NUREG-1437
Supplement 6

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 6

Regarding
Surry Power Station, Units 1 and 2

Final Report

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, DC 20555-0001

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NUREG-1437
Supplement 6

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

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Regarding Surry Power Station, Units 1 and 2

Final Report

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Abstract

The U.S. Nuclear Regulatory Commission (NRC) considered the environmental impacts of renewing nuclear power plant operating licenses (OLs) for a 20-year period in its *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2, and codified the results in 10 CFR Part 51. The GEIS (and its Addendum 1) identifies 92 environmental issues and reaches generic conclusions related to environmental impacts for 69 of these issues that apply to all plants or to plants with specific design or site characteristics. Additional plant-specific review is required for the remaining 23 issues. These plant-specific reviews are to be included in a supplement to the GEIS.

This Supplemental Environmental Impact Statement (SEIS) has been prepared in response to an application submitted to the NRC by the Virginia Electric and Power Company (VEPCo) to renew the OLs for Surry Power Station, Units 1 and 2, for an additional 20 years under 10 CFR Part 54. This SEIS includes the NRC staff's analysis that considers and weighs the environmental impacts of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the staff's recommendation regarding the proposed action.

Regarding the 69 issues for which the GEIS reached generic conclusions, neither VEPCo nor the staff has identified information that is both new and significant for any of these issues that apply to Surry Power Station, Units 1 and 2. In addition, the staff determined that information provided during the scoping process did not call into question the conclusions in the GEIS. Therefore, the staff concludes that the impacts of renewing the Surry Power Station OLs will not be greater than impacts identified for these issues in the GEIS. For each of these issues, the GEIS conclusion is that the impact is of SMALL[(a)] significance (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel, which were not assigned single significance levels).

Regarding the remaining 23 issues, those that apply to Surry Power Station, Units 1 and 2, are addressed in this SEIS. For each applicable issue, the staff concludes that the significance of the potential environmental impacts of renewal of the OLs is SMALL. The staff also concludes that additional mitigation measures are not likely to be sufficiently beneficial as to be warranted. The staff determined that information provided during the scoping process did not identify any new issue that has a significant environmental impact.

The NRC staff's recommendation is that the Commission determine that the adverse environmental impacts of license renewal for Surry Power Station, Units 1 and 2, are not so

(a) Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS; (2) the Environmental Report submitted by VEPCo; (3) consultation with Federal, State, and local agencies; (4) the staff's own independent review; and (5) the staff's consideration of public comments.

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Executive Summary

By letter dated May 29, 2001, the Virginia Electric and Power Company (VEPCo) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating licenses (OLs) for Surry Power Station, Units 1 and 2, for an additional 20-year period. If the OLs are renewed, State regulatory agencies and VEPCo will ultimately decide whether the plants will continue to operate based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners. If the OLs are not renewed, then the plants must be shut down at or before the expiration dates of the current OLs, which are May 25, 2012, for Unit 1 and January 29, 2013, for Unit 2.

Section 102 of the National Environmental Policy Act (NEPA) (42 USC 4321), directs that an environmental impact statement (EIS) is required for major Federal actions that significantly affect the quality of the human environment. The NRC has implemented Section 102 of NEPA in 10 CFR Part 51. Part 51 identifies licensing and regulatory actions that require an EIS. In 10 CFR 51.20(b)(2), the Commission requires preparation of an EIS or a supplement to an EIS for renewal of a reactor OL; 10 CFR 51.95(c) states that the EIS prepared at the OL renewal stage will be a supplement to the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2.[a]

Upon acceptance of the VEPCo application, the NRC began the environmental review process described in 10 CFR Part 51 by publishing a notice of intent to prepare an EIS and conduct scoping. The staff visited the Surry Power Station in September 2001 and held public scoping meetings on September 19, 2001, in Surry, Virginia. In preparing this Supplemental Environmental Impact Statement (SEIS) for Surry Power Station, Units 1 and 2, the staff reviewed the VEPCo Environmental Report (ER) and compared it to the GEIS; consulted with other agencies; conducted an independent review of the issues following the guidance set forth in NUREG-1555, Supplement 1, the *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal*; and considered the public comments received during the scoping process. The public comments received during the scoping process that were considered to be within the scope of the environmental review are provided in Appendix A, Part I, of this SEIS.

The staff prepared the draft SEIS and on April 26, 2002, the U.S. Environmental Protection Agency published an associated Notice of Availability in the *Federal Register* (FR; 67 FR 20763). A 75-day comment period began on that date during which members of the public could comment on the preliminary results of the NRC staff's review.

