8.0 Environmental Impacts of Alternatives to Operating License Renewal

This chapter examines the potential environmental impacts associated with denying the renewal of the operating licenses (OLs) (i.e., the no-action alternative), the potential environmental impacts from electric generating sources other than North Anna Power Station (North Anna), Units 1 and 2, the possibility of purchasing electric power from other sources to replace power generated by Units 1 and 2 and the associated environmental impacts, the potential environmental impacts from a combination of generating and conservation measures, and other generation alternatives that were deemed unsuitable for replacement of power generated by Units 1 and 2. The environmental impacts were evaluated using the U.S. Nuclear Regulatory Commission's (NRC's) three-level standard of significance–SMALL, MODERATE, or LARGE–developed using the Council on Environmental Quality guidelines and set forth in a footnote to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B:

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

The 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 categories of environmental justice and transportation.

8.1 No-Action Alternative

NRC's regulations implementing the National Environmental Policy Act (NEPA) (42 USC 4321) specify that the no-action alternative be discussed in an NRC environmental impact statement [10 CFR Part 51, Subpart A, Appendix A(4)]. For license renewal, the no-action alternative refers to a scenario in which the NRC would not renew the North Anna Units 1 and 2 OLs, and the Virginia Electric and Power Company (VEPCo) would then decommission North Anna Units 1 and 2 when plant operations cease. Replacement of North Anna Units 1 and 2 electricity

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

generation capacity would be met by (1) demand-side management and energy conservation, (2) power purchased from other electricity providers, (3) generating alternatives other than North Anna Units 1 and 2, or (4) some combination of these options.

VEPCo will be required to comply with NRC decommissioning requirements whether or not the OLs are renewed. If the North Anna Units 1 and 2 OLs are renewed, decommissioning activities may be postponed for up to an additional 20 years. If the OLs are not renewed, VEPCo would conduct decommissioning activities according to the requirements in 10 CFR 50.82.

The environmental impacts associated with decommissioning under both license renewal and the no-action alternative would be bounded by the discussion of impacts in Chapter 7 of the GEIS, Chapter 7 of this draft Supplemental Environmental Impact Statement (SEIS), and the *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities* (NRC 1988).[(a)] The impacts of decommissioning after 60 years of operation are not expected to be significantly different from those occurring after 40 years of operation.

The environmental impacts for the socioeconomic, historic and archaeological resources, and environmental justice impact categories are summarized in Table 8-1 and discussed in the ensuing paragraphs.

Table 8-1. Summary of Environmental Impacts of the No-Action Alternative

Impact Category	Impact	Comment
Socioeconomic	SMALL to MODERATE	Decrease in employment, higher-paying jobs and tax revenues. Most adverse impacts would be on Louisa County.
Historic and Archaeological Resources	SMALL to MODERATE	Land occupied by Units 1 and 2 could be developed after decommissioning.
Environmental Justice	SMALL to MODERATE	Loss of employment opportunities and social programs, particularly in Louisa County.

- Socioeconomic: When North Anna Units 1 and 2 cease operation, there will be a decrease in employment and tax revenues associated with the closure. These impacts would be felt in Henrico, Orange, Spotsylvania, and Richmond counties and the City of Richmond.

(a) The NRC staff is supplementing NUREG-0586 for reactor decommissioning. In October 2001, the staff issued draft Supplement 1 to NUREG-0586 dealing with Decommissioning of Nuclear Power Reactors (66 FR 56721, NRC 2001a) for public comment. The staff is currently finalizing the draft Supplement for publication as a final document.

Louisa County would be more adversely impacted than the other counties in both employment and tax revenue. Most secondary employment impacts and impacts on population would also be felt in the preceding locations. Approximately 80 percent of the employees who work at North Anna Units 1 and 2 live in these counties.

The no-action alternative would result in the loss of the taxes attributable to North Anna Units 1 and 2 as well as the loss of plant payrolls 20 years earlier than if the OLs were renewed. As previously mentioned, most of the tax revenue losses resulting from closure of North Anna Units 1 and 2 would occur in Louisa County. In 2000, VEPCo paid $10.58 million in property taxes to Louisa County for the nuclear generation units at North Anna, or about 42 percent of all property taxes collected by the County (see Table 2-15).[(a)] For the remaining two counties to which property taxes are paid, the loss in real property tax would not be significant, amounting to 1.2 and 1.4 percent for Orange and Spotsylvania Counties, respectively, in 2000.

Loss of the property tax revenue could have a significant, short-term negative impact on the ability of Louisa County to provide public services such as schools and road maintenance. There could also be an adverse, short-term impact on housing values, the local economy in Louisa County and surrounding areas, and employment if North Anna Units 1 and 2 were to cease operations.

VEPCo employees working at North Anna Units 1 and 2 currently contribute time and money toward community involvement, including schools, churches, charities, and other civic activities. It is likely that with a reduced presence in the community following decommissioning, community involvement efforts by VEPCo and its employees in the region would be reduced.

The degree and extent of such adverse impacts would depend on the economic development taking place in Louisa County and the other counties and cities over the next 20 years. If the Richmond area continues its growth and diversification into the first quarter of the 21st century as it has for the last decade, and assuming that the economic growth spills over to surrounding counties such as Louisa, Spotsylvania, and Orange, then the consequences of not renewing the OLs could be partially or entirely offset by the new jobs created by such growth. While many of the jobs from past economic development are higher-paying, white-collar positions (e.g., banking and financial service centers), it is not known if these types of jobs and the pay scale of the projected employment increase will be maintained. If the new jobs are skilled, higher-paying jobs, then the impacts of nonrenewal of the North Anna, Units 1 and 2, OLs could be significantly mitigated, and the socioeconomic consequence of

(a) Information obtained during an interview of Ms. Nancy Pleasants, Commissioner of Revenue, Louisa County October 15, 2001.

plant closure would be SMALL. If the jobs are less-skilled and lower-paying, then the impact of plant closure could be only partially offset and impacts could be MODERATE, particularly in Louisa County.

- Historic and Archaeological Resources: The potential for future adverse impacts to known or unrecorded cultural resources at North Anna following decommissioning of Units 1 and 2 will depend on the future use of the land occupied by the two units. Following decommissioning, land occupied by Units 1 and 2 would likely be retained by VEPCo for other corporate purposes, including potential development of the site given its location on Lake Anna. Eventual sale or transfer of the land occupied by Units 1 and 2, however, could result in adverse impacts to cultural resources if land-use patterns of the site, and lands surrounding the site, change dramatically. Notwithstanding this possibility, the impacts of this alternative on historic and archaeological resources are considered SMALL.

- Environmental Justice for No-Action: Current operations at North Anna Units 1 and 2 have no disproportionate impacts on the minority and low-income populations of the surrounding counties, and no environmental pathways have been identified that would cause disproportionate impacts. Closure of Units 1 and 2 could result in decreased employment opportunities in Henrico, Orange, and Spotsylvania Counties and Richmond County and City, with Louisa County potentially seeing the greatest impact. Real property tax revenues lost in Louisa County would be large, with possible negative and disproportionate impacts on minority or low-income populations depending on the County's ability to continue providing services to these populations. The environmental justice impacts under the no-action alternative are considered SMALL to MODERATE.

Impacts for all other impact categories would be SMALL, as shown in Table 9-1.

8.2 Alternative Energy Sources

This section discusses the environmental impacts associated with alternative sources of electric power to replace the power generated by North Anna Units 1 and 2, assuming that the OLs for Units 1 and 2 are not renewed. The order of presentation of alternative energy sources in Section 8.2 does not imply which alternative would most likely occur or have the least environmental impacts. The following generation alternatives are considered in detail:

- coal-fired generation at the North Anna site and at an alternate greenfield site (Section 8.2.1)

- natural-gas-fired generation at the North Anna site and at an alternate greenfield site (Section 8.2.2)

- nuclear generation at the North Anna site and an alternate greenfield site (Section 8.2.3).

The alternative of purchasing power from other sources to replace power generated at North Anna Units 1 and 2 is discussed in Section 8.2.4. Other power generation alternatives and conservation alternatives considered by the staff and found not to be reasonable replacements for Units 1 and 2 are discussed in Section 8.2.5. Section 8.2.6 discusses the environmental impacts of a combination of generation and conservation alternatives.

Each year the Energy Information Administration (EIA), a component of the U.S. Department of Energy (DOE), issues an Annual Energy Outlook. In the *Annual Energy Outlook 2002*, issued in December 2001 (DOE/EIA 2001a), EIA projects that combined-cycle or combustion turbine technology fueled by natural gas is likely to account for approximately 88 percent of new electric generating capacity between the years 2001 and 2020. Both technologies are designed primarily to supply peak and intermediate capacity, but combined-cycle technology also can be used to meet baseload[(a)] requirements. Coal-fired plants are projected by EIA to account for approximately 9 percent of new capacity during this period. Coal-fired plants are generally used to meet baseload requirements. Renewable energy sources, primarily wind, geothermal, and municipal solid waste units, are projected by EIA to account for the remaining 3 percent of capacity additions. The EIA's projections are based on the assumption that providers of new generating capacity will seek to minimize cost while meeting applicable environmental requirements. Combined-cycle plants are projected by EIA to have the lowest generation cost in 2005 and 2020, followed by coal-fired plants and then wind generation (DOE/EIA 2001a).

EIA also projects that new nuclear power plants will not account for any new generation capacity in the United States during the 2000 to 2020 time period because natural gas and coal-fired plants are projected to be more economical (DOE/EIA 2001a). In spite of this projection, a new nuclear plant alternative for replacing power generated by North Anna Units 1 and 2 is considered in Section 8.2.3. Since 1997, the NRC has certified three new standard designs for nuclear power plants under the procedures in 10 CFR Part 52, Subpart B. These designs are the U.S. Advanced Boiling Water Reactor (10 CFR Part 52, Appendix A), the System 80+ Design (10 CFR Part 52, Appendix B), and the AP600 Design (10 CFR Part 52, Appendix C). The submission to the NRC of these three applications for certification indicates continuing interest in the possibility of licensing new nuclear power plants. The NRC has recently established a New Reactor Licensing Program to prepare for and manage future reactor and site licensing applications (NRC 2001b).

North Anna Units 1 and 2 have a combined average net capacity of 1,790 megawatts electric (MW[e]). For the coal and natural gas alternatives, VEPCo's Environmental Report (ER)

(a) A baseload plant normally operates to supply all or part of the minimum continuous load of a system and consequently produces electricity at an essentially constant rate. Nuclear power plants are commonly used for baseload generation; i.e., these units generally run near full load.

assumes three standard 508-MW(e) units[a] as potential replacements for Units 1 and 2 (VEPCo 2001). The staff used this assumption in their evaluation, although it results in some environmental impacts that are roughly 17 percent lower than if full replacement capacity were constructed. VEPCo's reasoning is that although custom-sized units can be built, use of standardized sizes is more economical. Moreover, using four 508-MW(e) units for the analysis would overestimate environmental impacts and tend to make the fossil fuel alternatives less attractive.

8.2.1 Coal-Fired Generation

The coal-fired alternative is analyzed at both the North Anna site and at an alternate site. As discussed in Section 8.2, the staff assumed construction of three 508-MW(e) units.

The VEPCo ER (VEPCo 2001) assumes that coal and lime or limestone for a coal-fired plant sited at the North Anna would be delivered by a CSX rail line to an existing 11.3-km (7-mi) rail spur that leads to North Anna. The rail system at North Anna would require modifications to handle the increased traffic (VEPCo 2001). Lime[b] or limestone is used in the scrubbing process for control of sulfur dioxide (SO_2) emissions.

While construction at an alternate, greenfield site is not specifically discussed in VEPCo's ER, rail delivery would be the most likely option for delivering coal and lime/limestone to an alternate inland site for the coal-fired plant. Barge delivery of coal and lime/limestone is potentially feasible for a coastal site. A coal slurry pipeline is also a technically feasible delivery option; however, the associated cost and environmental impacts make a slurry pipeline an unlikely transportation alternative. Construction at an alternate site could necessitate the construction of a new transmission line to connect to existing lines and a rail spur to the plant site.

The coal-fired plant would consume approximately 4.4 million MT (4.9 million tons) per year of pulverized bituminous coal with an ash content by weight of approximately 10.7 percent (VEPCo 2001). The ER assumes a heat rate[c] of 3 J fuel/J electricity (10,200 Btu/kWh) and a

(a) Each of the coal-fired units would have a rating of 538 gross MW and 508 net MW. Each of the gas-fired units would have a rating of 528 gross MW and 508 net MW. The difference between "gross" and "net" is the electricity consumed onsite.

