related disproportionate and adverse impacts on minority or low-income populations related to subsistence.

High Density Communities

There are no Native American communities within the region of interest, and while some existing communities within the area exhibit disproportionately high percentages of minority (primarily Black races) and low-income populations, most of the higher percentages of minority and low-income populations can be attributed to the sparseness of the rural population in general. This was reinforced for the staff through a series of interviews with minority leaders and social service agency representatives in the affected counties, all of whom described the minority and low-income communities as "scattered" throughout the counties with no heavy concentrations in any one particular area.^(a) Therefore, the staff determined there were no environmental justice effects to consider with respect to densely populated minority or low-income communities.

5.7.4 Summary of Environmental Justice Impacts

Based on the underlying assumptions of the analysis discussed in Section 2.10, the impacts of plant operations on environmental justice would be SMALL because no environmental pathways, health characteristics, or other preconditions of the minority and low-income population were found that would lead to adverse and disproportionate impacts.

(a) Personal communication (phone interview) on October 9, 2006, with Reverend Robert Lynch, pastor of Bethel Apostolic Church, Waynesboro, Georgia, and head of the Burke County Citizens Hunger Action Committee (affiliated with the Golden Harvest Food Bank). Also confirmed in interviews with Screven County Family Services (with Bill Hillis), October 18, 2006, and Burke County Family Services (with Ms. Alane Hickman), October 19, 2006.

5.8 Nonradiological Health Impacts

This section addresses the health impacts of operating the proposed new units at the VEGP site from nonradiological parameters. Health impacts to the public from the cooling system, noise generated by operations, EMFs, and transporting operations and outage workers are discussed. Health impacts from the same sources are also evaluated for workers at the new units. Health impacts from radiological sources during operations are discussed in Section 5.9.

5.8.1 Thermophilic Microorganisms

Operation of VEGP Units 3 and 4 would result in a thermal discharge to the Savannah River (Southern 2008a). Such discharges have the potential to increase the growth of thermophilic microorganisms, including etiological agents, both in the circulating water system and the river. Thermophilic microorganisms include enteric pathogens such as *Salmonella* spp., *Pseudomonas aeruginosa*, thermophilic fungi, bacteria such as *Legionella* spp., and free-living amoeba such as *Naegleria fowleri* and *Acanthamoeba* spp. These microorganisms could result in potentially serious human health concerns, particularly at high exposure levels.

As described in the NUREG-1437 (NRC 1996), nuclear power plants that use cooling ponds, lakes, or canals and those that discharge to "small rivers" have the greatest chance of affecting the public from increases in thermophilic microbial populations. A small river is defined as one with an average flow rate of less than 2800 m³/s (100,000 ft³/s). The monthly average flow rates of the Savannah River between the years 1985 and 2005 ranged from about 200 to 400 m³/s (7000 to 14,000 ft³/s), which meets the criterion of a small river (Southern 2008a). The maximum projected cooling tower blowdown from operating two new units is about 1.81 m³/s (64 ft³/s), which is less than 1 percent of the minimum monthly average flow rate of the Savannah River (Southern 2008a). Modeling performed by Southern (2008a) using the CORMIX mixing zone model predicted a maximum blowdown temperature of 33.1°C (91.5°F) and a negligible impact on Savannah River temperature below the discharge outfall. In the vicinity of the existing and proposed discharge structures, there are limited recreational activities (e.g., boats may pass through), and the area is not commonly used for swimming.

Available data assembled by the U.S. Centers for Disease Control and Prevention (CDC) for the years 1937 to 2007 (CDC 1997, 1998, 1999, 2001, 2002a, 2003a, 2004, 2005, 2006, 2007, 2008), and from the States of Georgia and South Carolina for the years 2001 to 2006 (GDHR 2002, 2006; SCDHEC 2007), report a single occurrence of a waterborne disease in August 2002 resulting from exposure to *N. fowleri* of an 11-year old boy who had swum in a river in southern Georgia along with 9 other individuals (CDC 2004). In early September 2002, the Georgia Division of Public Health and CDC were notified that this exposure had resulted in a fatal case of primary amebic meningoencephalitis (PAM) (CDC 2003b). The environmental investigation revealed a high ambient air temperature (>32°C [>90°F]) and water temperature

(33°C [91°F]) in the river at the time of the exposure and that because no recent rainfall had occurred in the region, the river level was low, and the river was flowing slowly (CDC 2003b). Based on bacteriologic testing of the river water, fecal coliform levels were found to be within acceptable limits. *Naegleria fowleri* was isolated from two of three river water samples tested as well as from a control sample taken from a local lake (CDC 2003b). During 1989 to 2000, the CDC waterborne-disease outbreak surveillance system documented 24 fatal cases of PAM in the United States, this being the first case in Georgia since 1987 (CDC 2002b). Outbreaks of Legionellosis, Salmonellosis, or Shigellosis that occurred in Georgia or South Carolina were within the range of national trends (CDC 1997, 1998, 1999, 2001, 2002a, 2003a, 2004, 2005, 2006, 2007) in terms of cases per 100,000 population or total cases per year, and the outbreaks were associated with pools, spas, or lakes.

Epidemiological reports from the States of Georgia and South Carolina indicate a very low risk of outbreaks from thermophilic microorganisms associated with thermal discharges (GDHR 2002, 2006; SCDHEC 2007). Notably, there have been up to 40 cases per year of Legionellosis reported statewide in Georgia during the last 10 years and only one case of exposure to *N. fowleri* reported statewide during the last 5 years. During the period 2004 to 2006, counties in Georgia within the vicinity of VEGP reported Legionellosis in Jefferson County (6 cases) and Chatham County (9 cases), with no cases reported in Burke, Columbia, Emanuel, Effingham, Jenkins, McDuffie, Richmond, or Screven Counties. In South Carolina, up to 22 cases per year of Legionellosis have been reported statewide since 1995. For South Carolina counties in the vicinity of VEGP, Aiken County reported one case in 2004, and Barnwell County reported one case in 2006, with no cases reported in Allendale, Edgefield, Hampton or Jasper Counties during 2003 to 2006. No reported cases of exposure to *N. fowleri* in South Carolina were identified during the last 5 years.

Based on the historical low incidence of primary amoebic meningoencephalitis (PAM) in Georgia, the small temperature increase expected as a result of operating the new nuclear units, and the relative absence of swimming or other activities resulting in immersion in the water in the vicinity of the existing and proposed discharge structures, the staff concludes that the impacts on human health would be SMALL and that no mitigation would be warranted.

5.8.2 Noise

In the GEIS (NRC 1996), the staff discusses the environmental impacts of noise at existing nuclear power plants. Common sources of noise from plant operation include cooling towers, and transformers, with intermittent contributions from loud speakers and auxiliary equipment such as diesel generators. These noise sources are discussed in this section.

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The existing units at the VEGP site use natural draft cooling towers. According to the ER (Southern 2008a), there have been no complaints. According to the ER (Southern 2008a) and Westinghouse (2003), noise levels from cooling towers and diesel generators at new units could have noise levels as high as 55 dBA at a distance of 300 m (1000 ft). The nearest site boundary is more than 460 m (1500 ft) from the planned cooling tower location (Southern 2008a). At this distance, cooling tower and generator noise would be expected to about 51 dBA, not considering attenuation because of vegetation and topography. Similarly, the 55 dBA at 300 m (1000 ft) translates to about 41 dBA at about 1.6 km (1 mi), the approximate distance to the nearest residence (Southern 2008a).

According to the GEIS (NRC 1996), noise levels below 60 to 65 dBA are considered to be of small significance. More recently, the impacts of noise were considered in the *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities* (NUREG-0586, Supplement 1) (NRC 2002a). The criterion for assessing the level of significance was not expressed in terms of sound levels but based on the effect of noise on human activities and on threatened and endangered species. The criterion in NUREG-0586, Supplement 1, is stated as follows:

The noise impacts ... are considered detectable if sound levels are sufficiently high to disrupt normal human activities on a regular basis. The noise impacts ... are considered destabilizing if sound levels are sufficiently high that the affected area is essentially unsuitable for normal human activities, or if the behavior or breeding of a threatened and endangered species is affected.

The noise sources at the VEGP site are sufficiently distant from the plant boundaries that the noise generated by the plant is attenuated to near-ambient levels before reaching critical receptors outside the plant boundary.

Given the postulated noise levels for cooling towers and diesel generators at the VEGP ESP site, the staff concludes that the noise impacts would be SMALL and that mitigation would not be warranted.

5.8.3 Acute Effects of Electromagnetic Fields

In its ER, Southern states that two 500-kV transmission lines would service new generation at the VEGP site (Southern 2008a). The applicant then evaluates electric shock potential of a template 500-kV line built to present National Electrical Safety Code (NESC) standards as a surrogate design for all spans. On this basis, the applicant concludes that an induced current for a vehicle parked beneath a single 500-kV transmission line could be as high as 3.8 milliamp. The induced current for a vehicle parked beneath two 500-kV transmission lines could be higher or lower, depending on the configuration of the lines. Finally, the applicant commits to design any new transmission lines to ensure that two lines combined would be in compliance with the

5-milliamp standard in the present NESC. The staff assumes that transmission lines constructed to serve new generation at the VEGP site would be constructed to meet NESC criteria for construction and operation of transmission lines at the time of construction.

For the template span, the present NESC requirements for preventing electric shock from induced current were met. With the applicant's commitment to design new transmission lines to ensure that the present NESC criteria are met when two transmission lines are combined and the staff's assumption that transmission lines constructed to serve new generation at the VEGP site would be constructed to NESC standards in effect at the time of construction, the staff concludes that the impact to the public from acute effects of EMFs would be SMALL, and additional mitigation would not be warranted.

5.8.4 Chronic Effects of Electromagnetic Fields

Research on the potential for chronic effects from 60-Hz EMFs from energized transmission lines was reviewed and addressed by the NRC in the NUREG-1437 (NRC 1996). At that time, research results were not conclusive. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the U.S. Department of Energy. An NIEHS report (1999) contains the following conclusion:

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

This statement is not sufficient to cause the staff to consider the potential impacts as significant to the public. The staff will continue to follow developments in this area.

5.8.5 Occupational Health

In general, occupational health risks for new units are expected to be dominated by occupational injuries (e.g., falls, electric shock, asphyxiation) to workers engaged in activities such as maintenance, testing, and plant modifications. Historically, actual injury and fatality rates at nuclear reactor facilities have been lower than the average U.S. industrial rates. Further, Southern (2008a) reports that the incidence rate of total recordable cases at the VEGP site from 2000 to 2004 was 1.8 percent, which was less than the corresponding incidence rates for the State of Georgia and the United States for electrical power production workers (4.5 and 3.5 percent). Occupational injury and fatality risks are reduced by strict adherence to NRC and

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Occupational Safety and Health Administration (OSHA) safety standards (29 CFR Part 1910), practices, and procedures. Appropriate State and local statutes must also be considered when assessing the occupational hazards and health risks for new nuclear unit operation. The staff assumes adherence to NRC, OSHA, and State safety standards, practices, and procedures during new nuclear unit operations.

Additional occupational health impacts may result from exposure to hazards such as noise, toxic or oxygen-replacing gases, thermophilic microorganisms in the condenser bays, and caustic agents. Southern (2008a) reports that it maintains a health and safety program to protect workers from industrial safety risks at the operating units and would implement the program for the proposed new units. Health impacts to workers from nonradiological emissions, noise, and EMFs would be monitored and controlled in accordance with the applicable OSHA regulations and would be SMALL.

5.8.6 Impacts of Transporting Operations Personnel to the VEGP Site

The general approach used to calculate nonradiological impacts of fuel and waste shipments is the same as that used to calculate the impacts of transporting operations and outage personnel to and from the VEGP site. However, preliminary estimates are the only data available to estimate these impacts. The assumptions made to fill in reasonable estimates of the data needed to calculate nonradiological impacts are discussed below.

- The number of workers needed for operations was given by Southern (2008a) as 812 (two units), so each Westinghouse AP1000 reactor at the VEGP site requires about 406 operating personnel. An additional 1000 temporary workers are estimated to be needed for refueling outages. It was assumed that outages for the two units would not occur simultaneously.
- The average commute distance for operations and outage workers was assumed to be 32 km (20 mi) one way.
- To develop representative commuter traffic impacts, a source was located that provided a Georgia-specific fatality rate for all traffic for the years 2001 to 2006 (DOT 2008). The average fatality rate for the 2001 to 2006 period in Georgia was used as the basis for estimating Georgia-specific injury and accident rates. Adjustment factors were developed using national-level traffic accident statistics in the U.S. Department of Transportation publication *National Transportation Statistics 2007* (DOT 2007). The adjustment factors are the ratio of the national injury rate to the national fatality rate and the ratio of the national accident rate to the national fatality rate. These adjustment factors were multiplied by the Georgia-specific fatality rate to approximate the injury and accident rates for commuters in the State of Georgia.

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- The estimated impacts of transporting operations and outage workers to/from the VEGP site are shown in Table 5-7. The total annual traffic fatalities during operations, including both operations and outage personnel, represent about a 0.4 percent increase above the 12 traffic fatalities that occurred in Burke County, Georgia, in 2006 (DOT 2008). This represents a small increase relative to the current traffic fatality risk in the area surrounding the proposed VEGP site.

Table 5-7. Nonradiological Impacts of Transporting Workers to/from the VEGP Site

	Accidents per Year per Unit	Injuries per Year per Unit	Fatalities per Year per Unit
Permanent Workers	4.8×10^0	2.2×10^0	3.3×10^{-2}
Outage Workers	1.4×10^0	6.5×10^{-1}	9.7×10^{-3}

5.8.7 Summary of Nonradiological Health Impacts

The staff evaluated health impacts to the public and the workers from the cooling systems, noise generated by unit operations, and acute and chronic impacts of EMFs at the higher power levels, and transporting operations and outage workers to/from the two additional units. Health risks to workers are expected to be dominated by occupational injuries at rates below the average U.S. industrial rates. Health impacts to the public and workers from thermophilic microorganisms, noise generated by unit operations, and acute impacts of EMFs would be minimal. Based on the information provided by Southern and NRC's own independent review, the staff concludes that the potential impacts of nonradiological effects resulting from the operation of two additional units would be SMALL, and mitigation is not warranted. The staff has not come to conclusions on the chronic impacts of EMFs, but the available information is not sufficient to cause the staff to consider the potential impacts as significant to the public.

5.9 Radiological Impacts of Normal Operations

This section addresses the radiological impacts of normal operations of the proposed new units on the VEGP site, including a discussion of the estimated radiation dose to a member of the public and to the biota inhabiting the area around the VEGP site. Estimated doses to workers at the proposed units are also discussed. Radiological impacts were determined using the Westinghouse AP1000 reactor design with expected direct radiation and liquid and gaseous radiological effluent rates in the evaluation (see discussion in Section 3.2.3).

5.9.1 Exposure Pathways

The public and biota would be exposed to increased ambient background radiation from a nuclear unit via the liquid effluent, gaseous effluent, and direct radiation pathways. Southern estimated the potential exposures to the public and biota by evaluating exposure pathways typical of those surrounding a nuclear unit at the VEGP site. They considered pathways that

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could cause the highest calculated radiological dose based on the use of the environment by the residents located around the site (Southern 2008a). For example, factors such as the location of homes in the area, consumption of meat from the area, and consumption of vegetables grown in area gardens were considered.

For the liquid effluent release pathway, the ER considered the following exposure pathways in evaluating the dose to the maximally exposed individual (MEI): ingestion of aquatic food (i.e., fish), ingestion of drinking water, and direct radiation exposure from shoreline activities (see Figure 5-2). The analysis for population dose considered the following exposure pathways: ingestion of aquatic food and direct radiation exposure from shoreline, swimming, and boating activities. Drinking water was not evaluated because the current land-use census showed no drinking water use of the river within 160 km (100 mi) downstream of the site. Liquid effluents were assumed to be released into Savannah River at the end of a newly constructed discharge structure.

For the gaseous effluent release pathway, Southern considered the following exposure pathways in evaluating the dose to the individual: immersion in the radioactive plume, direct radiation exposure from deposited radioactivity, inhalation, ingestion of garden fruit and vegetables, and ingestion of beef. Southern (2008a) did not calculate a dose from milk ingestion because the most recent land-use census indicated that no milk cows existed within 8 km (5 mi) of the site.

Southern (2008a) calculated population doses using the same exposure pathways as used for the individual dose assessment, but with the addition of the cow milk ingestion pathway (see Figure 5-2).

Southern (2008a) states that direct radiation from the reactor buildings and planned ISFSI would be the primary sources of direct radiation exposure to the public from the VEGP site. However, Southern assumes that contained sources of radiation at the proposed VEGP Units 3 and 4 would be shielded and would not contribute to the external dose of the MEI individual or the population.

Exposure pathways considered in evaluating dose to the biota are shown in Figure 5-3 and included

- Ingestion of aquatic foods
- Ingestion of water
- External exposure from water immersion or surface effect
- Inhalation of airborne radionuclides
- External exposure to immersion in gaseous effluent plumes, and
- Surface exposure from deposition of iodine and particulates from gaseous effluents (NRC 1977).

February 1979

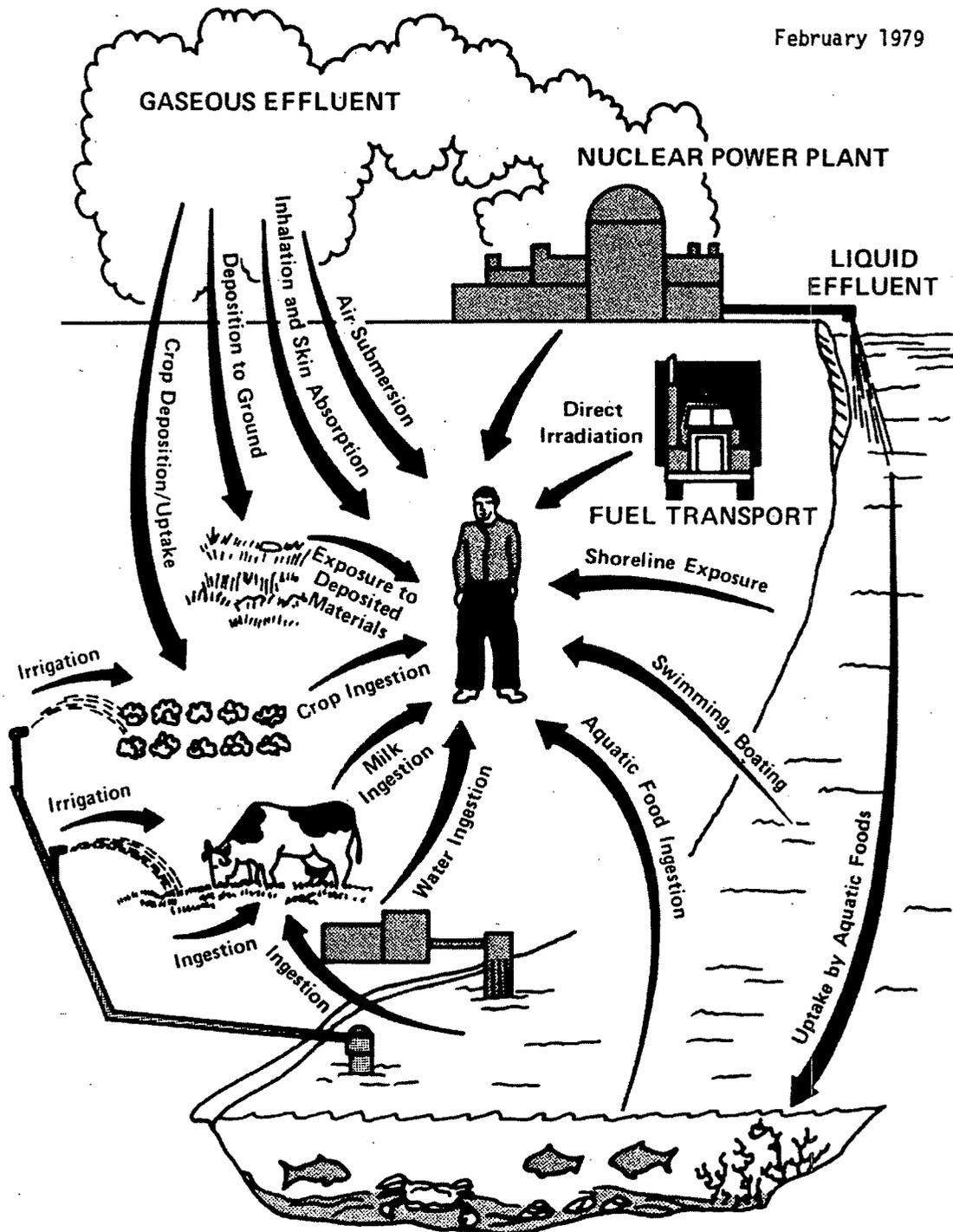


Figure 5-2. Exposure Pathways to Man (Soldat et al. 1974)

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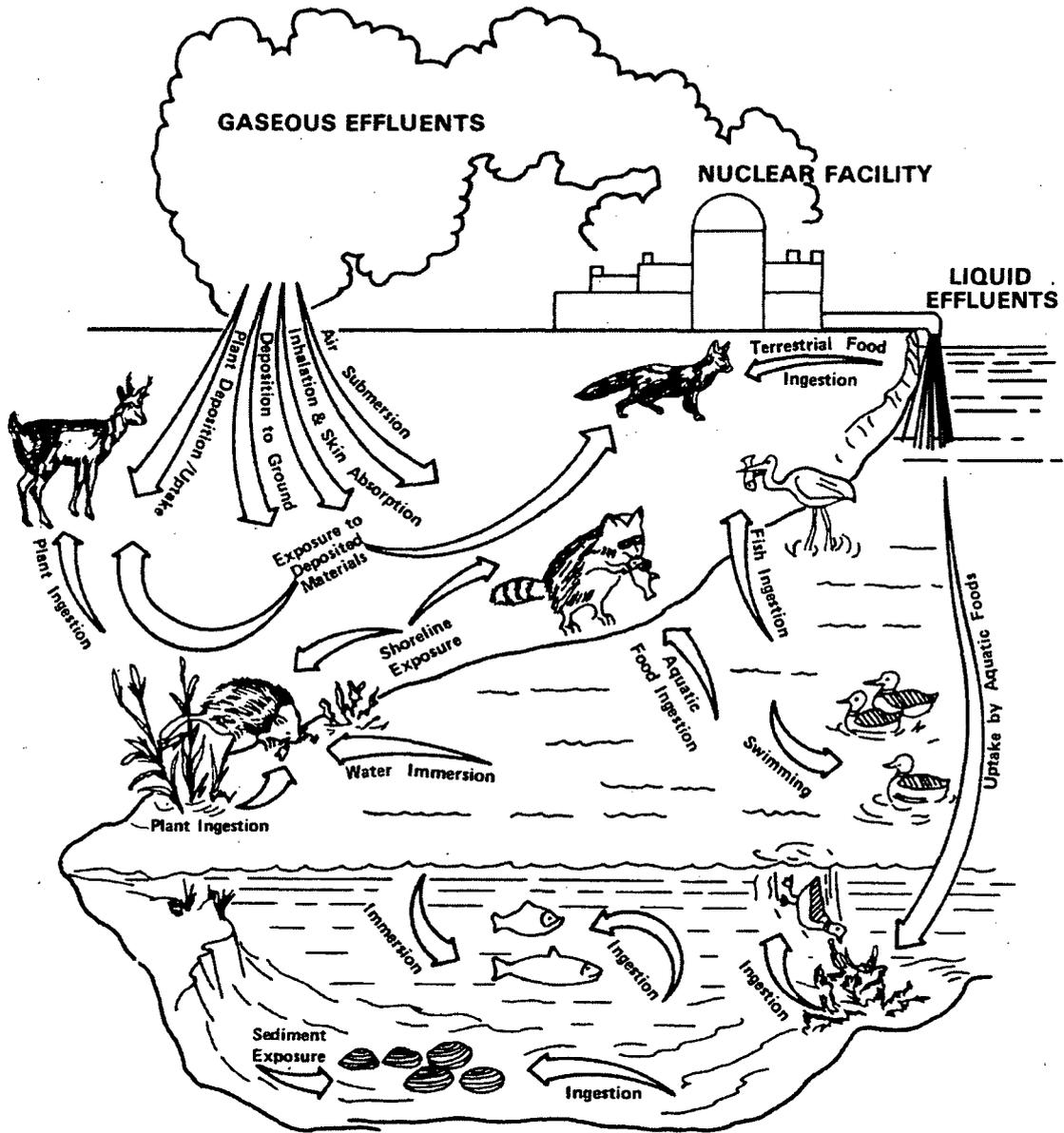


Figure 5-3. Exposure Pathways to Biota Other than Man (Soldat et al. 1974)

The staff reviewed the exposure pathways for the public and biota identified by Southern (2008a) and found them to be appropriate, based on a documentation review, a tour of environs, and interviews with Southern staff and contractors during the site visit in October 2006.

5.9.2 Radiation Doses to Members of the Public

Southern calculated the dose to the MEI individual and the population living within an 80-km (50-mi) radius of the site from both the liquid and gaseous effluent release pathways (Southern 2008a). As discussed in the previous sections, direct radiation exposure to the MEI individual from sources of radiation at the proposed VEGP Units 3 and 4 would be negligible.

5.9.2.1 Liquid Effluent Pathway

Liquid pathway doses were calculated using the LADTAP II computer program (Streng et al. 1986). The liquid effluent releases used in the estimates of dose are found in Table 3.5-1 of the ER (Southern 2008a). Other parameters used as inputs to the LADTAP II program include effluent discharge rate, dilution factor for discharge, transit time to receptor, and liquid pathway consumption and usage factors (i.e., fish consumption and drinking water consumption), and are found in Table 5.4-1 of the ER (Southern 2008a).

Southern calculated liquid pathway doses to the MEI and population. The maximum annual dose to the total body for two new units was 0.00034 mSv (0.034 mrem) for an adult. The maximum annual dose to the thyroid for two new units was 0.0003 mSv (0.03 mrem) for an infant. The maximum annual dose to the liver for two new units was 0.00042 mSv (0.042 mrem) for a child. Southern calculated the dose to the population living within an 80-km (50-mi) radius of the site to be 0.37 person-mSv/yr (37 person-mrem/yr) for two new units.

The staff recognizes the LADTAP II computer program as an appropriate method for calculating dose to the MEI for liquid effluent releases. The staff performed an independent evaluation of liquid pathway doses using input parameters from the ER and found similar results. All input parameters used in Southern calculations were judged by the staff to be appropriate. Results of the staff's independent evaluation are found in Appendix G.

5.9.2.2 Gaseous Effluent Pathway

Gaseous pathway doses to the MEI were calculated by Southern using the GASPAR II computer program (Streng et al. 1987) at the nearest residence and the exclusion area boundary. The GASPAR II computer program was also used to calculate annual population doses. The following activities were considered in the dose calculations: (1) direct radiation from immersion in the gaseous effluent cloud and from particulates deposited on the ground, (2) inhalation of gases and particulates, (3) ingestion of meat from animals eating contaminated grass, and (4) ingestion of garden vegetables contaminated by gases and particulates. Southern (2008a) states that no milk cows or milk goats are located within 8 km (5 mi) of the proposed site. However, Southern did provide individual dose results for the milk pathway in its ER for information purposes, but those results are not included in the total doses reported here and in the ER (Southern 2008a). Southern did include the milk pathway in the calculation of

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population dose. The gaseous effluent releases used in the estimate of dose to the MEI and population are found in Table 3.5-2 of the ER (Southern 2008a). Other parameters used as inputs to the GASPARD II program, including population data, atmospheric dispersion factors, ground deposition factors, receptor locations, and consumption factors, are found in Tables 5.4-2 and 5.4-4 of the ER (Southern 2008a). Gaseous pathway doses to the MEI calculated by Southern are found in Table 5-8.

Table 5-8. Doses to the Maximally Exposed Individual from Gaseous Effluent Pathway for Two Units^(a)

Location	Pathway	Total Body Dose (mSv/yr) ^(b)	Thyroid Dose (mSv/yr) ^(b)	Skin Dose (mSv/yr) ^(b)
Exclusion area boundary (0.8 km [0.5 mi] NE)	Plume	1.12×10^{-2}	-	4.60×10^{-2}
Nearest residence (1.1 km [0.67 mi] NE)	Plume	5.11×10^{-3}	-	2.56×10^{-2}
Nearest residence (1.1 km [0.67 mi] NE)	Ground	1.75×10^{-3}	-	2.05×10^{-3}
Nearest residence (1.1 km [0.67 mi] NE)	<u>Inhalation</u>			
	Adult	5.59×10^{-4}	5.19×10^{-3}	-
	Teen	5.65×10^{-4}	6.48×10^{-3}	-
	Child	5.00×10^{-4}	7.56×10^{-3}	-
	Infant	2.89×10^{-4}	6.78×10^{-3}	-
Nearest garden (1.1 km [0.67 mi] NE)	<u>Vegetable</u>			
	Adult	4.09×10^{-3}	4.00×10^{-2}	-
	Teen	6.08×10^{-3}	5.38×10^{-2}	-
	Child	1.33×10^{-2}	1.05×10^{-1}	-
Nearest meat animal (1.1 km [0.67 mi] NE)	<u>Meat</u>			
	Adult	1.25×10^{-3}	3.08×10^{-3}	-
	Teen	1.00×10^{-3}	2.34×10^{-3}	-
	Child	1.81×10^{-3}	3.84×10^{-3}	-
Nearest milk cow (1.1 km [0.67 mi] NE) ^(c)	<u>Cow Milk</u>			
	Adult	1.84×10^{-3}	5.46×10^{-2}	-
	Teen	2.97×10^{-3}	8.67×10^{-2}	-
	Child	6.42×10^{-3}	1.73×10^{-1}	-
	Infant	1.27×10^{-2}	4.18×10^{-1}	-

(a) Source was the ER (Southern 2008a), Tables 5.4-6 and 5.4-7. No infant doses were calculated for the vegetable or meat pathway because the doses that infants receive from this diet would be bounded by the dose calculated for the child.

(b) Multiply mSv/yr times 100 to obtain mrem/yr.

(c) This distance and direction from the VEGP site represents nearest residence. No milk-producing animals are known to be located within 8 km (5 mi) of the proposed site and these results for milk cow are provided for informational purposes only.

The staff recognizes the GASPARD II computer program as an appropriate tool for calculating dose to the MEI and population from gaseous effluent releases. The staff performed an independent evaluation of gaseous pathway doses and obtained similar results for the MEI.

The staff performed an independent evaluation of population dose and calculated a population dose 20 percent higher than that calculated by Southern (2007a). Section 5.4.1 of the

Environmental Standard Review Plan (ESRP) requires use of "...projected population for 5 years from the time of licensing action under consideration" (NRC 2000a). Assuming the ESP action occurs in year 2008 and adding 5 years yields 2013. The staff calculated the population dose for the population predicted to exist in the year 2013, while Southern (2008a) used the year 2000 census value. See Appendix G for details.

5.9.3 Impacts to Members of the Public

This section describes the staff's evaluation of the estimated impacts from radiological releases and direct radiation of two new units at the VEGP site. The evaluation addresses dose from operations to the MEI located at the VEGP site and the population dose (collective dose to the population within 80 km [50 mi]) around the VEGP site.

5.9.3.1 Maximally Exposed Individual

Southern (2008a) states that total body and organ dose estimates to the MEI from liquid and gaseous effluents for two new units would be within the design objectives of 10 CFR Part 50, Appendix I. Doses to total body and maximum organ at the Savannah River from liquid effluents were well within the respective 0.03-mSv/yr (3-mrem/yr) and 0.1-mSv/yr (10-mrem/yr) Appendix I design objectives. Doses at the exclusion area boundary from gaseous effluents were well within the Appendix I design objectives of 0.1 mGy/yr (10 mrad/yr) air dose from gamma radiation, 0.2 mGy/yr (20 mrad/yr) air dose from beta radiation, 0.05 mSv/yr (5 mrem/yr) to the total body, and 0.15 mSv/yr (15 mrem/yr) to the skin. In addition, dose to the thyroid was within the 0.15 mSv/yr (15 mrem/yr) Appendix I design objective. A comparison of dose estimates for each of two new units to the Appendix I design objectives is found in Table 5-9.

Table 5-9. Comparison of Maximally Exposed Individual Dose Estimates for a Single New Nuclear Unit from Liquid and Gaseous Effluents to 10 CFR Part 50, Appendix I, Design Objectives

Pathway/Type of Dose	Southern (2007a) ^(a)	Appendix I Design Objectives ^(a)
Liquid Effluents		
Total body dose	0.00017 mSv/yr (adult)	0.03 mSv/yr
Maximum organ dose	0.00021 mSv/yr (child liver)	0.1 mSv/yr
Gaseous Effluents (Noble gases only)		
Gamma air dose	0.0068 mGy/yr	0.1 mGy/yr
Beta air dose	0.0284 mGy/yr	0.2 mGy/yr
Total body dose	0.0056 mSv/yr	0.05 mSv/yr
Skin dose	0.0230 mSv/yr	0.15 mSv/yr
Gaseous Effluents (Radioiodines and particulates)		
Organ dose	0.0591 mSv/yr (child thyroid)	0.15 mSv/yr

(a) Multiply mSv/yr or mGy/yr times 100 to obtain mrem/yr or mrad/yr.

Source: Southern 2008a, 10 CFR Part 50 Appendix I.

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Gaseous and liquid effluents from the VEGP site are below the Appendix I design objectives (Southern 2008a). The cumulative effects of both the current operating units and two new units also are within Appendix I design objectives.

Southern (2008a) states that dose estimates from combined liquid and gaseous effluents to the MEI at the nearest residence from the new units are well within the regulatory standards of 40 CFR Part 190. As stated earlier, exposure at the site boundary from direct radiation sources at the new units would be negligible. Table 5-10 compares Southern's calculated doses from the two existing and proposed units to the dose standards from 40 CFR Part 190, i.e., 0.25 mSv/yr (25 mrem/yr) to the total body, 0.75 mSv/yr (75 mrem/yr) to the thyroid, and 0.25 mSv/yr (25 mrem/yr) to any other organ.

Doses to the MEI from the existing VEGP units are smaller than the dose estimates for the new units. Section 2.5 states that the maximum annual dose to a member of the public from gaseous and liquid effluents at the VEGP site is typically less than 0.001 mSv (less than 0.1 mrem). Section 4.9 states that direct exposures from the existing VEGP site do not vary significantly from background radiation levels at the site boundary. Therefore, the combined dose to the MEI from the existing VEGP units and the proposed new units would be well within the 40 CFR Part 190 standards, 10 CFR Part 20 standards, and 10 CFR Part 50, Appendix I, design objectives.

Table 5-10. Comparison of Maximally Exposed Individual Dose Estimates from Liquid and Gaseous Effluents to 40 CFR Part 190 Standards

Dose	Southern (2007a) Estimate (mSv/yr) ^{(a)(b)}	40 CFR Part 190 Standards (mSv/yr) ^(b)
Whole body dose equivalent	0.0236	0.25
Thyroid dose	0.1239	0.75
Dose to another organ	0.0888 (child liver)	0.25

(a) Sum of dose from liquid and gaseous effluent releases for existing and proposed units.
(b) Multiply mSv/yr times 100 to obtain mrem/yr.
Source: Southern 2008a, 40 CFR Part 190

5.9.3.2 Population Dose

Southern estimates the collective total body dose within an 80-km (50-mi) radius of the VEGP site to be 0.01837 person Sv/yr (1.837 person-rem/yr) (Southern 2008a). The estimated collective dose to the same population from natural background radiation is estimated to be 2.43×10^3 person-Sv/yr (2.43×10^5 person-rem/yr) (Southern 2008a). The dose from natural background radiation was calculated by multiplying the 80-km (50-mi) population estimate for 2000 of approximately 674,101 people by the annual background dose rate of 3.6 mSv/yr (360 mrem/yr) (Southern 2008a).

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Collective dose was estimated using the GASPAR II computer code and was attributed to the gaseous and liquid effluent pathway. The staff performed an independent evaluation of population doses and obtained results 20 percent higher. The difference results from using different years for the population estimate and both results are considered low (See Appendix G for further explanation).

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses below about 100 mSv (10,000 mrem) and at low dose rates. 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. A recent report by the National Research Council (2006), BEIR VII report, supports the linear, no-threshold dose response model. 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 probably overestimates those risks. Based on this model, the staff estimated the risk to the public from radiation exposure using the nominal probability coefficient for total detriment (730 fatal cancers, nonfatal cancers, and severe hereditary effects per 10,000 person-Sv [1,000,000 person-rem]) from International Commission on Radiological Protection (ICRP) Publication 60 (ICRP 1991). This coefficient was multiplied by the staff's estimated collective whole body population dose of 0.0217 person-Sv/yr (2.17 person-rem/yr) to calculate that the population living within 80 km (50 mi) of the VEGP site would incur less than one fatal cancer, nonfatal cancer, or severe hereditary effect annually. The risks from the cumulative radiation exposure from the existing VEGP units and the proposed VEGP units would be only slightly higher. This risk is very small compared to the estimated 212 fatal cancers, nonfatal cancers, and severe hereditary effects that the projected 2013 population would incur annually from exposure to natural sources of radiation. Because the population doses from the liquid effluents are very small compared to the gaseous effluents, the addition of this dose would not change the resulting risk estimates.

In addition, at the request of the U.S. Congress, the National Cancer Institute (NCI) conducted a study and published, "Cancer in Populations Living Near Nuclear Facilities," in 1990 (Jablan 1990). This report included an evaluation of health statistics around all nuclear power plants, as well as several other nuclear fuel cycle facilities, in operation in the United States in 1981 and found "no evidence that an excess occurrence of cancer has resulted from living near nuclear facilities" (Jablan 1990).

5.9.3.3 Summary of Radiological Impacts to Members of the Public

The staff evaluated the health impacts from routine gaseous and liquid radiological effluent releases from the new units at the VEGP site. Based on the information provided by Southern

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and NRC's own independent evaluation, the staff concludes there would be no observable health impacts to the public from normal operation of the new units, and the health impacts would be SMALL.

5.9.4 Occupational Doses to Workers

Southern (2008a) reported annual occupational dose estimates of about 1.5 person-Sv (150 person-rem) for existing VEGP Units 1 and 2 (0.75 person-Sv (75 person-rem per unit) during 2005. On the basis of information contained in NUREG-0713 (NRC 2002b), the average annual collective dose per operating pressurized water reactor in the United States was 0.83 person-Sv/yr (83 person-rem/yr) for the time period of 2001-2006. The estimated occupational doses for advanced reactor designs, including the Westinghouse AP1000 reactors at the VEGP site, were slightly less than the annual occupational doses for current light-water reactors (LWRs).

Southern (2008a) concluded that occupational exposures for the new units would likely be bounded by occupational exposures from currently operating LWRs because advanced LWR designs, including the Westinghouse AP1000 reactors at the VEGP site, have or would incorporate radiation protection features that are improved over the designs provided in currently operating LWRs.

The licensee of a new plant would need to maintain individual doses to workers within 0.05 Sv (5 rem) annually as specified in 10 CFR 20.1201 and incorporate ALARA provisions to maintain doses below this limit.

The staff concludes that the health impacts from occupational radiation exposure would be SMALL based on individual worker doses being maintained within 10 CFR 20.1201 limits and collective occupational doses being typical of doses found in current operating LWR reactors.

5.9.5 Impacts to Biota Other than Members of the Public

Southern estimated doses to representative biota species, including fish, muskrat, raccoon, heron, and duck. Additional results are reported for algae and invertebrates. Fish, invertebrates, and algae are referred to as aquatic species. Muskrats, raccoons, herons, and ducks are referred to as terrestrial species. Important biota species for the VEGP site and the corresponding surrogate species are as follows: (1) various mussel and mollusc species – invertebrates, (2) darter, shiner, catfish, sunfish, perch, eels, largemouth bass, striped bass – fish, (3) white-tailed deer, raccoon, gray squirrel, Eastern cottontail, coyotes, gray fox, and pocket gopher – raccoon and muskrat, (4) wood duck – duck, and (5) wood stork – heron. Surrogate species are well-defined and provide an acceptable method for judging doses to the biota. Exposure pathways considered in evaluating dose to the biota were discussed in Section 5.9.1 and shown in Figure 5-3. The NRC independent evaluation included

consideration of surrogate species that included invertebrates and algae; and found similar results to those reported by Southern (2008a) (see Appendix G).

5.9.5.1 Liquid Effluent Pathway

Southern (2008a) used the LADTAP II computer code to calculate doses to the biota from the liquid effluent pathway. In estimating the concentration of radioactive effluents in Savannah River, Southern (2008a) used a transit dilution model. Liquid pathway doses were higher for biota compared to man because of considerations for bioaccumulation of radionuclides, ingestion of aquatic plants, ingestion of invertebrates, and increased time spent in water and shoreline compared to man. The liquid effluent releases used in estimating biota dose are found in Table 3.5-1 of the ER (Southern 2008a). Total body dose estimates to the surrogate species from the liquid and gaseous pathways are shown in Table 5-11.

Table 5-11. Comparison of Biota Doses from the VEGP Site to 40 CFR Part 190^(a)

Biota	Liquid Effluents Dose (mGy/yr) ^(b)	Gaseous Effluents Dose (mGy/yr) ^(b)	Total Body Biota Dose All Pathways (mGy/yr) ^(b)	40 CFR Part 190 Total Body Dose Limit (mSv/yr) ^(b)
Fish	1.6×10^{-3}	-	1.6×10^{-3}	2.5×10^{-1}
Invertebrate	(c)	-	4.5×10^{-3}	2.5×10^{-1}
Algae	(c)	-	1.3×10^{-2}	2.5×10^{-1}
Muskrat	4.7×10^{-3}	1.5×10^{-2}	2.0×10^{-2}	2.5×10^{-1}
Raccoon	1.9×10^{-3}	2.2×10^{-2}	2.4×10^{-2}	2.5×10^{-1}
Heron	2.15×10^{-2}	1.5×10^{-2}	3.7×10^{-2}	2.5×10^{-1}
Duck	4.5×10^{-3}	2.2×10^{-2}	2.6×10^{-2}	2.5×10^{-1}

(a) Data taken from Table 5.4-10 of Southern (2008a).

(b) Multiply mGy/yr or mSv/yr times 100 to obtain mrad/yr or mrem/yr.

(c) Southern did not report results for these biota.

5.9.5.2 Gaseous Effluent Pathway

Gaseous effluents would contribute to the total body dose of the terrestrial surrogate species (i.e., muskrat, raccoon, heron, and duck). The exposure pathways include inhalation of airborne radionuclides, external exposure because of immersion in gaseous effluent plumes, and surface exposure from deposition of iodine and particulates from gaseous effluents. The dose calculated to the MEI from gaseous effluent releases in Table 5-8 would also be applicable to terrestrial surrogate species with two modifications. One modification defined in Southern (2008a) was increasing the ground deposition factors by a factor of two as terrestrial animals would be closer to the ground than the MEI. The second modification was to disable the vegetation intake pathway for muskrat and heron that are not known to consume vegetation. The gaseous effluent releases used in estimating dose are found in Table 3.5-2 of the ER (Southern 2008a). The ER used doses at the exclusion area boundary (0.8 km [0.5mi]) NE of the VEGP site) in estimating terrestrial species doses. Total body dose estimates to the surrogate species from the gaseous pathway are shown in Table 5-11.

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5.9.5.3 Impact of Estimated Biota Doses

Table 5-9 also compares the annual total body dose estimates to surrogate biota species from each of the two new nuclear units to the annual whole body dose standard in 40 CFR Part 190. Although the 40 CFR Part 190 standards apply to members of the public in unrestricted areas and not to biota, they are provided here for comparative purposes. Radiation doses to the biota are expressed in units of absorbed dose (mGy [mrad]) because dose equivalent (mSv [mrem]) only applies to human radiation doses. Southern assumed that mSv (mrem) and mGy (mrad) are approximately equivalent for comparison of biota doses to the 40 CFR Part 190 standards. Annual dose for no surrogate species exceeded the dose standard in 40 CFR Part 190. The biota dose estimates of the new units are conservative because they do not consider dilution or decay of liquid effluents during transit. Actual doses to the biota are likely to be much less.

The International Commission on Radiological Protection (ICRP 1977; ICRP 1991) states that if humans are adequately protected, other living things are also likely to be sufficiently protected. The International Atomic Energy Agency (IAEA 1992) and the National Council on Radiation Protection and Measurements (NCRP 1991) reported that a chronic dose rate of no greater than 10 mGy/d (1000 mrad/d) to the MEI in a population of aquatic organisms would ensure protection of the population. IAEA (1992) also concluded that chronic dose rates of 1 mGy/d (100 mrad/d) or less do not appear to cause observable changes in terrestrial animal populations. Table 5-12 compares the estimated total body dose to the biota from the proposed VEGP Units 3 and 4 to the IAEA chronic dose rate values for aquatic organisms and terrestrial animals. The cumulative effects of the existing VEGP units and the new units result in dose rates far less than those of the NCRP and IAEA studies.

Table 5-12. Comparison of Biota Doses from the Proposed VEGP Units 3 and 4 at the VEGP Site to Relevant Guidelines for Biota Protection^(a)

Biota	Total Body Dose - Southern ESP Units (mGy/d) ^(b)	IAEA/NCRP Guidelines for Protection of Biota Populations (mGy/d) ^(b)
Fish	4.4×10^{-6}	10
Invertebrate	1.2×10^{-5}	10
Algae	3.6×10^{-5}	10
Muskrat	5.5×10^{-5}	1
Raccoon	6.6×10^{-5}	1
Heron	1.0×10^{-4}	1
Duck	7.1×10^{-5}	1

(a) Total dose from liquid and gaseous effluents in Table 5-9.

(b) Multiply mGy/d times 100 to obtain mrad/d.

IAEA = International Atomic Energy Agency.

NCRP = National Council on Radiation Protection and Measurements.

The staff performed an independent evaluation of doses to biota and found similar results. Results of the staff's independent evaluation are found in Appendix G.

Based on the information provided by Southern and NRC's own independent evaluation, the staff concludes that the radiological impact on biota from the routine operation of the proposed Units 3 and 4 at the VEGP site would be SMALL, and mitigation is not warranted.

5.9.6 Radiological Monitoring

A radiological environmental monitoring program (REMP) has been in place for the VEGP site since operations began in 1987, with preoperational sample collection activities beginning in 1981 (Southern 2002). The REMP includes monitoring of the airborne exposure pathway, direct exposure pathway, water exposure pathway, aquatic exposure pathway from the Savannah River, and the ingestion exposure pathway in a 8-km (5-mi) radius of the station, with indicator locations near the plant perimeter and control locations at distances greater than 16 km (10 mi). Milk is not currently sampled because there is no known production within 8 km (5 mi) of the site. An annual survey is conducted for the area surrounding the site to verify the accuracy of assumptions used in the analyses, including the occurrence of milk production. The pre-operational REMP sampled various media in the environment to determine a baseline from which to observe the magnitude and fluctuation of radioactivity in the environment once the unit began operation. The pre-operational program included collection and analysis of samples of air particulates, precipitation, crops, soil, well water, surface water, fish, and silt as well as measurement of ambient gamma radiation. After operation of VEGP Unit 1 began in 1987, the monitoring program continued to assess the radiological impacts on workers, the public, and the environment. Radiological releases are summarized in the two annual reports: the *Annual Radiological Environmental Operating Report* (e.g., Southern 2002) and *Annual Radioactive Effluent Release Report* (e.g., Southern 2005). The limits for all radiological releases are specified in the *Vogtle Offsite Dose Calculation Manual* (Southern 2004). No additional monitoring program has been established for the new units. To the greatest extent practical, the REMP for the ESP program would utilize the procedures and sampling locations used by the existing VEGP site. The staff reviewed the documentation for the existing REMP, the *Vogtle Offsite Dose Calculation Manual*, and recent monitoring reports from VEGP and the Savannah River Site (Savannah River Site 2006), and determined that the current operational monitoring program is adequate to establish the radiological baseline for comparison with the expected impacts on the environment related to the construction and operation of the proposed new units at the VEGP site. In addition, the staff reviewed environmental quality and monitoring reports from the U.S. Geological Survey, U.S. Environmental Protection Agency, Georgia Department of Natural Resources, Georgia Environmental Protection Division, and South Carolina Department of Health and Environmental Control.

5.10 Environmental Impacts of Postulated Accidents

The staff considered the radiological consequences on the environment of potential accidents at new units at the VEGP site. Consequence estimates are based on the Westinghouse AP1000 reactor certified design (Westinghouse 2005) as set forth in 10 CFR Part 52, Appendix D. The

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term "accident," as used in this section, refers to any off-normal event not addressed in Section 5.9 that results in release of radioactive materials into the environment. The focus of this review is on events that could lead to releases substantially in excess of permissible limits for normal operations. Normal release limits are specified in 10 CFR Part 20, Appendix B, Table 2.

Numerous features combine to reduce the risk associated with accidents at nuclear power plants. Safety features in the design, construction, and operation of the plants, which comprise the first line of defense, are intended to prevent the release of radioactive materials from the plant. The design objectives and the measures for keeping levels of radioactive materials in effluents to unrestricted areas as low as reasonably achievable are specified in 10 CFR Part 50, Appendix I. There are additional measures that are designed to mitigate the consequences of failures in the first line of defense. These include the NRC's reactor site criteria in 10 CFR Part 100, which require the site to have certain characteristics that reduce the risk to the public and the potential impacts of an accident, and emergency preparedness plans and protective action measures for the site and environs, as set forth in 10 CFR 50.47, 10 CFR Part 50, Appendix E, and NUREG-0654/FEMA-REP-1 (NRC 1980). All of these safety features, measures, and plans make up the defense-in-depth philosophy to protect the health and safety of the public and the environment.

This section discusses (1) the types of radioactive materials, (2) the paths to the environment, (3) the relationship between radiation dose and health effects, and (4) the environmental impacts of reactor accidents, both design-basis accidents (DBAs) and severe accidents. The environmental impacts of accidents during transportation of spent fuel are discussed in Chapter 6.

The potential for dispersion of radioactive materials in the environment depends on the mechanical forces that physically transport the materials and on the physical and chemical forms of the material. Radioactive material exists in a variety of physical and chemical forms. The majority of the material in the fuel is in the form of nonvolatile solids. However, there is a significant amount of material that is in the form of volatile solids or gases. The gaseous radioactive materials include the chemically inert noble gases (e.g., krypton and xenon), which have a high potential for release. Radioactive forms of iodine, which are created in substantial quantities in the fuel by fission, are volatile. Other radioactive materials formed during the operation of a nuclear power plant have lower volatilities and, therefore, have lower tendencies to escape from the fuel than the noble gases and iodines.

Radiation exposure to individuals is determined by their proximity to radioactive material, the duration of their exposure, and the extent to which they are shielded from the radiation. Pathways that lead to radiation exposure include (1) external radiation from radioactive material in the air, on the ground, and in the water, (2) inhalation of radioactive material, and (3) ingestion of food or water containing material initially deposited on the ground and in water.

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses below about 100 mSv (10,000 mrem) and at low dose rates. However, radiation protection experts conservatively assume that any amount of radiation exposure 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 response model is used to describe the relationship between radiation dose and detriments such as cancer induction. A recent report by the National Research Council (2006), the BEIR VII report, supports the linear, no-threshold dose response theory. 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 probably overestimates those risks.

Physiological effects are clinically detectable should individuals receive radiation exposure resulting in a dose greater than about 0.25 Sv (25 rem) over a short period of time (hours). Doses of about 2.5 to 5.0 Sv (250 to 500 rem) received over a relatively short period (hours to a few days) can be expected to cause some fatalities.

5.10.1 Design-Basis Accidents

Southern evaluated the potential consequences of postulated accidents to demonstrate that a Westinghouse AP1000 reactor could be constructed and operated at the VEGP site without undue risk to the health and safety of the public (Southern 2008a). These evaluations used a set of surrogate DBAs that are representative for the reactor design being considered for the VEGP site and site-specific meteorological data. The set of accidents covers events that range from relatively high probability of occurrence with relatively low consequences to relatively low probability with high consequences.

The DBA review focuses on the certified Westinghouse AP1000 reactor at the VEGP site. The bases for analyses of postulated accidents for this design are well established because they have been considered as part of the NRC's advanced reactor design certification process. Potential consequences of DBAs are evaluated following procedures outlined in regulatory guides and standard review plans. The potential consequences of accidental releases depend on the specific radionuclides released, the amount of each radionuclide released, and the meteorological conditions. The source terms for the Westinghouse AP1000 reactor and methods for evaluating potential accidents are based on guidance in Regulatory Guide 1.183 (NRC 2000b).

For environmental reviews, consequences are evaluated assuming realistic meteorological conditions. Meteorological conditions are represented in these consequence analyses by an atmospheric dispersion factor, which is also referred to as χ/Q . Acceptable methods of calculating χ/Q for DBAs from meteorological data are set forth in Regulatory Guide 1.145 (NRC 1983).

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Table 5-13 lists χ/Q values pertinent to the environmental review of DBAs for the VEGP site. The first column lists the time periods and boundaries for which χ/Q and dose estimates are needed. For the exclusion area boundary, the postulated DBA dose and its atmospheric dispersion factor are calculated for a short-term, i.e., 2 hours, and for the low population zone, they are calculated for the course of the accident, i.e., 30 days (720 hours) composed of four time periods. The second column lists the χ/Q values presented in Southern's ER Section 2.7.5.2 using the site meteorological information discussed in ER Section 2.7.4 and the exclusion area boundary and low population zone distances (Southern 2008a). No credit was taken for building wake. Southern calculated the χ/Q values listed in Table 5-13 using a set of five years of meteorological data (1998-2002) for the VEGP site assuming the release point was located midway between the two proposed Westinghouse AP1000 reactors. Small χ/Q values are associated with greater dilution capability.

Table 5-13. Atmospheric Dispersion Factors for VEGP Site DBA Calculations

Time Period and Boundary	χ/Q (s/m ³)
0 to 2 hr, Exclusion Area Boundary	7.38×10^{-5}
0 to 8 hr, Low Population Zone	1.40×10^{-5}
8 to 24 hr, Low Population Zone	1.22×10^{-5}
1 to 4 d, Low Population Zone	9.15×10^{-6}
4 to 30 d, Low Population Zone	6.04×10^{-6}

Source: Southern 2008a

The staff reviewed the meteorological data used by Southern and the method used to calculate the atmospheric dispersion factors, thereby confirming that the atmospheric dispersion factors values are correct. On these bases, the staff concludes that the atmospheric dispersion factors for the VEGP site are acceptable for use in evaluating potential environmental consequences of postulated DBAs for the Westinghouse AP1000 reactor design at the VEGP site.

Table 5-14 lists the set of DBAs considered by Southern and presents Southern's estimate of the environmental consequences of each accident in terms of total effective dose equivalent (TEDE). TEDE is the sum of the committed effective dose equivalent from inhalation and the deep dose equivalent from external exposure. Dose conversion factors from Federal Guidance Report 11 (Eckerman et al. 1988) were used to calculate the committed effective dose equivalent. Similarly, dose conversion factors from Federal Guidance Report 12 (Eckerman and Ryman 1993) were used to calculate the deep dose equivalent.

The staff reviewed Southern's selection of DBAs by comparing the accidents listed in the application with the DBAs considered in the design certification process (Westinghouse 2005 NRC 2004b). The DBAs in the ER are the same as those considered in the design certification, therefore the staff concludes that the set of DBAs is appropriate. In addition, the staff reviewed the calculation of the site-specific consequences of the DBAs and found the calculations to be correct.

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There are no environmental criteria related to the potential consequences of DBAs. Consequently, the review criteria used in the staff's safety review of DBA doses are included in Table 5-14 to illustrate the magnitude of the calculated environmental consequences (TEDE doses). In all cases, the calculated TEDE values are considerably smaller than the TEDE doses used as safety review criteria. Therefore, the staff concludes that, with respect to DBAs, the VEGP site is environmentally suitable for operation of two new Westinghouse AP1000 reactors.

Table 5-14. DBA Doses for a Westinghouse AP1000 Reactor

Accident	Standard Review Plan Section ^(b)	TEDE in rem ^(a)		
		EAB ^(c)	LPZ ^(d)	Review Criterion
Main steam line break	15.1.5			
Pre-existing iodine spike		7.38×10^{-2}	2.58×10^{-2}	$2.5 \times 10^{+1(e)}$
Accident-initiated iodine spike		8.30×10^{-2}	7.67×10^{-2}	$2.5 \times 10^{+0(f)}$
Steam generator rupture	15.6.3			
Pre-existing iodine spike		1.66×10^{-1}	3.55×10^{-2}	$2.5 \times 10^{+1(e)}$
Accident-initiated iodine spike		8.30×10^{-2}	2.44×10^{-2}	$2.5 \times 10^{+0(f)}$
Loss-of-coolant accident	15.6.5	$3.52 \times 10^{+0}$	$1.54 \times 10^{+0}$	$2.5 \times 10^{+1(e)}$
Rod ejection	15.4.8	2.68×10^{-1}	1.66×10^{-1}	$6.25 \times 10^{+0(f)}$
Reactor coolant pump rotor seizure (locked rotor)	15.3.3			
No feedwater		6.46×10^{-2}	1.09×10^{-2}	$2.5 \times 10^{+0(f)}$
Feedwater available		4.61×10^{-2}	2.22×10^{-2}	$2.5 \times 10^{+0(f)}$
Failure of small lines carrying primary coolant outside containment	15.6.2	1.57×10^{-1}	2.86×10^{-2}	$2.5 \times 10^{+0(f)}$
Fuel handling	15.7.4	5.17×10^{-1}	9.63×10^{-2}	$6.25 \times 10^{+0(f)}$

(a) To convert rem to Sv, divide by 100.

(b) NUREG-0800 (NRC 1987).

(c) Exclusion area boundary.

(d) Low population zone.

(e) 10 CFR 50.34(a)(1), 10 CFR 52.17, and 10 CFR 100.21 criteria.

(f) Standard Review Plan criterion.

Source: Southern 2008a; NRC 1987

Summary of DBA Impacts

The NRC staff reviewed the DBA analysis in the ER, which is based on analyses performed for design certification of the Westinghouse AP1000 reactor design with adjustment for VEGP site-specific characteristics. The results of the Southern analyses indicate that the environmental risks associated with DBAs, if two new Westinghouse AP1000 reactors were to be located at

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the VEGP site, would be small. On this basis, the staff concludes that the environmental consequences of DBAs at the VEGP site would be of SMALL significance for two new Westinghouse AP1000 reactors.

As noted in Southern's comments on the draft EIS (Southern 2007f), Westinghouse, the AP1000 reactor vendor, has submitted a revision to the AP1000 design to NRC for review (Westinghouse 2007, NRC 2008). The NRC staff is reviewing that request independently of the VEGP review. The source term information in the Westinghouse submission indicates that the doses from postulated accidents would decrease should the proposed design revision be accepted. However, the staff has not completed its review of the design changes or done a site-specific analysis of the revised design at the Vogtle site.

5.10.2 Severe Accidents

In its ER, Southern considers the potential consequences of severe accidents for a Westinghouse AP1000 reactor at the VEGP site. Three pathways are considered: (1) the atmospheric pathway, in which radioactive material is released to the air, (2) the surface-water pathway, in which airborne radioactive material falls out on open bodies of water, and (3) the groundwater pathway, in which groundwater is contaminated by a basemat melt-through with subsequent contamination of surface water by the groundwater.

Southern bases its evaluation of the potential environmental consequences for the atmospheric and surface-water pathways on the results of the MACCS2 computer code (Chanin et al. 1990; Jow et al. 1990) run using Westinghouse AP1000 reactor source term information and site-specific meteorological, population, and land-use data. In response to an NRC request for additional information, dated December 29, 2006 (NRC 2006a), Southern provided the NRC with copies of the input and output files for the MACCS2 computer runs (Southern 2007d). The NRC staff has reviewed the input and output files, has run confirmatory calculations, and concurs with Southern's results.

Environmental consequences of some potential surface-water pathways (e.g., swimming and fishing) are not evaluated by MACCS2. Southern relied on generic analyses in the GEIS, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437 (NRC 1996) for these pathways. Similarly, the MACCS2 code does not address the potential environmental consequences of the groundwater pathway. Southern relied on generic analyses in the GEIS and earlier analyses to evaluate the potential consequences of releases to groundwater.

The MACCS computer code was developed to evaluate the potential offsite consequences of severe accidents for the sites covered by NUREG-1150 (NRC 1990). MACCS2 (Chanin and Young 1997) is the current version of MACCS. The MACCS and MACCS2 codes evaluate the consequences of atmospheric releases of material following a severe accident. The pathways modeled include exposure to the passing plume, exposure to material deposited on the ground

and skin, inhalation of material in the passing plume and resuspended from the ground, and ingestion of contaminated food and surface water. The primary enhancements in MACCS2 are that MACCS2 has (1) a flexible emergency-response model, (2) an expanded library of radionuclides, and (3) a semidynamic food-chain model (Chanin and Young 1997).

Three types of severe accident consequences were assessed: (1) human health, (2) economic costs, and (3) land area affected by contamination. Human health effects are expressed in terms of the number of cancers that might be expected if a severe accident were to occur. These effects are directly related to the cumulative radiation dose received by the general population. MACCS2 estimates both early cancer fatalities and latent fatalities. Early fatalities are related to high doses or dose rates and can be expected to occur within a year of exposure (Jow et al. 1990). Latent fatalities are related to exposure of a large number of people to low doses and dose rates and can be expected to occur after a latent period of several (2 to 15) years. Population health-risk estimates are based on the population distribution within an 80-km (50-mi) radius of the site. Economic costs of a severe accident include the costs associated with short-term relocation of people; decontamination of property and equipment; interdiction of food supplies, land, and equipment use; and condemnation of property. The affected land area is a measure of the areal extent of the residual contamination following a severe accident. Farm land decontamination is an estimate of the area that has an average whole body dose rate for the 4-year period following the release that would be greater than 0.005 Sv/yr (0.5 rem/yr) if not reduced by decontamination and that would have a dose rate following decontamination of less than 0.005 Sv/yr (0.5 rem/yr). Decontaminated land is not necessarily suitable for farming.

Risk is the product of the frequency and the consequences of an accident. For example, the probability of a severe accident without loss of containment for a Westinghouse AP1000 reactor at the VEGP site is estimated to be 2.2×10^{-7} per reactor year (Ryr^{-1}), and the cumulative population dose associated with a severe accident without loss of containment at the VEGP site is calculated to be 1.34×10^1 person-Sv (1.34×10^3 person-rem). The population dose risk for this class of accidents is the product of $2.2 \times 10^{-7} \text{ Ryr}^{-1}$ and 1.34×10^1 person-Sv (1.34×10^3 person-rem), or 2.9×10^{-6} person-Sv Ryr^{-1} (2.9×10^{-4} person-rem Ryr^{-1}). The following sections discuss the estimated risks associated with each pathway.

The risks presented in the tables that follow are risks per year of reactor operation. Southern has indicated that the VEGP site could hold two reactors of the Westinghouse AP1000 reactor design. The consequences of a severe accident would be the same regardless of whether one or two additional Westinghouse AP1000 reactors were built at the VEGP site. However, if two new Westinghouse AP1000 reactors were built, the risks would apply to each reactor, and the total risk for new reactors at the site would be twice the risk for a single reactor. Even if the risk values were doubled, the risks would still be significantly smaller than the risks associated with current-generation reactors.

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Air Pathway. The MACCS2 code directly estimates consequences associated with releases to the air pathway. The results of the MACCS2 runs are presented in Table 5-15. The core damage frequencies given in these tables are for internally initiated accident sequences while the plant is at power. Internally initiated accident sequences include sequences that are initiated by human error, equipment failures, loss of offsite power, etc. Estimates of the core damage frequencies for externally initiated events and during shutdown are discussed later.

Table 5-15 shows that the probabilistically weighted consequences, i.e., risks, of severe accidents for a Westinghouse AP1000 reactor located on the VEGP site are small for all risk categories considered. For perspective, Tables 5-16 and 5-17 compare the health risks from severe accidents for a Westinghouse AP1000 reactor at the VEGP site with the risks for current-generation reactors at various sites and with the AP1000 reactor at the North Anna, Clinton, and Grand Gulf ESP sites.

In Table 5-16, the health risks estimated for a Westinghouse AP1000 reactors at the VEGP site are compared to health-risk estimates for the five reactors considered in NUREG-1150 (NRC 1990). Although risks associated with both internally and externally initiated events were considered for the Peach Bottom and Surry reactors in NUREG-1150, only risks associated with internally initiated events are presented in Table 5-16. The health risks shown for the Westinghouse AP1000 reactor at the VEGP site are significantly lower than the risks associated with current-generation reactors presented in NUREG-1150. Table 5-16 also compares health risks of a Westinghouse AP1000 reactor at the VEGP site with health risks for a Westinghouse AP1000 reactor at three other ESP sites (NRC 2006b, c, d).

The last two columns of Table 5-16 provide average individual fatality risk estimates. To put these estimates into context for the environmental analysis, the staff compares these estimates to the safety goals. The Commission has set safety goals for average individual early fatality and latent cancer fatality risks from reactor accidents in the Safety Goal Policy Statement (51 FR 30028). These goals are presented here solely to provide a point of reference for the environmental analysis and does not serve the purpose of a safety analysis. The Policy Statement expressed the Commission's policy regarding the acceptance level of radiological risk from nuclear power plant operation as follows:

- Individual members of the public should be provided a level of protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and health
- Societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks.

Table 5-15. Mean Environmental Risks from a Westinghouse AP1000 Reactor Severe Accident at the VEGP Site

Release Category Description (Accident Class)	Environmental Risk						
	Core Damage Frequency (Ryr ⁻¹)	Population Dose (person-Sv Ryr ⁻¹) ^(a)	Fatalities (Ryr ⁻¹)		Cost ^(d) (\$ Ryr ⁻¹)	Farm Land Decontamination ^(e) (ha Ryr ⁻¹)	Population Dose from Water Ingestion (person Sv Ryr ⁻¹) ^(a)
IC Intact containment	2.2×10^{-7}	2.9×10^{-6}	$0.0 \times 10^{+0}$	1.8×10^{-7}	7.6×10^{-2}	7.5×10^{-8}	2.7×10^{-8}
BP Containment bypass, fission products released directly to environment	1.1×10^{-8}	2.2×10^{-4}	1.8×10^{-10}	1.4×10^{-5}	$3.8 \times 10^{+1}$	2.8×10^{-4}	1.4×10^{-5}
CI Containment isolation failure occurs prior to onset of core damage	1.3×10^{-9}	9.9×10^{-6}	6.7×10^{-12}	6.6×10^{-7}	$1.3 \times 10^{+0}$	1.8×10^{-5}	2.8×10^{-7}
CFE Early containment failure, after onset of core damage but before core relocation	7.5×10^{-9}	5.4×10^{-5}	6.6×10^{-13}	3.3×10^{-6}	$8.3 \times 10^{+0}$	6.8×10^{-5}	2.0×10^{-6}
CFI Intermediate containment failure, after core relocation but before 24 hr	1.9×10^{-10}	2.1×10^{-6}	4.0×10^{-14}	1.3×10^{-7}	2.3×10^{-1}	2.8×10^{-6}	2.7×10^{-8}
CFL Late containment failure occurring after 24 hr	3.5×10^{-13}	5.6×10^{-9}	$0.0 \times 10^{+0}$	3.7×10^{-10}	1.1×10^{-3}	1.3×10^{-8}	6.0×10^{-12}
Total	2.4×10^{-7}	2.8×10^{-4}	1.9×10^{-10}	1.9×10^{-5}	$4.8 \times 10^{+1}$	3.6×10^{-4}	1.7×10^{-5}

(a) To convert person-Sv to person-rem, multiply by 100.
(b) Early fatalities are fatalities related to high doses or dose rates that generally can be expected to occur within a year of the exposure (Jow et al. 1990).
(c) Latent fatalities are fatalities related to low doses or dose rates that can be expected to occur after a latent period of several (2 to 15) years.
(d) Cost risk includes costs associated with short-term relocation of people, decontamination, interdiction, and condemnation. It does not include costs associated with health effects (Jow et al. 1990).
(e) Land risk is area where the average whole body dose rate for the 4-year period following the accident exceeds 0.005 Sv/yr but can be reduced to less than 0.005 Sv/yr by decontamination.

Table 5-16. Comparison of Environmental Risks for a Westinghouse AP1000 Reactor at the VEGP Site with Risks for Current-Generation Reactors at Five Sites Evaluated in NUREG-1150^(a) and with Risks for the Westinghouse AP1000 Reactor at Three Other ESP Sites.

	Core Damage Frequency (Ryr ⁻¹)	50-mi (80-km) Population Dose Risk (person-Sv Ryr ⁻¹) ^(b)	Fatalities Ryr ⁻¹		Average Individual Fatality Risk Ryr ⁻¹	
			Early	Latent	Early	Latent Cancer
Grand Gulf ^(c)	4.0 × 10 ⁻⁶	5 × 10 ⁻¹	8 × 10 ⁻⁹	9 × 10 ⁻⁴	3 × 10 ⁻¹¹	3 × 10 ⁻¹⁰
Peach Bottom ^(c)	4.5 × 10 ⁻⁶	7 × 10 ⁺⁰	2 × 10 ⁻⁸	5 × 10 ⁻³	5 × 10 ⁻¹¹	4 × 10 ⁻¹⁰
Sequoyah ^(c)	5.7 × 10 ⁻⁵	1 × 10 ⁺¹	3 × 10 ⁻⁵	1 × 10 ⁻²	1 × 10 ⁻⁸	1 × 10 ⁻⁸
Surry ^(c)	4.0 × 10 ⁻⁵	5 × 10 ⁺⁰	2 × 10 ⁻⁶	5 × 10 ⁻³	2 × 10 ⁻⁸	2 × 10 ⁻⁹
Zion ^(c)	3.4 × 10 ⁻⁴	5 × 10 ⁺¹	4 × 10 ⁻⁵	2 × 10 ⁻²	9 × 10 ⁻⁹	1 × 10 ⁻⁸
Westinghouse AP1000 ^(d) Reactor at the VEGP site	2.4 × 10 ⁻⁷	2.8 × 10 ⁻⁴	1.9 × 10 ⁻¹⁰	1.9 × 10 ⁻⁵	1.6 × 10 ⁻¹²	1.1 × 10 ⁻¹¹
Westinghouse AP1000 ^(e) Reactor at North Anna	2.4 × 10 ⁻⁷	8.3 × 10 ⁻⁴	1.2 × 10 ⁻¹⁰	4.0 × 10 ⁻⁵	2.6 × 10 ⁻¹³	4.9 × 10 ⁻¹¹
Westinghouse AP1000 ^(f) Reactor at Clinton	2.4 × 10 ⁻⁷	2.2 × 10 ⁻⁴	1.4 × 10 ⁻⁸	1.2 × 10 ⁻⁵	6.4 × 10 ⁻¹³	5.5 × 10 ⁻¹¹
Westinghouse AP1000 ^(g) Reactor at Grand Gulf	2.4 × 10 ⁻⁷	1.4 × 10 ⁻⁴	< 1.0 × 10 ⁻¹²	6.9 × 10 ⁻⁶	< 1.0 × 10 ⁻¹⁴	2.0 × 10 ⁻¹¹

(a) NRC 1990
 (b) To convert person-Sv to person-rem, multiply by 100.
 (c) Risks were calculated using the MACCS code and presented in NUREG-1150 (NRC 1990).
 (d) Calculated with MACCS2 code using VEGP site-specific input.
 (e) NUREG-1811 (NRC 2006b)
 (f) NUREG-1815 (NRC 2006c)
 (g) NUREG-1817 (NRC 2006d)

Table 5-17. Comparison of Environmental Risks from Severe Accidents Initiated by Internal Events for a Westinghouse AP1000 Reactor at the VEGP Site with Risks Initiated by Internal Events for Current Plants, Including VEGP Units 1 and 2, Undergoing Operating License Renewal Review and Environmental Risks of the Westinghouse AP1000 Reactor at Other ESP Sites

	Core Damage Frequency (yr ⁻¹)	80-km (50-mi) Population Dose Risk (person-Sv Ryr ⁻¹) ^(a)
Current Reactor Maximum ^(b)	2.4×10^{-4}	6.9×10^{-1}
Current Reactor Mean ^(b)	3.1×10^{-5}	1.5×10^{-1}
Current Reactor Median ^(b)	2.5×10^{-5}	1.3×10^{-1}
VEGP Unit 1 or 2 ^(c)	1.6×10^{-5}	3.4×10^{-3}
Current Reactor Minimum ^(b)	1.9×10^{-6}	3.4×10^{-3}
Westinghouse AP1000 ^(d) Reactor at the VEGP site	2.4×10^{-7}	2.8×10^{-4}
Westinghouse AP1000 ^(e) Reactor at North Anna	2.4×10^{-7}	8.3×10^{-4}
Westinghouse AP1000 ^(f) Reactor at Clinton	2.4×10^{-7}	2.2×10^{-4}
Westinghouse AP1000 ^(g) Reactor at Grand Gulf	2.4×10^{-7}	1.4×10^{-4}

- (a) To convert person-Sv to person-rem, multiply by 100.
 (b) Based on MACCS and MACCS2 calculations for 60 current plants at 36 sites.
 (c) License Renewal ER for VEGP Units 1 and 2 (Southern 2007f)
 (d) Calculated with MACCS2 code using VEGP site-specific input.
 (e) NUREG-1811 (NRC 2006b)
 (f) NUREG-1815 (NRC 2006c)
 (g) NUREG-1817 (NRC 2006d)

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The following quantitative health objectives are used in determining achievement of the safety goals:

- The risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed one-tenth of 1 percent (0.1 percent) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed.
- The risk to the population in the area near a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed one-tenth of 1 percent (0.1 percent) of the sum of cancer fatality risks resulting from all other causes.