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

The staff held two public meetings in Surry, Virginia, on May 29, 2002, to describe the preliminary results of the NRC environmental review, answer questions, and provide members of the public with information to assist them in formulating comments on the draft SEIS. All of the comments received on the draft SEIS were considered by the staff in developing the final document and are presented in Appendix A, Part II of this SEIS.

This SEIS includes the NRC staff's analysis in which the staff considers and weighs the environmental effects of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures for reducing or avoiding adverse effects. It also includes the staff's recommendation regarding the proposed action.

The Commission has adopted the following statement of purpose and need for license renewal from the GEIS:

> The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decisionmakers.

The goal of the staff's environmental review, as defined in 10 CFR 51.95(c)(4) and the GEIS, is to determine

> ...whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

Both the statement of purpose and need and the evaluation criterion implicitly acknowledge that there are factors, in addition to license renewal, that will ultimately determine whether an existing nuclear power plant continues to operate beyond the period of the current OL.

NRC regulations [10 CFR 51.95(c)(2)] contain the following statement regarding the content of SEISs prepared at the license renewal stage:

> The supplemental environmental impact statement for license renewal is not required to include discussion of need for power or the economic costs and economic benefits of the proposed action or of alternatives to the proposed action except insofar as such benefits and costs are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation. In addition, the supplemental environmental impact statement prepared at the license renewal stage need not discuss other issues not related to the environmental effects of the proposed

action and the alternatives, or any aspect of the storage of spent fuel for the facility within the scope of the generic determination in § 51.23(a) ["Temporary storage of spent fuel after cessation of reactor operation–generic determination of no significant environmental impact"] and in accordance with § 51.23(b).

The GEIS contains the results of a systematic evaluation of the consequences of renewing an OL and operating a nuclear power plant for an additional 20 years. It evaluates 92 environmental issues using the NRC's three-level standard of significance—SMALL, MODERATE, or LARGE—developed using the Council on Environmental Quality guidelines. The following definitions of the three significance levels are set forth in a footnote to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B:

SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

MODERATE – Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

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

For 69 of the 92 issues considered in the GEIS, the analysis in the GEIS led to the following conclusions:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

These 69 issues were identified in the GEIS as Category 1 issues. In the absence of new and significant information, the staff relied on conclusions as amplified by supporting information in the GEIS for issues designated as Category 1 in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B.

Of the 23 issues that do not meet the criteria set forth above, 21 are classified as Category 2 issues requiring analysis in a plant-specific supplement to the GEIS. The remaining two issues, environmental justice and chronic effects of electromagnetic fields, were not categorized.

Environmental justice was not evaluated on a generic basis and must be addressed in a plant-specific supplement to the GEIS. Information on the chronic effects of electromagnetic fields was not conclusive at the time the GEIS was prepared.

This SEIS documents the staff's evaluation of all 92 environmental issues considered in the GEIS. The staff considered the environmental impacts associated with alternatives to license renewal and compared the environmental impacts of license renewal and the alternatives. The alternatives to license renewal that were considered include the no-action alternative (not renewing the OLs for Surry Power Station, Units 1 and 2) and alternative methods of power generation. Based on projections made by the U.S. Department of Energy's (DOE's) Energy Information Administration (EIA), gas- and coal-fired generation appear to be the most likely power-generation alternatives if the power from Units 1 and 2 is replaced. These alternatives are evaluated assuming that the replacement power generation plant is located at either the Surry Power Station or some other unspecified alternate location.

VEPCo and the staff have established independent processes for identifying and evaluating the significance of any new information on the environmental impacts of license renewal. Neither VEPCo nor the staff has identified information that is both new and significant related to Category 1 issues that would call into question the conclusions in the GEIS. Similarly, neither VEPCo nor the staff has identified any new issue applicable to Surry Power Station, Units 1 and 2, that has a significant environmental impact. These determinations include the consideration of public comments. Therefore, the staff relies upon the conclusions of the GEIS for all of the Category 1 issues that are applicable to Surry Power Station, Units 1 and 2.