(b) In a typical wet scrubber, lime (calcium hydroxide) or limestone (calcium carbonate) is injected as a slurry into the hot effluent combustion gases to remove entrained sulfur dioxide. The lime-based scrubbing solution reacts with sulfur dioxide to form calcium sulfite, which precipitates out and is removed in sludge form.

(c) Heat rate is a measure of generating station thermal efficiency. In English units, it is generally expressed in British thermal units (Btu) per net kilowatt-hour (kWh). It is computed by dividing the total Btu content of fuel burned for electric generation by the resulting net kWh generation.

capacity factor[a] of 0.85 (VEPCo 2001). After combustion, 99.9 percent of the ash (approximately 474,000 MT/yr [522,000 tons/yr]) would be collected and disposed of at the plant site. In addition, approximately 221,000 MT/yr (244,000 tons/yr) of scrubber sludge would be disposed of at the plant site based on annual lime usage of approximately 76,000 MT (84,000 tons) (VEPCo 2001).

Unless otherwise indicated, the assumptions and numerical values used in Section 8.2.1 are from the VEPCo ER (VEPCo 2001). The staff reviewed this information and compared it to environmental impact information in the GEIS. Although the OL renewal period is only 20 years, the impact of operating the coal-fired alternative for 40 years is considered (as a reasonable projection of the operating life of a coal-fired plant).

8.2.1.1 Once-Through Cooling System

For purposes of this SEIS, the staff assumed that a coal-fired plant located at North Anna would use the existing once-through system as a source of cooling. An alternate greenfield site could use either a closed-cycle or a once-through cooling system.

The overall impacts of the coal-fired generating system are discussed in the following sections and summarized in Table 8-2. The extent of impacts at an alternate site would depend on the location of the particular site selected.

- **Land Use**

  The North Anna site is approximately 422 ha (1043 ac). Construction of the power block and coal storage area would impact some land area and associated terrestrial habitat. However, in the ER VEPCo states it will make maximum use of existing facilities and infrastructure, limiting the amount of new construction that would be required (VEPCo 2001). Specifically, the staff assumed that the coal-fired replacement plant alternative would use the existing once-through cooling system, switchyard, offices, and transmission line right-of-way.

  The coal-fired generation alternative would necessitate converting some of the unused land at North Anna to coal storage and ash and scrubber sludge disposal. VEPCo estimates that ash and scrubber waste disposal over a 40-year plant life would require approximately

(a) The capacity factor is the ratio of electricity generated, for the period of time considered, to the energy that could have been generated at continuous full-power operation during the same period.

Table 8-2. Summary of Environmental Impacts of Coal-Fired Generation at North Anna Power Station and an Alternate Greenfield Site Using Once-Through Cooling

	North Anna		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Land Use	SMALL to MODERATE	Extensive use of existing infrastructure. Uses 172 ha (425 ac) of undeveloped portion of North Anna for waste disposal of coal ash and scrubber sludge over 40-year plant life. Additional offsite land impacts for coal and limestone mining.	SMALL to LARGE	Uses up to 1100 ha (2600 ac) for plant, offices, parking, and waste disposal; additional offsite land impacts for coal and limestone mining; possible impacts for transmission line and rail spur. Degree of impact dependent on whether alternate site is disturbed: SMALL to MODERATE impact previously developed site, LARGE impact greenfield site.
Ecology	SMALL to MODERATE	Uses previously developed areas except for waste disposal of coal ash and scrubber sludge. Potential habitat loss and fragmentation and reduced productivity and biological diversity could result from disturbing lands not previously disturbed.	SMALL to LARGE	Impact depends on whether site is previously developed (SMALL to MODERATE) or greenfield (MODERATE to LARGE), location and ecology of the site, surface water body used for intake and discharge, transmission line route; potential habitat loss and fragmentation, reduced productivity, and biological diversity.
Water Use and Quality				
Surface Water	SMALL	Uses existing once-through cooling system.	SMALL to MODERATE	Impact will depend on the volume of water withdrawn and discharged and the characteristics of the surface water body at the alternate site.
Groundwater	SMALL	Groundwater use is <1000 gpm; once-through cooling is employed.	SMALL	Groundwater use similar to impacts at North Anna site; impacts depend on groundwater use and availability.

Table 8-2. (contd)

Impact Category	North Anna Impact	North Anna Comments	Alternate Greenfield Site Impact	Alternate Greenfield Site Comments
Air Quality	MODERATE	Sulfur oxides • 4130 MT/yr (4550 tons/yr) Nitrogen oxides • 1075 MT/yr (1185 tons/yr) Particulates • 237 MT/yr (261 tons/yr) of total suspended particulates, which would include 54 MT/yr (60 tons/yr) of PM_{10}. Carbon monoxide • 1100 MT/yr (1215 tons/yr) Small amounts of mercury and other hazardous air pollutants and naturally occurring radioactive materials – mainly uranium and thorium. • Other pollutants–arsenic, beryllium, cadium, chromium, dioxin, hydrogen chloride and fluoride, lead, manganese, mercury, uranium, and thorium.	MODERATE	Potentially same impacts as at North Anna, although pollution-control standards may vary.
Waste	MODERATE	Total waste volume would be approximately 695,000 MT/yr (765,000 tons/yr) of ash and scrubber sludge requiring approximately 172 ha (425 ac) for disposal during the 40-year life of the plant.	MODERATE	Same impacts as at North Anna; waste disposal constraints may vary.
Human Health	SMALL	Impacts are uncertain, but considered SMALL in the absence of more quantitative data.	SMALL	Same impact as at North Anna.

Table 8-2. (contd)

	North Anna		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Socioeconomics	SMALL to MODERATE	During construction, impacts would be SMALL to MODERATE. Up to 2500 workers during the peak period of the 5-year construction period, followed by reduction of current North Anna Units 1 and 2 workforce from approximately 921 to 961 permanent and contractor employees to 200. Tax base preserved. Impacts during operation would be SMALL to MODERATE due to loss of employment in Louisa County, which may be offset by future economic growth in the County and surrounding Richmond metropolitan area.	SMALL to LARGE	Construction impacts depend on location, but could be LARGE if plant is located in a rural area. Louisa County would experience loss of Units 1 and 2 tax base and employment with potentially LARGE impacts. Impacts during operation at alternate site would be SMALL to MODERATE, depending upon the economy at the alternate site.
	SMALL to LARGE	Transportation impacts associated with construction workers could be MODERATE to LARGE. Transportation impacts during operation would be SMALL due to decreased workforce.	SMALL to LARGE	Transportation impacts associated with construction workers could be MODERATE to LARGE, depending on the transportation infrastructure at the alternate site. Transportation impacts during operation would be SMALL due to the decreased workforce.
		For rail transportation of coal and lime/limestone, the impact is considered SMALL.		For rail transportation of coal and lime/limestone, the impact is considered SMALL in a rural area and MODERATE in a more crowded, suburban area. For barge transportation, the impact is considered SMALL.

Table 8-2. (contd)

Impact Category	North Anna Impact	North Anna Comments	Alternate Greenfield Site Impact	Alternate Greenfield Site Comments
Aesthetics	SMALL to MODERATE	Three coal-fired power plant units and exhaust stacks would be visible in daylight hours from offsite. The plant would also be visible at night because of outside lighting. Rail transportation of coal and lime/limestone would also have a SMALL to MODERATE aesthetic impact. Coal-fired generation would introduce mechanical sources of noise audible offsite. These impacts are SMALL to MODERATE.	SMALL to LARGE	Impact would depend on the site selected and the surrounding land features and could be LARGE if a greenfield site is selected. If needed, a new transmission line or rail spur would add to the aesthetic impact. Rail transportation of coal and lime/limestone would be SMALL to MODERATE, again depending on the characteristics of the alternate site. Barge transportation of coal and lime/limestone would have a SMALL to MODERATE esthetic impact. Noise impact would be SMALL to MODERATE.
Historic and Archeological Resources	SMALL	Some construction would affect previously undeveloped parts of North Anna; cultural resource inventory should minimize any impacts on undeveloped lands. Studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on undeveloped land on cultural resources, even at a developed site.	SMALL	Alternate location would necessitate cultural resource studies. Studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on undeveloped sites on cultural resources.
Environmental Justice	SMALL to MODERATE	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole. Some impacts on housing may occur during construction; loss of from 721 to 761 operating jobs (permanent and contractor) at North Anna could reduce employment prospects for minority and low-income populations. Dependent, to some extent, on the economic vitality/expansion of the Richmond metropolitan and surrounding area.	SMALL to LARGE	Impacts at alternate site vary depending on population distribution and makeup. Could be SMALL to LARGE. Louisa County would lose significant revenue, which could have MODERATE to LARGE impacts on minority and low-income populations in terms of services the County could provide with the smaller property tax and employment base.

172 ha (425 ac) (VEPCo 2001).[a] Approximately 86 ha (213 ac) of second-growth mixed pine hardwoods would be converted to waste disposal facilities during the 20-year license renewal term. VEPCo believes that there is space within the existing North Anna footprint to accommodate waste disposal. After closure, the waste site would be re-vegetated and the land would become available for other uses. Additional land-use changes would occur offsite in an undetermined coal-mining area to supply coal for the plant. The GEIS estimates that approximately 8900 ha (22,000 ac) would be affected for mining the coal and disposing of the waste to support a 1000 MW(e) coal plant during its operational life (NRC 1996). A replacement coal-fired plant for North Anna Units 1 and 2 would be 1524 MW(e) and would affect proportionately more land. Partially offsetting this offsite land use would be the elimination of the need for uranium mining to supply fuel for Units 1 and 2. The GEIS states that approximately 405 ha (1000 ac) would be affected for mining the uranium and processing it during the operating life of a 1000-MW(e) nuclear power plant (NRC 1996).

The impact of a coal-fired generating unit on land use at North Anna is best characterized as SMALL to MODERATE. The impact would definitely be greater than the OL renewal alternative.

In the GEIS, NRC staff estimated that a 1000-MW(e) coal-fired plant would require approximately 700 ha (1700 ac) (NRC 1996). Construction of a 1524 MW(e) coal-fired generation alternative at an alternate site could impact proportionately more land. The degree to which the land use would be impacted depends on whether the alternate site is a greenfield site or previously developed industrial site. Additional land could be needed for a transmission line and for a rail spur to the plant site. Depending on transmission line and rail line routing requirements, this alternative would result in SMALL to LARGE land-use impacts.

- **Ecology**

Locating a coal-fired plant at the North Anna site would have some impact on ecological and terrestrial resources because of the need to convert 86 ha (213 ac) of undisturbed land for ash and scrubber sludge disposal. In addition, construction of the power block and coal storage area would impact some land area and associated terrestrial habitat. Operation of the coal-fired plant would use the existing cooling system, which would minimize impacts to aquatic resources. In summary, because the coal-fired alternative is developed on a previously disturbed area, is at an existing industrial site, and makes maximum use of

(a) While only half of the 172 ha (425 ac) would be attributable to the 20-year license renewal alternative, the total numbers are pertinent as a cumulative impact (VEPCo 2001).

existing facilities, it is expected that the ecological impacts would be SMALL to MODERATE, but still greater than renewal of the North Anna Units 1 and 2 OLs.

At an alternate site, the coal-fired generation alternative would introduce construction impacts and new incremental operational impacts. Even assuming siting at a previously disturbed area, the impacts could alter the ecology. Impacts could include wildlife habitat loss, reduced productivity, habitat fragmentation, and a local reduction in biological diversity. Use of cooling makeup water from a nearby surface water body could have adverse aquatic resource impacts. If needed, construction and maintenance of a transmission line and a rail spur would have ecological impacts. Overall, the ecological impacts at an alternate site would be SMALL to MODERATE (previously developed site) or MODERATE to LARGE (greenfield site).

- **Water Use and Quality**

Surface water. The coal-fired generation alternative at the North Anna site is assumed to use the existing once-through cooling system, which would minimize incremental water use and quality impacts. Operation using the existing cooling system should minimize any impacts on water quality. Thus, surface water impacts are expected to remain SMALL; the impacts would be sufficiently minor that they would not noticeably alter any important attribute of the resource.

For a coal-fired plant located at an alternate site, the impact on the surface water would depend on the volume of water needed for makeup water, the discharge volume, and the characteristics of the receiving body of water. Intake from and discharge to any surface body of water would be regulated by the Commonwealth of Virginia or another state. Some erosion and sedimentation would also likely occur during construction (NRC 1996). The impacts could range between SMALL to MODERATE.

Groundwater. The staff assumed that a coal-fired plant located at North Anna would obtain potable, process, and fire-protection water from the series of groundwater wells that currently supply Units 1 and 2 (see Section 2.2.2). Groundwater withdrawals would be less than no-action and license renewal alternatives because of the reduced workforce. Hence, impacts are considered SMALL. Use of groundwater for a coal-fired plant sited at an alternate site is a possibility. Groundwater withdrawal at an alternate site would likely require a permit from the Virginia Department of Environmental Quality (VDEQ). The impacts are considered SMALL.

