2.0 Description of Nuclear Power Plant and Site and Plant Interaction with the Environment

The North Anna Power Station, Units 1 and 2, are located in Louisa County in predominately rural central Virginia. The North Anna Power Station is situated on a peninsula on the southern shore of Lake Anna, a 27-km (17-mi) long reservoir. North Anna is situated approximately 64 km (40 mi) northwest of Richmond, Virginia. The plant consists of two units. Each unit is equipped with a nuclear steam unit supplied by Westinghouse Electric Corporation that uses a pressurized water reactor and once-through cooling system. The plant and its environs are discussed in Section 2.1, and the plant's interactions with the environment are presented in Section 2.2.

2.1 Plant and Site Description and Proposed Plant Operation During the Renewal Term

The North Anna Power Station is located in rural Louisa County, which had a population of about 25,000 in 2000. The plant is located in the triangle between the cities of Richmond, Charlottesville, and Fredericksburg. Figure 2-1 shows the location of the North Anna Power Station in relationship to the counties and important cities and towns within a 80-km (50-mi) radius. Interstate 95 passes within 26 km (16 mi) of North Anna, and Interstate 64 passes within 29 km (18 mi). The nearest community is the town of Mineral, approximately 10 km (6 mi) southwest of North Anna. Louisa, the County seat, is 19 km (12 mi) west of the site. The North Anna Power Station is situated on a peninsula on the southern shore of Lake Anna, approximately 8 km (5 mi) upstream from the North Anna Dam, at a minimum elevation of 83 m (271 ft) above mean sea level. The normal elevation of Lake Anna is 76 m (250 ft) above mean sea level. The station occupies approximately 422 ha (1043 ac) of land and its Waste Heat Treatment Facility covers about 1400 ha (3400 ac), as shown in Figure 2-2 and discussed in Section 2.1.3. All site land, subsurface lands, and mineral rights are owned by the Virginia Electric and Power Company (VEPCo). No public or commercial highways, railroads, or waterways traverse the site. VEPCo also owns and operates the North Anna Hydroelectric Project, an 855-kW capacity hydroelectric power plant at the base of the North Anna Dam.

Lake Anna, a man-made reservoir, was created in 1971 by erecting a dam on the main stem of the North Anna River. Impoundment of the reservoir started in January 1972 and was expected to continue until late 1973 or 1974; however, due to higher than expected precipitation, the reservoir was filled by December 1972 (AEC 1973). The lake is approximately 27 km (17 mi) long with 435 km (272 mi) of irregular shoreline and 3900 ha (9600 ac) of water surface. Lake Anna was created primarily as a source of cooling water for North Anna, although it has become a popular recreation area, while the dam provides downstream flood control. It is not

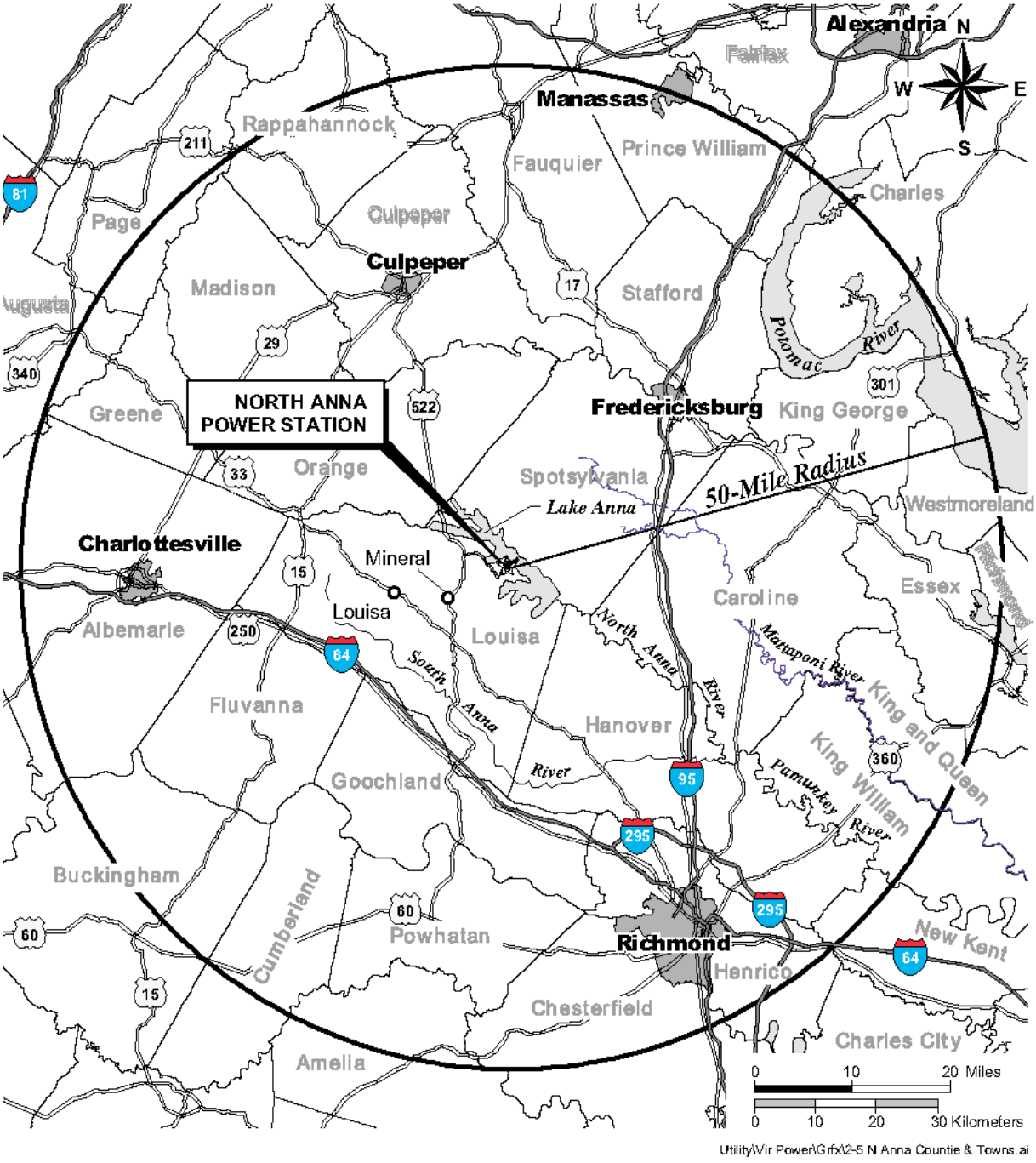

Figure 2-1. Location of North Anna Power Station, 80-km (50-mi) Region

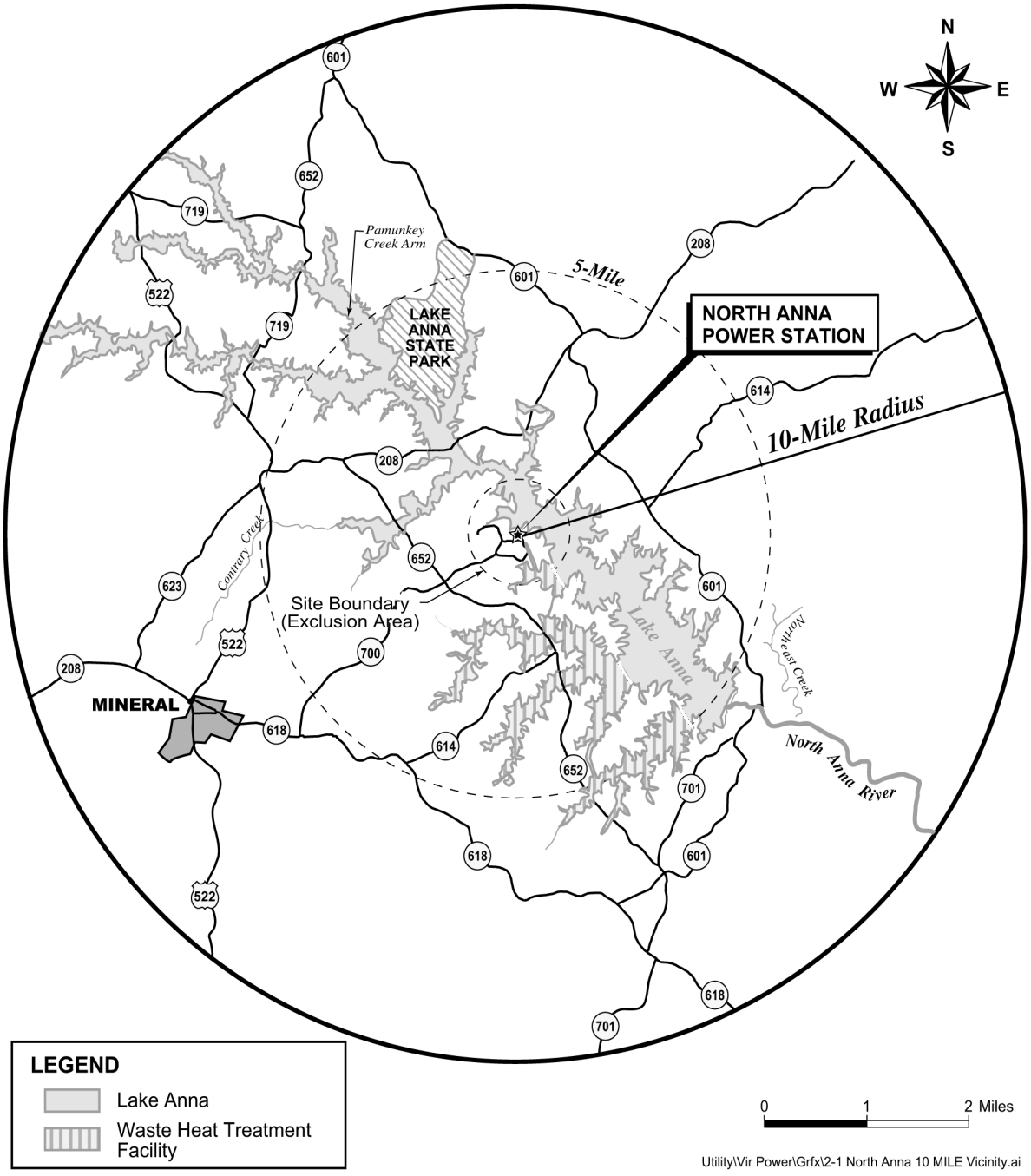

Figure 2-2. Location of North Anna Power Station, Units 1 and 2, 10-km (6-mi) Region

used as a source of potable or industrial water. VEPCo owns the land, above and below the surface, around the lake, up to the expected 78-m (255-ft) high-water mark above mean sea level. Recreational and retirement development has grown significantly around Lake Anna. Land between the many embayments remains privately held. A final Lake Anna Special Area Plan to coordinate planning efforts by the three counties for the Lake Anna region and watershed was released in March 2000 (Lake Anna 2000).

2.1.1 External Appearance and Setting

Distinctive features of the North Anna Power Station include the 41-m (135-ft) diameter cylindrical containment buildings with hemispherical domes. The domes are 0.76 m (2.5 ft) thick, and the overall height is approximately 58 m (191 ft). Another distinctive feature of North Anna is the 1400-ha (3400-ac) Waste Heat Treatment Facility (WHTF). The WHTF, formed by diking off the three southern-most arms of Lake Anna, consists of three cooling lagoons interconnected by canals (Figure 2-3). There is also an Independent Spent Fuel Storage Installation (ISFSI) located on the site (Figure 2-4).

The topography in the region of North Anna is characteristic of the central Piedmont Plateau of Virginia, with a gently undulating surface varying from 61 to 152 m (from 200 to 500 ft) above sea level. The surrounding region is covered with forest and cut-over second growth timber, interspersed with an occasional farm.

2.1.2 Reactor Systems

North Anna Power Station, Units 1 and 2, are shown in Figure 2-4. Each unit includes a three-coolant-loop pressurized light water reactor nuclear steam supply system and steam-driven turbine generator manufactured by Westinghouse. The balance of each unit was designed by VEPCo with the assistance of its architect-engineer, Stone & Webster Engineering Corporation. Each unit was designed for an output of 2775 MW(t), with corresponding gross electrical output of approximately 907 MW(e). Units 1 and 2 achieved commercial operation in June 1978 and December 1980, respectively. In 1986, based on an NRC-prepared environmental assessment and Finding of No Significant Impact, both units were uprated to a core power output of 2893 MW(t) with an expected gross output of 982 MW(e) and net capacity of 895 MW(e)[(a)] (VEPCo 2001b).

(a) Gross capacity is the output of the plant's generator. Net capacity is the gross capacity less the power used internally by the plant.