VEPCo's license renewal application presents an analysis of the Category 2 issues that are applicable to Surry Power Station, Units 1 and 2. The staff has reviewed the VEPCo analysis for each issue and has conducted an independent review of each issue. In addition, the staff has evaluated the two uncategorized issues, environmental justice and chronic effects from electromagnetic fields. Five Category 2 issues are not applicable because they are related to plant design features or site characteristics not found at Surry Power Station. Four Category 2 issues are not discussed in this SEIS because they are specifically related to refurbishment. VEPCo has stated that its evaluation of structures and components, as required by 10 CFR 54.21, did not identify any major plant refurbishment activities or modifications as necessary to support the continued operation of Surry Power Station, Units 1 and 2, for the license renewal period. In addition, any replacement of components or additional inspection activities are within the bounds of normal plant component replacement, and therefore, are not expected to affect the environment outside of the bounds of the plant operations evaluated in

the *Final Environmental Statement Related to Operation of Surry Power Station Unit 1* and *Final Environmental Statement Related to Operation of Surry Power Station Unit 2,* issued by the U.S. Atomic Energy Commission in 1972.

Twelve Category 2 issues related to operational impacts and postulated accidents during the renewal term, as well as environmental justice and chronic effects of electromagnetic fields, are discussed in detail in this SEIS. Five of the Category 2 issues and environmental justice apply to both refurbishment and to operation during the renewal term and are only discussed in this SEIS in relation to operation during the renewal term. For all 12 Category 2 issues and environmental justice, the staff concludes that the potential environmental effects are of SMALL significance in the context of the standards set forth in the GEIS. In addition, the staff determined that appropriate Federal health agencies have not reached a consensus on the existence of chronic adverse effects from electromagnetic fields. Therefore, no further evaluation of this issue is required. For severe accident mitigation alternatives (SAMAs), the staff concludes that a reasonable, comprehensive effort was made to identify and evaluate SAMAs. Based on its review of the SAMAs for Surry Power Station, Units 1 and 2, and the plant improvements already made, the staff concludes that none of the candidate SAMAs are cost-beneficial.

Mitigation measures were considered for each Category 2 issue. Current measures to mitigate the environmental impacts of plant operation were found to be adequate, and no additional mitigation measures were deemed sufficiently beneficial to be warranted.

If the Surry Power Station OLs are not renewed and the units cease operation on or before the expiration of their current OLs, then the adverse impacts of likely alternatives will not be smaller than those associated with continued operation of Surry Power Station, Units 1 and 2. The impacts may, in fact, be greater in some areas.

The recommendation of the NRC staff is that the Commission determine that the adverse environmental impacts of license renewal for Surry Power Station, Units 1 and 2 are not so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS; (2) the ER submitted by VEPCo; (3) consultation with other Federal, State, and local agencies; (4) the staff's own independent review; and (5) the staff's consideration of public comments.

Abbreviations/Acronyms

μCi	microcurie(s)
ac	acre(s)
ACC	averted cleanup and decontamination costs
A.D.	Anno Domini
ADAMS	Agencywide Document Access and Management System
AEA	Atomic Energy Act of 1954, 42 USC 2011, et seq.
AEC	U.S. Atomic Energy Commission
AFW	auxiliary feedwater
AOC	averted offsite property damage costs
AOE	averted occupational exposure costs
AOSC	averted onsite costs
APE	averted public exposure costs
ATWS	anticipated transients without scram
B.C.	before Christ
BIA	U.S. Bureau of Indian Affairs
Bq	becquerel(s)
Btu	British thermal unit(s)
°C	degrees Celsius
CAA	Clean Air Act of 1970, as amended, 42 USC 7401, et seq.
CCW	component cooling water
CDF	core damage frequency
CEQ	Council on Environmental Quality
CET	containment event tree
CFR	Code of Federal Regulations
Ci	curie(s)
cm	centimeter(s)
COE	cost of enhancement
COV	Code of Virginia
CWA	Clean Water Act of 1977 (also known as Federal Water Pollution Control Act), 33 USC 1251, et seq.
CZMA	Coastal Zone Management Act, 16 USC 1451, et seq.
d	day
DBAs	design-basis accidents
DoD	Department of Defense
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation

DSM	demand-side management
EIA	Energy Information Administration
EIS	environmental impact statement
ELF-EMF	extremely low frequency electromagnetic field
EPA	U.S. Environmental Protection Agency
ER	Environmental Report
ESA	Endangered Species Act, 16 USC 1531, et seq.
ESGR	emergency switchgear room
ESRP	*Environmental Standard Review Plan*, NUREG-1555, Supplement 1, *Operating License Renewal*
°F	degrees Fahrenheit
FES	final environmental statement
FR	Federal Register
ft	foot/feet
FWPCA	Federal Water Pollution Control Act (also known as the Clean Water Act of 1977)
FWS	U.S. Fish and Wildlife Service
gal	gallon
GEIS	*Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437
gpd	gallon(s) per day
gpm	gallon(s) per minute
GMP	General Maintenance Procedures
ha	hectare(s)
HEPA	high-efficiency particulate air (filter)
HIT	Hog Island Tract
HIWMA	Hog Island Wildlife Management Area
HLW	high-level waste
hr	hour(s)
HVAC	heating, ventilating, and air conditioning
Hz	hertz
in.	inch(es)
INEEL	Idaho National Engineering and Environmental Laboratory
IPA	integrated plant assessment
IPE	individual plant examination
IPEEE	individual plant examination for external events