- **Air Quality**

The air-quality impacts of coal-fired generation vary considerably from those of nuclear generation due to emissions of sulfur oxides (SO_x), nitrogen oxides (NO_x), particulates, carbon monoxide, hazardous air pollutants such as mercury, and naturally occurring radioactive materials.

Louisa County is in the Northeastern Air Quality Control Region (40 CFR 81.145). Louisa County is in compliance with the national ambient air quality standards for particulate matter, carbon monoxide, nitrogen dioxide, lead, sulfur dioxide, and ozone (40 CFR 81.347).

A new coal-fired generating plant located at North Anna would likely need a prevention of significant deterioration permit and an operating permit under the Clean Air Act (CAA). The plant would need to comply with the new source performance standards for such plants set forth in 40 CFR Part 60, Subpart Da. The standards establish limits for particulate matter and opacity (40 CFR 60.42a), SO_2 (40 CFR 60.43a), and NO_x (40 CFR 60.44a).

Section 169A of the CAA (42 USC 7401) establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment results from man-made air pollution. If a coal-fired plant were located close to a mandatory Class I area, additional air pollution control requirement could be imposed. However, the mandatory Class I Federal areas closest to the North Anna site are the Swanquarter Wilderness Area in eastern North Carolina, located approximately 312 km (194 mi) southeast of North Anna; Shenandoah National Park, located approximately 177 km (110 mi) northwest of North Anna; and the James River Face Wilderness located approximately 166 km (103 mi) west of North Anna. The U.S. Environmental Protection Agency (EPA) has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P, including a specific requirement for review of any new major stationary source in an area designated as attainment or unclassified under the CAA. Louisa County is classified as attainment or unclassified for criteria pollutants.[(a)] EPA issued a new regional haze rule in 1999 (64 FR 35714; July 1,1999 [EPA 1999]). The rule specifies that for each mandatory Class I Federal area located within a state, the state must establish goals that provide for reasonable progress towards 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)].

(a) Existing criteria pollutants under the CAA are ozone, carbon monoxide, particulates, sulfur dioxide, lead, and nitrogen oxide. Emission standards for criteria pollutants are set out at 40 CFR Part 50.

In 1998, EPA issued a rule requiring 22 eastern states, including Virginia, to revise their state implementation plans to reduce nitrogen oxide emissions (63 FR 49442, EPA 1998). Nitrogen oxide emissions contribute to violations of the national ambient air quality standard for ozone. The total amount of nitrogen oxides that can be emitted by each of the 22 states in the year 2007 ozone season (May 1 - September 30) is set out at 40 CFR 51.121(e). For Virginia, the amount is 163,470 MT (180,195 tons). Any new coal-fired plant in Virginia would be subject to this limitation.

Impacts for particular pollutants are as follows:

Sulfur oxides emissions. VEPCo states in its ER that an alternative coal-fired plant located at North Anna would use wet scrubber-lime/limestone for flue gas desulfurization (VEPCo 2001).

A new coal-fired power plant would be subject to the requirements in Title IV of the Clean Air Act. Title IV was enacted to reduce emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x), the two principal precursors of acid rain, by restricting emissions of these pollutants from power plants. Title IV caps aggregate annual power plant SO_2 emissions and imposes controls on SO_2 emissions through a system of marketable allowances. EPA issues one allowance for each ton of SO_2 that a unit is allowed to emit. New units do not receive allowances but are required to have allowances to cover their SO_2 emissions. Owners of new units must therefore acquire allowances from owners of other power plants by purchase or reduce SO_2 emissions at other power plants they own. Allowances can be banked for use in future years. Thus, a new coal-fired power plant would not add to net regional SO_2 emissions, although it might do so locally.

VEPCo estimates that by using the best technology to minimize SO_x emissions, the total annual stack emissions would be approximately 4130 MT (4548 tons) of SO_x (VEPCo 2001). This level of SO_x emission would be greater than the OL renewal alternative.

Nitrogen oxides emissions. Section 407 of the CAA establishes technology-based emission limitations for NO_x emissions. The market-based allowance system used for SO_2 emissions is not used for NO_x emissions. A new coal-fired power plant would be subject to the new source performance standards for such plants in 40 CFR 60.44a(d)(1). This regulation, issued on September 16, 1998 (EPA 1998), limits the discharge of any gases that contain nitrogen oxides (expressed as NO_x) in excess of 200 ng/J of gross energy output (1.6 lb/MWh), based on a 30-day rolling average.

VEPCo estimates that by using low NO_x burners with overfire air and selective catalytic reduction the total annual NO_x emissions for a new coal-fired power plant would be approxi-

mately 1075 MT (1185 tons) (VEPCo 2001). This level of NO_x emissions would be greater than the OL renewal alternative.

Particulate emissions. VEPCo estimates that the total annual stack emissions would include 237 MT (261 tons) of filterable total suspended particulates (particulates that range in size from less than 0.1 µm up to approximately 45 µm). The 237 MT would include 54 MT (60 tons) of PM_{10} (particulate matter having an aerodynamic diameter less than or equal to 10 µm). Fabric filters or electrostatic precipitators would be used for control. In addition, coal-handling equipment would introduce fugitive particulate emissions. Particulate emissions would be greater under the coal alternative than the OL renewal alternative.

During construction of a coal-fired plant, fugitive dust would be generated. In addition, exhaust emissions would come from vehicles and motorized equipment used during the construction process.

Carbon monoxide emissions. VEPCo estimates that the total carbon monoxide emissions would be approximately 1110 MT (1221 tons) per year. This level of emissions is greater than the OL renewal alternative.

Hazardous air pollutants including mercury. In December 2000, EPA issued regulatory findings on emissions of hazardous air pollutants from electric utility steam generating units (65 FR 79825, EPA 2000b). EPA determined that coal- and oil-fired electric utility steam-generating units are significant emitters of hazardous air pollutants. Coal-fired power plants were found by EPA to emit arsenic, beryllium, cadmium, chromium, dioxins, hydrogen chloride, hydrogen fluoride, lead, manganese, and mercury (EPA 2000b). EPA concluded that mercury is the hazardous air pollutant of greatest concern. EPA found that (1) there is a link between coal consumption and mercury emissions, (2) electric utility steam-generating units are the largest domestic source of mercury emissions, and (3) certain segments of the U.S. population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health effects due to mercury exposures resulting from consumption of contaminated fish (EPA 2000b). Accordingly, EPA added coal- and oil-fired electric utility steam-generating units to the list of source categories under Section 112(c) of the CAA for which emission standards for hazardous air pollutants will be issued (EPA 2000b).

Uranium and thorium. Coal contains uranium and thorium. Uranium concentrations are generally in the range of 1 to 10 parts per million. Thorium concentrations are generally about 2.5 times greater than uranium concentrations (Gabbard 1993). One estimate is that a typical coal-fired plant released roughly 4.7 MT (5.2 tons) of uranium and 11.6 MT (12.8 tons) of thorium in 1982 (Gabbard 1993). The population dose equivalent from the

uranium and thorium releases and daughter products produced by the decay of these isotopes has been calculated to be significantly higher than that from nuclear power plants (Gabbard 1993).

Summary. The GEIS analysis does not quantify emissions from coal-fired power plants, but implies that air impacts would be substantial. The GEIS also mentions global warming from unregulated carbon dioxide emissions and acid rain from SO_x and NO_x emissions as potential impacts (NRC 1996). Adverse human health effects, such as cancer and emphysema, have been associated with the products of coal combustion. The appropriate characterization of air impacts from coal-fired generation would be MODERATE. The impacts would be clearly noticeable but would not destabilize air quality.

Siting a coal-fired generation plant at a site other than North Anna would not significantly change air-quality impacts, although it could result in installing more or less stringent pollution-control equipment to meet applicable local requirements. Therefore, the impacts would be MODERATE.

- **Waste**

Coal combustion generates waste in the form of ash, and equipment for controlling air pollution generates spent selective catalytic reduction catalyst, additional ash, and scrubber sludge. Three 508-MW(e) coal-fired plants would generate approximately 695,000 MT (766,060 tons) of this waste annually for 40 years. The waste would be disposed of onsite, accounting for approximately 172 ha (425 ac) of land area over the 40-year plant life. Waste impacts to 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 revegetation, the land could be available for other uses. Construction-related debris would also be generated during construction activities.

In May 2000, EPA issued a Notice of Regulatory Determination on Wastes From the Combustion of Fossil Fuels (65 FR 33213, EPA 2000a). EPA concluded that some form of national regulation is warranted to address coal combustion waste products because (1) the composition of these wastes could present danger to human health and the environment under certain conditions; (2) EPA has identified 11 documented cases of proven damages to human health and the environment by improper management of these wastes in landfills and surface impoundments; (3) present disposal practices are such that, in 1995, these wastes were being managed in 40 to 70 percent of landfills and surface impoundments without reasonable controls in place, particularly in the area of groundwater monitoring; and

(4) EPA identified gaps in state oversight of coal combustion wastes. 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).

For these reasons, the appropriate characterization of impacts from waste generated from burning coal is MODERATE; the impacts would be clearly noticeable but would not destabilize any important resource.

Siting the facility at a site other than the North Anna would not alter waste generation, although other sites might have more constraints on disposal locations. Therefore, the impacts would be MODERATE.

- **Human Health**

Coal-fired power generation introduces worker risks from coal and limestone mining, and worker and public risks from coal and lime/limestone transportation and inhalation of stack emissions. Emission impacts can be widespread and health risks difficult to quantify. The coal alternative also introduces the risk of coal pile fires and attendant inhalation risks.

The staff stated in the GEIS that there could be human health impacts (cancer and emphysema) from inhalation of toxins and particulates from coal-fired plants, but does not identify the significance of these impacts (NRC 1996). 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 EPA and State agencies, set air emission standards and requirements based on human health impacts. These agencies also impose site-specific emission limits as needed to protect human health. As discussed previously, EPA has recently concluded that certain segments of the U.S. population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health effects due to mercury exposures from sources such as coal-fired power plants. However, in the absence of more quantitative data, human health impacts from radiological doses and inhaling toxins and particulates generated by burning coal are characterized as SMALL.

- **Socioeconomics**

Construction and Operation. Construction of the coal-fired alternative would take approximately 5 years. The staff assumed that construction would take place while North Anna Units 1 and 2 continue operation and would be completed by the time Units 1 and 2

permanently cease operations. The construction workforce would be expected to vary between 1200 and 2500 workers during the 5-year construction period (NRC 1996). These workers would be in addition to the approximately 851 permanent and 70 to 110 contract workers employed at Units 1 and 2. During construction of the new coal-fired plant, communities near North Anna would experience demands on housing and public services that could have SMALL to MODERATE impacts. These impacts would be tempered by construction workers commuting to the site from outside the immediate area of the site, including the Richmond metropolitan area, Fredericksburg, and Charlottesville, among others. Nearby communities to North Anna would be impacted by the loss of the construction jobs once construction is completed.

If the coal-fired replacement plant were constructed at North Anna and Units 1 and 2 were decommissioned, there would be a loss of approximately 721 to 761 permanent and contract employees, as VEPCo estimates that the completed coal-fired plant would employ approximately 200 workers (VEPCo 2001). There would be a commensurate reduction in demand on socioeconomic resources and contribution to the regional economy. The coal-fired plants would provide a new tax base to offset the loss of tax base associated with decommissioning of the nuclear units. For all of these reasons, the appropriate characterization of non-transportation socioeconomic impacts for a coal-fired plant constructed at the North Anna site would be SMALL to MODERATE; the socioeconomic impacts would be noticeable, but would be unlikely to destabilize the area. The impacts could be mitigated by the site's proximity to the Richmond metropolitan area and may be additionally offset if economic growth in Richmond and surrounding areas continues as during the last decade.

Construction of a replacement coal-fired power plant at an alternate site would relocate some socioeconomic impacts but would not eliminate them. Louisa County would experience the brunt of North Anna Units 1 and 2 operational job loss and would lose a significant tax base. These losses could have potentially LARGE socioeconomic impacts to the County, particularly over the short to intermediate term (from 5 to 10 years following plant closure). Communities around the new site would have to absorb the impacts of a large, temporary workforce (up to 2500 workers at the peak of construction) and a permanent workforce of approximately 200 workers. The staff stated in the GEIS that socioeconomic impacts at a rural site would be larger than at an urban site because more of the peak construction workforce would need to move to the area to work. Alternate sites would need to be analyzed on a case-by-case basis. Socioeconomic impacts at or near an urban, previously developed industrial area would be SMALL. Socioeconomic impacts at a rural site could be MODERATE to LARGE, depending on the relative location of the site to towns and cities that might be able to accommodate such impacts.