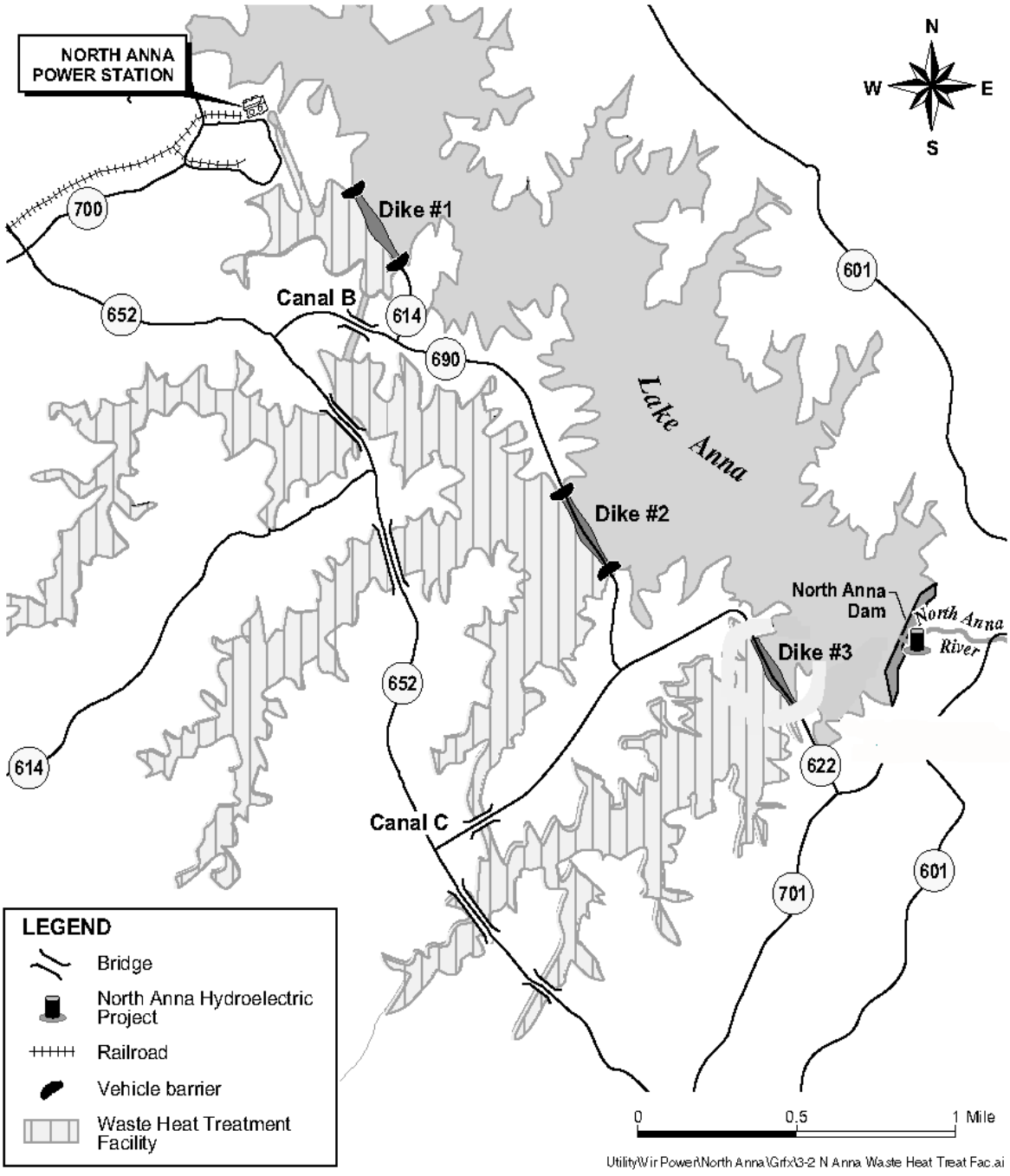

Figure 2-3. North Anna Power Station Waste Heat Treatment Facility

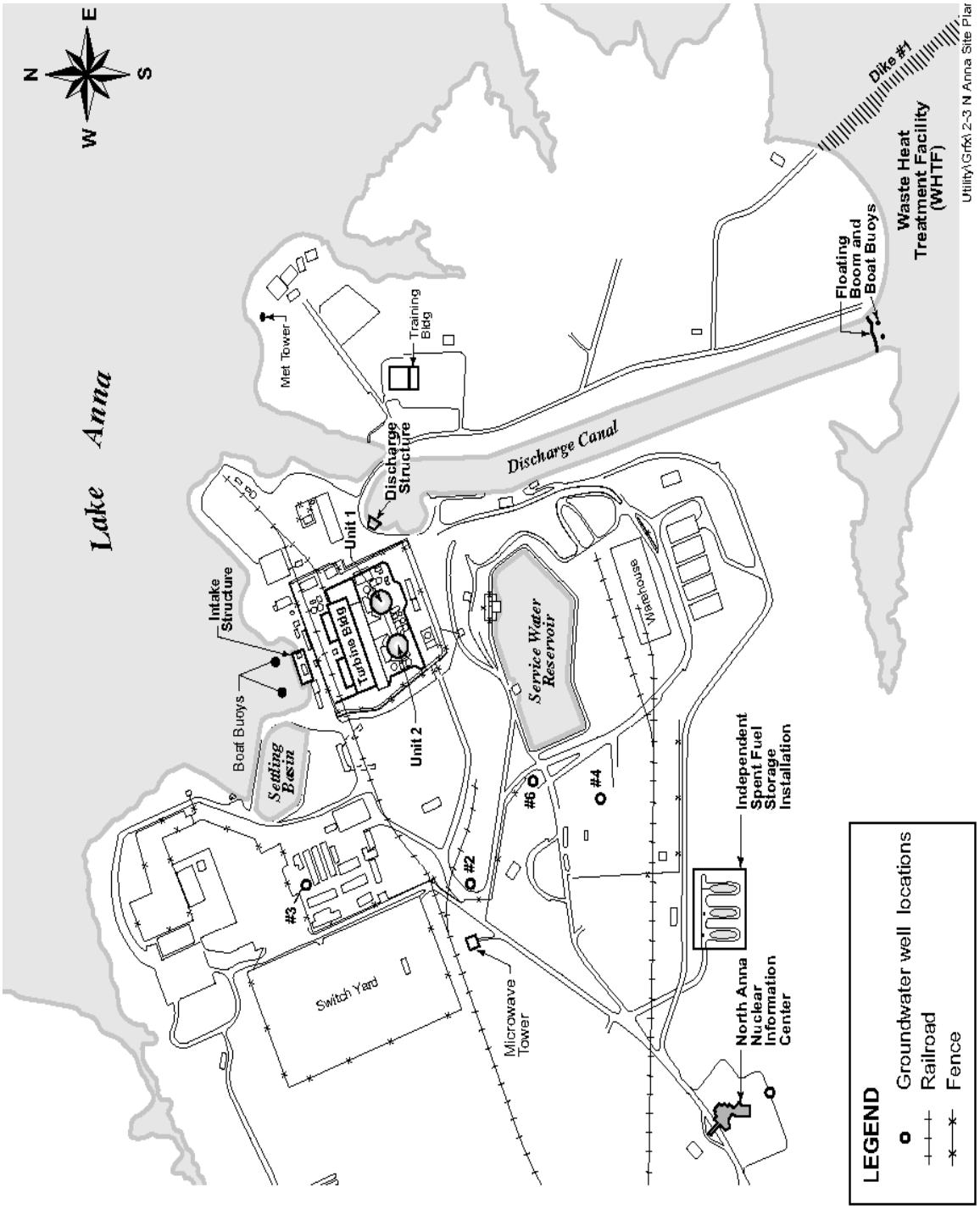

Figure 2-4. North Anna Power Station - Detail Map

Each reactor containment structure is a steel-lined, reinforced-concrete, 41-m (135-ft) diameter cylinder with a hemispheric dome and a flat reinforced-concrete foundation mat. The concrete vertical walls are 1.4 m (4.5 ft) thick, with an outside diameter of 41 m (135 ft). The dome is 0.76 m (2.5 ft) thick, and the overall height is approximately 58 m (191 ft). Air pressure inside each containment structure is maintained at 140 kPa (5 psig) below atmospheric pressure for routine operation. Together with its engineered safety features, each containment structure is designed to withstand an internal pressure of 410 kPa (45 psig) above atmospheric pressure accompanying the design-basis loss-of-coolant accident and provides radiation shielding for both normal operation and design-basis accident conditions (VEPCo 2001b).

2.1.3 Cooling and Auxiliary Water Systems

North Anna Power Station uses a once-through heat dissipation system that withdraws water from Lake Anna, pumps the water through the condenser, and returns heated water into the WHTF. When both units are operating at the design station load, 1.2×10^5 L/s (1.9×10^6 gpm) of water is withdrawn from Lake Anna and discharged into the WHTF with a temperature increase of approximately 8.1°C (14.5°F). This discharge is subject to the conditions of a National Pollutant Discharge Elimination System (NPDES) permit issued by the Virginia Department of Environmental Quality (VDEQ 2001).

Cooling water is withdrawn from Lake Anna through intakes located on a cove just north of North Anna (see Figure 2-4). Trash racks and traveling screens are used to prevent debris and fish from entering the cooling system.

After the water is used for condenser cooling, it is discharged into the 1400-ha (3400-ac) WHTF, formed before Lake Anna was filled by diking the three southern-most arms of Lake Anna. The WHTF consists of three cooling lagoons interconnected by canals (see Figure 2-3). Discharged cooling water moves from the first cooling lagoon in the WHTF to a second lagoon through Canal B, and from the second lagoon into the third lagoon through Canal C. The only discharge from the WHTF into Lake Anna is through Dike 3 near the dam. This discharge is also subject to the conditions of the NPDES permit issued by the VDEQ (VDEQ 2001).

The service water system, normally operated as a closed-loop system, uses a 4-ha (9-ac) reservoir and spray array to dissipate heat. Makeup water for the service water system is diverted and withdrawn from the cooling water system before the water enters the condensers. The service water system is used in a variety of applications, including component cooling (e.g., pump bearings and spent fuel pool) and air conditioning. Overflow from the service water reservoirs discharges into the WHTF. Finally, North Anna Power Station has ten groundwater withdrawal wells for domestic use.

2.1.4 Radioactive Waste Management Systems and Effluent Control Systems

VEPCo uses liquid, gaseous, and solid radioactive waste management systems to collect and treat the radioactive materials that are produced as a by-product of North Anna Power Station, Units 1 and 2, plant operations. These systems process radioactive liquid, gaseous, and solid effluents to maintain releases within regulatory limits and to levels as low as reasonably achievable (ALARA) before they are released to the environment. The North Anna Power Station waste processing systems meet the design objectives of 10 CFR Part 50, Appendix I ("Numerical guide for design objectives and limiting conditions for operation to meet the criterion 'As Low as is Reasonably Achievable' for Radiological Material in Light Water-Cooled Nuclear Power Reactor Effluents"). Radioactive material in the reactor coolant is the primary source of gaseous, liquid, and solid radioactive wastes in light water reactors. Radioactive fission products build up within the fuel as a consequence of the fission process. These fission products are contained in the sealed fuel rods, but small quantities escape the fuel rods and contaminate the reactor coolant. Neutron activation of the primary coolant system is also responsible for coolant contamination.

Non-fuel solid wastes result from treating and separating radionuclides from gases and liquids and from removing contaminated material from various reactor areas. Solid wastes also consist of reactor components, equipment, and tools removed from service, as well as contaminated protective clothing, paper, rags, and other trash generated from plant design modifications and operations and routine maintenance activities. Solid wastes are shipped to a waste processor for volume reduction before disposal or are sent directly to the licensed disposal facility. Spent resins and filters are dewatered and packaged for shipment to licensed offsite processing or disposal facilities. Currently, solid wastes are shipped to Barnwell, South Carolina.

Fuel rods that have exhausted a certain percentage of their fuel and are removed from the reactor core for disposal are called spent fuel. North Anna Power Station currently operates on a staggered 18-month refueling cycle per unit. The spent fuel assemblies are currently stored onsite in a spent fuel pool and in containers located in the ISFSI. The ISFSI operates under a separate license covering three dry storage pads. Each pad has space for up to 28 dry storage casks and currently 11 casks are filled and stored.

North Anna also provides for temporary onsite storage of mixed wastes, which contain both radioactive and chemically hazardous waste. Storage of radioactive material is regulated by the NRC under the Atomic Energy Act of 1954 (AEA), and accumulation and storage of hazardous wastes is regulated by the U.S. Environmental Protection Agency (EPA) under the Resource Conservation and Recovery Act of 1976 (RCRA).

The North Anna Offsite Dose Calculation Manual (ODCM) (VEPCo 2000b) describes the methods used for calculating radioactivity concentrations in the environment and the estimated

potential offsite doses associated with liquid and gaseous effluents from North Anna. The ODCM also specifies controls for release of liquid and gaseous effluents to ensure compliance with the following:

- The concentration of radioactive liquid effluents released from the site to the unrestricted area will not exceed 10 times the concentration specified in 10 CFR Part 20, Appendix B, Table 2, Column 2, for radionuclides other than dissolved or entrained gases. For dissolved or entrained noble gases, the concentration shall not exceed 7.4 Bq/mL (0.0002 µCi/mL).

- The dose or dose commitment per reactor to a member of the public from any radioactive materials in liquid effluents released to unrestricted areas shall be limited to the design objectives of 10 CFR Part 50, Appendix I (i.e., less than or equal to 0.015 mSv (1.5 mrem) to the total body and less than or equal to 0.05 mSv (5 mrem) to any organ during any calendar quarter, and less than or equal to 0.03 mSv (3 mrem) to the total body and less than or equal to 0.1 mSv (10 mrem) to any organ during any calendar year).

- The dose rate due to radioactive materials released in gaseous effluents from the site at and beyond the site boundary will be limited to (1) less than or equal to 5 mSv/yr (500 mrem/yr) to the whole body and less than or equal to 30 mSv/yr (3000 mrem/yr) to the skin for noble gases, and (2) less than or equal to 15 mSv/yr (1500 mrem/yr) to any organ for iodine-131, iodine-133, and tritium, and for all radioactive materials in particulate form with half-lives greater than 8 days per NUREG-1301 (NRC 1991).

- The air dose per reactor to areas at and beyond the site boundary due to noble gases released in gaseous effluents shall be limited to less than or equal to 0.1 mGy (10 mrad) for gamma radiation and less than or equal to 0.2 mGy (20 mrad) for beta radiation during any calendar year.

- The dose to any individual member of the public from nuclear facility operations will not exceed the maximum limits of 40 CFR Part 190 (less than 0.25 mSv [25 mrem] in a year) and 10 CFR Part 20 (less than or equal to 5 mSv [0.5 rem] in a year and less than or equal to 0.02 mSv [2 mrem] in any hour). |

The systems used for processing liquid waste, gaseous waste, and solid waste are described in the following sections.

2.1.4.1 Liquid Waste Processing Systems and Effluent Controls

Radioactive liquids are collected and treated in the liquid waste disposal system common to both reactor units. This system accommodates the radioactive wastes produced during simultaneous operation of the two units. Potentially high-level liquid wastes from the chemical and volume control, boron recovery, steam generator blowdown, and vent and drain sump systems, and the hot laboratory drains, liquid waste disposal, and spent resin flush water are discharged to the high-level waste (HLW) drain tanks. The contents of these tanks are processed through the ion exchanger filtration system.

Low-level liquid wastes collected from the ion exchanger filtration system, vent and drain, boron recovery drain tanks and test tanks, and the fluid waste treatment tank are pumped to the waste header, through the clarifier, and are discharged either to the circulating water system or processed through the waste demineralizer. Laundry waste, cold laboratory drainage, and personnel decontamination area shower and sink drainages are discharged into the contaminated drain tanks and are filtered and clarified before release. The demineralizers also receive liquid from the contaminated drain tank, the steam generator blowdown tank, and blowdown from the service water reservoir.