ISFSI	independent spent fuel storage installation
ISLOCA	interfacing system loss-of-coolant accidents
J	joule
JCSA	James City Service Authority
km	kilometer(s)
kPa	kilopascal
kV	kilovolt(s)
kWh	kilowatt hour(s)
L	liter(s)
lb	pound
LERF	large early release frequency
LNG	liquefied natural gas
LOCAs	loss-of-coolant accidents
LOOP	loss of offsite power
Lpd	liter(s) per day
LWR	light-water reactor
m	meter(s)
mA	milliampere(s)
MACCS2	MELCOR Accident Consequence Code System 2
mi	mile(s)
min	minute(s)
mg	milligram(s)
MG	motor-generator
mGy	milligray(s)
MJ	mega-Joules
mL	milliliter(s)
mph	mile(s) per hour
mrad	millirad(s)
mrem	millirem(s)
mSv	millisievert(s)
MT	metric ton(s) (or tonne[s])
MTHM	metric tons (or tonnes) heavy metal
MW	megawatt(s)
MWd/MTU	megawatt-days per metric ton (or tonne) of uranium
MW(e)	megawatt(s) electric
MW(t)	megawatt(s) thermal
MWh	megawatt hour(s)

NA	not applicable
NAS	National Academy of Sciences
NEPA	National Environmental Policy Act of 1969, 42 USC 4321, et seq.
NESC	National Electrical Safety Code
ng	nanogram(s)
NHPA	National Historic Preservation Act of 1966, 16 USC 470, et seq.
NIEHS	National Institute of Environmental Health Sciences
NMFS	National Marine Fisheries Service
NO_x	nitrogen oxide(s)
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NREL	National Renewable Energy Laboratory
ODCM	*Offsite Dose Calculation Manual Guidance*, NUREG-1301
OL	operating license
PARS	publicly available records
pCi	picocuries
PM_{10}	particulate matter with aerodynamic diameter less than or equal to 10 micrometers
ppt	parts per thousand
PRA	probabilistic risk assessment
PSD	prevention of significant deterioration
psig	pounds per square inch, gauge
PWR	pressurized water reactor
RAI	request for additional information
RCP	reactor coolant pump
RCRA	Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq.
rem	special unit of dose equivalent, equal to 0.01 Sv
REMP	radiological environmental monitoring program
rms	root mean square
RPC	averted power replacement costs
RRW	risk reduction worth
s	second(s)
SAMA	severe accident mitigation alternative
SAR	Safety Analysis Report
SBO	station blackout
SCR	selective catalytic reduction
SEIS	Supplemental Environmental Impact Statement

SER	Safety Evaluation Report
SGTR	steam generator tube rupture
SHPO	State Historic Preservation Officer
SMITTR	surveillance, monitoring, inspections, testing, trending, and recordkeeping
SO_2	sulfur dioxide
SO_x	sulfur oxide(s)
STC	source-term category
Sv	sievert
SW	service water
TBq	terabecquerel
TDAFW	turbine-driven auxiliary feedwater (pump)
UFSAR	Updated Final Safety Analysis Report
USC	United States Code
USCB	U.S. Census Bureau
USCOE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
V	volt(s)
VAC	Virginia Administrative Code
VDCR	Virginia Department of Conservation and Recreation
VDEQ	Virginia Department of Environmental Quality
VDGIF	Virginia Department of Game and Inland Fisheries
VDH	Virginia Department of Health
VDHR	Virginia Department of Historic Resources
VDOT	Virginia Department of Transportation
VEC	Virginia Employment Commission
VEPCo	Virginia Electric and Power Company
VIMS	Virginia Institute of Marine Sciences
VMRC	Virginia Marine Resources Commission
yr	year(s)