Transportation. During the 5-year construction period of replacement coal-fired units, up to 2500 construction workers would be working at the site in addition to the 921 to 961 permanent and contract workers employed at Units 1 and 2. The addition of these workers could place significant traffic loads on existing highways near North Anna. Such impacts would be MODERATE to LARGE.

For transportation related to the commuting of plant operating personnel, the impacts are considered SMALL. The maximum number of plant operating personnel would be approximately 200 compared to the current commuting workforce of approximately 921 to 961 permanent and contract workers. Therefore, traffic impacts associated with plant personnel commuting to a coal-fired plant would be expected to be SMALL compared to the current impacts from Unit 1 and 2 operations.

At North Anna, coal and lime/limestone likely would be delivered by rail. Each train would have approximately 115 rail cars. Each open-top rail car holds about 90 MT (100 tons) of coal. Additional rail cars would be needed for lime/limestone delivery. In all, approximately 425 trains per year would deliver the coal and lime/limestone for the three units. An average of roughly 16 train trips per week would be needed to transport the coal and lime/limestone. For each full train delivery, an empty train would return. On several days per week, there could be two to three trains per day using the rail spur to North Anna, resulting in blocking at grade crossings. North Anna is located in a semi-rural area, and the roads are lightly traveled during most parts of the day except at shift changes at the site. Therefore, the effect of the increased rail traffic on residents and vehicular traffic in the North Anna area is considered SMALL.

Transportation-related impacts associated with commuting construction workers at an alternate rural site are also site-dependent and could be MODERATE to LARGE. Transportation impacts related to commuting of plant operating personnel would also be site-dependent but can be characterized as SMALL.

At an alternate site, coal and limestone delivery likely would be delivered by rail, although barge delivery would be feasible at a coastal location. Impacts of rail transportation would be SMALL in a rural area and MODERATE in a more crowded, suburban area. Barge delivery of coal and lime/limestone would likely have SMALL socioeconomic impacts.

- **Aesthetics**

The three coal-fired power plant units could be as high as 60 m (200 ft) and be visible in daylight hours from offsite. The three exhaust stacks would be as high as 185 m (600 ft) (VEPCo 2001). The stacks would be visible in daylight hours. The plant units and

associated stacks also would be visible at night because of outside lighting. Visual impacts of a new coal-fired plant could be mitigated by landscaping and selecting building color consistent with the environment. Visual impact at night could be mitigated by reducing lighting and using shielding appropriately.

Coal-fired generation would introduce mechanical sources of noise that would be audible offsite. Sources contributing to total noise produced by plant operation are classified as continuous or intermittent. Continuous sources include the mechanical equipment associated with normal plant operations. 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. The incremental noise impacts of a coal-fired plant compared to existing North Anna Units 1 and 2 operations are considered to be SMALL to MODERATE.

At an alternate site, there would be an aesthetic impact from the buildings and exhaust stacks. This impact could be LARGE if a greenfield site is used. There would also be an aesthetic impact if construction of a new transmission line and/or rail spur is needed. 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 raises noise levels near the rail corridor, the short duration of the noise reduces the impact. In a more suburban location, the impacts are considered MODERATE. This is due to the frequency of train transport, the fact that many people are likely to be within hearing distance of the rail route, and the impacts of noise on residents in the vicinity of the facility and the rail line. At a more rural location, the impacts could be SMALL. Noise and light from the plant would be detectable offsite. Aesthetic impacts at the plant site would be mitigated if the plant were located in an industrial area adjacent to other power plants or industrial facilities, in which case the impacts could be SMALL. Overall, the aesthetic impacts associated with locating at an alternate site can be categorized as SMALL to LARGE, depending on the characteristics of the alternate site.

- **Historic and Archaeological Resources**

At the North Anna site or an alternate site, a cultural resource 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 adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site.

Before construction at North Anna or an alternate site, studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction

on cultural resources. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission line rights-of-way, rail lines, or other rights-of-way). Historic and archaeological resource impacts can generally be effectively managed and as such are considered SMALL.

- **Environmental Justice**

No environmental pathways or locations have been identified that would result in disproportionately high and adverse environmental impacts on minority and low-income populations if a replacement coal-fired plant were built at the North Anna. Some impacts on housing availability and prices during construction might occur, and this could disproportionately affect the minority and low-income populations to the extent housing frequented by these populations could come into increased demand. Closure of North Anna Units 1 and 2 would result in a decrease in employment of approximately 721 to 761 permanent and contract employees at the site. Resulting economic conditions could reduce employment prospects for minority or low-income populations. Overall, impacts are expected to be SMALL to MODERATE and may be mitigated by the economic vitality/expansion of the Richmond metropolitan and surrounding area.

Impacts at other sites would depend on the site chosen and the nearby population distribution. If a replacement coal-fired plant were constructed at an alternate site, Louisa County would experience a significant loss of property tax revenue that would affect the County's ability (at least in the short- to mid-term following plant closure) to provide services and programs. Impacts to minority and low-income populations in Louisa County could be SMALL to LARGE. Impacts at the alternate site would vary between MODERATE to LARGE, depending on the population makeup and distribution and the economy.

8.2.1.2 Closed-Cycle Cooling System

This section discusses the environmental impacts of constructing a coal-fired generation system at an alternate site using closed-cycle cooling with cooling towers. The impacts (SMALL, MODERATE, or LARGE) of this option are essentially the same as the impacts for a coal-fired plant using the once-through system. However, there are some environmental impact differences between the closed-cycle and once-through cooling systems. Table 8-3 summarizes the incremental differences.

Table 8-3. Summary of Environmental Impacts of Coal-Fired Generation at an Alternate Greenfield Site with Closed-Cycle Cooling System Utilizing Cooling Towers

Impact Category	Change in Impacts from Once-Through Cooling System
Land Use	10 - 12 additional ha (25 - 30 ac) required for cooling towers and associated infrastructure.
Ecology	Impact would depend on ecology at the site. Additional impact to terrestrial ecology from cooling tower drift. Reduced impact to aquatic ecology.
Surface Water Use and Quality	Discharge of cooling tower blowdown containing dissolved solids. Discharge would be regulated. Decreased water withdrawal and less thermal load on receiving body of water.
Groundwater Use and Quality	No change
Air Quality	No change
Waste	No change
Human Health	No change
Socioeconomics	No change
Aesthetics	Introduction of cooling towers and associated plume. Natural draft towers could be up to 158 m (520 ft) high. Mechanical draft towers could be up to 30 m (100 ft) high and also have an associated noise impact.
Historic and Archaeological Resources	No change.
Environmental Justice	No change

8.2.2 Natural-Gas-Fired Generation

The environmental impacts of the natural-gas-fired alternative are examined in this section for both the North Anna site and an alternate site. For the North Anna site, the staff assumed that the plant would use the existing once-through cooling system.

North Anna is not served by natural gas pipelines. A dedicated, high-pressure 6-m (2-ft) pipeline would have to be constructed to North Anna from Gordonsville, Virginia, a distance of

approximately 65 km (40 mi). The pipeline right-of-way would require 295 ha (729 ac).[(a)] VEPCo also notes in its ER that in the winter, when demand for natural gas is high, it may become necessary for a replacement natural-gas-fired plant to operate on fuel oil due to lack of gas supply. Operation with oil would result in more stack emissions (VEPCo 2001).

If a new natural-gas-fired plant were built elsewhere to replace North Anna Units 1 and 2, a new transmission line would need to be constructed to connect to existing lines. In addition, construction or upgrade of a natural gas pipeline from the plant to a supply point where a firm supply of gas would be available could be needed. One potential source of natural gas is liquefied natural gas (LNG) imported to either the Cove Point facility in Maryland or the Elba Island facility in Georgia. Both facilities are expected to be reactivated in 2003 (DOE/EIA 2000a). LNG imported to either facility would need to be vaporized and transported to the plant via pipeline.

The staff assumed that a replacement natural-gas-fired plant would use combined-cycle combustion turbines (VEPCo 2001). In a combined-cycle unit, hot combustion gases in a combustion turbine rotate the turbine to generate electricity. Waste combustion heat from the combustion turbine is routed through a heat-recovery boiler to make steam to generate additional electricity.

The following additional assumptions are made for the natural-gas-fired plants (VEPCo 2001):

- three 508-MW(e) units will be needed, each consisting of two 168-MW combustion turbines and a 172-MW heat recovery boiler
- natural gas with an average heating value of 39 MJ/m^3 (1059 Btu/ft^3) will be the primary fuel
- low-sulfur number 2 fuel oil will be used as backup fuel
- heat rate will be 2 J fuel/J electricity (6,700 Btu/kWh)
- capacity factor will be 0.85
- gas consumption will be 2.11 billion m^3/yr (74.7 billion ft^3/yr).

Unless otherwise indicated, the assumptions and numerical values used in Section 8.2.2 are from the VEPCo ER. The staff reviewed this information and compared it to environmental impact information in the GEIS. Although the OL renewal period is only 20 years, the impact of operating the natural-gas-fired alternative for 40 years is considered because this is as a reasonable projection of the operating life of the plant.

(a) Calculated as follows: 40 mi X 150 ft easement = 295 ha or 727 ac.

8.2.2.1 Once-Through Cooling System

The overall impacts of the natural gas-generating system are discussed in the following sections and summarized in Table 8-4. The extent of impacts at an alternate site will depend on the location of the particular site selected.

- **Land Use**

  For siting at North Anna, existing facilities and infrastructure would be used to the extent practicable, limiting the amount of new construction that would be required. Specifically, the staff assumed that the natural-gas-fired replacement plant alternative would use the existing once-through cooling system, switchyard, offices, and transmission line rights-of-way. In the GEIS staff estimated that 45 ha (110 ac) are needed for a plant site (NRC 1996). At North Anna, this much previously disturbed land is available within the boundaries of the plant site (VEPCo 2001). Additional land for backup oil storage facilities is required. There would be an additional impact of up to approximately 295 ha (729 ac) for construction of a natural gas pipeline to the North Anna site (VEPCo 2001). VEPCo states it would apply best management practices during construction of the pipeline such as minimizing soil loss, restoring vegetation immediately after the excavation is backfilled, and constructing the pipeline adjacent to existing, previously disturbed easements, if possible (VEPCo 2001). Land-use impacts of siting at North Anna would be SMALL to MODERATE and depend on the extent to which ecological damage could be minimized in the construction of the natural gas pipeline.

  For construction at an alternate site, the staff assumed that 45 ha (110 ac) would be needed for the plant and associated infrastructure (NRC 1996). A previously developed site with substantial infrastructure in place (e.g., gas line and transmission line), would be characterized as having SMALL impacts. For any new natural gas plant, additional land could be impacted for construction of a transmission line and/or natural gas pipeline to serve the plant and for backup oil facilities, in which case the impacts could be MODERATE. Land-use impacts at a greenfield site could be considered LARGE.

  Offsite of the North Anna or alternate site, additional land would be required for natural gas wells and collection stations. NRC staff estimated in the GEIS that approximately 1500 ha (3600 ac) would be needed for a 1000 MW(e) plant. A replacement gas-fired plant for North Anna Units 1 and 2 would be 1524 MW(e) and would affect proportionately more land. Partially offsetting these offsite land requirements would be the elimination of the need for uranium mining to supply fuel for Units 1 and 2. The staff estimated in the GEIS (NRC 1996) that approximately 400 ha (1000 ac) would be affected for mining the uranium and processing it during the operating life of a 1000 MW(e) nuclear power plant. Because

Table 8-4. Summary of Environmental Impacts of Natural-Gas-Fired Generation at North Anna and an Alternate Greenfield Site Using Once-Through Cooling

	North Anna Power Station Site		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Land Use	SMALL to MODERATE	45 ha (110 ac) of previously disturbed land needed for plant site. Additional impact of up to approximately 295 ha (729 ac) for construction of an underground gas pipeline. Maximum use of existing infrastructure at the site.	SMALL to LARGE	SMALL if infrastructure in place, 45 ha (110 ac) for power- block, offices, roads, and parking areas. MODERATE if additional land needed for transmission line and/or natural gas pipeline. LARGE if greenfield site and transmission lines required.
Ecology	SMALL to MODERATE	Uses undeveloped areas at North Anna plus land for a new gas pipeline.	SMALL to LARGE	Impact depends on whether a greenfield or previously developed site. Also, impacts depend on ecology of the site, surface water body used for intake and discharge, possible transmission and pipeline routes, potential habitat loss and frag-mentation, reduced productivity, and biological diversity.
Water Use and Quality				
Surface Water	SMALL	Uses existing once-through cooling system.	SMALL to MODERATE	Impact depends on volume of water withdrawal and discharge and characteristics of surface water body.
Groundwater	SMALL	Reduced groundwater withdrawals due to reduced workforce.	SMALL	Groundwater impacts would depend on use and availability.
Air Quality	SMALL to MODERATE	Sulfur oxides • 122 MT/yr (134 tons/yr) Nitrogen oxides • 459 MT/yr (506 tons/yr) Carbon monoxide • 602 MT/yr (664 tons/yr) PM_{10} particulates • 180 MT/yr (198 tons/yr) Some hazardous air pollutants.	SMALL to MODERATE	Same emissions as at North Anna site.
Waste	SMALL	Small amount of ash produced.	SMALL	Small amount of ash produced.
Human Health	SMALL	Impacts considered to be minor.	SMALL	Impacts considered to be minor.