The discharge flow from the liquid waste disposal system is combined and mixed with the water in the circulating-water system discharge tunnel. All liquid effluent discharges are monitored to ensure radiological control is maintained. Effluents downstream of the clarifier demineralizer filter are automatically isolated if their radioactivities exceed the alarm/trip setpoint for discharge release limits specified in 10 CFR Part 20, Appendix B, Table 2, Column 2. The circulating-water system discharge canal releases the treated effluent to Lake Anna in accordance with a
| NPDES-permitted and -monitored outfall (VDEQ 2001).

| For the two units during 2000, a total volume of 6.48×10^8 L (1.71×10^7 gal) of liquid waste was released prior to dilution. In this liquid waste, there was a total fission and activation product activity of 0.014 TBq (0.38 Ci) and total tritium activities of 32 TBq (861 Ci). These volume and activities are typical of past years. The composition of the liquid waste generated is reported in the *Annual Radioactive Effluent Release Report for the North Anna Power Station* (VEPCo 2001a). See Section 2.2.7 for a discussion of the theoretical doses to the maximally exposed individual as a result of these releases.

| VEPCo does not anticipate any increase in liquid waste releases on an annual basis during the renewal period.

2.1.4.2 Gaseous Waste Processing Systems and Effluent Controls

The North Anna gaseous waste disposal system is common to both units and collects and treats radioactive gases released during simultaneous operation of Units 1 and 2. The system is designed to collect, treat, and discharge potentially radioactive gases, fission product gases, and uncondensed vapors from the vent and drain system, boron recovery system, primary coolant leakages, and the reactor plant. The closed-loop disposal system consists of two waste gas compressors, two waste gas decay tanks, and associated piping to collect and filter vapors.

Waste gases are regulated by the process vent subsystem and the ventilation vent subsystem of the gaseous waste disposal system. Gaseous wastes enter the process vent subsystem from the waste gas decay tanks, the vent and drain system, the containment purge system, and the containment vacuum system. The ventilation vent subsystem regulates discharge of air from the steam reliefs of the boron evaporators, the ion exchange filtration system, gas strippers, and waste gas decay tanks. After treatment, the gaseous effluents are discharged to the atmosphere through a process vent stack located on top of the Unit 1 containment structure (VEPCo 2001c).

Radioactive waste gases collected in the waste gas decay tanks include iodine, xenon, and krypton (VEPCo 2001c). These gases are allowed to decay in one of two double-walled underground waste decay tanks. Before the gases are released from the waste decay tanks to the process vent, the contents are sampled and discharged at a permissible rate and activity as prescribed by the ODCM (VEPCo 2000b).

After release to the process vent, these gases are mixed with dilution air and combined with gases from the other paths (i.e., boron recovery system, containment vacuum system, the vent and drain system, and various pressure relief valves). Prior to release to the environment, the gases are mixed with filtered air from the auxiliary building and are passed through a charcoal filter and high-efficiency particulate air (HEPA) filters. The gases then pass through a regenerative heat exchanger and are monitored by a particulate and gas monitor to ensure that they meet 10 CFR Part 20 release limits for gaseous effluents before being released to the atmosphere. Release is terminated automatically if the radioactivity of the gaseous effluents exceeds ODCM pre-set release limits.

During 2000, there was a total fission and activation gas activity released from the two units of 3.88 TBq (105 Ci), a total iodine activity of 1.8×10^{-5} TBq (4.8×10^{-4} Ci), a total particulate activity of 6.8×10^{-9} TBq (1.8×10^{-7} Ci), and a total tritium activity of 4.05 TBq (109 Ci) (VEPCo 2001a). See Section 2.2.7 for a discussion of the theoretical doses to the maximally exposed individual as a result of these releases.

| VEPCo does not anticipate any increase in gaseous releases on an annual basis during the renewal period.

2.1.4.3 Solid Waste Processing

Solid wastes from North Anna consist of spent resin slurries, spent filter cartridges, and miscellaneous materials from station and radwaste facility operation and maintenance such as contaminated rags, paper, and equipment parts (VEPCo 2000c). Spent resin slurries from the plant's ion exchangers are collected in a shielded resin holdup tank in the decontamination building and then dewatered and transferred to a high-integrity container for shipment for disposal (VEPCo 2000c). Spent filter cartridges are also placed in high-integrity containers in preparation for disposal. Miscellaneous solid waste material is placed in appropriate containers and shipped offsite for compacting and disposal.

Solid wastes from North Anna are either shipped directly to an offsite licensed disposal facility (i.e., spent resins) or consigned to a licensed processing facility for volume-reduction and decontamination activities (i.e., compactible trash). The material that remains after volume reduction is transported by the processing facility to a final disposal facility.

Disposal and transportation of solid wastes are performed in accordance with the applicable requirements of 10 CFR Part 61 and Part 71, respectively. There are no releases to the environment from radioactive solid wastes created at North Anna.

In 2000, North Anna made 14 shipments of solid waste with a volume of 227 m^3 (8029 ft^3) and a total activity of 10.6 TBq (285 Ci) (VEPCo 2001a). In 1999, North Anna made 20 shipments of solid waste with a volume of 187 m^3 (6610 ft^3) and a total activity of 994 TBq (26,845 Ci) (VEPCo 2000d). The large difference in total activity released from 1999 to 2000 was due to the disposal of irradiated components during 1999. These shipments are representative of the shipments made in the past several years and are not expected to change appreciably during the license renewal period.

2.1.5 Nonradioactive Waste Systems

The primary nonradioactive chemical wastes generated at North Anna are the ion exchange resins used to treat the circulating water. The secondary source is blowdown from the steam generators that is discharged to the circulating water. Other sources are also generated, such as antifreeze, electrohydraulic fluid, fluorescent bulbs and batteries, wood, paper, and metal.

| Of the wastes generated, the hazardous wastes collected are shipped to a contractor for treatment or disposal. Waste lubricating oil is used as fuel in a fossil fuel plant for energy

recovery. An onsite paint shop recycles solvent. Electrohydraulic fluid is returned to the shipper to be recycled. Paper and metal are sent to a vendor for recycling or disposal. Wood is sent to a landfill. Sanitary wastes are treated by an onsite sewage treatment plant (regulated under a NPDES permit) (VDEQ 2001) and diverted to the head of the discharge canal for subsurface discharge.

Nonradioactive liquid waste produced as a result of plant operations and maintenance activities (e.g., water treatment activities, stormwater runoff) are sampled and treated in accordance with the site's NPDES Permit (VDEQ 2001) issued by VDEQ. Most of these streams are released to the WHTF. No chemical biocides are used (VEPCo 2001b).

2.1.6 Plant Operation and Maintenance

Routine maintenance performed on plant systems and components is necessary for safe and reliable operation of a nuclear plant. Some of the maintenance activities conducted at North Anna include inspection, testing, and surveillance to maintain the current licensing basis of the plant and to ensure compliance with environmental and public safety requirements. Certain activities can be performed while the reactor is operating. Others require that the plant be shut down. VEPCo refuels each North Anna unit on a staggered 18-month schedule, which means at least one refueling every year and two refuelings every other year. Up to 700 additional contract workers are employed for the 30- to 40-day refueling outage at each unit.

VEPCo performed an aging management review and developed an integrated plant assessment (IPA) for managing the effects of aging on systems, structures, and components in accordance with 10 CFR Part 54. The aging management program is described in Appendix B of the License Renewal Application (VEPCo 2001b). The IPA identified the programs and inspections that are managing the effects of aging at North Anna Power Station. Previously, VEPCo has performed some major construction activities at North Anna Power Station (e.g., steam generator replacement), and the IPA did not identify any need for refurbishment or replacement activities. VEPCo assumes that an additional 60 workers will be needed to perform all the necessary surveillance, monitoring, inspections, testing, trending, and record keeping activities during the license renewal period.

2.1.7 Power Transmission System

North Anna Power Station, Units 1 and 2, have three 500-kV transmission lines and one 230-kV transmission line leaving the site from the switchyard. Each transmission line occupies a separate right-of-way. The rights-of-way range from 37 to 84 m (from 120 to 275 ft) in width and from 24 to 66 km (from 15 to 41 mi) in length covering a total of approximately 1174 ha (2900 ac) (Table 2-1) (AEC 1973; VEPCo 2001b). The rights-of-way extend from the North

Anna site to the north, south, east, and west terminating in Morrisville, Midlothian, Ladysmith, and at the South Anna non-utility generator (Figure 2-5). The lines and rights-of-way were constructed between 1973 and 1984.

Table 2-1. North Anna Transmission Rights-of-Way

		Length		Width	Area	
Substation	kV	km (mi)	Direction	m (ft)	hectares (acres)	Construction Date
Morrisville	500	53 (33)	N	72 (235)	366 (905)	1973
Midlothian[(a)]	500	66 (41)	S	72 (235)	469 (1160)	1979
Ladysmith	500	24 (15)	E	84 (275)	192 (475)	1976
South Anna NUG	230	50 (31)	W	30 - 37 (100 - 120)	146 (360)	1984
Total		193 (120)			1174 (2900)	

(a) The transmission line to Midlothian Substation runs an additional 26 km (16 mi) in a shared right-of-way with a non-North Anna line.

VEPCo owns approximately 1 percent of the rights-of-way and has easements for the remaining 99 percent (VEPCo 2001b). The vegetation in the rights-of-way is managed through a combination of mechanical and herbicide treatments conducted on a 3-year cycle.

Mowing is the primary mechanical treatment, while Accord and Garlon are the primary herbicides used in the rights-of-way. In some areas (e.g., wetlands, dense vegetation), hand-cutting is used. Rare and sensitive plant species areas are identified and avoided or modified treatment practices are used to avoid adverse impacts. These modified vegetation treatments are developed in cooperation with the Virginia Department of Conservation and Recreation's (VDCR's) Natural Heritage Program (VEPCo 2001b). In addition, wildlife food plots and Christmas tree plantations are located along the rights-of-way and supported through cost-sharing by VEPCo (VEPCo 2001b).

2.2 Plant Interaction with the Environment

Sections 2.2.1 through 2.2.8 provide general descriptions of the environment near North Anna Power Station. They also provide detailed descriptions, where needed, to support the analysis of potential environmental impacts of refurbishment and operation during the renewal term, as discussed in Chapters 3 and 4. Section 2.2.9 describes the historic and archaeological resources in the area, and Section 2.2.10 describes possible impacts on other Federal project activities.

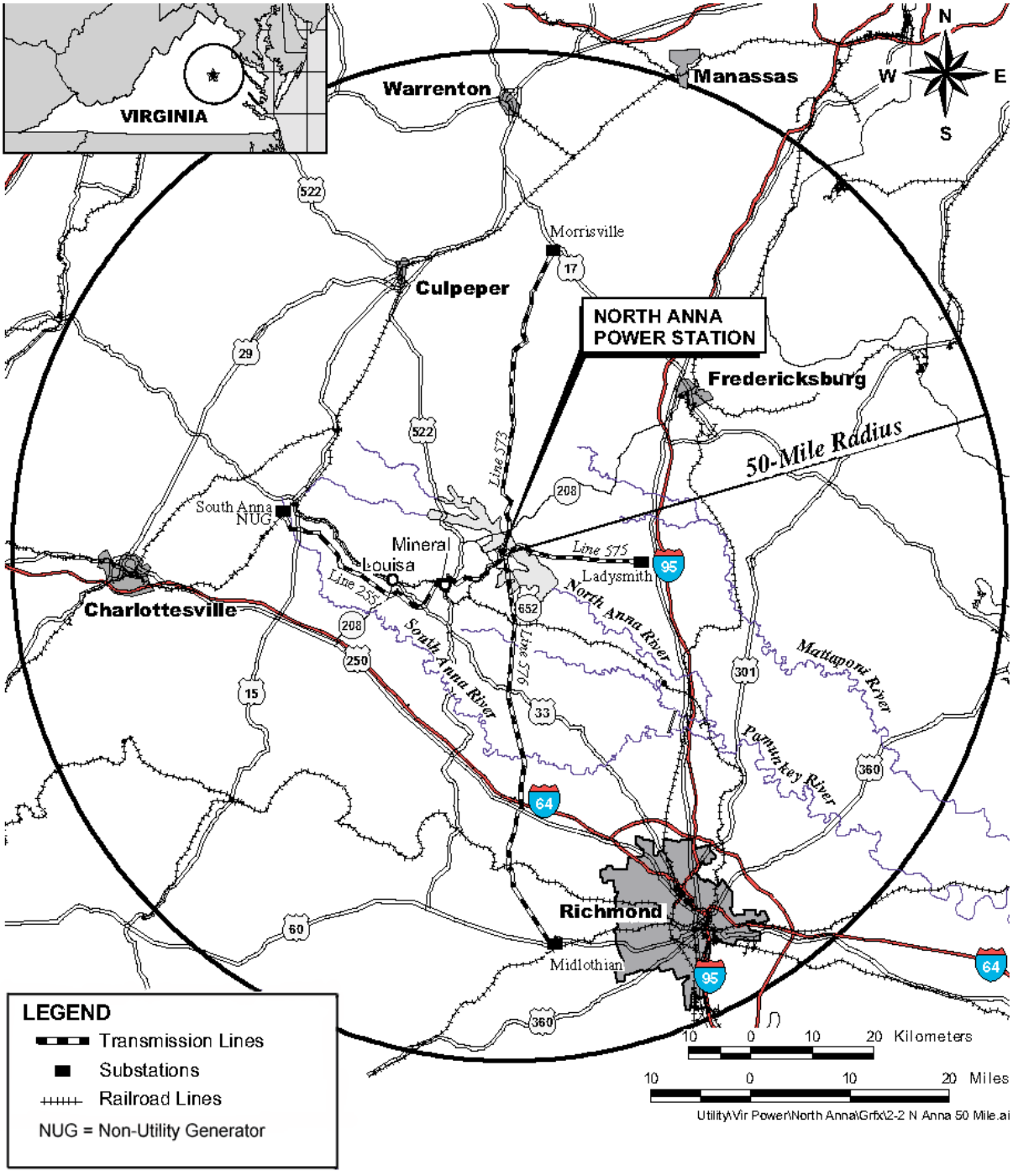

Figure 2-5. Location of Transmission Lines for North Anna Power Station, Units 1 and 2

2.2.1 Land Use

North Anna Power Station is located within the central Piedmont Plateau of Virginia. The topography is characterized as a gently undulating surface that varies from 60 m (200 ft) to 150 m (500 ft) above mean sea level. The North Anna site is on a peninsula on the southern shore of Lake Anna, a man-made reservoir, approximately 8 km (5 mi) upstream from the North Anna Dam. Forests comprising primarily pine and hardwoods cover the majority of the peninsula on which North Anna is sited. The predominant land use in Louisa County is forestry, a major contributor to the economy. Almost 70 percent of the total land area is forest interspersed with small farm agriculture.

North Anna Power Station covers approximately 422 ha (1043 ac) of land. The WHTF has a total surface area of 1400 ha (3400 ac) of water for heat dissipation behind three diked lagoons. VEPCo acquired 7550 ha (18,643 ac) of rural land for the development of the site including Lake Anna, the WHTF, and transmission line rights-of-way, as well as supporting facilities. VEPCo continues to own all land outside the site boundary that forms Lake Anna and the WHTF, up to the expected 78-m (255-ft) high-water mark above mean sea level, including approximately 2700 ha (6600 ac) that were not inundated.