1.0 Introduction

Under the Nuclear Regulatory Commission's (NRC's) environmental protection regulations in Title 10 of the Code of Federal Regulations (CFR) Part 51, which implement the National Environmental Policy Act (NEPA), renewal of a nuclear power plant operating license (OL) requires the preparation of an environmental impact statement (EIS). In preparing the EIS, the NRC staff is required first to issue the statement in draft form for public comment, and then issue a final statement after considering public comments on the draft. To support the preparation of the EIS, the staff has prepared a *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).[a] The GEIS is intended to (1) provide an understanding of the types and severity of environmental impacts that may occur as a result of license renewal of nuclear power plants under 10 CFR Part 54, (2) identify and assess the impacts that are expected to be generic to license renewal, and (3) support 10 CFR Part 51 to define the number and scope of issues that need to be addressed by the applicants in plant-by-plant renewal proceedings. The GEIS guides the preparation of complete plant-specific information in support of the OL renewal process.

The Virginia Electric and Power Company (VEPCo) operates Surry Power Station, Units 1 and 2, in southeastern Virginia under OLs DPR-32 and DPR-37, which were issued by the NRC. These OLs will expire on May 25, 2012, for Unit 1 and January 29, 2013, for Unit 2. On May 29, 2001, VEPCo submitted an application to the NRC to renew the Surry Power Station, Units 1 and 2 OLs for an additional 20 years under 10 CFR Part 54. The application also included renewal for North Anna Power Station in Louisa, Virginia. A separate environmental evaluation is being conducted for North Anna Power Station. VEPCo is a *licensee* for the purposes of its current OLs and an *applicant* for the renewal of the OLs. Pursuant to 10 CFR 54.23 and 51.53(c), VEPCo submitted an Environmental Report (ER; VEPCo 2001), in which VEPCo analyzed the environmental impacts associated with the proposed license renewal action, considered alternatives to the proposed action, and evaluated mitigation measures for reducing adverse environmental effects.

This report is the plant-specific supplement to the GEIS (i.e., the supplemental EIS [SEIS]) for the VEPCo license renewal application. This SEIS is a supplement to the GEIS because it relies, in part, on the findings of the GEIS. The staff will also prepare a separate safety evaluation report in accordance with 10 CFR Part 54.

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

1.1 Report Contents

The following sections of this introduction (1) describe the background for the preparation of this SEIS, including the development of the GEIS and the process used by the staff to assess the environmental impacts associated with license renewal, (2) describe the proposed Federal action to renew the Surry Power Station, Units 1 and 2 OLs, (3) discuss the purpose and need for the proposed action, and (4) present the status of VEPCo's compliance with environmental quality standards and requirements that have been imposed by Federal, State, regional, and local agencies that are responsible for environmental protection.

The ensuing chapters of this SEIS closely parallel the contents and organization of the GEIS. Chapter 2 describes the site, power plant, and interactions of the plant with the environment. Chapters 3 and 4, respectively, discuss the potential environmental impacts of plant refurbishment and plant operation during the renewal term. Chapter 5 contains an evaluation of potential environmental impacts of plant accidents and includes consideration of severe accident mitigation alternatives. Chapter 6 discusses the uranium fuel cycle and solid waste management. Chapter 7 discusses decommissioning, and Chapter 8 discusses alternatives to license renewal. Finally, Chapter 9 summarizes the findings of the preceding chapters and draws conclusions about any adverse impacts that cannot be avoided; the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity; and any irreversible or irretrievable commitment of resources. The final chapter also presents the staff's preliminary recommendation with respect to the proposed license renewal action.

Additional information is included in appendixes. Appendix A contains public comments received on the environmental review for license renewal and staff responses. Appendixes B through F, respectively, list the following:

- the preparers of the supplement
- the chronology of correspondence between NRC and VEPCo with regard to this SEIS
- the organizations contacted during the development of this SEIS
- VEPCo's compliance status in Table E-1 (this appendix also contains copies of consultation correspondence prepared and sent during the evaluation process)
- GEIS environmental issues that are not applicable to Surry Power Station, Units 1 and 2.

1.2 Background

Use of the GEIS, which examines the possible environmental impacts that could occur as a result of renewing individual nuclear power plant OLs under 10 CFR Part 54, and the established license renewal evaluation process support the thorough evaluation of the impacts of renewal of OLs.

1.2.1 Generic Environmental Impact Statement

The NRC initiated a generic assessment of the environmental impacts associated with the license renewal term to improve the efficiency of the license renewal process, by documenting the assessment results and codifying the results in the Commission's regulations. This assessment is provided in the GEIS, which serves as the principal reference for all nuclear power plant license renewal EISs.