These quantitative health objectives are translated into two numerical objectives as follows:

- The individual risk of a prompt fatality from all “other accidents to which members of the U.S. population are generally exposed,” is about 3.8×10^{-4} per year (NSC 2006), including a 1.5×10^{-4} per year risk associated with transportation accidents (BTS 2005). One-tenth of 1 percent of these figures imply that the individual risk of prompt fatality from a reactor accident should be less than 4×10^{-7} Ryr⁻¹.
- “The sum of cancer fatality risks resulting from all other causes” for an individual is taken to be the cancer fatality rate in the U.S., which is about 1 in 500 or 2×10^{-3} per year (Reed 2007). One-tenth of 1 percent of this implies that the risk of cancer to the population in the area near a nuclear power plant because of its operation should be limited to 2×10^{-6} Ryr⁻¹.

MACCS2 calculates average individual early and latent cancer fatality risks. The average individual early fatality risk is calculated using the population distribution within 1.6 km (1 mi) of the plant boundary. The average individual latent cancer fatality risk is calculated using the population distribution within 16 km (10 mi) of the plant. For the plants considered in NUREG-1150, these risks were well below the Commission’s safety goals. Risks calculated for the Westinghouse AP1000 reactor design at the VEGP site are lower than the risks associated with the current-generation reactors considered in NUREG-1150 and are well below the Commission’s safety goals.

The staff compared the core damage frequency (CDF) and population dose risk estimate for a Westinghouse AP1000 reactor at the VEGP site with statistics summarizing the results of contemporary severe accident analyses performed for 60 reactors at 36 sites. The results of these analyses are included in the final site-specific Supplements 1 through 30 to the GEIS for License Renewal, NUREG-1437 (NRC 1996), and in the ERs included with license renewal applications for those plants for which supplements have not been published. All of the analyses were completed after publication of NUREG-1150 (NRC 1990), and the analyses for 56 of the reactors used MACCS2, which was released in 1997. Table 5-15 shows that the CDF

estimated for the Westinghouse AP1000 reactor is significantly lower than those of current-generation reactors. Similarly, the population doses estimated for a Westinghouse AP1000 reactor at the VEGP site are well below the mean and median values for current-generation reactors undergoing license renewal including VEGP Units 1 and 2.

Finally, the population dose risk from a severe accident for a Westinghouse AP1000 reactor at the VEGP site (2.8×10^{-4} person-Sv/Ryr) may be compared to the dose risk for normal operation of a single Westinghouse AP1000 reactor at the VEGP site (9.2×10^{-3} person-Sv/Ryr) (see Section 5.9.3.2). The risk associated with a severe accident is more than an order of magnitude lower than the risk associated with normal operations.

The analyses described above are specifically for internally initiated events. The ER does not address potential consequences from externally initiated events. However, the Westinghouse AP1000 reactor vendor and the staff have addressed three externally initiated events during design certification of the Westinghouse AP1000 reactor. Those events are seismic, internal fire, and internal flooding events. The analyses are described Section 19.1.5 of the Final Safety Evaluation Report (FSER) for the Westinghouse AP1000 reactor (NRC 2004b). Analyses of the capability of the Westinghouse AP1000 reactor design to withstand external flooding, tornadoes, hurricanes, and site-specific external events were not performed. These analyses are required of the COL applicant (NRC 2004b [COL Action Item 19.1.5-1]). In addition, the COL applicant is required to update the PRA used to support the Westinghouse AP1000 reactor design certification, as necessary, when site-specific and plant-specific (as-built) data become available (NRC 2004b [COL Action Item 19.1.1.1-1]).

With respect to seismic events, the Westinghouse AP1000 reactor vendor performed a PRA-based seismic margin analysis. This analysis indicates that there is a high confidence (95 percent) that safety systems and components would survive a 0.5g peak acceleration during a seismic event. The safe-shut down earthquake for the Westinghouse AP1000 reactor design is 0.3g. Consequently, the staff concluded in the FSER that the Westinghouse AP1000 reactor design is acceptable.

With respect to internal fires, the Westinghouse AP1000 reactor vendor estimated the fire-induced CDFs to be about 5.6×10^{-8} per year, during power operation and about 8×10^{-8} per year during shutdown and considers these estimates to be conservative. While the staff believes that such a conclusion is not possible without a detailed PRA, the staff did conclude that the Westinghouse AP1000 reactor design is capable of withstanding severe accident challenges from internal fires in a manner superior to most, if not all, operating plant designs. In addition, because detailed PRA-based internal fires analyses at some operating plants have shown that fire-induced sequences can be leading contributors to CDF, COL applicants should provide an updated internal fires PRA that takes into account design details (e.g., cable routing, door and equipment locations, and fire detection and suppression system locations) to search for internal fire vulnerabilities (NRC 2004b [COL Action Item 19.1.5.2.1-1]).

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With respect to internal flooding, the Westinghouse AP1000 reactor vendor did not perform a detailed PRA to assess the risk from internal flooding. Instead, the vendor performed an internal flooding PRA commensurate with the level of detail available and made conservative assumptions, where detailed information was not available, to bound the flooding analysis. The staff found that this analysis was adequate to identify potential vulnerabilities and to lend insight into the design which could be used to support design certification requirements. Quantification of potential scenarios with the plant at power resulted in a total CDF from internal floods of about 1×10^{-9} per year. The CDF from internal floods when the plant is shut down is estimated to be about 3.2×10^{-9} per year. The vendor considers these estimates to be conservative. While the staff believes that such a conclusion is not possible without a detailed PRA, the staff did conclude that the Westinghouse AP1000 reactor design is capable of withstanding severe accident challenges from internal floods in a manner superior to operating plants and that the conclusions from the vendor's internal flood risk analysis complement this belief. In addition, because detailed PRA-based internal floods analyses at some operating plants have shown that flood-induced sequences can be leading contributors to CDF, COL applicants should provide an updated internal flood PRA that takes into account design details (e.g., pipe routing, door locations, flood barriers) to search for internal flooding vulnerabilities (NRC 2004b [COL Action Item 19.1.5.3-1]).

Surface-Water Pathways. Surface-water pathways are an extension of the air pathway. These pathways cover the effects of radioactive material deposited on open bodies of water. The surface-water pathways of interest include external radiation from submersion in water and activities near the water, ingestion of water, and ingestion of fish and other aquatic creatures. Of these pathways, the MACCS2 code evaluates only the ingestion of contaminated water. The risks associated with this surface-water pathway calculated for the VEGP site are included in the last column of Table 5-15.

Doses from surface-water pathways are not modeled in MACCS or MACCS2. Typical population exposure risk for the aquatic food pathway for plants located on small rivers were considered in the GEIS (NRC 1996). For these plants, the population dose from the food pathway was well below the population dose from the air pathway. The existing VEGP, which is co-located with the ESP site, is classified as being on a small river. The Savannah River is used for recreational activities including swimming and fishing. Analysis of water-related exposure pathways at the Fermi reactor (NRC 1981) suggests that population exposures from swimming are significantly lower than exposures from the aquatic ingestion pathway.

Should a severe accident occur at a Westinghouse AP1000 reactor located at the VEGP site, it is likely that Federal, State, and local officials would restrict access to the river below the site and in contaminated areas above the site. These actions would further reduce surface-water pathway exposures.

Groundwater Pathway. MACCS2 does not evaluate the environmental risks associated with severe accident releases of radioactive material to groundwater. However, this pathway has been addressed in NUREG-1437 in the context of renewal of licenses for current-generation reactors (NRC 1996). In NUREG-1437 the staff assumes a 1×10^{-4} Ryr⁻¹ probability of occurrence of a severe accident with a basemat melt-through leading to potential groundwater contamination, and the staff concluded that groundwater contribution to risk is generally a small fraction of the risk attributable to the atmospheric pathway.

The staff has reevaluated its assumption of a 1×10^{-4} Ryr⁻¹ probability of a basemat melt-through. The staff believes that the 1×10^{-4} probability is too large for new plants. The probability of core melt with basemat melt-through should be no larger than the total core damage frequency estimate for the reactor. Table 5-15 gives a total core damage frequency estimates of 2.4×10^{-7} Ryr⁻¹ for the Westinghouse AP1000 reactor. NUREG-1150 indicates that the conditional probability of a basemat melt-through ranges from 0.05 to 0.25 for current-generation reactors. New designs include features to reduce the probability of basemat melt-through in the event of a core melt accident. On this basis, the staff believes that a basemat melt-through probability of 1×10^{-7} Ryr⁻¹ is reasonable and still conservative.

Although the staff assumed that the probability of occurrence of a release via the groundwater pathway is significantly larger than a release via the atmospheric pathway for the Westinghouse AP1000 reactor, the groundwater pathway is more tortuous and affords more time for implementing protective actions and, therefore, results in a lower risk to the public. As a result, the staff concludes that the risks associated with releases to groundwater are sufficiently small that they would not have a significant effect on determination of suitability of the VEGP site.

Summary of Severe Accident Impacts. The NRC staff has reviewed the analysis in the ER and conducted its own confirmatory analysis using the MACCS2 code. The results of both the Southern analysis and the NRC analysis indicate that the environmental risks associated with severe accidents if a Westinghouse AP1000 reactor were to be located at the VEGP site would be small compared to risks associated with operation of the current-generation reactors at the VEGP site and other sites. These risks are well below the NRC safety goals. On these bases, the staff concludes that the probability-weighted consequences of severe accidents at the VEGP site would be of SMALL significance for a Westinghouse AP1000 reactor.

Neither Southern nor the NRC staff has evaluated the effects of the proposed revision to the AP1000 design (Westinghouse 2007; NRC 2008) on the site-specific consequences of postulated severe accidents for an AP1000 reactor at the Vogtle site.

5.10.3 Severe Accident Mitigation Alternatives

Southern elected to reference the Westinghouse AP1000 reactor design in its ESP application. The Westinghouse AP1000 reactor design (see Appendix D to Part 52-Design Certification

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Rule for the AP1000 Design) incorporates many features intended to reduce severe accident core damage frequencies (CDFs) and the risks associated with severe accidents. The effectiveness of the Westinghouse AP1000 reactor design features is evident in Tables 5-16 and 5-17, which compare CDFs and severe accident risks for the Westinghouse AP1000 reactor with CDFs and risks for current-generation reactors including VEGP Units 1 and 2. Core damage frequencies and risks have generally been reduced by a factor of 100 or more when compared to the existing units.

The purpose of the evaluation of severe accident mitigation alternatives (SAMAs) is to determine whether there are SAMDAs or procedural modifications or training activities that can be justified to further reduce the risks of severe accidents (NRC 2000a). Consistent with the direction from the Commission to consider the severe accident mitigation design alternatives (SAMDAs) at the time of certification, the Westinghouse AP1000 reactor vendor (Westinghouse 2005) and the staff, in its environmental assessment (EA) accompanying the rule (NRC 2004a, 2005), have considered a number of design alternatives for a Westinghouse AP1000 reactor at a generic site. On these bases, the staff concluded (NRC 2006e):

Because the AP1000 design already has numerous plant features designed to reduce CDF and risk, the benefits and risk reduction potential of any additional plant improvements is significantly reduced. This reduction is true for both internally and externally initiated events. Moreover, with the features already incorporated in the AP1000 design, the ability to estimate CDF and risk approaches the limits of probabilistic techniques. Specifically, when CDFs are estimated to be on the order of 1 in 1,000,000 years, it is possible that areas of the PRA where modeling is least complete, or supporting data are sparse or even nonexistent, may actually be the more important contributors to risk. Areas not modeled or incompletely modeled included human reliability, sabotage, rare initiating events, construction and design errors, and system interactions. Although improvements in these areas may introduce additional contributors to CDF and risk, the NRC does not expect that additional contributions would change the conclusions in absolute terms.

In its ER (Southern 2008a), Southern assessed 15 SAMDAs that were considered in the AP1000 DCD (Westinghouse 2005) using the VEGP site-specific information. Using procedures set forth in NUREG/BR-0184 (NRC 1997), the applicant determined that the maximum averted cost risk for a single Westinghouse AP1000 reactor at the VEGP site is so low that none of the SAMDAs is cost beneficial. A more realistic assessment would show that the potential reductions in cost risk are substantially less than the maximum averted cost risk because no SAMDA can reduce the remaining risk to zero. Based on a review of its previous evaluation of generic SAMDAs for the Westinghouse AP1000 reactor and the applicant's analysis, the staff concludes that there are no cost beneficial SAMDAs and that the SAMDA issue is resolved.

The SAMDA issue is a subset of the SAMA review. The other attributes of the SAMA review, namely procedural modifications and training activities, have not been addressed by the applicant. However, the applicant has stated (Southern 2008a) that "...appropriate administrative controls on plant operations would be incorporated into the plants' management systems as part of its baseline."

5.10.4 Summary of Postulated Accident Impacts

The staff evaluated the environmental impacts from DBAs and severe accidents for a Westinghouse AP1000 reactor at the VEGP site. Based on the information provided by Southern and NRC's own independent review, the staff concludes that the potential environmental impacts from a postulated accident from the operation of the proposed VEGP Units 3 and 4 would be SMALL.

5.11 Measures and Controls to Limit Adverse Impacts During Operation

The following general measures and controls on which the staff relied in its evaluation of environmental impacts during operation of two new units at the VEGP site include those that would be required of Southern (at the Federal, State, and local levels) by applicable permits and authorizations (contained in Tables 1.3-1, 1.3-2, and 1.3-4 of the ER) as well as the feasible measures and controls contained in Section 5.10 of the ER (Southern 2008a):

- Compliance with the applicable Federal, State, and local laws, ordinances, and regulations that prevent or minimize adverse environmental impacts (e.g., solid waste management, erosion and sediment control, air emission control, noise control, stormwater management, spill response and cleanup, and hazardous material management)
- Compliance with applicable requirements of permits and licenses required for operation (e.g., NPDES and GDNR permits and operating license requirements)
- Compliance with Southern or GPC procedures applicable to environmental control and management.

Some of these permits or approvals include:

- NPDES permit requirements imposed on water discharges from the new units (ER Sections 5.2 and 5.3)
- The Georgia Environmental Protection Agency permit limits and regulations for installing and operating air emission sources

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Southern evaluated the measures and controls shown in Section 5.10 of the ER (Southern 2008a) and considered them feasible from both a technical and economic standpoint. In addition, Southern expects these measures and controls to be adequate for avoiding or mitigating potential adverse impacts associated with operation of the new units. The staff considered these measures and controls in its evaluation of station operation impacts.

Table 5-18 lists a summary of measures and controls to limit adverse impacts during operation proposed by Southern. Table 5-18 is reproduced from sections of Southern's Table 5.10-1 of the ER (Southern 2008a).

5.12 Summary of Operational Impacts

Impact level categories are denoted in Table 5-19 as SMALL, MODERATE, or LARGE as a measure of their expected adverse impacts, if any. With the socioeconomic issues for which the impacts are likely to be beneficially MODERATE or LARGE, this is noted in the Comments column. The Impact Level column designates beneficial impacts as SMALL.

Table 5-18. Summary of Measures and Controls Proposed by Southern to Limit Adverse Impacts During Operation of Proposed VEGP Units 3 and 4 at the VEGP Site (Southern 2008a).

Impact Category	Specific Measures and Control
Land-Use Impacts	
The Site and Vicinity	Southern did not propose any additional measures or controls.
Transmission Line Rights-of-Way and Offsite Areas	<ul style="list-style-type: none"> • Maintenance practices would protect sensitive habitats and protected species, including wetlands and water crossings. • Routing decisions would consider protected species and critical habitats.
Historic Properties and Cultural Resources	Southern did not propose any additional measures or controls.
Air Quality Impacts	
Heat Dissipation to the Atmosphere	Southern did not propose any additional measures or controls.
Water-Related Impacts	
Hydrologic Alterations and Plant Water Supply	Southern did not propose any additional measures or controls.
Water-Use Impacts	Southern did not propose any additional measures or controls.
Water-Quality Impacts	Southern did not propose any additional measures or controls.
Future Water Use	Southern did not propose any additional measures or controls.
Cooling System Impacts	
Intake System	Southern did not propose any additional measures or controls.

Station Operational Impacts at the Proposed Site

Table 5-18. (contd)

Impact Category	Impact Category
Hydrodynamic Descriptions and Physical Impacts	Southern did not propose any additional measures or controls.
Aquatic Ecosystems	Southern did not propose any additional measures or controls.
Discharge System	Southern did not propose any additional measures or controls.
Thermal Description and Other Physical Impacts	Southern did not propose any additional measures or controls.
Aquatic Ecosystems	Southern did not propose any additional measures or controls.
Terrestrial Ecosystems	Southern did not propose any additional measures or controls.
Impacts to Members of the Public	Southern did not propose any additional measures or controls.
Radiological Impacts of Normal Operation	
Exposure Pathways	Releases of radiation would be within all regulatory limits.
Radiation Doses to Members of the Public	Southern did not propose any additional measures or controls.
Impacts to Members of the Public	Southern did not propose any additional measures or controls.
Impacts to Biota Other than Members of the Public	Southern did not propose any additional measures or controls.
Environmental Impact of Waste	
Nonradioactive Waste System Impacts	<ul style="list-style-type: none"> • All discharges would comply with Georgia NPDES permit and applicable water-quality standards. • Revise the existing VEGP Stormwater Pollution Prevention Plan or prepare and implement a new one to avoid/minimize releases of contaminated stormwater. • Revise the existing Spill Prevention Countermeasures and Control Plan or prepare and implement a new one to avoid/minimize contamination from spills. • Use approved transporters and offsite landfills for disposal of solid wastes. • Continue the existing program of waste minimization reuse and recycling. • Operate minor air emission sources in accordance with applicable regulations and certificates. • If necessary, modify the existing sanitary waste treatment system to accommodate increased volume.

Station Operational Impacts at the Proposed Site

Table 5-18. (contd)

Impact Category	Impact Category
Mixed Waste Impacts	<ul style="list-style-type: none"> • Limit mixed waste generation through source reduction, recycling, and treatment options. • Develop a Waste Minimization Program to address mixed waste inventory management, equipment maintenance, recycling and reuse, segregation, treatment (decay in storage), work planning, waste tracking, and awareness training. • Revise the existing Spill Prevention Countermeasures and Control Plan or prepare and implement a new one to avoid/minimize contamination from spills.
Waste Minimization	Develop a Waste Minimization Program to address mixed waste inventory management, equipment maintenance, recycling and reuse, segregation, treatment (decay in storage), work planning, waste tracking, and awareness training.
Radioactive Waste	Develop a Waste Minimization Program to address mixed waste inventory management, equipment maintenance, recycling and reuse, segregation, treatment (decay in storage), work planning, waste tracking, and awareness training.
Transmission System Impacts Terrestrial Ecosystems	Maintenance practices would protect sensitive habitats and protected species, including wetland and water crossings.
Aquatic Ecosystems	Southern did not propose any additional measures or controls.
Impacts to Members of the Public	Southern did not propose any additional measures or controls.
Uranium Fuel Cycle Impacts	
Uranium Fuel Cycle Impacts Relative to Westinghouse AP1000 Reactor	<ul style="list-style-type: none"> • Select mining techniques that minimize potential impacts. • Consider use of new technology that requires less uranium hexafluoride. • Consider use of centrifuge process over gaseous diffusion process, which could significantly reduce energy requirements and environmental impacts. • Consider use of new technologies with less fuel loading to reduce energy, emissions and water usage.
Socioeconomic Impacts	
Physical Impacts of Proposed Units	<ul style="list-style-type: none"> • Comply with permit limits and regulations for installing and operating air emission sources. • Perform view scape study for new structures onsite, including cooling towers, as part of final design. • Consider staggering outage shifts to reduce plant-associated traffic on local roads during shift changes.

Station Operational Impacts at the Proposed Site

Table 5-18. (contd)

Impact Category	Impact Category
Social and Economic Impacts of Proposed Units	Lead time would allow developers to construct new homes.
Environmental Justice	Southern did not propose any additional measures or controls; traffic volume would not exceed road capacities.
Decommissioning	
Decommissioning	Southern did not propose any additional measures or controls.
Transportation of Radioactive Waste	
Transportation of Radioactive Waste	Southern did not propose any additional measures or controls.
Nonradiological Health Impacts	
Nonradiological Health Impacts	Southern did not propose any additional measures or controls.

Table 5-19. Characterization of Operational Impacts at the VEGP Site

Category	Comments	Impact Level
Land-Use Impacts		
The Site and Vicinity	Operation of 2 new units within existing site. Possible new housing and retail space added in vicinity because of potential growth.	SMALL
Transmission Line Rights-of-Way	Most land-use impacts occur during construction.	SMALL
Air-Quality Impacts	Cooling tower, meteorological, and transmission line impacts are expected to be negligible. Pollutants emitted during operations considered insignificant and limits could be incorporated under existing permits.	SMALL
Water-Related Impacts		
Water Use	During normal and drought years, the impact would be SMALL.	SMALL
Water Quality	Water effluents would be regulated by the GDNR and the NPDES permit.	SMALL
Ecological Impacts		
Terrestrial Ecosystems	Impacts from operation of a new nuclear unit, including the associated heat dissipation system, transmission lines, and right-of-way maintenance would be negligible.	SMALL
Aquatic Ecosystems	Southern's adherence to the NPDES permit and EPA's intake structure design requirements would likely result in the maintenance of balanced aquatic populations.	SMALL

Station Operational Impacts at the Proposed Site

Table 5-19. (contd)

Category	Comments	Impact Level
Threatened and Endangered Species	The American alligator and the shortnose sturgeon are the only threatened or endangered animal species known to inhabit the area; other species are transient and would not be affected.	SMALL
Socioeconomic Impacts		
Physical Impacts		
Workers/Public	Workers would use protective equipment and receive training to mitigate any possible impact. The VEGP site location is relatively remote, so the public would not be affected.	SMALL
Buildings	No anticipated impact to onsite or offsite buildings.	SMALL
Roads	Upgrades before or during construction would cover the lesser impact of operational workforces.	SMALL
Aesthetics	Visual impact would be minimal because of remote location and sparse population. Visual impacts of operation at the VEGP site would be SMALL and similar to existing conditions. Aesthetic impact along new transmission line right-of-way would be MODERATE.	SMALL to MODERATE
Demography	Number of new employees would be small in proportion to population base in the region if in-migrating population settles according to current patterns for VEGP Units 1 and 2.	SMALL
Impacts to Community - Social and Economic		
Economy	Increased jobs would benefit the area economically, up to a moderate beneficial impact (Burke County) is possible.	SMALL to MODERATE Beneficial
Taxes	Degree of impact depends on distribution of revenues to county or state; generally impact is beneficial, especially for property taxes. Under current tax law, the beneficial impact of additional taxes would be LARGE for Burke County, and SMALL elsewhere.	SMALL to LARGE Beneficial
Infrastructure and Community Services		
Transportation	Improvements made for construction would be sufficient to cover any adverse impact from additional operational workers.	SMALL

Station Operational Impacts at the Proposed Site

Table 5-19. (contd)

Category	Comments	Impact Level
Recreation	Overall impacts on recreation near the VEGP site would be minimal because of the remote location and fact that the facility would be operating in an area with an existing nuclear power facility.	SMALL
Housing	Adequate housing is available in the region to handle operational workers.	SMALL
Public Services	Adequate in all counties for any population increase because of the operation workforce.	SMALL
Education	Current schools and planned additions would handle additional students.	SMALL
Historic and Cultural Resources	A cultural resource procedure is in place for minimizing impacts from routine land disturbances.	SMALL
Environmental Justice	Physical impacts would be SMALL. Economic impacts would be beneficial under existing tax law.	SMALL
Nonradiological Health Impacts	Small estimated river temperature increase would not significantly increase abundance of thermophilic microorganisms. Health impacts of noise, EMFs, and occupational injuries would be monitored and controlled in accordance with OSHA regulations.	SMALL
Radiological Health Impacts	Doses to the public and occupational workers would be monitored and controlled in accordance with NRC limits. ^(a)	SMALL
Impacts of Postulated Accidents		
Design-Basis Accidents	Doses for a Westinghouse AP1000 reactor are expected to be a small fraction of the regulatory dose limits.	SMALL
Severe Accidents	Risks would be small compared to current-generation nuclear power facilities.	SMALL

(a) The ICRP (ICRP 1977; ICRP 1991) states that if humans are adequately protected, other living things are also likely to be sufficiently protected.

5.13 References

10 CFR Part 20. Code of Federal Regulations, Title 10, *Energy*, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

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10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy*, Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

10 CFR Part 100. Code of Federal Regulations, Title 10, *Energy*, Part 100, "Reactor Site Criteria."

29 CFR Part 1910. Code of Federal Regulations, Title 29, *Labor*, Part 1910, "Occupational Safety and Health Standards."

36 CFR Part 800. Code of Federal Regulations, Title 36, *Parks, Forests, and Public Property*, Part 800, "Protection of Historic Properties."

40 CFR Part 81. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 81, "Designation of Areas for Air Quality Planning Purposes."

40 CFR Part 190. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operation."

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6.0 Fuel Cycle, Transportation, and Decommissioning

This chapter addresses the environmental impacts from (1) the uranium fuel cycle and solid waste management, (2) the transportation of radioactive material, and (3) the decommissioning of two new nuclear units at the Vogtle Electric Generating Plant (VEGP) site.

In its evaluation of uranium fuel cycle impacts from new units at the VEGP site, Southern Nuclear Operating Company, Inc. (Southern) used the Westinghouse AP1000 advanced light-water reactor (LWR) design, assuming a capacity factor of 93 percent. The capacity factor reported by Westinghouse Electric Company, LLC (2005) for the Westinghouse AP1000 reactor design is 95 percent. The results reported here assume two units with a capacity factor of 95 percent. If a different design is proposed at the construction permit (CP) or combined license (COL) stage, the staff anticipates that would constitute new and significant information requiring Southern to perform a new evaluation.

6.1 Fuel Cycle Impacts and Solid Waste Management

This section discusses the environmental impacts from the uranium fuel cycle and solid waste management for the Westinghouse AP1000 reactor design. The environmental impacts of this design are evaluated against specific criteria for LWR designs at Title 10 of the Code of Federal Regulations (CFR) 51.51.

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- and high-level wastes related to uranium fuel cycle activities to the environmental costs of licensing the nuclear power reactor. Table S-3 shall be included in the environmental report and may be supplemented by a discussion of the environmental significance of the data set forth in the table as weighed in the analysis for the proposed facility.

The Westinghouse AP1000 reactors proposed for the VEGP site will use uranium dioxide fuel; therefore, Table S-3 (10 CFR 51.51(b)) can be used to assess environmental impacts. Table S-3 values are normalized for a reference 1000-megawatt electrical (MW(e)) LWR at an 80-percent capacity factor. The 10 CFR 51.51(a) Table S-3 values are reproduced in Table 6-1. The power rating for the VEGP site is 6800 megawatts thermal (MW(t)), assuming

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that two Westinghouse AP1000 reactors would be located on the VEGP site (Southern 2008). With a capacity factor of 95 percent, this corresponds to 2185 MW(e).

Specific categories of natural resource use are included in Table S-3 (see Table 6-1). These categories relate to land use, water consumption and thermal effluents, radioactive releases, burial of transuranic and high-level and low-level wastes, and radiation doses from transportation and occupational exposures. In developing Table S-3, the staff considered two fuel cycle options that differed in the treatment of spent fuel removed from a reactor. The "no-recycle" option treats all spent fuel as waste to be stored at a Federal waste repository, whereas, the "uranium only recycle" option involves reprocessing spent fuel to recover unused uranium and return it to the system. Neither cycle involves the recovery of plutonium. The contributions in Table S-3 resulting from reprocessing, waste management, and transportation of wastes are maximized for both of the 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. The uranium fuel cycle is defined as the total of those operations and processes associated with provision, utilization, and ultimate disposition of fuel for nuclear power reactors.

Table 6-1. Table S-3 from 10 CFR 51.51(b), Table of Uranium Fuel Cycle Environmental Data^(a)

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000 MW(e) LWR
Natural Resource Use		
Land (acres):		
Temporarily committed ^(b)	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to a 100-MW(e) coal-fired power plant.
Permanently committed	13	
Overburden moved (millions of MT) ..	2.8	Equivalent to a 95-MW(e) coal-fired power plant.
Water (millions of gallons):		
Discharged to air	160	= 2 percent of model 1000-MW(e) LWR with cooling tower.
Discharged to water bodies	11,090	
Discharged to ground	127	
Total.....	11,377	< 4 percent of model 1000 MW(e) with once-through cooling.
Fossil fuel:		
Electrical energy (thousands of MW-hr)	323	<5 percent of model 1000 MW(e) LWR output.
Equivalent coal (thousands of MT)	118	Equivalent to the consumption of a 45-MW(e) coal-fired power plant.

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Table 6-1. (contd)

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000 MW(e) LWR
Natural gas (millions of standard cubic feet)	135	<0.4 percent of model 1000 MW(e) energy output.
Effluents—Chemical (MT)		
Gases (including entrainment): ^(c)		
SO _x ⁻¹	4400	
NO _x ^{-1(d)}	1190	Equivalent to emissions from 45 MW(e) coal-fired plant for a year.
Hydrocarbons.....	14	
CO.....	29.6	
Particulates.....	1154	
Other gases:		
F.....	0.67	Principally from uranium hexafluoride (UF ₆) production, enrichment, and reprocessing. The concentration is within the range of state standards—below level that has effects on human health.
HCl.....	0.014	
Liquids:		
SO ₄ ⁻	9.9	From enrichment, fuel fabrication, and reprocessing
NO ₃ ⁻	25.8	steps. Components that constitute a potential for
Fluoride.....	12.9	adverse environmental effect are present in dilute
Ca ⁺⁺	5.4	concentrations and receive additional dilution by
Cl ⁻	8.5	receiving bodies of water to levels below permissible
Na ⁺	12.1	standards. The constituents that require dilution and the
NH ₃	10	flow of dilution water are: NH ₃ —600 cfs, NO ₃ —20 cfs,
Fe.....	0.4	Fluoride—70 cfs.
Tailings solutions (thousands of MT).....	240	From mills only—no significant effluents to environment.
Solids		
	91,000	Principally from mills—no significant effluents to environment.
Effluents—Radiological (curies)		
Gases (including entrainment):		
Rn-222.....		Presently under reconsideration by the Commission.
Ra-226.....	0.02	
Th-230.....	0.02	
Uranium.....	0.034	
Tritium (thousands).....	18.1	
C-14.....	24	
Kr-85 (thousands).....	400	
Ru-106.....	0.14	Principally from fuel reprocessing plants.
I-129.....	1.3	
I-131.....	0.83	
Tc-99.....		Presently under consideration by the Commission.

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Table 6-1. (contd)

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1000 MW(e) LWR
Fission products and transuranics	0.203	
Liquids:		
Uranium and daughters	2.1	Principally from milling—included tailings liquor and returned to ground—no effluents; therefore, no effect on environment.
Ra-226	0.0034	From UF ₆ production.
Th-230	0.0015	
Th-234	0.01	From fuel fabrication plants—concentration 10 percent of 10 CFR Part 20 for total processing 26 annual fuel requirements for model LWR.
Fission and activation products	5.9×10^{-6}	
Solids (buried onsite):		
Other than high level (shallow)	11,300	9100 Ci comes from low-level reactor wastes and 1500 Ci comes from reactor decontamination and decommissioning—buried at land burial facilities. 600 Ci comes from mills—included in tailings returned to ground. Approximately 60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment.
TRU and HLW (deep)	1.1×10^7	Buried at Federal Repository.
Effluents—thermal (billions of British thermal units)	4063	<5 percent of model 1000-MW(e) LWR.
Transportation (person-rem):		
Exposure of workers and general public	2.5	
Occupational exposure (person-rem)	22.6	From reprocessing and waste management.

- (a) In some cases where no entry appears it is clear from the background documents that the matter was addressed and that, in effect, the table should be read as if a specific zero entry had been made. However, 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. These issues may be the subject of litigation in the individual licensing proceedings. Data supporting this table are given in the "Environmental Survey of the Uranium Fuel Cycle," WASH-1248 (AEC 1974); the "Environmental Survey of the Reprocessing and Waste Management Portion of the LWR Fuel Cycle," NUREG-0116 (Supp. 1 to WASH-1248) (NRC 1976); 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) (NRC 1977b); and in the record of the final rulemaking pertaining to Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management, Docket RM-50-3. The contributions from reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor, which are considered in Table S-4 of Sec. 51.20(g). The contributions from the other steps of the fuel cycle are 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, because 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 equivalent coal for power generation.
- (d) 1.2 percent from natural gas use and process.

In 1978, the Nuclear Nonproliferation Act of 1978 (22 USC 3201, et seq.) was enacted. This law 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 (119 Statute 594) was enacted. It authorized the U.S. Department of Energy (DOE) to conduct an advanced fuel recycling technology research and development program to evaluate proliferation-resistant fuel recycling and transmutation technologies that minimize environmental or public health and safety impacts. Consequently, while Federal policy does not prohibit reprocessing, additional DOE efforts would be necessary before commercial reprocessing and recycling of spent fuel produced in the U.S. commercial nuclear power plants could commence.

The no-recycle option is presented schematically in Figure 6-1. Natural uranium is mined in either open-pit or underground mines or by an *in situ* leach solution mining process. *In situ* leach mining, presently the primary form of mining in the United States, involves injecting a lixiviant solution into the uranium ore body to dissolve uranium and then pumping the solution to the surface for further processing. The ore or *in situ* leach solution is transferred to mills where it is processed to produce "yellowcake" (U_3O_8). A conversion facility prepares the uranium oxide by converting it to uranium hexafluoride, which is then processed by an enrichment facility to increase the percentage of the more fissile isotope uranium-235 and decrease the percentage of the non-fissile isotope uranium-238. At a fuel fabrication facility, the enriched uranium, which is approximately 5 percent uranium-235, is then converted to UO_2 . The UO_2 is pelletized, sintered, and inserted into tubes to form fuel assemblies, which are placed in a reactor to produce power. When the content of the uranium-235 reaches a point where the nuclear reactor has become inefficient with respect to neutron economy, the fuel assemblies are withdrawn from the reactor. After onsite storage for sufficient time to allow for short-lived fission product decay and to reduce the heat generation rate, the fuel assemblies would be transferred to a waste repository for internment. Disposal of spent fuel elements in a repository constitutes the final step in the no-recycle option.

The following assessment of the environmental impacts of the fuel cycle as related to the operation of the proposed project is based on the values given in Table S-3 (Table 6-1) and the staff's analysis of the radiological impact from radon-222 and technetium-99. In NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) (NRC 1996a,b, 1999),^(a) the staff provides a detailed analysis of the environmental impacts from the uranium fuel cycle. Although NUREG-1437 is specific to the impacts related to license

(a) NUREG-1437 was originally issued in 1996. Addendum 1 to NUREG-1437 was issued in 1999. Hereafter, all references to NUREG-1437 include NUREG-1437 and its Addendum 1.

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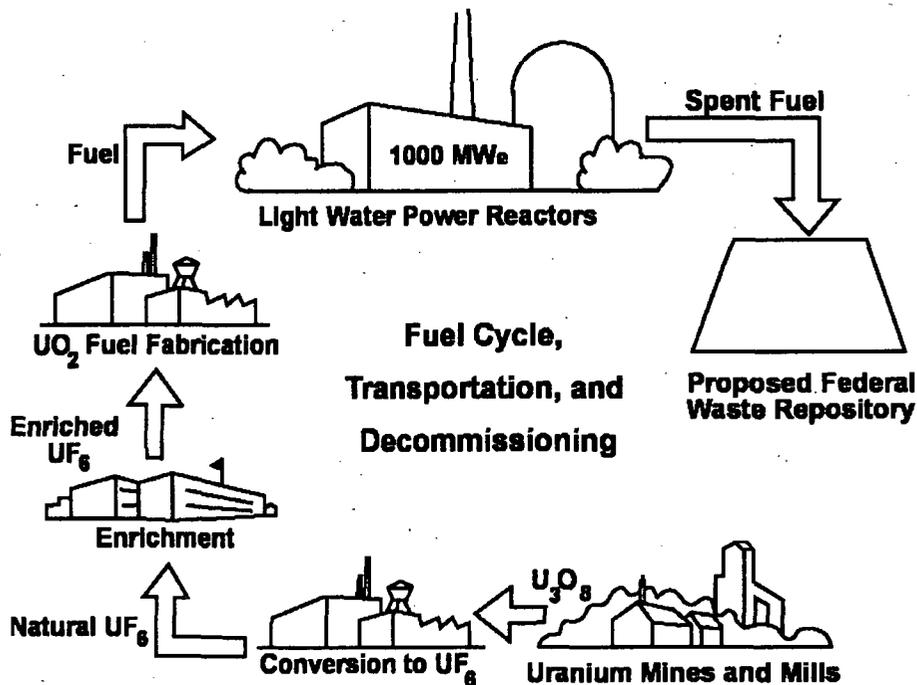


Figure 6-1. The Uranium Fuel Cycle: No-Recycle Option

renewal, the information is relevant to this review because the advanced LWR design considered here uses the same type of fuel; the staff's analyses in Section 6.2.3 of NUREG-1437 are summarized and set forth here.

The fuel cycle impacts in Table S-3 are based on a reference 1000-MW(e) LWR operating at an annual capacity factor of 80 percent for a net electric output of 800 MW(e). In the following review and evaluation of the environmental impacts of the fuel cycle, the staff considered the capacity factor of 95 percent with a total net electric output of 2185 MW(e) for the proposed two new units at the VEGP site (Southern 2008); this is about three times (i.e., 2185 MW(e) divided by 800 MW(e) yields 2.73) the impact values in Table S-3 (see Table 6-1). Throughout this chapter, this will be referred to as the 1000-MW(e) LWR-scaled model, reflecting 2185 MW(e) for the site and, for simplicity the Table S-3 results are scaled by a factor of 3 rather than 2.73.

Recent changes in the fuel cycle may have some bearing on environmental impacts; however, as discussed below, the staff is confident that the contemporary fuel cycle impacts are below those identified in Table S-3.

The values in Table S-3 were calculated from industry averages for the performance of each type of facility or operation within the fuel cycle. Recognizing that this approach meant that

there would be a range of reasonable values for each estimate, the staff followed the policy of choosing the assumptions or factors to be applied so that the calculated values would not be underestimated. This approach was intended to ensure that the actual environmental impacts would be less than the quantities shown in Table S-3 for all LWR nuclear power plants within the widest range of operating conditions. Many subtle fuel cycle parameters and interactions were recognized by the staff as being less precise than the estimates and were not considered or were considered but had no effect on the Table S-3 calculations. For example, to determine the quantity of fuel required for a year's operation of a nuclear power plant in Table S-3, the staff defined the model reactor as a 1000-MW(e) LWR reactor operating at 80-percent capacity with a 12-month fuel reloading cycle and an average fuel burnup of 33,000 MWd/MTU. This is a "reactor reference year" or "reference reactor year" depending on the source (either Table S-3 or the NUREG-1437), but it has the same meaning. The sum of the initial fuel loading plus all of the reloads for the lifetime of the reactor can be divided by the now more likely 60-year lifetime (40-year initial license term and 20-year license renewal term) to obtain an average annual fuel requirement. This was done in NUREG-1437 for both boiling water reactors and pressurized water reactors; the higher annual requirement, 35 metric tonnes (MT) of uranium made into fuel for a boiling water reactor, was chosen in NUREG-1437 as the basis for the reference reactor year (NRC 1996a,b). A number of fuel management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel and separative work (enrichment) requirements. Since Table S-3 was promulgated, these improvements have reduced the annual fuel requirement.

Another change is the elimination of the U.S. restrictions on the importation of foreign uranium. Until recently, the economic conditions of the uranium market favored utilization of foreign uranium at the expense of the domestic uranium industry. From the mid-1980s to 2004, the price of U_3O_8 remained below \$20 per pound. These market conditions forced the closing of most U.S. uranium mines and mills, substantially reducing the environmental impacts in the United States from these activities. However, more recently the spot price of U_3O_8 has increased dramatically from \$24 per pound in April 2005 to \$135 per pound in July 2007 and remained near \$60 per pound as of June 2008. As a result, there is a renewed interest in uranium mining and milling in the United States and the NRC anticipates receiving multiple license applications for uranium mining and milling in the next several years. The majority of these applications are expected to be for *in situ* leach solution mining that does not produce tailings. Factoring in changes to the fuel cycle suggests that the environmental impacts of mining and tail millings could drop to levels below those given in Table S-3; however, Table S-3 estimates have not been reduced for these analyses.

Section 6.2 of NUREG-1437 discusses the sensitivity to recent changes in the fuel cycle on the environmental impacts in greater detail.

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6.1.1 Land Use

The total annual land requirement for the fuel cycle supporting the 1000-MW(e) LWR-scaled model is about 137.2 ha (339 ac). Approximately 15.8 ha (39 ac) are permanently committed land, and 120 ha (300 ac) are temporarily committed. A "temporary" land commitment is a commitment for the life of the specific fuel cycle plant (e.g., a mill, enrichment plant, or succeeding plants). Following completion of decommissioning, such land can be released for unrestricted use. "Permanent" commitments represent land that may not be released for use after plant shutdown and decommissioning because decommissioning activities do not result in removal of sufficient radioactive material to meet the limits in 10 CFR Part 20, Subpart E, for release of that area for unrestricted use. Of the 120 ha (300 ac) of temporarily committed land, 95.9 ha (237 ac) are undisturbed and 26.7 ha (66 ac) are disturbed. In comparison, a coal-fired power plant using the same MW(e) output as the LWR-scaled model and using strip-mined coal requires the disturbance of about 240 ha (600 ac) per year for fuel alone. The staff concludes that the impacts on land use to support the 1000-MW(e) LWR-scaled model would be SMALL.

6.1.2 Water Use

The principal water use for the fuel cycle supporting a 1000-MW(e) LWR-scaled model is that required to remove waste heat from the power stations supplying electrical energy to the enrichment step of this cycle. Scaling from Table S-3, of the total annual water use of $1.29 \times 10^8 \text{ m}^3$ (3.41×10^{10} gal), about $1.26 \times 10^8 \text{ m}^3$ (3.33×10^{10} gal) are required for the removal of waste heat, assuming that a new unit uses once-through cooling. Other water uses involve the discharge to air (e.g., evaporation losses in process cooling) of about $1.82 \times 10^6 \text{ m}^3/\text{yr}$ (4.80×10^8 gal/yr) and water discharged to the ground (e.g., mine drainage) of about $1.44 \times 10^6 \text{ m}^3/\text{yr}$ (3.81×10^8 gal/yr).

On a thermal effluent basis, annual discharges from the nuclear fuel cycle are about 4 percent of the 1000-MW(e) LWR-scaled model using once-through cooling. The consumptive water use of $1.82 \times 10^6 \text{ m}^3/\text{yr}$ (4.80×10^8 gal/yr) is about 2 percent of the 1000-MW(e) LWR-scaled model using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle use cooling towers) would be about 6 percent of the 1000-MW(e) LWR-scaled model using cooling towers. Under this condition, thermal effluents would be negligible. The staff concludes that the impacts on water use for these combinations of thermal loadings and water consumption would be SMALL.

6.1.3 Fossil Fuel Impacts

Electric energy and process heat are required during various phases of the fuel cycle process. The electric energy is usually produced by the combustion of fossil fuel at conventional power plants. Electric energy associated with the fuel cycle represents about 5 percent of the annual electric power production of the reference 1000-MW(e) LWR. Process heat is primarily

generated by the combustion of natural gas. This gas consumption, if used to generate electricity, would be less than 0.4 percent of the electrical output from the model plant. The staff concludes that the fossil fuel impacts from the direct and indirect consumption of electric energy for fuel cycle operations would be SMALL relative to the net power production of the proposed project.

6.1.4 Chemical Effluents

The quantities of chemical, gaseous, and particulate effluents with fuel cycle processes are given in Table S-3 (Table 6-1) for the reference 1000-MW(e) LWR. The quantities of effluents would be about three times greater for the reference 1000-MW(e) LWR-scaled model. The principal effluents are SO_x, NO_x, and particulates. Based on data in the *Seventh Annual Report of the Council on Environmental Quality (CEQ 1976)*, these emissions constitute a small additional atmospheric loading in comparison with emissions from the stationary fuel combustion and transportation sectors in the United States, which is about 0.06 percent of the annual national releases for each of these effluents.

Liquid chemical effluents produced in fuel cycle processes are related to fuel enrichment and fabrication and may be released to receiving waters. These effluents are usually present in dilute concentrations such that only small amounts of dilution water are required to reach levels of concentration that are within established standards. Table S-3 (Table 6-1) specifies the amount of dilution water required for specific constituents. In addition, all liquid discharges into the navigable waters of the United States from plants associated with the fuel cycle operations would be subject to requirements and limitations set by appropriate Federal, State, Tribal, and local agencies.

Tailings solutions and solids are generated during the milling process and are not released in quantities sufficient to have a significant impact on the environment.

The staff determined that the impacts of these chemical effluents would be SMALL.

6.1.5 Radiological Effluents

Radioactive effluents estimated to be released to the environment from waste management activities and certain other phases of the fuel cycle process are set forth in Table S-3 (Table 6-1). Using these effluents in NUREG-1437 (NRC 1996a,b), the staff calculated the 100-year environmental dose commitment to the U.S. population from the fuel cycle of 1 year of operation of the model 1000-MW(e) LWR. The total overall whole body gaseous dose commitment and whole body liquid dose commitment from the fuel cycle (excluding reactor releases and dose commitments because of exposure to radon-222 and technetium-99) were calculated to be approximately 4 person-Sv (400 person-rem) and 2 person-Sv (200 person-rem), respectively. Scaling these dose commitments by a factor of about three for

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the 1000-MW(e) LWR-scaled model results in whole body dose commitment estimates of 12 person-Sv (1200 person-rem) for gaseous releases and 6 person-Sv (600 person-rem) for liquid releases. For both pathways, the estimated 100-year environmental dose commitment to the U.S. population would be approximately 18 person-Sv (1800 person-rem) for the 1000-MW(e) LWR-scaled model.

Currently, the radiological impacts associated with radon-222 and technetium-99 releases are not addressed in Table S-3. Principal radon releases occur during mining and milling operations and as emissions from mill tailings, whereas principal technetium-99 releases occur from gaseous diffusion enrichment facilities. Southern provided an assessment of radon-222 and technetium-99 in its Environmental Report (ER) (Southern 2008). This evaluation relied on the information discussed in NUREG-1437 (NRC 1996a,b).

In Section 6.2 of NUREG-1437 (NRC 1996a,b), the staff estimated the radon-222 releases from mining and milling operations and from mill tailings for each year of operations of the reference 1000-MW(e) LWR. The estimated releases of radon-222 for the reference reactor year for the 1000-MW(e) LWR-scaled model, or for the total electric power rating for the site for a year, are approximately 577.2 terre becquerels (TBq) (15,600 Ci). Of this total, about 78 percent would be from mining, 15 percent from milling operations, and 7 percent from inactive tails before stabilization. For radon releases from stabilized tailings, the staff assumed that the LWR-scaled model would result in an emission of 110 GBq (3 Ci) per site year; (i.e., about three times the NUREG-1437 [NRC 1996a,b] estimate for the reference reactor year). The major risks from radon-222 are from exposure to the bone and the lung, although there is a small risk from exposure to the whole body. The organ-specific dose-weighting factors from 10 CFR Part 20 were applied to the bone and lung doses to estimate the 100-year dose commitment from radon-222 to the whole body. The estimated 100-year environmental dose commitment from mining, milling, and tailings before stabilization for each site year (assuming the 1000-MW(e) LWR-scaled model) would be approximately 28 person-Sv (2800 person-rem) to the whole body. From stabilized tailings piles, the estimated 100-year environmental dose commitment would be approximately 0.52 person-Sv (52 person-rem) to the whole body. Additional insights regarding Federal policy/resource perspectives concerning institutional controls comparisons with routine radon-222 exposure and risk and long-term releases from stabilized tailing piles are discussed in NUREG-1437 (NRC 1996a,b).

Also as discussed in NUREG-1437, the staff considered the potential health effects associated with the releases of technetium-99. The estimated releases of technetium-99 for the reference reactor year for the 1000-MW(e) LWR-scaled model are 700 million becquerels (MBq) (0.02 Ci) from chemical processing of recycled uranium hexafluoride before it enters the isotope enrichment cascade and 560 MBq (0.015 Ci) into the groundwater from a repository. The major risks from technetium-99 are from exposure of the gastrointestinal tract and kidney, although there is a small risk from exposure to the whole body. Applying the organ-specific dose-

weighting factors from 10 CFR Part 20 to the gastrointestinal tract and kidney doses, the total-body 100-year dose commitment from technetium-99 to the whole body was estimated to be 3 person-Sv (300 person-rem) for the 1000-MW(e) LWR-scaled model.

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses below about 100 mSv (10,000 mrem) and at low dose rates. 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. A recent report by the National Research Council (2006), the BEIR VII report, supports the linear, no-threshold dose response model. Simply stated, any increase in dose, no matter how small, results in an incremental increase in health risk. This theory is accepted by the U.S. Nuclear Regulatory Commission (NRC) as a conservative model for estimating health risks from radiation exposure, recognizing that the model probably overestimates those risks.

Based on this model, the staff estimated the risk to the public from radiation exposure using the nominal probability coefficient for total detriment (730 fatal cancers, nonfatal cancers, and severe hereditary effects per 10,000 person-Sv [1,000,000 person-rem]) from International Commission on Radiological Protection (ICRP) Publication 60 (ICRP 1991). This coefficient was multiplied by the sum of the estimated whole body population doses from gaseous effluents, liquid effluents, radon-222, and technetium-99 discussed above (approximately 49 person-Sv/yr [4900 person-rem/yr]) to calculate that the U.S. population would incur a total of approximately 3.6 fatal cancers, nonfatal cancers, and severe hereditary effects annually. This risk is quite small compared to the number of fatal cancers, nonfatal cancers, and severe hereditary effects that would be estimated to the U.S. population annually from exposure to natural sources of radiation using the same risk estimation method.

Radon releases from tailings are indistinguishable from background radiation levels at a few kilometers from the tailings pile (at less than 1 km [0.6 mi] in some cases) (NRC 1996a,b). The public dose limit in the U.S. Environmental Protection Agency's (EPA's) regulation, 40 CFR Part 190, is 0.25 mSv/yr (25 mrem/yr) to the whole body from the entire fuel cycle, but most NRC licensees have airborne effluents resulting in doses of less than 0.01 mSv/yr (1 mrem/yr) (61 FR 65120).

In addition, at the request of the U.S. Congress, the National Cancer Institute (NCI) conducted a study and published *Cancer in Populations Living Near Nuclear Facilities* in 1990 (Jablan 1990). This report included an evaluation of health statistics around all nuclear power plants, as well as several other nuclear fuel cycle facilities, in operation in the United States in 1981 and found "no evidence that an excess occurrence of cancer has resulted from living near nuclear facilities" (Jablan 1990). The contribution to the annual average dose received by an individual from fuel-

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cycle-related radiation and other sources as reported in a report published by the National Council on Radiation Protection and Measurements (NCRP 1987a) is listed in Table 6-2. The nuclear fuel cycle contribution to an individual's annual average radiation dose is extremely small (less than 0.01 mSv [1 mrem] per year).

Table 6-2. Comparison of Annual Average Dose Received by an Individual from All Sources

Source		Dose (mSv/yr) ^(a)	Percent of Total
Natural			
	Radon	2	55
	Cosmic	0.27	8
	Terrestrial	0.28	8
	Internal (body)	0.39	11
	Total natural sources	3	82
Artificial			
	Medical x-ray	0.39	11
	Nuclear medicine	0.14	4
	Consumer products	0.10	3
	Total artificial sources	0.63	18
Other			
	Occupational	0.009	<0.30
	Nuclear fuel cycle	<0.01	<0.03
	Fallout	<0.01	<0.03
	Miscellaneous sources	<0.01	<0.03

(a) To convert mSv/yr to mrem/yr, multiply by 100.

Source: NCRP Report 93, *Ionizing Radiation Exposure of the Population of the United States* (NCRP 1987a)

Based on the analyses presented above, the staff concludes that the environmental impacts of radioactive effluents from the fuel cycle are SMALL.

6.1.6 Radiological Wastes

The quantities of buried radioactive waste material (low-level, high-level, and transuranic wastes) are specified in Table S-3 (Table 6-1). For low-level waste disposal at land burial facilities, the Commission notes in Table S-3 that there would be no significant radioactive releases to the environment. For high-level and transuranic wastes, the Commission notes that these are to be buried at a repository, such as the candidate repository at Yucca Mountain, Nevada, and that no release to the environment is expected to be associated with such disposal because it has been assumed that all of the gaseous and volatile radionuclides contained in the spent fuel are released to the atmosphere before the disposal of the waste. In NUREG-0116 (NRC 1976), which provides background and context for the Table S-3 values for high-level and transuranic wastes established by the Commission, the staff indicates that these high-level and transuranic wastes would be buried and would not be released to the environment.

On February 15, 2002, subsequent to receipt of a recommendation by the Secretary of Energy, the President recommended the Yucca Mountain site for the development of a repository for the geologic disposal of spent nuclear fuel and high-level nuclear waste (White House Press Release 2002).

The EPA developed Yucca Mountain-specific repository standards, which were subsequently adopted by the NRC in 10 CFR Part 63. In an opinion, issued July 9, 2004, the U.S. Court of Appeals for the District of Columbia Circuit (the Court) vacated EPA's radiation protection standards for the candidate repository, which required compliance with certain dose limits over a 10,000-year period (U.S. Court of Appeals 2004). The Court's decision also vacated the compliance period in NRC's licensing criteria for the candidate repository in 10 CFR Part 63. In response to the Court's decision, EPA issued its proposed revised standards on August 22, 2005, that would revise the radiation protection standards for the candidate repository (70 FR 49014). In order to be consistent with EPA's revised standards, NRC proposed revisions to 10 CFR Part 63 on September 8, 2005 (70 FR 53313). The 10 CFR Part 63 rulemaking, RIN 3150-AH68, is titled "Implementation of a Dose Standard After 10,000 Years," and the comment period was extended to December 7, 2005 (70 FR 67098). The proposed standards are 0.15 mSv (15 mrem) per year for 10,000 years following disposal and 3.5 mSv (350 mrem) per year for 10,000 years through 1 million years after disposal. The NRC received an application from DOE on June 3, 2008, for a license to construct and operate the nation's first geologic repository for high-level nuclear waste at Yucca Mountain, Nevada. If the application is formally docketed following a 95-day acceptance review period, the NRC is obligated by Congress to complete a formal licensing review within 3 years, with an option to request a 1-year extension.

Consequently, at this time, for the high-level waste and spent fuel disposal component of the fuel cycle, there is some uncertainty with respect to regulatory limits for offsite releases of radionuclides for the current candidate repository site. However, prior to promulgation of the affected provisions of the Commission's regulations, the staff assumed that limits were developed along the lines of the 1995 National Research Council report, *Technical Bases for Yucca Mountain Standards*, and that in accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository can and likely would be developed at some site that would comply with such limits, with peak doses to virtually all individuals of 100 millirem (1 mSv) per year or less (National Research Council 1995; NRC 1996a,b).

Despite the current uncertainty with respect to these rules, some judgment as to the National Environmental Policy Act of 1969 (NEPA) implications of offsite radiological impacts of spent fuel and high-level waste disposal should be made. The staff concludes that these impacts are acceptable in that the impacts would not be sufficiently large to require the NEPA conclusion that the construction and operation of new units at the VEGP site should be denied.

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Section 6.2 of NUREG-1437 (NRC 1996a,b) describes the generation, storage, and ultimate disposal of low-level waste, mixed waste, and spent fuel from power reactors. For the reasons stated above, the staff concludes that the environmental impacts of radioactive waste disposal are SMALL.

6.1.7 Occupational Dose

In its review and evaluation of the environmental impacts of the fuel cycle, the staff considered a capacity factor of 95 percent with a total net electric output of 2185 MW(e) for two new units at the VEGP site (Southern 2008). This is referred to as the 1000-MW(e) LWR-scaled model. The annual occupational dose attributable to all phases of the fuel cycle for the 1000-MW(e) LWR-scaled model is about 18 person-Sv (1800 person-rem). This dose is based on a 6 person-Sv (600 person-rem) occupational dose estimate attributable to all phases of the fuel cycle for the model 1000 MW(e) LWR (NRC 1996a,b). The environmental impact from this occupational dose is considered SMALL because the dose to any individual worker is maintained within the limits of 10 CFR Part 20, which is 0.05 Sv/yr (5 rem/yr).

6.1.8 Transportation

The transportation dose to workers and the public totals about 0.025 person-Sv (2.5 person-rem) annually for the reference 1000-MW(e) LWR per Table S-3 (Table 6-1). This corresponds to a dose of 0.075 person-Sv (7.5 person-rem) for the 1000-MW(e) LWR-scaled model. For comparative purposes, the estimated collective dose from natural background radiation to the population within 80 km (50 mi) of the VEGP site is 2.43×10^3 person-Sv/yr (2.43×10^5 person-rem/yr) (Southern 2008). On the basis of this comparison, the staff concludes that environmental impacts of transportation would be SMALL.

6.1.9 Conclusions

The staff evaluated the environmental impacts of the uranium fuel cycle, as given in Table S-3 (Table 6-1), considered the effects of radon-222 and technetium-99, and appropriately scaled the impacts for the 1000-MW(e) LWR-scaled model. Based on this evaluation, the staff concludes that the impacts would be SMALL and that mitigation is not warranted.

6.2 Transportation Impacts

This section addresses both the radiological and nonradiological environmental impacts from normal operating and accident conditions resulting from (1) shipment of unirradiated fuel to the VEGP site, (2) shipment of spent fuel to a monitored retrievable storage facility or a permanent repository, and (3) shipment of low-level radioactive waste and mixed waste to offsite disposal facilities.

The NRC evaluated the environmental effects of transportation of fuel and waste for LWRs in WASH-1238 (AEC 1972) and NUREG-75/038 (NRC 1975) and found the impact to be small. These documents provided the basis for Table S-4 in 10 CFR 51.52 that summarizes the environmental impacts of transportation of fuel and waste to and from one LWR of 3000 to 5000 MW(t) (1000 to 1500 MW(e)). Impacts are provided for normal conditions of transport and accidents in transport for a reference 1100-MW(e) LWR.^(a) Dose to transportation workers during normal transportation operations was estimated to result in a collective dose of 0.04 person-Sv (4 person-rem) per reference reactor year. The combined dose to the public along the route and dose to onlookers were estimated to result in a collective dose of 0.03 person-Sv (3 person-rem) per reference reactor year.

Environmental risks (radiological) during accident conditions were determined to be SMALL. Nonradiological impacts from postulated accidents were estimated as one fatal injury in 100 reactor years and one nonfatal injury in 10 reference reactor years. Subsequent reviews of transportation impacts in NUREG-0170 (NRC 1977a) and Sprung et al. (2000) concluded that impacts were bounded by Table S-4 in 10 CFR 51.52.

In accordance with 10 CFR 51.52(a), a full description and detailed analysis of transportation impacts is not required when licensing an LWR (i.e., impacts are assumed bounded by Table S-4) if the reactor meets the following criteria:

- The reactor has a core thermal power level not exceeding 3800 MW(t).
- Fuel is in the form of sintered uranium oxide pellets having a uranium-235 enrichment not exceeding 4 percent by weight; and pellets are encapsulated in zirconium-clad fuel rods.
- Average level of irradiation of the fuel from the reactor does not exceed 33,000 MWd/MTU, and no irradiated fuel assembly is shipped until at least 90 days after it is discharged from the reactor.
- With the exception of irradiated fuel, all radioactive waste shipped from the reactor is packaged and in solid form.
- Unirradiated fuel is shipped to the reactor by truck; irradiated (spent) fuel is shipped from the reactor by truck, rail, or barge; and radioactive waste other than irradiated fuel is shipped from the reactor by truck or rail.

The environmental impacts of the transportation of fuel and radioactive wastes to and from nuclear power facilities were resolved generically in 10 CFR 51.52, provided that the specific conditions in the rule (see above) are met; if not, then a full description and detailed analysis is

(a) The transportation impacts associated with the VEGP site were normalized for a reference 1100-MW(e) LWR at an 80-percent capacity factor for comparisons to Table S-4.

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required for initial licensing. The NRC may consider requests for licensed plants to operate at conditions above those in the facility's licensing basis; for example, higher burnups (above 33,000 MWd/MTU), enrichments (above 4 percent uranium-235), or thermal power levels (above 3800 MW(t)). Departures from the conditions itemized in 10 CFR 51.52(a) must be supported by a full description and detailed analysis of the environmental effects, as specified in 10 CFR 51.52(b). Departures found to be acceptable for licensed facilities cannot serve as the basis for initial licensing for new reactors.

In its application, Southern requested an ESP for two additional reactors at its VEGP site in Burke County, Georgia. Both proposed new reactors would be Westinghouse AP1000 advanced LWRs. The Westinghouse AP1000 reactor has a thermal power rating of 3400 MW(t), with a minimum net electrical output of 1115 MW(e). The Westinghouse AP1000 reactors are expected to operate with a 93 percent capacity factor, so the net electrical output (annualized) is about 1037 MW(e) (Southern 2008). Fuel for the plants would be enriched up to about 4.5 weight percent U-235 (Southern 2008), which exceeds the 10 CFR 51.52(a) condition. In addition, the expected irradiation level of about 48,700 MWd/MTU (Southern 2008) exceeds the 10 CFR 51.52(a) condition. Therefore, a full description and detailed analysis of transportation impacts is required. In comments on the draft EIS (Southern 2007), the applicant indicated that fuel enrichment may increase to 4.54 weight percent U-235 and irradiation levels may increase to 50,533 MWd/MTU. These increases do not affect the conclusion that a detailed analysis of transportation impacts is required. In this section of the EIS, the staff has discussed how these changes would affect the staff's environmental impact conclusions, if at all.

In its ER (Southern 2008), Southern provided a full description and detailed analyses of transportation impacts that was based primarily on previous EISs for proposed ESP sites at North Anna, Clinton, and Grand Gulf (NRC 2006a, 2006b, and 2006c, respectively). In these analyses, radiological impacts of transporting fuel and waste to/from the VEGP and alternative sites were calculated using the RADTRAN 5 computer code (Neuhauser et al. 2003). Since that time, a new version of RADTRAN 5 has been released (Weiner et al. 2006). Therefore, for this EIS, radiological impacts are calculated using the new version of RADTRAN 5. The results that were generated using the new version of RADTRAN 5 were then used to judge the adequacy of the applicant's analysis of transportation impacts.

The NRC review of the three previous ESP EISs was also considered when developing the scope of this EIS. The most significant change is that this EIS includes an explicit analysis of the non-radiological impacts of transporting workers and construction materials to/from the VEGP site. Publicly available information about traffic accident, injury, and fatality rates was used to estimate nonradiological impacts.

6.2.1 Transportation of Unirradiated Fuel

The staff performed an independent analysis of the environmental impacts of transporting unirradiated (i.e., fresh) fuel to the VEGP site. Radiological impacts of normal operating conditions and transportation accidents as well as nonradiological impacts are discussed in this section. Radiological impacts to populations and maximally exposed individuals (MEIs) are presented.

6.2.1.1 Normal Conditions

Normal conditions, sometimes referred to as "incident-free" transportation, are transportation activities in which shipments reach their destination without releasing any radioactive material to the environment. Impacts from these shipments would be from the low levels of radiation that penetrate the unirradiated fuel shipping containers. Radiation exposures would occur to (1) persons residing along the transportation corridors between the fuel fabrication facility and the VEGP site; (2) persons in vehicles traveling on the same route as a unirradiated fuel shipment; (3) persons at vehicle stops for refueling, rest, and vehicle inspections; and (4) transportation crew workers.

Truck Shipments

Table 6-3 provides an estimate of the number of truck shipments of unirradiated fuel for the Westinghouse AP1000 advanced reactor design compared to those of the reference 1100-MW(e) reactor specified in WASH-1238 (AEC 1972) operating at 80-percent capacity (880 MW[e]). After normalization, the number of truck shipments of unirradiated fuel to the VEGP site is fewer than the number of truck shipments of unirradiated fuel estimated for the reference LWR in WASH-1238.

Shipping Mode and Weight Limits

In 10 CFR 51.52, a condition is identified that states all unirradiated fuel is shipped to the reactor by truck. Southern specifies that unirradiated fuel would be shipped to the reactor site by truck. Section 10 CFR 51.52 includes a condition that the truck shipments not exceed 33,100 kg (73,000 lbs) as governed by Federal or State gross vehicle weight restrictions. Southern states in its ER that the unirradiated fuel shipments to the proposed VEGP site would comply with applicable weight restrictions (Southern 2008).

Radiological Doses to Transport Workers and the Public

Section 10 CFR 51.52, Table S-4, includes conditions related to radiological dose to transport workers and members of the public along transport routes. These doses are a function of many variables, including the radiation dose rate emitted from the unirradiated fuel shipments, the number of exposed individuals and their locations relative to the shipment, the time in transit

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(including travel and stop times), and number of shipments to which the individuals are exposed. For this EIS, the radiological dose impacts of the transportation of unirradiated fuel were calculated for the worker and the public using the RADTRAN 5 computer code (Weiner et al. 2006).

One of the key assumptions in WASH-1238 (AEC 1972) for the reference LWR unirradiated fuel shipments is that the radiation dose rate at 1 m (3.3 ft) from the transport vehicle is about 0.001 mSv/hr (0.1 mrem/hr). This assumption was also used in the analysis of the Westinghouse AP1000 reactor unirradiated fuel shipments. This assumption is reasonable because the Westinghouse AP1000 reactor fuel materials would be low-dose-rate uranium radionuclides and would be packaged similarly to that described in WASH-1238 (i.e., inside a metal container that provides little radiation shielding). The numbers of shipments per year were obtained by dividing the normalized shipments in Table 6-3 by 40 years of operation. Other key input parameters used in the radiation dose analysis for unirradiated fuel are shown in Table 6-4.

The RADTRAN 5 results for this "generic" unirradiated fuel shipment are as follows:

- Worker dose: 1.71×10^{-5} person-Sv/shipment (1.71×10^{-3} person-rem/shipment)
- General public dose (onlookers/persons at stops and sharing the highway):
 2.95×10^{-5} person-Sv/shipment (2.95×10^{-3} person-rem/shipment)
- General public dose (along route/persons living near a highway or truck stop):
 4.17×10^{-7} person-Sv/shipment (4.17×10^{-5} person-rem/shipment).

These values were combined with the average annual shipments of unirradiated fuel for the Westinghouse AP1000 reactor to calculate annual doses to the public and workers. Table 6-5 presents the annual radiological impacts to workers, public onlookers (persons at stops and sharing the road), and members of the public along the route (i.e., residents within 800 m

Table 6-3. Numbers of Truck Shipments of Unirradiated Fuel for Each Advanced Reactor Type

Reactor Type	Number of Shipments per Reactor Unit			Unit Electric Generation, MW(e) ^(c)	Capacity Factor ^(c)	Normalized, Shipments per 1100 MW(e) ^(d)
	Initial Core ^(a)	Annual Reload	Total ^(b)			
Reference LWR (WASH-1238)	18	6	252	1100	0.8	252
VEGP Westinghouse AP1000	23	5.4	233	1115	0.93	198

(a) Shipments of the initial core have been rounded up to the next highest whole number.

(b) Total shipments of unirradiated fuel over a 40-year plant lifetime (i.e., initial core load plus 39 years of average annual reload quantities).

(c) Unit capacities and capacity factors were taken from WASH-1238 for the reference LWR and the ER (Southern 2008) for the Westinghouse AP1000 reactor.

(d) Normalized to net electric output for WASH-1238 reference LWR (i.e., 1100-MW(e) plant at 80 percent or net electrical output of 880 MW(e)).

Table 6-4. RADTRAN 5 Input Parameters for Fresh Fuel Shipments

Parameter	RADTRAN 5 Input Value	Source
Shipping distance, km	3200	AEC (1972) ^(a)
Travel Fraction – Rural	0.90	NRC (1977a)
Travel Fraction – Suburban	0.05	
Travel Fraction – Urban	0.05	
Population Density – Rural, persons/km ²	10	DOE (2002a)
Population Density – Suburban, persons/km ²	349	
Population Density – Urban, persons/km ²	2260	
Vehicle speed – km/hr	88.49	Conservative in transit speed of 55 mph assumed; predominantly interstate highways used.
Traffic count – Rural, vehicles/hr	530	DOE (2002a)
Traffic count – Suburban, vehicles/hr	760	
Traffic count – Urban, vehicles/hr	2400	
Dose rate at 1 m from vehicle, mrem/hr	0.1	AEC (1972)
Packaging length, m	7.3	Approximate length of two LWR fuel element packages placed on end
Number of truck crew	2	AEC (1972), NRC (1977a), and DOE (2002a)
Stop time, hr/trip	4	Based on 1 30-minute stop per 400 km
Population density at stops, persons/km ²	See Table 6-8 for truck stop parameters	

(a) AEC (1972) provides a range of shipping distances between 40 km (25 mi) and 4800 km (3000 mi) for fresh fuel shipments. A 3200-km (2000-mi) "representative" shipping distance was assumed here.