Table 8-4. (contd)

	North Anna Power Station Site		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Socioeconomics	SMALL to MODERATE	During construction, impacts would be SMALL to MODERATE. Up to 1200 additional workers during the peak of the 3-year construction period, followed by reduction from current North Anna Units 1 and 2 workforce from 921 to 961 (permanent and contract) to 150; tax base preserved. Impacts during operation would be SMALL to MODERATE, due to loss of employment in Louisa County which may be offset by proximity to Richmond economy.	SMALL to LARGE	Impacts depend on site characteristics. During construction, impacts would be SMALL to MODERATE. Tax impacts on receiving county could be SMALL to LARGE. Up to 1200 additional workers during the peak of the 3-year construc-tion period. Louisa County would experience loss of North Anna Units 1 and 2 tax base and employment with potentially MODERATE to LARGE associated impacts.
	SMALL to MODERATE	Transportation impacts associated with construction workers would be SMALL to MODERATE. Transportation impacts during operation would be SMALL due to smaller workforce.	SMALL to LARGE	Transportation impacts associated with construction workers would be SMALL to LARGE and would depend on population density and road infrastructure at alternate site. Impacts during operation would be SMALL due to smaller workforce.
Aesthetics	SMALL	Some visibility of structures offsite.	SMALL to LARGE	SMALL if previously developed site and site disturbance minimal. SMALL to MODERATE impact from plant and stacks and whether site is previously developed. Impacts increased to strongly MODERATE with construction of a transmission line to previously developed site. LARGE if greenfield site developed.
Historic and Archeological Resources	SMALL	Any potential impacts likely can be managed effectively.	SMALL	Same as at North Anna Power Station site; any potential impacts likely can be managed effectively.

Table 8-4. (contd)

	North Anna Power Station Site		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Environmental Justice	SMALL to MODERATE	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole. Some impacts on housing may occur during construction; loss of 771 to 811 permanent and contract operating jobs at North Anna could reduce employment prospects for minority and low-income populations. Proximity to Richmond economic area may mitigate impacts.	SMALL to LARGE	Impacts at alternate site vary depending on population distribution and makeup at site could be SMALL to LARGE. Louisa County would lose significant revenue, which could have MODERATE to LARGE impacts on minority and low-income populations. Proximity to Richmond economic area may mitigate Louisa impacts.

the assumed replacement units for North Anna would generate 1524 MW(e), the land needed for gas wells and collection stations (and the land not needed for nuclear fuel) would be proportionately higher.

- **Ecology**

At North Anna, there would be ecological land-related impacts for siting of the gas-fired plant. There would also be moderate ecological impacts associated with bringing a new underground gas pipeline to North Anna. There would be losses to less mobile animals such as toads and turtles. Because these animals are fairly common throughout the area, VEPCo expects negligible reduction in their population resulting from construction of the pipeline and does not expect that pipeline construction would create any long-term reduction in the local or regional diversity of plants and animals (VEPCo 2001). Overall, the ecological impacts are considered SMALL to MODERATE.

Ecological impacts at an alternate site would depend on the nature of the land converted for the plant and the possible need for a new transmission line and/or gas pipeline. At a greenfield site, construction of a transmission line and a gas pipeline to serve the plant could be expected to have ecological impacts. Whether these impacts are temporary or permanent and the extent to which ecological resources are impacted is highly dependent on the location of the alternative site. Ecological impacts resulting from plant siting and utility easements could impact threatened or endangered species. There could be wildlife habitat loss and reduced productivity, habitat fragmentation, and a local reduction in biological diversity. The cooling water intake and discharge could have aquatic resource impacts. Hence, at a greenfield site the ecological impacts are expected to be MODERATE to LARGE. If the alternative site selected already has been developed, then the ecological impacts would be SMALL if the required infrastructure is already in place. Overall, the

ecological impacts at an alternate site are considered SMALL to LARGE, depending on the characteristics of the site selected.

- **Water Use and Quality**

Surface water. Overall, water-use and quality impacts at the North Anna site are considered SMALL as operation impacts are minimized by use of the existing intake/discharge system. Water-quality impacts from sedimentation during construction of a natural-gas-fired plant is characterized by the staff in the GEIS as SMALL (NRC 1996). The staff also note that operational water quality impacts would be similar to, or less than, those from other generating technologies.

For alternate sites, the impact on the surface water would depend on the volume of water needed for makeup water, the discharge volume, and the characteristics of the receiving body of water. Intake from and discharge to any surface body of water would be regulated by the Commonwealth of Virginia or another state. Water use and quality impacts at an alternate site are considered SMALL to MODERATE, depending on the characteristics of the alternate site.

Groundwater. The staff assumed that a natural-gas-fired plant located at North Anna would obtain potable, process, and fire-protection water from the series of groundwater wells that currently supply Units 1 and 2 (see Section 2.2.2). Groundwater withdrawals would be less than the no-action and license renewal alternatives because of the reduced workforce. Hence, impacts are considered SMALL.

It is possible that a gas-fired plant sited at an alternate site could use groundwater. Groundwater withdrawal at an alternate site would likely require a permit. For alternate greenfield sites, the impact to groundwater would depend on the site characteristics, including the amount of groundwater available. Overall, the impacts are considered SMALL.

- **Air Quality**

Natural gas is a relatively clean-burning fuel. The gas-fired alternative would release similar types of emissions but in lesser quantities than the coal-fired alternative. Hence, it would be subject to the same air quality regulations as a coal-fired plant.

VEPCo projects the following emissions for the natural-gas-fired alternative (VEPCo 2001):

Sulfur oxides - 122 MT/yr (134 tons/yr)

Nitrogen oxides - 459 MT/yr (506 tons/yr)
Carbon monoxide - 602 MT/yr (664 tons/yr)
PM_{10} particulates - 180MT/yr (198 tons/yr).

A natural-gas-fired plant would also have unregulated carbon dioxide emissions that could contribute to global warming.

As previously discussed, in December 2000, EPA issued regulatory findings on emissions of hazardous air pollutants from electric utility steam-generating units (EPA 2000b). Natural-gas-fired power plants were found by EPA to emit arsenic, formaldehyde, and nickel (EPA 2000b). Unlike coal and oil-fired plants, EPA did not determine that regulation of emissions of hazardous air pollutants from natural-gas-fired power plants should be regulated under Section 112 of the CAA.

In addition, construction activities would result in temporary fugitive dust. Exhaust emissions would also come from vehicles and motorized equipment used during the construction process. These would be similar to the coal-fired alternative, but smaller due to the smaller construction workforce.

Air emissions from the burning of natural gas would likely be the same at North Anna or at an alternate site. Impacts from the emissions would be clearly noticeable, but would not be sufficient to destabilize air resources as a whole. The overall air quality impact for a new natural gas-generating plant sited at North Anna or at an alternate site is considered SMALL to MODERATE, depending on the state of air quality at the alternate, greenfield site and the amount of number 2 fuel oil that may be needed to substitute for natural gas in winter months should a natural gas shortage develop–a situation applicable to both sites.

- **Waste**

There will be small amounts of solid-waste products (i.e., ash) from burning natural gas. In the GEIS the staff concluded that waste generation from gas-fired technology would be minimal (NRC 1996). Gas firing results in very few combustion by-products because of the clean nature of the fuel. Waste generation at a gas-fired plant would be largely limited to typical office wastes. Waste generation impacts would be so minor that they would not noticeably alter any important resource attribute. Construction-related debris would be generated during construction activities. Overall, the waste impacts would be SMALL for a natural-gas-fired plant sited at North Anna or at an alternate site.

In the winter, it may become necessary for a replacement baseload natural-gas-fired plant to operate on fuel oil due to shortages of natural gas. Oil combustion generates waste in

the form of ash, and equipment for controlling air pollution generates additional ash and scrubber sludge. The amount of ash and sludge generated would depend on the quantity of fuel oil combusted. Overall, the waste impacts associated with fuel oil combustion at a combined cycle plant are expected to be SMALL because the amount of oil combusted is expected to be relatively small. When natural gas is available, fuel oil is generally not price-competitive with gas.

- **Human Health**

In the GEIS the staff identified cancer and emphysema as potential health risks from 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 risks. NO_x emissions from the plant would be regulated. Human health effects would not be detectable or would be sufficiently minor that they would neither destabilize nor noticeably alter any important attribute of the resource. Overall, the impacts on human health of the natural-gas-fired alternative sited at North Anna or at an alternate site are considered SMALL.

- **Socioeconomics**

Construction and Operation. Construction of a natural-gas-fired plant would take approximately 3 years. Peak employment could be up to 1200 workers (NRC 1996). The staff assumed that construction would take place while Units 1 and 2 continue operation and would be completed by the time they permanently cease operations. During construction, the communities surrounding North Anna would experience demands on housing and public services that could have SMALL to MODERATE impacts. These impacts would be tempered by construction workers commuting to the site from cities such as Richmond, Fredericksburg, and Charlottesville, among others. After construction, the communities would be impacted by the loss of jobs. The current North Anna Units 1 and 2 workforce (approximately 921 to 961 permanent and contract workers) would decline through a decommissioning period to a minimal maintenance size. Approximately 150 workers would be needed to operate the natural-gas-fired plant. The new natural-gas-fired plant would replace the nuclear tax base in Louisa County. The impacts could be SMALL to MODERATE and may be moderated by Louisa County's proximity to Richmond.

Siting at an alternate site would result in the loss of the nuclear tax base and associated employment in Louisa County with potentially MODERATE to LARGE socioeconomic impacts. Socioeconomic impacts from locating the facilities at an alternate site would depend on the characteristics of the site. Impacts of construction could range between SMALL to MODERATE. Impacts during plant operation would be SMALL (smaller work-force), and the tax impacts could be SMALL to LARGE, depending on the relative proportion

of taxes paid by the plant to total county taxes. In the GEIS (NRC 1996), the staff concluded that socioeconomic impacts from constructing a natural-gas-fired plant would not be very noticeable and that the small operational workforce would have the lowest socio-economic impacts of any nonrenewable technology. Compared to the coal-fired and nuclear alternatives, socioeconomic impacts would be mitigated by the smaller construction workforce and the shorter construction time frame, and the smaller operations workforce.

Overall, socioeconomic impacts resulting from construction of a natural-gas-fired plant at North Anna would be SMALL to MODERATE and may be offset by the continued growth of the economy in Richmond and the surrounding area. For construction at an alternate site, socioeconomic impacts would be SMALL to LARGE, depending on the site characteristics at the alternate site.

Transportation. Transportation impacts associated with construction and operating personnel commuting to North Anna would be SMALL to MODERATE. The impacts can be classified as SMALL to LARGE for siting at an alternate site and would depend on the characteristics of the alternate site, including transportation infrastructure.

- **Aesthetics**

The turbine buildings and stacks (approximately 60 m [200 ft] high) would be visible during daylight hours from offsite, creating incremental visual impacts to those from existing North Anna facilities. The gas pipeline compressors would also be visible. Noise and light from the plant would be detectable offsite. At North Anna, these impacts would result in a SMALL aesthetic impact.

At an alternate site, the buildings and stacks could be visible offsite. Aesthetic impacts could be mitigated if the plant were located in an industrial area adjacent to other power plants or industrial facilities. Overall, the aesthetic impacts associated with a replacement natural-gas-fired plant at an alternate site are categorized as SMALL. The impacts would be greater if a new transmission line is needed and could be considered MODERATE. The impacts could be LARGE if a greenfield site is developed.

- **Historic and Archaeological Resources**

At both North Anna and an alternate site, a cultural resource 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 adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site.

Before construction at North Anna or at an alternate site, studies would likely be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on cultural resources. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated rights-of-way where new construction would occur (e.g., roads, transmission and pipeline rights-of-way, or other rights-of-way). Hence, impacts to cultural resources can be effectively managed under current laws and regulations and kept SMALL at either the existing North Anna site or at an alternate site.