The primary land cover is pine and pine-hardwood mixed forest (70 percent). The remainder of the land area is used for facility activities (20 percent) and as cleared areas (10 percent). Facility uses include generation, maintenance and distribution facilities, warehouses, training and administration buildings, lagoons and settling basin, parking lots, roads, a railroad line, information center, and the ISFSI. Cleared areas include the landscaped grounds, open areas, laydown areas, three historic cemeteries, security weapons range, and the John Goode Recreation Area, a VEPCo employee-only recreation and picnic area on a peninsula east of the station on the shore of Lake Anna.

VEPCo has granted easements to landowners abutting Lake Anna and the WHTF who request permission to use VEPCo property for the erection of piers, jetties, or other recreational structures for access to the lake waters. These structures require a reapproval by VEPCo with each property ownership transaction, and all permissions are expressly revocable. Boaters have access to the Lake and the cooling lagoons.

Louisa County is currently updating its comprehensive land use plan with the goal of preserving and protecting rural land for agriculture and forestry. The land adjacent to Lake Anna has become increasingly developed for primary, retirement, and vacation homes, as well as for commercial marinas. A final Lake Anna Special Area Plan was released in March 2000.

2.2.2 Water Use

North Anna Power Station uses water from Lake Anna for the once-through cooling system and service water system. Therefore, except for minor increases in evaporation due to the warmed discharge water, North Anna Power Station is not a consumptive user of water for cooling purposes. However, construction of the North Anna Dam and impoundment of the Lake Anna reservoir to provide cooling water for North Anna Power Station have considerably altered the regional water resources environment. Lake Anna represents the critical landscape feature to lakeside development and regional recreation. Instream flows downstream of the North Anna Dam are regulated by the Commonwealth of Virginia under the terms of the North Anna Power Station discharge permit (VDEQ 2001).

North Anna Power Station has ten groundwater withdrawal wells for domestic use. Six of these wells are permitted by VDEQ and are subject to withdrawal reporting requirements. The remaining four wells do not require permits due to their small size. The highest monthly average withdrawal reported for 1991 through 1999 was 2.6 L/s (41 gpm).

2.2.3 Water Quality

In addition to serving the cooling needs of North Anna Power Station, Lake Anna provides water of sufficiently high quality to serve a variety of needs including propagation of fish and wildlife and contact recreation. The formation of Lake Anna has mitigated some of the adverse water quality impacts upstream resulting from acid mine drainage from Contrary Creek, which flows into Lake Anna, providing a large volume of water to dilute the metals and pH associated with mine drainage and enabling sediments to deposit in the lake bottom.

Pursuant to the Federal Water Pollution Control Act of 1977, also known as the Clean Water Act, the water quality of the plant effluents is regulated through the NPDES. EPA has delegated implementation of NPDES to VDEQ within the Commonwealth of Virginia. Discharge of cooling water from North Anna Units 1 and 2 is currently authorized under NPDES Permit No. VA0052451 (VDEQ 2001). The permit, which is renewed every 5 years, expires January 11, 2006. Any new regulations promulgated by EPA or VDEQ would be included in future permits.

2.2.4 Air Quality

The climate within the central Piedmont Plateau where the North Anna site is located is classified as continental; the summers are warm and the winters are generally mild. The Blue Ridge Mountains to the west of the site act as a partial barrier to approaching winter storms and on a annual basis tend to channel winds along a general north-south orientation. Temperatures in

the region of the North Anna site rarely exceed 35°C (95°F) or fall below -12°C (10°F). Extreme temperature data for the region (Richmond, Virginia) indicate the highest reported temperature is 40°C (105°F), and the lowest reported temperature is -24°C (-12°F).

Thunderstorms are occasional in the region; a normal occurrence is about 37 per year (NOAA 1987). The majority of these storms occur during May through August. From 1886 through 1987, 33 tropical storms and 7 hurricanes passed within 190 km (100 nautical mi) of the site (VEPCo 2000c). The most recent severe weather event was hurricane Charley in August 1986, which brought from 2.5 to 7.6 cm (from 1 to 3 in) of rain to the region. Based on statistics for the 30 years from 1954 through 1983 (Ramsdell and Andrews 1986), on average, only six tornadoes are expected to occur in the Commonwealth of Virginia during a year. The probability of a tornado striking North Anna is expected to be about 5×10^{-5} per year.

The wind energy resource in the vicinity of North Anna is limited, with the annual average wind power rated as 1 on a scale of 1 to 7 with 1 being the lowest (Elliott, et al. 1986). Areas suitable for wind turbine application (rated class 3 or higher) in Virginia are limited to the ridges along the Appalachian Mountains and exposed coastal areas.

North Anna is located within the Northeastern Virginia Intrastate Air Quality Control Region (40 CFR 81.145). This region is designated as in attainment or unclassified for all criteria pollutants (40 CFR 81.347). The Commonwealth of Virginia, however, has been designated as a nonattainment area for the 1-hour ozone standard. The Commonwealth of Virginia will also be subject to a revised 8-hour ozone standard (40 CFR 50.10; EPA 1997a) and a new ambient air standard for $PM_{2.5}$ (40 CFR 50.7; EPA1997b), both promulgated by EPA in 1997. $PM_{2.5}$ is an acronym for particles with a diameter of 2.5 micrometers or less. EPA is taking steps to implement the new standards (e.g., developing its approach and collecting the data necessary to designate which areas are in nonattainment). Louisa County is not expected to be designated as a nonattainment area for the 8-hour ozone standard.

Finally, within Virginia two areas (James River Face Wilderness and Shenandoah National Park) are designated in 40 CFR 81.433 as mandatory Class 1 Federal areas in which visibility is an important value. The boundary of the closer of these areas, Shenandoah National Park, is within 67 km (42 mi) of the site.

Airborne emissions at North Anna are regulated by VDEQ. VEPCo holds an Exclusionary General Permit from VDEQ under Title 9 of the Virginia Administrative Code (9 VAC 5, Chapter 500) for all nonradiological airborne emissions resulting from plant operations. Emission sources at North Anna include two auxiliary boilers, four emergency diesel generators (3840 hp rating each), and a blackout generator (4640 hp rating). There are no emissions monitors at North Anna. Compliance under the Exclusionary General Permit is based on fuel sulfur content and fuel consumption records. A fuel oil sample is taken from each shipment and

analyzed to determine actual sulfur content of the oil. Annual operation of the auxiliary boilers and the diesel generators is limited under the permit to 3000 and 500 hours, respectively. Under the terms of the permit, North Anna provides VDEQ with emissions update information and compliance certification annually.

2.2.5 Aquatic Resources

Aquatic resources in the vicinity of the North Anna Power Station are associated with Lake Anna, the WHTF, and the North Anna River. Lake Anna was created to serve as the cooling water source for North Anna (VEPCo 2001b). The lake was made in 1971 by erecting the North Anna Dam on the main stem of the North Anna River, just upstream of the confluence of the North Anna River and Northeast Creek. Lake Anna began filling in January 1972 and reached capacity in December of that year. Lake Anna is approximately 27 km (17 mi) long with 435 km (272 mi) of shoreline. It is relatively shallow (maximum depth 27 m [90 ft]; average depth approximately 8 m [25 ft] at full pool), with a surface area of 3900 ha (9600 ac). The normal elevation of the reservoir is 76 m (250 ft) above mean sea level, at which stage it holds 4×10^8 m^3 (3×10^5 acre-feet) of water. The WHTF, formed by diking off the three southernmost arms of Lake Anna, consists of three cooling lagoons interconnected by canals. These lagoons have a total surface area of 1400 ha (3400 ac). Lake Anna is used extensively for recreation and fishing. The aquatic resources of Lake Anna are managed cooperatively by VEPCo and State natural resource agencies including the Virginia Department of Game and Inland Fisheries (VDGIF) and VDCR.

The creation of Lake Anna mitigates the impacts to the North Anna River of sedimentation and acid mine drainage from Contrary Creek, a tributary to the North Anna River, which drains an area that had been used extensively for iron pyrite mining (Herlihy and Mills 1989, VEPCo 2001b). Prior to impoundment of Lake Anna, the density and diversity of fish and benthic macroinvertebrates had been markedly reduced in the North Anna River immediately downstream of its confluence with Contrary Creek. Reportedly, this damage precluded other potential uses of the river and was one reason the North Anna site was selected for impoundment of the lake (AEC 1973). Contrary Creek now flows directly into Lake Anna. Low-pH creek water is diluted as it mixes with higher-pH reservoir water. Heavy metals are removed from the water column by adsorption to clay particles and the subsequent settling of these particles. Chemical precipitation (and co-precipitation with iron) may also remove zinc and copper ions from Contrary Creek water when it mixes with Lake Anna water.

Lake Anna is typical of many shallow reservoirs found in the central Piedmont Plateau of Virginia. Since impoundment, Lake Anna has gone through the ecological succession experienced by man-made reservoirs. The initial biotic community was highly productive because initial nutrient levels were high, followed by decreased productivity and ultimate stability (Paterson and Fernando 1970, Voshell and Simmons 1978). Aquatic communities in Lake Anna experienced gradual post-impoundment changes from riverine to lake communities.

Some of these communities had stabilized in Lake Anna by 1975 (VEPCo 1986), and all have been relatively stable since 1985 (VEPCo 1986, VEPCo 2002).

Lake Anna contains numerous phytoplankton, zooplankton, and benthic macroinvertebrate communities. Seventy-seven genera of phytoplankton have been identified, and diatoms, green algae, blue-green algae (cyanobacteria), and cryptomonads are the dominant forms. The zooplankton are dominated by small-bodied forms (rotifers and copepods). This has been attributed to selective predation upon larger-bodied zooplankton by landlocked schooling clupeids such as various shad species (Brooks and Dodson 1965). A total of 124 benthic taxa have been identified from Lake Anna (VEPCo 1986). Three bivalve species were collected in the North Anna basin prior to impoundment: *Elliptio complanatus*, *E. productus*, and *Sphaerium striatum* (AEC 1973).

In more recent years, the introduced Asiatic clam (*Corbicula* sp.) has dominated collections from both Lake Anna and the lower North Anna River. The Asiatic clam has spread rapidly throughout the United States since its first discovery in 1938 (VEPCo 1986). Asiatic clam populations expand rapidly when they invade a new habitat, and densities stabilize as the species reaches carrying capacity. Asiatic clams are present throughout Lake Anna; the greatest densities are found in mid-lake (VEPCo 1989a). After its initial invasion of Lake Anna, densities increased sharply from 1979 to 1981. Populations remained relatively stable between 1984 and 1988 (VEPCo 1989a). Therefore, VEPCo received approval from VDEQ to discontinue Asiatic clam sampling in 1989.

Small numbers of Unionids (*Elliptio* sp.) and fingernail clams (*Sphaeriidae*) have also been collected. Acid drainage and sediment from the Contrary Creek mine site historically depressed mussel populations downstream from the Contrary Creek-North Anna River confluence, the first major mussel beds were not apparent until 100 m downstream of the confluence of the North and South Anna Rivers (Reed and Simmons 1972). There are indications that mussel populations (*Elliptio* sp.) are recovering in the lower North Anna River (VEPCo 1986).

Approximately 39 species of fish (representing 12 families) have been identified in Lake Anna (VEPCo 1986). Species include those historically found in the North Anna River, those that had been in local farm ponds inundated by the new reservoir, and species introduced by VDGIF. Recreational species include largemouth bass (*Micropterus salmoides*), striped bass (*Morone saxatilis*), walleye (*Stizostedion vitreum*), bluegill (*Lepomis macrochirus*), yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigromaculatus*), white perch (*Morone americana*), pumpkinseed (*L. gibbosus*), redear sunfish (*L. microlophus*), redbreast (*L. auritus*), channel catfish (*Ictalurus punctatus*) and white catfish (*Ameiurus catus*). Forage species include threadfin shad (*Dorosoma petenense*) and gizzard shad (*D. cepedianum)*. Striped bass and walleye are stocked annually by VDGIF. Striped bass provide a “put-grow-and-take” fishery. Streams, including the North Anna River, that flow into Lake Anna appear to lack the flow, depth, and length to support striped bass spawning runs (VEPCo 1986, VEPCo 2001b). VDGIF

also placed 20 underwater fish structures in the reservoir over the 1983-1990 period to provide additional fish habitat in areas with “clean” bottoms. These fish structures were intended primarily to provide habitat for largemouth bass, black crappie, and sunfish (bluegill in particular). Sterile triploid herbivorous grass carp (*Ctenopharyngodon idella*) was stocked by VEPCo in the WHTF in 1994 to control growth of a nuisance submersed aquatic plant, namely the water hyacinth (*Hydrilla verticillata*).

The North Anna River joins the South Anna River 37 km (23 mi) downstream from the North Anna Dam (Figure 2-1), forming the Pamunkey River. Another 56 km (35 mi) downstream, the Pamunkey River joins the Mattaponi River to form the York River. In the North Anna River downstream of the dam, the periphyton community (single-celled, filamentous or colonial algae and associated microfauna attached to underwater surfaces) is dominated by diatoms, as are many southeastern streams. Caddisflies (*Tricoptera*) that feed on seston (living and dead plankton, plus particulate matter) from Lake Anna dominate the benthic macroinvertebrate community. Farther downstream, macroinvertebrate communities show more diversity and are similar to those of the South Anna River (VEPCo 2001b).

Over the past 18 years, up to 49 fish species have been observed in the North Anna River in the area between the dam and approximately 12 km (7 mi) upstream from the confluence of the South Anna River (VEPCo 2002). Prior to full impoundment, fish abundance in the North Anna River was depressed downstream from the Contrary Creek inflow (Reed and Simmons 1972). Since impoundment, abundance and diversity have steadily increased (VEPCo 2001b). Commonly observed species are the redbreast sunfish, bluegill, various shiners (*Notropis* sp. and *Notemigonus* sp.), fallfish (*Semotilis corporalis*), margined madtom (*Noturus insignis*) and the diadramous American eel (*Anguilla rostrata*). Important game fish include largemouth bass and smallmouth bass (*M. dolomieu*). Anadramous fish have been observed about 64 km (40 mi) downstream of the dam in the Pamunkey River just before the confluence with the Mattaponi River. These include shad (*Alosa* sp.) (Reed and Simmons 1972) and Atlantic Sturgeon (*Acipenser oxyrhynchus*) (Burkhead and Jenkins 1991). Native anadramous fish are rarely observed in the area of North Anna River near the dam. Blueback herring (*Alosa aestivalis*) has been observed near the dam (VEPCo 2000a). This species was stocked in Lake Anna by VDGIF in 1980 and 1981 (VEPCo 1986). In a letter dated October 26, 2001, the U.S. Fish and Wildlife Service (FWS) expressed concern of the impact of fish passage through the dam on the fish distribution in the North Anna River. Some fish present in Lake Anna do pass through the dam into the North Anna River at a rate of 0.6 to 3.1 fish per day (VEPCo 1989b). Threadfin shad, bluegill, white perch and golden shiner have been observed in dam passage samples, with bluegill the most commonly collected species.