Table 6-5. Radiological Impacts Under Normal Conditions of Transporting Unirradiated Fuel to the VEGP Site

Plant Type	Normalized Average Annual Shipments	Cumulative Annual Dose; person-Sv/yr per 1100 MW(e) ^(a) (880 MW(e) net)		
		Workers	Public – Onlookers	Public – Along Route
Reference LWR (WASH-1238)	6.3	1.1×10^{-4}	1.9×10^{-4}	2.6×10^{-6}
VEGP Westinghouse AP1000	5.0	8.5×10^{-5}	1.5×10^{-4}	2.1×10^{-6}
10 CFR 51.52, Table S-4 Condition	<1 per day	4.0×10^{-2}	3.0×10^{-2}	3.0×10^{-2}

(a) Multiply person-Sv/yr times 100 to obtain doses in person-rem/yr.

[0.5 mi] of the highway) for transporting unirradiated fuel to the VEGP site. The cumulative annual dose estimates in Table 6-5 were normalized to 1100 MW(e) (880 MW(e) net electrical output). The staff performed an independent review and determined that all dose estimates are bounded by the Table S-4 conditions of 0.04 person-Sv/yr (4 person-rem/yr) to transportation

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workers, 0.03 person-Sv/yr (3 person-rem/yr) to onlookers, and 0.03 person-Sv/yr (3 person-rem/yr) to members of the public along the route.

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses below about 100 mSv (10,000 mrem) and at low dose rates. However, radiation protection experts conservatively assume that any amount of radiation exposure 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 model is used to describe the relationship between radiation dose and detriments such as cancer induction. A recent report by the National Research Council (2006), the BEIR VII report, supports the linear, no-threshold dose response theory. 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 probably overestimates those risks.

Based on this model, the staff estimates the risk to the public from radiation exposure using the nominal probability coefficient for total detriment (730 fatal cancers, nonfatal cancers, and severe hereditary effects per 10,000 person-Sv [1,000,000 person-rem]) from ICRP Publication 60 (ICRP 1991). The public doses presented in Table 6-5 for the proposed Westinghouse AP1000 reactors are less than or equal to 2×10^{-4} person-Sv/yr (2×10^{-2} person-rem/yr); therefore, the total detriment estimates associated with these doses would all be less than 2×10^{-5} fatal cancers, nonfatal cancers, and severe heredity effects per year. To place these impacts in perspective, the average United States resident receives about 300 mrem/yr effective dose equivalent from natural background radiation (i.e., exposures from cosmic radiation, naturally occurring radioactive materials such as radon, and global fallout from testing of nuclear explosive devices) (NCRP 1987b). Using this average effective dose, approximately 160 fatal cancers, nonfatal cancers, and severe hereditary effects would occur in the population along this representative unirradiated fuel route from natural background radiation. The risks of transporting unirradiated fuel to the VEGP site are small compared to the fatal cancers, nonfatal cancers, and severe hereditary effects that would be expected to occur annually in the same population from exposure to natural sources of radiation.

MEIs Under Normal Transport Conditions

A scenario-based analysis was conducted to develop estimates of incident-free radiation doses to MEIs for fuel and waste shipments to and from the VEGP site. The following discussion applies to unirradiated fuel shipments to and spent fuel and radioactive shipments from any reactor design. The analysis is based on information in DOE (2002b) and incorporates information about exposure times, dose rates, and the number of times an individual may be exposed to an offsite shipment. Adjustments were made where necessary to reflect the fuel and waste shipments addressed in this EIS. In all cases, the staff assumed that the dose rate

emitted from the shipping containers is 0.1 mSv/hr (10 mrem/hr) at 2 m (6.6 ft) from the side of the transport vehicle, the maximum dose rate allowed by U.S. Department of Transportation (DOT) regulations, even though most unirradiated fuel and radioactive waste shipments would have much lower dose rates than the regulations allow (AEC 1972; DOE 2002a). An MEI is a person who may receive the highest radiation dose from a shipment to and/or from the VEGP site. The analysis is described below.

Truck crew member. Truck crew members would receive the highest radiation doses during incident-free transport because of their proximity to the loaded shipping container for an extended period of time. The analysis assumed that crew member doses are limited to 0.02 Sv (2 rem) per year, which is the DOE administrative control level presented in DOE-STD-1098-99, *DOE Standard, Radiological Control*, Chapter 2, Article 211 (DOE 2004). This limit is anticipated to apply to spent nuclear fuel shipments to a disposal facility, because DOE would take title to the spent fuel at the reactor site. Spent nuclear fuel represents the bulk of the fuel and waste shipments to and from reactor sites, and those with the highest radiation dose rates; consequently, crew doses from unirradiated fuel and radioactive waste shipments would be lower than the spent nuclear fuel shipments. The NRC limit for occupational exposures is 0.05 Sv/yr (5 rem/yr) (see 10 CFR Part 20).

The DOT does not regulate annual occupational exposures, but recommends limits to air crew members that are a 5-year effective dose of 0.02 Sv/yr (2 rem/yr) with no more than 0.05 Sv (5 rem) in a single year (Friedberg and Copeland 2003). As a result, a 0.02 Sv/yr (2 rem/yr) MEI dose to truck crews is a reasonable estimate to apply to shipments of fuel and waste from the VEGP site.

Inspectors. Radioactive shipments are inspected by Federal or State vehicle inspectors, for example, at State ports of entry. DOE (2002b) assumed that inspectors would be exposed for 1 hour at a distance of 1 m (3.3 ft) from the shipping containers. The dose rate at 1 m (3.3 ft) is about 0.14 mSv/hr (14 mrem/hr); therefore, the dose per shipment is about 0.14 mSv (14 mrem). This is independent of the location of the reactor site. Based on this conservative value, the annual doses to vehicle inspectors were calculated to be about 0.01 Sv/yr (1 rem/yr), assuming the same person inspects all shipments of fuel and waste to and from the VEGP site. This value is about one-half of the 0.02 Sv/yr (2 rem/yr) DOE administrative control level on individual doses and one-fifth of the 0.05 Sv/yr (5 rem/yr) NRC occupational dose limit. Doses to state inspectors would be doubled for a site with two Westinghouse AP1000 reactors, which would bring their annual dose to approximately the administrative limit.

Resident. The analysis assumed that a resident lives adjacent to a highway where a shipment would pass and would be exposed to all shipments along a particular route. Exposures to residents on a per-shipment basis were extracted from RADTRAN 5 output files. These dose estimates are based on an individual located 30 m (100 ft) from the shipments that are traveling 24 km/hr (15 mph). The potential radiation dose to the maximally exposed resident is about

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0.00039 mSv/yr (0.039 mrem/yr) for shipments of fuel and waste to/from the VEGP site. This dose would be doubled for a site with two Westinghouse AP1000 reactors.

Individual stuck in traffic. This scenario addresses potential traffic interruptions that could lead to a person being exposed to a loaded shipment for one hour at a distance of 1.2 m (4 ft). The analysis assumed this exposure scenario would occur only one time to any individual, and the dose rate was at the regulatory limit of 0.1 mSv/hr (10 mrem/hr) at 1.8 m (6 ft) from the shipment. The dose to the MEI was calculated in DOE (2002b) to be 0.016 mSv (1.6 mrem). These doses would not be doubled for a site with two Westinghouse AP1000 reactors because it was assumed that this scenario would occur only once to any individual.

Person at a truck service station. This scenario estimates doses to an employee at a service station where all truck shipments to and from the VEGP site are assumed to stop. DOE (2002b) assumed this person is exposed for 49 minutes at a distance of 15.8 m (52 ft) from the loaded shipping container. This results in a dose of about 0.0007 mSv/shipment (0.07 mrem/shipment) and an annual dose of about 0.05 mSv/yr (5 mrem/yr) for the VEGP site, assuming that a single individual services all unirradiated fuel, spent fuel, and radioactive waste shipments to and from the VEGP site. This dose would be doubled for a site with two Westinghouse AP1000 reactors.

6.2.1.2 Radiological Impacts of Transportation Accidents

Accident risks are a combination of accident frequency and consequence. Accident frequencies for transportation of unirradiated fuel to the VEGP site are expected to be lower than those used in the analysis in WASH-1238 (AEC 1972), which forms the basis for Table S-4 of 10 CFR 51.52, because of improvements in highway safety and security, and an overall reduction in traffic accident, injury, and fatality rates since WASH-1238 was published. There is no significant difference in consequences of accidents severe enough to result in a release of unirradiated fuel particles to the environment between the Westinghouse AP1000 and current-generation LWRs because the fuel form, cladding, and packaging are similar to those analyzed in WASH-1238. Consequently, the impacts of accidents during transport of unirradiated fuel for advanced LWRs to the VEGP site are expected to be smaller than the impacts listed in Table S-4 for current-generation LWRs.

6.2.1.3 Nonradiological Impacts of Transportation Accidents

Nonradiological impacts are the human health impacts projected to result from traffic accidents involving shipments of unirradiated fuel to the VEGP site; they do not consider radiological or hazardous characteristics of the cargo. Nonradiological impacts include the projected number of traffic accidents, injuries, and fatalities that could result from shipments of unirradiated fuel to the site and return shipments of empty containers from the site.

Nonradiological impacts are calculated using accident, injury, and fatality rates from published sources. The rates (i.e., impacts per vehicle-km traveled) are then multiplied by estimated travel distances for workers and materials. The general formula for calculating nonradiological impacts is:

$$\text{Impacts} = (\text{unit rate}) \times (\text{round-trip shipping distance}) \times (\text{annual number of shipments})$$

In this formula, impacts are presented in units of the number of accidents, number of injuries, and number of fatalities per year. Corresponding unit rates (i.e., impacts per vehicle-km traveled) are used in the calculations.

Accident, injury, and fatality rates were taken from Table 4 in ANL/ESD/TM-150 *State-Level Accident Rates for Surface Freight Transportation: A Reexamination* (Saricks and Tompkins 1999). Nation-wide median rates were used for shipments of unirradiated fuel to the site. The data are representative of traffic accident, injury, and fatality rates for heavy truck shipments similar to those to be used to transport unirradiated fuel to the VEGP site.

The nonradiological accident impacts for transporting unirradiated fuel to (and empty shipping containers from) the VEGP site are shown in Table 6-6. The nonradiological impacts associated with the WASH-1238 reference LWR are also shown for comparison purposes. Note that there are only small differences between the impacts calculated for the VEGP

Westinghouse AP1000 and the reference LWR in WASH-1238 due entirely to the smaller number of shipments. The impacts would be doubled for a site with two reactors.

Table 6-6. Nonradiological Impacts of Transporting Unirradiated Fuel to the VEGP Site, Normalized to Reference LWR

Plant Type	Total Shipments Normalized to Reference LWR	One-Way Shipping Distance km	Round-trip Distance km	Annual Impacts		
				Fatalities per Year	Injuries per Year	Accidents per Year
WASH-1238	252	3200	1.6×10^6	3.7×10^{-4}	7.8×10^{-3}	1.1×10^{-2}
VEGP Westinghouse AP1000	198	3200	1.3×10^6	2.9×10^{-4}	6.1×10^{-3}	9.0×10^{-3}

6.2.2 Transportation of Spent Fuel

The staff performed an independent analysis of the environmental impacts of transporting spent fuel from the proposed VEGP site to a spent fuel disposal repository. For the purposes of these analyses, the staff considered the proposed Yucca Mountain, Nevada, site as a surrogate destination. The staff considers that an estimate of the impacts of the transportation of spent fuel to a possible repository in Nevada to be a reasonable bounding estimate of the

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transportation impacts to a storage or disposal facility because of the distances involved and the representativeness of the distribution of members of the public in urban, suburban, and rural areas (i.e., population distributions) along the shipping routes. Radiological and nonradiological environmental impacts of normal operating conditions and transportation accidents, as well as nonradiological impacts, are discussed in this section.

This analysis is based on shipment of spent fuel by legal-weight trucks in shipping casks with characteristics similar to casks currently available (i.e., massive, heavily shielded, cylindrical metal pressure vessels). Each shipment is assumed to consist of a single shipping cask loaded on a modified trailer. These assumptions are consistent with assumptions made in the evaluation of the environmental impacts of transportation of spent fuel in Addendum 1 to NUREG-1437 (NRC 1999). These assumptions are conservative because the alternative assumptions involve rail transportation or heavy-haul trucks, which would reduce the overall number of spent fuel shipments (NRC 1999), thus reducing impacts. Also, use of current shipping cask designs results in conservative impact estimates because the current designs are based on transporting short-cooled spent fuel (approximately 120 days out of reactor). Future shipping casks would be designed to transport longer-cooled fuel (greater than 5 years out of reactor) and would require much less shielding to meet external dose limitations. Therefore, future shipping casks are expected to have higher cargo capacities, thus reducing the numbers of shipments and associated impacts.

Radiological impacts of transportation of spent fuel were calculated using the RADTRAN 5 computer code (Wiener et al. 2006). Routing and population data used in RADTRAN 5 for truck shipments were obtained from the TRAGIS routing code (Johnson and Michelhaugh 2003). The population data in the TRAGIS code are based on the 2000 census. Nonradiological impacts were calculated using published traffic accident, injury, and fatality data (Saricks and Tompkins 1999) in addition to route information from TRAGIS.

6.2.2.1 Normal Conditions

Normal conditions, sometimes referred to as "incident-free" transportation, are transportation activities in which shipments reach their destination without an accident occurring enroute. Impacts from these shipments would be from the low levels of radiation that penetrate the heavily shielded spent fuel shipping cask. Radiation exposures would occur to (1) persons residing along the transportation corridors between the VEGP site and the proposed repository location; (2) persons in vehicles traveling on the same route as a spent fuel shipment; (3) persons at vehicle stops for refueling, rest, and vehicle inspections; and (4) transportation crew workers. It was assumed that the destination for the spent fuel shipments is the proposed Yucca Mountain disposal facility in Nevada. This assumption is conservative because it tends to maximize the shipping distance from the VEGP site.

Shipping casks have not been designed for the spent fuel from advanced reactor designs such as the Westinghouse AP1000. Information in INEEL (2003) indicated that advanced LWR fuel designs would not be significantly different from existing LWR designs; therefore, current shipping cask designs were used for the analysis of Westinghouse AP1000 reactor spent fuel shipments. The assumed capacity of a truck shipment of Westinghouse AP1000 reactor spent fuel was 0.5 MTU/shipment, the same capacity as that used in WASH-1238 (AEC 1972).

Input to RADTRAN5 includes the total shipping distance between the origin and destination sites and the population distributions along the routes. This information was obtained by running the TRAGIS computer code (Johnson and Michelhaugh 2003) for the VEGP-to-Yucca-Mountain shipments. The resulting route characteristics information is shown in Table 6-7. Note that for truck shipments, all the spent fuel is assumed to be shipped to the Yucca Mountain site over designated highway-route controlled quantity routes. In addition, TRAGIS data was loaded into RADTRAN 5 on a state-by-state basis. This increases precision and allows the results to be presented for each state along the route between the VEGP site and Yucca Mountain, if desired.

Radiation doses are a function of many parameters, including vehicle speed, traffic count, dose rate, packaging dimensions, number in the truck crew, stop time, and population density at stops. A listing of the values for these and other parameters and the sources of the information is provided in Table 6-8.

For purposes of this analysis, the transportation crew for spent fuel shipments delivered by truck is assumed to consist of two drivers. Escorts were considered, but they were not included because their distance from the shipping cask would reduce the dose rates to levels well below the dose rates experienced by the drivers. Stop times were assumed to accrue at the rate of 30 min per 4 hrs driving time. TRAGIS outputs were used to determine the number of stops. Doses to the public at truck stops have been significant contributors to the doses calculated in previous RADTRAN 5 analyses. For this analysis, stop doses are the sum of the doses to individuals located in two annular rings centered at the stopped vehicle, as illustrated in Figure 6-2. The inner ring represents persons who may be at the truck stop at the same time as a spent fuel shipment and extends 1 to 10 m from the edge of the vehicle. The outer ring represents persons who reside near a truck stop and extends from 10 to 800 m from the vehicle. This scheme is similar to that used in Sprung et al. (2000). Population densities and shielding factors were also taken from Sprung et al. (2000), which were based on the observations of Griego et al. (1996).

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Table 6-7. Transportation Route Information for Shipments from Advanced Reactor Sites to the Yucca Mountain Spent Fuel Disposal Facility

Advance Reactor Site	One-way Shipping Distance, km				Population Density, persons/km ²			Stop time per trip, hr
	Total	Rural	Suburban	Urban	Rural	Suburban	Urban	
VEGP Westinghouse AP1000	4091	3230	754	107	9.4	334.7	2270.4	4

Note: This table presents aggregated route characteristics. Input to the RADTRAN 5 computer code was disaggregated to a state-by-state level.

Table 6-8. RADTRAN 5 Normal (Incident-free) Exposure Parameters

Parameter	RADTRAN 5 Input Value	Source
Vehicle speed, km/hr	88.49	Based on average speed in rural areas given in DOE (2002a). Conservative in-transit speed of 55 mph assumed; predominantly interstate highways used.
Traffic count – Rural, vehicles/hr	State-specific	Wiener et al. (2006)
Traffic count – Suburban, vehicles/hr		
Traffic count – Urban, vehicles/hr		
Vehicle occupancy, persons/vehicle	1.5	DOE (2002a)
Dose rate at 1 m from vehicle, mrem/hr	14	DOE (2002a, b) – approximate dose rate at 1 m that is equivalent to maximum dose rate allowed by Federal regulations (i.e., 10 mrem/hr at 2 m from the side of a transport vehicle).
Packaging dimensions, m	Length – 5.2 Diameter – 1.0	DOE (2002b)
Number of truck crew	2	AEC (1972), NRC (1977a), and DOE (2002a, b)
Stop time, hr/trip	4	See Table 6-7
Population Density at Stops, persons/km ²	30,000	Sprung et al. (2000). Nine persons within 10 m of vehicle. See Figure 6-2.
Min/Max Radii of Annular Area Around Vehicle at Stops, m	1 to 10	Sprung et al. (2000)
Shielding Factor Applied to Annular Area Surrounding Vehicle at Stops	1 (no shielding)	Sprung et al. (2000)
Population Density Surrounding Truck Stops, persons/km ²	340	Sprung et al. (2000)
Min/Max Radius of Annular Area Surrounding Truck Stop, m	10 to 800	Sprung et al. (2000)
Shielding Factor Applied to Annular Area Surrounding Truck Stop	0.2	Sprung et al. (2000)

The results of these normal (incident-free) exposure calculations are shown in Table 6-9 for the proposed VEGP site. Population dose estimates are given for workers (i.e., truck crew

members), onlookers (doses to persons at stops and persons on highways exposed to the spent fuel shipment,) and along the route (persons living near the highway). Annual doses were calculated assuming the annual number of spent fuel shipments is equivalent to the annual refueling requirements. Shipping schedules for spent fuel generated by the proposed new VEGP site units have not been determined; therefore, this assumption was judged by the staff

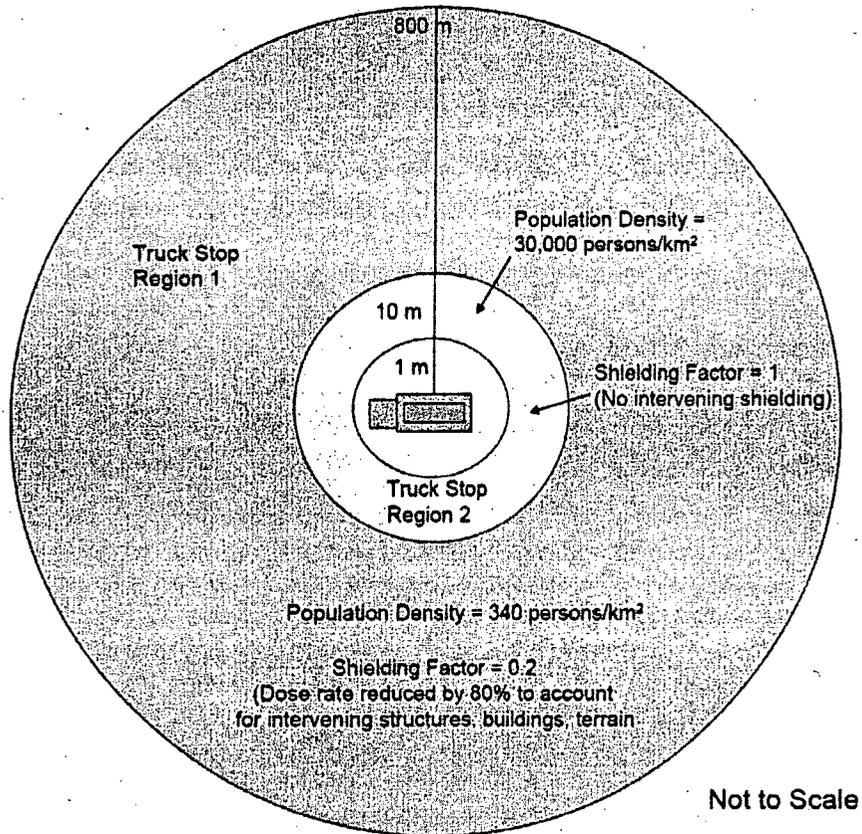


Figure 6-2. Illustration of Truck Stop Model

Table 6-9. Normal (Incident-Free) Radiation Doses to Transport Workers and the Public from Shipping Spent Fuel from the VEGP Site to the Proposed High-Level Waste Repository at Yucca Mountain

	Worker (Crew)	Onlookers	Along Route
Reference LWR, Person-Sv/yr ^a	1.1×10^{-1}	2.0×10^{-1}	5.8×10^{-3}
VEGP ESP Normalized Impacts, person-Sv/yr	7.3×10^{-2}	1.3×10^{-1}	3.8×10^{-3}
Table S-4 Condition	4×10^{-2}	3×10^{-2}	3×10^{-2}

(a) to convert person-Sv to person-rem, multiply by 100

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to be reasonable. Population doses were normalized to the reference LWR in WASH-1238 (880 net MW[e]). This corresponds to an 1100-MW(e) LWR operating at 80-percent capacity. Note that the impacts in Table 6-9 have been doubled to reflect operation of two reactors.

The bounding cumulative doses to the exposed population given in Table S-4 are

- 0.04 person-Sv/reactor-year (4 person-rem/reactor-year) to transport workers
- 0.03 person-Sv/reactor-year (3 person-rem/reactor-year) to general public (onlookers), and members of the public along the route.

Population doses to the crew and the population along the route for the reference LWR and the VEGP site shipments exceed Table S-4 values. A key reason for the higher population doses relative to Table S-4 is the longer shipping distances assumed for this ESP analysis (i.e., to a possible repository in Nevada) than were used in WASH-1238. WASH-1238 used a "typical" distance for a spent fuel shipment of 1600 km (1000 mi), whereas the shipping distance used in this assessment was about 4100 km (2500 mi). Another important difference is the stop model described above as well as additional precision that results from incorporating state-specific route characteristics and vehicle densities.

Where necessary, the staff made conservative assumptions to calculate impacts. Some of the key conservative assumptions are:

- Use of the regulatory maximum dose rate (0.1 mSv/hr [10 mrem/hr] at 2 m) in the RADTRAN 5 calculations. The shipping casks assumed in the EIS prepared by DOE in support of the application for a geologic repository at the proposed Yucca Mountain repository (DOE 2002b) were designed to transport spent fuel that has cooled for 5 years. Most spent fuel would have cooled for much longer than 5 years before it is shipped to a possible geologic repository. Based on this, shipments from the VEGP site is also expected to be cooled for longer than 5 years. Consequently, the estimated population doses in Table 6-9 could be further reduced if more realistic dose rate projections and shipping cask capacities are used.
- Use of 30 minutes as the average time at a truck stop in the calculations. Many stops made for actual spent fuel shipments are of short duration (i.e., 10 minutes) for brief visual inspections of the cargo (e.g., checking the cask tie-downs). These stops typically occur in minimally populated areas, such as an overpass or freeway ramp in an unpopulated area. Furthermore, empirical data provided in Griego et al. (1996) indicate that a 30-minute duration is toward the high end of the stop time distribution. Average stop times observed by Griego et al. (1996) are on the order of 18 minutes.

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A sensitivity study was performed to demonstrate the effects on the incident-free population doses of using more realistic dose rates and stop times. For this sensitivity study, the dose rate was reduced to 5 mrem/hr, the approximate 50 percent confidence interval of the dose rate distribution estimated by Sprung et al. (2000) for future spent fuel shipments. The stop time was reduced to 18 minutes per stop. All other RADTRAN 5 input values were unchanged. The result is that the annual crew doses were reduced to 2.6×10^{-2} person-Sv/yr, or about 36 percent of the annual dose shown in Table 6-9. The annual onlooker doses were reduced to 3.6×10^{-2} person-Sv/yr (28 percent) and the annual doses to persons along the route were reduced to 1.4×10^{-3} person-Sv/yr (37 percent).

Southern described the results of a RADTRAN 5 analysis of the impacts of incident-free transport of spent fuel to a spent fuel disposal facility. The assumed transport of spent fuel originated from the Savannah River Site (a distance approximately equal to the VEGP site) and terminated at the proposed repository at Yucca Mountain, Nevada. Dose estimates per shipment were taken from three previous ESP EISs (NRC 2006a, 2006b, 2006c) that used an earlier version of RADTRAN 5 than is available today. The results are similar to those calculated by the staff in this EIS.

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses below about 100 mSv (10,000 mrem) and at low dose rates. However, radiation protection experts conservatively assume that any amount of radiation exposure may pose some risk of causing cancer or a severe hereditary effect and that the risk is greater for higher radiation exposures. Therefore, a linear, no-threshold dose response model is used to describe the relationship between radiation dose and detriments such as cancer induction. A recent report by the National Research Council (2006), the BEIR VII report, supports the linear, no-threshold dose-response theory. 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 probably overestimates those risks.

Based on this model, the staff estimates the risk to the public from radiation exposure using the nominal probability coefficient for total detriment (730 fatal cancers, nonfatal cancers, and severe hereditary effects per 10,000 person-Sv [1,000,000 mrem]) from ICRP Publication 60 (ICRP 1991). The population dose to the public (sum of doses along route and to onlookers in Table 6-9) is about 0.13 person-Sv/yr (13 person-rem/yr); therefore, the total detriment estimates associated with this population dose would be less than 1×10^{-2} fatal cancers, nonfatal cancers, and severe hereditary effects per year. To place these impacts in perspective, the average U.S. resident receives about 300 mrem/yr effective dose equivalent from natural background radiation (i.e., exposures from cosmic radiation, naturally occurring radioactive materials such as radon, and global fallout from testing of nuclear explosive devices)

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(NCRP 1987b). Using this average effective dose, approximately 180 fatal cancers, nonfatal cancers, and severe hereditary effects would occur in the population along this representative route from natural background radiation. The risks of transporting spent fuel from the VEGP site to a spent fuel disposal facility are small compared to the fatal cancers, nonfatal cancers, and severe hereditary effects that the same population would incur annually from exposure to natural sources of radiation.

As mentioned previously, Southern advised the NRC staff that, based on changes between Revision 15 and Revision 16 of the AP1000 DCD, fuel enrichment levels would increase from 4.51% to 4.54%, and fuel irradiation levels would increase from 48,700 MWd/MTU to 50,533 MWd/MTU. The staff evaluated the effect of these changes on the staff analysis presented above. The staff determined it would have no impact on the staff conclusion with respect to calculated doses under normal conditions.

Dose estimates to the MEI from transport of unirradiated fuel, spent fuel, and wastes under normal conditions are presented in Section 6.2.1.1.

6.2.2.2 Radiological Impacts of Accidents

As discussed previously, the staff used the RADTRAN 5 computer code to estimate impacts of transportation accidents involving spent fuel shipments. RADTRAN 5 considers a spectrum of postulated transportation accidents, ranging from those with high frequencies and low consequences (e.g., "fender benders") to those with low frequencies and high consequences (i.e., accidents in which the shipping container is exposed to severe mechanical and thermal conditions).

Radionuclide inventories are important parameters in the calculation of accident risks. The radionuclide inventories used in this analysis were from *Early Site Permit Environmental Report Sections and Supporting Documentation* (INEEL 2003) and are the same as those presented in Southern's ER. This report includes 140 radionuclides for Westinghouse AP1000 reactor spent fuel. A screening analysis was conducted to select the dominant contributors to accident risks to simplify the RADTRAN 5 calculations. The screening identified the radionuclides that would contribute more than 99.999 percent of the dose from inhalation of radionuclides released following a transportation accident. Spent fuel inventories used in the staff analysis are presented in Table 6-10. The list of radionuclides set forth in the table includes all of the radionuclides that were included in the analysis conducted by Sprung et al. (2000). However, INEEL (2003) did not provide radionuclide source terms for radioactive material deposited on the external surfaces of LWR spent fuel rods (commonly called "crud"). Because crud is deposited from corrosion products generated elsewhere in the reactor cooling system and the complete reactor design and operating parameters are uncertain, the quantities and characteristics of crud deposited on Westinghouse AP1000 reactor spent fuel are not available at this time. The VEGP Westinghouse AP1000 reactor spent fuel transportation accident

impacts were calculated assuming the cobalt-60 inventory in the form of crud is 4.4 TBq/MTU (120 Ci/MTU), based on information in Sprung et al. (2000).

Robust shipping casks are used to transport spent fuel because of the radiation shielding and accident resistance required by 10 CFR Part 71. Spent fuel shipping casks must be certified Type B packaging systems, meaning they must withstand a series of severe postulated accident conditions with essentially no loss of containment or shielding capability. These casks are also designed with fissile material controls to ensure the spent fuel remains subcritical under normal and accident conditions. According to Sprung et al. (2000), the probability of encountering accident conditions that would lead to shipping cask failure is less than 0.01 percent (i.e., more than 99.99 percent of all accidents would result in no release of radioactive material from the shipping cask). The staff assumed that shipping casks for Westinghouse AP1000 reactor spent fuel would provide equivalent mechanical and thermal protection of the spent fuel cargo.

Table 6-10. Radionuclide Inventories Used in Transportation Accident Risk Calculations for Each Advanced Reactor Type ^{(a)(b)}

Radionuclide	Ci/MTU	Bq/MTU
Pu-241	6.96×10^4	2.57×10^{15}
Pu-238	6.07×10^3	2.24×10^{14}
Cm-244	7.75×10^3	2.87×10^{14}
Am-241	7.27×10^2	2.69×10^{13}
Pu-240	5.43×10^2	2.01×10^{13}
Pu-239	2.55×10^2	9.44×10^{12}
Sr-90	6.19×10^4	2.29×10^{15}
Cs-137	9.31×10^4	3.44×10^{15}
Am-243	3.34×10^1	1.24×10^{12}
Cm-243	3.07×10^1	1.13×10^{12}
Am-242m	1.31×10^1	4.85×10^{11}
Ru-106	1.55×10^4	5.72×10^{14}
Eu-154	9.13×10^3	3.38×10^{14}
Cs-134	4.80×10^4	1.78×10^{15}
Ce-144	8.87×10^3	3.28×10^{14}
Sb-125	3.83×10^3	1.42×10^{14}
Pu-242	1.82×10^0	6.72×10^{10}
Cm-242	2.83×10^1	1.05×10^{12}
Pm-147	1.76×10^4	6.52×10^{14}
Cm-245	1.21×10^0	4.46×10^{10}
Y-90	6.19×10^4	2.29×10^{15}
Eu-155	4.62×10^3	1.71×10^{14}
Kr-85	8.90×10^3	3.29×10^{14}
Co-60 ^(c)	1.20×10^2	4.40×10^{12}

(a) Divide becquerel/metric ton Uranium (Bq/MTU) by 3.7×10^{10} to obtain curies/MTU

(b) The source of the spent fuel inventories is INEEL (2003).

(c) Cobalt-60 is the key radionuclide constituent of fuel assembly crud.

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The RADTRAN 5 accident risk calculations were performed using radionuclide inventories (Bq/MTU) for the spent fuel shipments from a Westinghouse AP1000 reactor (INEEL 2003). The resulting risk estimates were then multiplied by assumed annual spent fuel shipments (MTU/yr) to derive estimates of the annual accident risks associated with spent fuel shipments from the VEGP site to the proposed repository at Yucca Mountain in Nevada. As was done for routine exposures, the staff assumed that the numbers of shipments of spent fuel per year are equivalent to the annual discharge quantities.

For this assessment, release fractions for current-generation LWR fuel designs (Sprung et al. 2000) were used to approximate the impacts from the Westinghouse AP1000 reactor spent fuel shipments. This assumes that the fuel materials and containment systems (i.e., cladding, fuel coatings) behave similarly to current LWR fuel under applied mechanical and thermal conditions.

The NRC staff used RADTRAN 5 to calculate the population dose from the released radioactive material from four of five possible exposure pathways.^(a) These pathways are:

- External dose from exposure to the passing cloud of radioactive material (cloudshine).
- External dose from the radionuclides deposited on the ground by the passing plume (groundshine). The staff's analysis included the radiation exposure from this pathway even though the area surrounding a potential accidental release would be evacuated and decontaminated, thus preventing long-term exposures from this pathway.
- Internal dose from inhalation of airborne radioactive contaminants (inhalation).
- Internal dose from resuspension of radioactive materials that were deposited on the ground (resuspension). The staff's analysis included the radiation exposures from this pathway even though evacuation and decontamination of the area surrounding a potential accidental release would prevent long-term exposures.

Table 6-11 presents the environmental consequences of transportation accidents when shipping spent fuel from the VEGP site to the proposed Yucca Mountain repository. The shipping distances and population distribution information for the routes were the same as those used for the normal "incident-free" conditions (see Section 6.2.2.1). The results are normalized to the WASH-1238 reference reactor (880-MW(e) net electrical generation, 1100-MW(e) reactor operating at 80-percent capacity).

(a) Internal dose from ingestion of contaminated food was not considered because the staff assumed evacuation and subsequent interdiction of foodstuffs following a postulated transportation accident.

Table 6-11. Annual Spent Fuel Transportation Accident Impacts for Advanced Reactors, Normalized to Reference 1100-MW(e) LWR Net Electrical Generation

	Population Impacts, Person-Sv/yr ^(a)
Reference LWR, Person-Sv/yr	3.5×10^{-7}
VEGP ESP Normalized Impacts, person-Sv/yr	2.2×10^{-7}

(a) Multiply person-Sv/yr times 100 to obtain person-rem/yr.

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses below about 100 mSv (10,000 mrem) and at low dose rates. However, radiation protection experts conservatively assume that any amount of radiation exposure 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 model is used to describe the relationship between radiation dose and detriments such as cancer induction. A recent report by the National Research Council (2006), the BEIR VII report, supports the linear, no-threshold dose response theory. 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 probably over estimates those risks.

Based on this model, the staff estimates the risk to the public from radiation exposure using the nominal probability coefficient for total detriment (730 fatal cancers, nonfatal cancers, and severe hereditary effects per 10,000 person-Sv [1,000,000 person-rem]) from ICRP Publication 60 (ICRP 1991). The population doses presented in Table 6-11 are less than 1×10^{-6} person-Sv/yr (1×10^{-4} person-rem/yr); therefore, the total detriment estimates associated with these population doses would all be less than 1×10^{-7} fatal cancers, nonfatal cancers, and severe hereditary effects per year. These risks are small.

As mentioned previously, Southern advised the NRC staff that, based on changes between Revision 15 and Revision 16 of the AP1000 DCD, fuel enrichment levels would increase from 4.51% to 4.54%, and fuel irradiation levels would increase from 48,700 MWd/MTU to 50,533 MWd/MTU. The staff evaluated the effect of these changes on the staff analysis presented above. The staff determined that while some levels might increase slightly, the elevation in the calculated dose levels would be insignificant and, accordingly, the staff's impact assessment would not change.

6.2.2.3 Nonradiological Impact of Spent Fuel Shipments

The general approach used to calculate nonradiological impacts of spent fuel shipments is the same as that used for unirradiated fuel shipments. The main difference is that the spent fuel shipping route characteristics are better-defined so the state-level accident statistics in Saricks

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and Tompkins (1999) may be used. State-by-state shipping distances were obtained from the TRAGIS output file and combined with the annual number of shipments and accident, injury, and fatality rates by state from Saricks and Tompkins (1999) to calculate nonradiological impacts. The results are shown in Table 6-12.

6.2.3 Transportation of Radioactive Waste

This section discusses the environmental effects of transporting waste from the VEGP site. The environmental conditions listed in 10 CFR 51.52 that apply to shipments of radioactive waste are as follows:

- Radioactive waste (except spent fuel) would be packaged and in solid form.
- Radioactive waste (except spent fuel) would be shipped from the reactor by truck or rail.
- The weight limitation of 33,100 kg (73,000 lb) per truck and 90.7 MT (100 tons) per cask per railcar would be met.
- Traffic density would be less than the one truck shipment per day or three railcars per month condition.

Table 6-12. Nonradiological Impacts of Transporting Spent Fuel from the VEGP site to Yucca Mountain, Normalized to Reference LWR

State	Highway Type	One-way Shipping	Nonradiological Impacts, per year		
		Distance, km	Accidents/yr	Injuries/yr	Fatalities/yr
AR	Interstate	4.6×10^2	4.9×10^{-3}	3.6×10^{-3}	2.3×10^{-4}
AZ	Interstate	5.7×10^2	6.1×10^{-3}	5.4×10^{-3}	4.3×10^{-4}
CA	Interstate	3.5×10^2	4.4×10^{-3}	3.4×10^{-3}	1.9×10^{-4}
	Primary	1.5×10^2	5.3×10^{-4}	4.0×10^{-4}	2.6×10^{-5}
GA	Interstate	4.3×10^2	2.3×10^{-2}	1.6×10^{-2}	6.6×10^{-4}
	Primary	4.6×10^1	2.5×10^{-3}	1.7×10^{-3}	7.2×10^{-5}
NM	Interstate	6.0×10^2	5.4×10^{-3}	5.5×10^{-3}	5.6×10^{-4}
NV	Primary	1.2×10^2	3.7×10^{-3}	2.4×10^{-3}	1.6×10^{-4}
OK	Interstate	5.3×10^2	1.1×10^{-2}	1.2×10^{-2}	5.7×10^{-4}
TN	Interstate	5.6×10^2	5.5×10^{-3}	4.1×10^{-3}	4.5×10^{-4}
TX	Interstate	2.8×10^2	1.4×10^{-2}	1.2×10^{-2}	2.9×10^{-4}
Totals		4.1×10^3	8.1×10^{-2}	6.7×10^{-2}	3.6×10^{-3}

Note: The number of shipments of spent fuel assumed in the calculations is 40 shipments/yr after normalizing to the reference LWR.

Radioactive waste from the Westinghouse AP1000 reactor is expected to be capable of being shipped in compliance with Federal or State weight restrictions. Table 6-13 presents estimates of annual waste volumes and annual waste shipment numbers for a Westinghouse AP1000 reactor at the VEGP site normalized to the reference 1100-MW(e) LWR defined in WASH-1238 (AEC 1972). The expected annual waste volumes and waste shipments for the Westinghouse AP1000 reactor were less than the 1100-MW(e) reference reactor that was the basis for

Table S-4. Maximum projected waste generation rates for the VEGP ESP reactor could exceed the reference LWR waste generation rate. However, waste generation rate projections are uncertain and are a function of Southern's radioactive waste management practices. Therefore, waste generation rates for the VEGP reactor are anticipated to be much closer to the expected rate than the maximum rate.

The sum of the daily shipments of unirradiated fuel, spent fuel, and radioactive waste is well below the one-truck-shipment-per-day condition given in 10 CFR 51.52, Table S-4 for a Westinghouse AP1000 reactor located at the VEGP site. Doubling the shipment estimates to account for empty return shipments of fuel and waste is included in the results. An additional doubling to account for a second reactor at the VEGP site is also less than the one-shipment-per-day condition.

Dose estimates to the MEI from transport of unirradiated fuel, spent fuel, and waste under normal conditions are presented in Section 6.2.1.1.

Table 6-13. Summary of Radioactive Waste Shipments from the VEGP Site

Reactor Type	Waste Generation Information	Annual Waste Volume, m ³ /yr per Unit	Electrical Output, MW(e) per Unit	Normalized Rate, m ³ /1100 MW(e) Unit (880 MW(e) Net) ^(a)	Shipments/1100 MW(e) (880 MW(e) Net) Electrical Output ^(b)
Reference LWR (WASH-1238)	3800 ft ³ /yr per unit	108	1100	108	46
VEGP Westinghouse AP1000, expected	1964 ft ³ /yr per unit ^(c)	56	1115 ^(c)	47	21
VEGP Westinghouse AP1000, maximum	5717 ft ³ /yr per unit ^(c)	162	1115 ^(c)	137	59

Conversions: 1 m³ = 35.31 ft³. Drum volume = 210 liters (0.21 m³).

(a) Capacity factors used to normalize the waste generation rates to an equivalent electrical generation output are 80 percent for the reference LWR (AEC 1972) and 93 percent for the VEGP Westinghouse AP1000 (Southern 2008). Waste generation for the Westinghouse AP1000 is normalized to 880 MW(e) net electrical output (1100-MW(e) unit with an 80-percent capacity factor).

(b) The number of shipments per 1100 MW(e) was calculated assuming the WASH-1238 average waste shipment capacity of 2.34 m³ per shipment (108 m³/yr divided by 46 shipments/yr).

(c) These values were taken from the ER (Southern 2008).

Nonradiological impacts of radioactive waste shipments were calculated using the same general approach as unirradiated and spent fuel shipments. For this EIS, the shipping distance was assumed to be 800 km (500 mi) one way (AEC 1972). Because the actual destination is uncertain, national median accident, injury, and fatality rates were used in the calculations (Saricks and Tompkins 1999). The results are presented in Table 6-14.

Table 6-14. Nonradiological Impacts of Radioactive Waste Shipments from the VEGP Site

	Shipments per Year	One-Way Distance, km	Fatalities per Year	Injuries per Year	Accidents per Year
WASH-1238	46	800	6.8×10^{-4}	1.4×10^{-2}	2.1×10^{-2}
VEGP Westinghouse AP1000	21	800	3.1×10^{-4}	6.5×10^{-3}	9.5×10^{-3}

Note: The shipments and impacts have not been normalized to the reference LWR; the expected waste volumes from the VEGP Westinghouse AP1000 reactor were used. Normalized shipments and impacts would be slightly smaller (see Table 6-12).

6.2.4 Conclusions

An independent confirmatory analysis was conducted of the impacts under normal operating and accident conditions of transporting construction materials, construction and operations personnel, and fuel and wastes to/from a Westinghouse AP1000 reactor proposed to be located at the proposed VEGP site. To make comparisons to Table S-4, the environmental impacts are normalized to a reference reactor year. The reference reactor is an 1100-MW(e) reactor that has an 80-percent capacity factor, for a total electrical output of 880 MW(e) per year. The environmental impacts can be adjusted to calculate impacts per site by multiplying the normalized impacts by the ratio of the total electric output for the proposed Westinghouse AP1000 reactor at the VEGP site to the electric output of the reference reactor.

Because of the conservative approaches and data used to calculate impacts, actual environmental effects are not likely to exceed those calculated in this EIS. Thus, the staff concludes that the environmental impacts of transportation of construction materials, personnel, fuel, and radioactive wastes to and from the VEGP site would be SMALL, and would be consistent with the environmental impacts associated with transportation of materials, personnel, fuel, and radioactive wastes from current-generation reactors presented in Table S-4 of 10 CFR 51.52.

6.3 Decommissioning Impacts

At the end of the operating life of a power reactor, NRC regulations require that the facility undergo decommissioning. Decommissioning is the removal of a facility safely from service and the reduction of residual radioactivity to a level that permits termination of the NRC license. The regulations governing decommissioning of power reactors are found in 10 CFR 50.75.

Environmental impacts from the activities associated with the decommissioning of any LWR before or at the end of an initial or renewed license are evaluated in the *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, NUREG-0586, Supplement 1 (NRC 2002). If an applicant for a CP or COL referencing the Southern ESP applies for a license to construct new nuclear units at the VEGP site, there is a requirement to provide a report containing a certification that financial assurance for radiological decommissioning would be

provided. At the time an application is submitted, the requirements in 10 CFR 50.33, 50.75, and 52.77 (and any other applicable requirements) would have to be met.

At the ESP stage, applicants are not required to submit information regarding the process of decommissioning, such as the method chosen for decommissioning, the schedule, or any other aspect of planning for decommissioning. Southern did not provide this information in its application; however, it did provide a decommissioning cost analysis summary. The regulatory requirements on decommissioning activities are expected to limit the impacts of decommissioning to a SMALL impact.

6.4 References

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7.0 Cumulative Impacts

When evaluating the potential impacts of construction and operation of new units at the Vogtle Electric Generating Plant (VEGP) site proposed by Southern Nuclear Operating Company, Inc. (Southern) in its early site permit (ESP) application and Environmental Report (ER) (Southern 2008a), the staff considered potential cumulative impacts that could occur because of the construction and operation of two Westinghouse Electric Company, LLC (Westinghouse) AP1000 advanced light-water reactors at the VEGP site. For purposes of this analysis, past actions include those related to the existing VEGP Units 1 and 2. Present actions are those related to resources at the time of the ESP application until the start of construction including the start of requested limited work authorization activities. Future actions are those that are reasonably foreseeable during construction and operation of the proposed VEGP Units 3 and 4, including decommissioning. Southern has submitted an application to renew the operating licenses for VEGP Units 1 and 2 (Southern 2007b). A draft supplemental environmental impact statement (EIS) for license renewal of VEGP Units 1 and 2 was published in April 2008 (NRC 2008). The impacts of this potential license renewal also are considered in this analysis. The geographical area over which past, present, and future actions could contribute to cumulative impacts is dependent on the type of action considered and is described below for each impact area. The staff considered cumulative effects of the proposed VEGP Units 3 and 4 with current operations at the Savannah River Site, and proposed new facilities at the Savannah River Site such as the proposed mixed oxide (MOX) fuel fabrication facility (NRC 2005).

The impacts of the proposed action, as described in Chapters 4 and 5, are combined with other past, present, and reasonably foreseeable future actions in the vicinity of VEGP that would affect the same resources impacted by the proposed VEGP Units 3 and 4, regardless of what agency (Federal or non-Federal) or person undertakes such actions. These combined impacts are defined as "cumulative" in 40 CFR 1508.7 and include individually minor but collectively significant actions taking place over a period of time. It is possible that an impact that may be SMALL by itself could result in a MODERATE or LARGE impact when considered in combination with the impacts of other actions on the affected resource. Likewise, if a resource is regionally declining or imperiled, even a SMALL individual impact could be important if it contributes to or accelerates the overall resource decline.

As mentioned previously, the staff analyzes the impacts of construction and operation of the proposed action in chapters 4 and 5, and discusses cumulative impacts in chapter 7. As a result of the NRC's recent new rule on limited work authorizations for nuclear power plants (see 72 FR 57416), the definition of construction activities in 10 CFR 50.10 has changed to more clearly reflect the NRC's jurisdiction. The staff's draft EIS (DEIS) for the Vogtle ESP review was published prior to the issuance of the final rule. To reflect the effects of the new rule, site

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preparation and preconstruction activities would most appropriately be analyzed in the staff's EIS as cumulative rather than as impacts of construction or operation of the proposed facility. However, in this instance, to ensure appropriate consideration of public comments on the DEIS and to avoid confusion from reorganizing the document following those comments, the staff has kept discussions of such impacts (e.g., those no longer defined by regulation as construction activities) in the chapters in which they were discussed in the DEIS. While the staff's analysis of construction activities in the DEIS and its discussion of cumulative impacts are different, they are generally at the same depth of analysis. The staff believes this approach will allow effective consideration of public comments while still ensuring that impacts relevant to the NEPA analysis are disclosed and fully evaluated. The discussion in this chapter continues to disclose and evaluate cumulative impacts to applicable resources from activities in addition to those previously evaluated in chapters 4 and 5.

7.1 Land Use

The NRC staff reviewed the available information on the impacts on land use of constructing one or more additional nuclear units at the VEGP site including one additional transmission line in a new right-of-way. In addition to land-use impacts at the VEGP site, cumulative impacts for land use include possible additional growth and land conversions to accommodate new workers and services. However, cumulative land-use impacts are expected to be relatively minor because the construction and the operations workforces are expected to be drawn from an area wider than Burke County, Georgia. Because the workforce would be dispersed over larger geographic areas in the labor supply region, the induced impacts on land use (resulting from either construction or operations of one or more new units at the VEGP site) can be absorbed in that wider region.

Construction of the planned 500-kV transmission line would have land-use impacts, as discussed in Sections 4.1.2 and 5.1.2 of this EIS. However, because the Georgia Power Company (GPC) generally provides easements for agricultural activities under transmission lines, the cumulative land-use impacts associated with construction of the new transmission line are expected to be relatively SMALL.

7.2 Air Quality

Permitted air emission sources nearby the VEGP site include the Allen B. Wilson Combustion Turbine Plant (Plant Wilson) and the Savannah River Site. Plant Wilson is located to the east-southeast on adjacent property to the current VEGP site and is operated by the GPC. The facility has six combustion turbines and one black start diesel generator, all of which are listed as significant emission units in the facility's Title V Clean Air Act operating permit 4911-033-0008-V-02.0 (Georgia EDP 2007). The Savannah River Site is a U.S. Department of Energy (DOE) facility and is located across the Savannah River to the east-northeast of the

VEGP site. Air emissions from Savannah River Site are permitted under DOE's operating permit (TV-0090-0041) and include radioactive, nonradioactive toxic, and criteria pollutants from approximately 47 nonexempt emission units, with each emission unit having specific emission limits, operating conditions, and monitoring and reporting requirements (Savannah River Site 2006). In addition, a MOX facility has been proposed for development on the Savannah River Site. The MOX facility would be in support of DOE's surplus plutonium disposition program for converting depleted uranium and weapons-grade plutonium into a MOX fuel that is proliferation-resistant. Estimated air emissions from the MOX facility are detailed in the EIS for the proposed facility (NRC 2005). Emissions of criteria pollutants primarily include dust during construction and NO₂ and particulates from processing during operation. Limited air emissions would also result from emergency and standby diesel-power generators and fuel storage (NRC 2005).

As was discussed in Section 2.3.2 of this EIS, the VEGP site is located in an area that is in attainment for all criteria pollutants for which National Ambient Air Quality Standards (NAAQS) have been established (40 CFR 81.314). Section 4.2 of this EIS examined air-quality impacts associated with construction; emissions would be predominately dust from construction activities and exhaust from equipment and vehicles. Emissions from construction are expected to be temporary and limited in magnitude and impacts on air quality would be small. Section 5.2 addressed air-quality impacts from operations. Natural draft cooling towers proposed for VEGP Units 3 and 4 would not release emissions regulated under the NAAQS. Air emissions from operations would be primarily from diesel generators and auxiliary power supplies. These systems would be permitted and operated in accordance with State and Federal regulatory requirements and emissions would be infrequent and impacts would be small. No other significant air impacts from other actions at the VEGP were identified. Based on its evaluation, the NRC staff concludes that the cumulative impacts to air quality would be SMALL and that mitigation is not warranted.

7.3 Water Use and Quality

The assessments performed by the NRC staff in Sections 4.3 and 5.3 describe the impacts of construction and operation of the proposed VEGP Units 3 and 4 on the hydrological environment. This section addresses the cumulative impacts of the proposed VEGP Units 3 and 4, the existing VEGP Units 1 and 2, the DOE's Savannah River Site directly across the Savannah River from the VEGP site, and other water users in the region.

7.3.1 Water-Use Impacts

The potential impacts on the environment from surface-water withdrawals from the Savannah River during operation of the proposed units are described in Section 5.2 of the ER (Southern 2008a). The potential impacts on the environment from groundwater use during operation of the proposed VEGP Units 3 and 4 at the VEGP site are described in Section 5.2.2.2 of the ER (Southern 2008a), in Southern's response to requests for additional information

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(Southern 2007a,b), and in Section 5.3.2.2 of this EIS. Other past, present, and reasonably foreseeable future actions in the vicinity of the proposed site include (1) the cumulative impact from operation of the existing VEGP Units 1 and 2, (2) saltwater intrusion issues in the State of Georgia, (3) observed tritium in the unconfined aquifer, and (4) contamination in the environment surrounding the Savannah River Site.

7.3.1.1 Surface-Water-Use Impacts

Water withdrawn from the Savannah River and used to cool both the existing VEGP Units 1 and 2 and the proposed VEGP Units 3 and 4 was compared as a percent of the total river discharge. As shown in Table 7-1, during periods of average discharge conditions, surface-water withdrawals amount to 2 percent of the discharge. During periods of drought, the withdrawal percentage increases, finally reaching 4.6 percent when the river discharge has declined to Drought Level 3. Comparable levels for Drought Level 4 are not shown in Table 7-1 because the river discharge is not specified in the Drought Plan but is variable based on inflow conditions.

Visually, the impact of withdrawing 4.9 m³/s (173 cfs) can be qualitatively gaged by inspecting Figure 2-5. Although the average river discharge rate is 250 m³/s (8830 cfs), numerous periods exist when the discharge rate exceeds 424.85 m³/s (15,000 cfs). At a discharge rate of

Table 7-1. Savannah River Discharge Rates and Combined Surface-Water Withdrawal Rates

Case	River Discharge m ³ /s (cfs)	Normal Withdrawal		Combined Withdrawal	
		VEGP Units 1 and 2 m ³ /s (cfs)	VEGP Units 3 and 4 m ³ /s (cfs)	m ³ /s (cfs)	% of river
Average Conditions	250 (8830)	2.55 (90)	2.35 (83)	4.9 (173)	2.0
Drought Level 1	119 (4200)	2.55 (90)	2.35 (83)	4.9 (173)	4.1
Drought Level 2	113 (4000)	2.55 (90)	2.35 (83)	4.9 (173)	4.3
Drought Level 3	108 (3800)	2.55 (90)	2.35 (83)	4.9 (173)	4.6

Sources: NRC 1985;Southern 2008a

424.85 m³/s (15,000 cfs), the combined withdrawal represents 1.2 percent of the total river discharge. The impact of these withdrawals on the shoreline was evaluated by investigating the net change in river stage resulting from a withdrawal of 4.9 m³/s (173 cfs). Assuming the river was at Drought Level 3 conditions, a further reduction of discharge resulting from the combined withdrawals of VEGP Units 1 through 4 resulted in a net lowering of the water surface elevation by 5 cm (2 in.). Water would be returned to the Savannah River from the site via two discharge outfalls, one serving VEGP Units 1 and 2 and the other serving the proposed VEGP Units 3 and 4. Under normal operating conditions, the consumptive use of the plants would be 1.90 m³/s (67 cfs) for VEGP Units 1 and 2 (NRC 1985) and 1.76 m³/s (62 cfs) for the proposed VEGP

Units 3 and 4 (Southern 2008a). Table 7-2 presents these consumptive water uses as ratios of the total discharge in the Savannah River. The combined consumptive use is approximately 1.5 percent of the average river discharge and 3.4 percent of the discharge during Drought Level 3 conditions.

Table 7-2. Consumptive Use of Savannah River Water

Case	River Discharge m ³ /s (cfs)	Normal Consumptive Use		Combined Consumptive Use	
		VEGP Units 1 and 2 m ³ /s (cfs)	VEGP Units 3 and 4 m ³ /s (cfs)	m ³ /s (cfs)	% of river
Average Conditions	250 (8830)	1.90 (67)	1.76 (62)	3.65 (129)	1.5
Drought Level 1	119 (4200)	1.90 (67)	1.76 (62)	3.65 (129)	3.1
Drought Level 2	113 (4000)	1.90 (67)	1.76 (62)	3.65 (129)	3.2
Drought Level 3	108 (3800)	1.90 (67)	1.76 (62)	3.65 (129)	3.4

Source: NRC 1985; Southern 2008a

As described in Section 2.6.2.1, nearby water users to the proposed VEGP Units 3 and 4 include the existing VEGP Units 1 and 2 at rkm 243 (RM 151), the South Carolina Electric and Gas (SCE&G) D-Area Powerhouse at rkm 249 (RM 155), and the SCE&G Urquhart Station at rkm 314 (RM 195). Of these, the D-Area Powerhouse consumptive use (1.94 m³/s [68.4 cfs]) and the Urquhart Station consumptive use (3.61 m³/s [127.5 cfs]) were the largest water users outside the VEGP site. During times of average or above-average flow in the Savannah River, the VEGP site water use would be 1.5 percent or less of the total river discharge.

Because (1) the total VEGP site withdrawals are expected to be less than 5 percent of the total river discharge even under drought conditions, (2) the total VEGP site consumptive use is expected to be less than 4 percent of the total river discharge, (3) other nearby surface-water users consume less water than the VEGP site would with the proposed two new units, and (4) the reduction in the river stage near the VEGP site caused by its normal withdrawals is expected to be less than 5 cm (2 in.) even under drought conditions, the staff concluded that the combined surface-water-use impacts to the Savannah River resulting from the operation of the proposed VEGP Units 3 and 4 would be minor. Although the effects may be detectable, they would not destabilize the resource; therefore, the staff concludes that the impacts would be SMALL, and mitigation is not warranted.

Southern, in its ER, also investigated the cumulative impact of the existing VEGP Units 1 and 2 outfall on the proposed VEGP Units 3 and 4 outfall. At a distance of 123.14 m (404 ft) downstream from the existing outfall, the expected increase in water temperature was computed to be less than 0.5°C (0.9°F) (Southern 2008a). Values computed in Southern's analysis were

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based on expected differences between ambient river and tower blowdown water temperatures, not the maximum range, as was done in the staff's analysis.

In addition to the above analysis, the staff also considered the cumulative impacts to water supplied from the Savannah River associated with the normal^a withdrawal rates for all four units at the VEGP site at two river flow rates below the Drought Level 3 values. Even assuming river flows of 3000 cfs and 2000 cfs, rather than the Drought Level 3 case of 3800 cfs river flow, the percentage of streamflow reduction in the Savannah River due to the operation of VEGP Units 1 through 4 would be 4.3 percent at 3000 cfs and 6.5 percent at 2000 cfs.

Following publication of the draft EIS, Southern advised the NRC staff (Southern 2007f) that based on changes between Revision 15 and Revision 16 of the AP1000 DCD, the normal surface water consumptive use for Vogtle Units 1 through 4 would increase by approximately 3 cfs). The staff evaluated the effect of this change on the staff's analysis presented above, which uses the DCD Revision 15 surface water consumption values currently in Southern's ER (Southern 2008a). The staff determined that this change would result in an increase in the normal water consumptive use to approximately 3.5 percent of the 3800 cfs river flow at Drought Level 3. At a river flow rate of 3000 cfs, the revised consumption use rate would be 4.4 percent, and for 2000 cfs it would be 6.6 percent. Because the change identified by Southern would result in only a minor increase in consumptive water use under Drought Level 3 conditions and that the impact level analyzed for the Revision 15 values was not near a known impact threshold, the staff determined that these changes would not alter the staff's cumulative analysis of impact to water supply presented above. Furthermore, even under low flow conditions of 3000 and 2000 cfs, the increased consumptive use identified by Southern would result in sufficiently small increases in consumptive water use that it similarly would not alter the staff's cumulative impact assessment.

Therefore, consistent with its analysis discussed above, the staff determined that the cumulative normal water consumptive use of all four VEGP units at the low flows of 3000 and 2000 cfs will reduce the streamflow in the Savannah River further. However, these extreme low flow conditions will be very rare, temporary and not destabilizing to the water supply resource.

Southern, in its ER, also investigated the cumulative impact of the existing VEGP Units 1 and 2 outfall on the proposed VEGP Units 3 and 4 outfall. At a distance of 123.14 m (404 ft) downstream from the existing outfall, the expected increase in water temperature was computed to be less than 0.5°C (0.9°F) (Southern 2008a). Values computed in Southern's analysis were

^a Staff determined that the 'normal' case was most appropriate for the cumulative analysis because it is more representative of long-term impacts and because it is unlikely that all plants would be operating simultaneously in the 'maximum' consumption mode.

In addition to the above analysis, the staff also considered the cumulative impacts to water supplied from the Savannah River associated with the normal^a withdrawal rates for all four units at the VEGP site at two river flow rates below the Drought Level 3 values. Even assuming river flows of 3000 cfs and 2000 cfs, rather than the Drought Level 3 case of 3800 cfs river flow, the percentage of streamflow reduction in the Savannah River due to the operation of VEGP Units 1 through 4 would be 4.3 percent at 3000 cfs and 6.5 percent at 2000 cfs.

Following publication of the draft EIS, Southern advised the NRC staff (Southern 2007f) that based on changes between Revision 15 and Revision 16 of the AP1000 DCD, the normal surface water consumptive use for Vogtle Units 1 through 4 would increase by approximately 3 cfs). The staff evaluated the effect of this change on the staff's analysis presented above, which uses the DCD Revision 15 surface water consumption values currently in Southern's ER (Southern 2008a). The staff determined that this change would result in an increase in the normal water consumptive use to approximately 3.5 percent of the 3800 cfs river flow at Drought Level 3. At a river flow rate of 3000 cfs, the revised consumption use rate would be 4.4 percent, and for 2000 cfs it would be 6.6 percent. Because the change identified by Southern would result in only a minor increase in consumptive water use under Drought Level 3 conditions and that the impact level analyzed for the Revision 15 values was not near a known impact threshold, the staff determined that these changes would not alter the staff's cumulative analysis of impact to water supply presented above. Furthermore, even under low flow conditions of 3000 and 2000 cfs, the increased consumptive use identified by Southern would result in sufficiently small increases in consumptive water use that it similarly would not alter the staff's cumulative impact assessment.

Therefore, consistent with its analysis discussed above, the staff determined that the cumulative normal water consumptive use of all four VEGP units at the low flows of 3000 and 2000 cfs will reduce the streamflow in the Savannah River further. However, these extreme low flow conditions will be very rare, temporary and not destabilizing to the water supply resource.

Because of the minor increase relative to the normal water withdrawals from all four units previously analyzed, the potential increased surface water consumptive use associated with Revision 16 of the AP1000 DCD would not affect the staff's conclusion that cumulative impacts associated with river flows down to Drought Level 3 to the surface water supply from operation of all four units at the VEGP site would be SMALL.

Therefore, although the cumulative surface-water-quality impacts may be detectable, they are expected to be minor and would not destabilize the resource. Therefore, the staff concludes that cumulative impacts resulting from the operation of the proposed VEGP Units 3 and 4 would be SMALL.

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7.3.1.2 Groundwater-Use Impacts

Potential offsite impact during the operation of VEGP Units 1, 2, 3, and 4 is represented by a total normal operation groundwater requirement of 93.50 L/s (1482 gpm) for all units. This is a multi-year average rate applicable to the long-term operation of VEGP. It is based on the normal operation of VEGP Units 1 and 2, requiring 46.1 L/s (730 gpm), and the proposed VEGP Units 3 and 4, requiring 47.44 L/s (752 gpm) (Southern 2008a). The maximum rate for the operation of VEGP Units 1 and 2 is 145 L/s (2300 gpm), and the proposed maximum rate for VEGP Units 3 and 4 is 198.1 L/s (3140 gpm). Thus, in the unlikely event that all four units were at the maximum groundwater usage, a total rate of 343.2 L/s (5440 gpm) would be required. However, this would not be a long-term rate, and may only be required for a short time (e.g., Southern simulated a 2-day period) (Southern 2007b). Potential offsite impact is evaluated based on the decline in hydraulic head in the Cretaceous aquifer using a simple conservative analysis based on withdrawal from a single onsite well nearest the VEGP property boundary.

The well selected for analysis is deep production well MU-2A, and the property boundary is 1740 m (5700 ft) away. Data on the hydraulic properties of the Cretaceous aquifer are published in the Final Safety Analysis Report for VEGP Units 1 and 2 (Southern 2003) and were gathered during the installation and testing of the deep production wells. The transmissivity of 0.0227 m²/s (158,000 gal/d/ft) is identified by Southern (2008a) as a mid-range value for use in analyses. The storativity value of 3.1E-04 (dimensionless) is the arithmetic mean of values reported in the Final Safety Analysis Report (Southern 2003).

The staff performed an independent analysis of cumulative normal and maximum unit operations confirming Southern's calculations and to examine a range of cases. The cumulative drawdown resulting from normal operation at the nearest offsite location is approximately 3.7 m (12 ft) in 2045 (i.e., after 59 years operation of VEGP Units 1 and 2 and 31 years operation of the proposed VEGP Units 3 and 4). Although the drawdown associated with a short-term (i.e., 2 days) maximum operational level is approximately 2.75 m (9.0 ft), a longer period response (i.e., 30 days) is approximately 5.9 m (19.4 ft). The long-term drawdown associated with normal operation represents a small fraction of the approximately 120 m (400 ft) of confining hydraulic head in the Cretaceous aquifer. The drawdown associated with maximum operation levels for brief periods would be temporary, and the hydraulic head would rebound to prior levels.

If either VEGP Unit 1 or 2 were to require maximum groundwater withdrawal, the incremental drawdown after 30 days would be approximately 0.9 m (3 ft). If either the proposed VEGP Unit 3 or 4 were to require maximum off-normal groundwater withdrawal, the incremental in drawdown after 30 days would be approximately 1.3 m (4.3 ft). Incremental drawdowns of 0.9 to 1.3 m (3 to 4.3 ft) would not dewater installed screens in either the Tertiary or Cretaceous

aquifers, and are within the operational tolerance of pumps installed to recover groundwater from confined aquifers.

In addition to identifying the MU-2A well for analysis, Southern identified the proposed locations of water supply wells for the proposed VEGP Units 3 and 4 (see Southern 2008a). The staff estimated the distance from the VEGP property line to the nearest proposed well location as 1070 m (3500 ft). The proximity of the boundary caused the drawdown estimates to increase by approximately 10 percent (i.e., 0.3 m of 3.5 m) for long time periods, by approximately 20 percent (i.e., 0.5 m of 2.5 m) for 30-day periods, and by approximately 40 percent (i.e., 1.1 m of 2.75 m) for 2-day periods. The incremental drawdown and drawdown are both SMALL and these results do not alter the staff's conclusions.

The estimates above reflect the potential impact at the property boundary from both normal or average and maximum withdrawal rates. The closest users of the Cretaceous aquifer are a municipal well 23.3 km (14.5 mi) away, an industrial well 13.7 km (8.5 mi) away, and wells located in the Savannah River Site D-Area 6.4 km (4 mi) away. At these distances, the cumulative drawdown resulting from the production of water during operation of all units through 2045 (approximately 30 years after startup of the proposed units) would be less than 3 m (10 ft) for these users. Thus, potential impacts are quantified for future groundwater users located adjacent to the proposed facility, and for existing groundwater users at some distance from the facility. The existing and projected increased use of groundwater in the region (i.e., the potential 50 percent increase by 2035 to 2045 described in Section 2.6.2.1) will not be substantially impacted by the proposed facility.

Clearly, the pumping stress to support the cumulative operation of VEGP Units 1, 2, 3, and 4 would not dewater the confined aquifer, does not substantially alter the 120 m (400 ft) of confined head in the Cretaceous aquifer, and does not substantially alter the hydraulic head in the Cretaceous aquifer at the nearest neighbor offsite well location.

Analysis of prior studies conducted by the U.S. Geological Survey reveals estimates of deep aquifer baseflow ranging from 5.21 m³/s (119 MGD) to 9.57 m³/s (218.4 MGD). The former baseflow is based on regional field measurements (Aucott et al. 1987), and the latter on regional modeling (Cherry 2006). Both estimates indicate a groundwater resource that is sufficient to sustain the incremental increase in normal operation for the proposed plants (0.047 m³/s [1.08 MGD]), the incremental increase in maximum demand (0.198 m³/s [4.52 MGD]) for the proposed plants, and the total demand under the unlikely condition of all plants requiring maximum demand (0.343 m³/s [7.83 MGD]). Of these amounts, only the last requires more groundwater than is permitted under the existing groundwater-use permit held by Southern, and it would require an increase of 0.080 m³/s (1.83 MGD) above the current permitted amount. This represents 1.5 percent of the lower estimate of the deep aquifer baseflow. Thus, groundwater use at this rate could be sustained for the life of the facility. However, during

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actual operation of the proposed facility, this maximum usage rate would not be sustained for extended periods.

The normal operation of the proposed plants will require 0.047 m³/s (1.08 MGD) of the lower estimate of aquifer baseflow (5.21 m³/s [119 MGD]) or 0.9 percent of the available groundwater resource. Based on permitted and reported groundwater usage in the region (Southern 2008a), approximately 60 MGD, or half of the baseflow in the deep aquifer, is allocated. Beyond the approximately 1 percent increase in allocation required by the proposed facility, there is an additional groundwater resource available to meet the projected 50 percent increase in resource usage.

Based on the projected relatively low drawdown of normal operation, the temporary drawdowns of maximum operation, and the presence of a groundwater resource sufficient to sustain the incremental increase and future increase in groundwater use, the staff concluded that cumulative groundwater-use impacts are SMALL and mitigation is not warranted.

Following publication of the draft EIS, Southern advised NRC staff (Southern 2007c) that, based on changes between Revision 15 and Revision 16 of the AP1000 DCD, the maximum groundwater demand for proposed Vogtle Units 3 and 4 would be expected to decrease by about 11 percent. Because the impacts if this groundwater demand would be bounded by the present analysis, the staff determined that its conclusions regarding cumulative groundwater use would not change.

7.3.2 Water-Quality Impacts

This section describes cumulative water-quality impacts resulting from operation and interaction of the proposed VEGP Units 3 and 4 with the surrounding environment.

7.3.2.1 Surface-Water-Quality Impacts

Near the mouth of the Savannah River approximately 240 km (150 mi) downstream of the VEGP site, saltwater is intruding into the Floridan aquifer because of groundwater withdrawals. The States of Georgia and South Carolina have issued management plans to address the saltwater intrusion issue. The plan issued by Georgia (GDNR 2006) requires (1) aggressive and practical measures to ensure efficient and effective use of groundwater resources, (2) justification for the water need, and (3) continuous monitoring of the Floridan aquifer for response to management practices. In its plan, Georgia also identifies other sources of fresh water in the coastal region including sources achieved through (1) conservation, particularly irrigation conservation, and (2) use of reclaimed water for lawn and golf-course irrigation. The South Carolina Water Plan (Badr et al. 2004) recommended, in part, that (1) use of surface and groundwater be optimized to reduce impacts, (2) groundwater withdrawal will not result in salt water intrusion, and (3) efficient irrigation techniques, recycling of treated municipal wastewater,

and desalination should all be studied as alternative water sources. However, to preserve the groundwater resource, a shift in water supply may occur whereby consumers of Floridan aquifer water may meet their water needs through the use of surface water originating from the Savannah River (GDNR 2006). Accordingly, the use of Savannah River water at the VEGP site may diminish the quantity of river water that would be available downstream. However, as discussed earlier in Section 5.3.2.1, the consumptive water use of the proposed VEGP Units 3 and 4 is expected to be less than 1 percent of the total river discharge during average periods and only up to 1.7 percent during periods of water scarcity (Drought Level 3). The normal cumulative water use for VEGP Units 1 through 4 (i.e., the VEGP site with four operating reactors) is not large when compared to the total Savannah River discharge and, as shown in Table 7-2, is expected to be 3.4 percent or less of the total river discharge.

The NRC staff's assessment of the cumulative water temperature impacts from VEGP Units 1 through 4 is in Section 5.3. This analysis considers the combined impacts by assigning the total effluent discharge from VEGP Units 1 through 4 to the outfall pipe for the proposed VEGP Units 3 and 4. It should be noted that this scenario is not proposed by Southern, but was considered to produce the maximum single thermal plume. The numerical model CORMIX was used to compute the extent of the effluent plume. The maximum downstream extent of the 2.8°C (5°F) above ambient isotherm was computed to occur 29.6 m (97 ft) downstream of the outfall pipe, and the maximum width of the curved isotherm was 4.6 m (15 ft).