- **Environmental Justice**

No environmental pathways or locations have been identified that would result in disproportionately high and adverse environmental impacts on minority and low-income populations if a replacement natural-gas-fired plant were built at North Anna. Some impacts on housing availability and prices during construction might occur in Louisa County, which could disproportionately affect minority and low-income populations. Closure of North Anna Units 1 and 2 would result in a decrease in employment of approximately 771 to 811 permanent and contract operating employees. Resulting economic conditions could reduce employment prospects for minority or low-income populations in Louisa County. The impacts could be offset by projected economic growth and the ability of affected workers to commute to other jobs in the County or nearby Richmond. Overall, impacts are expected to be SMALL to MODERATE.

Impacts at an alternate site would depend on the site chosen and the nearby population distribution. Minority and low-income populations at the alternate site could benefit from the plant's relocation through improved job prospects and the increased tax base that could enable more services to be provided. These impacts could be SMALL to LARGE. However, if a replacement natural-gas-fired plant were constructed at an alternate site, Louisa County would experience a significant loss of property tax revenue, as well as jobs, which would affect the County's ability to provide services and programs. Impacts to minority and low-income populations in Louisa County could be MODERATE to LARGE, again potentially offset by other economic growth in the area not related to North Anna.

8.2.2.2 Closed-Cycle Cooling System

This section discusses the environmental impacts of constructing a natural-gas-fired generation system at an alternate location using a closed-cycle cooling system with cooling towers. The

impacts (SMALL, MODERATE, or LARGE) of this option are essentially the same as the impacts for a natural-gas-fired plant using once-through cooling. However, there are minor environmental differences between the closed-cycle and once-through cooling systems. Table 8-5 summarizes the incremental differences.

Table 8-5. Summary of Environmental Impacts of Natural-Gas-Fired Generation at an Alternate Greenfield Site with Closed-Cycle Cooling Utilizing Cooling Towers

Impact Category	Change in Impacts from Once-Through Cooling System
Land Use	10 - 12 additional ha (25 - 30 ac) required for cooling towers and associated infrastructure.
Ecology	Impact would depend on ecology at the site. Additional impact to terrestrial ecology from cooling tower drift. Reduced impact to aquatic ecology.
Surface Water Use and Quality	Discharge of cooling tower blowdown containing dissolved solids. Discharge would be regulated. Decreased water withdrawal and less thermal load on receiving body of water.
Groundwater Use and Quality	No change.
Air Quality	No change.
Waste	No change.
Human Health	No change.
Socioeconomics	No change.
Aesthetics	Introduction of cooling towers and associated plume. Possible noise impact from operation of cooling towers.
Historic and Archaeological Resources	No change.
Environmental Justice	No change.

8.2.3 Nuclear Power Generation

Since 1997, the NRC has certified three new standard designs for nuclear power plants under 10 CFR Part 52, Subpart B. These designs are the U.S. Advanced Boiling Water Reactor (10 CFR Part 52, Appendix A), the System 80+ Design (10 CFR Part 52, Appendix B), and the AP600 Design (10 CFR Part 52, Appendix C). All of these plants are light-water reactors. Although no applications for a construction permit or a combined license based on these certified designs have been submitted to NRC, the submission of the design certification applications indicates continuing interest in the possibility of licensing new nuclear power plants.

In addition, recent escalation in prices of natural gas and electricity have made new nuclear power plant construction potentially more attractive from a cost standpoint. Consequently, construction of a new nuclear power plant at North Anna using the existing once-through cooling system and at an alternate site using both closed- and open-cycle cooling are considered in this section. The staff assumed that the new nuclear plant would have a 40-year lifetime.

The NRC has summarized environmental data associated with the uranium fuel cycle in Table S-3 of 10 CFR 51.51. The impacts shown in Table S-3 are representative of the impacts that would be associated with a replacement nuclear power plant built to one of the certified designs sited at North Anna or an alternate site. The impacts shown in Table S-3 are for a 1000-MW(e) reactor and would need to be adjusted to reflect replacement of Units 1 and 2, which have a net total capacity of 1790 MW(e) (VEPCo 2001). The environmental impacts associated with transporting fuel and waste to and from a light-water cooled nuclear power reactor are summarized in Table S-4 of 10 CFR 51.52. The summary of NRC's findings on NEPA issues for license renewal of nuclear power plants in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B is also relevant, although not directly applicable, for consideration of environmental impacts associated with the operation of a replacement nuclear power plant. Additional environmental impact information for a replacement nuclear power plant using once-through cooling is presented in Section 8.2.3.1, and environmental impact information for using closed-cycle cooling is presented in Section 8.2.3.2.

8.2.3.1 Once-Through Cooling System

The overall impacts of the nuclear generating system are discussed in the following sections. The impacts are summarized in Table 8-6. The extent of impacts at an alternate site will depend on the location of the particular site selected.

- **Land Use**

  The existing facilities and infrastructure at North Anna would be used to the extent practicable, limiting the amount of new construction that would be required. Specifically, the staff assumed that a replacement nuclear power plant would use the existing cooling system, switchyard, offices, and transmission line rights-of-way. Approximately 200 ha (500 ac) would be needed for the construction of the new plant. North Anna Units 1 and 2 would continue to operate as the new nuclear power facilities are being constructed.

  The impact of a replacement nuclear generating plant on land use at the North Anna site is best characterized as MODERATE. The impact would be greater than the OL renewal alternative.

Table 8-6. Summary of Environmental Impacts of New Nuclear Power Generation at North Anna Power Station and an Alternate Greenfield Site Using Once-Through Cooling

	North Anna Power Station Site		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Land Use	MODERATE	Requires approximately 200 ha (500 ac) for the plant.	MODERATE to LARGE	Requires approximately 200 to 400 ha (500 to 1000 ac) for the plant. Possible additional land if a new transmission line is needed.
Ecology	MODERATE	Uses undeveloped areas at current North Anna site plus additional offsite land. Potential habitat loss and fragmentation, and reduced productivity and biological diversity on offsite land.	MODERATE to LARGE	Impact depends on location and ecology of the site, surface water body used for intake and discharge, and transmission line route; potential habitat loss and fragmentation, reduced productivity, and biological diversity.
Water Use and Quality				
Surface water	SMALL	Uses existing once-through cooling system.	SMALL to MODERATE	Impact will depend on the volume of water withdrawn and discharged and the characteristics of the surface water body.
Groundwater	SMALL		SMALL	Impacts will depend on site characteristics and availability of groundwater.
Air Quality	SMALL	Fugitive emissions and emissions from vehicles and equipment during construction. Small amount of emissions from diesel generators and possibly other sources during operation.	SMALL	Same impacts as at North Anna site.
Waste	SMALL	Waste impacts for an operating nuclear power plant are set out in 10 CFR 51, Appendix B, Table B-1. Debris would be generated and removed during construction.	SMALL	Same impacts as at North Anna site.
Human Health	SMALL	Human health impacts for an operating nuclear power plant are set out in 10 CFR 51, Appendix B, Table B-1.	SMALL	Same impacts as at North Anna site.

Table 8-6. (contd)

	North Anna Power Station Site		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Socioeconomics	SMALL to MODERATE	During construction, impacts would be SMALL to MODERATE. Up to 2500 workers during peak period of the 6-year construction period. Operating workforce assumed to be similar to Units 1 and 2. Louisa County tax base preserved. Impacts during operation would be SMALL.	SMALL to LARGE	Construction impacts depend on location. Impacts at a rural location could be LARGE. Louisa County would experience loss of tax base and employment, potentially offset by projected economic growth of Richmond metropolitan area. Operation impacts at an alternate site would SMALL to MODERATE.
	SMALL to LARGE	Transportation impacts associated with construction workers could be MODERATE to LARGE. Operation impacts would be SMALL.	SMALL to LARGE	Transportation impacts associated with construction workers could be MODERATE to LARGE. Transportation impacts of operating the plant would be SMALL to MODERATE.
Aesthetics	SMALL	No exhaust stacks or cooling towers would be needed. Daytime visual impact could be mitigated by landscaping and appropriate color selection for buildings. Visual impact at night could be mitigated by reduced use of lighting and appropriate shielding. Noise impacts would be relatively SMALL and could be mitigated.	SMALL to LARGE	Impacts would depend on the characteristics of the alternate site. Impacts would be SMALL if the plant were located adjacent to an industrial area. New transmission lines would add to the impact and would be SMALL to MODERATE depending on the alternate site's characteristics. If a greenfield site is selected, then the impacts could be LARGE.
Historic and Archeological Resources	SMALL	Any potential impacts likely can be managed effectively.	SMALL	Any potential impacts likely can be managed effectively .
Environmental Justice	SMALL	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole. Some impacts on housing may occur during construction.	SMALL to LARGE	Impacts will vary depending on population distribution and makeup at the site. Impacts to minority and low-income residents of Louisa County associated with closure of North Anna Units 1 and 2 could be significant – MODERATE to LARGE. Impacts to receiving County is site-specific and could range from SMALL to LARGE.

Land-use impacts at an alternate site would be greater than at North Anna, including the possible need for a new transmission line. In addition, it may be necessary to construct a rail spur to an alternate site to bring in equipment during construction. Depending particularly on transmission line routing and whether an existing industrial site is used as the

alternate site, siting a new nuclear plant at an alternate site could result in MODERATE to LARGE land-use impacts.

- **Ecology**

  Locating a replacement nuclear power plant at the North Anna site would alter ecological resources because of the need to convert land to an industrial use. Some of this land, however, would have been previously disturbed. Potential habitat loss and fragmentation and reduced productivity and biological diversity could result. Siting at North Anna would have a MODERATE ecological impact that would be greater than renewal of Units 1 and 2 OLs.

  At an alternate site, there would be construction impacts and new incremental operational impacts. The impacts would be the greatest at an alternate greenfield site. Even assuming siting at a previously disturbed area, the impacts would alter the ecology. Impacts could include wildlife habitat loss, reduced productivity, habitat fragmentation, and a local reduction in biological diversity. Use of cooling water from a nearby surface water body could have adverse aquatic resource impacts. If needed, construction and maintenance of the transmission line would have ecological impacts. Overall, the ecological impacts at an alternate site could be MODERATE to LARGE.

- **Water Use and Quality**

  Surface water. The staff assumed that a replacement nuclear power plant at North Anna would use the existing cooling system, which would minimize incremental water-use and quality impacts. Surface-water impacts are expected to remain SMALL; the impacts would be sufficiently minor that they would not noticeably alter any important attribute of the resource.

  For alternate sites, the impact on the surface water would depend on the volume of water needed for makeup, the discharge volume, and the characteristics of the receiving body of water. Intake from and discharge to any surface body of water would be regulated by the Commonwealth of Virginia or another state. The impacts would be SMALL to MODERATE.

  Groundwater. The staff assumed that a new nuclear power plant located at North Anna would obtain potable, process, and fire-protection water from onsite groundwater wells similarly to the current practice for Units 1 and 2 (see Section 2.2.2). The impacts are considered SMALL.

A nuclear power plant sited at an alternate site may use groundwater. Groundwater withdrawal at an alternate site would likely require a permit. The impacts would depend on availability and how water is withdrawn, but overall are considered SMALL.

- **Air Quality**

Construction of a new nuclear power plant sited at the North Anna site or an alternate site would result in fugitive emissions during construction. Exhaust emissions would also emanate from vehicles and motorized equipment used during construction. An operating nuclear power plant would have minor air emissions associated with diesel generators. These emissions would be regulated by VDEQ or another state. Overall, emissions and associated impacts are considered SMALL.

- **Waste**

The waste impacts associated with operation of a nuclear power plant are set out in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, Table B-1. In addition to the impacts shown in Table B-1, construction-related debris would be generated during construction activities and removed to an appropriate disposal site. Overall, waste impacts are considered SMALL.

Siting the replacement nuclear power plant at a site other than North Anna would not alter waste generation. Therefore, the impacts would be SMALL.

- **Human Health**

Human health impacts for an operating nuclear power plant are set out in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. Overall, human health impacts are considered SMALL.

Siting the replacement nuclear power plant at a site other than North Anna would not alter human health impacts. Therefore, the impacts would be SMALL.

- **Socioeconomics**

Construction and Operation. The construction period and the peak workforce associated with construction of a new nuclear power plant are currently unquantified (NRC 1996). In the absence of quantified data, the staff assumed a construction period of 5 years and a peak construction workforce of 2500. The staff assumed that construction would take place while the existing North Anna Units 1 and 2 continue operation and would be completed by the time Units 1 and 2 permanently cease operations. During construction, the communities

surrounding North Anna would experience demands on housing and public services that could have SMALL to MODERATE impacts. These impacts would be tempered by construction workers commuting to the site from more distant communities outside of Louisa County. After construction, the communities would be impacted by the loss of the construction jobs.