No Federal-listed threatened or endangered fish species occur in counties immediately adjacent to Lake Anna, the North Anna River immediately upstream or downstream from Lake Anna (Orange, Louisa, Spotsylvania, Hanover, and Caroline Counties) or tributary streams crossed by North Anna transmission lines (which also includes Goochland, Powhatan, Henrico,

Chesterfield, Culpeper, and Fauquier Counties) (VDCR 2001; VDGIF 2002; FWS 2002). One Commonwealth-listed threatened species, the emerald shiner (*Notropis atherinoides*), was identified in a final environmental impact statement list of fish collected in the North Anna River prior to its impoundment (AEC 1973). However, this species is known only from the Clinch and Powell Rivers in the extreme western part of the State (Jenkins and Burkhead 1994, Burkhead and Jenkins 1991). The emerald shiner is often confused with the closely related comely shiner (*N. amoenus*) that occurs throughout the York River drainage and has been documented from Lake Anna and the North Anna River (Jenkins and Burkhead 1994). The comely shiner was not listed in the final environmental impact statement (AEC 1973) but has been collected regularly by VEPCo biologists in post-operational monitoring of the lower North Anna River (VEPCo 1989a). The emerald shiner has not been collected in any of the post-operational surveys or monitoring studies. The fish species listed in 1973 (AEC 1973) as the emerald shiner was more likely to have been the comely shiner.

Three Commonwealth- and Federal-listed freshwater mussel species could occur in streams in counties adjacent to Lake Anna, the North Anna River immediately upstream and downstream of Lake Anna, or in counties crossed by North Anna transmission lines (VDCR 2001; VDGIF 2002; FWS 2002). These are the dwarf wedgemussel (*Alasmidonta heterodon*), the Alantic pigtoe (*Fusonaia masoni*), and the James spinymussel (*Pleurobema collina*) (Table 2-2). One occurrence of the fluted kidneyshell mussel (*Ptychobranchus subtentum*), a candidate for Federal listing, is reported by the VDGIF Fish and Wildlife Information Service database as occurring in streams in Louisa County (VDGIF 2002). All other confirmed accounts of this species are confined to mountain streams in southwestern Virginia that are tributaries of the Tennessee River several hundred miles away. The slippershell mussel (*Alasmidonta viridis*) and the brook floater (*Alasmidonta varicosa*), both Commonwealth-listed endangered mussels, appear to be erroneously placed on species lists in counties where they are not known to occur. The slippershell mussel is found on a list for Orange County obtained from the VDCR (VDCR 2002); however, there was no date for the occurrence. According to the VDCR, the occurrence is a specimen at a museum mentioned in a report and has not been verified in the field. The VDCR indicated they would not have considered the slippershell mussel to be present in Orange County due to the quality of the record. The mussel is not listed on the species list obtained from the VDGIF (VDGIF 2002), and further review of its distribution shows it to be limited to counties in the far southwestern portion of Virginia. The brook floater is found on a list for Goochland County obtained from the VDGIF (VDGIF 2002). Again, there is no occurrence date listed for this species in this County, and further review of its known distribution shows it to be limited to counties in the far southwestern portion and counties in the far northern tip of Virginia.

Thus, it is unlikely these two mussel species occur in the vicinity of North Anna or its transmission lines.

Table 2-2. Aquatic Species Potentially Occurring in Counties Immediately Adjacent to Lake Anna, the North Anna River Immediately Upstream or Downstream of Lake Anna, or Tributary Streams Crossed by North Anna Transmission Lines Listed by the U.S. Fish and Wildlife Service or the Commonwealth of Virginia

Scientific Name	Common Name	Federal Status[a]	Commonwealth Status[a]
Invertebrates			
Alasmidonta heterodon	dwarf wedgemussel	E	E
Fusconaia masoni	Atlantic pigtoe	SOC	T
Pleurobema collina[b]	James spinymussel	E	E

(a) E = Endangered, T = Threatened, SOC = Species of Concern.
(b) This species has occurred in a county adjacent to Powhutan County and, thus, may occur in this county (FWS 2002).

None of these mussel species has been observed as occurring in streams in the vicinity of North Anna or in streams crossed by its transmission lines, nor were any collected in pre-impoundment surveys of the North Anna River or more recent monitoring surveys.

2.2.6 Terrestrial Resources

North Anna is located in the Piedmont physiographic province (Fleming et al. 2001). Common vegetation types on the North Anna site and the transmission line rights-of-way include short-leaf pine (*Pinus echinata*), Virginia pine (*Pinus virginiana*), bottomland hardwoods, and shrub bogs. In addition, there are croplands, tree plantations, old fields (reverted croplands), and pastures (AEC 1973, VEPCo 2001b) within the transmission line rights-of-way.

Wetlands are found on portions of the transmission line rights-of-way and at North Anna. They are small and associated with Lake Anna and artificial ponds. Staff at North Anna avoid these areas when possible during vegetation management activities, transmission line maintenance, and site maintenance. They consult with the U.S. Army Corps of Engineers, as needed, to comply with Section 404 of the Clean Water Act when activities are conducted near wetlands. Twelve Federal- and Commonwealth-listed threatened and endangered species potentially could occur at the North Anna Power Station or along the transmission line rights-of-way (VEPCo 2001b). The bald eagle (*Haliaeetus leucocephalus*) and the loggerhead shrike (*Lanius ludovicianus*) are the only Federal- or Commonwealth-listed species known to occur at the North Anna Power Station or along the transmission line rights-of-way (VEPCo 2001b). Table 2-3 lists the protected species and their status.

Table 2-3. Terrestrial Species Listed, Proposed, or Candidates as Endangered or Threatened by the U.S. Fish and Wildlife Service or the Commonwealth of Virginia that Occur or Potentially Occur Within the North Anna Site or the Associated Transmission Line Rights-of-Way

Scientific Name	Common Name	Federal Status[a]	Commonwealth Status[a]
Amphibians			
Ambystoma tigrinum	tiger salamander	--	E
Hyla gratiosa	barking treefrog	--	T
Birds			
Aimophila aestivalis	Bachman's sparrow	--	T
Ammodramus henslowii	Henslow's sparrow	--	T
Bartramia longicauda	upland sandpiper	--	T
Falco peregrinus	peregrine falcon	--	E
Haliaeetus leucocephalus	bald eagle	T	T
Lanius ludovicianus	loggerhead shrike	--	T
Mammals			
Plecotus rafinesquii	eastern big-eared bat	--	E
Vascular Plants			
Helonias bullata	swamp pink	T	E
Isotria medeoloides	small whorled pogonia	T	E
Aeschynomene virginica[b]	sensitive joint-vetch	T	E

(a) E = Endangered, T = Threatened, -- = Not listed.
(b) Habitat for this species is likely not found along the transmission lines because the habitat required (tidally influenced fresh waters) is not known in these areas.

The bald eagle is the only Federal-listed animal species that has been identified on the North Anna site and the transmission line rights-of-way. It is listed as threatened; however, it was proposed for removal from the list on July 6, 1999 (FWS 1999). Eagles usually nest in pines near large water bodies in Virginia. They feed primarily on fish but also eat carrion, waterfowl, small mammals, and reptiles. This species is found infrequently in the vicinity of North Anna and the transmission lines, and no known nests are in the area.

Three Federal-listed plant species could occur at the North Anna Power Station or along the transmission line rights-of-way. The small whorled pogonia (*Isotria medeoloides*) is a perennial species from 9.5 to 25 cm (from 4 to 10 in) high terminating in a whorl of five or six light green, elliptical, and somewhat pointed leaves. This species generally is found in open, dry, deciduous woods with acid soil. It occurs in habitat of relatively high-density shrub cover or sapling trees (NatureServe 2001). It is not known to occur on the North Anna site or the transmission line rights-of-way.

Swamp pink (*Helonias bullata*) is an annual species that can grow from 20 to 89 cm (from 8 to 35 in) during flowering and up to 1.5 m (5.0 ft) during seed maturation. It has a basal rosette of light green, lance-shaped, and parallel-veined leaves. It is found in wetlands that are saturated but not flooded, including bogs and swamps, and is commonly associated with some evergreens (NatureServe 2001). It is not known to occur on the North Anna site or the transmission line rights-of-way.

Sensitive joint-vetch (*Aeschynomene virginica*) is a single-stemmed, annual plant that can grow up to 2.4 m (7.9 ft) high. The leaves fold slightly if touched. The plant's habitat is restricted to tidally-influenced fresh water including fresh to slightly brackish tidal river shores (NatureServe 2001). It is not known to occur at North Anna or the transmission line rights-of-way.

2.2.7 Radiological Impacts

VEPCo has conducted a radiological environmental monitoring program (REMP) around the North Anna site since 1976 (NRC 1976). The radiological impacts to workers, the public, and the environment have been routinely monitored, documented, and compared with the appropriate standards. The two-fold purpose of the REMP is to:

- Provide representative measurements of radiation and radioactive materials in the exposure pathways for the radionuclides that have the highest potential for radiation exposures of members of the public

- Supplement the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways.

Radiological releases are summarized in the annual reports titled *Radiological Environmental Operating Program* (VEPCo and Teledyne Brown Engineering Environmental Services 2001) and *Annual Radioactive Effluent Release Report* (VEPCo 2001a). The limits for all radiological releases are specified in the North Anna ODCM, and these limits are designed to meet Federal standards and requirements (VEPCo 2000b). The REMP includes monitoring of the airborne

exposure pathway, direct exposure pathway (i.e., ambient radiation), water exposure pathway (i.e., ground/well water, river water, and surface water), aquatic exposure pathway (i.e., silt and shoreline sediments) from Lake Anna and North Anna River, and ingestion exposure pathway (i.e, milk, fish, and vegetation) in a 40-km (25-mi) radius of the station (VEPCo and Teledyne Brown Engineering Environmental Services 2001). In addition, the Virginia Department of Health (VDH) conducts an environmental radiation program that includes continuous monitoring of the air and ambient radiation and periodic sampling of fish, milk, shellfish, silt, soil, vegetation, and river water (VDH 2001).

Review of historical data on releases and the resultant dose calculations revealed that the doses to maximally exposed individuals in the vicinity of the North Anna site were a small fraction of the limits specified in the EPA's environmental radiation standards 40 CFR Part 190 as required by 10 CFR 20.1301(d). For 2000 (the most recent year that data were available), dose estimates were calculated based on actual liquid and gaseous effluent release data (VEPCo 2001a). Calculations were performed using the plant effluent release data, onsite meteorological data, and appropriate pathways identified in the ODCM. The maximum dose to an individual located at the station site boundary from liquid and gaseous effluents released during 2000 was 0.003 mSv (0.3 mrem) (VEPCo and Teledyne Brown Engineering Services 2001). Tritium was the major contributing radionuclide. A breakdown of doses in 2000 by pathway is provided below:

- Total body dose from liquid effluents was 0.003 mSv (0.3 mrem) for 2000, which is 5 percent of the 0.06 mSv (6 mrem) dose limit.[(a)] The critical organ dose from liquid effluents was 0.0034 mSv (0.34 mrem), 2 percent of the dose limit.

- The air dose due to noble gases in gaseous effluents was 4.3×10^{-5} mSv (4.3×10^{-3} mrad) gamma (0.02 percent of the 0.20 mGy [20 mrad] gamma dose limit)[(a)] and 1.4×10^{-4} mGy (1.4×10^{-2} mrad) beta (0.04 percent of the 0.40 mGy [40 mrad] beta dose limit).[(a)]

- The critical organ dose from gaseous effluents due to iodine-131, iodine-133, hydrogen-3, and particulates with half-lives greater than 8 days was 2.8×10^{-4} mSv (2.8×10^{-2} mrem), which is 0.09 percent of the 0.30 mSv (30 mrem) dose limit.[(a)]

The applicant does not anticipate any significant changes to the radioactive effluent releases or exposures from North Anna operations during the renewal period, and therefore, the impacts to the environment are not expected to change.

(a) The dose limit is twice the "10 CFR 50 Appendix I" dose limit because the limit is per unit and North Anna has two operating units.

2.2.8 Socioeconomic Factors

The region surrounding the North Anna site was identified in the Generic Environmental Impact Statement (GEIS, NRC 1996, 1999) as having a medium population density. The non-outage work force at North Anna comprises approximately 1000 persons, with as many as 700 additional contract workers arriving once or twice a year to participate in periodic refueling. An additional 60 full-time employees could be associated with the license renewal.

The staff reviewed the applicant's environmental report and information obtained from several county, city, and economic development staff during a site visit to Louisa County from October 15 through 19, 2001. The following information describes the economy, population, and communities near North Anna Power Station, Units 1 and 2.

2.2.8.1 Housing

Approximately 850 permanent employees and from 70 to 110 contract and licensee employees, assigned from other departments, work at North Anna Power Station, Units 1 and 2. Approximately 79 percent of these employees live in Henrico, Louisa, Orange, and Spotsylvania Counties, and in the City of Richmond.[(a)] The rest live in other locations. Table 2-4 presents the county of residence for 820 permanent employees.[(b)]

Table 2-4. North Anna Power Station—Permanent Employee Residence Information by Four-County Area of Potential Impact

County	Number of Personnel	Percent of Total Personnel
Henrico including City of Richmond	104	12.7
Louisa	237	28.9
Orange	120	14.6
Spotsylvania	186	22.7
Other	173	21.1
Total	820	100.0

Source: NRC 2001

(a) These counties and the City of Richmond together are collectively known as the area of potential impact. However, as is discussed subsequently in this section, Louisa County will have the majority of the impacts.

(b) The permanent work force is approximately 850; however, addresses were provided for only 820.

Table 2-5 presents a breakdown, by city and county, of the residency of the permanent North Anna Power Station, Units 1 and 2, employees. Table 2-5 does not include the residences of the contract employees. Given the number of VEPCo employees living in Henrico (including the City of Richmond), Louisa, Orange, and Spotsylvania Counties, and because the North Anna units are located in Louisa County, this SEIS focuses on these four counties with an emphasis on Louisa County since it will bear most of the impacts associated with relicensing.