The staff conducted a second assessment of the cumulative water temperature impacts from VEGP Units 1 through 4 by separating the effluent discharges, as proposed by Southern, into two different discharge pipes (i.e., the existing VEGP Units 1 and 2 and the proposed VEGP Units 3 and 4 pipes). Both pipes were assigned a diameter of 61 cm (2.0 ft). The effluent discharge from VEGP Units 1 and 2 was set at 631.5 L/s (22.3 cfs) based 4 cycles of concentration (Southern 2008a). The effluent discharge from the proposed VEGP Units 3 and 4 was set at the maximum design discharge of 1939.7 L/s (68.56 cfs) (Southern 2008a). The staff made a bounding assumption that all waste issuing from both pipes was at a temperature of 33.1°C (91.5°F). River temperatures were set to the minimum observed value of 5°C (41°F), resulting in the maximum temperature difference (28°C [50°F]) between the ambient river and the discharge effluent.

As in Chapter 5, the staff used the numerical model CORMIX version 5.0 (Jirka et al. 2004) to compute the size of the two discharge plumes. Southern states in its ER that the two discharge locations would be 123.14 m (404 ft) apart (Southern 2008a). At this distance downstream from the existing discharge, the increase in water temperature above ambient was computed by staff to be 0.8°C (1.4°F). For comparison, at half the distance between the proposed and existing outfalls (i.e., 60.96 m [200 ft]), the increase in water temperature was computed to be 1.1°C (2.0°F). Conservatively, the expected impact of the existing outfall on the proposed VEGP Units 3 and 4 outfall would be expected to be less than 1.0°C (1.8°F). The proposed VEGP Units 3

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and 4 plume computed as part of the second analysis in which the two discharges were separate was smaller in extent than the plume computed in Chapter 5, in which the two discharges were conservatively combined into one discharge. This difference would be expected because the effluent discharge is less.

In the cumulative water quality analysis conducted in Section 5.3.3.1, the staff considered water quality impacts from Units 1 and 2 in combination with proposed Units 3 and 4. As already explained in that Section, to provide additional context for its conclusions, the staff did consider the impacts to water quality in the Savannah River at river flow rates below the Drought Level 3 values analyzed. The staff found that the impacts under these conditions would not be significantly different from the impacts analyzed under the Drought Level 3 condition.

Following publication of the draft EIS, Southern advised the NRC staff (Southern 2007c) of updates to its original analysis based on changes in flow rates between Revision 15 and revision 16 of the AP1000 DCD. As already explained in Section 5.3.3.1, the staff determined that these changes would not affect the staff's conclusion that impacts of the effluent plume on the Savannah River would be SMALL and localized.

7.3.2.2 Groundwater-Quality Impacts

The potential cumulative impact on groundwater quality of VEGP Units 1, 2, 3, and 4 operation is addressed in this section. Three aspects of cumulative groundwater quality deserve mention: (1) water quality associated with the regional issue of saltwater intrusion, (2) water quality associated with observed tritium in the Water Table aquifer in the vicinity of the VEGP site, and (3) the potential for Savannah River Site contamination to impact the quality of groundwater withdrawn at the VEGP site.

Saltwater Intrusion

The staff review of the potential impact of VEGP operations on saltwater intrusion resulted in the acquisition and review of the permitting plan published by the State of Georgia (GDNR 2006). After nearly a decade of study, the State of Georgia issued the permitting plan for managing saltwater intrusion (GDNR 2006). Burke County is identified in that plan as one of 19 counties that do not contribute substantially to the development or extent of saltwater intrusion in coastal areas. However, applications for water-use permits in the 19-county region, including Burke County, would be reviewed to ensure a justified need exists, and that aggressive and practical conservation and reuse principles would be applied. Southern notes in its ER that groundwater wells would be completed in the Cretaceous aquifer to supply groundwater for operation of the proposed VEGP Units 3 and 4, and that Southern would request a modification of the existing groundwater-use permit (Southern 2008a). The quality of water withdrawn from groundwater wells in Burke County is not impacted by saltwater intrusion and the proposed project will not

contribute to the saltwater intrusion occurring in the coastal regions of Georgia and South Carolina.

Tritium in the Unconfined Aquifer

The staff reviewed the potential for VEGP operation to contribute to tritium absorbed in the unconfined aquifer. The staff independently reviewed documents published by the State of Georgia and the U.S. Geological Survey (USGS) to fully understand the observed tritium contamination. Tritium has been identified as a pollutant in the Water Table aquifer in the vicinity of the VEGP site (Summerour et al. 1998). Tritium was first discovered in 1988 in a public water supply well serving the DeLaigle Mobile Home Park, which is a short distance from the VEGP site, and it was initially believed to contaminate the confined aquifer system. A thorough study of the region (Summerour et al. 1994, 1998) revealed the following:

- The measured tritium levels were well below the drinking water standard, and there was no public health threat.
- The Water Table aquifer was contaminated, and the Tertiary aquifer was only contaminated by a poor well completion that has since been sealed.
- The contamination likely resulted from recharge of the Water Table aquifer by atmospheric deposition of tritium that was released from the Savannah River Site.

Transriver flow within the groundwater system was assumed initially to be a second potential pathway for tritium found in the Georgia aquifer systems (i.e., groundwater flowing from the Savannah River Site in South Carolina beneath the Savannah River into Georgia) (Summerour et al. 1998). Transriver flow has been studied by the USGS (Clarke and West 1997, 1998; Cherry 2006; Cherry and Clark 2007) and found to be an unlikely source for the broadly observed tritium found in the unconfined aquifer in Georgia. Southern does not withdraw water from the Water Table aquifer for operation of the VEGP site. The source of the tritium has been resolved and does not involve VEGP operation; thus, there is no reason to believe the proposed project will contribute to the issue of tritium in the unconfined aquifer.

Savannah River Site Groundwater Contamination

To evaluate the potential for VEGP operation to cause groundwater contamination at the Savannah River Site to be drawn to VEGP wells in Georgia, the staff reviewed several USGS studies referenced by Southern, and the staff acquired and reviewed documents detailing groundwater contamination and management practices at the Savannah River Site. Several aspects of the hydrogeology of the Georgia and South Carolina aquifer systems argue against the movement of groundwater contamination from the Savannah River Site into Georgia groundwater. However, there are circumstances illustrated by USGS analyses when it could

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occur to a limited extent. Salient aspects of the hydrogeology and Savannah River Site contamination are listed below:

- The Savannah River in the vicinity of Savannah River Site and the VEGP site incises the Water Table aquifer and acts as a discharge boundary for the unconfined aquifer, thus intercepting all unconfined aquifer groundwater from both Georgia and South Carolina. Contamination in the unconfined aquifer underlying Savannah River Site is intercepted by the Savannah River.
- In the vicinity of Savannah River Site and the VEGP site, the Tertiary aquifer exhibits hydraulic head contours indicative of either groundwater flow toward the Savannah River from both states, or groundwater flow toward upriver locations where the river has incised the overlying confining unit allowing the Tertiary aquifer to discharge to the Savannah River alluvium. Thus, contamination in the Tertiary aquifer underlying the Savannah River Site is intercepted by the Savannah River.
- In the vicinity of the Savannah River Site and the VEGP site, three aspects of the Cretaceous aquifer are significant:
 - DOE maintains an upward hydraulic gradient in areas where the deep confined aquifer is used for groundwater production, and hence, a natural barrier is maintained between the uppermost confined aquifer and the deep confined aquifer (Wells 1999). This barrier protects the quality of Cretaceous aquifer groundwater.
 - USGS has studied the transriver flow issue (Clarke and West 1997, 1998; Cherry 2006) and found that contaminants in the groundwater at the Savannah River Site are not drawn to the production wells at the VEGP site. In general, Cherry (2006) shows that regions of transriver flow discharge are within the Savannah River Alluvium near the river and are of limited extent.
 - The USGS study by Cherry (2006) presents piezometric contours of the confined aquifer, and it appears groundwater in the confined system moves toward the VEGP site laterally from either side of the Savannah River and from groundwater saddles in the deep aquifer system to the southeast of the site. The groundwater then moves in an upstream direction away from the VEGP site to erosional windows in the confining unit, thus allowing Cretaceous aquifer discharge to the Savannah River.
 - The USGS (Cherry and Clarke 2007) applied the updated model (Cherry 2006) to simulate future pumping scenarios. Those scenarios examined normal long-term pumping rates for the proposed VEGP Units 3 and 4, and showed groundwater produced by the VEGP production wells in the Cretaceous aquifer originated in upland areas of Georgia, near the county line between Burke and Jefferson Counties. Under normal long-term pumping rates, no recharge originating in South Carolina, including the Savannah River Site, was drawn to the VEGP production wells in the deep confined aquifer.

Accordingly, while there is limited contamination to groundwater attributable to the Savannah River Site, existing and proposed use of groundwater at VEGP does not appear to contribute to the broader migration of that contamination. Thus the VEGP operation does not introduce any cumulative impacts to the groundwater resource.

Summary

Based on the above, the proposed project does not contribute to the existing issues of saltwater intrusion, tritium in the water table aquifer, or groundwater contamination underlying the Savannah River Site. The VEGP site does not introduce contaminants to the aquifer system. The staff has examined potential VEGP operational influences on groundwater. Based on (1) the absence of impacts concerning saltwater intrusion, (2) an understanding of tritium levels in the Water Table aquifer and its origin, and (3) an understanding of the relationship between aquifers underlying the Savannah River Site and the VEGP site, and the circumstances that may lead to contamination at the Savannah River Site reaching Georgia, the staff concludes that cumulative impacts to groundwater would be SMALL, and mitigation is not warranted.

Following publication of the draft EIS, Southern advised NRC staff (Southern 2007f) that, based on changes between Revision 15 and Revision 16 of the AP1000 DCD, the maximum groundwater demand for Vogtle Units 3 and 4 would be expected to decrease by about 11 percent. Because the impacts of this groundwater demand would be bounded by the present analysis, the staff determined that its conclusions regarding groundwater quality would not change.

7.4 Terrestrial Ecosystem

Construction and operation of two new units at the VEGP site were evaluated to determine the magnitude of their contribution to regional cumulative adverse impacts on terrestrial ecological resources. An assessment of potential impacts caused by plant construction was made for important terrestrial species (animal and plant) and habitats (as defined in NRC 2000) by evaluating the impact of construction in light of other past, present, and future actions in the region. An assessment of potential impacts caused by plant operation was made for resource attributes normally affected by cooling tower operation, transmission line operation, and right-of-way maintenance. For this analysis, the geographic region encompassing past, present, and foreseeable future actions is the area immediately surrounding the VEGP site, including adjoining sections of the Savannah River bottomland.

The GPC completed a transmission line study in 2007 to identify potential rights-of-way for the proposed 500-kV transmission line (GPC 2007). For the analysis of cumulative impacts related to the addition of the transmission line and its right-of-way, the geographic region encompassing past, present, and foreseeable future actions is the original study area identified by the GPC (GPC 2007).

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VEGP Site

Approximately 225 ha (556 ac) of land would be disturbed by construction of the proposed VEGP Units 3 and 4 (Southern 2007b, 2008b). An estimated 8.5 ha (21 ac) of wetlands habitat on the site would be disturbed (Southern 2008b). Most of the wetlands acreage involved would be in the Savannah River floodplain (Southern 2007b). Of the 8.5 ha (21 ac) that would be disturbed, only a small portion would be permanently lost (Southern 2007b). The amount of acreage that would be disturbed represents about 12.5 percent of the total 69 ha (170 ac) of wetlands currently available onsite and less than 0.03 percent of available wetlands associated with the Savannah River floodplain in the vicinity of the VEGP site (i.e., within 16 km [10 mi] from midpoint of VEGP). Approximately 0.57 ha (1.4 ac) of land composed of pond and bottomland hardwood would be within the onsite portion of the new transmission line right-of-way. At this time, it is not known if any of this land would be considered wetlands. An estimated 120 ha (297 ac) of upland habitat including planted pines, previously disturbed areas, and open fields would be lost to permanent structures and facilities (including the onsite portion of the new transmission line), representing about 17 percent of the total 700 ha (1730 ac) of pine forests and open areas currently available onsite. The amount of upland habitat that would be disturbed is less than 0.5 percent of the available forested habitat (23,788 ha [58,781 ac]) in the vicinity of the VEGP site (NRSAL 2003). An estimated 1.6 ha (4 ac) of mixed hardwood and pine habitat would be lost to permanent structures and facilities, representing less than 1 percent of the total 248 ha (612 ac) of hardwood habitat available onsite and less than 0.5 percent of hardwoods (25,887 ha [63,966 ac]) in the vicinity of the site (NRSAL 2003).

The area around the VEGP site is rural and primarily forested and farmland. The habitats that would be disturbed at VEGP are common in the region, and are not considered to be critical for the survival of any species, including those that are Federally protected. In addition, the percent of wetlands that would be disturbed represents only a small portion of the available wetlands in the vicinity of the site. Therefore, the staff concludes that the development of the VEGP site on the cumulative habitat loss and important species in the region associated with construction impacts would be negligible.

There are four generating stations within 90 mi (145 km) of the VEGP site: the SCE&G Urquhart station, 21 mi (34 km) from the VEGP site; the SCE&G D area powerhouse station, 20 mi (32 km) from the VEGP site; the GPC plant McIntosh, 83 mi (134 km) from the VEGP site; and the GPC Port Wentworth, 77 mi (124 km) from the VEGP site. Fossil plants release carbon dioxide, mercury, nitrous oxides, and sulfur dioxide, among other air emissions. Nitrous oxides and sulfur dioxides can combine with water to form acid rain, which can lead to erosion and changes in soil pH levels. Mercury can deposit on soils and surface water, which may then be taken up by terrestrial plant and animal species, and poses the risk of bioaccumulation. For these reasons, the four generating stations are likely to have current and future impacts to the environment on the VEGP site and surrounding area (NRC 2008).

There are three non-power generating plants that are on the Savannah River within the geographic area: the International Paper Corporation, the Savannah Industrial and Domestic Water plant, and the Beaufort-Jasper Water and Sewer authority wastewater treatment plant. Chemical discharges and the resulting bioaccumulation from these plants have the potential to have impacts on the surrounding area, including vegetation, wildlife, and wetlands (NRC 2008).

The Savannah River Site could have impacts on terrestrial habitats. Included in the Savannah River Site facility are former nuclear reactors, current operational coal-fired generating plant, and a proposed facility to convert weapons-grade plutonium into nuclear reactor fuel. The Savannah River Site, when originally constructed, added runoff from additional roads and impervious surfaces, increased development on wetlands and riparian zones, and caused a decrease in forest habitat. Current operations at the Savannah River Site, through chemical discharges and water withdrawal, could also have a cumulative impact on the geographic area. Future actions, such as additional construction and maintenance of buildings and facilities could affect the VEGP site and the surrounding area (NRC 2008).

Since VEGP is a nuclear plant there is little additional impact to the environment from airborne releases typical of fossil fuel or other industrial facilities. Therefore, even in combination with emissions from the facilities described above, the operation of VEGP Units 3 and 4 would not result in unacceptable deposition rates of airborne pollutants. Furthermore, terrestrial habitat loss or alteration for the proposed action would be confined primarily to the VEGP site. This loss or alteration of habitat, even in combination with chemical discharges and habitat modification associated with the other facilities in the region as discussed above, would not destabilize the terrestrial resource.

During the review of the Southern ESP application, no other past, present, or future actions in the region were identified that could significantly affect wildlife and wildlife habitat in ways similar to those associated with the proposed VEGP Units 3 and 4 site cooling tower operation (cooling tower noise, drift from cooling towers, and birds colliding with cooling towers). Southern estimates that a single plume from each of the proposed VEGP Units 3 and 4 cooling towers would have a maximum deposition rate of 4.0 kg/ha/mo (3.6 lbs/ac/mo) (Southern 2008b). Southern estimates that maximum deposition would occur approximately 490 m (1600 ft) from each tower. Thus, the deposition from the proposed VEGP Units 3 and 4 cooling towers could overlap because the towers are only 340 m (1100 ft) apart. The maximum estimated cumulative deposition rate is about 8.0 kg/ac/mo (7.2 lbs/ac/mo) at 490 m (1600 ft) from the proposed VEGP Units 3 and 4 towers (4.3 kg/ac [3.8 lbs/ac] per tower). At this distance, the maximum deposition would occur on the VEGP site. The existing pair of cooling towers for VEGP Units 1 and 2 is located approximately 1200 m (4000 ft) to the east-northeast of the proposed cooling towers (Southern 2008a). This separation distance is greater than the distance of the maximum deposition rate of 490 m (1600 ft) predicted for the proposed VEGP Units 3 and 4 cooling towers (Southern 2008a). Moreover, given the location and orientation of the proposed cooling towers with respect to the existing cooling towers, it is unlikely that plumes would interact

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appreciably for any extended period of time (Southern 2008a). General guidelines for predicting effects of drift deposition on plants suggest that many species have thresholds for visible leaf damage in the range of 10 to 20 kg/ha/mo (9 to 18 lbs/ac/mo) during the growing season (NRC 1996). Because of the separation distance, it is unlikely the maximum cumulative deposition for all units would reach a threshold that would cause visible leaf damage, and impacts would be negligible for the VEGP site. Furthermore, there are no other significant sources of cooling tower drift in the vicinity of the site.

The impacts associated with cooling tower operation were considered negligible for the VEGP site; the cumulative adverse impact of these types of activities in the region would also be considered minor. Consequently, the staff concludes that the contribution of VEGP site cooling tower operation to cumulative impacts on wildlife and wildlife habitat in the region would be minimal.

Transmission Line Right-of-Way

The extent and type of wildlife habitat within the proposed new transmission line right-of-way is not known at this time because Southern and the GPC are evaluating rights-of-way alternatives within a larger Representative Delineated Corridor (RDC). It is anticipated that the transmission line would cross Burke, Jefferson, McDuffie, and Warren Counties and would be 45 m (150 ft) wide and 97 km (60 mi) long (Southern 2008a). There are no U.S. Forest Service Wilderness Areas, Wild/Scenic Rivers or Wildlife Refuges, State or National Parks within the RDC (GPC 2007). If possible, wetland areas would be avoided in the routing (GPC 2007).

A hypothetical transmission line right-of-way that represents what the GPC believes is a feasible route within the RDC was identified as part of a 2007 study (GPC 2007). Based on the GPC analysis, habitats within the right-of-way could include approximately 97 ha (240 ac) of forested habitat, 133.1 ha (329 ac) of planted pine, 2.6 ha (6.4 ac) of open water, and 63.9 ha (158 ac) of open land (Southern 2007b). Other land-use categories identified as potentially being impacted, such as quarry mine, pecan orchard, utility, transportation, and row crops, provide little value as wildlife habitat. In the region surrounding the proposed transmission line right-of-way, there are approximately 18,085 ha (44,688 ac) of forest, 1354 ha (3346 ac) of open water, and 17,262 ha (42,656 ac) of open land (GPC 2007). Assuming the actual routing was similar to the hypothetical route, the number of acres of forested habitat, open water, open land, and planted pine forest that would be affected represent a very small portion of the available habitat. If the actual route was similar to the hypothetical route, impacts on wildlife habitat in the region would be negligible. However, if the actual route differs from the hypothetical route, wildlife habitat impacts could either be greater or smaller.

There are no known occurrences of Federally listed threatened and endangered species within the RDC. However, suitable habitat for the red-cockaded woodpecker (*Picoides borealis*), wood stork (*Mycteria americana*), flatwoods salamander (*Ambystoma cingulatum*), American alligator

(*Alligator mississippiensis*), Georgia aster (*Symphyotrichum georgianum*), and Canby's dropwort (*Oxypolis canbyi*) could exist within the RDC. The GPC would site the line in accordance with Georgia Code Title 22, Section 22-3-161. Part of the GPC procedures for implementing this regulation include consultation with FWS and GDNR and an evaluation of impacts to special habitats and threatened and endangered species. In addition, the GPC would comply with all applicable laws, regulations, and permit requirements, and would use good engineering and construction practices (Southern 2008a). Based on this review, cumulative impacts on important species and habitat loss in the region associated with construction would be negligible.

During the review of the Southern application, no other past, present, or future actions in the region were identified that could significantly affect wildlife and wildlife habitat in ways similar to those associated with transmission line operation and right-of-way maintenance (i.e., birds colliding with transmission lines, flora and fauna affected by electromagnetic fields and right-of-way maintenance, and floodplains and wetlands affected by right-of-way maintenance). Thus, because these impacts were considered negligible for the VEGP site transmission line operation and right-of-way maintenance, the cumulative adverse impacts of these types of activities in the region would also be minor. Consequently, the staff concludes that the contribution of the operation of transmission lines and the maintenance of transmission line rights-of-way to cumulative impacts on wildlife and wildlife habitat in the region would be minimal.

Summary

The cumulative terrestrial resource impacts may be detectable, but are expected to be minor and not destabilize the resource. Therefore, the staff concludes that cumulative impacts to terrestrial resources resulting from the construction and operation of the proposed VEGP Units 3 and 4, including transmission line operation and maintenance, would be SMALL.

7.5 Aquatic Ecosystem

The staff evaluated construction and operation of the proposed Units 3 and 4 at the VEGP site to determine whether interactions with past, present, and future actions could contribute to adverse cumulative impacts to aquatic resources. For this analysis, the geographic area of interest is the Savannah River from upstream of the VEGP site to the mouth of the river.

7.5.1 Construction

Factors contributing to the impacts include the construction of the proposed VEGP Units 3 and 4, operation of the existing VEGP Units 1 and 2 (with or without the addition of the proposed VEGP Units 3 and 4), activities at the DOE Savannah River Site on the South Carolina side of the Savannah River, anthropogenic activities not directly related to VEGP or the Savannah River (e.g., increased urban development and recreational activity in or near the

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river), and natural environmental stressors (e.g., short- or long-term changes in precipitation or temperature and the resulting response of the aquatic community). The staff considered these potential sources of impacts in its evaluation of the cumulative aquatic ecology impacts presented in Southern's ER.

From an aquatic ecological perspective, the construction of VEGP Units 1 and 2 did not change the Savannah River observably or significantly. Likewise, activities related to construction of the intake and discharge structures and the barge slip to support the proposed VEGP Units 3 and 4 would have minimal and temporary impacts on the aquatic ecosystem that can largely be mitigated, as discussed in Section 4.4.2. No species of special interest or Federally or State-listed threatened and endangered species are expected to be affected by construction activities (including the shortnose sturgeon [*Acipenser brevirostrum*] occurring at, or adjacent to, the VEGP site).

The staff anticipates that dredging the Federal navigation channel in the Savannah River downstream of the VEGP site would have the potential for adverse impacts to aquatic organisms. The U.S. Army Corps of Engineers (USACE), as authorized by the Rivers and Harbors Act, has the responsibility for maintaining a 27.4-m-wide by 2.74-m-deep (90-ft wide by 9-ft deep) channel in the Savannah River for navigational purposes. The Federal navigation channel was last used for a commercial shipment in 1979 and has not been maintained since that time. Recent measurements by the USACE indicate that, depending on the level of water flow, most areas of the navigation channel above rkm 56 (RM 35) would likely need to be dredged to allow barge traffic during normal river flow as discussed in Section 4.4.2. Prior to any authorization for dredging in the Savannah River, the USACE would be required by NEPA to assess the impact of dredging on the river biota. At the present time the dredging project is incompletely defined, the amount of material to be removed is unknown, and the locations of the dredged material disposal areas have not been identified. Specifics of the project would be provided in the USACE's assessment to fulfill the NEPA requirement. This would presumably include mitigative actions to preserve the threatened, endangered, and sensitive mussel species that occur in the Savannah River.

Even though a detailed assessment has not been conducted, the staff concludes that this action would likely have an effect on aquatic organisms for most trophic levels. These impacts could include temporary loss of benthic habitat, disruption of spawning migrations, resuspension of sediments that may be contaminated, and would also require the disposal of dredged materials. If dredging of the Savannah River channel was undertaken, in part to facilitate barge transportation to the VEGP site, some or all of the above impacts could be realized. Nevertheless, the use of BMPs, time of year restrictions, relocation of benthic organisms, and restrictions on equipment type could ameliorate many of the impacts. The staff concludes that the cumulative impacts to aquatic organisms in the region from the construction including dredging of a navigation channel could be MODERATE, depending on the type of mitigation.

However, these impacts would be evaluated in more detail in the NEPA analysis that would need to be conducted by the USACE.

7.5.2 Operations

For operations, the staff considered that anthropogenic stressors not directly associated with the VEGP site activities may contribute to the cumulative impacts to the river. Current and future conditions of the local aquatic resources are influenced by the cumulative effects of past actions and future changes. Water consumption, drought, entrainment and impingement at intake structures of other facilities located on the Savannah River, thermal effects from cooling water discharges, chemical contaminants, environmental changes associated with changes in regional water use, fishing pressures, and habitat modification and loss may have altered the aquatic ecosystem.

These impacts include habitat loss and nonpoint pollution related to increased urbanization along the shores of the river and increased recreational use of the Savannah River. Although the potential for long-term development in this area exists, its interactions with plant operations are not expected to result in significant adverse impacts to the river downstream of the VEGP site.

The presence of natural environmental stressors (e.g., short- or long-term changes in precipitation or temperature) would contribute to the cumulative environmental impacts to the Savannah River. These impacts are not related to Southern's activities and are difficult to predict. At certain times of the year, the VEGP site operations, other anthropogenic stressors, and climatic events could combine to adversely impact the aquatic populations of the Savannah River. Adequate freshwater flows are necessary in the lower river to prevent saltwater from moving upstream and degrading fish and wildlife habitat. Adequate releases are also necessary to allow for assimilation of National Pollutant Discharge Elimination System-permitted wastewater that enters the river in the Augusta area. These issues were identified in a report entitled *Savannah River Basin Comprehensive Reconnaissance Study* issued by the U.S. Army Corps of Engineers in July 1999 (USACE 1999) and are being addressed by both the States of Georgia and South Carolina (Southern 2007a).

Several facilities currently intake from or discharge into the Savannah River in the area between Augusta and Savanna, Georgia, including the Savannah River Site, several electric generation facilities located on the Savannah River, a paper mill, and municipal water supply systems. These facilities will contribute to the cumulative effect of consumption, impingement, entrainment, thermal and chemical discharges.

Water consumed for operation of the proposed VEGP Units 3 and 4 would be less than 1 percent of the total river discharge during normal water periods and up to 1.7 percent during periods of relative water scarcity (Drought Level 3). Including the consumptive use of VEGP Units 1, 2, 3, and 4, cumulative water use for the entire VEGP site, expressed as a percentage

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of Savannah River discharge, would range from 1.5 to 3.4 percent, as discussed in Section 7.3.2.1. There is always a potential for a drought in the Southeast U.S. that results in more severe drought level conditions. The principal impacts of drought are the loss of aquatic habitat for organisms, such as spawning or nursery areas; and changes in water quality such as temperature and flow rates. Aquatic organisms inhabiting Atlantic coastal rivers and streams are pre-adapted to tolerate large variations in water flow. Periodic droughts occur in rivers in the southeastern United States and aquatic species have the ability to tolerate temporary reductions in aquatic habitat without having a lasting effect on the aquatic population. Thus, the staff considers the cumulative impacts to the aquatic ecosystem from cumulative water consumption along the middle Savannah River including the two existing and two proposed VEGP Units 1 and 2 to be minor.

The staff considered the potential cumulative impacts of entrainment of aquatic organisms. The other facilities that withdraw large amounts of water in the vicinity of VEGP Units 3 and 4 include, VEGP Units 1 and 2 and the Savannah River site. Studies on the entrainment due to past reactor operations at the Savannah River Site have been conducted (Paller et al. 1986). One study found that in 1983 and 1985, 8.3 to 12.3 percent of the ichthyoplankton drifting past the three Savannah River Site intake pumphouses on the Savannah River were entrained. However, the study concluded that these high levels of entrainment might not be significant, because: there are many spawning sites for the entrained species in the Savannah River, including downstream; ichthyoplankton typically have naturally high rates of mortality; and there was no evidence to indicate that numbers of ichthyoplankton in the river were decreasing (Paller et al. 1986). Water withdrawals from the Savannah River site have been substantially reduced from the time that this study was conducted.

Based on the small percentage of water withdrawn from the Savannah River currently by the Savannah River Site and the two existing and two proposed VEGP units, as well as the design of the cooling intake canal and structure, the significantly greater larval densities in the oxbows, as opposed to the straighter part of the river at the location of the VEGP site, the typically high fecundity of most species inhabiting rivers, and the high natural mortality rates of eggs and larvae, the staff finds that the impacts to the fish of the Savannah River from entrainment would be minor.

Preliminary data collected from the first few months of an impingement study indicate that the impingement losses from VEGP Units 1 and 2 are minor. Based on the similarity in design of VEGP Units 3 and 4 to Units 1 and 2, the staff determined that impingement at these units would also be minor. The other large water user in the vicinity of the VEGP site, the Savannah River site, has conducted impingement studies in the past and has determined that losses associated with operation of that facility are also minor (Specht 1987). Therefore, the staff concludes that cumulative losses from impingement are unlikely to adversely affect Savannah River fish populations.

The studies conducted in the Savannah River to determine the effects of Savannah River Site thermal discharges found no evidence of adverse impacts on the river ecosystem (Specht 1987). These studies and their conclusions indicate that the historical effects on the aquatic resources of the Savannah River from the operations of Savannah River Site facilities were minor, and the current effects of the operation of the D-Area powerhouse are much smaller. The thermal discharge from the Savannah River site would be undetectable at the VEGP site. Therefore, there would be no cumulative thermal impact associated with the VEGP site and the Savannah River Site.

The staff also considered the potential cumulative impacts related to thermal discharges from the existing VEGP Units 1 and 2. The assessments performed by the staff and described in Section 5.3 explicitly considered the combined impacts of concurrent operation of the existing VEGP Units 1 and 2 and the proposed VEGP Units 3 and 4. The maximum size, computed by the staff, of the area that would result in a 2.8°C (5°F) temperature increase above ambient mixing zone was approximately 29.6 m (97 ft) long (downstream) and 4.6 m (15 ft) wide. The size of the plume is small in comparison to the width of the Savannah River near the VEGP site. The effluent discharge from VEGP Units 1 and 2 at the proposed location for the VEGP Unit 3 and 4 discharge (123 m [404 ft]) downstream of the discharge for VEGP Units 1 and 2, resulted in an average increase of less than 0.5°C (0.9°F) (Southern 2007a). Because this change in temperature is so small, the cumulative effects from operation of VEGP Units 1 and 2 would not negatively impact aquatic organisms and is not expected to affect species of special interest or Federally or State-listed threatened and endangered species.

The staff considered the potential cumulative impacts from chemical releases from the existing VEGP units. VEGP Units 1 and 2 are in compliance with the Clean Water Act Section 316(a) (thermal discharges) impacts from cooling water systems. Chemical releases from the existing units currently comply with the State of Georgia's National Pollutant Discharge Elimination System permit requirements and would continue to be monitored in the future and are expected to result in no detectable impacts to aquatic organisms.

In addition to the above analysis, the staff also considered the cumulative impacts to aquatic biota in the Savannah River associated with the normal^a withdrawal rates for all four units at the VEGP site at two river flow rates below the Drought Level 3 values. Even assuming river flows of 3000 cfs and 2000 cfs, rather than the Drought Level 3 case of 3800 cfs river flow, the percentage of water withdrawn from the Savannah River due to the operation of VEGP Units 1 through 4 would be 5.8 percent at 3000 cfs and 8.7 percent at 2000 cfs.

^a Staff determined that the 'normal' case was most appropriate for the cumulative analysis because it is more representative of long-term impacts and because it is unlikely that all plants would be operating simultaneously in the 'maximum' consumption mode.

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At river flows of 3000 and 2000 cfs, the river stage and available habitat for aquatic organisms would be reduced, which would concentrate aquatic biota populations, and through-screen velocities at the intake would increase, likely resulting in an increase in impingement. The lower flows of 3000 and 2000 cfs would result in an increased fraction of water flowing past the site being drawn into the cooling water system. Accordingly, entrainment would increase proportionately for both the 3000 and 2000 cfs river flow cases.

Although it is likely that impingement mortality to fish would increase, the losses would be minor and no detrimental effect on the fishery would occur. Fish inhabiting large rivers are used to flowing water and can escape the velocities that would be expected in the vicinity of the VEGP intake structures.

Entrainment mortality for some species would increase at the lower river flow rates (3000 and 2000 cfs) based on the reduction in habitat and the increased percentage of water withdrawal. Water withdrawal rates that approach ten percent, even in a riverine environment, may result in some adverse and detectable impact to some fish populations. EPA determined that limiting withdrawals from a river to five percent of the source waterbody mean flow was technically achievable and larger withdrawals may result in greater levels of entrainment. DOE Savannah River Site (SRS) conducted an ichthyoplankton study in the 1980s and concluded that operation of the SRS was not having an adverse impact on fish populations despite entrainment losses to the ichthyoplankton of 8.3 and 12.3 percent (Paller et al. 1986). The staff notes that such losses at SRS combined with the entrainment losses from the four units at the VEGP site during the hypothetical low flow conditions of 3000 and 2000 cfs could have a localized detrimental effect on some fish populations. However, such effects are unlikely to have any long term persistent impacts on populations in the river because the unusual low flow conditions would likely be temporary.

Because of the cumulative effects of all four units combined with the potential for losses at the SRS under these low flow conditions, the impact to some species of fish from entrainment may be significant and detectable. Although the resource may be affected through the alteration of the fish community, with some species declining in abundance while others increasing, the staff concludes that the resource would not be destabilized (i.e., the effects would not result in the collapse of the fishery).

Because of the small amount of water discharged in relation to the river flow and the resulting dilution of the discharge plume, the effects on aquatic biota in the river from the thermal and chemical discharges from VEGP Units 1 through 4 at the 3000 and 2000 cfs river flow rates would not result in discharge related impacts to aquatic biota that are significantly different from those analyzed for VEGP operation at Drought Level 3.

Following publication of the draft EIS, Southern advised the NRC staff (Southern 2007f) that based on changes between Revision 15 and Revision 16 of the AP1000 DCD, the normal

surface water withdrawal for Vogtle Units 1 through 4 would increase by approximately 3.5 cfs. The staff evaluated the effect of this change on the staff's analysis presented above, which uses the DCD Revision 15 surface water withdrawal values currently in Southern's ER (Southern 2008a). The staff determined that this change would result in an increase in the normal water withdrawal to approximately 4.6 percent of the 3800 cfs river flow at Drought Level 3. At a river flow rate of 3000 cfs, the revised withdrawal rate would be 5.9 percent, and for 2000 cfs it would be 8.8 percent. Accordingly, because the change identified by Southern would result in only a minor increase in consumptive water use under Drought Level 3 conditions, the staff determined that these changes still would not alter the staff's cumulative analysis of impact to aquatic biota presented above. Furthermore, even under low flow conditions of 3000 and 2000 cfs, the increased withdrawals identified by Southern would result in sufficiently small increases in water use that it similarly would not alter the staff's impact assessment.

Therefore, consistent with its analysis discussed above, the staff determined that the cumulative normal water withdrawals of all four VEGP units at the low flows of 3000 and 2000 cfs may result in adverse impact to the fishery, primarily due to entrainment. However, as noted above, this impact is likely to be temporary and not destabilizing.

The potential increased surface water withdrawals associated with Revision 16 of the AP1000 DCD, because of the minor increase relative to the normal water withdrawals from all four units previously analyzed, would not affect the staff's conclusion that cumulative impacts associated with river flows down to Drought Level 3 to aquatic biota from operation of all four units at the VEGP site would be minor.

For the reasons stated above, the cumulative effects resulting from the operation of VEGP Units 3 and 4 would not negatively impact aquatic organisms and are not expected to affect species of special interest or Federally or State-listed threatened and endangered species, and are considered by the staff to be minor. In addition, other past, current, and reasonably foreseeable future actions are estimated to have little impact on aquatic resources, and therefore, the potential cumulative impacts on the aquatic resources would be minor.

As a result of the awareness of the issues related to the need for adequate flow in the river, the small amount of consumptive loss from all the units at the VEGP site, and the negligible direct effects that construction and operation of the facility would have on aquatic organisms, the staff concludes that cumulative impacts to aquatic resources as a result of the proposed VEGP Units 3 and 4 would be **SMALL**.

7.6 Socioeconomics, Historic and Cultural Resources, Environmental Justice

Much of the analyses of socioeconomic impacts presented in Sections 4.5 and 5.5 already incorporate cumulative impact analysis because the metrics used for analysis only make sense when placed in the total or cumulative context. For example, the impact of the total number of additional housing units that may be needed can only be evaluated with respect to the total number that would be available in the affected area. Therefore, the geographical area of the cumulative analysis varies depending on the particular impacts considered, and may depend on specific boundaries, such as taxation jurisdictions, or may be distance-related, as in the case of environmental justice.

There are potential cumulative impacts on road congestion on the River Road connector to VEGP. The potential cumulative increase in the number of vehicles during a combined outage, construction, and permanent workforce egress and ingress into the site are likely, but temporary, and can be mitigated with proper planning, incentives to car pool, and minor road improvements, such as turn lanes, which are already planned.

The construction and operation of one or more additional units at the VEGP site would not be likely to add to any cumulative socioeconomic impacts beyond those already evaluated in Sections 4.5 and 5.5. In other words, the impacts of issues such as transportation or taxes are not likely to be detectable beyond the regions previously evaluated and would quickly decrease with increasing distance from the site. The staff concludes that construction impacts would generally be SMALL, but there are exceptions if more workers than expected settle in Burke County, in which case a MODERATE impact level may be reached for the impacts on roads, housing, and some public services. In terms of beneficial effects, including tax revenues benefits, the impacts on Burke County would be LARGE under current Georgia law.

As part of the analysis of the cumulative socioeconomic impacts, NRC staff considered the potentially simultaneous construction of the nearby Savannah River Site MOX facility in Barnwell County, South Carolina, which may have socioeconomic impacts in both Richmond and Columbia Counties in Georgia. County planners from both Richmond and Columbia Counties expect negligible impacts on socioeconomic infrastructure and housing in the region as a result of the VEGP proposed activities, even at the height of construction.^(a) NRC's staff, therefore, expects cumulative impacts including Savannah River Site MOX facility construction impacts on the 80-km (50-mi) region around VEGP to be SMALL.

(a) Information provided by Jeff Browning, Columbia County Planner, in e-mail correspondence, dated November 7, 2006, and in interviews with Richmond County Planners (PNNL 2006).

The construction and operation of one or more additional units at the VEGP site would likely add significantly to cumulative cultural resource impacts. Cultural resources are non-renewable; therefore, the impact of destruction of cultural resources is cumulative. Because impacts to important resources from construction of the proposed VEGP Units 3 and 4 are moderate, the cumulative environmental impacts related to cultural resources would be MODERATE. The staff did not identify other past, present, or future actions with adverse cultural resource implications.

The staff found no unusual resource dependencies or practices or environmental pathways through which minority and low-income populations would be disproportionately affected. As a result, the cumulative environmental impacts related to environmental justice would be SMALL. However, if significant demands are placed on Burke County services as a result of more workers than expected settling in the county (without a corresponding increase in tax revenues), the socioeconomic impacts of reduced services or higher taxes would fall disproportionately on the residents of the county.

7.7 Nonradiological Health

In Section 5.8.1, the health impacts of operating the existing and two new units at the VEGP site were evaluated regarding the ambient temperature of the Savannah River and the potential formation of thermophilic microorganisms. The evaluation showed that the addition of two new units is not likely to increase populations of thermophilic microorganisms. Health risks to workers can be expected to be dominated by occupational injuries at rates below the average U.S. industrial rates. Health impacts to the public and workers from noise, dust emissions, acute electromagnetic fields, and transportation also were evaluated and found to be small. The staff concludes that the cumulative impacts resulting from construction and operation of the existing VEGP Units 1 and 2 and the proposed new VEGP Units 3 and 4 on nonradiological health would be SMALL, and that mitigation is not warranted. No other factors or inputs were identified that would impact those conclusions. The staff has not come to a conclusion on the chronic impacts of electromagnetic fields, but the available information is not sufficient to cause the staff to consider the impact as significant to the public.

7.8 Radiological Impacts of Normal Operation

The radiological exposure limits and standards for the protection of the public and for occupational exposures have been developed assuming long-term exposures and, therefore, incorporate cumulative impacts. As described in Section 5.9, the public and occupational doses predicted from the proposed operation of two new units at the VEGP site are well below regulatory limits and standards. Specifically, the site boundary dose to the maximally exposed individual (MEI) from the VEGP site would be well within the regulatory standard of 40 CFR Part 190. For purposes of this cumulative impact analysis, the area within an 80-km (50-mi)

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radius of the VEGP site is considered, which includes the existing operating VEGP Units 1 and 2 and DOE's Savannah River Site in South Carolina.

As stated in Section 2.5, Southern has conducted a radiological environmental monitoring program around the VEGP site since 1987. The radiological environmental monitoring program measures radiation and radioactive materials from all sources, including the existing units at the VEGP site. The NRC, the DOE, and the States of Georgia and South Carolina would regulate or control any reasonably foreseeable future actions in the region that could contribute to cumulative radiological impacts. The Savannah River Site has monitored radionuclides for many years and has completed annual tritium monitoring since 1960. The annual release of tritium from the Savannah River Site has decreased from about 140,000 Ci in the mid 1960s to the present level below 5000 Ci. The Savannah River Site (2006) reports mean tritium concentrations in the Savannah River (based on weekly sampling results) of 79.4 pCi/L upstream of the VEGP site (River Mile 160.0), 984 pCi/L at the VEGP site outfall (River Mile 150.4), and 546 pCi/L downstream of the VEGP site (River Mile 118.8). These results, which include all sources of tritium (i.e., the VEGP site, Savannah River Site, and any other sources), remain far below the EPA drinking water standard of 20,000 pCi/L.

Southern (2008a) calculated the combined total body dose for the existing VEGP Units 1 and 2 and the proposed VEGP Units 3 and 4 to be 2.36 mrem/yr, and the corresponding population dose to be 2.05 person-rem/yr for a population of 674,101. The Savannah River Site (2006) reports the dose to the MEI from Savannah River Site releases to be 0.13 mrem/yr, with approximately 60 percent contribution from H-3, 20 percent from Cs-137, and 4 percent from I-129. The Savannah River Site (2006) reports the population dose to be about 5.0 person-rem/yr for a population of 713,500. Nine additional activities at the Savannah River Site, with the most significant contributor to dose being salt processing, have a combined MEI dose of 0.41 mrem/yr and a population dose of 21.6 person-rem/yr (NRC 2005).

Additional nuclear facilities within 80 km (50 mi) of the VEGP site include Chem-Nuclear Inc., a commercial low-level waste burial site approximately 30 km (19 mi) east northeast of the VEGP site; Starmet CMI, Inc., a facility that formerly processed uranium-contaminated metals located approximately 29 km (18 mi) east of the VEGP site; and hospitals located in the area. The operations of Chem-Nuclear, Inc. and cleanup at Starmet CMI, Inc. are reported not to noticeably affect radiation levels in air or water pathways near the Savannah River Site and would be expected to have an even lower effect near the VEGP site, which is more distant from these facilities.

A reasonably foreseeable future action near the VEGP site is the potential construction and operation of facilities related to the proposed MOX fabrication facility at the Savannah River Site. These MOX fabrication facilities are composed of the Pit Disassembly and Conversion Facility, the Fuel Fabrication Facility, and the Waste Solidification Facility. The dose to the MEI

is reported to be 0.004 mrem/yr, and the corresponding population dose is reported to be 1.6 person-rem/yr (NRC 2005).

The MEIs for these facilities likely are composed of different individuals, locations, and periods of time. Simple addition of MEI doses does not yield a technically accurate result; however, it is done here to be conservative (i.e., to ensure an overestimate of the impact). Combining these results yields an estimate of cumulative impacts of about 2.9 mrem/yr for the MEI and about 30 person-rem/yr for the population dose.

Therefore, the staff concludes that the cumulative radiological impacts of operating two new units, along with the existing units at VEGP and the influence of the Savannah River Site, would be SMALL and that additional mitigation is not warranted.

7.9 Severe Accidents

The environmental impacts of potential severe accidents for a single Westinghouse AP1000 reactor at the VEGP site are discussed in Section 5.10.2 and 5.10.3. Southern has requested an ESP for two Westinghouse AP1000 reactors. Assuming that the risks for two reactors are independent, the risks associated with two Westinghouse AP1000 reactors at the VEGP site are twice the risks for a single reactor.

The risks associated with two Westinghouse AP1000 reactors in addition to the two existing reactors is the sum of the risks for the four individual reactors. Southern (2007b) states that the population dose risk for VEGP Unit 1 or VEGP Unit 2 is about 1.9×10^{-2} person-Sv/Ryr (1.9 person-rem/Ryr); the population dose risk for the two existing reactors is about 3.7×10^{-2} person-Sv/Ryr (3.7 person-rem/Ryr). The population dose risk for a single Westinghouse AP1000 reactor is about 2.8×10^{-4} person-Sv/Ryr (2.8×10^{-2} person-rem/Ryr). Thus, the combined risk for the existing two units plus two Westinghouse AP1000 reactors is about 3.8×10^{-2} person-Sv/Ryr (3.8 person-rem/Ryr). This is not a significant increase in risk. Similar conclusions are obtained when other risks, such as cost risk, early fatalities, and decontamination areas, are evaluated. As a result, the staff concludes that the cumulative severe accident impacts associated with adding two Westinghouse AP1000 reactors to the VEGP site are SMALL.

7.10 Fuel Cycle, Transportation, and Decommissioning

The addition of the proposed new units on the VEGP site would result in the need for additional nuclear fuel. The impacts of producing this fuel include mining of the uranium ore, milling of the ore, conversion of the uranium oxide to uranium hexafluoride, enrichment of the uranium hexafluoride, fuel fabrication where the uranium hexafluoride is converted into uranium oxide fuel pellets, and disposition of the spent fuel in a proposed Federal waste repository. As

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discussed in Section 6.1 of this EIS, the environmental impacts of fuel cycle activities for the proposed units would be about three times those presented in Table S-3 of 10 CFR 51.51. Table S-3 provides the environmental impacts from uranium fuel cycle operations for a model 1000-MW(e) light-water reactor operating at 80-percent capacity with a 12-month fuel-loading cycle and an average fuel burnup of 33,000 MWd/MTU. Per 10 CFR 51.51(a), the staff considers the impacts in Table S-3 to be acceptable for the 1000-MW(e) reference reactor. As discussed in Section 6.1.1 of this EIS, advances in reactors since the development of Table S-3 impacts would have the effect of reducing environmental impacts of the operating reference reactor. For example, a number of fuel management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel and separative work (enrichment) requirements. Fuel cycle impacts would occur not only at the VEGP site but would also be scattered through other locations in the United States, or in the case of foreign-purchased uranium, in other countries. The staff considers the cumulative fuel cycle impacts of operating the VEGP site to be SMALL.

The addition of the proposed new VEGP Units 3 and 4 would result in additional shipments of unirradiated fuel to the site and additional shipments of spent fuel and waste from the site. Cumulative impacts would be approximately twice that of the existing operating plant. Environmental impacts from transportation of unirradiated fuel, spent fuel, and waste are found in Section 6.2 of this EIS based on the Westinghouse AP1000 reactor design. The following conclusions were derived from the staff's analysis of unirradiated fuel shipments: (1) the number of unirradiated fuel shipments equates to less than one truck shipment per day within criteria specified in Table S-4 of 10 CFR 51.52, (2) annual dose to workers and the public would be less than the dose specified in Table S-4, and (3) health impacts are projected to be small (i.e., less than 1×10^{-4} detriment/yr). The following conclusions were derived from the staff's analysis of spent fuel: (1) after accounting for conservative assumptions in the staff's evaluation, doses to the worker and the public would be within criteria specified in Table S-4, and (2) health impacts from normal conditions and accident conditions would be small (i.e., less than 0.1 detriment/yr). Regarding transportation of waste, the staff concluded that the normalized number of waste shipments would be within the value specified in Table S-4 for the 1100-MW(e) reference reactor. Cumulative impacts of transportation for operating the VEGP site would be SMALL.

As discussed in Section 6.3 of this EIS, environmental impacts from decommissioning are expected to be small because the licensee would have to comply with decommissioning regulatory requirements. In Supplement 1 to NUREG-0586, *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, the NRC found the impacts on radiation dose to workers and the public, waste management, water quality, air quality, ecological resources, and socioeconomics to be small (NRC 2002). Therefore, the cumulative impacts for the VEGP site would be SMALL.

7.11 Staff Conclusions and Recommendations

The staff considered the potential impacts resulting from construction and operation of two additional nuclear units together with the past, present, and future actions in the VEGP site area. For the duration of the proposed action (i.e., the construction period plus 40 years of operation), the evaluation took into account the potential impacts from factors known or likely to affect the environment. This included considering conditions at the site and surrounding vicinity from past, present, and future human activities.

For each impact area, the staff concludes the potential cumulative impacts resulting from construction and operation are generally SMALL, and additional mitigation is not warranted.

7.12 References

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

40 CFR Part 81. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 81 "Designation of Areas for Air Quality Planning Purposes."

40 CFR Part 190. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."

40 CFR Part 1508. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 1508, "Terminology and Index."

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8.0 Need for Power

The U.S. Nuclear Regulatory Commission (NRC) regulation implemented in Title 10 of the Code of Federal Regulations (CFR) Part 51.50(b)(2) states that an early site permit (ESP) application "...need not include an assessment of the economic, technical, or other benefits (for example need for power) and costs of the proposed action." Potential applicants for an ESP are allowed to defer the analysis until they submit an application for a construction permit (CP) or a combined license (COL). However, an applicant may address the Need for Power in its ESP application. Southern Nuclear Operating Company, Inc. (Southern) chose to include a discussion of the Need for Power in its ESP application (Southern 2008a) in preparation for its COL application, which it submitted in March 2008 (Southern 2008b).

The NRC's *Environmental Standard Review Plan of Nuclear Plants* (NUREG-1555), Section 8.0 through Section 8.4, guides the staff's review of the Need for Power analysis (NRC 2000). The guidance in NUREG-1555 is limited because of changes in the regulatory structure that were occurring as this guidance was being revised. Deregulation in the electricity markets has a significant impact on the analysis of the Need for Power. Applicants may be power generators rather than traditional utilities; therefore, analysis of the Need for Power must be sufficiently flexible to accommodate the applicant type. Because of deregulation in bulk sales markets for electricity, the advent of independent power producers, and the increased use of purchases and exchanges of electricity among utilities to meet demand, the demand for electricity by ultimate consumers and customers within a utility's service area is increasingly not being met by the utility's own generating resources. Trading of electricity is further facilitated by the Federal Energy Regulatory Commission's final rule (61 FR 21540), requiring all public utilities that own, control, or operate facilities used for transmitting electricity in interstate commerce to file open access nondiscriminatory transmission tariffs that contain minimum terms and conditions on nondiscriminatory service.

The term "relevant service area" is used here to indicate any region to be served by the proposed facility, whether or not it corresponds to a traditional utility service area. "Relevant service area" is a situation-specific concept and must be defined on a case-by-case basis.

Affected states or regions may prepare a Need for Power evaluation and assessment of the regional power system for planning or regulatory purposes. A Need for Power analysis may also be prepared by a regulated utility and submitted to a regulatory authority, such as a State public utility commission. The NRC staff would review the evaluation and determine if it is (1) systematic, (2) comprehensive, (3) subject to confirmation, and (4) responsive to forecasting uncertainty (NRC 2000). If the Need for Power evaluation is found to be acceptable, no additional independent review by the NRC is needed. However, the data may be supplemented

by information from other sources such as the Energy Information Agency, Federal Energy Regulatory Commission, and the North American Electric Reliability Corporation.

8.1 Description of Power System

Southern has been authorized to submit the ESP application by the Georgia Power Company (GPC), acting as agent for the following co-owners of the existing VEGP Units 1 and 2: the GPC, 45.7 percent; the Oglethorpe Power Corporation (OPC), 30.0 percent; the Municipal Electric Authority of Georgia (MEAG), 22.7 percent; and the city of Dalton, an incorporated municipality in the State of Georgia acting by and through its Board of Water, Light, and Sinking Fund Commissioners (Dalton Utilities), 1.6 percent. The existing co-owners of VEGP Units 1 and 2 support the development of VEGP Units 3 and 4, and anticipate the same ownership interest percentages in VEGP Units 3 and 4 as exist in VEGP Units 1 and 2. The GPC and Southern are subsidiaries of Southern Company, which owns and operates the electricity generating facilities shown in Figure 8-1 (Southern 2008a).

Southern is engaged in the operation of nuclear power plants. Besides operating VEGP Units 1 and 2, it operates the Edwin I. Hatch Nuclear Plant, Units 1 and 2 (Plant Hatch) for GPC; and the Joseph M. Farley Nuclear Plant Units 1 and 2 (Plant Farley) for Alabama Power Company. The combined electric generation of all six units is approximately 5700 MW(e) (DOE/EIA 2007a). Should a nuclear facility be constructed at the proposed VEGP site, Southern is expected to be the exclusive licensed operator of VEGP Units 3 and 4 (Southern 2008a).

The GPC is engaged in the generation and transmission of electricity and the distribution and sale of such electricity within the State of Georgia. The GPC serves more than 2 million customers in a service area of approximately 148,000 km² (57,000 mi²). With a rated electricity generation capability of approximately 14,000 MW(e), the GPC currently provides retail electric service in all but six of Georgia's 159 counties (Southern 2008a).

The OPC, an Electric Membership Corporation (EMC), supplies electricity at wholesale prices to 38 EMCs in the State of Georgia, which in turn distribute this electricity at retail to their residential, commercial, and industrial customers. The EMCs serve approximately 1.5 million metered electric customers, representing approximately 3.7 million people of the 9 million total residents in the State of Georgia. The EMCs serve customers in 150 of the 159 counties in Georgia (Southern 2008a).

The MEAG is an electric generation and transmission public corporation, which provides wholesale power to 49 communities in the State of Georgia and other wholesale customers outside the State of Georgia. These communities, in turn, supply electricity to more than 600,000 retail customers, representing approximately 10 percent of Georgia's population, in their respective service areas across the State (Southern 2008a).

8.2 Power Demand/Integrated Resource Planning

Need for Power is an intricate part of all integrated resource planning, and is a derivative of load demand forecasting.

Integrated resource planning can be thought of as a process of planning to meet users' needs for electricity services in a way that satisfies multiple objectives with limited resources. Broad objectives can include, but are not limited to:

- conforming to national, regional, State, and local development objectives
- ensuring that all households and businesses have access to electricity services
- maintaining reliability of supply
- minimizing the short-term or long-term economic costs of delivering electricity services
- minimizing the environmental impacts of electricity supply and use
- enhancing energy security by minimizing the use of external resources
- providing economic benefits.

Integrated resource planning is built on principles of comprehensive analysis. Traditional methods of electric resource planning focused on "supply-side" projections only for such things as construction of generation, transmission, and distribution facilities. Integrated resource planning considers a full range of feasible supply-side and demand-side options, and assesses them against a common set of planning objectives.

Integrated resource planning provides an opportunity for electric planners to address complex issues in a structured, inclusive, and transparent manner. At the same time, it provides a chance for interested parties both inside and outside the planning region to review, understand, and provide additional input.

The steps in the integrated resource planning process generally are to:

- establish objectives
- survey historical energy use patterns and develop load demand forecasts
- investigate electricity supply options
- investigate demand-side management measures
- prepare and evaluate supply plans
- prepare and evaluate demand-side management plans
- integrate supply-side and demand-side plans into candidate integrated resource plans
- select the preferred plan.

8.3 Power Supply/Integrated Resource Planning in the State of Georgia

The mission of the Georgia Public Service Commission (GPSC) is to ensure that consumers receive safe, reliable, and reasonably priced electric services from financially viable and technically competent companies subject to its jurisdiction. For companies subject to its jurisdiction, the GPSC has the authority to set rates and require long range plans and projections.

The GPSC regulates the GPC. Under the Georgia Integrated Resource Planning Act, at least every 3 years the GPC must submit to the GPSC an integrated resource plan (IRP) that:

- includes GPC's electric demand and energy forecast for at least a 20-year period
- includes GPC's program for meeting the requirements shown in its forecast in an economical and reliable manner
- includes GPC's analysis of all capacity resource options, including demand-side and supply-side options
- sets forth GPC's assumptions and conclusions with respect to the effect of each capacity option.

Provisions in the Georgia Integrated Resource Planning Act require the GPSC to hold a public hearing on the IRP and establish criteria for the GPSC to use in determining whether to approve and adopt a plan. A related provision in the Georgia Integrated Resource Planning Act prohibits a utility from constructing an electric plant, or increasing the capacity of an existing plant, without first obtaining a certificate of public convenience and necessity from the GPSC. A certificate application must include the current IRP and a benefit-cost analysis for the proposed additional capacity.

The Consumer's Utility Counsel Division of the Governor's Office of Consumer Affairs represents State residents and small commercial customers in utility proceedings, including IRP reviews, before the GPSC (Official Code of Georgia [OCGA], Section 46-10). This provides a viewpoint that might not otherwise be present in the review process for IRPs.

The GPSC has established detailed regulatory requirements for IRPs in Chapter 515-3-4 of the Rules and Regulations of the State of Georgia. The requirements include the following:

- Energy and Demand Forecasting. An IRP must report and use 3 years of historic data and address each of the next 20 years (forecast). Forecasting must be weather-normalized and

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address the jurisdictional area, retail and wholesale loads, customer classes, and annual load factors. The GPSC regulations specify forecasting methodologies and standards for data inputs. Finally, an IRP must include an evaluation of the sensitivity of the results to changes in major assumptions and estimates used. The sensitivities must include a reasonable range of sales and demand and include base-growth, high-growth, and low-growth scenarios.

- Capacity Resource Identification. The IRP must identify existing resources, including power purchases, sales and exchanges, demand-side programs, cogeneration, standby generation, spinning reserves, interruptible service, pooling or coordination agreements, generation, and transmission. The IRP must address potential new supply-side and demand-side resources and the associated decision-making process (the GPSC IRP regulations detail the process for securing long-term new supply-side options.)
- Integrated Plan Development and Filing. In addition to energy and demand forecasting and capacity resource identification, the IRP must address alternatives to proposed generation; environmental impact of proposed and alternative generation; economic, environmental, and other benefits to the State of Georgia and consumers; and financial information. The IRP must identify the integrated combination of demand-side and supply-side resources selected to satisfy future electric demands. Periodically after IRP approval, the GPC must report on actions taken to implement the IRP and any deviations from the plan. A new IRP must be filed with the GPSC every 3 years.

The GPSC staff retains experts to assist in reviewing the IRP, developing data requests and reviewing responses, providing reports to and testimony before the GPSC, and responding to GPSC requests. The GPSC can approve the IRP, approve it subject to stated conditions or modifications, approve it in part and reject in part, reject the IRP in its entirety, or provide an alternative plan.

In addition to IRP requirements, the GPSC has detailed requirements for obtaining GPSC approval and certification of new supply-side resources. An application for GPSC certification for constructing or purchasing capacity (purchase agreement) must include a discussion of how the proposed application is consistent with the current IRP, a benefit-cost analysis, and detailed information about the proposal and alternatives. Once the GPSC certifies a power purchase agreement, that capacity is added to the IRP's base case for meeting forecast loads.

As part of the 2007 IRP filing with the GPSC (Docket No. 17687-U and 24505-U), the GPC has provided information showing the details of the load and energy forecasts. Portions of this information is proprietary to the GPC.

The proprietary information provided in the IRP constitutes detailed forecasted information regarding GPC's future energy and demand growth. This information could be used to

determine GPC's short-term capacity needs. If revealed to the public, a generation wholesaler or power marketer could use the information to tailor proposals with the intention of pricing products that could undermine GPC's market position. Such disclosure could unfairly allow competitors to manipulate the wholesale market and ultimately harm retail customers through higher prices and less reliability. Lastly, GPC's competitors are not required to file their respective forecast information.

Furthermore, the information is subject to substantial procedures to maintain its secrecy. Only select GPC affiliated personnel are granted access to the information on a "need-to-know" basis. Generally, parties outside the GPC who would be granted access to the IRP information would be required to sign confidentiality agreements.

For the reasons cited above, the GPSC granted the GPC proprietary status on parts of its IRP filings. GPC has not included the full IRP into the NRC Docket in support of its Need for Power analysis, but has supplied a summary of its IRP highlights, procedures, and conclusions, in the VEGP application (Southern 2008a). To facilitate the Need for Power review, access to the full 2007 IRP, including proprietary information, was granted to the NRC staff in March 2007. This access to NRC staff occurred at Southern Company's Headquarters in Atlanta, Georgia.

8.4 Assessment of Need for Power/NRC Findings on GPC's IRP

8.4.1 Evaluation of GPC's IRP

The staff considered the GPSC evaluation of GPC's IRP and other energy forecasts to develop a conclusion about the Need for Power. In July 2007, the GPSC issued its final order approving the 2007 GPC IRP (GPSC 2007). The order is an explanation of the proceedings and conclusions. The GPSC approved a 13.5 percent reserve margin for planning within 3 years, and a 15 percent reserve margin for longer forecasts and approved planning that identifies the need for new (generating) resources beginning in 2010. The GPSC determined that it is reasonable for GPC to investigate the opportunity to build nuclear resources. The 2007 GPC IRP includes nuclear generation and shows nuclear additions using the Westinghouse AP1000 nuclear technology as a base case option, with commercial generation expected to start in year 2015/2016.

8.4.2 Other Forecasts for Energy

The NRC compared GPC's IRP demand for electricity forecast in its territory to the U.S. Department of Energy, Energy Information Administration's (DOE-EIA) Annual Energy Outlook 2007 (DOE/EIA 2007b), which looks at the United States as a whole. The Annual Energy Outlook forecasts total electricity sales to increase by 41.0 percent, from 3660 billion

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kilowatt-hours in 2005 to 5168 billion kilowatt-hours in 2030. By end-user sector, electricity demand is projected to grow by 39 percent from 2005 to 2030 in the residential sector, 63 percent in the commercial sector, and by 17.0 percent in the industrial sector. This translates into an average annual increase of 1.3 percent in the residential sector, 2.0 percent increase in the commercial sector, and 0.6 percent increase in the industrial sector.

Increases in the demand for electricity are related to population increases, as well as an increase of personal consumption. According to the U.S. Census Bureau, the population in the State of Georgia is expected to increase 46.8 percent from 8.2 million in 2000, to 12.0 million in 2030 (USCB 2007). The surrounding States of Florida and South Carolina anticipate increases in populations of 79.5 percent and 28.3 percent, respectively. These forecast increases are during a time when the population of the whole United States is expected to grow 29.2 percent from 281.4 million in 2000 to 363.6 million in 2030.

In addition, the staff estimates that gross average annual personal consumption for electricity in the State of Georgia may increase 0.30 percent from 13,000 kilowatt-hours per year in 2005 to 14,000 kilowatt-hours per year in 2030, the same gross average annual personal consumption as forecast in the United States as a whole.

GPC assumes a demand for electricity in Georgia alone to grow by an average annual rate of 1.8 percent through 2030. Given the relative changes expected in demography, the demand for electricity growth rate in the State of Georgia is compatible to the national average annual rate of 1.4 percent, as stated in the *Annual Energy Outlook* (DOE/EIA 2007b).

On July 20, 2006, the North American Electric Reliability Corporation was certified as the Electric Reliability Organization in the United States, pursuant to Section 215 of the Federal Power Act. Included in this certification was a provision for the Electric Reliability Organization to delegate authority for the purpose of proposing and enforcing reliability standards in particular regions of the country by entering into delegation agreements with regional entities.

The South Eastern Reliability Council (SERC) serves as a regional entity with delegated authority from the North American Electric Reliability Corporation for the purpose of proposing and enforcing reliability standards within the SERC Region. The State of Georgia is in the SERC territory of responsibility, and the GPC, OPC, and MEAG are SERC members.

The SERC is a nonprofit corporation responsible for promoting and improving the reliability, adequacy, and critical infrastructure of the bulk power supply systems in all or portions of 16 central and southeastern States (Figure 8-2). Owners, operators, and users of the bulk power system in these States cover an area of approximately 560,000 square miles and comprise what is known as the SERC Region.

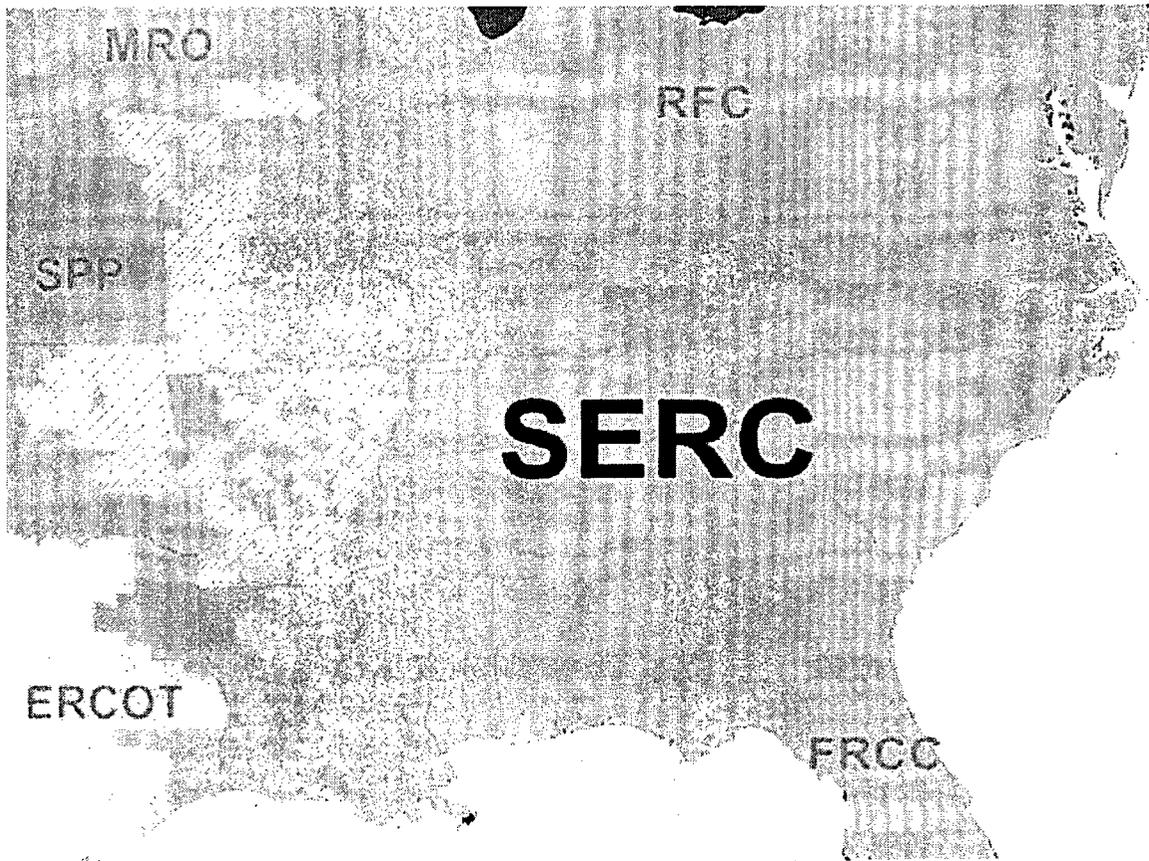


Figure 8-2. SERC Service Territory (SERC 2006)

The NRC also examined the electric energy forecast developed by SERC. Among SERC's 2007 conclusions (SERC 2007):

- There has been significant merchant generation built since 1998, but much of it has not been contracted to serve loads within the SERC region.
- More recent surveys have shown downward trends in merchant generation development.
- Projected peak demand is forecast to increase at 2.08 percent annually through 2016.
- Electric demand is forecast to increase 1.7 percent annually through 2016.
- SERC is projecting firm capacity margins of about 13 to 15 percent through 2016, which is a requirement imposed on its members to maintain system reliability.

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8.4.3 NRC Conclusions

The NRC staff finds that the GPC has submitted an IRP to the GPSC that contains a detailed review of the Need for Power in the State of Georgia and parts of the surrounding area. The NRC staff reviewed the IRP, and the Need for Power contained within, and determined it is (1) systematic, (2) comprehensive, (3) subject to confirmation, and (4) responsive to forecasting uncertainty (NRC 2000). The NRC staff reviewed and accepts the Need for Power evaluation contained in the IRP submitted to the GPSC.

The NRC staff has considered the past, present, and planned power-producing capability and the predicted load demands from GPC's IRP, the *Annual Energy Outlook* (DOE/EIA 2007b), the U.S. Census Bureau, and the SERC. The NRC staff has concluded that the GPC's detailed prediction of its (proprietary) future load demand is a reasonable basis for planning for 2007 to 2030 and that the GPC cannot expect to satisfy a significant portion of that demand load by additional electric purchases from neighboring producers.

Based on this analysis, the staff concludes that there is a justified Need for Power in the region of interest.

8.5 References

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9.0 Environmental Impacts of Alternatives

This chapter describes alternatives to the proposed action and discusses the environmental impacts of those alternatives. Section 9.1 discusses the no-action alternative. Section 9.2 addresses alternative energy sources. Section 9.3 examines plant design alternatives. Section 9.4 reviews Southern Nuclear Operating Company, Inc.'s (Southern's) region of interest (ROI) and examines its suitability and the suitability of Southern's alternative site-selection process. Section 9.5 summarizes the environmental impacts for the alternative sites. Section 9.6 examines issues that are common to all of the alternative sites and addresses them collectively for all the alternative sites. Section 9.7 summarizes the impacts at the alternative sites. The comparison of the alternative sites with the Vogtle Electric Generating Plant (VEGP) site is made in Chapter 10.

The environmental impacts of the alternatives are evaluated using the U.S. Nuclear Regulatory Commission (NRC's) three-level standard of significance – SMALL, MODERATE, or LARGE – developed using Council on Environmental Quality guidelines (CEQ 1997) and set forth in the footnotes to Table B-1 of Title 10 of the Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B. The impact categories evaluated in this chapter are the same as those used in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS)*, NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999)^(a) with the additional impact category of environmental justice. While NUREG-1437 was developed for license renewal, it provides useful information for this review and is referenced throughout this chapter.

The evaluation of alternative sites is a two-step process, as set forth in NUREG-1555, Section 9.3 (NRC 2000), and stems from the NRC decision related to licensing the Seabrook Nuclear Power Plant (Public Service Company of New Hampshire 1977). The first step looks at a full suite of environmental issues, using reconnaissance-level information to determine if any of the alternative sites are environmentally preferable to the proposed VEGP site. If an alternative site appears environmentally preferable to the proposed site, the analysis proceeds to the second step. If not, then the evaluation of alternative sites ends at the first step. The second step considers economic, technological, and institutional factors among the environmentally preferred sites to determine if any are obviously superior to the proposed site. If there is no obviously superior site, then the proposed site prevails. A staff conclusion that an alternative site is obviously superior to the early site permit (ESP) site proposed by Southern would normally lead to a recommendation that the ESP application be denied.

(a) NUREG-1437 was originally issued in 1996. Addendum 1 to NUREG-1437 was issued in 1999. Hereafter, all references to the "GEIS" include NUREG-1437 and its Addendum 1.

9.1 No-Action Alternative

For purposes of an ESP application, the no-action alternative refers to a scenario in which the NRC would deny the ESP request. Upon such a denial, the construction and operation of one or more new nuclear units at the proposed location on the VEGP site in accordance with the 10 CFR Part 52 process referencing an approved ESP would not occur.