The GEIS documents the results of the systematic approach that was taken to evaluate the environmental consequences of renewing the licenses of individual nuclear power plants and operating them for an additional 20 years. For each potential environmental issue, the GEIS (1) describes the activity that affects the environment, (2) identifies the population or resource that is affected, (3) assesses the nature and magnitude of the impact on the affected population or resource, (4) characterizes the significance of the effect for both beneficial and adverse effects, (5) determines whether the results of the analysis apply to all plants, and (6) considers whether additional mitigation measures would be warranted for impacts that would have the same significance level for all plants.

The NRC's standard of significance of impacts was established using the Council on Environmental Quality (CEQ) terminology for "significantly" (40 CFR 1508.27, which requires consideration of both "context" and "intensity"). Using the CEQ terminology, the NRC established three significance levels: SMALL, MODERATE, or LARGE. The definitions of the three significance levels are set forth in a footnote to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, as follows:

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

The GEIS assigns a significance level to each environmental issue, assuming that ongoing mitigation measures would continue.

The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants, and whether additional mitigation measures would be warranted. Issues are assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required in this SEIS unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria of Category 1, and therefore, additional plant-specific review for these issues is required.

In the GEIS, the staff assessed 92 environmental issues and determined that 69 qualified as Category 1 issues, 21 qualified as Category 2 issues, and 2 issues were not categorized. The last two issues, environmental justice and chronic effects of electromagnetic fields, are to be addressed in a plant-specific analysis. Of the 92 issues, 11 are related only to refurbishment, 6 are related only to decommissioning, 67 apply only to operation during the renewal term, and 8 apply to both refurbishment and operation during the renewal term. A summary of the findings for all 92 issues in the GEIS is codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B.

1.2.2 License Renewal Evaluation Process

An applicant seeking to renew its OLs is required to submit an ER as part of its application. The license renewal evaluation process involves careful review of the applicant's ER and assurance that all new and potentially significant information not already addressed in or

available during the GEIS evaluation is identified, reviewed, and assessed to verify the environmental impacts of the proposed license renewal.

In accordance with 10 CFR 51.53(c)(2) and (3), the ER submitted by the applicant must

- provide an analysis of the Category 2 issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B in accordance with 10 CFR 51.53(c)(3)(ii)
- discuss actions to mitigate any adverse impacts associated with the proposed action and environmental impacts of alternatives to the proposed action.

In accordance with 10 CFR 51.53(c)(2), the ER does not need to

- consider the economic benefits and costs of the proposed action and alternatives to the proposed action except insofar as such benefits and costs are either (1) essential for making a determination regarding the inclusion of an alternative in the range of alternatives considered, or (2) relevant to mitigation
- consider the need for power and other issues not related to the environmental effects of the proposed action and the alternatives
- discuss any aspect of the storage of spent fuel within the scope of the generic determination in 10 CFR 51.23(a) in accordance with 10 CFR 51.23(b)
- contain an analysis of any Category 1 issue unless there is significant new information on a specific issue—this is pursuant to 10 CFR 51.23(c)(3)(iii) and (iv).

New and significant information is (1) information that identifies a significant environmental issue not covered in the GEIS and codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, or (2) information that was not considered in the analyses summarized in the GEIS and that leads to an impact finding that is different from the finding presented in the GEIS and codified in 10 CFR Part 51.

In preparing to submit its application to renew the Surry Power Station, Units 1 and 2 OLs, VEPCo developed a process to ensure that information not addressed in or available during the GEIS evaluation regarding the environmental impacts of license renewal for Surry Power Station, Units 1 and 2, would be properly reviewed before submitting the ER. VEPCo also ensured such new and potentially significant information related to renewal of the licenses for Units 1 and 2 would be identified, reviewed, and assessed during the period of NRC review. VEPCo reviewed the Category 1 issues that appear in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, to verify that the conclusions of the GEIS remained valid with respect to

Surry Power Station, Units 1 and 2. This review was performed by personnel from VEPCo and its support organization who were familiar with NEPA issues and the scientific disciplines involved in the preparation of a license renewal ER.

The NRC staff also has a process for identifying new and significant information. That process is described in detail in *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal* (ESRP), NUREG-1555, Supplement 1 (NRC 2000). The search for new information includes (1) review of an applicant's ER and the process for discovering and evaluating the significance of new information; (2) review of records of public comments; (3) review of environmental quality standards and regulations; (4) coordination with Federal, State, and local environmental protection and resource agencies; and (5) review of the technical literature. New information discovered by the staff is evaluated for significance using the criteria set forth in the GEIS. For Category 1 issues where new and significant information is identified, reconsideration of the conclusions for those issues is limited in scope to the assessment of the relevant new and significant information; the scope of the assessment does not include other facets of the issue that are not affected by the new information.