Table 2-5. North Anna Power Station, Units 1 and 2 – Permanent Employee Residence Information by County and City

County and City[a]	VEPCo Employees
HANOVER COUNTY	
Ashland	10
Doswell	1
Hanover	1
Mechanicsville	11
Montpelier	20
Rockville	2
Total Hanover County	45
HENRICO COUNTY	
Glen Allen	39
Sandston	2
Total Henrico County	41
City of Richmond	63
LOUISA COUNTY	
Bumpass	48
Louisa	104
Mineral	84
Trevilians	1
Total Louisa County	237
ORANGE COUNTY	
Burr Hill	1
Barboursville	5
Gordonsville	35
Locust Grove	6
Mine Run	1
Orange	53
Rhoadesville	7
Somerset	1
Unionville	11
Total Orange County	120
SPOTSYLVANIA COUNTY	
Beaverdam	18
Fredericksburg	83
Partlow	7
Spotsylvania	77
Thornburg	1
Total Spotsylvania County	186
OTHER	
Other Counties and Cities	159
Grand Total	851

(a) Addresses are for unincorporated counties and incorporated areas (cities and towns).
Source: NRC 2001

VEPCo refuels each nuclear unit at the North Anna site on an 18-month staggered schedule. During refueling outages, site employment increases by as many as 700 temporary workers for 30 to 40 days. The staff assumed that residences of the temporary workers are similarly dispersed throughout the region as are those of North Anna's permanent employees.

Table 2-6 provides the number of housing units and housing unit vacancies for the area of potential impact for 1980, 1990, and 2000. Each county in the area of potential impact has a comprehensive land use plan. Louisa County updated its plan in September 2001 (Louisa County 2001). Louisa County is adding from 350 to 400 homes a year to its housing stock. This rate has been fairly constant over the last 3 to 4 years.[(a)]

Table 2-6. Housing Units and Housing Units Vacant (Available) by County During 1990 and 2000

	1990	2000	Approximate Percentage Change
HENRICO COUNTY			
Housing Units	94,540	112,570	19.1
Occupied Units	89,140	108,120	21.3
Vacant Units	5400	4450	-17.6
LOUISA COUNTY			
Housing Units	9080	11,855	30.6
Occupied Units	7425	9945	33.9
Vacant Units	1655	1910	15.5
ORANGE COUNTY			
Housing Units	9040	11,355	25.6
Occupied Units	7930	10,150	28.0
Vacant Units	1110	1205	8.7
SPOTSYLVANIA COUNTY			
Housing Units	20,485	33,330	62.7
Occupied Units	18,945	31,310	65.3
Vacant Units	1540	2020	31.4
CITY OF RICHMOND			
Housing Units	94,140	92,280	-2.0
Occupied Units	85,335	84,550	-0.1
Vacant Units	8805	7735	-12.2

Sources: U.S. Census Bureau (USCB) 2000a and 2000b.

Table 2-7 contains data on population, estimated population, and annual growth rates for the area of potential impact.

(a) Interview with Nancy Pleasants (Commissioner of Revenue) and Jerry Hall (Assessor; Commissioner of Revenue) Louisa County on October 15, 2001.

Table 2-7. Population Growth in Henrico, Louisa, Orange, and Spotsylvania Counties, and the City of Richmond, 1980 to 2010

	Henrico County		Louisa County		Orange County		City of Richmond		Spotsylvania County	
	Population	Annual Growth Percent	Population	Annual Growth Percent	Population	Annual Growth Percent	Population	Annual Growth Percent	Population	Annual Growth Percent
1970	154,465	--	14,005	--	13,790	--	255,835	--	16,425	--
1980	180,735	1.6	17,825	2.4	18,065	2.7	226,165	-1.2	31,995	6.7
1990	217,880	1.9	20,325	1.3	21,420	1.7	210,330	-0.7	57,405	5.9
2000	262,300	1.9	25,625	2.3	25,880	1.9	206,600	-0.2	90,395	4.6
2010	277,000[(a)]	0.5	30,005	1.6	29,800	1.4	196,610	-0.5	111,000	2.1

Sources: USCB (1991, 1998, 2000b); Virginia Employment Commission (2001a); Virginia Statistical Abstract (2000).
(a) Projected population for 2010; values for 1970 through 2000 are actual census population numbers.

2.2.8.2 Public Services

- **Water Supply**

Table 2-8 summarizes the daily water consumption and areas served by each water system within the area of potential impact. Henrico County provides water to approximately 83,411[(a)] residential, commercial, and industrial customers. Currently, the county purchases its water supply from the City of Richmond and has no restrictions on amount. Henrico County's average daily water use is 130,000 m^3/day (35 MGD). The county also has service agreements to supply limited amounts of water to Hanover and Goochland Counties (Henrico County 2001b). Because of the rapid growth rate in Richmond and surrounding counties, a water supply treatment plant is under construction for Henrico County with a capacity of 210,000 m^3/day (55 MGD). It is scheduled to become operational in 2003. Permit negotiations are under way to enlarge the plant by 2010 (Claytor 2000).

Richmond's source of water is the James River. It supplies approximately 562,000 people in the City of Richmond and in Chesterfield, Hanover, and Henrico Counties. It has a maximum capacity of 500,000 m^3/day (132 MGD) and an average use of 310,000 m^3/day (83 MGD) (City of Richmond 2000). Richmond is upgrading the plant to treat 570,000 m^3/day (150 MGD).

About 80 percent of Louisa County's source of residential drinking water is from groundwater through individual wells. Twelve small private water supply systems exist in the county. The major treatment plant in the county is the Northeast Creek water treatment

(a) Personal communication from Mr. David Wallace, Customer Services Supervisor, Department of Public Utilities Henrico County, Virginia, August 9, 2002.

Table 2-8. Major Public Water Supply Systems in Henrico, Louisa, Orange, and Spotsylvania Counties

Water System	Source	Maximum Daily Capacity m^3/day (MGD)	Average Daily Use m^3/day (MGD)	Area Served
Henrico County	James River	NA	130,000 (35)	Henrico, Hanover, and Goochland Counties
City of Richmond	James River	480,000 (128)	310,000 (83)	Richmond, Chesterfield, Hanover, and Henrico Counties
Louisa County Water Authority	Groundwater/NE Creek Reservoir	3800 (1)	1100 (0.3)	Towns of Louisa, Mineral, and some County residents
Town of Orange	Rapidan River	7600 (2)	5700 (1.5)	Town of Orange
Rapidan Service Authority	Groundwater	NA	75 (0.02)	Town of Gordonsville, plus 50 to 60 homes on Route 20
Wilderness Treatment Plant	Rapidan River	6100 (1.6)	1500 (0.4)	Town of Wilderness/Lake of the Woods
Spotsylvania County	Ni River	23,000 (6)	17,000 (4.5)	Supplies most residential, commercial, and industrial areas in the County

NA = not available.

plant that supplies the town of Louisa, part of the town of Mineral, and some county residents. The plant has a capacity of approximately 3800 m^3/day (1 MGD) and average use is 1100 m^3/day (0.3 MGD). To provide water for industrial users, two new groundwater wells and a storage tank are under construction at the Zion's Crossroads area in the western part of the county (Kincheloe 2000) in addition to the storage tank there that is already supplementing the existing water supply system.

Ninety percent of Orange County residents obtain their drinking water from individual groundwater wells. The town of Orange draws its water from the Rapidan River[(a)] and owns and operates a 7600 m^3/day (2 MGD)-capacity water treatment plant that supplies the town (Kendall 2000). Average daily use is around 5700 m^3/day (1.5 MGD) (Kendall 2000).

(a) The town of Orange does not draw from a reservoir on the river but directly from the river in what is known as a "run-of-the-river" withdrawal.

Part of the Town of Orange's treatment plant production, around 2000 m^3/day (0.5 MGD), is sold to the Rapidan Service Authority (RSA). RSA supplies the town of Gordonsville (Lloyd 2000). RSA operates two other Orange County facilities. The source of water for these plants is the Rapidan River and groundwater. RSA's Wilderness Treatment Plant has a 6100 m^3/day (1.6 MGD) treatment capacity and supplies, on average, approximately 1500 m^3/day (0.4 MGD) to Lake of the Woods and the Town of Wilderness (Clemmons 2000).

Spotsylvania County has a public water system suppling most residential, commercial, and industrial areas within the county. Rural areas of the county are served by wells and springs (Spotsylvania County 2000). The Ni River Treatment Plant, which draws water from the Ni River, has a capacity of 23,000 m^3/day (6 MGD) and average use of 17,000 m^3/day (4.5 MGD). Another larger treatment plant is under construction (Johnson 2000).

Public water supply is not a constraint to growth in the vicinity of North Anna. There are supply concerns in some individual municipalities and in some of the impact counties, where it is assumed the majority of new employees associated with license renewal would live. However, there are no limitations on new sources of water from groundwater. In addition, most treatment plants located in the area of potential impact have reserve treatment capacity. In cases where municipal systems are approaching the limits of their reserve capacities, plans are in place to address those limitations by constructing new treatment systems or expanding existing facilities.

- **Education**

Louisa County has one high school, one middle school, and three elementary schools. For the school year 2000 – 2001, there were 4232 students in the school system (Louisa County Public Schools 2001; Louisa County 2001). Orange County schools have a total enrollment of approximately 3800 students spread among five elementary schools, one middle school, and one high school (Orange County Public Schools 2001).

Spotsylvania County has 26 schools in its system (16 elementary schools, 6 middle schools, and 4 high schools). In addition, the County has one vocational school, and one special high school for intellectually gifted students (Spotsylvania County Schools 2001). Approximately 20,350 students are enrolled in the county school system[(a)], and an additional 350 are in the special high school (Spotsylvania County Schools 2001). Henrico County, which includes Richmond, has 41 elementary schools, 10 middle schools, 9 high schools,

(a) Personal communication (by telephone) with Ms. Gerry Calavetinos, Administrative Assistant for School Admissions, Spotsylvania Public Schools, Virginia, December 4, 2001.

and two technical centers (Henrico County Public Schools 2001). Total school enrollment is more than 41,000.

- **Transportation**

  There are 32 counties within the 80-km (50-mi) radius of the North Anna site (see Figure 2-1). One county is in Maryland while the remaining counties are in Virginia. The 31-county Virginia area is served by two major freeways. Interstate 95 (I-95) runs north-south through the region and connects it to Washington, D.C. on the north and Richmond, Virginia on the south. Interstate 64 lies in a northwest direction from Richmond on the east to Charlottesville on the west. Interstate 295 serves as a beltway around Richmond.

  The area is also traversed by several other Commonwealth and Federal highways including Highway 15 from the vicinity of Warrenton in the north, through Culpeper, and on southwards. Highway 29 runs more northeast to southwest from the vicinity of Manassas, through Culpeper, to Charlottesville and extends on to the southwest. Highway 33 passes through Louisa and on southeast to Richmond. Highway 250 runs between Charlottesville and Richmond. Numerous State highways traverse the area including Highways 700, 652, 208 and 522, among others.

  Road access to North Anna is via State Highway 700, a two-lane paved road. State Highway 700 intersects State Highway 652 approximately one-half mile from the North Anna site. The major commuting routes in the immediate vicinity of North Anna are State Highways 700, 652, 208, 522, and 618. These roads all carry a level-of-service designation "B" (stable flow in which the freedom to select speed is unaffected but the freedom to maneuver is slightly diminished).

2.2.8.3 Offsite Land Use

The predominant land use in Louisa County and a major contributor to the economy is forestry, which is approximately 68 percent of the County's land area. Most of the forested land is privately owned. Agricultural lands occupy 23.5 percent and water resources about 3 percent of land use. Developed uses occupy 6 percent, with residential development predominating with 5.5 percent. This rural county has recently experienced significant population growth but little industrial growth. Residential land use has increased from 1.8 percent in 1979 to 5.5 percent by 2000. The county has prepared over 50 industrial sites for development. Many have access to various combinations of rail, gas, water, and sewer (Louisa County, Virginia, n.d.).

Spotsylvania County (70 percent land use in forestry and agriculture) is fast-growing because of its proximity to Washington, D.C. and northern Virginia. Recreational and retirement develop-

ment is also growing significantly around Lake Anna. Orange County, with 95 percent of land use in forestry and agriculture, is beginning to be impacted by development.

Henrico County is adjacent to Richmond and is undergoing rapid development. Approximately 45 percent of Henrico County remains undeveloped. Most of the heavily developed part of the County is along I-95. The area east of I-95 is facing development pressures in the coming decade.

Lake Anna has influenced land use development in Louisa, Orange, and Spotsylvania Counties. Residential development of mid-to-upscale homes characterizes development around the lake. Prior to 1998, the three counties did not coordinate land use planning activities in the Lake Anna watershed. In 1998, a committee was formed to examine the watershed and develop a plan enabling the counties to coordinate their efforts to address growth and protect the Lake Anna region. The Lake Anna Special Area Plan was issued as final in March 2000 (Lake Anna 2000).

The Commonwealth of Virginia mandates that cities and counties have comprehensive land use plans, and all four counties (Henrico, Louisa, Orange, and Spotsylvania) have such plans. Table 2-9 shows land use in the four counties.

VEPCo pays annual property taxes to Louisa, Orange, and Spotsylvania Counties for North Anna (see Table 2-15). For 1995 to 2000, VEPCo's tax payments to Louisa County represented approximately 46 percent of the County's yearly property tax revenues and 22.5 percent of its annual budget. VEPCo's tax payment to Orange and Spotsylvania Counties represented approximately 1.4 and 1.5 percent of these Counties' property tax revenues, respectively, and 0.3 percent of their annual operating budgets. Based on total tax payments coming from the operation of North Anna, Louisa County could continue to maintain its current level of development and public services. Spotsylvania, Orange, and Henrico Counties would experience negligible land use impacts from operation of North Anna.

2.2.8.4 Visual Aesthetics and Noise

Access to the North Anna site is provided by Virginia Highway 700. The terrain is gently undulating and wooded. Most of the site structures are screened from public view up to the proximity of the plant boundary. Noise from plant operations is not noticeable. The exception is boiler blowdown, which lasts for only a short time.