The no-action alternative generally consists of two parts. First, under the no-action alternative the NRC would not issue the ESP. There are no environmental impacts associated with not issuing the ESP, except that the impacts associated with construction activities authorized by a limited work authorization that could be allowed pursuant to 10 CFR 52.17(c) and 10 CFR 52.25 would be avoided.

Second, given that this environmental impact statement (EIS) addresses the environmental effects of construction and operation of new nuclear generating units as directed by the Commission in 10 CFR 52.18, the no-action alternative would result in no such construction and operation. Therefore, the impacts predicted in this EIS would not occur.

In this context, the no-action alternative would accomplish none of the benefits intended by the ESP process, which would include

- early resolution of siting issues before large investments of financial capital and human resources in new plant design and construction are made
- early resolution of issues on the environmental impacts of construction and operation of new nuclear generating units
- the ability to bank sites on which nuclear plants may be located
- the facilitation of future decisions on whether to construct new nuclear power generation facilities.

9.2 Energy Alternatives

The objective of Southern in seeking an ESP for the VEGP site is to secure a site for new baseload electric power generation (Southern 2008). This section examines the potential environmental impacts associated with alternatives to construction of a new baseload nuclear generating facility. Section 9.2.1 discusses energy alternatives not requiring new generating capacity. Section 9.2.2 discusses energy alternatives requiring new generating capacity. Other alternatives are discussed in Section 9.2.3. A combination of alternatives is discussed in Section 9.2.4. Section 9.2.5 compares the environmental impacts from new nuclear, coal-fired, and natural-gas-fired generating units at the VEGP site.

For analysis of energy alternatives, Southern assumed a bounding electrical output target value of 2234 megawatts electric (MW[e]) (Southern 2008). The staff also used this level of output in its analysis of energy alternatives.

9.2.1 Alternatives Not Requiring New Generating Capacity

Four alternatives to the proposed action that do not require Southern to construct new generating capacity are to

- Purchase the needed electric power from other suppliers.
- Reactivate retired power plants.
- Extend the operating life of existing power plants.
- Implement conservation or demand-side management programs.

The viability of these four alternatives depends on when Southern would seek a construction permit (CP) or combined license (COL) from the NRC (assuming an ESP is granted). For example, the status of existing and retired nuclear power plants varies over time. If Southern is granted an ESP, the duration of the permit would be for 10 to 20 years (10 CFR 52.27(a)). In addition, if Southern is granted an ESP, it would be able to apply for renewal of the permit under the procedures in 10 CFR 52.29 through 52.33.

The staff concluded in Section 8.4.3 of the EIS that GPC's detailed prediction of its future load demand is a reasonable basis for planning for 2007 to 2030 and that GPC cannot expect to satisfy a significant portion of that demand load by additional electric purchases from neighboring producers. However, if power to replace the capacity of the new nuclear units was to be purchased from sources within the United States or from a foreign country, the generating technology likely would be one of those described in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS)* for license renewal (e.g., coal, natural gas, or nuclear) (NRC 1996). The description of the environmental impacts of other technologies described in NUREG-1437 for license renewal is representative of the impacts associated with the construction and operation of new generating units at the VEGP site. Under the purchased power alternative, the environmental impacts of power production would still occur but would be located elsewhere within the region, nation, or in another country. The environmental impacts of coal-fired and natural-gas-fired plants are discussed in Section 9.2.2.

If the purchased power alternative is implemented, the only environmental unknown is whether new transmission line rights-of-way would be required. The construction of new lines could have both environmental and aesthetic consequences, particularly if new transmission line rights-of-way have to be acquired. The staff concludes that the local environmental impacts from purchased power would be SMALL when existing transmission line rights-of-way are used and could range from SMALL to LARGE if acquisition of new rights-of-way is required. The

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environmental impacts of power generation would depend on the generation technology and location of the generation site and, therefore, are unknown.

Nuclear power facilities are initially licensed by the NRC for a period of 40 years. The operating license can be renewed for up to 20 years, and NRC regulations permit additional license renewal. Southern currently operates three nuclear power plants. The Edwin I. Hatch Nuclear Plant (Plant Hatch) and the Joseph M. Farley Nuclear Plant (Plant Farley) have received renewed operating licenses from the NRC. Southern submitted an application to the NRC to renew the operating licenses for VEGP Units 1 and 2 on June 29, 2007 (Southern 2007a). The environmental impacts of continued operation of a nuclear power plant are significantly less than construction of a new plant. However, continued operation of an existing nuclear plant does not provide additional generating capacity.

The only power plants that GPC is currently proposing for retirement are Plant McDonough Units 1 and 2 (GPSC 2007). The coal-fired Plant McDonough units have a combined capacity of approximately 517 MW(e) (GPC 2007). The units are located close to downtown Atlanta and were installed in 1963 and 1964. The staff concludes that extending the life of the two Plant McDonough units would not be a reasonable alternative to the proposed action. Fossil-fueled plants slated for extensive refurbishment, predominately coal-fired and natural-gas-fired plants, tend to be old enough to have economic difficulty meeting the current and more restrictive environmental standards. As a result, Southern concluded that the environmental impacts of a refurbishment scenario are bounded by the coal-fired and natural-gas-fired alternatives (Southern 2008).

Georgia Power Company (GPC) expects to achieve approximately 1000 MW(e) of demand reduction by 2010 through the implementation of existing and new demand-side management programs. This load reduction represents more than 5 percent of the company's current load (GPC 2007). The 1000 MW(e) is accounted for in GPC's Integrated Resource Plan (see Section 8.3 of the EIS) and is therefore not available to offset the need for two new nuclear generating units that would generate baseload power.

GPC offers several conservation and demand-side management programs to its customers to reduce peak electricity demands and daily power consumption. In its most recent Integrated Resource Plan filing to the Georgia Public Service Commission (GPSC), GPC proposed the following five new demand-side management pilot programs: (1) the Power Credit Multifamily Program, (2) the Programmable Thermostat with Home Performance with ENERGY STAR Program, (3) the Compact Fluorescent Light Bulb Program, (4) the Electric Water Heater Insulation Program, and (5) the Commercial Tax Incentive Program. In a July 2007 order, the GPSC found that each program should be approved on a pilot basis as proposed by GPC (GPSC 2007). As part of the Home Performance with ENERGY STAR pilot program, GPC also will provide customer incentives for making home improvements or home improvement financing interest rate buy-downs (GPC 2008). In the July 2007 order, GPSC also directed

GPC to expand several of its demand-side management programs in an effort to capture more of the economic and achievable potential to improve end-use energy efficiency. The staff considers conservation and demand-side programs in section 9.2.4 of the EIS as part of a combination of alternatives.

The staff believes it would be unreasonable for an applicant to request a CP or COL if (1) the power could be purchased from other electricity suppliers at a reasonable cost, (2) the power could be obtained by reactivating one or more retired generating plants or by extending the life of one or more existing generating plants, or (3) conservation or demand-side management programs could make the additional power from the new nuclear units unnecessary.

Based on the preceding discussion, the staff concludes that the options of purchasing electric power from other suppliers, reactivating retired power plants, extending the operating life of existing power plants, and conservation and demand-side programs are not reasonable alternatives to providing new baseload power generation capacity.

9.2.2 Alternatives Requiring New Generating Capacity

In keeping with the NRC's evaluation of alternatives to operating license renewal, a reasonable set of energy alternatives to the construction and operation of one or more new nuclear units at the VEGP site should be limited to analysis of discrete power generation sources and those power generation technologies that are technically reasonable and commercially viable (NRC 1996). The current mix of baseload power generation options in Georgia is one indicator of the feasible choices for power generation technology within the State.

This section discusses the environmental impacts of energy alternatives to the proposed action that would require Southern to construct new generating capacity. The discussion in Section 9.2.2 is limited to the individual alternatives that Southern identified as viable: coal-fired and natural-gas-fired generation. The impacts discussed in this section are estimates based on present technology.

The staff assumed that new generation capacity would be located at the VEGP site for the coal-fired and natural-gas-fired alternatives. Either natural draft or mechanical draft cooling towers would be used for the coal-fired and natural-gas-fired alternatives (Southern 2008). Southern estimates that one new 500-kV electric power transmission line in a new right-of-way would be needed to serve a new baseload generating facility at the VEGP site (Southern 2008).

Each year, the Energy Information Administration (EIA), a component of the U.S. Department of Energy (DOE), issues an annual energy outlook. In its Annual Energy Outlook 2007 (DOE/EIA 2007), the EIA reference case projects that coal-fired capacity would account for approximately 54 percent of total electric generating capacity additions between 2006 and 2030. Coal-fired plants generally are used to meet baseload requirements. EIA projects that natural-gas-fired

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plants would account for approximately 36 percent of new capacity additions during this period. EIA projects that renewable energy sources would account for approximately 6 percent of new capacity additions during the period and that new nuclear plants would account for approximately 4 percent (DOE/EIA 2007). The EIA projections are based on the assumption that providers of new generating capacity would seek to minimize cost while meeting applicable environmental requirements.

9.2.2.1 Coal-Fired Power Generation

For the coal-fired generation alternative, the staff assumed construction of four pulverized coal-fired units, each with a net capacity of 530 MW(e) at the VEGP site. These assumptions are consistent with the ESP application submitted by Southern (Southern 2008). The staff also assumed the construction of an additional transmission line right-of-way, as discussed in Section 3.3. The plant is assumed to have an operating life of 40 years.

The staff also considered an integrated gasification combined cycle (IGCC) coal-fired plant. IGCC is an emerging technology for generating electricity with coal that combines modern coal gasification technology with both gas turbine and steam turbine power generation (Southern 2008). The technology is cleaner than conventional pulverized coal plants because major pollutants can be removed from the gas stream before combustion. The IGCC alternative also generates less solid waste than the pulverized coal-fired alternative. The largest solid waste stream produced by IGCC installations is slag, a black, glassy, sand-like material that is potentially a marketable by-product. The other large-volume by-product produced by IGCC plants is sulfur, which is extracted during the gasification process and can be marketed rather than placed in a landfill. IGCC units do not produce ash or scrubber wastes (Southern 2008). In spite of the preceding advantages, the staff concludes that, at present, a new IGCC plant is not a reasonable alternative to a 2234-MW(e) nuclear power generation facility for the following reasons: (1) IGCC plants are more expensive than comparable pulverized coal plants (DOE/EIA 2007), (2) existing^(a) IGCC plants have considerably smaller capacity than the proposed 2234-MW(e) nuclear plant, (3) system reliability of existing IGCC plants has been lower than pulverized coal plants, (4) the existing IGCC plants have had an extended (though ultimately successful) shakedown period (NPCC 2005), and (5) a lack of overall plant performance warranties for IGCC plants has hindered commercial financing (NPCC 2005). For these reasons, IGCC plants are not considered further in this EIS.

Coal and limestone (calcium carbonate) for a pulverized coal-fired plant would be delivered to the plant by train. Southern estimates that the plant would consume approximately 7 million MT (7.3 million tons) per year of pulverized bituminous coal with an ash content of approximately

(a) Currently operating coal gasification power plants in the United States are the Tampa Electric IGCC Project (Polk Power Station), using the Chevron-Texaco gasification process, and the Wabash River Coal Gasification Repowering Project, using the ConocoPhillips E-Gas process (NPCC 2005).

11 percent (Southern 2008). Lime or limestone, used in the scrubbing process for control of sulfur dioxide (SO₂) emissions, is injected as a slurry into the hot effluent combustion gases to remove entrained SO₂. The lime-based scrubbing solution reacts with SO₂ to form calcium sulfite, which precipitates and is removed from the process as sludge. Southern estimates that approximately 166,000 MT (183,000 tons) per year of limestone would be used for flue gas desulfurization (Southern 2008).

Air Quality

Southern assumed a plant design that would minimize air emissions through a combination of boiler technology and post-combustion pollutant removal. Southern estimates that the coal-fired alternative emissions for SO₂, nitrogen oxides (NO_x), carbon monoxide (CO), and particulate matter (PM) would be as follows (Southern 2008):

- SO₂ – 5068 MT (5587 tons) per year
- NO_x – 1647 MT (1815 tons) per year
- CO – 1647 MT (1815 tons) per year
- PM₁₀ – 83 MT (91 tons) per year.
- PM_{2.5} – 0.35 MT (0.39 tons) per year.

PM₁₀ is particulate matter with a diameter equal to or less than 10 microns (40 CFR 50.6).

PM_{2.5} is particulate matter with a diameter equal to or less than 2.5 microns (40 CFR 50.7).

The impacts on air quality from coal-fired generation would vary considerably from those of nuclear generation because of emissions of SO₂, NO_x, CO, PM, and hazardous air pollutants such as mercury. A coal-fired plant would also have unregulated carbon dioxide emissions that could contribute to global warming.

The acid rain requirements of the Clean Air Act capped the nation's SO₂ emissions from power plants. Southern would need to obtain sufficient pollution credits either from a set-aside pool or purchases on the open market to cover annual emissions from the plant. The market-based allowance system used for SO₂ emissions is not used for NO_x emissions.

A new coal-fired generation plant at the VEGP site would likely need a prevention of significant deterioration (PSD) permit and an operating permit under the Clean Air Act. The plant would need to comply with the new source performance standards (NSPS) for such plants in 40 CFR 60, Subpart Da. The standards establish emission limits for PM and opacity (40 CFR 60.42Da), SO₂ (40 CFR 60.43Da), NO_x (40 CFR 60.44Da), and mercury (40 CFR 60.45Da).

The U.S. Environmental Protection Agency (EPA) has various regulatory requirements for visibility protection in 40 CFR 51, Subpart P, including a specific requirement for review of any

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new major stationary source in an area designated as in attainment or unclassified for criteria pollutants under the Clean Air Act (40 CFR 51.307(a)). Criteria pollutants under the Clean Air Act are lead, ozone, particulates, CO, NO₂, and SO₂. Ambient air-quality standards for criteria pollutants are in 40 CFR Part 50. The VEGP site is in an area designated as in attainment or unclassified for all criteria pollutants (40 CFR 81.311).

Section 169A of the Clean Air Act (42 USC 7491) establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment occurs because of air pollution resulting from human activities. In addition, EPA regulations provide that for each mandatory Class I Federal area located within a State, the State must establish goals that provide for reasonable progress toward achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for those days on which visibility is most impaired over the period of the implementation plan and ensure no degradation in visibility for the least visibility-impaired days over the same period (40 CFR 51.308(d)(1)). If a new coal-fired power generation station were located close to a mandatory Class I area, additional air-pollution control requirements could be imposed. There are no mandatory Class I Federal areas within 160 km (100 mi) of the VEGP site.

The fugitive dust emissions from construction activities would be mitigated using best management practices (BMPs); such emissions would be temporary.

NUREG-1437 for license renewal (NRC 1996) did not quantify emissions from coal-fired power plants, but suggested that air impacts would be substantial. NUREG-1437 also mentioned global warming from unregulated carbon dioxide emissions and acid rain from sulfur oxides and nitrogen oxide emissions as a potential impact (NRC 1996). Adverse human health effects, such as cancer and emphysema, have been associated with the byproducts of coal combustion.

Overall, the staff concludes that air-quality impacts from coal-fired generation at the VEGP site would be MODERATE. The impacts would be clearly noticeable, but would not destabilize air quality.

Waste Management

NUREG-1437 for license renewal (NRC 1996) and the NRC's experience from operating license renewal analyses indicate that coal combustion generates waste in the form of ash, and equipment for controlling air pollution generates additional ash, spent selective catalytic reduction (SCR) catalyst, and scrubber sludge. In its Environmental Report (ER) (Southern 2008), Southern estimates that a coal-fired plant would generate approximately 715,000 MT (788,000 tons) per year of ash. Southern would expect to recycle approximately 35 percent of the ash (Southern 2008). The coal plant would also generate approximately 197,800 MT (218,000 tons) per year of scrubber sludge. Southern estimates that disposal of the ash and

scrubber sludge over a 40-year plant life would require approximately 164 ha (406 ac) (Southern 2008).

In May 2000, EPA issued a "Notice of Regulatory Determination on Wastes from the Combustion of Fossil Fuels" (65 FR 32214). EPA concluded that some form of national regulation is warranted to address coal combustion waste products because of health concerns. Accordingly, EPA announced its intention to issue regulations for disposal of coal-combustion waste under Subtitle D of the Resource Conservation and Recovery Act (RCRA) of 1976.

Waste impacts on groundwater and surface water could extend beyond the operating life of the plant if leachate and runoff from the waste storage area occurs. Disposal of the waste could noticeably affect land use and groundwater quality, but with appropriate management and monitoring, it would not destabilize any resources. After closure of the waste site and re-vegetation, the land could be available for other uses. Construction-related debris would be generated during plant construction activities.

For the reasons stated above, the staff concludes that the impacts from waste generated at a coal-fired plant would be MODERATE. The impacts would be clearly noticeable but would not destabilize any important resource.

Human Health

Coal-fired power generation introduces worker risks from coal and limestone mining, worker and public risk from coal and lime/limestone transportation, worker and public risk from disposal of coal-combustion waste, and public risk from inhalation of stack emissions. In addition, the discharges of uranium and thorium from coal-fired plants can potentially produce radiological doses in excess of those arising from nuclear power plant operations (Gabbard 1993).

Regulatory agencies, including the EPA and State agencies, base air emission standards and requirements on human health impacts. These agencies also impose site-specific emission limits as needed to protect human health. Given the regulatory oversight exercised by the EPA and State agencies, the staff concludes that the human health impacts from radiological doses and inhaled toxins and particulates generated from coal-fired generation would be SMALL.

Other Impacts

Approximately 450 ha (1100 ac) of land would need to be converted to industrial use for the powerblock, infrastructure and support facilities, coal and limestone storage and handling, and landfill disposal of ash and scrubber sludge (Southern 2008). Additional land would be needed for a new transmission line right-of-way. Land-use changes would occur offsite in an undetermined coal-mining area to supply coal for the plant. Overall, the staff concludes that land-use impacts would be MODERATE.

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The impacts on water use and quality from constructing and operating a coal-fired plant at the VEGP site would be comparable to the impacts associated with a new nuclear plant. Cooling water would likely be withdrawn directly from the Savannah River. Plant discharges would consist mostly of cooling tower blowdown, characterized primarily by an increased temperature and concentration of dissolved solids relative to the receiving waterbody and intermittent low concentrations of biocides (e.g., chlorine). Treated process waste streams and sanitary wastewater may also be discharged. All discharges would be regulated by the Georgia Department of Natural Resources (GDNR) through a National Pollution Discharge Elimination System (NPDES) permit. Indirectly, water quality could be affected by acids and mercury from air emissions. The water would be consumed because of evaporation from the cooling towers. In NUREG-1437 for license renewal, the staff determined that some erosion and sedimentation would likely occur during construction of new facilities (NRC 1996). Overall, the staff concludes that the water-use and water-quality impacts would be SMALL.

The coal-fired generation alternative would introduce impacts from construction and new incremental impacts from operations. The impacts could include wildlife habitat loss and fragmentation, reduced productivity, and a local reduction in biological diversity. The impacts could occur at the ESP site and at the sites used for coal and limestone mining. Extraction of cooling make-up water could have adverse impacts on aquatic resources. Construction and maintenance of a new transmission line would have ecological impacts. Cooling tower drift would have minimal impacts on terrestrial ecology. Disposal of fly ash could affect water quality and the aquatic environment. The impacts on threatened and endangered species at the VEGP site would be similar to the impacts from a new nuclear facility. Overall, the staff concludes that the ecological impacts would be MODERATE.

Socioeconomic impacts would result from the approximately 200 workers needed to operate the coal-fired facility, demands on housing and public services during construction, and the loss of jobs after construction. Overall, the staff concludes that these impacts would be SMALL to MODERATE, resulting from the mitigating influence of the site's proximity to the surrounding population area and the relatively small number of workers needed to operate the plant. The plant would pay significant property taxes to Burke County. Considering the population and economic condition of the county, the staff concludes that the taxes would have a LARGE beneficial impact on the county.

The four coal-fired powerblock units would be as much as 60 m (200 ft) tall and would be visible offsite during daylight hours. The four exhaust stacks would be as much as 180 m (600 ft) high. The stacks and associated emissions would likely be visible in daylight hours for distances greater than 16 km (10 mi). Cooling towers and associated plumes also would have aesthetic impacts. Natural draft towers could be up to 180 m (600 ft) high. The powerblock units and associated stacks and cooling towers would also be visible at night because of outside lighting. The Federal Aviation Administration (FAA) generally requires that all structures exceeding an

overall height of 200 ft above ground level have markings and/or lighting so as not to impair aviation safety (FAA 2000). A mitigating factor is that the VEGP site is currently an industrial site located in a rural, forested area. The visual impacts of a new coal-fired plant could be further mitigated by landscaping and color selection for buildings that is consistent with the environment. Visual impacts at night could be mitigated by reduced use of lighting, provided the lighting meets FAA requirements, and appropriate use of shielding. The new transmission line would have a larger aesthetic impact. Overall, the staff concludes that the aesthetic impacts associated with new coal-fired power generation at the VEGP site would be SMALL, but the aesthetic impacts of the transmission lines would be MODERATE.

Coal-fired power generation would introduce mechanical sources of noise that would be audible offsite. Sources contributing to the noise produced by plant operation are classified as continuous or intermittent. Continuous sources include the mechanical equipment associated with normal plant operations and mechanical draft cooling towers. Intermittent sources include the equipment related to coal handling, solid-waste disposal, transportation related to coal and lime/limestone delivery, use of outside loudspeakers, and the commuting of plant employees. Noise impacts associated with rail delivery of coal and lime/limestone would be most significant for residents living in the vicinity of the facility and along the rail route. Although noise from passing trains significantly increases noise levels near the rail corridor, the short duration of the noise reduces the impacts. Nevertheless, given the frequency of train transport and the fact that many people are likely to be within hearing distance of the rail line, the impacts of noise on residents in the vicinity of the facility and of the rail line are considered MODERATE. Noise and light from the plant would be detectable offsite.

Historic and cultural resource impacts for a new coal-fired plant located at the VEGP site would be similar to the impacts for a new nuclear plant as discussed in Sections 4.6 and 5.6. A cultural resources inventory would likely be needed for any onsite property that has not been previously surveyed. Other lands, if any, that are acquired to support the plant would also likely need an inventory of field cultural resources, identification and recording of existing historic and archaeological resources, and possible mitigation of the adverse effect from ground-disturbing actions. The studies would likely be needed for all areas of potential disturbance at the plant site, any offsite affected areas, such as mining and waste-disposal sites, and along associated rights-of-way where new construction would occur, for example, roads and transmission line rights-of-way. The staff concludes that the historic and cultural resource impacts would be MODERATE.

As discussed in Section 2.10, there are large proportions of minority and low-income persons in the population near the VEGP site. Environmental impacts on minority and low-income populations associated with a coal-fired plant at the VEGP site could be SMALL to MODERATE, depending on the distribution and intensity of adverse air-quality impacts on the local population.

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The construction and operation impacts of coal-fired power generation at the VEGP site are summarized in Table 9-1.

9.2.2.2 Natural-Gas-Fired Power Generation

For the natural gas alternative, the staff assumed construction and operation of a natural-gas-fired plant with a closed-cycle cooling system and cooling towers located at the VEGP site. The staff assumed that the natural-gas-fired plant would use combined-cycle combustion turbines, which is consistent with the Southern ESP application (Southern 2008). The staff used the Southern assumption of four units with a net capacity of 530 MW(e) per unit (Southern 2008). The staff also assumed the construction of an additional transmission line right-of-way, as discussed in Section 3.3 of this EIS.

Table 9-1. Summary of Environmental Impacts of Coal-Fired Power Generation

Impact Category	Impact	Comment
Land use	MODERATE	Uses approximately 450 ha (1100 ac) for powerblock; coal handling, storage, and transportation facilities; infrastructure facilities; waste disposal; and cooling-water facilities. Additional land needed for a new transmission line right-of-way. Mining activities would have additional impacts offsite.
Air quality	MODERATE	SO ₂ – 5068 MT (5587 tons) per year NO _x – 1647 MT (1815 tons) per year CO – 1647 MT (1815 tons) per year PM ₁₀ – 82.6 MT (91 tons) per year PM _{2.5} – 0.35 MT (0.39 tons) per year Small amounts of hazardous air pollutants
Water use and quality	SMALL	Impacts would be comparable to the impacts for a new nuclear power plant located at the VEGP site.
Ecology	MODERATE	Uses the undeveloped upland area of the VEGP site and probably some adjacent offsite undeveloped land. Potential upland hardwood forest loss and fragmentation, reduced productivity and biological diversity, and impacts on terrestrial ecology from cooling tower drift. Additional impacts are associated with coal mining and construction of a rail spur.
Waste management	MODERATE	Total waste volume would be approximately 715,000 MT (788,000 tons) per year of ash and an additional 197,800 MT (218,000 tons) per year of scrubber sludge.
Socioeconomics	LARGE Beneficial to MODERATE Adverse	Construction-related impacts would be noticeable. Impacts during operation would be minor. Local property tax base would benefit mainly during operations. Depending on where the workforce lives, the construction-related impacts would be noticeable or minor. Impacts during operation likely would be smaller than during construction. The plant and new

Table 9-1. (contd)

Impact Category	Impact	Comment
Human health	SMALL	transmission line would have aesthetic impacts. Some offsite noise impacts would occur. Regulatory controls and oversight would be protective of human health.
Historic and cultural resources	MODERATE	Any potential impacts could likely be effectively managed. Most of the facility and infrastructure would be built on previously disturbed ground.
Environmental justice	SMALL to MODERATE	There is a high proportion of minority and low-income persons in the local population. Impacts would depend on the distribution and intensity of adverse air-quality impacts on this population.

Air Quality

Natural gas is a relatively clean-burning fuel. When compared to a coal-fired plant, a natural-gas-fired plant would release similar types of emissions but in lower quantities.

A new natural-gas-fired power generation plant would likely need a prevention of significant deterioration permit and an operating permit under the Clean Air Act. A new natural-gas-fired, combined-cycle plant would also be subject to the new source performance standards specified in 40 CFR 60, Subparts Da and GG. These regulations establish emission limits for particulates, opacity, SO₂, and NO_x.

The EPA has various regulatory requirements for visibility protection in 40 CFR 51, Subpart P, including a specific requirement for review of any new major stationary source in areas designated as in attainment or unclassified under the Clean Air Act. The VEGP site is in an area designated as in attainment or unclassified for criteria pollutants (40 CFR 81.311).

Section 169A of the Clean Air Act (42 USC 7491) establishes a national goal of preventing future impairment of visibility and remedying existing impairment in mandatory Class I Federal areas when impairment is from air pollution caused by human activities. In addition, EPA regulations provide that for each mandatory Class I Federal area located within a State, State regulatory agencies must establish goals that provide for reasonable progress toward achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for the most impaired days over the period of the implementation plan and ensure no degradation in visibility for the least-impaired days over the same period (40 CFR 51.308(d)(1)). If a new natural-gas-fired power plant were located close to a mandatory Class I area, additional

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air-pollution control requirements could be imposed. There are no mandatory Class I Federal areas within 160 km (100 mi) of the VEGP site.

Southern estimates that a natural-gas-fired plant equipped with appropriate pollution control technology would have approximately the following emissions (Southern 2008):

- SO₂ – 153 MT (169 tons) per year
- NO_x – 490 MT (540 tons) per year
- CO – 102 MT (112 tons) per year
- PM_{2.5} – 85 MT (94 tons) per year.

A natural-gas-fired power plant would also have unregulated carbon dioxide emissions that could contribute to global warming.

The combustion turbine portion of the combined-cycle plant would be subject to EPA's National Emission Standards for Hazardous Air Pollutants for Stationary Combustion Turbines (40 CFR 63, Subpart YYYYY) if the site is a major source of hazardous air pollutants. Major sources have the potential to emit 9 MT/yr (10 tons/yr) or more of any single hazardous air pollutant or 23 MT/yr (25 tons/yr) or more of any combination of hazardous air pollutants (40 CFR 63.6085(b)).

The fugitive dust emissions from construction activities would be mitigated using BMPs; such emissions would be temporary.

The impacts of emissions from a natural-gas-fired power generation plant would be clearly noticeable, but would not be sufficient to destabilize air resources. Overall, the staff concludes that air-quality impacts resulting from construction and operation of new natural-gas-fired power generation at the VEGP site would be SMALL to MODERATE.

Waste Management

In NUREG-1437, the staff concluded that waste generation from natural-gas-fired technology would be minimal (NRC 1996). The only significant waste generated at a natural-gas-fired power plant would be spent SCR catalyst, which is used to control NO_x emissions. The spent catalyst would be regenerated or disposed of offsite. Other than spent SCR catalyst, waste generation at an operating natural-gas-fired plant would be largely limited to typical operations and maintenance waste. Construction-related debris would be generated during construction activities. Overall, the staff concludes that waste impacts from natural-gas-fired power generation would be SMALL.

Human Health

In NUREG-1437, the staff identified cancer and emphysema as a potential health risk from natural-gas-fired plants (NRC 1996). The risk may be attributable to NO_x emissions that

contribute to ozone formation, which in turn contribute to health risk. Air emissions from a natural-gas-fired power generation plant located at the VEGP site would be regulated by the GDNR. The human health effect is expected to be either undetectable or sufficiently minor. Overall, the staff concludes that the impacts on human health from natural-gas-fired power generation would be SMALL.

Other Impacts

The natural-gas-fired generating plant would require approximately 64 ha (159 ac) for the power-block and support facilities (Southern 2008). Construction of a natural gas pipeline from the VEGP site to the closest natural gas distribution line would require approximately 99 ha (242 ac) (Southern 2008). Thus, the total land-use commitment would be approximately 160 ha (400 ac). Additional land would be needed for a new transmission line right-of-way. For any new natural-gas-fired power plant, additional land would also be required for natural gas wells and collection stations. In NUREG-1437, the staff estimated that approximately 1460 ha (3600 ac) would be needed for a 1000-MW(e) plant (NRC 1996). Overall, the land-use impacts from new natural-gas-fired power generation would be MODERATE.

The impacts on water use and quality from constructing and operating a natural-gas-fired plant at the VEGP site would be comparable to the impacts associated with constructing and operating a new nuclear facility. Closed-cycle cooling with cooling towers is assumed. The impacts on water quality from sedimentation during construction of a natural-gas-fired plant were characterized in NUREG-1437 as SMALL (NRC 1996). NRC also noted in NUREG-1437 that the impacts on water quality from operations would be similar to, or less than, the impacts from other generating technologies. Overall, the staff concludes that impacts on water use and quality would be SMALL.

Siting of the natural-gas-fired plant would have ecological impacts that would be comparable to a new nuclear facility. Much of the impact would occur in areas that were previously disturbed during the construction of VEGP Units 1 and 2. Constructing a new underground gas pipeline to the site would cause temporary ecological impacts. Ecological impacts on the plant site and utility easements would not affect threatened and endangered species, although some wildlife habitat loss and fragmentation, reduced productivity, and a local reduction in biological diversity would be likely. Withdrawal and discharge of make-up water for the cooling system could affect aquatic resources, and drift of condensation from the cooling towers could affect terrestrial ecology. Overall, the staff concludes that ecological impacts would be SMALL to MODERATE.

Socioeconomic impacts would result from the approximately 88 workers needed to operate the natural-gas-fired facility, demands on housing and public services during construction, and the loss of jobs after construction. Overall, the staff concludes that these impacts would be SMALL because of the mitigating influence of the site's proximity to the surrounding population area and the relatively small number of workers needed to construct and operate the plant in comparison

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to nuclear and coal-fired generation alternatives. The plant would pay property taxes to Burke County. Considering the population and economic condition of the county, the staff concludes that the taxes would have a MODERATE beneficial impact on the county.

The turbine buildings, four exhaust stacks (approximately 60 m [200 ft] tall) and associated emissions, cooling towers, condensation plumes from the cooling towers, and the gas pipeline compressors would be visible during daylight hours from offsite. Noise and light from the plant would be detectable offsite. A mitigating factor is that the VEGP site is currently an industrial site located in a rural, forested area. The new transmission line would have a greater aesthetic impact. Overall, the staff concludes that the aesthetic impacts associated with new natural-gas-fired power generation at the VEGP site would be SMALL, but the impact along new transmission lines would be MODERATE.

Historic and cultural resource impacts for a new natural gas-fired plant located at the VEGP site would be similar to the impacts for a new nuclear plant as discussed in Sections 4.6 and 5.6. A cultural resources inventory would likely be needed for any onsite property that has not been previously surveyed. Other lands, if any, that are acquired to support the plant would also likely need an inventory of field cultural resources, identification, and recording of existing historic and archaeological resources, and possible mitigation of the adverse effect from ground-disturbing actions. The studies would likely be needed for all areas of potential disturbance at the plant site, any offsite affected areas, such as mining and waste-disposal sites, and along associated rights-of-way where new construction would occur, for example, roads and transmission line rights-of-way. The staff concludes that the historic and cultural resource impacts would be MODERATE.

As described in Section 2.10, there are large proportions of minority and low-income persons in the population around the VEGP site. The impacts of a natural-gas-fired plant at the VEGP site on minority or low-income populations would depend on the distribution and magnitude of adverse air-quality impacts, but would likely be SMALL.

Other construction and operation impacts would be SMALL. In most cases, the impacts would be detectable, but they would not destabilize any important attributes of the resources involved. Because of the minor nature of these impacts, mitigation beyond that discussed would not be warranted. The impacts of natural-gas-fired power generation at the VEGP site are summarized in Table 9-2.

9.2.3 Other Alternatives

This section discusses energy alternatives that Southern determined are not reasonable, the staff's conclusions about the overall environmental impacts of each alternative, and the staff's basis for the conclusions. New nuclear units at the VEGP site would be a baseload generation plant. Any feasible alternative to the new units would need to generate baseload power. In

performing its initial evaluation in its ER, Southern relied on NUREG-1437 for license renewal (NRC 1996). The staff reviewed the information submitted by Southern and conducted an independent review and finds that Southern's conclusion that these generation options are not reasonable alternatives to one or more new nuclear units is acceptable.

The staff has not assigned significance levels to the environmental impacts associated with the alternatives discussed in this section because, in general, the generation alternatives would have to be installed at a location other than the VEGP site. Any attempt to assign significance levels would require the staff's speculation about the unknown site.

9.2.3.1 Oil-Fired Power Generation

EIA's reference case projects that oil-fired power plants would not account for any new electric power generation capacity in the United States through the year 2030 (DOE/EIA 2007). Oil-fired generation is more expensive than nuclear, natural-gas-fired, or coal-fired generation options. In addition, future increases in oil prices are expected to make oil-fired generation increasingly more expensive. The high cost of oil has resulted in a decline in its use for electricity generation. In Section 8.3.11 of NUREG-1437 for license renewal, the staff estimated that construction of a 1000-MW(e) oil-fired plant would require about 49 ha (120 ac) of land (NRC 1996). Operation of an oil-fired power plant would have environmental impacts that would be similar to those of a comparably sized coal-fired plant (NRC 1996).

Table 9-2. Summary of Environmental Impacts of Natural-Gas-Fired Power Generation

Impact Category	Impact	Comment
Land use	MODERATE	Approximately 160 ha (400 ac) would be needed for power-block, cooling towers and support systems, and connection to a natural gas pipeline. Additional land needed for transmission line right-of-way, infrastructure, and other facilities.
Air quality	SMALL to MODERATE	SO ₂ – 153 MT (169 tons) per year NO _x – 490 MT (540 tons) per year CO – 102 MT (112 tons) per year PM _{2.5} – 85 MT (94 tons) per year Some hazardous air pollutants
Water use and quality	SMALL	Impacts would be comparable to the impacts for a new nuclear power plant located at the VEGP site.
Ecology	SMALL to MODERATE	Many of the impacts would occur in areas that were previously disturbed during the construction of VEGP Units 1 and 2. Thus, potential habitat loss and fragmentation and reduced productivity and biological diversity would be small. Impacts on terrestrial ecology from cooling tower drift could occur.
Waste management	SMALL	The only significant waste would be from spent SCR catalyst used for control of NO _x emissions.

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Table 9-2. (contd)

Impact Category	Impact	Comment
Socioeconomics	MODERATE Beneficial to MODERATE Adverse	Construction and operations workforces would be relatively small. Addition to property tax base, while smaller than for a nuclear or coal-fired plant, might still be quite noticeable. Construction-related impacts would be noticeable. Impacts during operation would be minor because of the small workforce involved. The plant and new transmission line would have aesthetic impacts.
Human health	SMALL	Regulatory controls and oversight would be protective of human health.
Historic and cultural resources	MODERATE	Any potential impacts could likely be effectively managed. Most of the facility and infrastructure would be built on previously disturbed ground.
Environmental justice	SMALL	High proportion of minority and low-income in local population, but adverse health impacts would not be likely.

For the preceding economic and environmental reasons, the staff concludes that an oil-fired power plant at or in the vicinity of the VEGP site would not be a reasonable alternative to construction of a 2234-MW(e) nuclear power generation facility that would be operated as a baseload plant.

9.2.3.2 Wind Power

Most of Georgia and South Carolina are in a wind power Class 1 region (average wind speeds lower than 5.6 m/s) (DOE 2005). Class 1 regions have the lowest potential for wind energy generation. Class 1 areas are unsuitable for wind energy development (DOE 2005). Wind turbines typically operate at a 25 to 40 percent capacity factor compared to 90 to 95 percent for a baseload plant such as a nuclear plant (AWEA 1998). The largest operating wind farm is over 700 MW (AWEA 2007a), but most are well under 200 MW. A utility-scale wind generation plant would generally require about 24 ha (60 ac) per MW of installed capacity, although much of this land could be used for other purposes (AWEA 2007b). With modern wind turbine designs, well over 1000 wind turbines would be required to produce the 2234 MW(e) of the proposed nuclear units.

Southern Company and the Georgia Institute of Technology studied the viability of offshore wind turbines in the southeast (Southern Company and GIT 2007). Among the conclusions of the study authors were the following: (1) the available wind data indicates that a wind farm located offshore in Georgia would likely have an adequate wind speed to support a project, although offshore project costs run approximately 50-100 percent higher than land based systems; (2) based on today's prices for wind turbines, the 20-year levelized cost of electricity produced from an offshore wind farm would be above the current production costs from existing power

generation facilities; (3) the current commercially available offshore wind turbines are not built to withstand major hurricanes above a Category 3 or a 1-min sustained wind speed of 200 km/h (124 mph); and (4) the U.S. Department of Interior Minerals Management Service (MMS) has jurisdiction, as authorized in the Energy Policy Act of 2005, over alternative energy-related projects on the outer continental shelf, including wind power developments. MMS has been authorized to complete a rulemaking process outlining the permitting requirements for such projects. Until these regulations are finalized, only limited activities toward the development of an offshore wind farm in Federal waters can be conducted.

For the preceding reasons, the staff concludes that a wind energy facility at or in the vicinity of the VEGP site would not currently be a reasonable alternative to construction of a 2234-MW(e) nuclear power generation facility that would be operated as a baseload plant.

9.2.3.3 Solar Power

Solar technologies use energy and light from the sun to provide heating and cooling, light, hot water, and electricity for consumers. Solar power technologies (both photovoltaic and thermal) cannot currently compete with conventional nuclear and fossil-fueled technologies in grid-connected applications because of solar power's higher capital cost per kilowatt of capacity. Energy storage requirements also limit the use of solar energy systems as baseload electricity supply. In NUREG-1437 for license renewal, the staff determined that the average capacity factor of photovoltaic cells is about 25 percent, and the capacity factor for solar thermal systems is about 25 to 40 percent (NRC 1996).

Construction of solar generating facilities has substantial impacts on natural resources (such as wildlife habitat, land use, and aesthetics). As stated in NUREG-1437, land requirements are high – 142 km² (55 mi²) per 1000 MW(e) for photovoltaic (NRC 1996) and approximately 57 km² (22 mi²) per 1000 MW(e) for solar thermal systems (NRC 1996). Neither type of solar electric system would fit the land area footprint available at the VEGP site.

For flat-plate solar collectors, Georgia has good available resources throughout the State. For concentrating solar collectors, Georgia could pursue some types of technologies, but large-scale thermal utility systems would not be effective (DOE 2006a).

For the preceding reasons, the staff concludes that a solar energy facility at or in the vicinity of the VEGP site would not currently be a reasonable alternative to construction of a 2234-MW(e) nuclear power generation facility that would be operated as a baseload plant.

9.2.3.4 Hydropower

Georgia has an estimated 613 MW of developable hydroelectric resources (INEEL 1998). As stated in Section 8.3.4 of NUREG-1437 for license renewal (NRC 1996), the percentage of

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U.S. generating capacity supplied by hydropower is expected to decline because hydroelectric facilities have become difficult to site as a result of public concerns about flooding, destruction of natural habitat, and alteration of natural river courses. In NUREG-1437, the staff estimated that land requirements for hydroelectric power are approximately 400,000 ha (1 million ac) per 1000 MW(e) (NRC 1996).

Because of the relatively low amount of undeveloped hydropower resource in Georgia and the large land-use and related environmental and ecological resource impacts associated with siting hydroelectric facilities large enough to produce 2234 MW(e), the staff concludes that local hydropower is not a feasible alternative to construction of a new nuclear power generation facility operated as a baseload plant at the VEGP site.

9.2.3.5 Geothermal Energy

Geothermal energy has an average capacity factor of 90 percent and can be used for baseload power where available. However, geothermal technology is not widely used as baseload power generation because of the limited geographical availability of the resource and immature status of the technology (NRC 1996). Geothermal plants are most likely to be sited in the western continental United States, Alaska, and Hawaii, where hydrothermal reservoirs are prevalent (DOE 2006c). Geothermal systems have a relatively small footprint and minimal emissions (MIT 2006). Georgia does have high-temperature geothermal resources that are suitable for direct heating applications (DOE 2006a). A recent study led by the Massachusetts Institute of Technology concluded that a \$300-\$400 million investment over 15 years would be needed to make early-generation enhanced geothermal system power plant installations competitive in the evolving U.S. electricity supply markets (MIT 2006).

For these reasons, the staff concludes that a geothermal energy facility at or in the vicinity of the VEGP site would not currently be a reasonable alternative to construction of a 2234-MW(e) nuclear power generation facility operated as a baseload plant.

9.2.3.6 Wood Waste

In NUREG-1437 for license renewal, the staff determined that a wood-burning facility can provide baseload power and operate with an average annual capacity factor of around 70 to 80 percent and with 20 to 25 percent efficiency (NRC 1996). The fuels required are variable and site-specific. A significant impediment to the use of wood waste to generate electricity is the high cost of fuel delivery and high construction cost per megawatt of generating capacity. The larger wood-waste power plants are only 40 to 50 MW(e) in size. Estimates in NUREG-1437 suggest that the overall level of construction impacts per megawatt of installed capacity would be approximately the same as that for a coal-fired plant, although facilities using wood waste for fuel would be built at smaller scales (NRC 1996). Similar to coal-fired plants,

wood-waste plants require large areas for fuel storage and processing and involve the same type of combustion equipment.

Because of uncertainties associated with obtaining sufficient wood and wood waste to fuel a baseload power plant, the ecological impacts of large-scale timber cutting (for example, soil erosion and loss of wildlife habitat), and high inefficiency, the staff determined that wood waste would not be a reasonable alternative to a 2234-MW(e) nuclear power generation facility operated as a baseload plant.

9.2.3.7 Municipal Solid Waste

Municipal solid-waste combustors incinerate the waste and use the resultant heat to produce steam, hot water, or electricity. The combustion process can reduce the volume of waste by up to 90 percent and the weight of the waste by up to 75 percent (EPA 2006). Municipal waste combustors use three basic types of technologies: mass burn, modular, and refuse-derived fuel (DOE/EIA 2001). Mass burning technologies are most commonly used in the United States. This group of technologies processes raw municipal solid waste "as is," with little or no sizing, shredding, or separation before combustion. In NUREG-1437 for license renewal, the staff determined that the initial capital cost for municipal solid-waste plants is greater than for comparable steam-turbine technology at wood-waste facilities because of the need for specialized waste-separation and waste-handling equipment for municipal solid waste (NRC 1996).

Municipal solid-waste combustors generate an ash residue that is buried in landfills. The ash residue is composed of bottom ash and fly ash. Bottom ash refers to that portion of the unburned waste that falls to the bottom of the grate or furnace. Fly ash represents the small particles that rise from the furnace during the combustion process. Fly ash is generally removed from flue gases using fabric filters and/or scrubbers (DOE/EIA 2001).

Currently, approximately 89 waste-to-energy plants are operating in the United States. These plants generate approximately 2700 MW(e), or an average of approximately 30 MW(e) per plant (IWSA 2007). Given the small size of the plants, the staff concludes that generating electricity from municipal solid waste would not be a reasonable alternative to a 2234-MW(e) nuclear power generation facility operated as a baseload plant.

9.2.3.8 Other Biomass-Derived Fuels

In addition to wood and municipal solid-waste fuel, several other biomass-derived fuels are available for fueling electric generators, including burning crops, converting crops to a liquid fuel such as ethanol, and gasifying crops (including wood waste). In NUREG-1437 for license renewal, the staff determined that none of these technologies has progressed to the point of being competitive on a large scale or of being reliable enough to replace a large baseload

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generating plant (NRC 1996). EIA states that biomass is the largest source of renewable electricity generation among the nonhydropower renewable fuels (DOE/EIA 2007). Co-firing biomass with coal is relatively inexpensive when low-cost biomass resources are available (DOE/EIA 2007). A 2003 study concluded that use of biomass-derived fuels for electricity generation in Georgia was not currently economically competitive with existing generation technologies (Curtis et al. 2003).

In its January 2007 Integrated Resource Plan filed with the GPSC, GPC stated that biomass (i.e., wood, wood waste, and agricultural residues) are widely available in the southeast and that a dedicated biomass-fired power plant capable of generating 50 MW to 100 MW of power is feasible. A major consideration is obtaining fuel under a long-term contract and at a reasonable price. The plant may convert the biomass to a gas for combustion in a turbine that would drive a generator to produce electricity. Because of its low energy-density in raw form, raw biomass tends to have a high transportation cost. This places an upper limit on the size of a dedicated biomass-consuming power plant (GPC 2007).

Although biomass can potentially provide some new baseload power in Georgia, the staff concludes that biomass-derived fuels do not offer a reasonable alternative to a 2234-MW(e) nuclear power generation facility operated as a baseload plant.

9.2.3.9 Fuel Cells

Fuel cells work without combustion and its associated environmental side effects. Power is produced electrochemically by passing a hydrogen-rich fuel over an anode, air over a cathode, and then separating the two by an electrolyte. The only by-products are heat, water, and carbon dioxide. Hydrogen fuel can come from a variety of hydrocarbon resources by subjecting them to steam under pressure. Natural gas is typically used as the source of hydrogen.

Phosphoric acid fuel cells are generally considered first-generation technology. Higher-temperature, second-generation fuel cells achieve higher fuel-to-electricity and thermal efficiencies. The higher temperatures contribute to improved efficiencies and give the second-generation fuel cells the capability to generate steam for cogeneration and combined-cycle operations.

During the past three decades, significant efforts have been made to develop more practical and affordable fuel cell designs for stationary power applications, but progress has been slow. The cost of fuel cell power systems must be reduced before they can be competitive with conventional technologies (DOE 2006b).

The staff concludes that, at the present time, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation. Future gains in cost competitiveness for fuel cells compared to other fuels are speculative.

For the preceding reasons, the staff concludes that a fuel cell energy facility located at or in the vicinity of the VEGP site would not currently be a reasonable alternative to construction of a 2234-MW(e) nuclear power generation facility operated as a baseload plant.

9.2.4 Combination of Alternatives

Individual alternatives to the construction of one or more new nuclear units at the VEGP site might not be sufficient on their own to generate Southern’s target value of 2234 MW(e) because of the small size of the resource or lack of cost-effective opportunities. Nevertheless, it is conceivable that a combination of alternatives might be cost effective. There are many possible combinations of alternatives.

Section 9.2.2.2 assumes the construction of four 530-MW(e) natural-gas-fired, combined-cycle generating units at the VEGP site using closed-cycle cooling with cooling towers. For a combined alternatives option, the staff assessed the environmental impacts of an assumed combination of three 530-MW(e) natural-gas-fired, combined-cycle generating units at the VEGP site using closed-cycle cooling with cooling towers, 60 MW of wind energy, 60 MW of hydropower, 100 MW from biomass sources including municipal solid waste, and 424 MW from conservation and demand-side management programs. A summary of the environmental impacts associated with the construction and operation of this combination of alternatives is in Table 9-3.

Table 9-3. Summary of Environmental Impacts of a Combination of Power Sources

Impact Category	Impact	Comment
Land use	MODERATE	A natural-gas-fired plant would have land-use impacts for the power-block, new transmission line right-of-way, cooling towers and support systems, and connection to a natural gas pipeline. Wind, hydro, and biomass facilities and associated transmission lines would also have land-use impacts.
Air quality	SMALL to MODERATE	Emissions from the natural-gas-fired plant would be approximately: SO ₂ – 115 MT (127 tons) per year NO _x – 367 MT (405 tons) per year CO – 76 MT (84 tons) per year PM _{2.5} – 64 MT (71 tons) per year Municipal solid waste and biomass facilities would also have emissions.
Water use and quality	SMALL	Impacts would be comparable to the impacts for a new nuclear power plant located at the VEGP site.

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Table 9-3. (contd)

Impact Category	Impact	Comment
		biological diversity would likely be minimal. Impacts on terrestrial ecology from cooling tower drift could occur. Wind energy facilities could result in some avian mortality. Hydropower facilities would impact terrestrial and aquatic habitat.
Waste management	SMALL to MODERATE	The only significant waste would be from spent SCR catalyst used for control of NO _x emissions and ash from biomass and municipal solid-waste sources.
Socioeconomics	MODERATE Beneficial to MODERATE Adverse	Construction and operations workforces would be relatively small. Addition to property tax base, while smaller than for a nuclear or coal-fired plant, might still be quite noticeable. Construction-related impacts would be noticeable. Impacts during operation would be minor because of the small workforce involved. The plant and new transmission line would have aesthetic impacts.
Human health	SMALL	Regulatory controls and oversight would be protective of human health.
Historic and cultural resources	MODERATE	Any potential impacts could likely be effectively managed. Most of the facilities and infrastructure at the site would likely be built on previously disturbed ground.
Environmental justice	SMALL	Some impacts on housing availability and prices during construction may occur, as might beneficial impacts from property tax revenues.

9.2.5 Summary Comparison of Alternatives

Table 9-4 contains a summary of the staff's environmental impact characterizations for constructing and operating new nuclear, coal-fired, and natural-gas-fired, combined-cycle generating units at the VEGP site. The combination of alternatives shown in Table 9-4 assumes siting of natural-gas-fired, combined-cycle units at the ESP site and siting of other generating units in the general vicinity (within 160 km [100 mi]) of the site. Closed-cycle cooling with natural draft or mechanical cooling towers is assumed for all thermal plants.

The staff reviewed the available information on the environmental impacts of power generation alternatives compared to the construction of new nuclear units at the VEGP site. Based on this review, the staff concludes that, from an environmental perspective, none of the viable energy alternatives are clearly preferable to construction of a new baseload nuclear power generation plant.

9.3 System Design Alternatives

Sections 9.3.1 and 9.3.2 contain information regarding alternative plant cooling systems for the proposed Units 3 and 4 at the VEGP site. Section 9.3.1 discusses use of a once-through cooling system and Section 9.3.2 discusses use of a dry or hybrid wet/dry heat dissipation system.

Table 9-4. Summary of Environmental Impacts of Construction and Operation of New Nuclear, Coal-Fired, and Natural-Gas-Fired Generating Units, and a Combination of Alternatives

Impact Category	Nuclear	Coal	Natural Gas	Combination of Alternatives
Land use	MODERATE	MODERATE	MODERATE	MODERATE
Air quality	SMALL	MODERATE	SMALL to MODERATE	SMALL to MODERATE
Water use and quality	SMALL	SMALL	SMALL	SMALL
Ecology	SMALL to MODERATE	MODERATE	SMALL to MODERATE	SMALL to MODERATE
Waste management	SMALL	MODERATE	SMALL	SMALL to MODERATE
Socioeconomics	LARGE Beneficial to MODERATE Adverse	LARGE Beneficial to MODERATE Adverse	MODERATE Beneficial to MODERATE Adverse	MODERATE Beneficial to MODERATE Adverse
Human health	SMALL	SMALL	SMALL	SMALL
Historic and cultural resources	MODERATE	MODERATE	MODERATE	MODERATE
Environmental justice	SMALL	SMALL to MODERATE	SMALL	SMALL

The purpose of the plant cooling system is to dissipate heat to the environment. The various cooling system options differ in how and where the heat transfer takes place and, hence, have different environmental impacts. For the natural draft wet tower cooling system proposed for both VEGP Units 3 and 4, waste heat is transferred to the atmosphere primarily through evaporation and conduction. Water would be lost from the cooling system due to evaporation, drift, and tower blowdown discharge, and make-up water would be supplied from the Savannah River. Southern states in its ER that approximately 50 to 75 percent of the make-up water flow would be used to replace evaporative water losses with the remaining 25 to 50 percent of the water losses resulting from tower blowdown (Southern 2008). Cooling system water losses resulting from drift are minor in comparison to evaporative and

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blowdown discharge losses, and the maximum drift rate reported by Southern is 24 gpm when both towers are operating (Southern 2008).

9.3.1 Plant Cooling System – Once-Through Operation

A once-through cooling system for VEGP Units 3 and 4 would not employ cooling towers, instead it would transfer waste heat to the atmosphere and aquatic environment of the Savannah River by convection, evaporation, long-wave radiation, and conduction. This type of cooling design would withdraw a larger volume of water from the Savannah River through the intakes as compared to the proposed wet tower design.

Southern states in its ER that the water withdrawal requirements for a once-through cooling system would be 53.5 m³/s (1890 cfs) per unit (Southern 2008). Therefore, if both VEGP Units 3 and 4 were operating with once-through cooling, the combined water withdrawal rate would be 107 m³/s (3780 cfs). Staff computed the Savannah River flow statistics for the Jackson, South Carolina, streamflow gage, which is approximately 6 mi upstream of the site, between October 1971 and when the gage was discontinued (September 2002). The average daily Savannah River flow rate during the period-of-record was 250 m³/s (8830 cfs), and the minimum discharge was 91.18 m³/s (3220 cfs). Surface-water withdrawals for VEGP Units 3 and 4 using once-through cooling represent 43 percent of the average Savannah River discharge passing the site, and could potentially be greater than the river discharge during times of drought. As discussed on Section 2.6.1.1 of this EIS, the once-through cooling system withdrawal would also approximately equal the total discharge released from Thurmond Dam 108 m³/s (3800 cfs) under Drought Level 3 conditions.

Based on the quantity of water that would be withdrawn from the Savannah River to cool the proposed VEGP Units 3 and 4 using once-through cooling, the staff concludes that a wet tower cooling system would be preferable to a once-through cooling system. See Sections 7.3.1 and 7.5 for additional information.

9.3.2 Dry or Hybrid Wet/Dry Cooling Towers

The use of a dry cooling system design versus the proposed combination wet tower design for VEGP Units 3 and 4 would largely eliminate the impacts on aquatic biota in the Savannah River. Dry cooling towers would eliminate thermal and chemical discharges associated with the plant cooling system as well as any losses to aquatic organisms due to impingement and entrainment.

However, a dry cooling tower also has some disadvantages. In comparing dry cooling and wet cooling, EPA (66 FR 65256) found there are additional expenses associated with dry cooling, making this technology less cost effective. In addition, to achieve the necessary cooling, dry systems must move a large amount of air through a heat exchanger, and the fans that move the

air consume a significant amount of power. This, in turn, would increase the environmental impacts of fuel use and spent fuel transport and storage relative to the net electrical power production. The fans and the large volume of air required for cooling also result in elevated noise levels. The dry cooling system would also occupy more land than a mechanical or natural draft wet-cooling tower system, affecting site land use and increasing terrestrial impacts.

Hybrid wet/dry cooling towers employ both a wet section and a dry section and reduce or eliminate the visible plumes associated with wet cooling towers. Consumptive water use for the hybrid wet/dry cooling alternative is bounded by the wet cooling towers water use. Compared to the wet cooling towers, less evaporation, make-up water, and blowdown are involved in the hybrid wet/dry process, therefore reducing water-related impacts. However, the disadvantages of dry cooling still apply to the dry cooling portion of the heat dissipation process. The dry cooling process is not as efficient as the wet cooling process because it requires the movement of a large amount of air through the heat exchanger to achieve the necessary cooling. This results in a net loss of electrical power for distribution, which would increase the environmental impacts of fuel use and spent fuel transport and storage. In addition, the hybrid wet/dry cooling towers would occupy more land than a wet cooling tower system, affecting site land use and increasing terrestrial impacts.

Even with the disadvantages described above, a dry or hybrid wet/dry cooling system could be a preferred option if a wet tower system would cause significant adverse impacts to water availability, water quality, or aquatic resources. However, as described in Sections 5.3 and 5.4.2, the staff found that the impacts of the proposed natural draft, wet tower system on water use, water quality, and aquatic resources would be SMALL. Therefore, the staff concludes that neither a dry or hybrid wet/dry cooling system would be preferable to the proposed wet tower system for VEGP Units 3 and 4.

9.4 Region of Interest and Alternative Site-Selection Process

NRC regulations require that the ER submitted in conjunction with an application for an ESP include an evaluation of alternative sites to determine whether any obviously superior alternative exists to the site proposed (10 CFR 52.17(a)(2)). This section includes a discussion of Southern's ROI for possible siting of a new nuclear power plant and Southern's alternative site-selection process.

9.4.1 Southern's Region of Interest

Generally, the ROI is the geographic area considered in searching for candidate ESP sites (NRC 2000). The ROI is typically the State in which the proposed site is located or the relevant service area for the proposed plant (NRC 2000).

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Southern selected its three-state service area (Alabama, Georgia, and Mississippi) as its ROI (Southern 2008). Southern's designated ROI is consistent with the preceding ROI description in NRC's Environmental Standard Review Plan (NRC 2000). The staff concludes that the ROI used in Southern's ESP application is reasonable for consideration and analysis of potential ESP sites. The staff also finds that Southern's basis for defining its ROI did not arbitrarily exclude desirable candidate ESP locations.

9.4.2 Southern's Site-Selection Process

Southern determined that the advantages of co-locating new nuclear generating units with an existing power plant owned by Southern outweighed the potential advantages of other possible siting alternatives (Southern 2008). The following potential advantages of co-location were identified by Southern (Southern 2008):

- The total number of required generating sites is reduced.
- Construction of new transmission line rights-of-way may not be required due to potential use of existing rights-of-way.
- No additional land acquisitions would be necessary, and Southern can readily obtain control of the property.
- The site has already gone through the alternatives review process mandated by the National Environmental Policy Act (NEPA) of 1969, and was the subject of extensive environmental screening during the original site-selection process.
- The site development costs and environmental impact of any preconstruction activities would be reduced.
- Construction, installation, and operation and maintenance costs would be reduced because of existing site infrastructure.

Based on the preceding advantages, Southern limited its identification of potential sites for new nuclear generation units to sites with existing electric power generation facilities owned by Southern. Within its ROI, Southern selected the following existing Southern plant sites as potential sites for new nuclear units (Southern 2007b):

Alabama

Plant Barry (coal)
Plant Gaston (coal)
Plant Gorgas (coal)
Plant Greene County (coal)
Plant Miller (coal)
Plant Farley (nuclear)
The Barton Site (nuclear greenfield)

Georgia

Plant Bowen (coal)
Plant Branch (coal)
Plant Hammond (coal)
Plant Scherer (coal)
Plant Hatch (nuclear)
Plant Vogtle (nuclear)

The Barton site is an undeveloped greenfield site in central Alabama that was originally proposed for a four-unit nuclear plant in the 1970s, but never developed (Southern 2008).

Southern's principal criteria for selecting the potential sites were the availability of sufficient land for two Westinghouse AP1000 reactors and the availability of sufficient cooling water for the units (Southern 2007b).

Southern screened its list of potential sites to the following candidate sites: Plant Farley, Plant Hatch, the Barton greenfield site, and the VEGP site. In selecting the four candidate sites, Southern's existing plant sites with coal-fired power plants were eliminated for the following reasons (Southern 2007b):

- Co-located nuclear plants offer distinct advantages because of existing infrastructure and support facilities.
- The environmental impacts of the existing Southern nuclear facilities are known and the impacts of a co-located new facility should be comparable to those of the operating nuclear plant.
- Site physical criteria, primarily geologic/seismic suitability, have been characterized at the existing Southern nuclear sites; these factors are very important in determining site suitability.
- Electric power transmission infrastructure is available at the existing Southern nuclear sites and the sites have nearby power markets.
- The existing Southern nuclear sites have local support and the availability of experienced personnel.

For the screening of the four candidate sites to a proposed site, Southern performed an environmental analysis for each candidate site. The analysis is documented in Section 9.3 of Southern's ER and the results are summarized in Tables 9.3-2 and 9.3-3 of the ER (Southern 2008). Southern's analysis considered the land use, water-related, ecological, and socioeconomic impacts of locating two new Westinghouse AP1000 reactors at each candidate site. On the basis of its environmental analysis, Southern selected the VEGP site as its proposed ESP site. In making this selection, Southern determined that none of the other three candidate sites was obviously superior to the proposed VEGP site (Southern 2008).

The staff reviewed the siting methodology used by Southern and concluded that Southern's process for selecting potential and candidate sites and its proposed site was reasonable. In conducting its review, the staff took into account that the NRC's environmental review guidance for alternative nuclear plant sites (Environmental Standard Review Plan 9.3) recognizes there would be special cases for which the proposed site for a new nuclear generating plant was not selected on the basis of a systematic site-selection process (NRC 2000). One example cited in

the guidance is when an existing nuclear power plant site previously found acceptable on the basis of a review conducted under NEPA is proposed for the siting of a new nuclear plant.

9.5 Evaluation of Alternative Sites

The three alternative ESP sites examined in detail in this section are Plant Hatch, located in Appling and Toombs Counties, Georgia; Plant Farley, located in Houston County, Alabama; and the Barton greenfield site, located in Chilton and Elmore Counties, Alabama. The staff visited each of the three alternative sites and the proposed VEGP site. The staff collected and analyzed reconnaissance-level information for each of the three alternative sites. Section 9.7 contains tables of the staff's characterization of the impacts at the alternative sites.

As mentioned previously, the staff analyzes the impacts of construction and operation of the proposed action in Chapters 4 and 5, and discusses cumulative impacts in Chapter 7. As a result of the NRC's recent new rule on limited work authorizations for nuclear power plants (see 72 FR 57416), the definition of construction activities in 10 CFR 50.10 has changed to more clearly reflect NRC's jurisdiction. The staff's draft EIS for the Vogtle ESP review was published prior to the issuance of the final rule. To reflect the effects of the new rule, site-preparation and preconstruction activities would most appropriately be analyzed in the staff's EIS as cumulative impacts rather than as impacts of construction or operation of the proposed facility. However, in this instance, to ensure appropriate consideration of public comments on the draft EIS and to avoid confusion that might result from reorganizing the document following those comments, the staff will keep discussions of such impacts (e.g., those no longer defined by regulation as construction activities) in the chapters in which they were discussed in the draft EIS. While the staff's analysis of construction activities in the draft EIS and its discussion of cumulative impacts are different, they are generally at a similar depth of analysis. The staff believes this approach will allow effective consideration of public comments while still ensuring that impacts relevant to the NEPA analysis are disclosed and fully evaluated. Accordingly, this chapter of the final EIS, including the analysis of alternative sites, continues to contain the staff's analysis of those impacts discussed in Chapter 4 of the draft EIS, such as site-preparation activities and construction of transmission lines.

9.5.1 Plant Hatch

This section covers the staff's evaluation of the potential environmental impacts of siting two new nuclear units at Plant Hatch.

9.5.1.1 Land Use, Air Quality, and Transmission Line Rights-of-Way

Plant Hatch is located in Appling and Toombs Counties, Georgia. The plant is located southeast of where U.S. Highway 1 crosses the Altamaha River (Figure 9-1). The Plant Hatch site encompasses approximately 906 ha (2240 ac). All of the industrial facilities are located in

Appling County on a 542-ha (1340-ac) parcel south of the Altamaha River. The site also includes approximately 360 ha (900 ac) in Toombs County on the north side of the Altamaha River. Approximately 142 ha (350 ac) of the plant site are composed of wetlands and transmission rights-of-way. Approximately 650 ha (1600 ac) are managed for timber production and wildlife habitat (Southern 2008).

The land in the site vicinity is rural and characterized by low, rolling, sandy hills that are predominately forested. The Plant Hatch site is not subject to the Georgia Coastal Zone Management Act because the plant is not located within one of the designated Georgia coastal zone counties (GDNR 2003a).

No new land would be required for the siting of new nuclear reactor units at Plant Hatch. The footprint of new generating units would be approximately 120 ha (300 ac). An additional 101 ha (250 ac) would be needed for temporary facilities and laydown yards (Southern 2008).

Based on the information provided by Southern and NRC's own independent review, the staff concludes that the land-use impacts of constructing and operating two new nuclear reactor units at the Plant Hatch site would be SMALL.

There are six transmission lines in four transmission line rights-of-way that exit the Plant Hatch site. The transmission line rights-of-way pass through rolling hills that are primarily a mixture of cultivated land, grazing land, and managed timberlands. Southern assumed that if new nuclear reactor units were located at Plant Hatch, one new 500-kV transmission line would be needed (Southern 2008). The new transmission line would be at least 80 km (50 mi) in length and would either be installed in a new right-of-way or an expansion of an existing right-of-way (Southern 2007c). Two of the existing transmission line rights-of-way run through counties designated under the Georgia Coastal Management Program (GDNR 2003a). Any expansion of these transmission line rights-of-way would require review under the procedures established under the Georgia Coastal Management Act. Procedures for siting new transmission lines in Georgia are discussed in Section 4.1.2 of this EIS.

Because detailed information concerning the routing of the possible new transmission line right-of-way is not known at this time, a complete evaluation of potential land-use impacts cannot be made. Nevertheless, based on the information it has available, the staff concludes that the transmission line land-use impacts of constructing two new nuclear power units at the Plant Hatch site would be SMALL to MODERATE. Operational impacts would be SMALL.

Similar to Burke County, where the VEGP site is located, Appling and Toombs Counties are designated as being unclassified or in attainment with the National Ambient Air Quality Standards (40 CFR 81.311). The air-quality impacts of constructing and operating two new nuclear reactor units at Plant Hatch would be similar to the air-quality impacts at the VEGP site.

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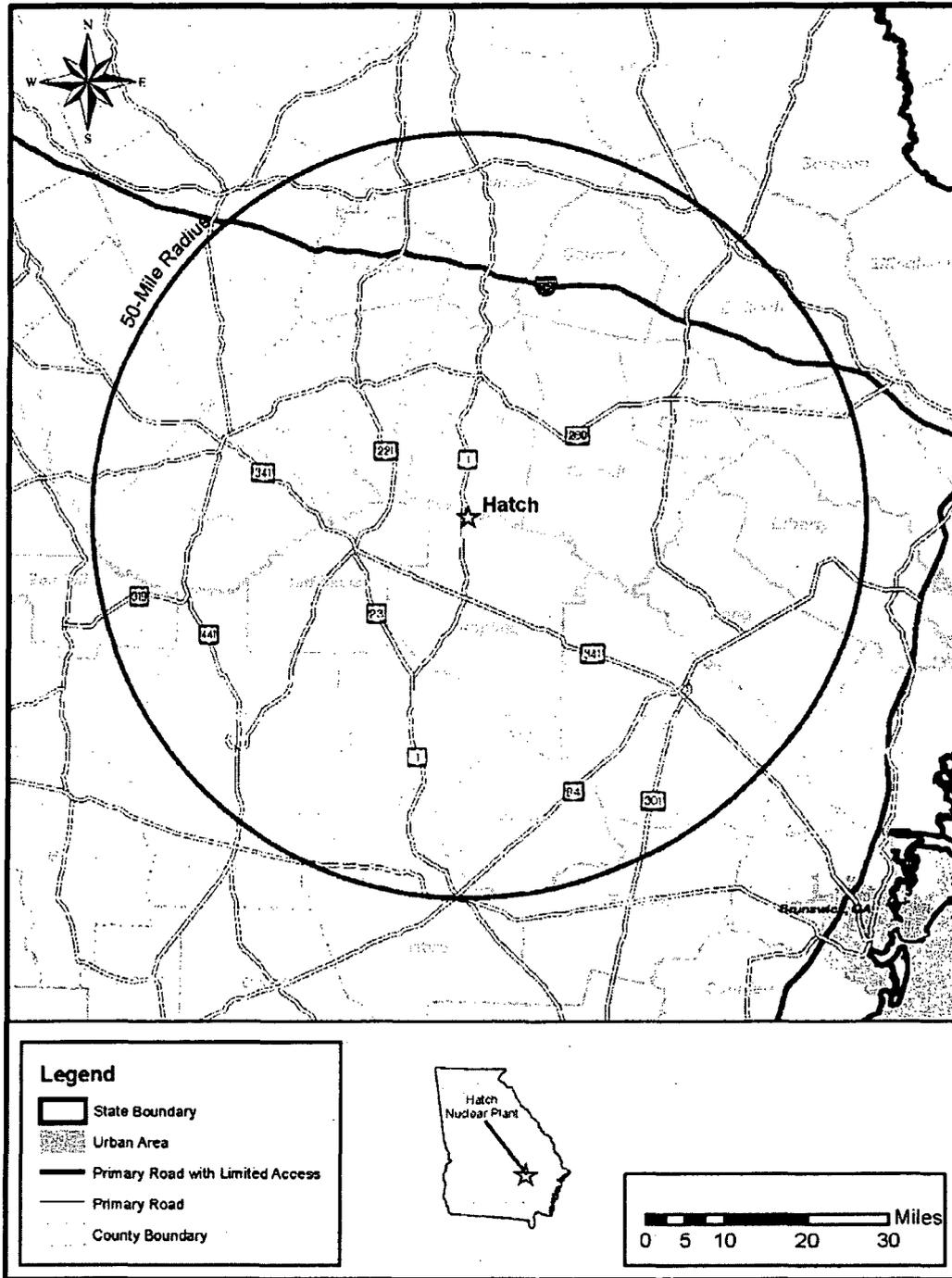


Figure 9-1. Plant Hatch 80-km (50-mi) Vicinity (Southern 2008)

Therefore, the staff concludes that the air-quality impacts of constructing and operating two new nuclear generating units at the Plant Hatch site would be SMALL.

9.5.1.2 Water Use and Quality

The staff assumed that a new nuclear facility at Plant Hatch would withdraw make-up water from the Altamaha River, and that facility cooling water demands would be satisfied with wet towers. The staff computed the 7Q10 (lowest streamflow that occurs on 7 consecutive days and has a 10-year recurrence interval period, or a 1-in-10 chance of occurring in any one year) and the 30Q2 (lowest streamflow that occurs on 30 consecutive days and has a 2-year recurrence interval period, or a 1-in-2 chance of occurring in any one year) based on data from the U.S. Geological Survey (USGS) stream gage 02225000 (Altamaha River near Baxley, Georgia). Data collected from October 1970 to April 2007 were used to estimate the 7Q10 and 30Q2 values. This gage is approximately 19 km (12 mi) north of Baxley (Plant Hatch is located approximately 18 km [11 mi] north), and the drainage area upstream of the flow gage was reported by the USGS to be 30,000 km² (11,600 mi²). The 7Q10 and 30Q2 values computed by the staff were 47 m³/s (1660 cfs) and 76.2 m³/s (2690 cfs), respectively. For the calendar years 1971 through 2006, the average annual-mean discharge at the gage was 319.56 m³/s (11,285 cfs), and the minimum annual-mean discharge was 106.5 m³/s (3762 cfs).