Chapters 3 through 7 discuss the environmental issues considered in the GEIS that are applicable to Surry Power Station, Units 1 and 2. At the beginning of the discussion of each set of issues, there is a table that identifies the issues to be addressed and lists the sections in the GEIS where the issue is discussed. Category 1 and Category 2 issues are listed in separate tables. For Category 1 issues for which there is no new and significant information, the table is followed by a set of short paragraphs that state the GEIS conclusion codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, followed by the staff's analysis and conclusion. For Category 2 issues, in addition to the list of GEIS sections where the issue is discussed, the tables list the subparagraph of 10 CFR 51.53(c)(3)(ii) that describes the analysis required and the SEIS sections where the analysis is presented. The SEIS sections that discuss the Category 2 issues are presented immediately following the table.

The NRC prepares an independent analysis of the environmental impacts of license renewal and compares these impacts with the environmental impacts of alternatives. The evaluation of the VEPCo license renewal application began with publication of a notice of acceptance for docketing and opportunity for a hearing in the Federal Register (FR; 66 FR 39213 [NRC 2001a]) on July 27, 2001. The staff published a notice of intent to prepare an EIS and conduct scoping (66 FR 42897 [NRC 2001b]) for Surry Power Station on August 15, 2001. Two public scoping meetings were held on September 19, 2001, in Surry, Virginia. Comments received during the scoping period were summarized in the *Environmental Impact Statement Scoping Process: Summary Report – Surry Power Station, Units 1 and 2, Virginia* (NRC 2002), dated January 16, 2002. Comments that are applicable to this environmental review are presented in Part I of Appendix A.

The staff followed the review guidance contained in *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal*, NUREG-1555, Supplement 1 (NRC 2000). The staff and its contractors retained to assist the staff visited the Surry Power Station on September 19 and 20, 2001, to gather information and to become familiar with the site and its environs. The staff also reviewed the comments received during scoping and consulted with Federal, State, regional, and local agencies. A list of the organizations consulted is provided in Appendix D. Other documents related to Surry Power Station, Units 1 and 2 were reviewed and are referenced.

On April 26, 2002, the U.S. Environmental Protection Agency (EPA) published the Notice of Availability of the draft SEIS (67 FR 20763; EPA 2002). A 75-day comment period began on that date during which members of the public could comment on the preliminary results of the NRC staff's review. During this comment period, two public meetings were held in Surry, Virginia, on May 29, 2002. During these meetings, the staff described the preliminary results of the NRC environmental review and answered questions related to it to provide members of the public with information to assist them in formulating their comments. The comment period for the Surry Units 1 and 2 draft SEIS ended July 12, 2002. Comments made during the 75-day comment period, including those made at the two public meetings, are presented in Part II of Appendix A. The NRC responses to these comments are also provided.

This SEIS presents the staff's analysis in which the staff considers and weighs the environmental effects of the proposed renewal of the OLs for Surry Power Station, Units 1 and 2, the environmental impacts of alternatives to license renewal, and mitigation measures available for avoiding adverse environmental effects. Chapter 9, "Summary and Conclusions," provides the NRC staff's recommendation to the Commission on whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable.

1.3 The Proposed Federal Action

The proposed Federal action is renewal of the OLs for Surry Power Station, Units 1 and 2. The Surry Power Station is located in the southeastern part of Virginia, on the James River, across from Jamestown and Williamsburg, Virginia.

The current OL for Unit 1 expires on May 25, 2012, and for Unit 2 on January 29, 2013. By letter dated May 29, 2001, VEPCo submitted an application to the NRC (VEPCo 2001) to renew these OLs for an additional 20 years of operation (i.e., until May 25, 2032, for Unit 1 and January 29, 2033, for Unit 2). The plant has two Westinghouse-designed light-water reactors, each with a design rating for a gross electrical power output of 855 megawatts electric (MW[e]). Plant cooling is provided by a once-through cooling system to remove waste heat from the

reactor-steam electric system. Cooling water is withdrawn from the James River. Units 1 and 2 produce electricity to supply the needs of more than 400,000 homes.