Table 2-9. Land Use in Henrico, Louisa, Orange, and Spotsylvania Counties[a]

County and Land Use	Hectares	Acres	Percent of Total
Henrico			
Residential	14,865	36,732	23.5
Commercial	2094	5175	3.3
Industrial	1451	3586	2.3
Undeveloped[b]	27,744	68,554	43.9
Water	1757	4341	2.8
Other[c]	15,303	37,812	24.2
Total Henrico	63,214	156,200	100.0
Louisa			
Residential	7322	17,655	5.0
Agriculture	31,979	79,019	23.5
Forest	92,474	228,500	68.0
Water	3994	9868	3.0
Other[d]	649	1604	0.5
Total Louisa	136,418	336,646	100.0[e]
Orange			
Developed land[f]	4597	11,360	5.0
Agriculture	34,021	84,064	37.0
Forest	53,330	131,776	58.0
Water	N/A	N/A	
Total Orange	91,948	227,200	100.0[e]
Spotsylvania			
Residential	22,793	56,320	22.0
Developed land[g]	3108	7680	3.0
Agriculture	18,649	46,080	18.0
Forest	53,874	133,120	52.0
Other	5180	12,800	5.0
Total Spotsylvania	103,604	256,000	100.0

(a) The City of Richmond is heavily developed. For this reason, the land use of this jurisdiction is not discussed.
(b) Includes land being used for agricultural purposes.
(c) Includes public and semi-public (churches, schools, parks, etc.) and miscellaneous land classifications (rights-of-way, utilities, transportation and communications facilities).
(d) Includes commercial and industrial lands.
(e) Numbers have been adjusted to achieve a total of 100 percent.
(f) Developed land is defined to include residential, commercial, industrial and public use.
(g) Developed land is defined to include industrial and commercial.
N/A not available
Sources: Spotsylvania County (1999); Louisa County (2001); Henrico Planning Office (1999 and 2001); VEPCo (2001b).

From the waters of Lake Anna, North Anna Power Station, Units 1 and 2, and adjacent buildings are visible from Brumley's Point looking southeast to the North Anna site. Again, there is no perceptible noise, except during boiler blowdown.[(a)]

2.2.8.5 Demography

Population was estimated from North Anna out to 80 km (50 mi) in 16-km (10-mi) concentric rings. VEPCo's population estimates for the 80-km (50-mi) area surrounding the site are based on information from the Updated Final Safety Analysis Report (UFSAR) for Units 1 and 2 (VEPCo 2000c). NRC Guidance calls for the use of the most recent USCB decennial census data, which for North Anna is the 1990 census (USCB 1991).

- **Resident Population Within 80 km (50 mi)**

  Table 2-10 presents the population distribution within 80 km (50 mi) of the North Anna site for population estimates in 10-year increments from 1990 to 2030.

  In 2000, an estimated 1,614,983 people lived within 80 km (50 mi) of North Anna. Between 1990 and 2000, the total population within the 80-km (50-mi) radius is projected to have increased by 25.6 percent. Between 2000 and 2010, the population is projected to increase by 17.7 percent followed by a slight downward trend through 2030. Growth between 2020 and 2030 is projected to be 13.0 percent (VEPCo 2000c).

Table 2-10. Population Distribution from 1990 to 2030 Within 80 km (50 mi) of the North Anna Site

Year	0 to 16 km (0 to 10 mi)	16 to 32 km (10 to 20 mi)	32 to 48 km (20 to 30 mi)	48 to 64 km (30 to 40 mi)	64 to 80 km (40 to 50 mi)	Total
1990	11,887	67,871	138,267	514,490	553,641	1,286,156
2000 (est.)	14,506	85,749	174,602	642,823	697,303	1,614,983
2010 (est.)	16,549	100,919	204,434	753,445	824,708	1,900,056
2020 (est.)	18,587	115,309	234,267	864,067	952,113	2,184,342
2030 (est.)	20,625	129,698	264,099	974,689	1,079,518	2,468,629

Source: VEPCo (2000c).

All or parts of 32 counties and five major cities are located within 80 km (50 mi) of North Anna. The largest population center within the 16-km (10-mi) area is the town of Mineral,

(a) Personal communication George D. O'Connell, Reservoir Coordinator, Nuclear Site Services, Dominion Generation November 5, 2001.

which lies to the southwest of North Anna. The population of Mineral for 2000 is 424 (USCB 2000b). Lake Anna State Park also lies within the 16-km (10-mi) radius to the northwest of the site.

The Town of Louisa, located to the southwest of the North Anna site, falls within the 32-km (20-mi) radius. It has a population of 1401 (USCB 2000b). The towns of Fredericksburg, population 19,279 (USCB 2000b), northeast of the site, and Culpeper, population 9,664 (USCB 2000b), to the north of the site, fall within or on the edge of the 48-km (30-mi) radius. Charlottesville, population 45,049 (USCB 2000b), located to the west of North Anna, and Richmond, population 197,790 (USCB 2000b), east of the site, lie within or on the edge of the 64-km (40-mi) radius.

Spotsylvania and Louisa are ranked among the fastest growing Counties in Virginia. Between 1990 and 1998, these counties experienced 45.4 and 21.8 percent increases in population, respectively. During the same time period, Henrico and Orange Counties had increases of 13.5 and 16.9 percent, respectively (VEPCo 2001b). Richmond's population decreased 2.5 percent during the same period (Virginia Statistical Abstract 2000).

Table 2-11 lists the age distribution of Henrico, Louisa, Orange, and Spotsylvania counties and City of Richmond in 2000 and compares it to Virginia's population. The counties' age-distributed populations closely track within 2 to 3 percent. The exceptions are Spotsylvania County's under-18 age group (30.0 percent versus 24.6 percent for Virginia) and Orange County's 25-to-44 age group (27.8 percent versus 31.6 percent for Virginia).

Table 2-11. Estimated Age Distribution of Population in 2000

	Henrico		Louisa		Orange		City of Richmond		Spotsylvania		Virginia	
Age Group	**People**	**%**	**People**	**%**	**People**	**%**	**People**	**%**	**People**	**%**	**People**	**%**
Under 18	64,702	24.7	6255	24.4	5955	23.0	44,795	21.7	27,108	30.0	1,738,262	24.6
18 to 24	20,553	7.8	1691	6.6	1678	6.5	26,640	12.9	6626	7.3	679,398	9.6
25 to 44	86,166	32.9	7656	29.9	7184	27.8	65,517	31.7	29,062	32.2	2,237,655	31.6
45 to 64	58,278	22.2	6710	26.2	6620	25.6	41,961	20.3	20,073	22.2	1,630,867	23.0
65 and over	32,601	12.4	3315	12.9	4444	17.2	27,686	13.4	7526	8.3	792,333	11.2
Totals	262,300	100.0	25,627	100.0	25,881	100.0	206,599	100.0	90,395	100.0	7,078,515	100.0

Source: USCB (2001).

- **Transient Population**

The area within the first 16 km (10 mi) of North Anna is predominately rural and characterized by farmland and wooded tracts. No significant industrial or commercial

facilities are in the area, and none are anticipated. As a result, transient employment is most likely to be out of, rather than into, the area.

Lake Anna and its recreational use is the greatest contributor to a transient population. Lake Anna is the cooling water source for the North Anna facility. Numerous recreational sites are located around the reservoir, consisting of boat ramps, wet slips, camping sites, picnic areas, etc. A central data collection site for recreational use of the lake does not exist. VEPCo developed an estimate of lake use on a peak weekend day in mid-summer based on representative usage of recreational facilities, e.g., boating, picnicking, and camping (VEPCo 2000c). Data for the estimate were provided by the Virginia State Department of Conservation and Recreation for the recreational facilities on Lake Anna. The estimate does not include use of the lake by local residents with their own private boat docks. Table 2-12 shows the estimated transient population in the vicinity of the lake.[(a)]

The resulting estimated total peak daily transient population on Lake Anna is 5900 for boating and other uses of the lake and 3000 for Lake Anna State Park. The use of the WHTF is limited to residents around the WHTF and their guests, thus, its peak use is less than 1000. Given the conservative assumptions and the potential for double-counting, these numbers may be high (VEPCo 2000c).

Table 2-12. Estimated Transient Population Recreating at Lake Anna Facilities

Facility	Daily Peak Transient Population	Annual Usage	Comments/Assumptions
Lake Anna	5900	530,000	Annual use based on 180 days @ 2950/average day.
Waste Heat Treatment Facility	<1000	90,000	Peak daily based on doubling the resident population in cooling lagoon sectors (one guest per resident). Annual use based on 180 days @ 500/average day.
Lake Anna State Park	3000	93,000	Peak daily use during summer. Annual use was 93,000 in 1991. Use in 1993 was 87,000. Park closes in winter. Usage includes occupants of boats launched at the park.

Source: VEPCo (2000c).

(a) The UFSAR VEPCo (2000c) discusses the methodology and assumptions for deriving the numbers shown in Table 2-12.

The annual transient population is less certain because of the dramatic drop in boating on weekdays and outside the summer months. Based on the Lake Anna State Park data, assuming 180 days of operation, the average daily attendance is less than one fifth of the peak daily attendance. Assuming that the average attendance, excluding the park, is one-half the peak daily figure, the total annual attendance in the vicinity of Lake Anna would be about 710,000, based on a 180-day use period.

- **Migrant Labor**

Migrant workers are typically members of minority or low-income populations. Because migrant workers travel and can temporarily spend a significant amount of time in an area without being an actual resident, they may be unavailable for census takers to count. If this occurs, migrant workers would be under-represented in USCB minority and low-income population counts.

In 1997, Louisa County had 385 individual farms. The main crops grown within Louisa County are legumes, grass hay, corn for grain, soybeans, corn for silage, and wheat. Beef cattle production is also important, with 71 percent of the farms holding cattle and calf inventories and 71 percent of the farms selling cattle and livestock (Louisa County 2001). Migrant workers do not harvest agricultural crops in Louisa County; however, they do re-plant forest land that has been harvested.[(a)]

Over the past 5 years, most completely harvested forest land in Louisa County has been reforested (replanted) or allowed to regenerate naturally. From July 1998 through June 2000, approximately 1465 ha (3560 ac) of forest land were thinned or cleared. In 1999, 877 ha (2130 ac) were reforested (Louisa County 2001). Planting takes place from late January through March and is often done under Virginia Department of Forestry contract, even on private lands. Migrant laborers often plant the trees. Data on the number of migrant workers participating in the planting are not available, but the number is considered to be small. Given the expected small number of migrant workers, and the fact that if they were concentrated in a single location they would not be there for long, the staff concludes that migrant workers would not materially change the population characteristics of any particular census tract within Louisa County.

(a) Personal communication with Don Gallihugh, Louisa County Farm Service Agency, October 18, 2001.

2.2.8.6 Economy

The communities potentially impacted socioeconomically by North Anna's license renewal activities are Henrico, Louisa, Orange, and Spotsylvania Counties, all in central Virginia. Louisa County, where North Anna Power Station, Units 1 and 2, are located, would see the greatest impact. All these counties have experienced steady growth in population and economic activity during the last decade. The economy of each of the counties is briefly discussed in the following.

Some comparative economic statistics for the four counties and Virginia are presented in Tables 2-13 and 2-14. Table 2-13 presents information on the unemployment rate (for October 2001), the percent of individuals below the poverty line for 1997, and median household income (estimated for 1997). On a comparative basis, Henrico and Spotsylvania Counties were relatively better off than the other counties and the Commonwealth.

Henrico County is part of the Richmond-Petersburg metropolitan statistical area, which is home to approximately 950,000 people. The Richmond-Petersburg area is the primary economic driving force within an 80-km (50-mi) radius of North Anna. The Richmond metropolitan statistical area is located approximately 161 km (100 mi) from Washington, D.C. and has a transportation network of trucking and railroad terminals and interstate highway access to main east-west and north-south routes. It also has an international airport and the western-most inland port in the Commonwealth of Virginia with direct access to the Atlantic Ocean, giving it access to both domestic and international markets (City of Richmond 2001). The Richmond

Table 2-13. Percent Unemployment, Individual Poverty, and Median Household Income

	Unemployment (% October 2001)	Poverty (% Estimated 1997)	Median Household Income (1997 $)
Henrico County	3.5	7.9	44,122
Louisa County	3.6	12.6	34,609
Orange County	3.1	10.6	39,156
City of Richmond	5.3	23.0[a]	N/A[b]
Spotsylvania County	1.6	6.8	51,218
Virginia	3.5	11.6	40,209

Sources: Virginia Employment Commission (2001b); USCB (1997, 2000b).
(a) Estimated for 1995.
(b) Not available.

Table 2-14. Major Employers in Louisa County, Virginia

Employer	Product	Number of Employees
VEPCo	Electric	900+
Kloeckner–Pentaplast	Rigid PVC	630
Klearfold, Inc.	Plastic packing	176
Louisa County	Government Services	250[(a)]
Louisa County Public Schools	Education	680
Tri-Dim	Filters	100

Sources: Louisa County Economic Development, and personal communication, Louisa County Government and public schools.
(a) Inclusive of full- and part-time employees (VEPCo 2001b).

area is headquarters for more than 35 major corporations including nine Fortune 500 companies, 16 Fortune 1000 headquarters, and three Forbes 500 largest private companies (Henrico County 2001a). Service is the largest employment sector, followed by retail and wholesale trade and government. Capital One Financial Corporation is the largest private employer in the area (Times Dispatch 2001). The unemployment rate in Henrico County was 3.5 percent in October 2001 (Virginia Employment Commission 2001b).

Louisa County is located in the triangle between Richmond, Fredericksburg, and Charlottesville. Interstate 64 runs east-west through the County, as does a CSX rail line. Because North Anna is located in Louisa County, it has benefitted more economically than have the other counties. Table 2-14 shows the top five employers in Louisa County.

Until the 1990s, Louisa County had been rural and dominated by farming and forestry, which are still economically important. In the 1990s, the County's population grew by 26 percent, without a comparable increase in industrial and commercial development (Louisa County 2001). The number of jobs in the county decreased from 5600 in 1990 to 5000 in 1996, a decrease of 11 percent. The reason for the decline was the closing of two clothing manufacturers located in the county (Louisa County 2001).

Since 1996, employment has been increasing but is not back to the 1990 level. By the first quarter of 1999, the number of jobs in Louisa County had increased to 5400, still 200 fewer than the 1990 high. One positive aspect of the county's economic development is the arrival of a Walmart Regional Distribution Center in Zion Crossroads in the western part of the county that will employ approximately 750 people.

More than half of Louisa County's 11,650 resident workers commute to jobs outside the county (Louisa County 2001, VEPCo 2001b). In many respects, Louisa County is a bedroom community for the larger metropolitan regions, particularly Richmond and, to a lesser extent, Fredericksburg and Charlottesville.