The net consumptive water loss for the wet towers proposed at the VEGP site was 62 cfs. Expressed as a percentage of the 7Q10 and 30Q2, the consumptive water loss for two additional units represents 4 and 2 percent, respectively, of the total flow in the Altamaha River. Southern (2008) estimated cumulative consumptive water loss for the existing and two new units as 3.1 m³/s (109 cfs), which represents 7 and 4 percent, respectively, of the 7Q10 and 30Q2 flows on the Altamaha River.

Any releases of contaminants to the waters of the State of Georgia would be regulated by GDNR through the NPDES permit process to ensure that water quality is protected.

Based on the requirements of the NPDES permit and the above analysis, the staff concludes that the water-use and water-quality impacts of two additional units at Plant Hatch would be SMALL.

9.5.1.3 Terrestrial Resources

The Plant Hatch site encompasses approximately 906 ha (2240 ac), including 360 ha (900 ac) in southern Toombs County and 542 ha (1340 ac) south of the Altamaha River in northern Appling County, Georgia. Approximately 120 ha (300 ac) are currently used for general operation and maintenance. Approximately 142 ha (350 ac) are composed of wetlands and transmission line rights-of-way, and approximately 650 ha (1600 ac) are actively managed for wildlife and timber production (Southern 2008).

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The largest wetlands area covers approximately 40 ha (100 ac) just east of the generating facilities and cooling towers. Wetlands on the site are typically dominated by bald cypress (*Taxodium distichum*) and black gum (*Nyssa sylvatica*). There are approximately 280 ha (700 ac) of deciduous floodplain forest onsite in the Altamaha River floodplain; this forest is dominated by blackgum, cypress, oak (*Quercus* spp.), and hickory (*Carya* spp.) trees. There are approximately 160 ha (400 ac) of planted pine forests (loblolly [*Pinus taeda*] and longleaf [*P. palustris*] pines) on the Plant Hatch site, mostly south and southwest of the generating facilities (NRC 2001).

Southern assumed that structures required for the construction of the proposed project at the Plant Hatch site would be situated in abandoned fields or developed areas of the existing plant site, and would avoid sensitive areas such as wetlands and mature forests (Southern 2008).

Several State-listed species of concern were identified on the Plant Hatch site or within the transmission line rights-of-way during the 1998 and 1999 threatened and endangered species surveys. Bachman's sparrows (*Aimophila aestivalis*) (listed as "rare" by GDNR) were observed in the Florida and Thalmann rights-of-way. One State-listed plant species (yellow pitcherplant (*Sarracenia flava*), listed as "unusual" by GDNR) was found on the Plant Hatch site, and five State-listed species were identified on the transmission line rights-of-way. These consisted of the parrot pitcherplant (*S. psittacina*) (threatened), purple honeycomb head (*Balduina atropurpurea*) (rare), cutleaf beardtongue (*Penstemon dissectus*) (rare), yellow pitcherplant (unusual), and hooded pitcherplant (*S. minor*) (unusual) (NRC 2001). In addition, the gopher tortoise (*Gopherus Polyphemus*) is known to occur in undeveloped portions of Plant Hatch (Southern 2008). Bald eagles (*Haliaeetus leucocephalus*) (state-threatened) have been observed by GPC biologists in the vicinity of Plant Hatch (Southern 2008).

Six transmission lines encompassing about 2910 ha (7200 ac) make up the transmission system connected to the Plant Hatch site. These transmission lines occur in four rights-of-way. The Plant Hatch transmission lines are primarily within the Coastal Plain physiographic province, but the western portion of the Bonaire 500-kV transmission line enters the Sandhills physiographic province. The transmission lines extend for a distance of nearly 160 km (100 mi) in several different directions from the plant site, and therefore traverse the full range of habitat types and geophysical conditions typically found in south-central Georgia (NRC 2001). These lines traverse a variety of land-use areas including urban and suburban, agricultural, forested, sandhills, floodplains, and abandoned fields. The lines cross three designated Wildlife Management Areas: Ocmulgee, Paulk's Pasture, and the Little Satilla. Otherwise, the lines do not cross any State or Federal parks, National wildlife refuges, or State wildlife management areas. The lines do not cross any "critical habitats" as defined in the Endangered Species Act (Southern 2008).

Construction Impacts

The footprint of a new plant would be approximately 120 ha (300 ac) and an additional 101 ha (250 ac) would be required for temporary facilities and laydown yards. The proposed project could be configured to fit within the existing, previously disturbed area of the Plant Hatch site (Southern 2008).

Southern assumed that construction of new nuclear units at Plant Hatch would require the addition of one 500-kV transmission line, within a 60-m (200-ft) wide, 80-km (50-mi) long, transmission line right-of-way. The additional transmission line could be installed via expansion of an existing right-of-way, or it could follow a new right-of-way (Southern 2008). At this time, the location and total number of acres and habitats that would be removed to upgrade the transmission system are not known.

Southern stated that land clearing associated with construction of the plant and transmission lines would be conducted according to Federal and State regulations, permit conditions, existing Southern procedures, good construction practices, and established BMPs (Southern 2008). Based on the information provided by Southern and NRC's own independent review, the staff concludes that the impacts on terrestrial resources from construction of two new nuclear units at the Plant Hatch site would be SMALL. Because of the uncertainty concerning the possible routing of a new transmission line right-of-way, the staff concludes that the terrestrial resource impacts associated with construction of the new transmission line at the Plant Hatch site could be SMALL to MODERATE.

Operational Impacts

Impacts on terrestrial ecological resources from operation of two new nuclear units at the Plant Hatch site include those associated with cooling towers and transmission lines. Impacts resulting from the operation of cooling towers and transmission lines would be of similar magnitude at all the alternative sites and, thus, cannot be used to discriminate between them. Therefore, operational impacts to terrestrial resources are discussed generically in Section 9.6.1.

Threatened and Endangered Species – Terrestrial

Threatened and endangered species surveys were conducted in 1998 and 1999 to evaluate the presence of plant and animal species listed or proposed by the U.S. Fish and Wildlife Service (FWS) as endangered or threatened, or listed by GDNR as endangered, threatened, rare, or unusual on the Plant Hatch site and associated transmission lines. Several Federally listed species were observed (or evidence of these species was found) in or adjacent to existing transmission line rights-of-way during these surveys. The shed skin of an Eastern indigo snake (*Drymarchon corais couperi*) (listed as "threatened" by FWS and GDNR), was found in the North

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Tifton transmission line right-of-way. American alligators (*Alligator mississippiensis*) (listed as "threatened due to similarity of appearance" by FWS), were observed at survey locations in three transmission line rights-of-way. Red-cockaded woodpeckers (*Picoides borealis*) (listed as "endangered" by FWS and GDNR) were observed at two locations adjacent to the Florida transmission line right-of-way (Southern 2008).

Endangered wood storks (*Mycteria americana*) were not detected during the 1998 and 1999 field surveys, but have been observed by GPC biologists and natural resources managers in the general area of the Plant Hatch site. This species is not believed to be nesting in the vicinity of the plant. Wood storks have been observed in a beaver pond wetlands just east of the existing cooling towers. Southern stated that land clearing associated with construction of the plant and transmission lines would be conducted according to Federal and State regulations, permit conditions, existing Southern procedures, good construction practices, and established BMPs (Southern 2008).

Based on the information provided by Southern and NRC's own independent review, the staff concludes that the impacts to threatened and endangered species from construction of two new nuclear units at the Plant Hatch site would be SMALL. Because of uncertainty concerning the possible routing of the transmission line right-of-way, the staff concludes that the threatened and endangered species impacts associated with construction of the new transmission lines at the Plant Hatch site could be SMALL to MODERATE.

9.5.1.4 Aquatic Resources

The Altamaha River is the major source of water for Plant Hatch. The Altamaha River, is relatively undisturbed and has no channelization, dredging or major reservoirs. The existing Plant Hatch withdraws cooling water from the Altamaha River through a single intake structure located on the southern shoreline. The intake structure was designed and located to have the ability to intake water under all river conditions including low flow and probable flood levels. Water is discharged back into the river via two lines 384 m (1260 ft) downstream from the intake and approximately 1.2 m (4 ft) below low flow levels (NRC 2001).

The GDNR has classified the Altamaha River as a "High-Priority Water" of the State because of the presence of high-priority species and diverse aquatic communities within the river's watershed. The designation is designed to protect aquatic biodiversity in the State and is part of the state's comprehensive wildlife conservation strategy, which is detailed in "Georgia's Wildlife Action Plan" (GDNR 2007a).

The Altamaha River supports 74 species of fish representing 25 different families. The predominant families of fish found in the river include sunfish (Centrarchidae), minnows (Cyprinidae), suckers (Catostomidae), and catfish (Ictaluridae). Those species available for recreational fishing in the river include the redbreast sunfish (*Lepomis auritus*), largemouth bass

(*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), redear sunfish (*Lepomis microlophus*), black crappie (*Pomoxis nigromaculatus*), flathead catfish (*Pylodictis olivaris*), and channel catfish (*Ictalurus punctatus*). The flathead catfish is an exotic species introduced into the Altamaha River system in the 1970s and it appears to be causing the decline in several native fish species populations (GDNR 2003b).

In addition to the freshwater species noted above, several species of anadromous fish are also found in the Altamaha River. Anadromous fish hatch in freshwater, migrate to saltwater to grow and mature, and then return to freshwater to spawn. The anadromous species found in the Altamaha include American shad (*Alosa sapidissima*), hickory shad (*A. mediocris*), blueback herring (*A. aestivalis*), Atlantic sturgeon (*Acipenser oxyrinchus*) and the shortnose sturgeon (*A. brevirostrum*). The American shad is an important commercial species in Georgia and the Altamaha River supports the largest shad harvest in the State. At one time, the two species of sturgeon were also fished commercially from the river, but due to declining populations the shortnose sturgeon is now listed as a Federally endangered species and the commercial fishery is closed for both species (GDNR 2003b).

Five years of data were collected from 1975 to 1980 for monitoring of entrained and impinged fish at the intake structure of Plant Hatch. The total number of individual fish collected during the five years was 165 specimens representing 22 different species. The majority of the species were collected only once during each of the five years. The most abundant species collected was the hogchoker (*Trinectes maculatus*) (NRC 2001). One sturgeon larva was collected in the vicinity of Plant Hatch in the 1970s. Identification of the specimen to species was not possible (NRC 2004a).

In 1998, Southern commissioned a freshwater mussel survey of the Altamaha River throughout a 19-km (12-mi) reach upstream and downstream of Plant Hatch. The survey documented viable populations of 12 different mussel species, most of which were considered by FWS and GDNR to be "species of concern" (Southern 2008). Species of concern are those species whose population numbers are in decline, whose habitat is rapidly disappearing, or whose status is unknown.

Construction Impacts

New cooling water intake and discharge structures would be required to support additional units at Plant Hatch. Construction of a new intake would result in the temporary displacement of aquatic biota within the vicinity of the intake. It is expected that affected biota would return to the area after construction is complete. Sedimentation due to disturbances of the river bank and bottom could impact local benthic populations. However, the impacts on aquatic organisms would be temporary and largely mitigable through the use of BMPs. The staff concludes that the impact on the aquatic biota of the Altamaha River from construction of two additional units at the Plant Hatch would be SMALL.

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In addition, a new 500-kV transmission line with a 60-m (200-ft) wide, 80-km (50-mi) long, right-of-way would be needed. The additional transmission line could be installed via expansion of an existing right-of-way, or it could follow a new right-of-way (Southern 2008). Because no information on routing has been provided, the impacts to the aquatic ecosystem in waterbodies crossed by the new right-of-way is not known. However, assuming the use of BMPs during construction, the staff concludes that construction of the new transmission lines for Plant Hatch could be SMALL to MODERATE depending on where the right-of-way is routed and whether a new or existing right-of-way is used.

Operational Impacts

The staff evaluated the potential for impacts to aquatic populations in the Altamaha River due to impingement and entrainment resulting from the operation of two nuclear units at Plant Hatch. The NRC has found that entrainment and impingement of fish and shellfish has not resulted in population level effects in facilities that use the cooling system found at Plant Hatch (closed-cycle with cooling towers). During the license renewal of Plant Hatch, the staff did not find any significant new information that would cause them to conclude otherwise (NRC 2001). Thermal effects due to the discharge of heated effluents are expected to be negligible due to the low discharge flow rates from the new units relative to the river flow. Assuming closed-cycle cooling system that meets the EPA's Phase I regulations for new facilities (66 FR 65256), with a maximum through-screen velocity of 0.15 m/s (0.5 ft/s) at the cooling water intake, an intake flow of less than or equal to 5 percent of the mean annual flow of the Altamaha River, and a design and location of the new intake consistent with the existing intake, then anticipated impacts to aquatic populations from entrainment and impingement are expected to be minor. Therefore operation of two additional units at Plant Hatch site is expected to have a SMALL impact.

Threatened and Endangered Species

The shortnose sturgeon is the only federally listed (endangered or threatened) aquatic species in the Altamaha River in the vicinity of Plant Hatch. It is listed as a Federal and State-endangered species. A biological assessment was initiated by the NRC in 2000 to determine the potential impact from Plant Hatch to the shortnose sturgeon in the Altamaha River. The assessment was provided to the National Marine Fisheries Service (NMFS) by the NRC in compliance with Section 7 of the Endangered Species Act. The staff specifically evaluated the potential impacts from impingement, entrainment, thermal effects, and periodic river maintenance dredging associated with continued plant operation (NRC 2004a). The staff concluded that Plant Hatch may affect, but is not likely to adversely affect, the shortnose sturgeon. The NMFS responded on August 10, 2005 by concluding that continued operation of the Hatch Plant with periodic maintenance dredging is not likely to adversely affect shortnose sturgeon (NMFS 2005).

Based on the biological opinion and assuming a new intake structure would be of similar design and location to the existing structure, it is unlikely that construction or operation of additional units at Plant Hatch would have an impact on the shortnose sturgeon populations of the Altamaha River. Therefore, impacts to the endangered shortnose sturgeon directly related to construction or operation of two additional units would be minor.

Two State-listed species of molluscs occur in the vicinity of Plant Hatch. The Altamaha arc mussel (*Alasmidonta arcuata*) is a freshwater mussel that lives in sandy mud below sand bars in slow-moving water and eddies. It is listed by the State of Georgia as a threatened species because of its rarity and vulnerability (GDNR 2007b). The species is endemic to the Altamaha River system and is susceptible to excessive sedimentation and habitat destruction (NRC 2001).

The Altamaha spiny mussel (*Elliptio spinosa*) is another freshwater mussel endemic to the Altamaha River system. It is a State-listed endangered species and a candidate for Federal listing as an endangered species (GDNR 2007b). This mussel can be found buried in sandbars in swift current areas of the Altamaha River. The Altamaha spiny mussel is the largest spiny mussel in the world. It is also highly susceptible to excessive sedimentation in the river and destruction of its limited habitat (NRC 2001).

Based on the potential for the presence of threatened mussels and mussels of concern in the Altamaha River in the vicinity of Plant Hatch, the construction could result in some impacts to mussel species; however, they would be temporary and could be mitigated by time-of-year restrictions on dredging, implementation of BMPs, and relocation if needed, depending on the area of disturbance. Operation of the existing facility has not resulted in an adverse impact to mussel or shortnose sturgeon populations of the Altamaha River. Therefore the impacts of construction and operation of two additional units would be expected to be SMALL.

9.5.1.5 Socioeconomics

In evaluating the socioeconomic impacts of construction at Plant Hatch near Baxley, Georgia, in Appling and Toombs Counties, the staff and Southern undertook a reconnaissance survey of the site using readily obtainable data from the Internet or published sources. The socioeconomic subsections follow the organizational structure of the socioeconomic discussions in Sections 2.8, 4.5, and 5.5. Impacts from both construction and station operation are discussed.

Physical Impacts

Construction activities can cause temporary and localized physical impacts such as noise, odor, vehicle exhaust, vibration, shock from blasting, and dust emissions. The use of public roadways, railways, and waterways would be necessary to transport construction materials and

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equipment. The Georgia State Department of Transportation is planning extensive road improvement work on the existing roads near the site, including U.S. Routes 1 and 280 (GDOT 2006). Offsite areas that would support construction activities (for example, borrow pits, quarries, and disposal sites) are expected to be already permitted and operational. Impacts on those facilities from construction of the new units would be small incremental impacts associated with their normal operation.

Potential impacts from station operation include noise, odors, exhausts, thermal emissions, and visual intrusions. New units would produce noise from the operation of pumps, cooling towers, transformers, turbines, generators, and switchyard equipment. Traffic at the site would also be a source of noise. Any noise coming from the proposed VEGP site would be controlled in accordance with standard noise protection and abatement procedures (Southern 2008). By inference, this practice is also expected to apply to the Plant Hatch site. Commuter traffic would be controlled by speed limits. Good road conditions and appropriate speed limits would minimize the noise level generated by the workforce commuting to Plant Hatch site (Southern 2008).

Any new units at the Plant Hatch site would have standby diesel generators and auxiliary power systems. Permits obtained for these generators would ensure that air emissions comply with applicable regulations. In addition, the generators would be operated on a limited, short-term basis. During normal plant operation, new units would not use a significant quantity of chemicals that could generate odors that exceed odor threshold values. Good access roads and appropriate speed limits would minimize the dust generated by the commuting workforce (Southern 2008).

Construction activities would be temporary and would occur mainly within the boundaries of the Plant Hatch site. Offsite impacts would represent small incremental changes to offsite services supporting the construction activities. During station operations, noise levels would be managed to State and local ordinances. Air-quality permits would be required for the diesel generators, and chemical use would be limited, which should limit odors. Based on the information provided by Southern and NRC's own independent review, the staff concludes that the physical impacts of construction and operation would be SMALL.

Aesthetics

The Plant Hatch site encompasses approximately 906 ha (2240 ac) and is characterized by low, rolling sandy hills that are predominantly forested. The developed area at Plant Hatch is located near the center of a 542 ha (1340 ac) parcel on the south bank of the Altamaha River. The existing facilities at Plant Hatch are visible from portions of U.S. Highway 1 and from the adjacent reach of the Altamaha River (Southern 2008).

The construction of new nuclear units at Plant Hatch could be viewed from offsite at certain locations, but the addition of another facility would not substantially change the view which results from the current units. There would be a need to construct cooling-water intake and discharge structures at the site. Additional mechanical or natural draft cooling towers would be required. The operation of two new nuclear units probably would have visual impacts similar to those of the existing Plant Hatch units, with the addition of more visible plumes from cooling towers. The NRC staff concludes that the marginal impacts of construction and operation of new nuclear units at Plant Hatch on aesthetics would be **SMALL**. However, depending on the specific routing, the aesthetic impact of a new 60-m (200-ft)-wide, 80-km (50-mi)-long transmission line right-of-way could be **MODERATE**.

Demography

The Plant Hatch site is located in Appling and Toombs Counties, near the town of Baxley, Georgia. The population distribution around the site is relatively low and dispersed with typical rural characteristics. In the year 2000, U.S. Census data indicates that Appling County had a population of 17,419 and Toombs County had a population of 26,067. The total population within 80 km (50 mi) of the site was approximately 387,582 people (19.3 persons per km²), and the population within 32 km (20 mi) of the site was 58,752 people (18.3 persons per km²). The nearest large population center (as defined in 10 CFR 100.3), is Savannah, Georgia, (population approximately 131,510) located approximately 108 km (67 mi) northeast of the Plant Hatch site (Southern 2008).

Based on the analysis of construction impacts presented in Section 4.5.2 of this EIS, construction of new nuclear units at Plant Hatch would increase the population in the 80-km (50-mi) region during the construction phase by approximately 5500 people. The majority of the current Plant Hatch workforce lives in Appling (30 percent) or Toombs (41 percent) Counties. The remaining employee residences are distributed throughout 28 counties, mostly within 80 km (50 mi) of the site. Southern assumes that the residential distribution of the construction workforce would resemble the residential distribution of the current Plant Hatch workforce. Of the total population increase, 1650 people (30 percent of 5500) would settle in Appling County and 2260 people would settle in Toombs County. These numbers constitute 8.7 percent and 9.5 percent of the 2000 populations of Appling and Toombs Counties, respectively.

Impacts are generally considered to be small if plant-related population growth is less than 5 percent of the study area's total population and moderate if growth is between 5 and 20 percent (NRC 2001). The construction employees and their families would represent **MODERATE** increases to population in Appling and Toombs Counties and **SMALL** elsewhere in the 80-km (50-mi) region.

Southern assumes that operation of new units at the VEGP site (see Section 5.5.2) would increase the population by 2152 people in the 80-km (50-mi) region. Once again, assuming that

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approximately 30 percent would settle in Appling County and 41 percent would settle in Toombs County, the resulting population increase in the region resulting from plant operation would represent a 4 percent increase for Appling County and a 3 percent increase for Toombs County and current population levels. The demographic impacts associated with operation of the two new units would be SMALL.

Social and Economic Impacts

Economy

Based on 2000 census data, within the region surrounding Plant Hatch, 55,445 persons are in the labor force. Appling County's business profile is led by manufacturing (18.4 percent of the county's total employment), followed by educational, health, and social services (17.9 percent), and construction (11.7 percent). The unemployment rate for Appling County in 2004 was 6.1 percent, compared to 4.6 percent for the State of Georgia. In neighboring Toombs County, the business profile is led by educational, health, and social services (18.4 percent of the county's total employment), followed by manufacturing (14.9 percent), and retail trade (9.9 percent). The unemployment rate in Toombs County was 6.0 percent in 2004 (Southern 2008).

Economic impacts would be spread across the 80-km (50-mi) region but would be greatest in Appling and Toombs Counties. Impacts are generally considered small if plant-related employment is less than 5 percent of the study area's total employment and moderate if employment is between 5 and 10 percent (NRC 1996). During the construction of the new units, up to 3500 construction workers would be required to build the plant (at the peak construction phase) and most of these would need to in-migrate to the region. The peak construction workforce would represent more than 5 percent of the current workforce in the region and NRC staff concludes that the impacts of construction on the economy of the region would be MODERATE and beneficial, but temporary.

The wages and salaries of the operating and construction workforce would have a multiplier effect that could result in increases in business activity, particularly in the retail and service sectors. This would have a positive impact on the business community and could provide opportunities for new businesses to get started and increased job opportunities for local residents.

Once the new units are operational, approximately 812 new operations jobs would be added to the local economy. Southern assumes that all of these new operations workers would have to move to the region from outside the region. These new jobs would constitute a small percentage of the total number of jobs in the region (1 percent within 80 km [50 mi] of the plant).

Based on the information provided by Southern and NRC's own independent review, the staff concludes that a significant number of construction laborers would need to in-migrate to the area and the number of jobs added to the region during the construction phase would have MODERATE impacts on the local economy. Once the new units are operational, 812 jobs would be added to the local economy; however, this would only constitute a small growth rate in jobs relative to the total number of existing jobs in the region, and the economic impacts would be SMALL and beneficial.

Taxes

As with new proposed units at the VEGP site (Sections 4.5.3 and 5.5.3), there would be some positive sales, use, income, and corporate tax revenue benefits that would be generated as a result of the construction and operation of new units at Plant Hatch. Sales, use, income, and corporate taxes would be paid directly to the State general fund; thus, the regional marginal impacts would be minimal. The primary tax impacts would occur once the new units become valued as property assets and property tax revenues are collected by Appling County according to the millage rate negotiated on value of the plant. Southern anticipates that it would begin paying annual property taxes to Appling County for new units at Plant Hatch during construction of the project. Assuming a 40-year operational life, property taxes to Appling County could average between \$20,000,000 and \$29,000,000 annually during the first decade of operation and between \$3,500,000 and \$5,000,000 annually during the last decade of operation, based on the changing value of the plant (Southern 2008). The current Plant Hatch property taxes made up 68 percent of Appling County's total property tax revenues in 1998 (NRC 2001). The NRC staff concludes that the potential beneficial impacts of taxes collected during construction would be MODERATE and beneficial and LARGE and beneficial during operation in Appling County, and SMALL and beneficial in the remainder of the 80-km (50-mi) region, assuming Georgia tax law remains unchanged.

Summary of Social and Economic Impacts

Based on the information provided by Southern, and NRC's own independent review, the staff concludes that the overall socioeconomic impacts of construction and operation of two new units at the Plant Hatch site would be LARGE and beneficial to Appling County, MODERATE and beneficial in Toombs County, and SMALL and beneficial elsewhere in the 80-km (50-mi) region.

Infrastructure and Community Services

Transportation

Road access to Plant Hatch is via U.S. Highway 1, the major north-south highway route bisecting Appling and Toombs Counties. U.S. Highway 1 is a four-lane highway from Baxley

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past Plant Hatch where it enters Toombs County and becomes a two-lane road north of Plant Hatch to Interstate 16. Interstate 16 is the major east-west freeway serving the area. In 2004, the annual average daily traffic count for the highway was 5050 vehicles south of the Plant Hatch site and 4700 vehicles north of the site. The State plans to widen the entire highway to four lanes, which would provide four-lane access from Baxley all the way to Interstate 16 (GDOT 2006). Right-of-way acquisition for the widening project is anticipated to begin in 2007, and construction would begin after 2008 (Southern 2008).

Assuming construction shifts as described in Section 4.5.4, an additional 1750 cars could be on the highway during shift change, causing potential congestion. Also, the traffic of hauling construction materials (100 trucks per day) to the site could cause additional congestion on U.S. Highway 1 during certain times of the day. Heavy congestion and delays could be experienced if planned road improvements on U.S. Highway 1 occur during construction of new nuclear units at Plant Hatch. Transportation impacts are expected to be MODERATE when increases in traffic begin to cause delays or other operational problems. Overall, impacts of construction on transportation would likely be MODERATE and some mitigating actions would need to be undertaken. With respect to operation of the facility, adding an additional 760 cars during the afternoon shift (see shift assumptions in Section 5.5.4.1) to the existing traffic on the road would not strain current road capacity. Shift changes for the current units and new nuclear units at Plant Hatch could be staggered so that the traffic increase would not cause congestion, which would be particularly important during the outage periods when nearly 1000 additional temporary contract workers would be employed to perform outage operations. Impacts of the operations workforce would be SMALL once the two new units are operational.

Recreation

Recreational facilities located within the boundaries of the Plant Hatch site include a 40-ha (100-ac) tract of land west of U.S. Highway 1 used as a Boy Scout Camp, a wayside park, an employee recreation area, and the Plant Hatch Visitors Center. Other recreational facilities within 16 km (10 mi) of Plant Hatch include the Altamaha River, the Bullard Creek Wildlife Management Area, Grays Landing, and miscellaneous parks and sports facilities operated by the city of Baxley. During construction of new nuclear units at Plant Hatch, it is anticipated that access to onsite recreational facilities could be interrupted during periods of peak activity but other recreational facilities in the region could accommodate typical users of the onsite facilities. The attractiveness of the Altamaha River for sport fishing and other recreational uses could be impacted during construction of intake and discharge structures. Other recreational facilities could be affected by increased traffic on area roads during peak travel periods, but impacts could be minimized by informing the public of any potential traffic issues and notable construction activities (Southern 2008). The NRC staff concludes that the likely impacts of plant construction and operation on tourism and recreation would be SMALL.

Housing

According to 2000 U.S. Census data, Appling County had 7854 housing units, 1248 of which (15.9 percent) were vacant. Toombs County had 11,371 housing units, 1494 of which (13.1 percent) were vacant. Jeff Davis County had 5581 housing units, 753 of which (13.5 percent) were vacant. Montgomery County had 3492 housing units, 573 of which (16.4 percent) were vacant, and Tattnall County had 8578 housing units, 1521 of which (17.7 percent) were vacant (Southern 2008).

Based on the analysis in Section 4.5.2, approximately 5500 construction workers and their families would in-migrate to the 80-km (50-mi) region during the construction of two new units at Plant Hatch. Currently, available housing in the two-county area (Appling and Toombs Counties) is minimally adequate to accommodate the expected influx of workers. Workers could also find housing in other parts of the 80-km (50-mi) region or construct new housing; however, the impacts of in-migrating workers would likely be MODERATE in terms of impacting housing demand and prices and rental rates in Appling and Toombs Counties and possibly other neighboring counties, depending on settlement patterns.

Southern assumes that operation of new nuclear units at Plant Hatch would increase the population in the 80-km (50-mi) region by 2152 people (see Section 5.5.2). Assuming approximately 30 percent would settle in Appling County and 41 percent would settle in Toombs County, the current housing supply in each respective county could accommodate all the new families expected in Appling and Toombs Counties. The impact of operating the new units on housing is therefore likely to be SMALL.

Public Services

Construction and plant operations would not draw water or produce wastewater that would use municipal systems; however, the influx of construction workers and plant operations staff settling in the region would impact local municipal water and water treatment facilities. In Appling County, the municipalities of Baxley and Surrency are the only county areas served by public water supply systems. Baxley provides water service within the city and outside the city limits in certain areas through a distribution system that currently uses four wells screened to the Floridan Aquifer. According to data collected in 2000, the wells can produce approximately 11.7 million liters per day (L/d) (3.1 million gpd). The estimated demand on the wells is 2.3 million L/d (600,000 gpd). Considering this estimated demand, Baxley has approximately 9.5 million L/d (2.5 million gpd) of available capacity. The town of Surrency has two wells also pumping from the Floridan Aquifer. In 2000, these wells were capable of producing 1.1 million L/d (290,000 gpd). Toombs County has three municipal water systems: Vidalia, Lyons, and Santa Claus. All three municipalities withdraw their water from the Floridan Aquifer. According to data collected in 2000, Lyons has a capacity of 16.3 L/d (4.3 million gpd), with an estimated demand of 2.6 million L/d (700,000 gpd). This leaves a reserve capacity of 13.6 million L/d

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(3.6 million gpd). Vidalia has the capacity to pump 18.5 million L/d (4.9 million gpd) and estimated demand requires 7.6 million L/d (2.0 million gpd), leaving a reserve capacity of approximately 11.0 million L/d (2.9 million gpd). Santa Claus is served by one well, for which capacity and demand data are not available (NRC 2001). Considering the excess capacity in these systems, the influx of the construction and operations workforce would only have a SMALL marginal impact on these public services.

For a relatively small community, the major influx of construction workers may produce moderate impacts on police and fire services, commensurate with demographic and housing impacts in Appling and Toombs Counties. Medical services would also be expected to be limited in the region; however, Southern could mitigate use of the local medical systems during the construction phase of the project by providing extensive first aid onsite to treat minor injuries and ailments. The employment of additional construction workers and operations staff would not be expected to significantly strain the social services provided in the region.

Considering the excess capacity in the current water and waste treatment system the public utility system could easily accommodate the influx of workers to the region. The impacts on public utilities would likely be SMALL. For many of the other public services provided in the region, the overall impact would be expected to be SMALL.

Education

Appling County has four elementary schools, one middle school, and one high school. Total enrollment in all the schools was approximately 3400 during the 2006 school year. Toombs County has three elementary schools, one middle school, and one high school. Total enrollment for 2006 was 2840 students. The city of Vidalia has its own school system, including primary, elementary, and middle schools, and one high school. Total enrollment in the Vidalia school system for the 2006 school year for preschool through grade twelve was 2606 students (NCES 2007).

Based on the analysis in Section 4.5.4.5, new nuclear units at Plant Hatch would increase the school-aged population in the 80-km (50-mi) region by 1100 during the peak of the construction phase. Assuming that 30 percent would settle in Appling County and 41 percent would settle in Toombs County, the student population would increase by 330 in Appling County and by 450 in Toombs County, representing roughly 10 percent of total 2006 enrollment in Appling County and 8 percent in Toombs County. There may potentially be MODERATE impacts on the local school system during the construction phase of the project at Plant Hatch; however, considering the corresponding tax benefits that would be received in Appling, it is possible some of these impacts could be mitigated, depending on the time these benefits are generated and received by the county.

Based on the analysis in Section 5.5.4.5, Southern assumes that operation of new nuclear units at Plant Hatch would increase the school-aged population in the 80-km (50-mi) region by 464 people. Approximately 30 percent would settle in Appling County and 41 percent would settle in Toombs County. The Appling County student population would increase by 3.2 percent and the Toombs County student population would increase by 2.8 percent. These increases in student population are below 4 percent of the total student populations in Appling and Toombs Counties, hence project-related enrollment increases would constitute a SMALL impact on the education systems.

Summary of Infrastructure and Community Services

Based on the information provided by Southern and NRC staff's independent review, the staff concludes that impacts on infrastructure and community services from construction and operation of two new nuclear units at Plant Hatch would be SMALL to MODERATE and adverse during the construction phase of the project. During the operation phase of the ESP project, community service and infrastructure impacts would likely be SMALL.

Summary of Socioeconomics

In summary, on the basis of information provided by Southern and NRC's own independent review, the staff concludes that the impacts of the construction and operations at the Plant Hatch site on socioeconomics would be MODERATE adverse impacts for Toombs and Appling counties in terms of transportation, housing, and educational impacts during construction phase. The impacts on the Appling County economy and tax base during plant operation likely would be beneficial and MODERATE to LARGE. A portion of the tax revenue increase could be used to improve local transportation infrastructure and educational facilities to accommodate the population growth.

9.5.1.6 Historic and Cultural Resources

The likely footprint for new nuclear units at Plant Hatch does not appear to have any historic properties located within areas likely to be impacted by new construction and operations. Miscellaneous archaeological surveys conducted over the years in the area indicate that while sites may exist on the premises, either the sites are not eligible for listing on the National Register of Historic Places or are located away from likely areas of new construction. Protective measures would be put in place in the event that historic or archaeological materials are discovered during construction or during operations. In the event that an unanticipated discovery is made, site personnel would be instructed to notify the Georgia SHPO and would consult with them in conducting an assessment of the discovery to determine if additional work is needed. The impacts on historical and cultural resources are predicted to be SMALL at the Plant Hatch site.

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9.5.1.7 Environmental Justice

The 2000 Census and block groups were used for ascertaining minority and low-income populations in the area. There are 337 block groups within an 80-km (50-mi) radius of Plant Hatch. Black minority populations exist in 55 block groups; "Aggregate of Minority Races" populations exist in 63 block groups; "Hispanic Ethnicity" minority populations exist in 5 block groups; and "All Other Single Minorities" exist in 3 block groups. No other minority populations exist in the geographic area. The Census Bureau data characterize 12.64 percent of Georgia households as low income. There are 41 block groups out of the possible 337 that contain a low-income population percentage that exceed that State's average by 20 percent or more. There are no minority or low-income populations within a 10-km (6-mi) radius of Plant Hatch.

Construction activities (noise, fugitive dust, air emissions, traffic) would not disproportionately adversely affect minority populations because of their distance from Plant Hatch. Minority and low-income populations would most likely benefit from construction activities through an increase in construction-related jobs in the region. The operation of the proposed project at Plant Hatch is also unlikely to have a disproportionate impact on minority or low-income populations. In the Plant Hatch License Renewal EIS, the NRC noted that no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing through which the populations could be disproportionately adversely affected have been identified. In addition, no location-dependent disproportionate adverse impacts affecting these minority and low-income populations have been identified or observed (NRC 2001).

The impacts associated with construction and operation of two new units at Plant Hatch on minority and low-income populations are expected to be SMALL. See Section 5.7 for more information on environmental justice impacts.

9.5.2 Plant Farley

This section covers the staff's evaluation of the potential environmental impacts of siting new nuclear units at Plant Farley.

9.5.2.1 Land Use, Air Quality, and Transmission Line Rights-of-Way

Plant Farley is located in Houston County, Alabama (Figure 9-2). The plant is located on the west side of the Chattahoochee River about 10 km (6 mi) north of the intersection of U.S. Highway 84 and State Highway 95. The Plant Farley site encompasses approximately 749 ha (1850 ac) (Southern 2008). Approximately 200 ha (500 ac) are used for nuclear power generation and maintenance facilities, laydown areas, parking lots, and roads. The remainder of the site consists of forested areas, ponds, wetlands, and open fields. Approximately 200 ha (500 ac) of the existing Plant Farley site would be needed if new nuclear reactor units were located at Plant Farley (Southern 2008).

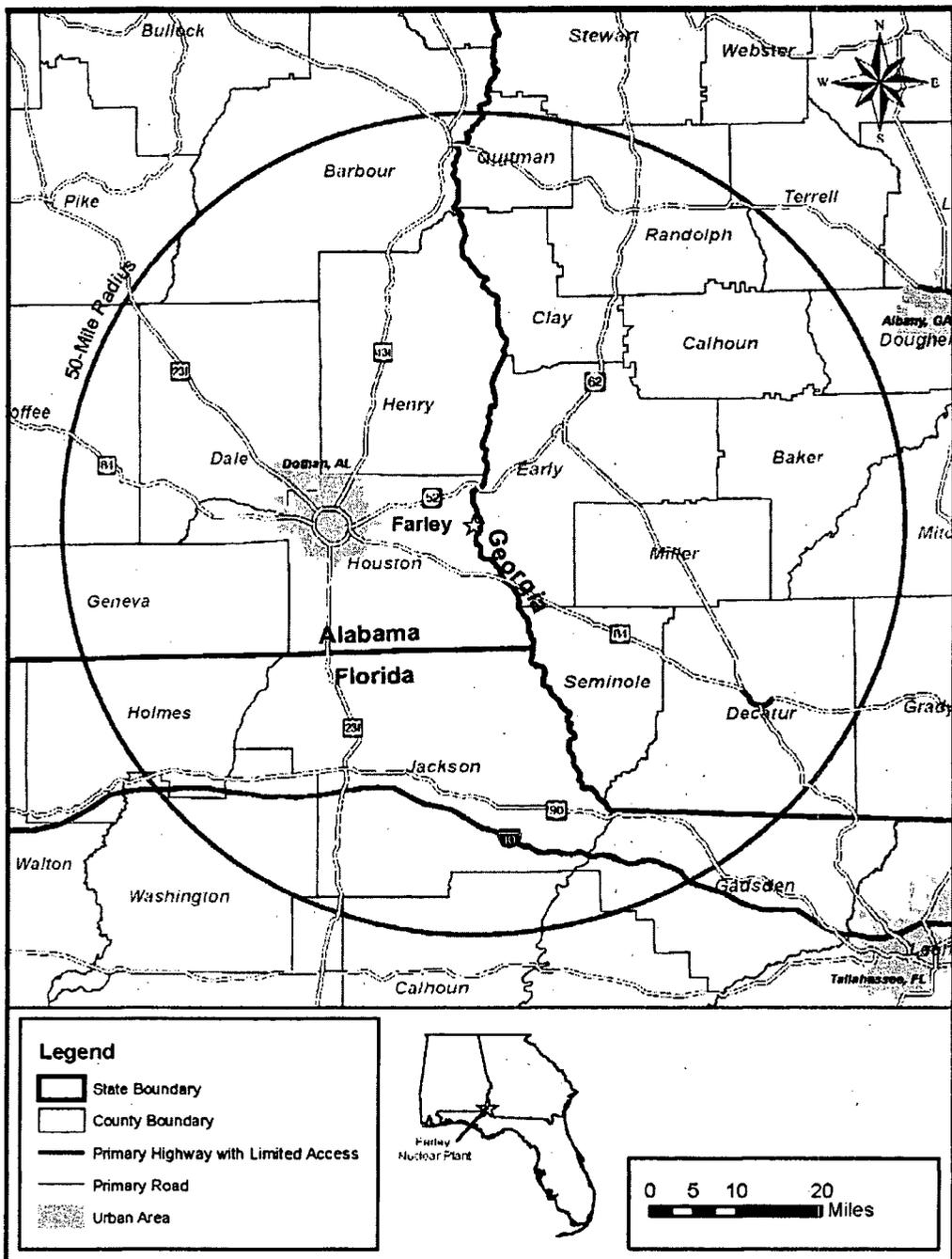


Figure 9-2. Plant Farley 80-km (50-mi) Vicinity (Southern 2008)

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The land in the vicinity of Plant Farley is rural and is forested or used as farmland. The Plant Farley site is not subject to the Alabama Coastal Zone Program because the Program only applies in Baldwin and Mobile Counties (ADEM 2005).

Based on the information provided by Southern and NRC's own independent review, the staff concludes that the land-use impacts of constructing and operating new nuclear reactor units at the Plant Farley site would be SMALL.

There are six transmission lines that exit the Plant Farley site. The rights-of-way pass through rolling hills that are primarily a mixture of forests and farmland. Southern assumed that if two new nuclear generating units were located at Plant Farley, one new 500-kV transmission line would be needed (Southern 2008). The new transmission line would be installed in a new 60-m (200-ft)-wide right-of-way and would be approximately 16 km (10 mi) long. Southern would obtain needed State and Federal permits related to construction of a new transmission line (NRC 2007). Based on the information it has available, the staff concludes that the transmission line right-of-way land-use impacts of constructing two new nuclear reactor units at the Plant Farley site would be MODERATE. Operational impacts would be SMALL.

Similar to Burke County, Georgia, where the VEGP site is located, Houston County is designated as being unclassified or in attainment with the National Ambient Air Quality Standards (40 CFR 81.301). The air-quality impacts of constructing and operating two new nuclear reactor units at Plant Farley would be similar to the air-quality impacts at the VEGP site. The staff concludes that the air-quality impacts of constructing and operating two new nuclear reactor units at the Plant Farley site would be SMALL.

9.5.2.2 Water Use and Quality

The staff assumed that two new nuclear units at Plant Farley would withdraw make-up water from the Chattahoochee River, and that facility cooling water demands would be satisfied with wet towers. The staff computed the 7Q10 and the 30Q2 based on data from USGS stream gage 02343801 (Chattahoochee River near Columbia, Alabama). Data collected from October 1975 to September 2005 were used to estimate the 7Q10 and 30Q2 values. This gage is approximately 3 km (2 mi) south of Columbia, and the drainage area upstream of the flow gage was reported by the USGS to be 21,264 km² (8210 mi²). The 7Q10 and 30Q2 values computed by the staff were 56.4 m³/s (1990 cfs) and 119 m³/s (4200 cfs), respectively. For the calendar years 1976 through 2005, the average annual-mean discharge at the gage was 308.60 m³/s (10,898 cfs), and the minimum annual-mean discharge was 140.17 m³/s (4950 cfs).

The net consumptive water loss for the wet towers proposed at the VEGP site would be 1.76 m³/s (62 cfs) (Southern 2008). Expressed as a percentage of the 7Q10 and 30Q2, the

consumptive water loss for two additional units sited at Plant Farley represents 3 and 1 percent, respectively, of the total flow in the Chattahoochee River. Southern (2008) estimated cumulative consumption net loss for the existing and two new units at 2.5 m³/s (90 cfs), which represents 5 and 2 percent, respectively, of the 7Q10 and 30Q2 flows in the Chattahoochee River.

Any releases of contaminants to the waters of the State of Alabama would be regulated by the Alabama Department of Environmental Management (ADEM) through the NPDES permit process to ensure that water quality is protected.

Based on the requirements of the NPDES permit and the above analysis, the staff concludes that the water-use and water-quality impacts of two additional units at Plant Farley would be SMALL.

9.5.2.3 Terrestrial Resources

Plant Farley encompasses approximately 749 ha (1850 ac) on the west bank of the Chattahoochee River. It is located near the boundary of the Dougherty Plain and Southern Red Hills physiographic regions of the east Gulf Coastal Plain. Two major topographical subdivisions occur at the site: (1) gently rolling upland west of the Chattahoochee River Valley and (2) the river terraces and floodplain of the Chattahoochee River. This contributes to a diverse distribution of habitats, with diverse wildlife and plant species. Habitats at Plant Farley consist of a river bluff forest, ravine forest, flood plain forest, pine-mixed hardwood forest, pine forest, non-floodplain wetlands and mowed grassy areas (NRC 2005).

Approximately 200 ha (500 ac) of the site are used for nuclear power generation and maintenance facilities. The developed areas are primarily located on a plateau approximately one-half mile west of the river, with the area adjacent to the river mostly undeveloped. The remainder of the site consists of forested areas, ponds, wetlands, and open fields. Alabama Power Company manages about 530 ha (1300 ac) of this land as a wildlife preserve. Construction of the proposed project at Plant Farley would require that a portion (up to 223 ha [550 ac]) of the wildlife preserve be cleared for development (Southern 2008). The Farley Wildlife Management Plan strategies include managing vegetation to promote and protect diverse habitats, periodic thinning or logging of pine timber stands, mowing grassy areas, and installing nest boxes. The Wildlife Habitat Council has recognized Plant Farley as a certified corporate wildlife habitat for its wildlife and land management efforts since 1992 (NRC 2005).

Most of the floodplain forests are dominated by high floodplain or ridge floodplain species. On the ridges and in the high floodplains, willow oak (*Quercus phellos*), shumard oak (*Q. shumardii*), bitternut hickory (*Carya cordiformis*), sweetgum (*Liquidambar styraciflua*), swamp chestnut oak (*Q. michauxii*), and American cherrybark oak (*Q. pagoda*) are present. Along the river in early successional areas, sycamore (*Platanus occidentalis*), silver maple (*Acer saccharinum*), and black willow (*Salix nigra*) dominate. In sloughs, backwaters, and

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poorly-drained areas, bald cypress (*Taxodium distichum*), water tupelo (*Nyssa aquatica*), red maple (*Acer rubrum*), and laurel oak (*Q. laurifolia*) are commonly found (NRC 2005).

Several non-floodplain wetlands occur on the Plant Farley site. Most of these are generally weedy marsh areas with scattered red maple, sweetgum, black willow, and buttonbush (*Cephalanthus occidentalis*) woody species. Plume grass (*Erianthus* sp.), woolgrass bulrush (*Scirpus cyperinus*), needlerushes (*Juncus* spp.), and other wet-site emergent, non-woody species are also found in these wetlands. One wetlands area has a broad expanse of open water dominated by water lillies (*Nuphar lutea* and *Nymphaea odorata*), water shield (*Brasenia schreberi*), and non-woody marsh grasses such as woolgrass bulrush and common needlerush (*Juncus effusus*) (NRC 2005).

The hardwood bottoms in the vicinity of the river include species such as the water oak (*Q. nigra*), white oak (*Q. alba*), and tuliptree (*Liriodendron tulipifera*). The hardwood areas and mixed pine-hardwood areas along the streams and in the upland areas consist of various oaks, sweetgum, and poplar (NRC 2005).

The forested portions of the site contain terrestrial wildlife species typically found in similar habitats in southern Alabama. Common mammals at the site include the gray squirrel (*Sciurus carolinensis*), raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), armadillo (*Dasypus novemcinctus*), eastern cottontail (*Sylvilagus floridanus*), and white-tailed deer (*Odocoileus virginianus*). Wading birds (egrets and herons) occur in wetlands, along the edges of ponds, and along the Chattahoochee River. Numerous bird species (e.g., common bobwhite [*Colinus virginianus*], blue jay [*Cyanocitta cristata*], and various warblers), and several reptile and amphibian species, including the Alabama State-protected gopher tortoise (*Gopherus polyphemus*) occur at the site (Southern 2008).

Six transmission lines connect the Plant Farley site to the transmission grid. These include approximately 525 km (326 mi) of lines that occupy approximately 2403 ha (5938 ac) of the transmission line rights-of-way (Southern 2008). The transmission line rights-of-way are located primarily within the east Gulf Coastal Plain physiographic province. The region is characterized by sandy soils and flat to gently rolling terrain. The transmission line rights-of-way traverse primarily forests or farmland. There are no areas designated by the FWS as critical habitat for endangered species at the Plant Farley site or adjacent to any of the associated transmission line rights-of-way. The Raccoon Creek-Tifton transmission line right-of-way crosses Elmodel Wildlife Management Area in western Georgia. The South Bainbridge right-of-way crosses the Lake Seminole Wildlife Management Area in southwestern Georgia. The lines do not cross any other State or Federal parks, National wildlife refuges, or State wildlife management areas (Southern 2008; NRC 2005).

Two State-listed plant species (Thorne's [swamp] buckthorn [*Sideroxylon thornei*] and Florida willow [*Salix floridana*]), and two plant species listed as unusual by GDNR (yellow pitcherplant [*Sarracenia flava*] and hooded pitcherplant [*Sarracenia minor*]) were found in plant surveys

conducted on the Plant Farley site and related transmission line rights-of-way in 2001 to 2002. Both species of pitcherplants were found along the Farley-Raccoon Creek-Tifton transmission line. No other State-listed plant species were observed on the transmission line rights-of-way during the surveys (NRC 2005).

State-listed animal species observed on the Farley site and related transmission line rights-of-way during recent surveys include the gopher tortoise (*Gopherus polyphemus*), eastern coachwhip snake (*Masticophis flagellum flagellum*), dusky gopher frog (*Rana capito*), bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), and southeastern pocket gopher (*Geomys pinetis*). In addition; Bachman's sparrow (*Aimophila aestivalis*), listed as rare in Georgia; and the little blue heron (*Egretta caerulea*), listed as a species of special concern in Florida; have been observed on Plant Farley transmission line rights-of-way. Bachman's sparrows were heard singing at two locations on the Farley-South Bainbridge right-of-way. The little blue heron was observed foraging in a marsh on the Farley-Sinai Cemetery right-of-way (NRC 2005).

Construction Impacts

Southern assumed that the construction of the proposed project at Plant Farley would require the addition of one 500-kV transmission line requiring a 60-m (200-ft)-wide transmission corridor. This line would be 16 km (10 mi) long and connect to the Webb Substation and would require an additional 96.3 ha (238 ac) of transmission line right-of-way (Southern 2008). The line may be constructed parallel to an existing corridor but would not share a corridor with the existing transmission line (Southern 2007c). The land in the vicinity of the Farley-Webb transmission line right-of-way is mainly agricultural with a few portions of the transmission line right-of-way traversing small isolated wetlands and forested areas. Widening this transmission line corridor by 61 m (200 ft) would not result in the crossing of any additional State or Federal lands or other conservation areas (Southern 2008).

With the exception of the transmission line rights-of-way, all construction activities associated with the new units at the Plant Farley site would occur on the existing Southern property. Southern (2007c) stated that "The area proposed for the two unit footprint at Farley is located within area disturbed by the construction of the existing powerblock in an area that now includes the ISFSI and old steam generator storage building as well as parking and laydown area. The cooling towers for the new units will be located in a previously disturbed area of floodplain. The majority of the impacted area (~90%) has been developed and has no value to the wildlife preserve. A small amount of revegetated land may be impacted, but it has little habitat value."

During construction of the proposed project at the Plant Farley site, wildlife would be permanently displaced from 121 ha (300 ac) dedicated to the project and associated support facilities and temporarily displaced from an additional 101 ha (250 ac). Currently maintained as a wildlife preserve by Alabama Power Company, clearing this area would result in a reduction of

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wildlife habitat onsite. Approximately 320 ha (800 ac) of wildlife preserve would remain at the Plant Farley site (Southern 2008).

Based on the available information regarding the habitats that would be removed during construction onsite and for the new transmission line right-of-way, information provided by Southern, and NRC's own independent review, the staff concludes that the impacts on terrestrial resources from construction of two new nuclear units at the Plant Farley site could be SMALL to MODERATE and construction associated with the new transmission line right-of-way could be SMALL to MODERATE.

Operational Impacts

Impacts on terrestrial ecological resources from operation of two new nuclear units at Plant Farley site include those associated with cooling towers and transmission lines. Impacts resulting from the operation of cooling towers and transmission lines would be of similar magnitude at all the alternative sites and, thus, cannot be used to discriminate between them. Therefore, operational impacts on terrestrial resources are discussed generically in Section 9.6.1.

Threatened and Endangered Species

Thirteen Federally listed threatened and endangered terrestrial species are known to occur in the vicinity of the Plant Farley site or its transmission lines: the endangered gray bat (*Myotis grisescens*), the endangered Indiana bat (*Myotis sodalis*), the endangered wood stork (*Mycteria americana*), the endangered red-cockaded woodpecker (*Picoides borealis*), the threatened (due to similarity of appearance) American alligator (*Alligator mississippiensis*), the threatened Eastern indigo snake (*Drymarchon corais couperi*), the endangered flatwoods salamander (*Ambystoma cingulatum*), the threatened crystal lake nailwort (*Paronychia chartacea minima*), the endangered chaffseed (*Schwalbea americana*), the endangered fringed campion (*Silene polypetala*), the endangered gentian pinkroot (*Spigelia gentianoides*), the endangered Florida torreyia (*Torreyia taxifolia*), and the endangered relict trillium (*Trillium reliquum*) (Southern 2008).

Land disturbance required to site the proposed nuclear power plants at the Plant Farley site would take place in Houston County. Two Federally listed terrestrial species are known to occur in Houston County: the Eastern indigo snake and the flatwoods salamander. Suitable habitat for the Eastern indigo snake exists at the Plant Farley site and this species could potentially exist onsite. Before construction activities begin, Southern would perform a detailed survey to ensure protection of the endangered Eastern indigo snake (Southern 2008).

In fall 2006, the NRC contacted the FWS (Daphne, Alabama) regarding the potential presence of threatened and endangered species at the VEGP site and three alternative sites for two new units. The FWS responded that they had recently reviewed listed species present on the Plant

Farley site and along existing transmission lines in Alabama, as part of Southern's efforts to extend the operating license of Plant Farley Units 1 and 2. The FWS stated as long as new units at the Plant Farley alternative site would be constructed on the existing Plant Farley property and that the facility would continue to follow FWS guidelines for protecting wildlife and habitat, Federally listed threatened and endangered (T&E) species would not likely be adversely affected. FWS requested that Southern evaluate whether appropriate habitat may exist for the bald eagle and flatwoods salamander in any newly proposed transmission line right-of-way (FWS 2006).

Southern stated that habitat preferred by the flatwoods salamander does not exist at the Plant Farley site or along the Webb transmission line right-of-way and with the exception of the Eastern indigo snake, it is unlikely that any other Federally listed wildlife species occur at the Plant Farley site or along the Farley-Webb transmission line right-of-way (Southern 2008). Based on the information regarding the habitats that would be removed during construction onsite and for the new transmission corridor, information provided by Southern, information provided by FWS, and NRC's own independent review, the staff concludes that the impacts to threatened and endangered species from construction of two new nuclear units at the Plant Farley site and construction associated with the addition of a transmission line right-of-way would be SMALL.

9.5.2.4 Aquatic Resources

Southern currently withdraws water from the lower Chattahoochee River for Plant Farley. The principal aquatic resources at the site are associated with the Chattahoochee River. Other important aquatic habitats include the 44.1-ha (108-ac) service and make-up water pond (on the Plant Farley site) and a few small creeks onsite (NRC 2005).

The fish community of the Chattahoochee River in the vicinity of Plant Farley site is diverse, composed of a mix of common southeastern stream species (many of which adapt well to reservoir conditions), species typically found in swamps and backwaters of rivers, and a small number of migratory and semi-migratory species. Approximately 92 species are known to occur in the Chattahoochee River system and approximately two-thirds of these species can be found in the lower Chattahoochee (NRC 2005). Some of the fishes commonly observed or collected in the lower Chattahoochee near the Plant Farley site include longnose gar (*Lepisosteus osseus*), redbfin pickerel (*Esox americanus*), river redhorse (*Moxostoma carinatum*), greater jumprock (*Moxostoma lachneri*), green sunfish (*Lepomis cyanellus*), redbreast sunfish (*L. auritus*), channel catfish (*Ictalurus punctatus*), several common minnow species (*Notropis* spp.), bowfin (*Amia calva*), spotted sucker (*Minytrema melanops*), chain pickerel (*Esox niger*) and flier (*Centrarchus macropterus*). Several other fish species found in the Chattahoochee River in the vicinity of the Plant Farley site are adapted to a range of environmental conditions and are abundant in the rivers, lakes, reservoirs, and swamps across the Southeast. These include gizzard shad (*Dorosoma cepedianum*), common carp (*Cyprinus carpio*), blacktail shiner

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(*Cyprinella venusta*), bluegill (*L. machrochirus*), and largemouth bass (*Micropterus salmoides*) (NRC 2005).

Recreational fisheries in the area harvest several species of bass, including striped bass (*Morone saxatilis*), white bass (*M. chrysops*) and hybrid bass (the palmetto bass, *M. saxatilis* x *M. chrysops*).

Small numbers of catadromous American eels (*Anguilla rostrata*) are also found in the lower Chattahoochee River in vicinity of the Plant Farley site. Catadromous species live in freshwater habitat, and migrate to saltwater to spawn. Small numbers are found year-round in the Chattahoochee River in the vicinity of the Plant Farley site (NRC 2005).

Studies of the benthic populations in the river indicate that species diversity and abundance of freshwater mussels have declined since the early 20th century and dramatically over the last several decades. The decline has been attributed to erosion and sedimentation (from land clearing and intensive farming in the area), dredging, snag removal, channel modifications (for navigation), introduction of dams and associated impoundments, runoff of agricultural chemicals and animal wastes (chiefly poultry), mining activities, and wastewater treatment facility discharges (NRC 2005).

During the 2004 mussel survey below the Plant Farley outflow, it was noted that the loose sandy substrate did not provide anchoring for native mussels and that in the total search, only a few old shells of mussels, and no live specimens, were found (Yokley 2004). The wide-variety of mussel species that were once abundant in the Chattahoochee River are apparently now restricted to remnant and isolated populations in small headwater streams, and common, single-species populations in impoundments on the river (Brim Box and Williams 2000). In addition, the Asiatic clam (*Corbicula fluminea*) has become established in the Chattahoochee River system and is competing with the native mussel populations for resources. The Asiatic clam is a highly invasive, non-native mussel species that crowds out desirable endemic species. It has a higher tolerance to pollutants and is known to clog intake pipes, damage industrial water systems, alter aquatic habitat, and disrupt irrigation canals.

Construction Impacts

Construction of a new cooling water intake for two additional units would result in temporary displacement of aquatic biota within the Chattahoochee River. It is expected that the disturbance to aquatic resources would be localized and of short duration and that the aquatic biota would return to the area once construction is complete. Sedimentation due to disturbances of the river bank and bottom could impact local benthic populations. However, the impacts on aquatic organisms would be temporary and largely mitigable through the use of BMPs. Based on the information provided by Southern and NRC's own independent review of

additional information, the staff concludes that depending on the method of construction and any need for dredging, the impact on aquatic resources at Plant Farley could be SMALL.

It is assumed that the proposed project would require the addition of one 500-kV transmission line requiring a new 60-m (200-ft)-wide transmission line right-of-way. This line would connect to the Webb Substation and would require an additional 96.3 ha (238 ac) of transmission line right-of-way. The land in the vicinity of the Farley-Webb transmission line right-of-way is largely agricultural with a few portions of the transmission line right-of-way traversing small isolated wetlands and forested areas (Southern 2008). The exact location of the transmission line right-of-way is not currently known. Because no information on routing has been provided, the impacts to the aquatic ecosystem in water bodies that would be crossed by the new right-of-way is not known. However, assuming the use of BMPs during construction, the staff concludes that the impacts could be SMALL to MODERATE depending on the specific routing of the right-of-way.

Operational Impacts

Impingement and entrainment of aquatic organisms from the Chattahoochee River would be the most likely impacts that could occur from operation of two new units at Plant Farley. The NRC has found that entrainment and impingement of fish and shellfish has not been a problem at facilities that use the type of cooling system found at Plant Farley (closed-cycle with cooling towers).

During license renewal at Plant Farley, the staff determined that the impacts to aquatic resources from issues such as water use, entrainment and impingement of fish and shellfish, thermal plume barrier, and low dissolved oxygen, would be minor; no new and significant information had been identified during the analysis that would have given a different conclusion (NRC 2005). Assuming a closed-cycle cooling system with a maximum through-screen velocity of 0.15 m/s (0.5 ft/s) at the cooling water intake, an intake flow of less than or equal to 5 percent of the mean annual flow of the Chattahoochee River, and a design and location of the new intake that is consistent with the existing intake, there would be no anticipated impacts to aquatic populations from entrainment and impingement. After reviewing the recent NRC staff assessment for license renewal at the Farley site and the additional information provided by Southern, the staff concludes that the potential for adverse operational impacts to aquatic resources from two additional units at Plant Farley would be SMALL.

The staff also concludes that the operational impacts to aquatic biota from the transmission lines would also be SMALL, assuming BMPs are used for right-of-way maintenance.

Threatened and Endangered Aquatic Species

Several Federally or State-listed protected aquatic species are currently or historically located within the two counties associated with the Plant Farley site. The site itself is located within

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Houston County, Alabama, and the section of the Chattahoochee River adjacent to the site is located within Early County, Georgia. Both states and the FWS were contacted regarding the presence of threatened and endangered species located within those two counties. The species identified by the agencies are provided in Table 9-5. Based on the information available, it appears that most, if not all, of these species have been extirpated from this section of the river due to damming of the river, habitat loss and degradation, siltation, and sedimentation. Though activities at the Plant Farley site would not directly impact any of these species, site activities could affect the ability of a species to reestablish itself in the area. Some species on the list, although known to currently exist within the identified counties, are located in other parts of the county outside the area of impact.

As part of its review of Southern's application to renew the Plant Farley operating licenses, the NRC submitted a biological assessment to the FWS (NRC 2004b). The FWS concurred that renewal of the operating license was not likely to adversely affect any Federally listed threatened and endangered species (FWS 2004).

Table 9-5. Aquatic Threatened and Endangered Species within Vicinity of the Plant Farley Site

Species	Alabama State Status (Houston Co.)	Georgia State Status (Early Co.)	Federal Status
Fish			
Alabama shad	Protected		
<i>Alosa alabamae</i>			
bluenose shiner		Threatened	
<i>Pteronotropis welaka</i>			
Gulf sturgeon	Protected		Threatened
<i>Acipenser oxyrinchus desotoi</i>			
Invertebrates			
Choctaw bean	Protected	Candidate	Candidate
<i>Villosa choctawensis</i>			
delicate spike		Endangered	
<i>Elliptio arctata</i>			
Gulf moccasinshell	Protected	Endangered	Endangered
<i>Medionidus penicillatus</i>			
inflated spike		Threatened	
<i>Elliptio purpurella</i>			
oval pigtoe	Protected	Endangered	Endangered
<i>Pleurobema pyriforme</i>			
shiny rayed pocketbook	Protected	Endangered	Endangered
<i>Hamiota subangulata</i>			
southern sandshell	Protected		Candidate
<i>Lampsilis australis</i>			

ALNHP 2007; GDNr 2007b; FWS 2007a, b

In the fall of 2006, the FWS was again contacted by the NRC regarding the potential presence of threatened and endangered species at Plant Farley for two new units. The Daphne, Alabama, field office responded that they had recently reviewed listed species present on the site, in the mixing zone of the Chattahoochee River, and along existing transmission lines in Alabama, as part of Plant Farley's relicensing efforts. The FWS concurred with the NRC finding that reissuance of the operating license for Plant Farley was not likely to adversely affect any Federally listed threatened and endangered species in Alabama or in the Chattahoochee River. Based on the assumption that new units at the Plant Farley alternative site would be constructed on the existing Plant Farley property and that the facility would continue to follow FWS guidelines for protecting wildlife and habitat, the FWS stated that they could again concur with a "not likely to adversely affect determination" for Alabama listed species (FWS 2006).

If the new units at Plant Farley were to require expansion of the mixing zone or an increase in discharge volumes, the FWS requested that surveys be conducted for the presence of the Southern sandshell (*Lampsilis australis*) and Choctaw bean (*Villosa choctawensis*), if suitable habitat exists within the area of impact. These two species are currently candidate species. Candidate species are not afforded protection through the Endangered Species Act; however, it is possible that their listing status could change before completion of the permitting process and beginning of construction. The FWS further requested that habitat surveys for Federally listed species be conducted for any new transmission line rights-of-way (FWS 2006).

The impacts on aquatic organisms would be temporary and largely mitigable through the use of BMPs. However, disturbances of the riverbank and bottom and resulting sedimentation could result in a detectable impact to rare native mussel species. Although the staff believes that the habitat present in the vicinity of the area may not be optimal for rare mussels, without a survey the staff cannot say with certainty that rare mussels are not present. Based on the information provided by Southern and NRC's own independent review of the Plant Farley operating license renewal EIS and associated studies, and opinion from the FWS, the staff concludes that the overall impact to Federally listed threatened and endangered species from construction and operation of two new nuclear units at the Plant Farley site would be SMALL.

9.5.2.5 Socioeconomics

In evaluating the socioeconomic impacts of construction at Plant Farley, Southern undertook a "reconnaissance" survey of the site using readily obtainable data from the Internet or published sources. The NRC staff performed its own review of the data. The socioeconomic subsections follow the organizational structure of the socioeconomic discussions in Sections 2.8, 4.5, and 5.5. The impacts expected from both construction and station operation are discussed.

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Physical Impacts

The potential construction activities associated with constructing two new units at Plant Farley could potentially cause temporary and localized physical impacts such as noise, odor, vehicle exhaust, vibration, shock from blasting, and dust emissions. The use of public roadways and waterways would be necessary to transport construction materials and equipment. All construction activities would occur within the existing Plant Farley site. Offsite areas that would support construction activities (for example, borrow pits, quarries, and disposal sites) are expected to be already permitted and operational. Impacts on those facilities from construction of new nuclear units would be small incremental impacts associated with their normal operation (Southern 2008).

Potential impacts from station operation include noise, odors, exhausts, thermal emissions, and visual intrusions. New nuclear units would produce noise from the operation of pumps, fans, transformers, turbines, generators, and switchyard equipment. Traffic at the site would also be a source of noise. However, noise attenuates quickly so ambient noise levels would be minimal at the site boundary. Also, Plant Farley is located in a rural area surrounded by forests and agricultural land, so residents in the area are sparse. Commuter traffic would be controlled by speed limits. Good road conditions and appropriate speed limits would minimize the noise level generated by the workforce commuting to the site (Southern 2008).

New nuclear units would have standby diesel generators and auxiliary power systems. Permits obtained for these generators would ensure that air emissions comply with applicable regulations. In addition, the generators would be operated on a limited, short-term basis. During normal plant operation, the proposed project would not use a significant quantity of chemicals that could generate odors that exceed odor threshold values. Good access roads and appropriate speed limits would minimize the dust generated by the commuting workforce.

Construction activities would be temporary and would occur mainly within the boundaries of the Plant Farley site. Offsite impacts would represent small incremental changes to offsite services supporting the construction activities. During station operations, ambient noise levels would be minimal at the site boundary. Air-quality permits would be required for the diesel generators, and chemical use would be limited, which would limit odors. Therefore, based on the information provided by Southern and NRC's own independent review, the staff concludes that the physical impacts of construction and operation would be SMALL.

Aesthetics

The developed areas at Plant Farley are primarily located on a plateau approximately one-half mile west of the Chattahoochee River, with the area immediately adjacent to the river mostly undeveloped. The remainder of the site consists of forested areas, ponds, wetlands, and open fields. Two major topographical subdivisions exist at the site: (1) gently rolling upland west of

the Chattahoochee River Valley and (2) the river terraces and flood plain of the Chattahoochee River. Habitats at the Plant Farley site consist of river bluff, forest, ravine forest, flood plain forest, pine-mixed hardwood forest, pine forest, non-flood plain wetlands, and mechanically maintained grassy areas (NRC 2005).

Construction of new nuclear units at Plant Farley could be viewed from offsite at certain locations, but the addition of new units would not substantially change the view given the existence of the current units. There would be a need to construct cooling-water intake and discharge structures at the site. Additional mechanical or natural draft cooling towers would be required. The operation of new nuclear units would have visual impacts similar to those of the existing Plant Farley units, with the addition of more visible plumes from cooling towers. Impacts of construction and operation of new nuclear units on aesthetics near Plant Farley would be expected to be SMALL. However, depending on the specific routing, the aesthetic impact of the new transmission line could be MODERATE.

Demography

Plant Farley is in Houston County, Alabama on the Chattahoochee River approximately 160 km (100 mi) southeast of Montgomery, Alabama. Based on 2000 Census data, Geneva County, located southwest of the plant, had a population of 25,764; Henry County, located north of the plant, had a population of 16,310; and Houston County had a population of 88,787 (Southern 2008). The population within 80 km (50 mi) of the site was approximately 393,639 people (20 persons per km²). The city of Dothan, located 27 km (17 mi) from Plant Farley, which is the city where most Plant Farley employees live, had a population of 57,737 (Southern 2008). The population within 32 km (20 mi) of the site was 93,120 people (29 persons per km²).

Based on the analysis of construction impacts presented in Section 4.5.2 of this EIS, new nuclear units at Plant Farley would increase the population in the 80-km (50-mi) region during the construction phase by approximately 5500 people. The majority of the Plant Farley workforce lives in Houston County (77 percent) and the remaining employee residences are distributed across 22 counties in Alabama, Georgia, and Florida, mostly within 80 km (50 mi) of the site. Assuming the residential distribution of the construction workforce would resemble the residential distribution of the current Plant Farley workforce, approximately 4235 people (77 percent of 5500) or 4.4 percent of the 2000 population would settle in Houston County. Overall, the population increase from in-migration of construction workers would constitute 1.3 percent of the 2000 population of the 80-km (50-mi) region. The NRC staff concludes that the impacts of plant construction on increases in population could potentially be MODERATE in Houston County; however, given that it is likely that most of the in-migrating construction employees would choose to live in and around Dothan, and considering that a portion of the suburban growth in Dothan is now spreading into Dale and Henry Counties, it is more likely that

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this impact would be dispersed over these three counties and the impacts would be SMALL. The demographic impacts are considered SMALL in the remainder of the 80-km (50-mi) region.

Based on the analysis in Section 5.5.2, Southern assumes that operation of new nuclear units at Plant Farley would increase the population in the 80-km (50-mi) region by 2152 people. Once again, assuming that approximately 77 percent would settle in Houston County, the addition of the new employees and their families would equate to a 2 percent increase for Houston County. Overall, the potential increases in population would represent a SMALL increase in the total population.

Social and Economic Impacts

Economy

According to a 2006 report produced by the Southeast Alabama Regional Planning and Development Commission (SEARPDC), the southeast Alabama region where Plant Farley is located, has experienced a reduction in labor force due to numerous industrial plant closings in recent years. These closings primarily affected low-skill textile workers with limited opportunities elsewhere. The economy has also been negatively impacted by the General Agreement on Tariffs and Trade, which increased competition in the peanut industry with importation of foreign peanuts into the United States. Layoffs, downsizing, and closures have eliminated thousands of jobs in the region (SEARPDC 2006). Houston County's economy has seen a major shift from manufacturing to services and retail trade and the service sector now comprises a much larger percentage of the county's earnings than does manufacturing. Dothan, in Houston County, remains a regional retail and medical services center. Henry County has shown strong growth in employment and earnings attributable to manufacturing. While the percentage of employees in the manufacturing sector has decreased, the number employed has increased. Income earnings from farming continue to decrease throughout the region with the exception of Geneva County, which has benefitted from its economically profitable poultry production in recent years (SEARPDC 2006).

The total number of employees in 2000 for Houston County was nearly 60,000. Henry and Geneva Counties had 6822 and 9606, respectively (Southern 2008). The economic impacts would likely be spread across the 80-km (50-mi) region, but would be greatest in Houston County, particularly around Dothan. During the construction of the new units, up to 3500 construction workers would be required to build the plant (at the peak construction phase) and most of these would need to in-migrate to the region. The peak construction workforce would represent approximately 6 percent of the current workforce in the region and the NRC staff concludes that the impacts of construction on the economy of the region would be MODERATE and beneficial, but temporary.

The wages and salaries of the operating and construction workforce would have a multiplier effect that could result in increases in business activity, particularly in the retail and service

sectors. This would have a positive impact on the business community and could provide opportunities for increases in new business startups and increased job opportunities for local residents.