The replacement nuclear units are assumed to have an operating workforce comparable to the 921 to 961 permanent and contract workers currently working at North Anna Units 1 and 2. The replacement nuclear units would provide a new tax base to offset the loss of tax base associated with decommissioning of North Anna Units 1 and 2. For all of these reasons, the appropriate characterization of non-transportation socioeconomic impacts for replacement nuclear units constructed at North Anna would be SMALL to MODERATE; the socioeconomic impacts would be noticeable, but would be unlikely to destabilize the area.

Socioeconomic impacts at alternate sites would need to be analyzed on a case-by-case basis. In the GEIS (NRC 1996), the staff noted that socioeconomic impacts at a rural site would be larger than at an urban site because more of the peak construction workforce would need to move to the area to work. Construction of a replacement nuclear power plant at an alternate site would relocate some socioeconomic impacts, but would not eliminate them. Louisa County would experience the impact of North Anna Units 1 and 2 operational job loss and loss of tax base, and the communities around the new site would have to absorb the impacts of a large, temporary workforce (up to 2500 workers at the peak of construction) and a permanent workforce of up to 961 workers. For Louisa County, the socioeconomic impacts could be LARGE. The socioeconomic impacts to the county at the alternate location could be SMALL to LARGE depending on the degree of economic development, the proportion of the county's property tax base represented by the new plant, etc.

Transportation. The addition of up to 2500 construction workers to the 921 to 961 permanent and contract workers at Units 1 and 2 could place significant traffic loads on existing highways, particularly those leading to North Anna. Such impacts would be MODERATE to LARGE. Transportation impacts related to commuting of plant operating personnel would be similar to current impacts associated with operation of Units 1 and 2 and are considered SMALL.

Transportation impacts associated with commuting workers at an alternate site are site-dependent but could be MODERATE to LARGE. Transportation impacts related to commuting of plant operating personnel would also be site-dependent but can be characterized as SMALL to MODERATE.

- **Aesthetics**

The containment buildings for a replacement nuclear power plant sited at North Anna and other associated buildings would likely be visible in daylight hours from offsite. Visual impacts could be mitigated by landscaping and selecting a color for buildings that is consistent with the environment. The visual impact could also be mitigated by below-grade construction. Visual impact at night could be mitigated by reducing lighting and using shielding appropriately. No exhaust stacks would be needed. No cooling towers would be needed, assuming use of the existing once-through cooling system.

Noise from operation of a replacement nuclear power plant would potentially be audible offsite in calm wind conditions or when the wind is blowing from the direction of the plant. Mitigation measures such as reducing or eliminating use of outside loudspeakers could reduce the noise level and keep the impact SMALL.

At an alternate site, there would be an aesthetic impact from the buildings. There would also be a significant aesthetic impact if a new transmission line were needed. Noise and light from the plant would be detectable offsite. The impact of noise and light could be mitigated if the plant is located in an industrial area adjacent to other power plants, in which case the impacts could be SMALL. The impact could be MODERATE if a new transmission line is needed to connect the plant to the power grid, or LARGE if a greenfield site is selected. Overall, the aesthetic impacts associated with locating at an alternate site can be categorized as SMALL to LARGE, depending on the characteristics of the alternate site.

- **Historic and Archaeological Resources**

At both the North Anna site and an alternate site, a cultural resource inventory likely would be needed for any onsite property not previously surveyed. Other lands, if any, that are acquired to support the plant likely would also need an inventory of field cultural resources, identification and recording of existing historic and archaeological resources, and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site.

Before construction at North Anna or another site, studies likely would be needed to identify, evaluate, and address mitigation of the potential impacts of new plant construction on cultural resources. The studies likely would be needed for all areas of potential disturbance at the proposed plant site and along associated rights-of-way where new construction would occur (e.g., roads, transmission line rights-of-way, rail lines, or other rights-of-way). Historic and archaeological resource impacts generally can be managed effectively and as such are considered SMALL.

- **Environmental Justice**

  No environmental pathways or locations have been identified that would result in disproportionately high and adverse environmental impacts on minority and low-income populations if a replacement nuclear power plant were built at North Anna. Some impacts on housing availability and prices during construction might occur, and this could disproportionately affect minority and low-income populations. However, this is expected to be mitigated by North Anna's proximity to Richmond. After completion of construction, it is possible that the local government's ability to maintain social services could be reduced at the same time that diminished economic conditions reduce employment prospects for minority and low-income populations. However, Louisa County's economic health should improve as the tax base of the older nuclear units are replaced by the new, higher-valued (i.e., less-depreciated) plant. Hence, the ability of the County to provide social services should improve because of the higher tax base, assuming assessment rates remain stable. Overall, socioeconomic impacts are expected to be SMALL.

  Impacts at an alternate site would depend on the site chosen and the nearby population distribution. If a replacement nuclear power plant were constructed at an alternate site, Louisa County would experience a significant loss of property tax revenue which could affect the county's ability to provide services and programs. Impacts to minority and low-income populations in Louisa County could be MODERATE to LARGE but potentially offset by other related economic growth in the area. Impacts to the receiving county could be SMALL to LARGE and depend on the relative increase to the tax base resulting from the new plant's construction.

8.2.3.2 Closed-Cycle Cooling System

This section discusses the environmental impacts of constructing a nuclear power plant at an alternate site using closed-cycle cooling with cooling towers. The impacts (SMALL, MODERATE, or LARGE) of this option are essentially the same as the impacts for a nuclear power plant using the once-through cooling system. However, there are minor environmental differences between the closed-cycle and once-through cooling systems. Table 8-7 summarizes the incremental differences.

8.2.4 Purchased Electrical Power

If available, purchased power from other sources could potentially obviate the need to renew North Anna, Units 1 and 2 OLs. VEPCo currently has purchase agreements for 145 MW from the Southeastern Power Administration and approximately 3500 MW of non-utility generation (VEPCo 2001). Overall, Virginia is a net importer of electricity.

Table 8-7. Summary of Environmental Impacts of a New Nuclear Power Plant Sited at an Alternate Greenfield Site with Closed-Cycle Cooling

Impact Category	Change in Impacts from Once-Through Cooling System
Land Use	10 - 12 additional ha (25 - 30 ac) required for cooling towers and associated infrastructure.
Ecology	Impact would depend on ecology at the site. Additional impact to terrestrial ecology from cooling tower drift. Reduced impact to aquatic ecology.
Surface Water Use and Quality	Discharge of cooling tower blowdown containing dissolved solids. Discharge would be regulated. Decreased water withdrawal and less thermal load on receiving body of water.
Groundwater Use and Quality	No change.
Air Quality	No change.
Waste	No change.
Human Health	No change.
Socioeconomics	No change.
Aesthetics	Introduction of cooling towers and associated plume. Natural draft towers could be up to 158 m (520 ft). Mechanical draft towers could be up to 30 m (100 ft) high and also could have an associated noise impact.
Historic and Archaeological Resources	No change.
Environmental Justice	No change.

To replace North Anna, Units 1 and 2 capacity with imported power, VEPCo would need to construct a new 500-kV transmission line that VEPCo estimates would be approximately 160 km (100 mi) long (VEPCo 2001). Assuming a 0.09-km (300-ft) easement width, the transmission line would impact approximately 15 km^2 (6 mi^2).

Imported power from Canada or Mexico is unlikely to be available for replacement of North Anna, Units 1 and 2 capacity. In Canada, 62 percent of the country's electricity capacity is derived from renewable energy sources, principally hydropower (DOE/EIA 2001b). Canada has plans to continue developing hydroelectric power, but the plans generally do not include large-scale projects (DOE/EIA 2001b). Canada's nuclear generation is projected to increase by 1.7 percent by 2020, but its share of power generation is projected to decrease from 14 percent currently to 13 percent by 2020 (DOE/EIA 2001b). EIA projects that total gross U.S. imports of electricity from Canada and Mexico will gradually increase from 47.9 billion kWh in 2000 to

66.1 billion kWh in 2005 and then gradually decrease to 47.4 billion kWh in 2020 (DOE/EIA 2001a). On balance, it is unlikely that electricity imported from Canada or Mexico would be able to replace the North Anna Units 1 and 2 capacity.

If power to replace North Anna, Units 1 and 2 capacity were to be purchased from sources within the United States or a foreign country, the generating technology would likely be one of those described in this SEIS and in the GEIS (probably coal, natural gas, or nuclear). The description of the environmental impacts of other technologies in Chapter 8 of the GEIS is representative of the purchased electrical power alternative to renewal of North Anna, Units 1 and 2 OLs. Thus, the environmental impacts of imported power would still occur, but would be located elsewhere within the region, nation, or another country.

8.2.5 Other Alternatives

Other generation technologies are discussed in the following sections.

8.2.5.1 Oil-Fired Generation

EIA projects that oil-fired plants will account for very little of the new generation capacity in the United States from 2000 to 2020 because of higher fuel costs and lower efficiencies (DOE/EIA 2001a). Oil-fired operation is more expensive than nuclear or coal-fired operation. Future increases in oil prices are expected to make oil-fired generation increasingly more expensive than coal-fired generation. The high cost of oil has prompted a steady decline in its use for electricity generation. Construction and operation of an oil-fired plant would also have environmental impacts. For example, in Section 8.3.11 of the GEIS, the staff estimated that construction of a 1,000-MW(e) oil-fired plant would require about 50 ha (120 ac). Additionally, operation of oil-fired plants would have environmental impacts (including impacts on the aquatic environment and air) that would be similar to those from a coal-fired plant.

8.2.5.2 Wind Power

The Commonwealth of Virginia is in a wind power Class 1 region (average wind speeds at 10-m [30-ft] elevation of 0 to 4.4 m/s [9.8 mph]). Class 1 has the lowest potential for wind energy generation (DOE 2001a). Wind turbines are economical in wind power Classes 4 through 7 (average wind speeds of 5.6 to 9.4 m/s [12.5 to 21.1 mph] [DOE 2001a]). Consequently, the staff concludes that locating a wind-energy facility on or near the North Anna site would not be economically feasible given the current state of wind energy generation technology.

8.2.5.3 Solar Power

Solar power technologies, photovoltaic and thermal, cannot currently compete with conventional fossil-fueled technologies in grid-connected applications due to the higher capital costs per kilowatt of capacity. 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). Energy storage requirements limit the use of solar-energy systems as a baseload electricity supply.

There are substantial impacts to natural resources (wildlife habitat, land-use, and aesthetic impacts) from construction of solar-generating facilities. As stated in the GEIS, land requirements are high—14,000 ha (35,000 ac) per 1000 MW(e) for photovoltaic and approximately 6000 ha (14,000 ac) per 1000 MW(e) for solar thermal systems. Neither type of solar electric system would fit at the North Anna site, and both would have large environmental impacts at a greenfield site.

The North Anna site receives approximately 4 kWh of solar radiation per m^2 per day, compared to 7 to 8 kWh of solar radiation per m^2 per day in areas of the western United States, such as California, which are the most promising for solar technologies (DOE/EIA 2000a). Because of the natural resource impacts (land and ecological), the area's relatively low rate of solar radiation, and high cost, solar power is not deemed a feasible baseload alternative to renewal of the North Anna, Units 1 and 2 OLs. Some solar power may substitute for electric power in rooftop and building applications. Implementation of nonrooftop solar generation on a scale large enough to replace North Anna, Units 1 and 2 would likely result in LARGE environmental impacts.

8.2.5.4 Hydropower

Virginia has an estimated 617 MW of undeveloped hydroelectric resource (INEEL 1997). This amount is less than needed to replace the 1790 MW(e) capacity of North Anna, Units 1 and 2. As stated in Section 8.3.4 of the GEIS, hydropower's percentage of U.S. generating capacity is expected to decline because hydroelectric facilities have become difficult to site as a result of public concern about flooding, destruction of natural habitat, and alteration of natural river courses. In the GEIS, estimated land requirements for hydroelectric power are approximately 400,000 ha (1 million ac) per 1000 MW(e) (NRC 1996). Replacement of North Anna Units 1 and 2 generating capacity would require flooding more than this amount of land. Due to the relatively low amount of undeveloped hydropower resource in Virginia and the large land-use and related environmental and ecological resource impacts associated with siting hydroelectric facilities large enough to replace North Anna Units 1 and 2, the staff concludes that local hydropower is not a feasible alternative to renewal of the North Anna Units 1 and 2 OLs. Any

attempts to site hydroelectric facilities large enough to replace North Anna Units 1 and 2 would result in LARGE environmental impacts.

8.2.5.5 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 generation due to the limited geographical availability of the resource and immature status of the technology (NRC 1996). As illustrated by Figure 8.4 in the GEIS, geothermal plants are most likely to be sited in the western continental United States, Alaska, and Hawaii, where hydrothermal reservoirs are prevalent. There is no feasible eastern location for geothermal capacity to serve as an alternative to North Anna Units 1 and 2. The staff concludes that geothermal energy is not a feasible alternative to renewal of the North Anna Units 1 and 2 OLs.