The construction of North Anna in Louisa County has kept the County's property tax assessment rates significantly below those of neighboring counties. It also enabled the county to begin an economic development program in the 1970s with the construction of its industrial park.[(a)] While recognizing that North Anna has been economically beneficial to it, Louisa County would like to become less dependent on North Anna through diversification of the local economy. Walmart is being looked upon to train and provide employment for labor at the lower end of the pay scale.[(b)] The County would like to diversify its economy by attracting technology and bio-research firms.[(c)]

Orange County's economy is led by agribusiness, manufacturing, and commercial retail services. Orange and Gordonsville are the only two incorporated towns in the County. A planned, gated residential community exists at Lake of the Woods (Orange County 2000).

Orange County's labor force was approximately 11,375 in 2000, with 45 percent of working adults commuting out of the County to work. The existing employment base in Orange County consists of approximately 7108 jobs generated by over 535 businesses and industries. The largest employer (600 people) is a textile plant (Liberty Fabrics). The second largest employer (300 people) is American Woodmark Corporation, a maker of cabinet components (Orange County 2001).

Spotsylvania County is located halfway between Washington, D.C., and Richmond, Virginia. Economically, it is more associated with the Washington, D.C., metropolitan area through the commuting patterns of its residents (Spotsylvania County 2000). It is estimated that 40 to 60 percent of the County's approximately 46,000 workers commute to jobs outside the County (Spotsylvania County Office of Economic Development 2001).

Historically, agriculture and forestry have been important components of the Spotsylvania County economy. The relative economic importance of agricultural and forest activities has declined as the commercial and industrial base of the County has grown. The fastest growing commercial and industrial sectors from 1990 to 2000, by employment, were retail trade

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(a) Interview with Mr. G. B. Duke, Duke Oil, Mineral, Virginia October 17, 2001.
(b) Defined as being substantially better than minimum wage (currently $5.50 per hour), but generally less than $10 per hour.
(c) Interview with Mr. Lee Lintecum, Louisa County Administrator, October 19, 2001.

(129 percent); state, local, and Federal government (approximately 129 percent); transportation, communications, and public utilities (136 percent); and manufacturing of nondurable goods (101 percent) (Spotsylvania County Office of Planning 2001).

VEPCo pays annual property taxes to Louisa, Orange, and Spotsylvania Counties for North Anna. Table 2-15 presents information on the property taxes North Anna pays to each County, the percent of total property taxes paid, and each County's total budget. The preponderance of taxes are paid to Louisa County, where North Anna is located. For the period 1995 to 2000, North Anna's property taxes averaged about 46 percent of Louisa County's,[(a)] 1.5 percent of Orange County's, and 1.5 percent of Spotsylvania County's total property tax revenues. VEPCo's annual property tax payments to Louisa County for the 6-year period averaged approximately 22.5 percent of the county's total annual budget. VEPCo projects that North Anna's annual property tax payments will continue to increase slightly (absolute amount) through the license renewal period (VEPCo 2001b). However, the percent such payments represent of the total county taxes paid will probably continue to decline. The potential effects of electric utility deregulation in Virginia are not yet fully known. Any changes to North Anna tax rates due to deregulation, however, would not be affected by license renewal.

The significance of this discussion on the economy is that the four-county area around North Anna is in a state of change. Henrico and Spotsylvania counties are doing the best economically. Spotsylvania County, for at least the last two decades, has been influenced economically by the Washington, D.C. and northern Virginia economies, with many white-collar professionals choosing to live in Spotsylvania (for the suburban-country lifestyle) and commute to jobs in Washington, D.C. and northern Virginia. Also, over the last two decades the Richmond area has become economically diversified and has grown significantly. Some of this growth has impacted Spotsylvania County, to the north, and Henrico County, which abuts Richmond.

Orange and Louisa Counties have also benefitted from the growth in neighboring Henrico and Spotsylvania Counties. In addition, both Louisa and Spotsylvania Counties have been impacted by Lake Anna. Orange County has been impacted to a lesser extent since it has fewer miles of shoreline on Lake Anna. Development around Lake Anna has been oriented toward upscale second and retirement homes. Land values around the lake have increased significantly. Starter homes are being built on Louisa County's eastern edge, closer to Richmond. Moderate income homes and developments are scattered across Louisa County, and upscale neighborhoods are being built in the western end of the county closest to Charlottesville and around Lake Anna.

(a) 1995 property tax data were not available for Louisa County. The 46 percent reflects the average of taxes paid for 1996-2000. The other county averages are based on 1995-2000 data.

Table 2-15. Property Tax Revenues Generated in Louisa, Orange, and Spotsylvania Counties; Property Taxes North Anna Paid to Louisa, Orange, and Spotsylvania Counties; and Louisa, Orange, and Spotsylvania Counties Operating Budgets 1995 – 2000

Year	Total Property Tax Revenues	Property Tax Paid to County for North Anna	Percent of Total Property Taxes	Total County Budget
		Louisa		
1995	N/A	10,683,585	N/A	61,218,248[a]
1996[b]	22,761,970	11,115,929	49	54,532,295
1997	24,082,838	11,361,154	47	41,908,510
1998	24,116,482	11,006,924	46	45,122,433
1999	25,118,670	11,145,065	44	44,965,205
2000	25,209,205	10,583,390	42	45,069,880
		Orange		
1995	7,811,992	119,713	1.5	32,212,892
1996	8,047,224	128,328	1.6	34,214,668
1997	8,662,086	125,590	1.4	35,679,113
1998	9,354,981	149,679	1.6	38,328,996
1999[c]	10,540,257	132,419	1.3	41,743,551
2000	11,163,897	133,099	1.2	44,931,523
		Spotsylvania		
1995[d]	30,676,005	466,998	1.5	123,703,715
1996	32,894,971	491,668	1.5	131,403,347
1997	35,742,696	519,070	1.5	152,712,966
1998	38,531,812	558,833	1.5	184,888,334
1999	43,606,652	628,429	1.4	189,744,780
2000	49,147,669	674,457	1.4	195,986,091

(a) The total County budget is higher during 1995 and 1996 because of school construction.
(b) 1996 through 2000 values provided by Marty McCloud, Director of Finance, Louisa County, Virginia (November 18, 2001).
(c) 1999 and 2000 values provided by Phyllis Yancey, Treasurer's Office, Orange County, Virginia (November 2, 2001).
(d) 1995 to 2000 total budget and property taxes collected from North Anna provided by Mary Sorrell, Budget Manager, Spotsylvania County, Virginia (November 6, 2001).
N/A = not available.

VEPCo has a significant impact on the economic well-being of Louisa County, paying 46 percent of the property taxes between 1996 and 2000. Louisa County schools have benefitted substantially from the taxes VEPCo pays for North Anna by being able to upgrade their infrastructure. If the County were to lose the North Anna tax base, the impacts would be substantial, and it might take from 5 to 10 years for the County to recover from such a loss.[(a)] However, over time the contribution of total North Anna property taxes payable to Louisa County will decline, assuming the current rate of economic growth in the County continues. Thus, while the economic importance of North Anna is expected to decline, it may decline even faster if Louisa County experiences substantial economic growth as have Spotsylvania and Henrico Counties during the 1990s.

2.2.9 Historic and Archaeological Resources

This section discusses the cultural background and the known and potential historic and archaeological resources at the North Anna site and the immediate surrounding area.

2.2.9.1 Cultural Background

The area around the North Anna site is rich in prehistoric and historic Native American and historic Euro-American resources. Recent documents provide adequate background detail for the cultural chronology and prehistoric and historic period contexts of the area. Consequently, only a brief summary is provided here. For the nuclear plant itself, Ahlman and Mullin (2001) discuss the prehistoric and historic contexts of the site. Another overview document (Goode and Dutton 1999) discusses the cultural background at the nearby North Anna State Park, located upriver and north of the plant. Historic period overviews are available for both Louisa County (Thomas Jefferson Planning District 1995), where the plant is located, and Spotsylvania County (Traceries 1996), situated just across the North Anna River to the northeast of the plant. Cooke (1997) also provides an historical overview of Louisa County. The following cultural chronology summaries are based on these sources.

Prehistoric Period

The prehistoric Native American occupation of the region around the North Anna site includes three general periods: the Paleo-Indian period (about 10,000 to 8000 B.C.), the Archaic period (about 8000 to 1000 B.C.), and the Woodland period (about 1000 B.C. to 1600 A.D.). Toward the end of the Woodland period, from 1500 to 1675 A.D., a transitional episode known as the

(a) Interview with Melvin Carter, Director of Planning and Community Development, Louisa County, October 16, 2001.

Protohistoric period occurred in which initial contacts were made with Europeans, and cultural changes associated with subsequent white settlement of the area took place.

The prehistoric periods were marked by initial reliance on big game hunting for subsistence, followed by increased use of smaller game animals and plant foods in the Archaic era. Major environmental changes in the Archaic period led to an increasingly more sedentary lifestyle primarily in riverine settings. Late in the Archaic era, more sedentary villages and an increasing reliance on cultivated crops became the norm. The subsequent Woodland period was characterized by larger base camps in the river valleys, with subsistence based on agriculture, hunting and gathering, and intergroup trade. The latter part of the Woodland period is primarily identified by the introduction of European trade goods.

Historic Period, Native American

At the time of European contact and subsequent intrusion into the area surrounding North Anna, the lands, including the piedmont and mountains of western Virginia, were occupied by several Siouan-speaking Indian groups. One of the Monacan Indian groups, part of the larger Monacan Confederacy, is commonly associated with the area of present-day Louisa County. Between 1607 and 1720, the Monacan were gradually displaced from their homelands through a series of encounters with the encroaching Europeans, and by the 1677 “Treaty Between Virginia and the Indians.” By 1700, the Monacan had left Louisa County (Cooke 1993). Although some of the Monacan left the area permanently, going as far away as Pennsylvania and Canada, a remnant group moved to the Bear Mountain area of Amherst County, Virginia around 1720. Today, the Virginia Monacan Tribe numbers about 900 individuals. In 1989, the Monacan Tribe was recognized by the Virginia General Assembly as one of the eight indigenous tribes in the state and became a member of the Virginia Council on Indians (Monacan Indian Nation Website).

Historic Period, Euro-American

Similar to the prehistoric period, the historic period in Virginia can be subdivided into sequential time periods that describe associated events. These include: European Settlement to Society Period (1607 – 1750), Colony to Nation Period (1750 – 1789), Early National Period (1789 – 1830), Antebellum Period (1830 – 1860), Civil War Period (1861 – 1865), Reconstruction and Growth Period (1865 – 1917), World War I to World War II Period (1939-1945), and The New Dominion Period (1945 – present).

European settlement of the area around the North Anna site began shortly after 1700, and Louisa County was formed in 1742. The earliest non-native economy of the area was based on growing tobacco in the fertile lands along the North and South Anna River valleys. In the early 1800s, production of tobacco resulted in severe soil exhaustion, and wheat and corn replaced it

as staple crops. Although the area remained largely rural and agricultural, mining and quarrying were important to the economy of Louisa County at various times in the 1800s. Iron, copper, sulfur, gold and other ores were mined, and whetstone materials were quarried. The area just upriver from North Anna was the scene of intensive gold mining from about 1830 to 1900.

2.2.9.2 Historic and Archaeological Resources at North Anna

To assess known and potential cultural resource sites at North Anna, several existing literature and database sources were consulted, and several organizations were contacted (Appendix D). Particularly useful in this regard was the recent cultural resource assessment for the plant site, commissioned by VEPCo (Ahlman and Mullin 2001).

Examination of archaeological and historical site files at the Virginia Department of Historic Resources Archives indicated that no recorded cultural resource sites are known to exist at North Anna Power Station. Similarly, review of historical documentation at the Louisa County Historical Museum, including historic maps dating between 1751 and 1863, indicates few historic resources in the vicinity of North Anna other than an early road paralleling the south side of the North Anna River that appears to be near the western boundary of the North Anna Power Station. An unpublished map based on county deeds from 1765 to 1815 shows the presence of the "Jerdones Mill" on the North Anna riverbank, just upriver from the North Anna Power Station, along with the associated "Jerdones Mill Road." The same map shows an "Old Mine Road" within the North Anna site area (Truce n.d.).

Background research undertaken by Ahlman and Mullin (2001) indicates that undisturbed lands within the North Anna boundary have the potential to contain both unrecorded prehistoric and historic archaeological properties. As a follow-up to the assessment, five known historic-period cemeteries were recorded, three of which lie within the administrative boundary of North Anna Power Station and two that are located just downriver from the North Anna Dam. Two of these cemeteries have associated archaeological remains of former structures.

Reconnaissance-level archaeological and historical investigations were also completed in 1969 and 1970 for both the North Anna site area and lake bed area, with few results (AEC 1973). A few Archaic-period artifacts were noted in the area, but the investigator did not deem them worthy of recording and evaluating. In addition, according to records in the Louisa County Historical Society files, a total of 33 historic-period cemeteries were identified in the area along the river that was to be inundated. Many of these were avoided by adjusting project boundaries, although some were removed prior to inundation. This total apparently includes at least four of the cemeteries recorded recently at North Anna Power Station. Finally, cultural resource surveys along transmission lines associated with the North Anna site have largely resulted in no significant findings for cultural resources (e.g., Saunders 1976; MacCord 1981).

2.2.10 Related Federal Project Activities and Consultations

The staff reviewed the possibility that activities of other Federal agencies might impact the renewal of the operating license for North Anna. Any such activities could result in cumulative environmental impacts and the possible need for the Federal agency to become a cooperating agency for preparation of this SEIS [10 CFR 51.10 (b)(2)].

The North Anna Hydroelectric Project (Project No. 6335-001), a small, two-unit hydroelectric power plant of 855-kW capacity located in Louisa County, Virginia, is situated at the base of North Anna Dam, where Lake Anna discharges into the North Anna River. It is owned and operated by VEPCo. An Exemption From Licensing for the hydroelectric plant was filed with the Federal Energy Regulatory Commission in March 1984; an order granting the exemption was issued in September 1984.

The staff determined there were no Federal project activities in the vicinity of North Anna that could result in cumulative impacts or would make it desirable for another Federal agency to become a cooperating agency for preparing this SEIS.

NRC is required under Section 102 of the National Environmental Policy Act of 1969 (NEPA) to consult with and obtain the comments of any Federal agency that has jurisdiction by law or special expertise with respect to any environmental impact involved. NRC is consulting with FWS. Consultation correspondence is included in Appendix E.

2.3 References

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

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

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

10 CFR Part 54. Code of Federal Regulations, Title 10, *Energy,* Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."

10 CFR Part 61. Code of Federal Regulations, Title 10, *Energy*, Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste."

10 CFR Part 71. Code of Federal Regulations, Title 10, *Energy*, Part 71, "Packaging and Transportation of Radioactive Material."

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

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

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