Once the new units are operational, approximately 812 new operations jobs would be added to the local economy. Southern assumes that all of these new operations workers would have to move to the region from outside the region. These new jobs would constitute a small percentage of the total number of jobs in the region (1 percent of Houston County jobs).

Based on the information provided by Southern and NRC's own independent review, the staff concludes that a significant number of construction laborers would need to in-migrate to the area and the number of jobs added to the region during the construction phase would have MODERATE and beneficial impacts on the local economy. Once the new units are operational, 812 jobs would be added to the local economy; however, this would only constitute a small growth rate in jobs relative to the total number of existing jobs in the region, and the economic impacts would be SMALL and beneficial.

Taxes

As with the new proposed units at the VEGP site (Sections 4.5.3 and 5.5.3), there would be some positive sales, use, income, and corporate tax revenue benefits that would be generated as the result of the construction and operation of new units at Plant Farley. These benefits, however, would be paid directly to the State general fund, and thus the marginal regional impacts would be minimal. The primary tax impacts would occur once the new units become valued as property assets and property tax revenues are collected by Houston County, according to the millage rate negotiated on value of the plant. Southern anticipates that it would begin paying annual property taxes to Houston County during construction of the proposed project at Plant Farley. Assuming a 40-year operational life, property taxes to Houston County could average between \$15 million and \$21.5 million annually during the first decade of operation and between \$3 million and \$4 million during the last decade of operation, based on the changing value of the plant (Southern 2008). The current Plant Farley property taxes produced between 31 and 39 percent of Houston County's tax revenue base between 1995 and 2002 (NRC 2005). The NRC staff concludes that the potential beneficial impacts of taxes collected during construction would be MODERATE and beneficial. During operation the impacts would be LARGE and beneficial in Houston County and SMALL in the remainder of the 80-km (50-mi) region, assuming Alabama tax law remains unchanged.

Summary of Social and Economic Impacts

Based on information provided by Southern and NRC staff's independent review, the staff concludes that impacts on social and economic resources from construction and operation of two new nuclear units at the Plant Farley site would be MODERATE to LARGE beneficial

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impacts in Houston County and SMALL in the remainder of the 80-km (50-mi) region around the plant.

Infrastructure and Community Services

Transportation

Road access to Plant Farley is via State Road 95, a two-lane paved road with a north-south orientation. State Road 95 passes through the towns of Columbia to the north and Gordon to the south. Employees traveling from Dothan, Alabama, use either U.S. 84 or State Road 52. U.S. 84 is a four-lane highway that intersects State Road 95 near Gordon. State Road 52 crosses State Road 95 southwest of Columbia. The Alabama Department of Transportation does not maintain level-of-service designation for roadways in the State. However, a daily average of 870 cars traveled State Road 95 near Plant Farley in 2004 (Southern 2008).

Assuming construction shifts as described in Section 4.5.1, an additional 1750 cars could be on the highway during shift change, causing potential congestion. Also, the traffic of hauling construction materials (100 trucks per day) to the site could cause additional congestion to State Road 95, and State Road 52 and U.S. Route 84 from Dothan during certain times of the day. Transportation impacts are generally considered SMALL when increases in traffic do not result in delays or other operational problems, and MODERATE when increases in traffic begin to cause delays or other operational problems (NRC 2005). Therefore, the NRC staff concludes that impacts of construction on transportation would be MODERATE during the peak construction period because delays or other operational problems are anticipated.

With respect to operation of the facility, adding an additional 760 cars during the afternoon shift (see shift assumptions Section 5.5.4.1) to the existing traffic on the road would not strain current road capacity. Shift changes for the current units and new units at Plant Farley could be staggered so that the traffic increase would not cause congestion, which would be particularly important during the outage periods when nearly 1000 additional temporary contract workers are employed to perform outage operations. Impacts of the commuting workforce on transportation would be SMALL during operation of the plant.

Recreation

Three U.S. Army Corps of Engineers reservoirs are in the vicinity of Plant Farley: Walter F. George Lake, George W. Andrews Lake, and Lake Seminole. All have recreational uses in including camping, boat ramps, marinas, picnic areas, playgrounds, swimming areas, and trails (Southern 2008). Walter F. George Lake and George W. Andrews Lake are located more than 30 mi upstream of Plant Farley in Henry and Barbour Counties, Alabama, and Clay, Quitman, and Stewart Counties, Georgia. Seminole Lake is located almost 40 km (25 mi) downstream of Plant Farley on the border of Georgia and Florida, in Jackson County, Florida and Seminole and Decatur Counties, Georgia. Construction and operation of new nuclear units at Plant Farley

would not impact these recreation areas because of their distance from Plant Farley. Therefore, the impacts of facility construction and operation on recreation would be SMALL.

Housing

In 2005, Houston County had 42,220 housing units, 4536 of which (10.7 percent) were vacant. In 2000, Henry County had 8037 housing units, 1512 of which (18.8 percent) were vacant, and Geneva County had 10,477 housing units with 1638 vacant (13.5 percent) (USCB 2007a). Based on the analysis in Section 4.5.2, approximately 5500 construction workers and their families would in-migrate to the 80-km (50-mi) region. Currently, available housing in the three-county area is adequate to accommodate the expected influx of workers. Workers could also find housing in other parts of the 80-km (50-mi) region or construct new housing. Given this increased demand for housing, prices of existing housing could rise; however, the overall dispersed impacts on housing within the 80-km (50-mi) region are expected to be SMALL.

Southern assumes that operation of the new units at Plant Farley would increase the population in the 80-km (50-mi) region by 2152 people, and approximately 77 percent would settle in Houston County. The current housing supply in Houston County could accommodate all the new families expected to settle in this county. The impact of operating the new units on housing is therefore likely to be SMALL.

Public Services

According to studies commissioned by SEARPDC, water related resource problems pose potential barriers to future development in Houston County due to both residential and industrial demand. Over the past 20 years, groundwater overdraft areas have developed within the region. The potentiometric surface in the vicinity of Dothan, Ft. Rucker (Dale County), and Enterprise (approximately 40 km [25 mi] west of Dothan and 50 km [31 mi] from Plant Farley) have experienced significant declines in the Nanafalia-Clayton aquifer, which is the major water supply in the area. The city of Dothan has reported a decline of 30 m (100 ft) in the depth of the aquifer, and a recommendation has been made by the U.S. Department of Agriculture, the U.S. Natural Resources Conservation Service, and the U.S. Forest Service that all water systems in the area develop a 10- to 20-year plan for additional water supplies (NRC 2005). Dothan, which is the nearest urban area to Plant Farley, is serviced by Dothan Utilities, the largest potable water supplier in Houston County. Water is pumped from various shallow and deep groundwater wells located throughout the Dothan area. As the city grows and new development occurs, water mains are constructed and extended to meet the increased demand. Dothan likely would need additional water sources and conservation measures by as early as 2020. One of the options the city is considering is constructing, by 2011, a 38 million L/d (10 million gallons per day [gpd]) surface-water treatment plant on the Chattahoochee River upstream of Plant Farley between Columbia and Plant Farley. This treatment plant would be

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expandable to 76 million L/d (20 million gpd). The plant would connect to the city via a 91-cm (36-in) pipe (NRC 2005).

Construction and operation of new nuclear units at the Plant Farley site would not require municipal water and treatment systems. The planned water system expansions would already be underway by the time new units would be constructed at Plant Farley; however, it is likely, considering the current system capacity constraints, that a major influx of construction workers could temporarily strain the system and impacts could be MODERATE. When the new units become operational, the minor population increase from the 812 construction workers and families would likely have SMALL impacts on the public utility system.

Dothan is equipped with police and fire protection services that are currently adequately funded and keeping up with growth in the county, in part, due to tax revenue benefits from the existing plant. Thus, the marginal impacts on these services from construction and operation workers and their families are expected to be minor. Dothan serves as the regional medical center for parts of Florida, Georgia, and southeastern Alabama; thus, Houston County is well served with medical services (NRC 2005). In addition, any of the minor injuries incurred during construction of the units could be treated onsite; thus the construction and operation of new units at Plant Farley would not be expected to overburden the local medical system. The employment of additional construction workers and operations staff would not be expected to significantly strain the social services provided in the region, and therefore such impacts are considered SMALL.

Education

In 2006, 14,870 students attended Houston County mainstream public schools. The Dothan City district is served with 18 schools (including 10 elementary schools, 3 middle schools, 2 high schools, 2 magnet schools and 1 vocational school) with enrollment at 8652, while the Houston County School District has 11 schools (including four elementary schools, one middle school, four high schools, an alternative school and a vocational school) with enrollment at 6218 (NCES 2007).

Based on the analysis in Section 4.5.4.5, new nuclear units at Plant Farley would increase the school-aged population in the 80-km (50-mi) region by 1100 during the peak of the construction phase. Assuming that 77 percent would settle in Houston County, enrollment could increase by approximately 850 in Houston County Schools during the peak construction period. MODERATE impacts on local school systems could be expected during peak construction, because enrollment could increase as much as 6 percent over current enrollment levels; however, this county would potentially receive additional tax revenue benefits from Southern during the construction phase, which could mitigate these impacts.

Based on the analysis in Section 5.5.4.5, Southern assumes that operation of new nuclear units at Plant Farley would increase the school-aged population in the 80-km (50-mi) region by

464 people. Assuming approximately 77 percent would settle in Houston County, enrollment would only increase by 3 percent over current enrollment levels; therefore, impacts would be expected to be SMALL.

Summary of Infrastructure and Community Services

Based on the information provided by Southern and NRC's own independent review, the staff concludes that impacts on infrastructure and community services from construction of two new nuclear units at the Plant Farley site would be SMALL to MODERATE. Once the two new units are operational, these impacts on community services and infrastructure would likely be SMALL.

Summary of Socioeconomics

In summary, based on the information provided by Southern and NRC's own independent review, the staff concludes that the socioeconomic impacts of constructing two new nuclear units on the Plant Farley site would be SMALL, except in Houston County. In Houston County, the exceptions are as follows: the impacts on the tax base would be beneficial and MODERATE; the impacts on the economy of Houston County would likely be beneficial and MODERATE, local transportation could be adversely affected and the effect is likely to be MODERATE and, similarly, social services could be strained during construction of the plant such that the impacts would be MODERATE. Schools would see a significant enrollment increase during the construction phase, which may produce MODERATE adverse impacts; however, depending on when the beneficial tax revenues from the plant begin to be paid to the county, these impacts could be fully mitigated. Once the two new reactors are operational, the socioeconomic impacts on the region would be SMALL, except in Houston County where the economic and tax impacts would likely be LARGE and beneficial.

9.5.2.6 Historic and Cultural Resources

The likely footprint for the construction of two new nuclear units at Plant Farley does not appear to have any historic properties located within areas likely to be impacted by new construction and operations. Miscellaneous archaeological surveys conducted over the years in the area indicate that while sites may exist on the premises, either the sites are not eligible for listing on the National Register of Historic Places or are located away from likely areas of new construction. Protective measures would be put in place in the event that historic or archaeological materials are discovered during construction or during operations. In the event that an unanticipated discovery is made, site personnel would be instructed to notify the Georgia SHPO and would consult with them in conducting an assessment of the discovery to determine if additional work is needed. The impacts to historic and cultural resources are predicted to be SMALL at the Plant Farley site.

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9.5.2.7 Environmental Justice

The 2000 Census data and block groups were used for ascertaining minority and low-income populations in the area. Minority populations exist in the vicinity of Plant Farley, including block groups with significant black races and Hispanic ethnicity populations. Low-income populations also exist in the 80-km (50-mi) radius. In Houston County, black minority and low-income minority populations exist in Dothan, approximately 27 km (17 mi) west of Plant Farley. Black minority and low-income populations also exist in Early County, Georgia, bordering Plant Farley to the east across the Chattahoochee River. The only block group with a significant hispanic ethnicity minority population is located in Gadsden County, Florida, approximately 80 km (50 mi) from Plant Farley. No significant minority or low-income populations exist within 10 km (6 mi) of Plant Farley (Southern 2008).

Construction activities (noise, fugitive dust, air emissions, traffic, impacts to housing or public services) would not disproportionately adversely affect minority populations because of their distance from Plant Farley.

Operation of the proposed project at Plant Farley is also unlikely to have a disproportionate adverse impact on minority or low-income populations. No unusual resource dependencies, such as subsistence agriculture, hunting, or fishing were identified during the license renewal process for Plant Farley (NRC 2005). Offsite impacts from operation of the proposed project at Plant Farley to minority and low-income populations would be SMALL.

9.5.3 Barton Site

This section covers the staff's evaluation of the potential environmental impacts of siting new nuclear units at the Barton site.

9.5.3.1 Land Use, Air Quality, and Transmission Line Rights-of-Way

Southern's undeveloped Barton site is located in Chilton and Elmore Counties, Alabama (Figure 9-3). The site is located on the west side of the Coosa River between Chestnut Creek to the north and Jake Creek to the south. The Barton site encompasses approximately 1130 ha (2800 ac) (Southern 2008). The site is mainly forested and is characterized by moderately rolling hills.

The footprint of a new generating plant at the Barton site would be approximately 160 ha (400 ac) and an additional 61 ha (150 ac) would be required for temporary facilities and laydown yards (Southern 2008). Because the site is undeveloped, additional land would be required for roads, parking lots, and a switchyard. State Road 22 passes approximately 6 km (4 mi) north of the Barton site at its closest point. A 6.4 km (4 mi) paved road with a 30-m (100-ft) right-of-way would be constructed to State Road 22 to provide vehicle access to the site. Development of the road would require approximately 20 ha (50 ac). A CSX Transportation railroad line passes approximately 9 km (6 mi) southwest of the Barton site at its closest point (Southern 2007c). A

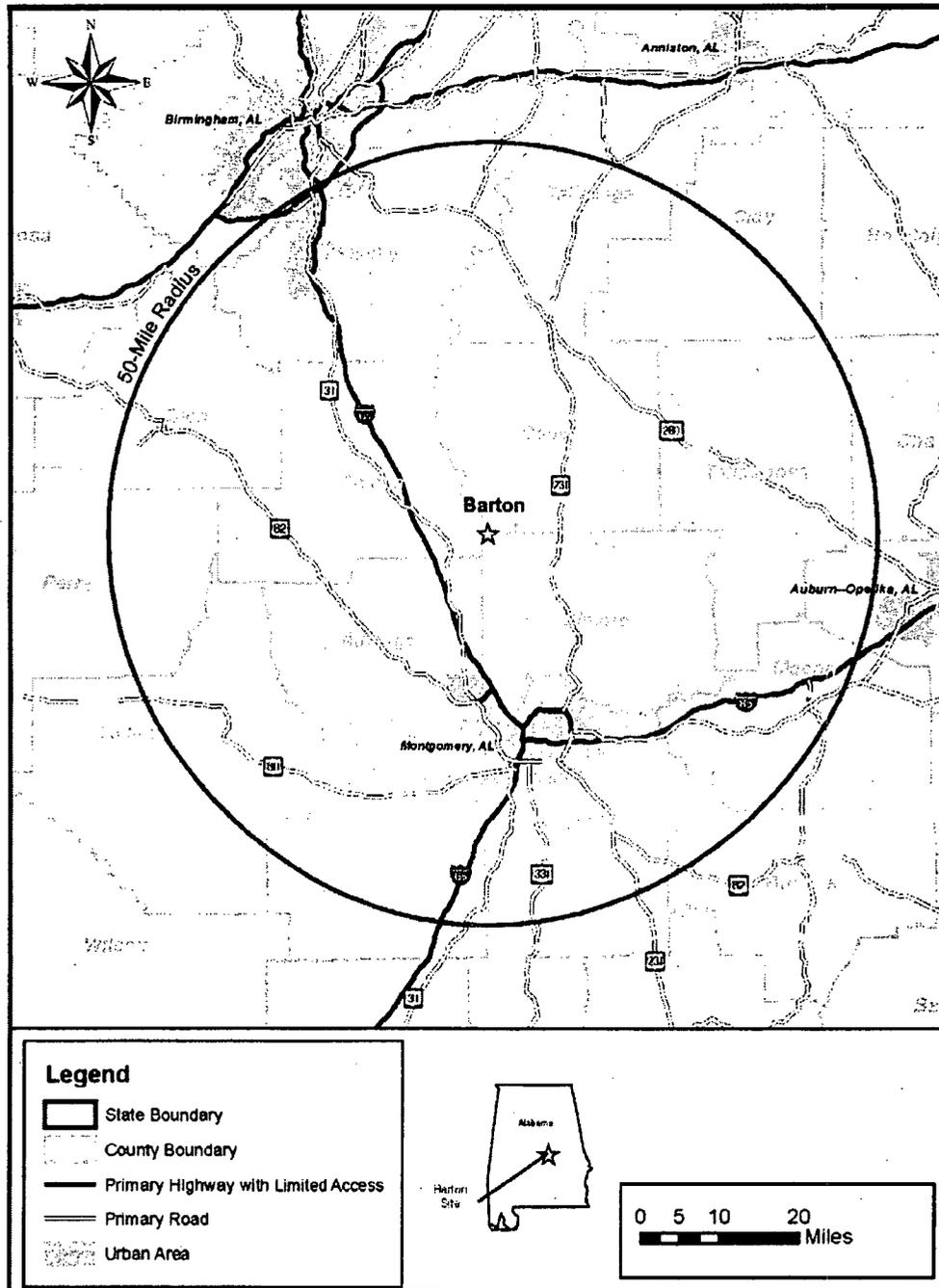


Figure 9-3. The Barton Site 80-km (50-mi) Vicinity (Southern 2008)

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connecting rail spur, requiring approximately 49 ha (120 ac), would be constructed to transport materials and equipment to the site.

The land in the vicinity of the Barton site is predominately wooded, with some agricultural land and a small amount urban. The Barton site is not subject to the Alabama Coastal Zone Program because the Program only applies in Baldwin and Mobile Counties (ADEM 2005).

Based on the information provided by Southern and NRC's own independent review, the staff concludes that the land-use impacts of constructing two new nuclear units at the Barton site would be MODERATE. Operational impacts would be SMALL.

Southern assumed that two 500-kV transmission lines requiring a 90-m (300-ft)-wide right-of-way would be needed to connect new generating units at the Barton site to Alabama Power Company's transmission system (Southern 2008). Southern assumed that the lines would connect to the substation at the Gaston Generating Plant, which is approximately 56 km (35 mi) north of the Barton site. Routing the new transmission lines to the Gaston Generating Plant would require about 515.2 ha (1273 ac) of transmission line right-of-way (Southern 2008). Southern would give consideration to avoiding possible conflicts with any natural or man-made areas where important environmental resources are located (Southern 2008). Route selection would also avoid populated areas and residences to the extent possible. Lands which are currently used for forests or timber production would be altered. Trees would be replaced by grasses and other low-growing types of ground cover. The new transmission line right-of-way would not be expected to permanently affect agricultural areas, but would have the potential to affect residents and forested land along the right-of-way. Southern would obtain needed State and Federal permits related to construction of a new transmission line. Based on the information it has available, the staff concludes that the transmission line land-use impacts of constructing new nuclear units at the Barton site would be MODERATE, and the operational impacts would be SMALL.

Chilton and Elmore Counties are designated as being unclassified or in attainment with the National Ambient Air Quality Standards (40 CFR 81.301). The air-quality impacts of constructing and operating two new nuclear units at the Barton site would be similar to the air-quality impacts at the VEGP site. The staff concludes that the air-quality impacts of constructing and operating two new nuclear units at the Barton site would be SMALL.

9.5.3.2 Water Use and Quality

The staff assumed that a new nuclear facility at the Barton site would withdraw all water required for the plant from the Coosa River upstream from Jordan Dam because groundwater yields at the site are very small. The staff computed the 7Q10 and 30Q2 based on data from USGS stream gage 0241100 (Coosa River at Jordan Dam near Wetumpka, Alabama). Data for the period from October 1974 to September 2005 were used to estimate the 7Q10 and 30Q2

values. The drainage area upstream of the flow gage was reported by the USGS to be 10,102 mi². The 7Q10 and 30Q2 values computed by the staff were 58.9 m³/s (2080 cfs) and 111 m³/s (3920 cfs), respectively. For the calendar years 1975 through 2005, the average annual mean discharge at the gage was 464.68 m³/s (16,410 cfs), and the minimum annual mean discharge was 152.97 m³/s (5402 cfs).

The net consumptive water loss for the site was assumed to be sum of the total groundwater withdrawal for the two nuclear units (0.20 m³/s [7 cfs; 3,140 gpm]) and the proposed wet tower consumptive use 1.76 m³/s (62 cfs), or a total of 1.95 m³/s (69 cfs). Expressed as a percentage of the 7Q10 and 30Q2, the consumptive water loss represents 3 percent and 2 percent, respectively, of the total flow in the Coosa River.

Any releases of contaminants to the waters of the State of Alabama would be regulated by the ADEM through the NPDES permit process to ensure that water quality is protected.

Based on the requirements of the NPDES permit and the above analysis, the staff concludes that the water-use and water-quality impacts of two nuclear units at the Barton site would be SMALL.

9.5.3.3 Terrestrial Resources

The Barton site is approximately 1130 ha (2800 ac) on the west bank of Jordan Reservoir between Chestnut Creek to the north and Jake Creek to the south. Land on this site is undeveloped and predominantly forested. Habitat consists of hardwoods, pines, and mixed hardwood/pine.

Forested habitats occupy the area for about 3.2 km (2 mi) surrounding the site, and land beyond 3.2 km (2 mi) of the site is predominately a mixture of forest and agriculture. Animal species that occur on the Barton site are those typically found in similar habitats in central Alabama, such as the opossum (*Didelphis virginiana*), eastern cottontail (*Sylvilagus floridanus*), gray squirrel (*Sciurus carolinensis*), raccoon (*Procyon lotor*), white-tailed deer (*Odocoileus virginianus*), and various reptiles, amphibians, and birds. Southern assumed that at least 223 ha (550 ac) of forest would have to be cleared for the construction of the Barton Nuclear Plant and associated facilities (Southern 2008).

There are 13 State-listed species that occur in counties within 16 km (10 mi) of the Barton site (Autauga, Chilton, Coosa, Elmore Counties) or in Talledega County, which the transmission line right-of-way would also presumably pass through. The following State-protected species occur in these counties: seal salamander (*Desmognathus monticola*), bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), osprey (*Pandion haliaetus*), Rafinesque's big-eared bat (*Corynorhinus rafinesquii*), southeastern pocket gopher (*Geomys pinetis*), southeastern bat (*Myotis austroriparius*), meadow jumping mouse

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(*Zapus hudsonius*), American alligator (*Alligator mississippiensis*), black-knobbed map turtle (*Graptemys nigrinoda*), Alabama map turtle (*Graptemys pulchra*), southern hognose snake (*Heterodon simus*), and alligator snapping turtle (*Macrolemys temminckii*) (ALNHP 2007).

Construction Impacts

The footprint of a new plant would be approximately 160 ha (400 ac) and an additional 61 ha (150 ac) would be required for temporary facilities and laydown yards. In addition, acreage would be required for roads, parking lots, and a switchyard. A 6.4 km (4 mi) paved road with a 30 m (100 ft) right-of-way would be constructed to provide vehicle access from State Road 22 to the Barton site. Development of the road would require approximately 20 ha (50 ac). A 9.7 km (6 mi) connecting rail spur, requiring approximately 49 ha (120 ac), would also be constructed to transport materials and equipment to the site (Southern 2008). The land surrounding the site is predominately forested and the staff assumes a large portion of the acreage needed for roads and the rail spur would require removal of forest habitat.

Southern assumed that two 500-kV transmission lines requiring a 90-m (300-ft)-wide transmission line right-of-way would be needed to connect new generating units at the Barton site to Alabama Power Company's transmission system. These lines would connect to the substation at the Gaston Generating Plant, which is approximately 56 km (35 mi) north of the Barton site near Wilsonville, Alabama. Routing the new transmission lines to the Gaston Generating Plant would require about 515.2 ha (1273 ac) of transmission line right-of-way. During routing, consideration would be given to avoiding possible conflicts with any natural or man-made areas where important environmental resources are located (Southern 2008).

Southern stated that land clearing associated with construction of the plant and transmission lines would be conducted according to Federal and State regulations, permit conditions, existing Southern procedures, good construction practices, and established BMPs (Southern 2008).

Based on the information provided by Southern and NRC's own independent review, the staff concludes that the impacts to terrestrial resources from construction of two new nuclear units at the Barton site would be MODERATE and construction associated with the creation of a new transmission line right-of-way impacts could be MODERATE.

Operational Impacts

Impacts on terrestrial ecological resources from operation of two new nuclear units at the Barton site include those associated with cooling towers and transmission lines. Impacts resulting from the operation of cooling towers and transmission lines would be of similar magnitude at all the alternative sites and cannot be used to discriminate between them. Therefore, operational impacts are discussed generically in Section 9.6.1.

Threatened and Endangered Species Impacts

Formal surveys for threatened and endangered species on the Barton site (Autauga, Chilton, Coosa, Elmore Counties) have not been conducted. However, Southern is not aware of any known occurrences of Federally listed threatened and endangered species onsite (Southern 2008). There are 13 Federally listed terrestrial plant and animal species recorded in counties within 16 km (10 mi) of the Barton site as well as Talledaga County, through which transmission lines from the Barton site would presumably pass. The following Federally listed terrestrial species occur in these counties: red-cockaded woodpecker (*Picoides borealis*), wood stork (*Mycteria americana*), Eastern indigo snake (*Drymarchon corais couperi*), Price's potato-bean (*Apios priceana*), Georgia rockcress (*Arabis georgiana*), Kral's water-plantain (*Sagittaria secundifolia*), green pitcherplant (*Sarracenia oreophila*), and Alabama canebrake pitcherplant (*Sarracenia rubra alabamensis*) (FWS 2007c). In addition, a query of the Alabama State Element Occurrence database found the Federally protected American alligator (*Alligator mississippiensis*), least tern (*Sterna antillarum*), grey bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), and the Georgia aster (*Symphotrichum georgianum*) as occurring in these counties (ALNHP 2007).

The NRC contacted the FWS (Daphne, Alabama) field office concerning Federally listed threatened and endangered species in the vicinity of the Barton site. The FWS provided preliminary comments on potential impacts to protected species by construction of two units at the site and the associated transmission lines (FWS 2006).

The FWS requested that surveys for Federally listed threatened and endangered species be conducted in suitable habitat that may be impacted by construction of the proposed project at the Barton site, including the new transmission line rights-of-way. Plant surveys need to be conducted when identifiable above-ground parts are present. These surveys should be conducted by a qualified botanist prior to any clearing or vegetative maintenance activity in the proposed transmission line right-of-way (FWS 2006).

Southern stated that field surveys would be conducted for Federally listed and State-protected species as part of the permitting process before any clearing or construction activities at the site and along associated transmission line rights-of-way and additional access roads. Land clearing associated with construction of the plant (including access roads) and transmission lines would be conducted according to Federal and State regulations, permit conditions, existing procedures implemented by Southern, good construction practices, and established BMPs (Southern 2008). Based on the information provided by Southern and NRC's own independent review, the staff concludes that the impacts to threatened and endangered species from construction of two new nuclear units at the Barton site and construction associated with addition of a new transmission line right-of-way could be SMALL to MODERATE.

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9.5.3.4 Aquatic Resources Including Endangered Species

The Barton site is located on the Jordan Reservoir, a 6800-ac impoundment on the Coosa River. The lake was created in 1928 by the Alabama Power Company to provide flood control and hydroelectric power.

The Jordan Reservoir is popular for various types of recreation including boating, swimming, and fishing. Common sports fish found in Lake Jordan include the Alabama spotted bass (*Micropterus punctatus*), largemouth bass (*M. salmoides*), hybrid striped bass (*Morone chrysops* x *M. saxatilis*), bluegill (*Lepomis macrochirus*), readear sunfish (*L. microlophus*), and black (*Pomoxis nigromaculatus*) and white crappie (*P. annularis*). Additional non-game fish include channel catfish (*Ictalurus punctatus*), blue catfish (*I. furcatus*), and flathead catfish (*Pylodictis olivaris*). The Alabama Wildlife and Freshwater Fisheries Division regularly stocks Jordan Reservoir with several bass species (ADCNR 2007).

A portion of Chestnut Creek runs through the northern section of the 1050-ha (2600-ac) Barton site and the entire site lies within the Chestnut Creek watershed. The *Lower Coosa River Basin Management Plan* (Delaney 2005) designates the Chestnut Creek watershed as a "high-priority watershed." The designation of "high priority" means that a watershed has the greatest number of features that could have a negative impact on the water quality within the watershed and typically the highest number of features to be protected. The classification is based on an 18-factor rating system that considers features such as land-use character, housing density, impaired waterbodies, and endangered species. The Chestnut Creek watershed scored the highest (negative impact) in the following areas: water-quality monitoring data, land-use character, soil suitability for development, increase in traffic volume, presence of a dam, housing density, septic system density, and number of endangered species.

The watershed also has water-quality issues associated with high nutrient levels and low dissolved oxygen (Delaney 2005). High nutrient levels can have a negative impact on oxygen levels necessary to sustain a healthy aquatic ecosystem. Excessive nutrient levels in a waterbody can result in excessive plant growth. The plants then consume more oxygen than they produce leading to depleted dissolved oxygen levels which in turn taxes the aquatic species that are dependent on oxygen for survival. Jordan Reservoir has developed this "eutrophic" characteristic, in spite of the water movement through the reservoir system (Hearn 1997; Delaney 2005)

Construction Impacts

If the proposed reactors were to be constructed at the Barton site, it is assumed that Jordan Reservoir would be used as a source for cooling water. Construction of a cooling water intake structure would result in temporary displacement of fish within the vicinity of the intake construction area. It is expected that these fish would return to the area once construction was

complete. Sedimentation due to disturbances of the river bank and bottom could impact local benthic species, such as mussels. Surveys of the area of disturbance would be conducted before construction to characterize the impacted populations and create a plan to mitigate the temporary construction impacts (Southern 2008). Based on information provided by Southern and NRC's own independent review, the staff concludes that if BMPs are used, construction impacts to aquatic resources at Barton site would be SMALL.

Construction of two 500-kV transmission lines requiring a 90-m (300-ft)-wide right-of-way could have impacts to aquatic habitats along the right-of-way. Because no information on the routing has been provided, the impacts to the aquatic ecosystem in waterbodies crossed by the new right-of-way is not known. However, Southern has indicated that field surveys would be conducted and BMPs would be employed during right-of-way construction. Based on this information and NRC's own independent review, the staff concludes that construction impacts to aquatic resources during transmission line construction would be SMALL to MODERATE, depending on the transmission right-of-way routing.

Operational Impacts

The aquatic impact most likely to occur from operation of a new facility on the Barton site would be entrainment and impingement of organisms from Jordan Reservoir. Assuming a closed-cycle cooling system, a maximum through-screen velocity of 0.15 m/s (0.5 ft/s) at the cooling water intake with an intake flow of less than or equal to 5 percent of the mean annual flow of the Coosa River, and a design and location of the new intake that is consistent with the existing intake, the anticipated impacts to aquatic populations from entrainment and impingement are expected to be minor. Operational impacts associated with water use and discharge cannot be determined without additional detailed analysis. However, based on the information provided by Southern and NRC's own independent review of reconnaissance-level information, as well as the staff's experience from other facilities, the staff concludes that with proper design, the impacts to aquatic resources from operation of two new nuclear units at the Barton site would likely be SMALL.

The staff also concludes that operational impacts to aquatic biota from the transmission lines would also be SMALL assuming that BMPs are used for maintenance.

Threatened and Endangered Species

The FWS and Alabama Natural Heritage Program (ALNHP) list several protected species of fish, snails, and mussels within the three counties encompassed by the site and counties in which transmission lines would traverse (Table 9-6). However, none of these species is recently known to occur within an area that would be directly impacted by the Barton facility construction. Protected species known to currently inhabit the Coosa River or associated creeks are found in areas below the Jordan Dam or above the Mitchell Dam.

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The NRC contacted the FWS (Daphne, Alabama) field office concerning Federally listed threatened and endangered species in the vicinity of the Barton site. The FWS provided preliminary comments on potential impacts to protected species by construction of two units at the site and the associated transmission lines (FWS 2006). The area of greatest concern to the FWS is within the Coosa River, downstream of Jordan Dam. This reach of the river is a high-priority restoration area for the FWS and State of Alabama and is considered a classic example of "big river" habitat. The FWS, State, and Alabama Power Company spent many years coordinating efforts to ensure stabilization of habitat downstream of the dam with hopes of recolonization or reintroduction of species. This reach of the river is also habitat for several protected species and is designated as a critical habitat for nine mussel species. Critical habitat is a specific geographic area that provides essential elements necessary for survival of a threatened and endangered species. These habitats can be currently occupied by a protected species or used for reintroduction of a species to aid in its recovery.

Table 9-6. Aquatic Threatened and Endangered Species Within Vicinity of the Barton Site

Species		Alabama State Status	Federal Status	County of Occurrence
Fish				
Alabama sturgeon	<i>Scaphirhynchus suttkusi</i>	Protected	Endangered	Autauga, Elmore
Alabama shad	<i>Alosa alabamae</i>	Protected		Elmore
blue shiner	<i>Cyprinella caerulea</i>	Protected	Threatened	Coosa, Talladega
coldwater darter	<i>Etheostoma ditrema</i>	Protected		Chilton, Coosa, Talladega
crystal darter	<i>Crystallaria asprella</i>	Protected		Elmore
paddlefish	<i>Polyodon spathula</i>	Protected		Elmore
slackwater darter	<i>Etheostoma boschungii</i>	Protected	Threatened	Talladega
Invertebrates				
Coosa moccasinshell mussel	<i>Medionidus parvulus</i>	Protected	Endangered	Talladega
fine-lined pocketbook mussel	<i>Lampsilis altilis</i>	Protected	Threatened	Chilton, Coosa, Elmore, Talladega
interrupted rocksnail	<i>Leptoxis formani</i>	Protected	Candidate	Elmore
lacy elimia	<i>Elimia crenatella</i>	Protected	Threatened	Talladega
painted rocksnail	<i>Leptoxis taeniata</i>	Protected	Threatened	Chilton, Elmore, Talladega
rough hornsnail	<i>Pleurocera foremani</i>	Protected	Candidate	Elmore
silt elimia	<i>Elimia haysiana</i>	Protected		Elmore
southern clubshell	<i>Pleurobema decisum</i>	Protected	Endangered	Talladega
southern pigtoe	<i>Pleurobema georgianum</i>	Protected	Endangered	Coosa, Talladega
spotted rocksnail	<i>Leptoxis picta</i>	Protected		Elmore
triangular kidneyshell	<i>Ptychobranhus greenii</i>	Protected	Endangered	Talladega
tulotoma snail	<i>Tulotoma magnifica</i>	Protected	Endangered	Coosa, Elmore, Talladega

Table 9-6. (contd)

Species Plant	Alabama State Status	Federal Status	County of Occurrence
Kral's water-plaintain FWS 2007c; ALNHP 2007	<i>Sagittara secundifolia</i>	Threatened	Coosa

Water-quality impacts to aquatic populations downstream of the Jordan Dam cannot fully be determined without additional detailed analysis. Such analysis would be conducted if the Barton site were selected for the new units. However, based on the location of the threatened and endangered species in the area (downstream of Jordan Dam) and because no new construction would occur in that area, and operational impacts are anticipated to be minor. The NRC staff concludes that the impacts to threatened and endangered species from construction or operation at the Barton site would be SMALL.

9.5.3.5 Socioeconomics

In evaluating the socioeconomic impacts of construction at the Barton site, Southern undertook a "reconnaissance" survey of the site using readily obtainable data from the Internet or published sources. The staff conducted some local interviews with knowledgeable local officials. The socioeconomic subsections follow the organizational structure of the socioeconomic discussions in Sections 2.8, 4.5, and 5.5. The impacts expected from both construction and operation are discussed.

Physical Impacts

Construction activities can cause temporary and localized physical impacts such as noise, odor, vehicle exhaust, vibration, shock from blasting, and dust emissions. The use of public roadways and railways would be necessary to transport construction materials and equipment. The majority of construction activities would occur within the boundaries of the Barton site. However, an access road and a connecting rail spur (requiring about 69 ha [170 ac]) would be constructed on lands adjacent to the site. These new transportation rights-of-way would be routed to avoid residences and populated areas. Offsite areas that would support construction activities (for example, borrow pits, quarries, and disposal sites) are expected to be already permitted and operational. Impacts on those facilities from construction of new nuclear units would be small incremental impacts associated with their normal operation (Southern 2008).

Potential impacts from station operation include noise, odors, exhausts, thermal emissions, and visual intrusions. The proposed project would produce noise from the operation of pumps, fans, transformers, turbines, generators, and switchyard equipment. Traffic at the site would also be a source of noise. However, noise attenuates quickly so ambient noise levels would be minimal at the site boundary. Also, the Barton site is located in a rural area surrounded by forests and

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agricultural land, with few residents in the area. Commuter traffic would be controlled by speed limits. Good road conditions and appropriate speed limits would minimize the noise level generated by the workforce commuting to the site (Southern 2008).

New nuclear units would have standby diesel generators and auxiliary power systems. Permits obtained for these generators would ensure that air emissions comply with applicable regulations. In addition, the generators would be operated on a limited, short-term basis. During normal plant operation, the nuclear units would not use a significant quantity of chemicals that could generate odors that exceed odor threshold values. Good access roads and appropriate speed limits would minimize the dust generated by the commuting workforce. Construction activities would be temporary and would occur mainly within the boundaries of the Barton site. Offsite impacts would represent small incremental changes to offsite services supporting the construction activities. During station operations, ambient noise levels would be minimal at the site boundary. Air-quality permits would be required for the diesel generators, and chemical use would be limited, which should limit odors. Therefore, the physical impacts of construction and operation would be SMALL.

Aesthetics

The construction and operation of new nuclear units at the Barton site would have impacts on aesthetic and scenic resources. With the exception of the intake and outfall structures, which would be located on the west bank of the Jordan Reservoir, all facility structures would be built near the center of the site, which is relatively hidden from view of the public with trees and other foliage. From Jordan Reservoir, the plant may be visible from certain angles, although from most points the structures would be hidden by elevated terrain, trees, and other foliage. The intake and outfall would be visible from portions of the reservoir that are near the site.

The upper portions of facility structures may be visible from elevated areas near the site. There would be occasional visible plumes associated with the cooling towers. The visibility of the plumes would be dependent upon the weather and wind patterns, and the location of the viewer within the general topography of the area.

Southern assumed that two 500-kV transmission lines, requiring a 90-m (300-ft) wide right-of-way would be needed to connect new generating units at the Barton site to Alabama Power Company's transmission system (Southern 2008). MODERATE aesthetic impacts are expected as a result of building and operating the new transmission line that would be installed in a 515-ha (1273-ac) right-of-way to connect to the substation at Gaston Generating Plant, approximately 56 km (35 mi) north of the Barton site. Impacts on aesthetic resources are considered to be moderate if some complaints arise about diminution in the enjoyment of the physical environment and measurable impacts that do not alter the continued functioning of socioeconomic institutions and processes. Construction and operation of an industrial facility on a previously undeveloped site and new transmission lines would likely result in some complaints

from the affected public regarding diminution in the enjoyment of the physical environment (Southern 2008). Therefore, impacts of construction and operation of the proposed project at the Barton site and additional transmission lines on aesthetics would be MODERATE and could warrant mitigation.

Demography

The Barton site is a greenfield site located in Chilton and Elmore Counties, Alabama. The population distribution around the site is relatively low and dispersed with typical rural characteristics. Based on the 2000 Census data, the total population of the four counties in the site region was approximately 161,340: 43,671 in Autauga County, 39,593 in Chilton County, 12,202 in Coosa County and 65,874 in Elmore County. The population within 80 km (50 mi) of the site was 735,226 (36.6 persons per km²), and the population within 32 km (20 mi) of the site was 90,677 (28.2 persons per km²). The nearest population center, as defined in 10 CFR 100.3 is Montgomery, Alabama (population 201,568), located approximately 43 km (27 mi) south of the site (Southern 2008).

Due to the proximity of the Barton site to Montgomery as well as to Birmingham (approximately 80 km [50 mi] to the northwest with a population of 242,820), the most populous metropolitan areas in Alabama, it is expected that a significant number of the construction workers could be drawn from the regional labor pool (USCB 2007b). It would also be expected that most of the in-migrating construction workers would choose to locate in or near these larger cities, because they are within commuter distance to the plant, and the housing and amenities would be relatively plentiful. Some employees relocating to the region would also choose to reside in more rural locations; however, there is no reason to believe they would concentrate in any particular region; thus, the population impacts would be dispersed. Even when assuming the relatively high in-migration estimates presented in 4.5.2 (5500), the total influx of workers and families would represent less than a 1 percent increase in population in the 80-km (50-mi) region; therefore, the NRC staff concludes that the demographic impacts of constructing two new units at the Barton site would be SMALL.

Approximately 952 workers (812 operations personnel plus 140 security personnel) would be required for the operation of new generating units at the Barton site (Southern 2008). Most employees relocating to the region would likely move to the larger metropolitan areas and the remainder would be scattered throughout the counties in the region. If all 952 employees and their families were to come from outside the region, the potential increase in population in the most impacted counties would not be substantial. Overall, the potential increases in population would represent a SMALL increase in the total population for the most impacted counties.

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Social and Economic Impacts

Economy

Based on 2000 census data within the four counties surrounding the Barton site, 74,683 persons are in the labor force. The overall unemployment rate for the region is lower than that of the State, which is 6.2 percent. Elmore County's business profile is led by educational, health, and social services (16.8 percent of the county's total employment), followed by manufacturing (14.5 percent), and retail trade (12.0 percent). The unemployment rate for Elmore County in 2000 was 5.0 percent. In neighboring Chilton County, the business profile is led by manufacturing (16.9 percent of the county's total employment), followed by educational, health, and social services (14.7 percent), and construction (13.1 percent). The unemployment rate in Chilton County was 4.3 percent in 2000 (Southern 2008).

The wages and salaries of the operating workforce would have a multiplier effect that could result in increases in business activity, particularly in the retail and service sectors. This would have a positive impact on the business community and could provide opportunities for new businesses to get started, and increased job opportunities for local residents. The economic effect on the 80-km (50-mi) region would be beneficial. It is likely that the marginal impacts associated with construction of two new units at the Barton site would be beneficial to the region; however, considering that the region is relatively economically diverse, with a plentiful job supply, these impacts would be SMALL and beneficial as a result of interacting with a relatively robust economic base in the region.

Taxes

Southern anticipates that it would pay annual property taxes to Chilton and Elmore Counties, beginning during construction of the proposed project at the Barton site. Alabama assesses property at 30 percent of its value. Assuming a 40-year operational life, property taxes that would be split between Chilton and Elmore Counties could average between \$15,000,000 and \$21,500,000 annually for the first decade of operations and between \$3,000,000 and \$4,000,000 for the last decade of operations, based on the changing value of the plant (Southern 2008). Chilton and Elmore Counties have experienced rapid growth over the past few years; consequently, it is difficult to predict the degree of impact that the Barton site would have on the tax base for these counties. Assuming that the valuation of the new nuclear units at the Barton site would be similar to the Plant Farley Nuclear Plant in Houston County, tax payments for the site could represent 20 to 30 percent of the tax revenue for these counties (Southern 2008). Therefore, the NRC staff concludes that the potential beneficial impacts of taxes collected during construction and operation of the proposed project at the Barton site

would be MODERATE and beneficial in Chilton and Elmore Counties and SMALL and beneficial in the remainder of the 80-km (50-mi) region.

Summary of Social and Economic Impacts

Based on information provided by Southern and NRC's own independent review, the staff concludes that impacts on social and economic resources from construction and operation of two new nuclear units at the Barton site would be MODERATE and beneficial in Chilton and Elmore Counties and SMALL and beneficial elsewhere in the 80-km (50-mi) region.

Infrastructure and Community Services

Transportation

Road access to the Barton site would be via State Road 22, which has an east-west orientation. State Road 22 passes through the town of Rockford, Alabama to the east and merges with U.S. Highway 31 about one mile north of the town of Verbena, Alabama. Employees traveling from Birmingham and other towns north of the site would access State Road 22 from U.S. Highway 31. Employees traveling from Montgomery, Alabama and other towns south of the site would access State Road 22 from U.S. Highway 31 via State Road 111 or State Road 143. All roads on these travel routes are two-lane paved roads. The Alabama Department of Transportation does not maintain level-of-service designation for roadways in the State. However, a daily average of 1580 cars traveled State Road 22 near the Barton site in 2004. Assuming construction shifts as described in Section 4.5.4.1, an additional 1750 cars could be on a two-lane highway during shift changes, causing potential congestion. Also, the traffic of hauling construction materials (100 trucks per day) to the site could bring additional congestion to State Road 22, U.S. Highway 31 and State Roads 111 and 143 during certain times of the day (Southern 2008).

Impacts of construction on transportation would be MODERATE and some mitigating actions would be needed.

With respect to the operations of the facility, adding at most an additional 860 cars (assuming a single occupant per car and shift changes assumed in Section 5.5.4.1) to the existing 1580 cars per day on the road would not materially congest the highway. Shift changes for the proposed project at the Barton site could be staggered so that the traffic increase would not cause congestion, which would be particularly important during the outage periods when nearly 1000 additional temporary contract workers are employed to perform outage operations. Impacts of the commuting workforce on transportation would be MODERATE during the construction phase and SMALL during the operation of the plant.

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Recreation

The Barton site is currently undeveloped and is used by hunters. Construction and operation of new nuclear units on the site would exclude the entire 1130 ha (2800 ac) from hunting and other recreational use for at least the estimated 40-year life of the plant.

The developed areas at the Barton site would be located near the center of the property, with the area immediately adjacent to the Jordan Reservoir mostly undeveloped. The remainder of the site would consist of forested areas, ponds, and open fields. The Jordan Reservoir is relatively undeveloped, particularly in the upper half of the reservoir, where the Barton site is located; however, there are some higher-end homes immediately adjacent to the Barton site. The reservoir offers opportunities for wildlife viewing, camping, boating, fishing, and other recreation (Southern 2008).

Two Alabama Power Company reservoirs are in the vicinity of the Barton site in addition to the Jordan Reservoir: Lay Lake and Mitchell Lake. Both reservoirs have recreational uses including camping, boat ramps, marinas, picnic areas, playgrounds, swimming areas, and trails. Mitchell Lake is located about 7.2 km (4.5 mi) upstream of the Barton site in Chilton and Coosa Counties, Alabama. The upper portions of facility structures and occasional plumes from the cooling towers may be visible from elevated areas near Mitchell Dam. No other impacts on Mitchell Lake's recreation areas would be expected. Lay Lake is located more than 29 km (18 mi) upstream of the Barton site in Chilton, Coosa, and Shelby Counties, Alabama. Construction and operation of the proposed project at the Barton site would not impact recreation areas on Lay Lake because of its distance from the Barton site (Southern 2008). Impacts on tourism and recreation are considered small if current facilities are adequate to handle local levels of demand. Therefore, impacts of facility construction and operation would be SMALL.

Housing

In 2000, the U.S. Census reported that Chilton County had 17,651 housing units, 2364 of which (13.4 percent) were vacant. Elmore County had 8037 housing units, 1512 of which (18.8 percent) were vacant, Autauga County had 17,660 housing units with 1659 vacant (9.4 percent), and Coosa County had 6142 housing units with 1460 vacant (23.8 percent). Assuming that the construction workforce would commute from the area within an 80-km (50-mi) radius of the Barton site, which has a population of 735,226, there would be few discernible impacts on housing availability, rental rates or housing values, or housing construction or conversion. Those who choose to relocate to the region would find adequate housing available (Southern 2008). Therefore, NRC staff concludes that impacts on housing in the region from constructing and operating two new reactors on the Barton site would be SMALL.

Public Services

Public services include water supply and wastewater treatment facilities; police, fire and medical facilities; and social services. It is likely that new operations and construction employees relocating from outside the region would live in residentially developed areas with well established public utilities and community services. Beyond Birmingham and Montgomery (the two largest cities in the region), there are several mid-sized communities with public utility and community services from which an in-migrating family could choose to settle including Clanton (population 7800) in Chilton County, Milbrook (population 10,386) in Autauga County, Alexander City (population 15,008) in Tallapoosa County, and Sylacauga (population 12,616) in Talladega County (USCB 2007b). The construction and operation of new nuclear units at the Barton site would not likely use municipal water and treatment systems. It is not expected that public services would be materially impacted by the influx of construction or operations workers and their families and public service impacts are considered SMALL.

Education

Chilton County has 12 schools with a total enrollment of 7210, while Elmore County has two school districts with 18 schools between them and a total enrollment of 12,136. In addition, the neighboring Montgomery school district has 63 schools with a total enrollment of 31,985 (NCES 2007). It is unlikely that the influx of construction workers, even assuming the relatively high in-migration estimates from 4.5.3.7 (1100 school-aged children), would noticeably impact this region due to the number of schools and educational resources in the region. Likewise, the smaller influx of workers and families that would move into the region to operate the plant would only impose SMALL impacts on education.

Summary of Infrastructure and Community Services

Based on information provided by Southern and NRC's own independent review, the staff concludes that impacts on infrastructure and community services from construction and operation of two new nuclear reactors at the Barton site would be SMALL to MODERATE.

Summary of Socioeconomics

In summary, based on the information provided by Southern and NRC's own independent review, the staff concludes that the socioeconomic impacts of the construction and operations on the region surrounding the Barton site would be SMALL with the following exceptions. The impacts on the tax revenue impacts of Chilton and Elmore Counties would be MODERATE and beneficial. The impacts on transportation near the plant during construction would likely be MODERATE during construction. Some additional transportation upgrades may be necessary. Impacts to aesthetics would be MODERATE and recreational resources would be SMALL and occur during both construction and operation of the new reactors.

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9.5.3.6 Historic and Cultural Resources

The likely footprint for the proposed plant at the Barton greenfield site does not appear to have any historic properties located within areas likely to be impacted by new construction and operations. Miscellaneous archaeological surveys conducted over the years in the area indicate that while sites may exist on the premises, either the sites are not eligible for listing on the National Register of Historic Places or are located away from likely areas of new construction. Protective measures would be put in place in the event that historic or archaeological materials are discovered during construction or during operations. In the event that an unanticipated discovery is made, site personnel would be instructed to notify the SHPO and would consult with them in conducting an assessment of the discovery to determine if additional work is needed. The impacts to historical and cultural resources are predicted to be SMALL at the Barton site.

9.5.3.7 Environmental Justice

The 2000 Census and block groups were used for ascertaining minority and low-income populations in the area. There are 577 block groups within an 80-km (50-mi) radius of the Barton site. Black minority populations exist in 207 block groups; and "Aggregate of Minority Races" populations exist in 200 block groups. No other minority populations exist in the geographic area. The Census Bureau data characterize 16.67 percent of Alabama households as low income. There are 59 block groups that contain a low-income population percentage that exceeds the State average by 20 percent. There are no minority or low-income populations within a 10-km (6-mi) radius of the Barton site (Southern 2008).

Construction activities (noise, fugitive dust, air emissions, traffic) would not disproportionately impact minority populations because of their distance from the Barton site. Operation of the proposed project at the Barton site is also unlikely to have a disproportionate impact on minority or low-income populations. A review of environmental assessments and planning documents for projects in the Coosa River basin and adjacent lands identified no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing through which the populations could be disproportionately affected. In addition, no location-dependent disproportionate impacts affecting these minority and low-income populations have been identified (Southern 2008).

Based on the information provided by Southern and NRC's own independent review, the staff concludes that the offsite impacts of construction and operation of two new units at the Barton site to minority and low-income populations would be SMALL. No adverse and disproportionately high impacts were identified.

9.6 Issues Among Sites Handled Generically

In evaluating the alternative sites, the staff found certain impacts would not vary among sites, and, as a result, would not affect the evaluation of whether an alternative site is environmentally preferable to the proposed site. These impacts include some operational terrestrial impacts, some areas of socioeconomic; nonradiological and radiological effects on members of the public, workforce, and biota; postulated accidents. As a result, the impacts of these five impact categories are not evaluated as part of the site-specific alternatives analysis. In addition, there were generic aspects of other impact categories that were not included in the discussions of each site. Instead, they are discussed generically in the following subsections.

9.6.1 Terrestrial Ecology

Terrestrial ecological impacts that may result from operation of new nuclear units at the alternative sites include those associated with cooling towers, transmission system structures, and maintenance of transmission line rights-of-way. An evaluation of impacts resulting from operation of cooling towers and transmission lines and transmission line right-of-way maintenance cannot be conducted in any detail due to missing information, such as the type, number, and specific location of cooling towers at each alternative site, and locations of any new rights-of-way that could result from transmission system upgrades. Consequently, conclusions in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437 (NRC 1996) were used to assess terrestrial impacts resulting from the operation of cooling towers and impacts from transmission line rights-of-way maintenance and operation.

NUREG-1437 (NRC 1996) evaluated terrestrial ecological impacts resulting from operation of existing nuclear power plants. Because the types of terrestrial ecological impacts resulting from operation of new nuclear units would be similar to those of existing nuclear power plants, NUREG-1437 (NRC 1996) is useful for this analysis.

For impacts resulting from transmission line operation and transmission line right-of-way maintenance, the staff assumed that the existing transmission lines at the Plant Farley and Plant Hatch sites would not have the capacity to carry the power that would be generated by new nuclear units. Construction of the proposed project at either site would require the addition of a new transmission line that would result in either an expansion of the existing rights-of-way or construction of a new transmission line right-of-way. Barton is a greenfield site and new transmission line rights-of-way would be required. Given these assumptions, conclusions in NUREG-1437 (NRC 1996) were used for impacts resulting from transmission line operation and transmission line right-of-way maintenance.

9.6.1.1 Cooling Towers

Impacts on crops, ornamental vegetation, and native plants from cooling tower drift cannot be evaluated in detail in the absence of information on the type (mechanical or natural draft), number, and specific location of cooling towers at each alternative site. Similarly, bird collisions with cooling towers cannot be evaluated in the absence of information on the type (mechanical or natural draft for a wet cooling system; dry for a dry system) and number of cooling towers at each alternative site. The impacts of cooling tower drift and bird collisions for existing power plants were evaluated in NUREG-1437 (NRC 1996) and found to be of minor significance for all plants, including those with various numbers and types of cooling towers. On this basis, the staff concludes, for the purpose of comparing the alternative sites, that the impacts of cooling tower drift and bird collisions with cooling towers resulting from operation of new nuclear units at all of the alternative sites would be minor.

The effects of noise on most wildlife species are poorly understood partly because noise disturbance cannot be generalized across species or genera, and there may be response differences among individuals or groups of individuals of the same species (Larkin et al 1996; AMEC Americas Limited 2005). An animal's response to noise can depend on a variety of factors including the noise level, frequency distribution, duration, existence of background noise, time of year, animal activity, age, and sex (AMEC Americas Limited 2005). The potential effects of noise on wildlife include acute or chronic physiological damage to the auditory system, increased energy expenditure, physical injury incurred during panicked responses, and interference with normal activities, such as feeding, impaired communication among individuals and groups (AMEC Americas Limited 2005). The impacts of these effects might include habitat loss through avoidance, reduced reproductive success and mortality. Long term noise thresholds are not established for wildlife, evidence for habituation is limited, long-term effects are generally unknown, and how observed behavioral and physiological response might be manifested ecologically and demographically are poorly understood (AMEC Americas Limited 2005).

The noise levels from natural draft cooling tower operation and diesel generators are estimated to be approximately 55 decibels (dBA) SPL (Sound Pressure Level) at 300 m (1000 ft) (Southern 2008a). Researchers have found that dBA measurements contain frequencies out of the hearing bandwidth of birds and some mammals and are not inclusive of the total hearing range for other animals. Because of this, the dBA weighting system does not accurately characterize sound exposure or hearing response for wildlife (Dooling 2002; AMEC Americas Limited 2005). Natural-draft cooling towers emit broadband noise spectrally very similar to environmental (wind) noise. In the case of relatively flat spectra the spectrum level of cooling tower and diesel generator noise given the estimated dBA SPL would be approximately 15 dB SPL. Cooling tower noise does not change appreciably with time (steady state) and the estimated noise level at 300m is well below the 80-to- 85-dBA SPL threshold at which birds and small mammals are startled or frightened (Golden et al. 1980). Using the startle criterion

reported by Golden et al., the noise level expected to be generated by cooling tower and diesel generated operations would only approach startle levels in the immediate vicinity (within 5m for noise with approximately 60 dBA SPL at 300 m) of the tower or generator. In addition, birds and other animals show habituation to acoustic deterrents (complex sounds designed with spectral components to be within the hearing band of the target animal). Thus, noise generated by natural draft cooling towers would be unlikely to disturb transient wildlife beyond the site perimeter fence. Seasonally or long-term resident wildlife could be expected to habituate to cooling tower and generator noise.

Wildlife may also be affected by noise "masking" hearing of important sounds to which the animal would react if they were heard. The approach of a predator would be one such sound. In general, masking of signals in the frequency range of greatest sensitivity of an animal is probably more important to the well being of the animal than are sounds which evoke a behavioral (startle) response causing the animal to move away from the sound source (Dooling 2002). The potential for some level of masking, particularly at frequencies above 2 or 3 kHz is likely within and external to the site perimeter. Nevertheless, the loss of individuals due to this phenomenon would be localized and would be expected to have a minimal impact on overall population health.

Transmission Lines

The impacts associated with transmission line operation consist of bird collisions with transmission lines and electromagnetic field (EMF) effects on flora and fauna. The impacts associated with right-of-way maintenance activities are alteration of habitat due to cutting and herbicide application, and similar related impacts where rights-of-way cross floodplains and wetlands.

Bird collisions with transmission lines are of minor significance at operating nuclear power plants, including transmission line rights-of-way with variable numbers of power lines (NRC 1996). Although additional transmission lines would be required for new nuclear units at the alternative sites, increases in bird collisions would be minor and these would likely not be expected to cause a measurable reduction in local bird populations. Consequently, the incremental number of bird collisions posed by the addition of new transmission lines for new nuclear units would be negligible at all the alternative sites.

EMFs are unlike other agents that have an adverse impact (e.g., toxic chemicals and ionizing radiation) in that dramatic acute effects cannot be demonstrated and long-term effects, if they exist, are subtle (NRC 1996). A careful review of biological and physical studies of EMFs did not reveal consistent evidence linking harmful effects with field exposures (NRC 1996). The impacts of EMFs on terrestrial flora and fauna are of small significance at operating nuclear power plants, including transmission systems with variable numbers of power lines (NRC 1996). Since 1997, more than a dozen studies have been published that looked at cancer in animals that were exposed to EMFs for all or most of their lives (Moulder 2005). These studies have

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found no evidence that EMFs cause any specific types of cancer in rats or mice (Moulder 2005). Therefore, the incremental EMF impact posed by addition of new transmission lines for new nuclear units would be negligible at all the alternative sites.

Existing roads providing access to the existing transmission line rights-of-way at the alternative sites would likely be sufficient for use in any expanded rights-of-way; however, new roads would be required during the construction of new transmission line right-of-way. Transmission line right-of-way management activities (cutting and herbicide application) and related impacts to floodplains and wetlands in transmission line rights-of-way are of minor significance at operating nuclear power plants, including those with transmission line rights-of-way of variable widths (NRC 1996). Consequently, the incremental effects of transmission line right-of-way maintenance and associated impacts to floodplains and wetlands posed by expanding existing rights-of-way or the addition of a new transmission line right-of-way for new nuclear units would be negligible at all the alternative sites.

Conclusion

Based on information provided by Southern and NRC's own independent review, the staff concludes that the impacts from operation of new nuclear units (including cooling towers, transmission lines, and transmission line rights-of-way) at any of the alternative sites would be SMALL.

9.6.2 Socioeconomics

There are several physical impacts with socioeconomic consequences where generic treatment of issues related to construction and operation of new nuclear units is appropriate.

9.6.2.1 Physical Impacts

Many of the physical impacts of construction and operation would be similar regardless of the sites. People who work or live around the alternative sites could be exposed to noise, fugitive dust, and gaseous emissions from construction activities. Construction workers and personnel working onsite could be the most impacted. Air-pollution emissions are expected to be controlled by applicable BMPs and Federal, State, and local regulations. During station operation, standby diesel generators used for auxiliary power would have air-pollution emissions. It is expected that these generators would see limited use and, if used, would be used for only short time periods. Applicable Federal, State, and local air-pollution requirements would apply to all fuel-burning engines. At the site boundary for most sites, the annual average exposure from gaseous emission sources is anticipated not to exceed applicable regulations during normal operations. The impacts of station operations on air quality are expected to be minimal. As with construction impacts, potential offsite receptors are generally located well away from the site boundaries.

Residential and commercial areas are located away from the alternative site boundaries, applicable air-pollution regulations would have to be met by Southern, and applicable BMPs would be put in place. Therefore, based on information provided by Southern and NRC's own independent review of reconnaissance-level information, the staff concludes that the physical impacts of station construction and operation on workers and the local public would be **SMALL**.

Construction activities and station operations are not expected to impact any offsite buildings. Most buildings not located onsite are well removed from the site boundaries. Buildings most vulnerable to shock and vibration from pile-driving and other related activities are those located on the alternative sites. No physical impacts to structures, including any residences near the site boundaries, would be expected. Therefore, based on NRC's own independent review of reconnaissance-level information, the staff concludes that the physical impacts of station construction and operation on offsite buildings would be **SMALL**.

Roads

During construction, additional cars and trucks were assumed to use the roads in the vicinity of each alternative site. This is in addition to the existing operations workforce at most of the alternative sites and the approximately 1000 temporary workers hired during refueling outages. Heavy loads of construction materials and equipment and the increased traffic might necessitate additional maintenance and repair of roads. Certain road upgrades, such as such installing turn lanes, staggering workforce shifts, and providing incentives to car pool, could mitigate some of these impacts. Based on NRC's own independent review of reconnaissance-level information, including visits to the alternative sites, the staff concludes that the physical impacts of construction on roads in the vicinity of the alternative sites would be **MODERATE** unless at least some of the identified mitigation measures are implemented.

During station operations, the roads and highways within the vicinity of the alternative sites would experience an increase from the addition of operations personnel. This is in addition to the existing operations workforce at the current operating units at each of the sites, except for the Barton site, which is a greenfield site. In addition, approximately 1000 temporary workers are hired for refueling outages. In all cases, the increase in road traffic due to the additional operations workforce would be well below current road capacities; therefore, the staff concludes that the physical impacts of operations on roads would be **SMALL**, and that mitigation would not be warranted.

Aesthetics

Construction at all the alternative sites could be viewed from outside the sites at certain locations. All sites are located in rural areas with sparse residential or commercial development near the site. Construction of cooling-water intake structures could impact the body of water within which the construction takes place. The impacts could increase suspended solids

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concentrations in the waterbodies and fish species might be temporarily displaced as a result of minor disturbances associated with construction activities, including noise, dredging, etc. This in turn could impact recreation and recreational opportunities such as fishing. However, such impacts are transitory and are not expected to have any long-term, permanent consequences. Onsite erosion and stormwater runoff control measures would be expected to be implemented in accordance with State and Federal regulations. Any construction impacts on the view would be temporary. Based on NRC's own independent review of reconnaissance-level information, including visits to the alternative sites, the staff concludes that the impacts of construction on aesthetics would be SMALL at all sites.

Demography, Infrastructure, and Community Impacts

Because of the dissimilarities among the sites, the demographic, infrastructure and community impacts of each of the alternative sites has been covered in the site-specific discussions.

9.6.3 Nonradiological Health Impacts

Nonradiological health impacts from construction of two new nuclear units on the construction workers at the alternative sites would be similar to those evaluated in Section 4.8. They include occupational injuries, noise, odor, vehicle exhaust, and dust. Applicable Federal and State regulations on air quality and noise would be complied with during the plant construction phase. None of the alternative sites have site characteristics that would be expected to lead to fewer or more construction accidents than would be expected for any of the other alternative sites. All the alternative sites are in rural areas and construction impacts would likely be minimal on the surrounding populations that are classified as medium and low population areas. The staff concludes that health impacts to construction workers resulting from the construction of two new nuclear units at any of the alternative sites would be SMALL.

Occupational health impacts to operational employees would likely be the same for all the alternative sites. Thermophilic microorganisms would not be a concern at the alternative sites using a closed-cycle, wet cooling system with natural draft cooling towers. Health impacts to workers from occupational injuries, noise, and electric fields would be similar. None of the alternative sites has site characteristics that would be expected to lead to fewer or more operational accidents than would be expected for any of the other alternative sites. Noise and electric fields would be monitored and controlled in accordance with applicable Occupational Safety and Health Administration regulations.

The staff expects that the occupational health impacts to operations employees of two new nuclear units at any of the alternative sites would be SMALL. Similarly, impacts to public health of two new nuclear units' operation at the VEGP site or any of the alternative sites would be expected to be minimal. The staff concludes that the public health impacts would be SMALL.

9.6.4 Radiological Impacts of Normal Operations

Exposure pathways for gaseous and liquid effluents from two new nuclear units on the ESP site or an alternative site would be similar. Gaseous effluent pathways include external exposure to the airborne plume, external exposure to contaminated ground, inhalation of airborne activity, and ingestion of contaminated agricultural products. Liquid effluent pathways include ingestion of aquatic foods, ingestion of drinking water, external exposure to shoreline sediments, and external exposure to water through boating and swimming.

Section 5.9 discusses the estimates of doses to the maximally exposed individual and the general population for two new nuclear units at the proposed VEGP site for both liquid effluent and gaseous-effluent pathways. The estimated doses to the maximally exposed individual were well within the design objectives of 10 CFR Part 50, Appendix I. The same bounding liquid and gaseous effluent releases would be used to evaluate doses to the maximally exposed individual and the population at each alternative site. Even with differences in pathways, atmospheric and water dispersion factors, and population, doses estimated to the maximally exposed individual for the alternative sites would be expected to be well within the Appendix I design objectives. Population doses within 80 km (50 mi) of the proposed facility would be similar for the alternative sites because the VEGP site and the three alternative sites are each medium or low population areas; however, they would still be small compared to the population dose from natural background radiation. Therefore, the staff concludes that radiation doses and resultant health impacts from two new nuclear unit's operations would be SMALL at all of the alternative sites.

Occupational doses to workers at the new units would be the same for the alternative sites as they would be for the proposed site. The Westinghouse AP1000 advanced reactor design of the new units would likely result in less occupational exposure annually than from current operating plants. The staff concludes that the occupational radiation doses from two new nuclear units' operation would be SMALL for all of the candidate sites.

Table 5-5 provides the annual total body dose estimates to surrogate biota species for a new nuclear unit. The annual dose for no surrogate species exceeded the dose standard in 40 CFR Part 190. The 40 CFR Part 190 standards apply to members of the public in unrestricted areas and not specifically to biota. The estimates are conservative because they not do consider dilution or decay of liquid effluents during transit. Actual doses to biota are likely to be much lower. The staff reviewed the available information relative to the radiological impact on biota other than humans, and performed an independent estimate of dose to the biota. The staff concludes that no measurable radiological impact on biota is expected from the radiation and radioactive material released to the environment as a result of the routine operation of new nuclear units and that the impacts to biota of radiation doses at any one of the alternative sites would be SMALL.

9.6.5 Postulated Accidents

In Section 5.10, the staff considered a suite of design-basis accidents for a new nuclear unit at the VEGP site. The evaluation involved calculation of doses for specified periods at the exclusion area and low-population zone boundaries, and comparison of those doses with doses based on regulatory limits and guidelines. Similar analyses have not been conducted for the alternative sites. Had such evaluations been conducted, the differences in the results would only have been the result of meteorological conditions and the distances to the site boundaries. The release characteristics would have been the same at all sites.

For the VEGP site and meteorology, the doses for each accident sequence considered were well below the corresponding regulatory limits and guidelines. The general climatological conditions at the alternative sites are sufficiently similar to the conditions at the proposed site that it is highly unlikely that differences in local meteorological conditions would be sufficient to cause doses from design-basis accidents for a new nuclear unit at any of the alternative sites to exceed regulatory limits or guidelines. Similarly, because two of the alternative sites are located at existing nuclear power plant sites and the third in a rural area with relatively low population, it is unlikely that differences in distances to the exclusion area and low-population zone boundaries would be sufficient to cause doses from design-basis accidents for a new nuclear unit at any of the alternative sites to exceed regulatory limits or guidelines. Therefore, the staff concludes that for the purposes of consideration of alternative sites, the impact of design basis accidents at each of the alternative sites would be SMALL.

Section 5.10 also includes a detailed analysis of the potential consequences of severe accidents for the postulated plants for the VEGP site. Similar analyses have not been conducted for the alternative sites. Had such evaluations been conducted, the differences in the results would only have been the result of site-specific factors such as meteorological conditions, population distribution, and land-use distribution. The release characteristics would have been the same at all sites.

The probability-weighted consequences estimated for severe accidents for new nuclear units at the proposed VEGP site are well below the consequences estimated for severe accidents at current generation reactors (see Section 5.10). This result suggests that the consequences of severe accidents at any of the alternative sites would be less than the consequences of a severe accident at an existing plant at the site. The Commission has determined that the probability-weighted consequences of severe accidents are SMALL for all existing plants (10 CFR 51, Subpart B, Table B-1). On this basis, the staff concludes that, for the purposes of consideration of alternative sites, the impact of severe accidents at each of the alternative sites likely would be SMALL.

9.7 Summary of Alternative Site Impacts

Southern selected three sites as alternative sites to the proposed VEGP site. The three sites selected for detailed review are

- Plant Hatch, located in Appling and Toombs Counties, Georgia
- Plant Farley, located in Houston County, Alabama
- The Barton greenfield site, located in Chilton and Elmore Counties, Alabama.

A summary of the staff's characterizations of locating Southern's proposed nuclear units at each alternative site is in Section 9.7.1 for construction impacts and Section 9.7.2 for operational impacts.

9.7.1 Summary of Alternative Site Construction Impacts

The staff's characterizations of the environmental impacts of constructing two new nuclear power units at the three alternatives sites are provided in Table 9-7.

Table 9-7. Characterization of Construction Impacts at the Alternative ESP Sites

Category	Plant Hatch	Plant Farley	Barton Site
Land-Use Impacts			
The site and vicinity	SMALL	SMALL	MODERATE
Transmission line rights-of-way	SMALL to MODERATE ^(a)	MODERATE	MODERATE
Air quality	SMALL	SMALL	SMALL
Water-Related Impacts			
Water use	SMALL	SMALL	SMALL
Water quality	SMALL	SMALL	SMALL
Ecological Impacts			
Terrestrial ecosystems			
Site	SMALL	SMALL	MODERATE
Transmission line right-of-way	SMALL to MODERATE ^(a)	SMALL	MODERATE
Threatened and Endangered Species			
Site	SMALL	SMALL	SMALL to MODERATE
Transmission line right-of-way	SMALL to MODERATE ^(a)	SMALL	SMALL to MODERATE ^(a)
Aquatic ecosystems			
Site	SMALL	SMALL	SMALL
Transmission line right-of-way	SMALL to MODERATE ^(a)	SMALL to MODERATE ^(a)	SMALL to MODERATE ^(a)

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Table 9-7. (contd)

Category	Plant Hatch	Plant Farley	Barton Site
Aquatic			
Threatened and endangered species	SMALL	SMALL	SMALL
Socioeconomic Impacts			
Physical Impacts	SMALL	SMALL	SMALL
Aesthetics	SMALL	SMALL	MODERATE
Demography	MODERATE ^(b)	MODERATE ^(c)	SMALL
Impacts to the Community - Social and Economic			
Economy	MODERATE Beneficial ^(d)	MODERATE Beneficial ^(e)	SMALL Beneficial
Taxes	SMALL to MODERATE Beneficial ^(d)	SMALL to MODERATE Beneficial ^(e)	MODERATE Beneficial ^(f)
Impacts to the Community - Infrastructure and Community			
Transportation	MODERATE	MODERATE	MODERATE
Recreation	SMALL	SMALL	SMALL
Housing	MODERATE ^(b)	SMALL	SMALL
Public and social services and infrastructure	SMALL	MODERATE	SMALL
Education	MODERATE	MODERATE	SMALL
Historic and cultural resources	SMALL	SMALL	SMALL
Environmental justice	SMALL	SMALL	SMALL
Nonradiological health	SMALL	SMALL	SMALL
Radiological health	SMALL	SMALL	SMALL

(a) Related to transmission system upgrades.
 (b) MODERATE impact in Appling and Toombs Counties, SMALL elsewhere.
 (c) MODERATE impact in Houston County, SMALL elsewhere.
 (d) MODERATE beneficial in Appling County, SMALL beneficial elsewhere.
 (e) MODERATE beneficial in Houston County, SMALL beneficial elsewhere.
 (f) MODERATE beneficial in Chilton and Elmore Counties, SMALL elsewhere.