8.2.5.6 Wood Waste

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 barrier to the use of wood waste to generate electricity is the high delivered fuel cost and high construction cost per MW of generating capacity. The larger wood-waste power plants are only 40 to 50 MW(e) in size. Estimates in the GEIS suggest that the overall level of construction impact per MW of installed capacity should 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). Like coal-fired plants, wood-waste plants require large areas for fuel storage and processing and involve the same type of combustion equipment.

Due to uncertainties associated with obtaining sufficient wood and wood waste to fuel a base-load generating facility, ecological impacts of large-scale timber cutting (e.g., soil erosion and loss of wildlife habitat), and high inefficiency, the staff has determined that wood waste is not a feasible alternative to renewing the North Anna Units 1 and 2 OLs.

8.2.5.7 Municipal Solid Waste

Municipal waste combustors incinerate the waste and use the resultant heat to generate 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 2001). Municipal waste combustors use three basic types of technologies: mass burn, modular, and refuse-derived fuel (DOE/EIA 2001c). Mass burning technologies are most commonly used in the United States. This group of technologies process raw municipal solid waste “as is,” with little or no sizing,

shredding, or separation before combustion. The initial capital costs for municipal solid-waste plants are greater than for comparable steam-turbine technology at wood-waste facilities. This is due to the need for specialized waste-separation and waste-handling equipment for municipal solid waste (NRC 1996).

Growth in the municipal waste combustion industry slowed dramatically during the 1990s after rapid growth during the 1980s. The slower growth was due to three primary factors: (1) the Tax Reform Act of 1986, which made capital-intensive projects such as municipal waste combustion facilities more expensive relative to less capital-intensive waste disposal alternatives such as landfills; (2) the 1994 Supreme Court decision (*C&A Carbone, Inc. v. Town of Clarkstown*), which struck down local flow-control ordinances that required waste to be delivered to specific municipal waste combustion facilities rather than at landfills that may have had lower fees; and (3) increasingly stringent environmental regulations that increased the capital cost necessary to construct and maintain municipal waste combustion facilities (DOE/EIA 2001c).

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 2001c).

Currently, there are approximately 102 waste-to-energy plants operating in the United States. These plants generate approximately 2800 MW(e), or an average of approximately 28 MW(e) per plant (Integrated Waste Services Association 2001). The staff concludes that generating electricity from municipal solid waste would not be a feasible alternative to replace the 1790 MW(e) baseload capacity of North Anna Units 1 and 2 and, consequently, would not be a feasible alternative to renewal of the North Anna Units 1 and 2 OLs.

8.2.5.8 Other Biomass-Derived Fuels

In addition to wood and municipal solid waste fuels, there are several other concepts for fueling electric generators including burning crops, converting crops to a liquid fuel such as ethanol, and gasifying crops (including wood waste). In the GEIS, the staff stated that none of these technologies has progressed to the point of being competitive on a large scale or being reliable enough to replace a baseload plant such as North Anna Units 1 and 2 (NRC 1996). For these reasons, such fuels do not offer a feasible alternative to renewal of the North Anna Units 1 and 2 OLs.

8.2.5.9 Fuel Cells

Fuel cells work without combustion and its environmental side effects. Power is produced electrochemically by passing a hydrogen-rich fuel over an anode and air over a cathode and 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. 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. DOE projects that by 2003, two second-generation fuel cell technologies using molten carbonate and solid oxide technology, respectively, will be commercially available in sizes up to 2 MW at a cost of $1000 to $1500 per kW of installed capacity (DOE 2001b). For comparison, the installed capacity cost for a natural-gas-fired combined-cycle plant is on the order of $500 to $600 per kW (NWPPC 2000). As market acceptance and manufacturing capacity increase, natural gas-fueled fuel cell plants in the 50- to 100-MW range are projected to become available (DOE 2001b). Presently, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation. Fuels cells are, consequently, not a feasible alternative to renewal of the North Anna Units 1 and 2 OLs.

8.2.5.10 Delayed Retirement

The only VEPCo generating plants currently scheduled for retirement are Possum Point Units 1 and 2 located about 15 km (25 mi) south of Washington, D.C. These oil-fired units each have a nameplate-generating capacity[(a)] of 69 MW (DOE/EIA 2000b). Delayed retirement of Possum Point Units 1 and 2 would not come close to replacing the 1790 MW(e) capacity of North Anna Units 1 and 2. For this reason, delayed retirement of VEPCo generating units would not be a feasible alternative to renewal of the North Anna Units 1 and 2 OLs.

8.2.5.11 Utility-Sponsored Conservation

VEPCo has developed residential, commercial, and industrial programs to reduce both peak demands and daily energy consumption. These programs are commonly referred to as demand-side management (DSM). VEPCo currently operates the following DSM programs: Rate Schedule SG (standby generation), Rate Schedule CS (curtailable service), Rider J (interruptible electric water heater service), and the Real Time Pricing Rate. VEPCo projects that by 2007, its DSM programs will reduce peak power requirements in the summer and winter by 74 and 130 MW, respectively (VEPCo 2001). VEPCo also projects that energy requirements

(a) The nameplate-generating capacity is the full-load, continuous rating of a generating plant.

in 2007 will be reduced by 14 gigawatt hours, 99 percent of which would be from load management programs (VEPCo 2001).

Historic and projected reduction in generation needs as a result of DSM programs have been credited in VEPCo's planning to meet projected customer demand. Because these DSM savings are part of the long-range plan for meeting projected demand, they are not available offsets for North Anna Units 1 and 2. Therefore, the conservation option is not considered a reasonable replacement for the OL renewal alternative.

8.2.6 Combination of Alternatives

Although individual alternatives to North Anna Units 1 and 2 might not be sufficient on their own to replace the capacity of these units due to size or cost, it is conceivable that a combination of alternatives might be cost-effective.

As discussed in Section 8.2, North Anna Units 1 and 2 have a combined average net capacity of 1790 MW(e). For the coal and natural gas alternatives, VEPCo assumes in its ER three standard 508-MW(e) units as potential replacements for Units 1 and 2 (VEPCo 2001). This approach is followed in this SEIS, although it results in some environmental impacts that are roughly 17 percent lower than if full replacement capacity were constructed.

There are many possible combinations of alternatives. Table 8-8 summarizes the environmental impacts of an assumed combination of alternatives consisting of 1016 MW(e) of combined-cycle natural-gas-fired generation at North Anna using the existing once-through cooling system, and at an alternate location using closed-cycle cooling, with 387 MW(e) purchased from other generators and 387 MW(e) gained from additional DSM measures. The impacts associated with the combined-cycle natural-gas-fired units are based on the gas-fired generation impact assumptions discussed in Section 8.2.2, adjusted for the reduced generating capacity. While the DSM measures would have few environmental impacts, operation of the new gas-fired plant would result in increased emissions and environmental impacts. The environmental impacts of imported power would still occur but would be located elsewhere within the region, nation, or another country as discussed in Section 8.2.4. The environmental impacts associated with purchased power are not shown in Table 8-8. The staff concludes that it is very unlikely that the environmental impacts of any reasonable combination of generating and conservation options could be reduced to the level of impacts associated with renewal of North Anna Units 1 and 2 OLs.

Table 8-8. Summary of Environmental Impacts for an Assumed Combination of Generating and Acquisition Alternatives

	North Anna		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Land Use	SMALL to MODERATE	9 ha (23 ac) for powerblock, offices, roads, and parking areas. Additional impact of up to approximately 295 ha (729 ac) for construction of an underground gas pipeline.	SMALL to LARGE	30 ha (74 ac) for powerblock, offices, roads, and parking areas. Additional impact for construction of an underground natural gas pipeline and a transmission line – MODERATE. Greenfield site increases impact to LARGE.
Ecology	SMALL to MODERATE	Uses undeveloped areas at the North Anna site plus land for a new gas pipeline.	SMALL to LARGE	Impact depends on location and ecology of the site, surface water body used for intake and discharge, and transmission and pipeline routes; potential habitat loss and fragmentation, reduced productivity, and biological diversity. Greenfield site increases impact.
Water Use and Quality				
Surface water	SMALL	Uses existing once-through cooling system.	SMALL to MODERATE	Impact depends on volume of water withdrawal and discharge and characteristics of surface water body.
Groundwater	SMALL	Reduced groundwater withdrawals due to reduced workforce.	SMALL	Groundwater impacts would depend on use and available supply.
Air Quality	SMALL to MODERATE	Sulfur oxides • 81 MT/yr (89 tons/yr) Nitrogen oxides • 306 MT/yr (337 tons/yr) Carbon monoxide • 402 MT/yr (443 tons/yr) PM_{10} particulates • 120 MT/yr (132 tons/yr) Some hazardous air pollutants.	SMALL to MODERATE	Same as siting at North Anna Power Station.
Waste	SMALL	Small amount of ash produced.	SMALL	Same as siting at North Anna Power Station.
Human Health	SMALL	Impacts considered to be minor.	SMALL	Impacts considered to be minor.

Table 8-8. (contd)

	North Anna		Alternate Greenfield Site	
Impact Category	**Impact**	**Comments**	**Impact**	**Comments**
Socioeconomics	SMALL to MODERATE	During construction, impacts would be SMALL to MODERATE. Up to 1200 additional workers during the peak of the 3-year construction period, followed by reduction from current North Anna Power Station, Units 1 and 2, workforce of 921 to 961 (permanent and contract) to approximately 150; tax base preserved. Impacts during operation would be SMALL to MODERATE due to loss of employment to Louisa County.	SMALL to LARGE	Construction impacts depend on location, but could be significant if location is in a rural area. Louisa County would experience loss of tax base and employment with potentially LARGE impacts. Impacts during operation at an alternate site would be SMALL to MODERATE depending on economy at alternate site and relative impact of plant to tax base.
	SMALL to MODERATE	Transportation impacts associated with construction workers would be SMALL to MODERATE. Transportation impacts during operation would be SMALL due to smaller workforce.	SMALL to LARGE	Transportation impacts associated with construction workers would be SMALL to LARGE and dependent on population density at alternative site. Impacts during operation would be SMALL due to smaller workforce.
Aesthetics	SMALL	Some visibility of structures offsite.	SMALL to LARGE	SMALL if alternate site previously developed. MODERATE impact from plant, stacks, cooling tower plumes, and new transmission lines. LARGE if greenfield site.
Historic and Archeological Resources	SMALL	Any potential impacts likely can be managed effectively.	SMALL	Any potential impacts likely can be managed effectively.
Environmental Justice	SMALL to MODERATE	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole. Some impacts on housing may occur during construction; loss of approximately 750 operating jobs at North Anna could reduce employment prospects for minority and low-income populations.	SMALL to LARGE	Impacts at alternate site vary depending on population distribution and makeup at site. Louisa County would lose significant revenue, which could have MODERATE to LARGE impacts to minority and low-income populations. Impacts to receiving County could be SMALL to MODERATE.

8.3 Summary of Alternatives Considered

The environmental impacts of the proposed action, license renewal, are SMALL for all impact categories (except collective offsite radiological impacts from the fuel cycle and from high level waste and spent fuel disposal, for which a single significance level was not assigned). The alternative actions, i.e., no-action alternative (discussed in Section 8.1), new generation alternatives (from coal, natural gas, and nuclear, discussed in Sections 8.2.1 through 8.2.3, respectively), purchased electrical power (discussed in Section 8.2.4), alternative technologies (discussed in Section 8.2.5), and the combination of alternatives (discussed in Section 8.2.6) were considered.

The no-action alternative would result in decommissioning North Anna Power Station, Units 1 and 2, and would require replacing electrical generating capacity by (1) DSM and energy conservation, (2) power purchased from other electricity providers, (3) generating alternatives other than North Anna Units 1 and 2, or (4) some combination of these options. For each of the new generation alternatives (coal, natural gas, and nuclear), the environmental impacts would not be less than the impacts of license renewal. For example, the land-disturbance impacts resulting from construction of any new facility would be greater than the impacts of continued operation of North Anna Units 1 and 2. The impacts of purchased electrical power (imported power) would still occur, but would occur elsewhere. Alternative technologies are not considered feasible at this time, and it is very unlikely that the environmental impacts of any reasonable combination of generation and conservation options could be reduced to the level of impacts associated with renewal of the OLs for North Anna Units 1 and 2.

The staff concludes that the alternative actions, including the no-action alternative, may have environmental effects in at least some impact categories that reach MODERATE or LARGE significance.

8.4 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 Functions.”

10 CFR Part 52. Code of Federal Regulations, Title 10, *Energy,* Part 52, “Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants.”

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."

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

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