9.7.2 Summary of Alternative Site Operation Impacts

The staff's characterizations of the environmental impacts of operating two new nuclear power units at the three alternative sites are provided in Table 9-8.

Table 9-8. Characterization of Operational Impacts at the Alternative ESP Sites

Category	Plant Hatch	Plant Farley	Barton Site
Land-Use Impacts			
Site and vicinity	SMALL	SMALL	SMALL
Transmission line rights-of-way	SMALL	SMALL	SMALL
Air quality	SMALL	SMALL	SMALL
Water-Related Impacts			
Water use	SMALL	SMALL	SMALL
Water quality	SMALL	SMALL	SMALL
Ecological Impacts			
Terrestrial ecosystems	SMALL	SMALL	SMALL

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Table 9-8. (contd)

Category	Plant Hatch	Plant Farley	Barton Site
Aquatic ecosystems	SMALL	SMALL	SMALL
Threatened and endangered species	SMALL	SMALL	SMALL
Socioeconomic Impacts			
Physical Impacts	SMALL	SMALL	SMALL
Aesthetics	SMALL to MODERATE ^(a)	SMALL to MODERATE ^(b)	MODERATE
Demography	SMALL	SMALL	SMALL
Impacts to the Community - Social and Economic			
Economy	SMALL	SMALL	SMALL
Taxes	Beneficial LARGE Beneficial ^(c)	Beneficial LARGE Beneficial ^(d)	Beneficial MODERATE Beneficial ^(e)
Impacts to the Community - Infrastructure and Community			
Transportation	SMALL	SMALL	SMALL
Recreation	SMALL	SMALL	SMALL
Housing	SMALL	SMALL	SMALL
Public and social services and infrastructure	SMALL	SMALL	SMALL
Education	SMALL	SMALL	SMALL
Historic and cultural resources	SMALL	SMALL	SMALL
Environmental justice	SMALL	SMALL	SMALL
Nonradiological health	SMALL	SMALL	SMALL
Radiological health	SMALL	SMALL	SMALL
Postulated Accidents			
Design-basis accidents	SMALL	SMALL	SMALL
Severe accidents	SMALL	SMALL	SMALL
(a) SMALL at Plant Hatch site, MODERATE along transmission lines. (b) SMALL at Plant Farley site, MODERATE along transmission lines. (c) LARGE beneficial in Appling County, SMALL beneficial elsewhere. (d) LARGE beneficial in Houston County, SMALL beneficial elsewhere. (e) MODERATE beneficial in Chilton and Elmore Counties, SMALL beneficial elsewhere.			

9.8 References

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy*, Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

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10 CFR Part 100. Code of Federal Regulations, Title 10, *Energy*, Part 100, "Reactor Site Criteria."

40 CFR Part 50. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 50, "National Primary and Secondary Ambient Air Quality Standards."

40 CFR Part 51. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 51, "Requirements for Preparation, Adoption, and Submittal of Implementation Plans."

40 CFR Part 60. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 60, "Standards of Performance for New Stationary Sources."

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10.0 Comparison of the Impacts of the Proposed Action and the Alternative Sites

The need to compare the proposed site with alternative sites arises from the requirement in Section 102(2)(C)(iii) of the National Environmental Policy Act of 1969 (NEPA)(42 USC 4332) that environmental impact statements include an analysis of alternatives to the proposed action. The U.S. Nuclear Regulatory Commission (NRC) criteria to be employed in assessing whether a proposed site is to be rejected in favor of an alternative site is based on whether the alternative site is "obviously superior" to the site proposed by the applicant (Public Service Co. of New Hampshire 1977). An alternative site is "obviously superior" to the proposed site if it is "clearly and substantially" superior to the proposed site (Rochester Gas & Electric Corp. 1978). The standard of obviously superior "...is designed to guarantee that a proposed site will not be rejected in favor of an alternate unless, on the basis of appropriate study, the Commission can be confident that such action is called for (New England Coalition on Nuclear Pollution 1978)."

The "obviously superior" test is appropriate for two reasons. First, the analysis performed by the NRC in evaluating alternative sites is necessarily imprecise. Key factors considered in the alternative site analysis, such as population distribution and density, hydrology, air quality, aquatic and terrestrial ecological resources, aesthetics, land use, and socioeconomics are difficult to quantify in common metrics. Given this difficulty, any evaluation of a particular site must have a wide range of uncertainty. Second, the applicant's proposed site has been analyzed in detail, with the expectation that most adverse environmental impacts associated with the site have been identified. The alternative sites have not undergone a comparable level of detailed study. For these reasons, a proposed site may not be rejected in favor of an alternative site when the alternative site is marginally better than the proposed site, but only when it is obviously superior (Rochester Gas & Electric Corp. 1978). NEPA does not require that a nuclear plant be constructed on the single best site for environmental purposes. Rather, "...all that NEPA requires is that alternative sites be considered and that the effects on the environment of building the plant at the alternative sites be carefully studied and factored into the ultimate decision (New England Coalition on Nuclear Pollution 1978)."

The NRC staff's review of alternative sites consists of a two-part sequential test (NRC 2000). The first part of the test determines whether any environmentally preferred sites are among the candidate sites. The staff considers whether the applicant has (1) reasonably identified candidate sites, (2) evaluated the likely environmental impacts of construction and operation at these sites, and (3) used a logical means of comparing sites that led to the applicant's selection of the proposed site. Based on NRC's own independent review, the staff then determines whether any of the alternative sites are environmentally preferable to the applicant's proposed site. If the staff determines that one or more alternative sites are environmentally preferable, then it would compare the estimated costs (i.e., environmental, economic, and time) of

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constructing the proposed plant at the proposed site and at the environmentally preferable site or sites (NRC 2000). The second part of the test determines if an alternative site is obviously superior to the proposed site. The staff must determine that (1) one or more important aspects, either singly or in combination, of a reasonably available alternative site are obviously superior to the corresponding aspects of the applicant's proposed site, and (2) the alternative site does not have offsetting deficiencies in other important areas. A staff conclusion that an alternative site is obviously superior to the applicant's proposed site would normally lead to a recommendation that the application for the permit be denied.

10.1 Comparison of the Proposed Site with the Alternative Sites

The staff reviewed the Environmental Report submitted by Southern Nuclear Operating Company, Inc. (Southern 2008) and supporting documentation and conducted site visits at the Vogtle Electric Generating Plant (VEGP) site and the alternative sites. The staff found that Southern had reasonably identified alternative sites, evaluated the environmental impacts of construction and operation, and used a logical means of comparing sites. The following section summarizes NRC's own independent assessment of the proposed and alternative sites.

The staff's characterization of the expected environmental impacts of constructing and operating new units at the VEGP site and alternative sites is summarized in Tables 10-1 and 10-2. Table 10-1 compares the alternatives' construction impacts, and Table 10-2 the operational impacts. Full explanations for the particular characterizations are in Chapters 4 and 5 for the proposed site and in Sections 9.5 and 9.6 for the alternative sites. In the following analysis, the staff indicated a likely impact level based on professional judgment, experience, and consideration of controls likely to be imposed under required Federal, State, or local permits that would not be acquired until an application for a construction permit or combined construction and operating license is underway. These considerations and assumptions were similarly applied at each of the alternative sites to provide a common basis for comparison.

Some environmental impacts considered are generic to all sites and, therefore, do not influence the comparison of impacts between the applicant's proposed site and the alternative sites. The generic environmental impacts common to all sites are nonradiological and radiological health impacts, environmental impacts from postulated accidents, and some aspects of ecology and socioeconomics.

The environmental impact areas shown in Tables 10-1 and 10-2 have been evaluated using the NRC's three-level standard of significance – SMALL, MODERATE, or LARGE – developed using the Council on Environmental Quality guidelines and set forth in the footnotes to Table B-1 of Title 10 of the Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B:

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

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

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

Table 10-1. Comparison of Construction Impacts at the VEGP Site and Alternative Sites

Category	VEGP	Plant Hatch	Plant Farley	Barton Site
Land-Use Impacts				
The site and vicinity	SMALL	SMALL	SMALL	MODERATE
Transmission line	MODERATE	SMALL to MODERATE ^(a)	MODERATE	MODERATE
Air quality	SMALL	SMALL	SMALL	SMALL
Water-Related Impacts				
Water use	SMALL	SMALL	SMALL	SMALL
Water quality	SMALL	SMALL	SMALL	SMALL
Ecological Impacts				
Terrestrial ecosystems				
Site	SMALL	SMALL	SMALL to MODERATE	MODERATE
Transmission line right-of-way	SMALL to MODERATE ^(a)	SMALL to MODERATE ^(a)	SMALL to MODERATE	MODERATE
Terrestrial Threatened and Endangered Species				
Site	SMALL	SMALL	SMALL	SMALL to MODERATE
Transmission line right-of-way	SMALL to MODERATE ^(a)	SMALL to MODERATE ^(a)	SMALL	SMALL to MODERATE ^(a)
Aquatic ecosystems				
Site	SMALL	SMALL	SMALL	SMALL
Transmission line right-of-way	SMALL	SMALL to MODERATE ^(a)	SMALL to MODERATE ^(a)	SMALL to MODERATE ^(a)
Threatened and Endangered Species	SMALL	SMALL	SMALL	SMALL
Socioeconomic Impacts				
Physical impacts				
Aesthetics	SMALL to MODERATE ^(b)	SMALL to MODERATE ^(b)	SMALL to MODERATE ^(b)	MODERATE
Demography	MODERATE ^(c)	MODERATE ^(d)	MODERATE ^(e)	SMALL
Impacts to the Community - Social and Economic				
Economy	MODERATE beneficial ^(c)	MODERATE beneficial ^(d)	MODERATE beneficial ^(e)	SMALL beneficial
Taxes	MODERATE beneficial ^(c)	MODERATE beneficial ^(d)	MODERATE beneficial ^(e)	MODERATE beneficial ^(f)

Comparison of the Impacts of the Proposed Action and the Alternative Sites

Table 10-1. (contd)

Category	VEGP	Plant Hatch	Plant Farley	Barton Site
Impacts to the Community - Infrastructure and Community				
Transportation	MODERATE	MODERATE	MODERATE	MODERATE
Recreation	SMALL	SMALL	SMALL	SMALL
Housing	SMALL	MODERATE	SMALL	SMALL
Public and social services and infrastructure	SMALL	SMALL	MODERATE	SMALL
Education	SMALL	MODERATE	MODERATE	SMALL
Historic and cultural resources	MODERATE	SMALL	SMALL	SMALL
Environmental justice	SMALL	SMALL	SMALL	SMALL
Nonradiological health	SMALL	SMALL	SMALL	SMALL
Radiological health	SMALL	SMALL	SMALL	SMALL
(a) Depends on location of transmission line right-of-way				
(b) SMALL at plant site SMALL to MODERATE along transmission right-of-way				
(c) MODERATE in Burke County, SMALL elsewhere				
(d) MODERATE in Appling and Toombs Counties, SMALL elsewhere				
(e) MODERATE in Houston County, SMALL elsewhere				
(f) MODERATE in Chilton and Elmore Counties, SMALL elsewhere				

The staff determined that the impact level from construction for most of the environmental categories at most of the sites is SMALL (see Table 10-1). However, transmission line land use is MODERATE and terrestrial ecosystems is SMALL to MODERATE for all sites because of potential changes in the transmission systems at all sites. Aesthetic impacts of transmission lines is likely to be MODERATE at all sites. Land-use impacts at the Barton site would be greater than at the proposed VEGP site or the other two alternative sites. More detailed information on these issues is presented in Chapter 4 for the VEGP site, and in Chapter 9 for the alternative sites.

Similarly, the staff found that the impact level from operations from most of the environmental issues at most sites is SMALL (see Table 10-2).

Table 10-2. Comparison of Operational Impacts at the VEGP Site and Alternative Sites

Category	VEGP	Plant Hatch	Plant Farley	Barton Site
Land-use Impacts				
The site and vicinity	SMALL	SMALL	SMALL	SMALL
Transmission-line rights-of-way	SMALL	SMALL	SMALL	SMALL
Air quality	SMALL	SMALL	SMALL	SMALL
Water-related Impacts				
Water use	SMALL	SMALL	SMALL	SMALL
Water quality	SMALL	SMALL	SMALL	SMALL
Ecological Impacts				
Terrestrial ecosystems	SMALL	SMALL	SMALL	SMALL
Aquatic ecosystems	SMALL	SMALL	SMALL	SMALL

Comparison of the Impacts of the Proposed Action and the Alternative Sites

Table 10-2. (contd)

Category	VEGP	Plant Hatch	Plant Farley	Barton Site
Threatened and endangered species	SMALL	SMALL	SMALL	SMALL
Socioeconomic Impacts				
Physical Impacts	SMALL	SMALL	SMALL	SMALL
Aesthetics	SMALL to MODERATE ^(a)	SMALL to MODERATE ^(a)	SMALL to MODERATE ^(a)	MODERATE
Demography	SMALL	SMALL	SMALL	SMALL
Impacts to the Community - Social and Economic				
Economy	MODERATE beneficial ^(b)	SMALL beneficial	SMALL beneficial	SMALL beneficial
Taxes	LARGE beneficial ^(c)	LARGE beneficial ^(d)	LARGE beneficial ^(e)	MODERATE beneficial ^(f)
Impacts to the Community - Infrastructure and Community				
Transportation	SMALL	SMALL	SMALL	SMALL
Recreation	SMALL	SMALL	SMALL	SMALL
Housing	SMALL	SMALL	SMALL	SMALL
Public and social services and infrastructure	SMALL	SMALL	SMALL	SMALL
Education	SMALL	SMALL	SMALL	SMALL
Historic and Cultural resources	SMALL	SMALL	SMALL	SMALL
Environmental justice	SMALL	SMALL	SMALL	SMALL
Nonradiological health	SMALL	SMALL	SMALL	SMALL
Radiological health	SMALL	SMALL	SMALL	SMALL
Postulated Accidents				
Design-basis accidents	SMALL	SMALL	SMALL	SMALL
Severe accidents	SMALL	SMALL	SMALL	SMALL

(a) Aesthetics impact at the plant site would be SMALL, but the impact would be MODERATE along new transmission line right-of-way.

(b) MODERATE beneficial in Burke County, SMALL elsewhere

(c) LARGE beneficial in Burke County, SMALL elsewhere

(d) LARGE beneficial in Appling County, SMALL elsewhere

(e) LARGE beneficial in Houston County, SMALL elsewhere

(f) MODERATE beneficial in Chilton and Elmore Counties, SMALL elsewhere

10.2 Environmentally Preferable Sites

10.2.1 Construction

The impacts of construction at the VEGP site are generally SMALL for most impact categories. However, as noted in Chapter 4, there could be MODERATE land-use, ecological, and aesthetic impacts associated with the new transmission line rights-of-way. In addition, as noted in Section 4.5, there are some impact subcategories under infrastructure and community services (i.e., transportation, recreation, housing, public services, and education) for which the impacts could be MODERATE if most of the construction workers move into Burke County.

Comparison of the Impacts of the Proposed Action and the Alternative Sites

Although SMALL in most surrounding counties, the tax and economic benefits to Burke County during the construction phase could be beneficially MODERATE. The installation of the water intake pipeline may result in MODERATE impacts to archeological resources.

The impacts of construction at the Plant Hatch alternative site are considered SMALL for most impact categories except land-use and aesthetic impacts of the transmission line rights-of-way which may be MODERATE, terrestrial ecosystems including threatened and endangered species along the transmission rights-of-way, which could be MODERATE, and some impact categories under socioeconomic impacts (i.e., demography, transportation, public services, and education), which could be MODERATE if a significant number of the construction workers move into Appling County. Although SMALL in most of the affected counties, the overall economic and tax benefits in Appling County during the construction phase would be beneficially MODERATE as noted in Section 9.5.1.5.

The impacts of construction at the Plant Farley alternative site are considered SMALL for most impact categories except land-use and aesthetic impacts of new transmission line rights-of-way which may be MODERATE, and some impact categories under socioeconomic impacts (i.e., demography, transportation, public and social services, and education), which could be MODERATE in Houston County. Although the impacts to the economy and taxes would be SMALL in most counties near the Plant Farley site, the impacts to the economy and taxes would be beneficially MODERATE as noted in Section 9.5.2.5.

The impacts of construction at the Barton site are considered SMALL for most impact categories except the land use at the site and the vicinity, the land-use impacts of new transmission line rights-of-way, terrestrial ecosystems, including threatened and endangered species, transportation, and aesthetics, which could be MODERATE. Although the tax impacts of construction in most counties near the Barton site would be SMALL, in Chilton and Elmore Counties tax benefits would be beneficially MODERATE in Houston County, as noted in Section 9.5.3.5.

Although there are some differences in the environmental impacts of construction at the VEGP site and the alternative sites, the staff concludes that none of these differences is sufficient to determine that any of the alternative sites is environmentally preferable to the proposed VEGP site.

10.2.2 Operations

The impacts of operations at the VEGP site would be SMALL for all major impact categories except for the SMALL to MODERATE beneficial impacts on the economy, the SMALL to LARGE beneficial impacts on taxes (discussed in Section 5.5.3), and a MODERATE aesthetic impacts along the new transmission line.

Comparison of the Impacts of the Proposed Action and the Alternative Sites

The impacts of operations at the Plant Hatch alternative site would be SMALL for almost all impact categories. The impact on the economy and taxes would be SMALL beneficial except in Appling County, which would experience LARGE beneficial impacts, as noted in Section 9.5.1.5. The aesthetic impact along the new transmission line is likely to be MODERATE.

The impacts of operations at the Plant Farley alternative site would be SMALL for almost all impact categories. The impact on taxes would be SMALL beneficial except in Houston County, where it could be LARGE beneficial, as noted in Section 9.5.2.5. The aesthetic impact along the new transmission line would likely be MODERATE.

The impacts of operations at the Barton alternative site would be SMALL for all impact categories except aesthetics, which could be MODERATE, as discussed in Section 9.5.3.5. The impact on taxes would be SMALL beneficial except in Chilton and Elmore Counties, where it could be MODERATE beneficial, as noted in Section 9.5.3.5.

Although there would be some differences in the environmental impacts of operation at the VEGP site and the alternative sites, the staff concludes that none of these differences is sufficient to determine that any of the alternative sites are environmentally preferable to the VEGP site.

10.3 Obviously Superior Sites

None of the alternative sites were determined to be environmentally preferable to the VEGP site. Therefore, none of the alternative sites is obviously superior to the VEGP site.

10.4 Comparison with the No-Action Alternative

The no-action alternative refers to a scenario in which NRC denies the applicant's request. If the application for the proposed VEGP ESP were denied, the impacts of the construction activities would not occur. Further, denial of the application would prevent early resolution of safety and environmental issues for the site. These issues would have to be addressed during a future licensing action (i.e., ESP, construction permit, or combined license), should the applicant decide to pursue construction and operation activities for a nuclear facility at the site at a later time.

In the event that the NRC denies the ESP application, the applicant could follow any of several paths to satisfy its electric power generation needs. The following paths could be pursued individually or in combination, and each would have associated environmental impacts.

Comparison of the Impacts of the Proposed Action and the Alternative Sites

- Reapply with a revised application for the same proposed site.
- Seek an ESP, a construction permit, or combined license for a new nuclear unit for a different location.
- Purchase power from other electricity providers.
- Establish conservation and demand-side management programs.
- Construct new generation facilities other than nuclear at the currently proposed site.
- Construct new generation facilities at other locations.
- Delay retirement of existing generating facilities.
- Reactivate previously retired generating facilities.

The activities that are permissible under an ESP are limited to construction activities defined by 10 CFR 50.10(a) if the applicant has requested a limited work authorization and has a site redress plan. These construction activities are permissible only if the final environmental impact statement concludes that the activities would not result in any significant environmental impacts that could not be redressed. The results of the staff's assessment of the site redress plan are discussed in Section 4.11. As discussed in that section, the staff concludes that the potential limited construction activities described in Southern's site redress plan would not result in any significant adverse impacts that could not be redressed.

10.5 References

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

National Environmental Policy Act of 1969, as amended (NEPA). 42 USC 4321, et seq. Public Law 91-190.

New England Coalition on Nuclear Pollution. 1978. *New England Coalition on Nuclear Pollution v. NRC*. 582 F.2d 87 (1st Circuit 1978).

Public Service Co. of New Hampshire. 1977. *Public Service Company of New Hampshire (Seabrook Station, Units 1 and 2), CLI-77-8*. 5 NRC 503, 526 (1977), *affirmed*, *New England Coalition on Nuclear Pollution v. NRC*. 582 F.2d 87 (1st Circuit 1978).

Comparison of the Impacts of the Proposed Action and the Alternative Sites

Rochester Gas & Electric Corp. 1978. *Rochester Gas & Electric Corp. (Sterling Power Project Nuclear Unit No. 1)*. ALAB-502, 8 NRC 383, 397 (1978), *affirmed*, CLI-80-23, 11 NRC 731 (1980).

Southern Nuclear Operating Company, Inc. (Southern). 2008. *Southern Nuclear Operating Company, Vogtle Early Site Permit Application, Revision 4*. Southern Company, Birmingham, Alabama. Accession No. ML081020073.

U.S. Nuclear Regulatory Commission (NRC). 2000. *Environmental Standard Review Plan: Standard Plans for Environmental Reviews for Nuclear Power Plants*. NUREG-1555, Office of Nuclear Reactor Regulation, Washington, D.C. Accessed at <http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1555/>.

11.0 Conclusions and Recommendations

On August 14, 2006, the U.S. Nuclear Regulatory Commission (NRC) received an application from Southern Nuclear Operating Company, Inc. (Southern) for an early site permit (ESP) for a site adjacent to the Vogtle Electric Generating Plant (VEGP), in Burke County, Georgia. This application has been revised through Revision 4, which was submitted to NRC in March 2008 (Southern 2008a). The site is located approximately 24 km (15 mi) east northeast of Waynesboro, Georgia, and 42 km (26 mi) southeast of Augusta, Georgia. An ESP is a Commission approval of a location for the siting of one or more nuclear power facilities, and is a separate action from the filing of an application for a construction permit (CP) or combined license (COL) for such a facility. An ESP application may refer to a reactor's or reactors' characteristics or plant parameter envelope, which is a set of postulated design parameters that bound the characteristics of a reactor or reactors that might be built at a selected site; alternatively, an ESP may refer to a detailed reactor design. In its application, Southern specified the Westinghouse AP1000 as the proposed reactor design for the VEGP site. An ESP is not a license to build a nuclear power plant; rather, the application for an ESP initiates a process undertaken to assess whether a proposed site is suitable should the applicant receive an ESP and later decide to pursue a CP or COL.

Section 102 of the National Environmental Policy Act of 1969 (NEPA) (42 USC 4321 et seq.) directs that an environmental impact statement (EIS) is required for major Federal actions that significantly affect the quality of the human environment. Subpart A of Title 10 of the Code of Federal Regulations (CFR) Part 52 contains the NRC regulations related to ESPs. The NRC has implemented Section 102 of NEPA in 10 CFR Part 51. As set forth in 10 CFR 52.18, the Commission has determined that an EIS would be prepared during the review of an application for an ESP. The purpose of Southern's requested action, issuance of the ESP, is for the NRC to determine whether the VEGP site is suitable for two new nuclear units by resolving certain safety and environmental issues before Southern incurs the substantial additional time and expense of designing and seeking approval to construct such facilities at the site. Part 52 of CFR Title 10 describes the ESP as a "partial construction permit." An applicant for a CP or COL for a nuclear power plant or plants to be located at the site for which an ESP was issued can reference the ESP, thus reducing the need to review siting issues at that stage of the licensing process. However, issuance of a CP or COL to construct and operate a nuclear power plant is a major Federal action and would require an EIS to be issued in accordance with 10 CFR Part 51.

Three primary issues – site safety, environmental impacts, and emergency planning – must be addressed in an ESP application. Likewise, in its review of the application, the NRC assesses the applicant's proposal in relation to these issues and determines if the application meets the requirements of the Atomic Energy Act of 1954 and the NRC regulations.

Conclusions and Recommendations

This EIS addresses the potential environmental impacts resulting from the construction and operation of two new nuclear units at the proposed ESP site.

In its application, Southern requested authorization in the form of a limited work authorization (LWA) to perform certain preliminary construction activities if an ESP is issued. The application, therefore, includes a site redress plan that specifies how the applicant would stabilize and restore the site to its preconstruction condition (or conditions consistent with an alternative use) in the event a nuclear power plant is not constructed on the ESP site. Although it is not required in an ESP application (10 CFR 52.17(a)(2)), Southern chose to address the benefits of the proposed action (e.g., the need for power).

As mentioned previously, the staff analyzes the impacts of construction and operation of the proposed action in Chapters 4 and 5, and discusses cumulative impacts in Chapter 7. As a result of the NRC's recent new rule on limited work authorizations for nuclear power plants (see 72 FR 57416), the definition of construction activities in 10 CFR 50.10 has changed to more clearly reflect NRC's jurisdiction. The staff's draft EIS for the Vogtle ESP review was published prior to the issuance of the final rule. To reflect the effects of the new rule, site-preparation and preconstruction activities would most appropriately be analyzed in the staff's EIS as cumulative impacts rather than as impacts of construction or operation of the proposed facility. However, in this instance, to ensure appropriate consideration of public comments on the draft EIS and to avoid confusion that might result from reorganizing the document following those comments, the staff will keep discussions of such impacts (e.g., those no longer defined by regulation as construction activities) in the chapters in which they were discussed in the draft EIS. While the staff's analysis of construction activities in the draft EIS and its discussion of cumulative impacts are different, they are generally at a similar depth of analysis. The staff believes this approach will allow effective consideration of public comments while still ensuring that impacts relevant to the NEPA analysis are disclosed and fully evaluated. Accordingly, this chapter of the final EIS, including the analysis of costs and benefits of the proposed action, continues to contain the staff's analysis of those impacts discussed in Chapter 4 of the draft EIS, such as site preparation activities and construction of transmission lines.

Upon acceptance of the VEGP site application for docketing, the NRC began the environmental review process described in 10 CFR Part 51 by publishing in the *Federal Register* a Notice of Intent to prepare an EIS and conduct scoping (71 FR 58882). The staff held a public scoping meeting in Waynesboro, Georgia, on October 19, 2006, and visited the VEGP site on October 17-19, 2006. Subsequent to the site visit and the scoping meeting and in accordance with NEPA and 10 CFR Part 51, the staff determined and evaluated the potential environmental impacts of constructing and operating two new nuclear units at the VEGP site.

Included in this EIS are (1) the results of the NRC staff's analyses, which consider and weigh the environmental effects of the proposed action and of constructing and operating two new nuclear units at the VEGP site, (2) mitigation measures for reducing or avoiding adverse effects, (3) the

environmental impacts of alternatives to the proposed action, and (4) the staff's recommendation regarding the proposed action based on its environmental review.

During the course of preparing this EIS, the staff reviewed the Environmental Report (ER) submitted by Southern (Southern 2008a); consulted with Federal, State, Tribal, and local agencies; and followed the guidance set forth in RS-002, *Processing Applications for Early Site Permits* (NRC 2004), to conduct an independent review of the issues. The review standard draws from the previously published NUREG-0800, *Standard Review Plans for the Review of Safety Analysis Reports for Nuclear Power Plants* (NRC 1987), and NUREG-1555, *Environmental Standard Review Plan: Standard Review Plans for Environmental Reviews for Nuclear Power Plants* (NRC 2000). In addition, the NRC considered the public comments related to the environmental review received during the scoping process. These comments are provided in Appendix D of this EIS.

The results of this evaluation were documented in a draft EIS issued for public comment in August 2007. During the comment period, the staff conducted a public meeting on October 4, 2007, near the VEGP site to describe the results of the NRC environmental review, answer questions, and provide members of the public with information to assist them in formulating comments on the draft EIS. After the comment period closed, the staff considered and dispositioned the comments received. These comments are addressed in Appendix E of this EIS.

Following the practice of the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NUREG-1437) (NRC 1996), supplemental license renewal EISs, and previous ESP EISs, environmental issues are evaluated using the three-level standard of significance – SMALL, MODERATE, or LARGE – developed by NRC using guidelines from the Council on Environmental Quality (40 CFR 1508.27). Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, provides the following definitions of the three significance levels:

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

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

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

Mitigation measures were considered for each environmental issue and are discussed in the appropriate sections. During its environmental review, the staff considered planned activities and actions that Southern indicates it and others would likely take should Southern receive an

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ESP and later decide to apply for a CP or COL.^(a) In addition, Southern provided estimates of the environmental impacts resulting from the construction and operation of two new nuclear units on the ESP site.

Section 102(2)(C) of NEPA requires that an EIS include information on:

- the environmental impact of the proposed action
- any adverse environmental effects that cannot be avoided should the proposal be implemented
- alternatives to the proposed action
- the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity
- any irreversible and irretrievable commitments of resources that would be involved if the proposed action is implemented.

Activities permitted under an ESP that includes an LWA and a site redress plan defined in 10 CFR 50.10(a), may include driving of piles, placement of backfill, and other actions associated with the assembly, installation, and testing of safety-related structures, systems, or components. These activities are identified in the site redress plan. An LWA is not required for preparation of the site for construction of the facility, installation of temporary construction facilities, excavation for facility structures, construction of service facilities, and construction of certain structures, systems, and components that do not prevent or mitigate the consequences of postulated accidents. The following discussions of the NEPA requirements address the impacts of construction and operation of up to two new nuclear units at the VEGP site. As discussed in earlier chapters of this EIS and explained further below, the construction impacts bound any impacts of construction activities allowed under 10 CFR 52.25.

11.1 Impacts of the Proposed Action

Impacts associated with construction of the proposed ESP facilities are discussed in Chapter 4 and are summarized in Table 4-7. Impacts associated with operation of the proposed facilities are discussed in Chapter 5 and are summarized in Table 5-19. Construction and operational impacts are discussed in the EIS to make an informed decision on siting. The impacts of operations would only occur if an operating license or COL is issued by the NRC.

The staff considered the potential cumulative impacts resulting from construction and operation of Units 3 and 4 at the VEGP site with past, present, and reasonably foreseeable future actions in the VEGP site area in Chapter 7 of this EIS. For each impact area, the staff's determination is

(a) Southern submitted an application for a COL at the VEGP site on March 31, 2008.

that the potential cumulative impacts resulting from construction and operation would be SMALL and that mitigation would not be warranted. Several issues have the potential for MODERATE impacts, most of which would occur under temporary circumstances or as the result of a larger-than-expected concentration of construction workers settling near the VEGP site.

11.2 Unavoidable Adverse Environmental Impacts

Section 102(2)(C)(ii) of NEPA requires that an EIS include information on any adverse environmental effects that cannot be avoided should the proposal be implemented. Unavoidable adverse environmental impacts are those potential impacts of construction and operation of the two proposed new units that cannot be avoided and for which no practical means of mitigation are available.

There would be no unavoidable adverse environmental impacts associated with the granting of the ESP with the exception of impacts associated with any limited construction activities approved in an LWA request and identified in the site redress plan. However, there are unavoidable adverse environmental impacts associated with construction and operation of Units 3 and 4 at the VEGP site.

This EIS evaluates the impacts of all site-preparation and preliminary construction activities as part of the overall construction impacts. However, under rules at 10 CFR 50.10, Southern may perform the following site-preparation activities, regardless of whether or not the ESP is issued, subject to other State or Federal permits.

- preparation of the site for construction of the facility (including such activities as clearing, grading, and construction of temporary access roads and borrow areas)
- installation of temporary construction support facilities (including such items as warehouse and shop facilities, utilities, concrete mixing plants, docking and unloading facilities, and construction support buildings)
- excavation for facility structures
- the construction of service facilities (including such facilities as roadways, paving, railroad spurs, fencing, exterior utility and lighting systems, and sanitary sewage treatment facilities)
- the construction of structures, systems, and components that do not prevent or mitigate the consequences of postulated accidents, which could cause undue risk to the health and safety of the public.

Southern has requested an LWA that would allow for activities related to construction of the main safety-related structures, systems, and components, such as driving piles; subsurface preparation; placement of backfill, concrete, or permanent retaining walls within an excavation; and installation of a foundation, including placement of concrete.

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These activities are described in the volume of the application titled Southern Nuclear Operating Company Early Site Permit Application for the Vogtle Electric Generating Plant, Part 4 Site Redress Plan (Southern 2008a).

If the ESP is granted to Southern and if Southern performs any or all of the activities described in the site redress plan but the NRC does not in the future approve a CP under 10 CFR Part 50 or a COL under 10 CFR Part 52, according to 10 CFR 52.17, Southern would need to redress the portion of the site associated with construction activities according to the site redress plan included in the application (Southern 2008a). The staff reviewed the list of allowed construction activities in the event that the ESP is granted and reviewed the full site redress plan submitted by Southern. In accordance with 10 CFR 52.17, the application demonstrated that there is reasonable assurance that redress carried out under the plan would achieve an environmentally stable and aesthetically acceptable site suitable for whatever non-nuclear use may conform with local zoning requirements. As a result of NRC's independent review as described in Section 4.11, the staff concludes that the potential limited construction activities described in Southern's site redress plan would not result in any significant adverse impacts that could not be redressed.

11.2.1 Unavoidable Adverse Impacts During Construction

Chapter 4 discusses in detail the potential impacts from construction of the proposed new nuclear units (Units 3 and 4) at the VEGP site. The unavoidable adverse impacts related to construction are listed in Table 11-1 and are summarized below. The primary unavoidable adverse environmental impacts during construction would be related to land use. All construction activities for VEGP Units 3 and 4, including ground-disturbing activities, would occur within the existing VEGP site boundary. The area that would be affected as a result of constructing and operating permanent facilities is approximately 131 ha (324 ac). Additional areas would be disturbed on a short-term basis as a result of temporary activities and facilities and laydown areas (Southern 2008a).

Dewatering systems employed during excavation within the powerblock area would depress the water table in the general vicinity; however, the impacts would be localized and temporary. The alteration of the land surface at VEGP Units 3 and 4 would cause a localized change in the recharge rate to the Water Table aquifer.

Construction activities for the proposed 500-kV transmission line right-of-way would occur both onsite and offsite. The onsite land-use impacts are included in the 131 ha (324 ac). The approximate route is shown in Figure 4-1, but the exact route of the transmission line right-of-way has not been determined at this time. However, Southern stated in its ER that the transmission line right-of-way would be 46 m (150 ft) wide and 97 km (60 mi) long and traverse Burke, Warren, Jefferson, and McDuffie Counties.

Table 11-1. Unavoidable Adverse Environmental Impacts from Construction of VEGP Units 3 and 4

Impact Category	Adverse Impacts Based on Southern's Application	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Land Use	Yes	Comply with requirements of applicable Federal, State, Tribal, and local permits	131 ha (324 ac) disturbed on a long-term basis; additional land disturbed on a temporary basis
Hydrological and Water Use	Yes	Obtain a CWA Section 401 Certification prior to site-preparation activities	Dewatering systems would depress the water table in the general vicinity, but the impacts would be localized and temporary
Ecological Terrestrial	Yes	Observe best management practices (BMPs). Comply with requirements of applicable Federal, State, Tribal, and local permits	131 ha (324 ac) disturbed on a long-term basis on the VEGP site; new transmission line right-of-way would disturb additional terrestrial habitats
Aquatic	Yes	Observe BMPs. Obtain a 401 certification prior to site-preparation and construction activities	Loss of some benthic macroinvertebrates and some shoreline habitats.
Socioeconomic	Yes	Traffic control and management measures would protect any local roads during construction	Local traffic would increase during construction, available housing could be limited if workers concentrate in Burke County
Radiological	Yes	Use of as low as reasonably achievable principles	Dose to construction workers
Air Quality	Yes	Implement actions to reduce fugitive dust	Equipment emissions and fugitive dust from operation of earth-moving equipment are sources of air pollution
Environmental Justice	No	None	None

An estimated 8.5 ha (21 ac) of wetlands habitat on the VEGP site would be lost to permanent structures and facilities associated with construction of the proposed ESP facility. Approximately 0.57 ha (1.4 ac) of land composed of pond and bottomland hardwood forest would be within the proposed 500-kV transmission line right-of-way. About 113 ha (279 ac) of upland habitat, including planted pines, previously disturbed areas and open fields, and approximately 1.6 ha (4 ac) of mixed hardwood and pine habitat, would be lost to permanent structures and facilities. A small amount of shoreline and approximately 5 ha (12.5 ac) with most of it in the Savannah River floodplain would be affected by construction of the new intake structure and canal. Construction of the new transmission line could impact threatened and endangered species. Georgia Power Company (GPC) will site the transmission line in

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accordance with Georgia Code Title 22, Section 22-3-161. GPC's procedures for implementing this code section include consultation with the Georgia Department of Natural Resources and U.S. Fish and Wildlife Service, as well as an evaluation of impacts to special habitats and threatened and endangered species. In addition, the GPC will comply with all applicable laws, regulations, and permit requirements, and will use good engineering and construction practices (Southern 2008a). Socioeconomic impacts of construction include an increase in traffic from construction workers, and possible demand pressure on the local housing market if workers concentrate in Burke County. Atmospheric and meteorological impacts include fugitive dust from construction activities that can be mitigated by the dust-control plan. Radiological doses to construction workers from the adjacent units are expected to be well below regulatory limits. No unusual resource dependencies on minority and low-income populations in the region were identified. In addition, no environmental pathways related to construction and operation activities were found that would lead to adverse and disproportionate impacts on minority and low-income populations.

11.2.2 Unavoidable Adverse Impacts During Operation

Chapter 5 provides a detailed discussion of the potential impacts from operation of the proposed Units 3 and 4 at the VEGP site. The unavoidable adverse impacts related to operation are listed in Table 11-2 and are summarized below. The unavoidable adverse impacts from operation for land use would be small and further mitigation would not be warranted.

Hydrological, water use, and water-quality impacts during operation would be small. Impacts to the Savannah River from water use are mitigated through the U.S. Army Corps of Engineers (USACE) Drought Contingency Plan (USACE 2006) for the basin and releases from J. Strom Thurmond Dam. Water-related impacts during operation would also be mitigated through Southern's adherence to State permits for water withdrawal and discharge. Terrestrial impacts would be small during operation, assuming BMPs are followed. The proposed new unit is expected to have a closed-cycle cooling system resulting in relatively low entrainment and impingement impacts. Aquatic impacts would be small during operation because of Southern's adherence to the National Pollutant Discharge Elimination System permit. Socioeconomic impacts would primarily be increased demand for services, with the increase in tax revenue available to support the increase in services. It is expected that air-quality impacts would be negligible and that pollutants emitted during operations would be insignificant.

11.3 Alternatives to the Proposed Action

Alternatives to the proposed actions are discussed in Chapter 9 of this EIS. Alternatives considered are the no-action alternative, energy production alternatives, system design alternatives, and alternative sites.

The no-action alternative, described in Section 9.1, refers to a scenario in which the NRC would deny the ESP request. A comparison of the proposed action with the no-action alternative is provided in Section 10.4 of this EIS. All of the impacts of the no-action alternative are considered to be SMALL.

Table 11-2. Unavoidable Adverse Environmental Impacts from Operation of VEGP Units 3 and 4

Impact Category	Adverse Impacts Based on Southern's Application	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Land use	Yes	Local land management plans	Possible new housing and retail space added in vicinity because of potential growth
Hydrological and Water Use	Yes	Comply with State permit limits	Increased water use because of the addition of Units 3 and 4
Ecological			
Terrestrial	No	None	None
Aquatic	Yes	Adherence to NPDES permit limits	Increase in entrainment and impingement of aquatic organisms
Socioeconomic	Yes	Tax payments would offset impacts	Increased use of services
Radiological	Yes	Use of as low as reasonably achievable principles	Dose to workers, the public, and biota
Air Quality	No	None	None
Environmental Justice	No	None	None

Alternative energy sources are described in Section 9.2 of this EIS. Detailed analyses of coal- and natural-gas-fired alternatives are provided in Section 9.2.2, other energy sources are discussed in Section 9.2.3, and alternatives that would not require additional generating capacity are described in Section 9.2.1. The staff concluded that none of the alternative power production options was both practical and environmentally preferable to the proposed action.

Alternative system designs are discussed in Section 9.3 of this EIS, focusing on alternative cooling system designs. The staff concluded that once-through cooling would not be practical at the VEGP site because of insufficient flow in the Savannah River. The staff concluded that the potential benefits of dry cooling towers or hybrid wet/dry cooling towers would not justify the expense and loss of efficiency that would result. The staff concludes that the impacts on water use and quality of the proposed wet tower cooling system would be SMALL, as described in Section 5.3.

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Alternative sites are discussed in Section 9.5 of this EIS, and the impacts of construction and operation of the ESP facilities at the alternative sites are compared to the impacts at the proposed VEGP site in Chapter 10 of this EIS. Table 10-1 contains the staff's characterization of construction impacts at the proposed and alternative sites. The staff's characterization of operational impacts at the proposed and alternative sites is provided in Table 10-2. The staff concludes that while there are differences in construction and operational impacts at the proposed and alternative sites, none of the alternative sites is environmentally preferable or obviously superior to the proposed VEGP site.

11.4 Relationship between Short-Term Uses and Long-Term Productivity of the Human Environment

Section 102(2)(C)(iv) of NEPA requires that an EIS include information on the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity. The only short-term use of the environment that could occur if the proposed action is implemented would be limited construction activities conducted by Southern that would be authorized in an ESP. Any such activities are unlikely to adversely affect the long-term productivity of the environment. The evaluation of the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity for the construction and operation of the ESP units can be performed by discussing the benefits of operating the units. The principal benefit is the production of electricity. In accordance with 10 CFR 52.18, an EIS for an ESP does not need to include an assessment of the benefits of the proposed action. However, in its application, Southern elected to include in its ESP application a benefit-cost analysis of two new units at the VEGP site. Therefore, the staff prepared its own analysis, presented in Section 11-6. If new nuclear power plants are constructed on the VEGP site, power production would continue until the operating license or COL expires or the licensee chooses to cease operation. Once the plants are shut down, they would be decommissioned according to NRC regulations. Once decommissioning is complete and the NRC license is terminated, the site would be available for other uses.

11.5 Irreversible and Irretrievable Commitments of Resources

Section 102(2)(C)(v) of NEPA requires that an EIS include information on any irreversible and irretrievable commitments of resources that would occur if the proposed action is implemented. The only irreversible and irretrievable commitments of resources that would be expended if the proposed action is implemented would be resources used by Southern for the limited construction activities authorized by the ESP, and the site-preparation and preliminary construction activities performed in support of the ESP-authorized activities. If not used during the ESP stage, any such resource commitments for construction or site-preparation activities

would be used at the CP or COL stage or could be used for other activities even if NRC does not eventually approve a CP or a COL for the VEGP location.^(a)

Irretrievable commitments of resources during construction of the proposed new units generally would be similar to that of any major construction project. A study by the U.S. Department of Energy (DOE 2004) on new reactor construction estimated the following quantities of materials would be required for a new reactor: 9,357 m³ (12,239 yd³) of concrete, 2,819 MT (3,107 tons) of rebar, 2,000,000 m (6,500,000 ft) of cable, and 83,820 m (275,000 ft) of piping would be needed for a single reactor building. Therefore, twice these amounts would be needed for VEGP Units 3 and 4, and considerably more would be required for all the other site structures. The actual commitment of construction resources (concrete, steel, and other building materials) would depend on the final site design described at the CP or COL stage. However, only a portion of the total would be used during the ESP-authorized construction activities or the supporting site-preparation and preliminary construction activities. Hazardous materials such as asbestos would not be used, if possible. If materials such as asbestos were used, it would be in accordance with applicable safety regulations and practices.

The staff expects that the use of construction materials in the quantities associated with those expected for Units 3 and 4 at the VEGP site, while irretrievable, would be of small consequence with respect to the availability of such resources.

The main resource that would be irretrievably committed during operation of the new nuclear units would be uranium. The availability of uranium ore and existing stockpiles of highly enriched uranium in the United States and Russia that could be processed into fuel is sufficient, so that the irreversible and irretrievable commitment would be of small consequence.

11.6 Benefit-Cost Balance

This section identifies the benefits and costs of constructing and operating two new nuclear generation units on the VEGP site. The intent of this section is to identify all potential societal benefits of the proposed activities and compare these to the potential internal (i.e., private) as well as external (i.e., societal) costs of the proposed activities. The purpose is to generally inform the ESP process by gathering and reviewing information that demonstrates the likelihood that the benefits of the proposed activities outweigh the aggregate costs.

Although the NRC has requirements for licensees (10 CFR 50.75) to provide reasonable assurance that funds would be available for the decommissioning process, general issues related to Southern's financial viability are outside NRC's mission and authority and, thus, would not be considered in this EIS. It is not possible to quantify and assign a value to all benefits and

^(a) Southern submitted a COL application for the VEGP site on March 31, 2008.

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costs associated with the proposed action. This analysis, however, attempts to identify, quantify, and provide monetary values for benefits and costs when reasonable estimates are available.

11.6.1 Benefits

The most apparent benefit from constructing and operating a power plant is that it would eventually generate power and provide thousands of residential, commercial, and industrial consumers with electricity. Maintaining an adequate supply of electricity in any given region has social and economic importance, because this resource is the foundation for economic stability and growth and fundamental to maintaining the current standard of living. In addition to nuclear power, however, there are a number of different power generation technology options that could meet this need, including natural-gas-powered plants, coal-fired generation, and hydroelectric plants. Because the focus of this EIS is on the proposed expansion of the VEGP site generating capacity, this section focuses primarily on the relative benefits of the VEGP option rather than the broader, more generic benefits of electricity supply.

11.6.1.1 Societal Benefits

In general, from a societal perspective, there are two primary benefits associated with nuclear power generation relative to most other alternative generating systems, which are described below.

1. Price Stability and Longevity. Because of relatively low and non-volatile fuel costs, nuclear energy is a dependable provider of electricity that can be provided at relatively stable prices to the consumer over a long period of time. Unlike some other energy sources, nuclear energy is generally not subject to unreliable weather or climate conditions, unpredictable cost fluctuations, and is less dependent on foreign suppliers than other energy sources.

For the production of electricity to be beneficial to a society, there must be a corresponding demand, or "need for power," in the region. Chapter 8 defines and discusses the need for power in more detail. The Georgia Public Service Commission (GPSC) regulates investor-owned utilities in the State of Georgia. As part of its mission to ensure that consumers receive safe, reliable, and reasonably priced electricity from financially viable entities, GPSC requires that all utilities under its jurisdiction submit Integrated Resource Plans (IRPs) every 3 years. The IRP provides GPSC with a means for consistently assessing a variety of demand and supply resources to cost effectively meet customer energy-service needs. It considers population growth, culture, lifestyle, the economy, the environment, available energy technology, and other factors and assesses many different ways to meet the forecasted demand with both supply-side and demand-management solutions. GPSC also ensures that the demand for power in the region is at a level that justifies additional power generation by investor-owned utilities and that the appropriate type of generation is chosen to meet this demand.

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The GPC submits an IRP for GPSC approval every 3 years. The GPC submitted its 2007 IRP for review to the GPSC, and a final ruling on the 2007 IRP was made on July 12, 2007 (GPSC 2007). As part of the 2007 IRP, the GPC's mix study selected nuclear energy as the most cost-effective resource in the 2015/2016 time frame. VEGP Units 3 and 4 would each be designed to generate approximately 1117 MW(e) net, for a total of 2234 MW. Assuming a reasonably low capacity factor of 85 percent, the two-unit plant average annual electrical energy generation would be more than 16,000,000 MWh. A reasonably high-capacity factor of 93 percent would result in slightly more than 18,000,000 MWh of electricity (Southern 2008a).

2. Energy Security and Fuel Diversity. Currently, more than 70 percent of the electricity generated in the United States is generated with fossil-based technologies; thus, non-fossil-based generation, such as nuclear generation, are essential to maintaining diversity in the aggregate power generation fuel mix (DOE/EIA 2006). Nuclear power contributes to the diverse U.S. energy mix, hedging the risk of shortages and price fluctuations for any one generating system and reducing the nation's dependence on imported fossil fuels.

One of the goals of the IRP process is to ensure that a region's given electricity generation relies on a mix of different fuels. A diverse fuel mix helps to protect consumers from contingencies such as fuel shortages or disruptions, price fluctuations, and changes in regulatory practices. The GPC fuel mix is made up of approximately 72 percent coal, 19 percent nuclear, 3 percent hydroelectric, and just under 6 percent natural gas and oil (Southern 2008a). The GPC IRP for 2004 shows a trend of increasing dependence on gas, and a corresponding decreasing dependence on nuclear, coal, and hydro energy (GPC 2004). In the past 15 years, virtually all new power plants built in Georgia have been fueled by natural gas. GPSC has raised concerns during the IRP approval process regarding the trend to rely more heavily on a relatively price-volatile fuel source for new electric generation, and has urged utilities to study the feasibility of building new nuclear plants (GPSC 2004). In response to the 2007 IRP, GPSC reaffirmed its conclusion that it was reasonable for GPC to investigate the opportunity to build nuclear units (GPSC 2007). The proposed expansion of the VEGP site generating capacity could provide additional nuclear power generation to the generation mix that could provide the region with a hedge against risks of future shortages and price fluctuations of alternative generating systems.

11.6.1.2 Regional Benefits

Tax Revenue Benefits

Southern's current tax payments to Burke County for the VEGP site represent approximately 80 percent of the total county property tax revenues. If two new units are operational at the VEGP site, there would be a significant regional tax revenue benefit realized by Burke County (see Section 5.5.3.2). The amount of property taxes that will be paid by the co-owners for the new units during operations depend on many factors, most of which are not known at this time;

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however, based on electrical output of 1117 MW(e) per unit and the estimated cost of each Westinghouse AP1000 reactor installed, the annual property tax revenues generated by the two new units could range from \$20 to \$29 million in the first 10 years of operation, and then decline as the value of the plant declines over time to around \$3.5 to \$5 million for Burke County.

Regional Productivity and Community Impacts

The new units would require an operating workforce of about 812 people who would stimulate the creation of 341^(a) additional indirect jobs. In total, approximately 1153 new jobs within about a 80-km (50-mi) radius of the plant would be created by the startup of the new units and would be maintained throughout the life of the plant. The economic multiplier effect of the increased spending by the direct and indirect workforce created as a result of two new units would increase the economic activity in the region, most noticeably in rural Burke County (Southern 2008a). Sections 4.5.3.1 and 5.5.3.1 provide additional information on the economic impacts of constructing and operating Units 3 and 4 on the VEGP site.

The existence of the VEGP site has resulted in infrastructure improvements to the region, including upgrading and paving the road that leads to the plant. It is expected that there would be various other local infrastructure improvements that would be made during the construction of VEGP Units 3 and 4, including road improvements around the plant (Southern 2008a).

NRC staff's interviews in surrounding VEGP communities revealed high perceived benefit to having both a "good corporate citizen" (Southern) in the region as well as the presence of significant groups of relatively well-paid and well-educated employees associated with the nuclear plant expansion. Local officials and service organization representatives all emphasized the philanthropic and service value that Southern and its employees bring to the community (PNNL 2006).

11.6.2 Costs

Internal costs to the applicant as well as external costs to the surrounding region and environment would be incurred during the construction and operation of two new units on the VEGP site. Internal costs include the costs to physically construct the power plant (capital costs), as well as operating and maintenance costs, fuel costs, waste disposal, and decommissioning costs. External costs include all costs imposed on the environment and region surrounding the plant and may include such things as a loss of regional productivity, environmental degradation, or loss of wildlife habitat.

(a) The indirect jobs are created from the multiplier effect, which is $812 \times \text{multiplier } 0.42 = 341$ (BEA 2005).

11.6.2.1 Internal Costs

The most substantial monetary cost associated with nuclear energy is the cost of capital construction. Nuclear power plants have relatively high capital costs for building the plant, but low fuel costs relative to alternative power generation systems. The real price of key heavy construction commodities, such as cement, steel, and copper, have increased substantially in recent years, which will have a significant impact on nuclear plant capital costs (although it should be noted that these price increases will increase construction costs for non-nuclear power plants, as well).^(a) Because of the large capital costs for nuclear power, and the relatively long construction period before revenue is returned, servicing the capital costs of a nuclear power plant is the most important factor determining the economic competitiveness of nuclear energy. Construction delays can add significantly to the cost of a plant. Because a power plant does not yield profits during construction, the longer construction times translate directly into higher interest expenses on borrowed construction funds. In general, since no new nuclear plants have been built in the United States in many years, there is a great deal of uncertainty about the true costs of a new unit.

Construction Costs

In evaluating monetary costs related to constructing Units 3 and 4 at the VEGP site, Southern reviewed recent published literature, vendor information, internally generated financial information, and internally generated, site-specific information. The NRC staff also reviewed recently published literature on the topic and compared this with Southern's cost estimates. The cost estimates reviewed were not based on nuclear plant construction experience in the United States, which is more than 20 years old, but rather construction costs overseas, which are more recent.

The phrase commonly used to describe the monetary cost of constructing a nuclear plant is "overnight capital cost." The capital costs are those incurred during construction, when the actual outlays for equipment and construction and engineering are expended. Overnight costs include engineering, procurement, and construction costs; however, it is presumed that the plant is constructed "overnight," thus interest is not included. Estimates of overnight capital costs for construction resulting from three comprehensive studies of nuclear plant costs (University of Chicago 2004; MIT 2003; DOE 2004) range from \$1100 per kW to \$2100 per kW (expressed in various year dollars). After escalating these construction cost estimates using real escalation

(a) Although in real terms, the construction costs for large projects remained relatively flat from 1998 to 2002, various construction cost indices from such sources such as the Electric Power Research Institute and McGraw Hill estimate real cost escalation for large power plant construction projects to be approximately 4 percent per year since 2002 (through 2007). This is based on actual field data as well as data on commodity costs, labor cost information, and other equipment (USDI/Reclamation 2008).

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rates during the 2002–2007 time frame, the top end of the range increases to around \$3000 per kW in 2007 dollars.

On April 8, 2008, Southern signed an Engineering, Procurement, and Construction (EPC) contract with Shaw Construction and Westinghouse (proposed reactor vendor). Although much of the information and calculations that went into these negotiations are business sensitive, Southern has formally stated that the overnight cost of capital to build two new nuclear units on the VEGP site is estimated to be in the range of \$3200 per kW to \$3500 per kW (Southern 2008b,c). Together with an installed capacity of 2234 MW(e), the \$3200 to \$3500 estimate per kW results in an overnight capital cost of construction for VEGP Units 3 and 4 of approximately \$7.1 to \$7.8 billion (Southern 2008b,c).

Operation Costs

Operation costs are frequently expressed as levelized cost of electricity, which is the price per kWh of producing electricity, including the cost needed to cover operating costs and annualized capital costs. Overnight capital costs account for a third of the levelized cost, and interest costs on the overnight costs account for another 25 percent (University of Chicago 2004). Levelized cost estimates range from \$36 to \$83 per MWh (3.6 to 8.3 cents per kWh). Factors affecting the range include choices for discount rate, construction duration, plant life span, capacity factor, cost of debt and equity and split between debt and equity financing, depreciation time, tax rates, and premium for uncertainty. Estimates include decommissioning but, due to the effect of discounting a cost that would occur as much as 40 years in the future, decommissioning costs have relatively little effect on the levelized cost. Considering such factors as the specific technologies selected, allocation of first-of-a-kind costs, site locations, and parity adjustments to allow comparison between counties, Southern originally estimated that \$65 per MWh (6.5 cents per kWh) was a reasonable levelized cost of electricity estimate for nuclear generation on the VEGP site (Southern 2008a). The estimate, however, corresponded with Southern's original lower estimate of overnight capital cost (\$2000 kW capacity). If the portion of the levelized cost attributable to capital expenses is escalated to Southern's current estimate (\$3200 to \$3500 kW)(Southern 2008c), the estimated levelized cost of electricity is in the range of 7.8 to 8.1 cents per kWh.

Fuel Costs

From the outset, the basic attraction of nuclear energy has been its low fuel costs compared to coal, oil and gas-fired plants. Uranium, however, has to be processed, enriched, and fabricated into fuel elements, and about half of the cost is results from enrichment and fabrication. Allowances must also be made for the management of radioactive spent fuel and the ultimate disposal of this spent fuel or the wastes separated from it (University of Chicago 2004). The average fuel expenses for new-generation reactors have been calculated to be around 1.6 cents per kWh for new-generation reactors in 2003 dollars (MIT 2003).

Waste Disposal

The back-end costs of nuclear power contribute a very small share of total cost, both because of the long lifetime of a nuclear reactor and the fact that provisions for waste-related costs can be accumulated over that time. It should also be recognized, however, that radioactive nuclear waste also poses unique disposal challenges for long-term management. The United States has yet to implement final disposition of spent fuel or high-level radioactive waste streams created at various stages of the nuclear fuel cycle. Because these radioactive wastes present some danger to present and future generations, the public and its elected representatives, as well as prospective investors in nuclear power plants, properly expect continuing and substantial progress towards solution to the waste-disposal problem. Successful operation of the planned disposal facility at Yucca Mountain would ease, but not solve, the waste-disposal issue for the United States if nuclear power expands substantially (MIT 2003). Spent fuel management costs are estimated to be 0.1 cents per kWh (WNA 2007; DOE 2008)

Decommissioning

The NRC has requirements for licensees at 10 CFR 50.75 to provide reasonable assurance that funds would be available for the decommissioning process. Because of the effect of discounting a cost that would occur as much as 40 years in the future, decommissioning costs have relatively little effect on the levelized cost of electricity generated by a nuclear power plant (WNA 2007).

11.6.2.2 External Costs

External costs are social and/or environmental effects caused by the proposed construction of and generation of power two new reactors at the VEGP site. This EIS includes the NRC staff's analysis that considers and weighs the environmental impacts of constructing and operating new nuclear units at the VEGP site or at alternative sites, and mitigation measures available for reducing or avoiding these adverse impacts. It also includes the staff's recommendation to the Commission regarding the proposed action.

Environmental and Social Costs

Chapter 4 of this EIS describes the impacts of construction on the environment with respect to the land, water, ecology, socioeconomics, radiation exposure to construction workers, and measures and controls to limit adverse impacts during construction of the proposed new units at the VEGP site. Chapter 5 examines environmental issues associated with operation of the proposed new nuclear VEGP Units 3 and 4 for an initial 40-year period. Potential operational impacts on land use, air quality, water, terrestrial and aquatic ecosystems, socio-economics, historic and cultural resources, environmental justice, nonradiological and radiological health effects, postulated accidents, and applicable measures and controls that would limit the adverse impacts of station operation during the 40-year operating period are considered. In accordance with 10 CFR Part 51, all impacts identified in Chapters 4 and 5 have been analyzed and a

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significance level of potential adverse impacts (i.e., SMALL, MODERATE, or LARGE) assigned. Chapter 6 addresses the environmental impacts from (1) the uranium fuel cycle and solid waste management, (2) the transportation of radioactive material, and (3) the decommissioning of nuclear units at the VEGP site. Chapter 9 includes the NRC staff's review of alternative sites and alternative power generation systems. Section 11.2 identifies unavoidable adverse impacts of the proposed action (i.e., impacts after consideration of proposed mitigation actions), and Section 11.5 identifies irretrievable commitments of resources. In Chapter 10, impacts were also compared to the adverse impacts for the three alternative sites, Plant Farley, Plant Hatch, and the Barton Site.

Unlike electricity generated from coal and natural gas, operation of a nuclear power plant does not result in any emissions of air pollutants associated with global warming and climate change (e.g., nitrogen oxides, sulfur dioxide, carbon dioxide) or methyl mercury. Combustion-based power plants are responsible for 36 percent of the carbon dioxide, 64 percent of the sulfur dioxide, 26 percent of the nitrogen oxide, and 13 percent of the mercury emissions from industrial sources in the United States (DOE/EIA 2006). The majority of the electric power industry's emissions are from coal-fired plants (Southern 2008a). Chapter 9 of this EIS analyzes coal- and natural-gas-fired alternatives to the construction and operation of VEGP Units 3 and 4. Air emissions from these alternatives and nuclear power are summarized in Chapters 5 and 9.

Safety

For some people, nuclear power has perceived high risk associated with safety, environmental, and health effects, heightened by the 1979 Three Mile Island and 1986 Chernobyl reactor accidents, and also by accidents at fuel cycle facilities in the United States, Russia, and Japan. In recent years, there has also been growing concern about the safe and secure transportation of nuclear materials and the security of nuclear facilities from terrorist attack. It should be noted, however, that the intent of this EIS is to analyze and assess any potential adverse safety, environmental, and health effects; thus, NRC staff conclusions regarding these topics are found in Chapters 4, 5, and 6 of this EIS. It is further noted that NRC staff interviews with local officials and community members around the VEGP site did not reveal any significant perceived risk of safety, environmental, or health effects related to the operation of nuclear power plants in the region.

11.6.3 Summary of Benefits and Costs

Southern's business decision to pursue expansion of VEGP generating capacity by adding two additional nuclear reactors is an economic decision, based on private financial factors subject to regulation by the GPSC. The internal costs to construct additional units appear to be substantial; however, Southern's decision to pursue this expansion implies that the company

has already concluded that the private, or internal, benefits of the proposed facility outweigh the internal costs. Although no specific monetary values could reasonably be assigned to the identified societal benefits, it would appear that the potential societal benefits of the proposed expansion of VEGP are substantial. In comparison, the external socio-environmental costs imposed on the region appear to be relatively small.

Table 11-3 includes a summary of both internal and external costs of the proposed activities at VEGP, as well as the identified benefits. The table includes a reference to other sections of this EIS when more detailed analyses and when impact assessments are available for specific topics. These assessments are included in the table.

The staff concludes, on the basis of the assessments summarized in this EIS, that the construction and operation of the proposed VEGP Units 3 and 4, with mitigation measures identified by the staff, would have accrued benefits that most likely would outweigh the economic, environmental, and social costs associated with constructing and operating two new units at the VEGP site.

Table 11-3. Summary of Benefits and Costs of the Proposed Action

Benefit-Cost Category	Description	Impact Assessment^(a)
Benefits		
Electricity generated	16,000,000 to 18,000,000 MWh per year for the 40-year life of the plant	
Generating capacity	2234 MW (two units at 1117 MW each)	
Fuel diversity and energy security	Nuclear option provides diversity to coal- and natural-gas-fired baseload generation	
Tax revenues	Property tax revenues could range from approximately \$29 million to \$3.5 million annually over the 40-year life of the units (see Sections 4.5.3.2 and 5.5.3.2)	LARGE
Local economy	Increased jobs would benefit the area economically and increase economic diversity of region (see Sections 4.5.3.1 and 5.5.3.1)	SMALL to MODERATE
Transportation	Minor upgrades to roads around the VEGP site	
Public services and education	Additional tax revenues and philanthropic dollars to the community expected from Southern's corporate donations as well as donations of time and money from its employees	SMALL to MODERATE
Costs		
	<u>Internal Costs^(b)</u>	
Construction cost	\$7.1-\$7.8 billion (overnight capital cost - 2008\$)	
Operating cost	7.8-8.1 cents per kWh (levelized cost of electricity - 2008\$)	
Fuel Expenses ^(c)	1.6 cents per kWh	

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Table 11-3. (contd)

Benefit-Cost Category	Description	Impact Assessment ^(a)
Spent fuel management ^(d)	0.1 cent per kWh	
Decommissioning ^(e)	0.1–0.2 cent per kWh	
Material and resources	25,000 yds ³ concrete 6000 tons rebar 13,000,000 linear feet cable 550,000 feet of piping having a diameter of > 2.6 in. 981 MT uranium	
Tax payments	Corporate income, business, and property taxes must be paid by the VEGP site owners to the County and State. Although taxes associated with income and operation of the plant are not estimated, the tax payments on property assessment could range from \$29 million to \$3.5 million annually over the 40-year life of the units.	
Land use	131 ha (324 ac) occupied on a long-term basis by the two new nuclear reactors and associated infrastructure. Rights-of-way would need to be acquired and developed for transmission (see Sections 4.1 and 5.1). <u>External Costs</u>	
Land use	The land acquired for new transmission line rights-of-way may be taken out of other productive or beneficial use (see Sections 4.1 and 5.1).	SMALL to MODERATE
Air-quality impacts	Negligible impacts (see Sections 4.2, 5.2, and 9.2). Avoidance of sulfur dioxide, nitrogen oxide, carbon monoxide, carbon dioxide, and particulate emissions.	SMALL
Ecological impacts	Terrestrial impacts expected to be small. Southern's adherence to the NPDES permit would likely result in balanced aquatic populations. Transmission line impacts would be greater. No threatened or endangered terrestrial or aquatic species likely to be adversely affected (see Sections 4.4 and 5.4).	SMALL to MODERATE
Physical impacts of plant construction and operation on community	Impacts limited primarily to boundaries of the site (see Sections 4.5.1 and 5.5.1).	SMALL
Housing	Adequate housing is available in the area (see Section 4.5.4.3).	SMALL

Table 11-3. (contd)

Benefit-Cost Category	Description	Impact Assessment ^(a)
Transportation	Temporary stress on road/local road network because of congestion during construction and potential degradation from construction and operation activities (see Sections 4.5.4.1 and 5.5.4.1).	SMALL to MODERATE
Public services	Potential short-term strain on community services in Burke County during early stages of 7-year construction period (see Section 4.5.4.4).	SMALL
Aesthetics and recreation	Because the plant already exists onsite, very little marginal impact on aesthetic and recreation from additional reactors (see Sections 4.5.1.4, 4.5.3.4, 5.5.1.4, and 5.5.3.4).	SMALL to MODERATE
Cultural resources	There would likely be an adverse effect to a cultural resource. Southern has committed to develop procedures to manage cultural resources in the event of an inadvertent discovery onsite (see Sections 4.6 and 5.6).	MODERATE
Health impacts (nonradiological and radiological)	Small estimated temperature increases would not significantly increase abundance of thermophilic microorganisms. Radiological doses to the public and occupational workers would be monitored and controlled in accordance with regulatory limits (see Sections 4.8, 4.9, 5.8 and 5.9).	SMALL

(a) Impact assessments are listed for all impacts evaluated in detail as part of this EIS. The details on impact assessments are found in the indicated sections of this EIS.

(b) Internal costs are costs incurred by Southern to implement proposed construction and operation of the VEGP site. Note that no impact assessments are provided for these private financial impacts.

(c) Fuel expenses are also included in levelized operating cost estimate and are based on an MIT study (MIT 2003).

(d) Based on Yucca Mountain waste maintenance levy. Source: WNA 2007.

(e) Decommissioning expenses are also included in levelized operating cost (WNA 2007).

11.7 Staff Conclusions and Recommendations

The staff's recommendation to the Commission related to the environmental aspects of the proposed action is that the ESP should be issued. The staff's evaluation of the safety and emergency preparedness aspects of the proposed action will be addressed in the staff's safety evaluation report that is anticipated to be published in November 2008.

This recommendation is based on (1) the ER submitted by Southern (Southern 2008a), (2) additional comments, submittals, and responses to requests for additional information provided by Southern, (3) consultation with Federal, State, Tribal, and local agencies, (4) NRC's own independent review, (5) the staff's consideration of comments related to the environmental review that were received during the public scoping and draft EIS review processes, and (6) the

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assessments summarized in this EIS, including the potential mitigation measures identified in the ER and in the EIS. In addition, in making its recommendation, the staff determined that there are no environmentally preferable or obviously superior sites. Finally, the staff concludes that the construction activities defined at 10 CFR 50.10(a) and described in the site redress plan would not result in any adverse significant impact that cannot be redressed.

A comparative summary showing the environmental impacts of locating two new nuclear units at the VEGP site and at any of the alternative sites is shown in Table 11-4. Impacts of the no-action alternative, or denial of the ESP application, are also shown. Table 11-4 shows that the significance of the environmental impacts of the proposed action is SMALL for all impact categories with the exception of (1) land-use and ecological resources because of uncertainty surrounding possible transmission line right-of-way locations, (2) a MODERATE historic and cultural resource impact, and (3) certain socioeconomic categories because of the influx of construction workers. The alternative sites may have environmental effects in at least some categories that reach MODERATE significance. The staff concludes that none of the alternative sites assessed is obviously superior to the VEGP site.

Table 11-4. Summary of Environmental Significance of Locating Two New Nuclear Reactors at the VEGP Site and at Alternative Sites and for the No-Action Alternative

Impact Category	Proposed Action	No-Action Alternative	Plant Farley	Plant Hatch	Barton Site
	ESP Site	Denial of ESP			
Land use	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL to MODERATE	MODERATE
Air quality	SMALL	SMALL	SMALL	SMALL	SMALL
Water use and quality	SMALL	SMALL	SMALL	SMALL	SMALL
Ecology	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL to MODERATE	MODERATE
Socioeconomics	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Historic and cultural resources	MODERATE	SMALL	SMALL	SMALL	SMALL
Environmental justice	SMALL	SMALL	SMALL	SMALL	SMALL
Human health	SMALL	SMALL	SMALL	SMALL	SMALL

11.8 References

10 CFR Part 50. Code of Federal Regulations, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

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10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy*, Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

40 CFR Part 1508. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 1508, "Terminology and Index."

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Docket No. 52-011

11. ABSTRACT (200 words or less)

This Final Environmental Impact Statement (FEIS) has been prepared in response to an application submitted to the U.S. Nuclear Regulatory Commission (NRC) by Southern Nuclear Operating Company, Inc. (Southern) for an Early Site Permit (ESP). The proposed action requested in Southern's application is for the NRC to (1) approve a site within the existing Vogtle Electric Generating Plant (VEGP) boundaries as suitable for the construction and operation of a new nuclear power generating facility, and (2) issue an ESP for the proposed location at the VEGP site, adjacent to the existing VEGP units.

The NRC staff's preliminary recommendation to the Commission related to the environmental aspects of the proposed action is that the ESP should be issued as proposed. The staff's evaluation of the site safety and emergency preparedness aspects of the proposed action are addressed in the staff's Safety Evaluation Report issued in August 2007. This recommendation is based on: (1) the application, including the Environmental Report (ER), submitted by Southern; (2) consultation with Federal, State, Tribal, and local agencies; (3) the staff's independent review; (4) the staff's consideration of comments related to the environmental review that were received during the public scoping process; and (5) the assessments summarized in this FEIS, including the potential mitigation measures identified in the ER and this FEIS. In addition, in making its recommendation, the staff determined that there are no environmentally preferable or obviously superior sites. Finally, the staff has concluded that the site preparation and preconstruction activities allowed by 10 CFR 50.10(e)(1) requested by Southern in its application will not result in any significant adverse environmental impact that cannot be redressed.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)

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