1.4 The Purpose and Need for the Proposed Action

Although a licensee must have a renewed license to operate a reactor beyond the term of the existing OL, the possession of that license is just one of a number of conditions that must be met for the licensee to continue plant operation during the term of the renewed license. Once an OL is renewed, State regulatory agencies and the owners of the plant will ultimately decide whether the plant will continue to operate based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners.

Thus, for license renewal reviews, the NRC has adopted the following definition of purpose and need (GEIS Section 1.3 [NRC 1996]):

> The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and where authorized, Federal (other than NRC) decisionmakers.

This definition of purpose and need reflects the Commission's recognition that, unless there are findings in the safety review required by the Atomic Energy Act or findings in the NEPA environmental analysis that would lead the NRC to reject a license renewal application, the NRC does not have a role in the energy-planning decisions of State regulators and utility officials as to whether a particular nuclear power plant should continue to operate. From the perspective of the licensee and the State regulatory authority, the purpose of renewing an OL is to maintain the availability of the nuclear plant to meet system energy requirements beyond the current term of the plant's license.

1.5 Compliance and Consultations

VEPCo is required to hold certain Federal, State, and local environmental permits, as well as meet relevant Federal and State statutory requirements. In its ER, VEPCo provided a list of the authorizations from Federal, State, and local authorities for current operations as well as environmental approvals and consultations associated with Surry Power Station, Units 1 and 2, license renewal. Authorizations and consultations most relevant to the proposed OL renewal action are summarized in Table 1-1. The full list of authorizations and consultations provided by VEPCo is included in Appendix E.

Table 1-1. Federal, State, and Local Authorizations and Consultations

Agency	Authority	Requirement	Number	Permit Expiration or Consultation Date	Activity Covered
NRC	Atomic Energy Act, 10 CFR Part 50	Operating license	DPR-32 (Unit 1) DPR-37 (Unit 2)	May 25, 2013 (Unit 1) January 29, 2013 (Unit 2)	Operation of Surry Power Station, Units 1 and 2
FWS and NMFS	Endangered Species Act, Section 7	Consultation	NA	NRC letter to FWS (January 24, 2002); NMFS letter to VEPCo (March 23, 2001)	Operation during the renewal term
FWS	Migratory Bird Treaty Act	Permit	MB705136-0	March 31, 2003	Removal of osprey nests causing safety hazards
USCOE	FWPCA, Section 404	Permit	97-RP-19, Project 99-V1336; VMRC 92-1347	August 8, 2003	Periodic dredging to maintain intake channel in the James River.
VMRC	COV Title 28.2			December 31, 2002	
VDEQ	FWPCA	NPDES permit and FWPCA Section 401 certification	VA0004090	November 1, 2006	Permit for plant and storm water discharges
VDEQ	9 VAC 25-610-40	Permit	GW0003900	August 1, 2009	Withdrawal of groundwater
VDEQ	9 VAC 5-20-160	Registration	50336	None	Annual re-certification of air emission sources
VDEQ	Coastal Zone Management Act, Section 307	Consistency determination	NA	Letter from VDEQ to VEPCo (February 20, 2002)	Compliance with the Virginia Coastal Program
VDHR	National Historic Preservation Act, Section 106	Consultation	NA	NRC letter to VDHR (January 3, 2002)	Impact on sites listed or eligible for listing in the National Register of Historic Places

COV - Code of Virginia
FWPCA - Federal Water Pollution Control Act (also known as the Clean Water Act)
FWS - U.S. Fish and Wildlife Service
NMFS - National Marine Fisheries Service
NPDES - National Pollutant Discharge Elimination System
NA - Not applicable
USCOE - U.S. Army Corps of Engineers
VAC - Virginia Administrative Code
VDEQ - Virginia Department of Environmental Quality
VDHR - Virginia Division of Historic Resources
VMRC - Virginia Marine Resources Commission

The staff has reviewed the list and consulted with the appropriate Federal, State, and local agencies to identify any compliance or permit issues or significant environmental issues of concern to the reviewing agencies. These agencies did not identify any new and significant environmental issues. The ER states that VEPCo is in compliance with applicable environmental standards and requirements for Surry Power Station, Units 1 and 2. The staff has also not identified any environmental issues that are both new and significant.

1.6 References

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

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

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

40 CFR Part 1508. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 1508, "Terminology and Index."

Atomic Energy Act of 1954 (AEA). 42 USC 2011, et seq.

Coastal Zone Management Act (CZMA). 16 USC 1451, et seq.

Endangered Species Act (ESA). 16 USC 1531, et seq.

Federal Water Pollution Control Act. 33 USC 1251, et seq. (Also known as the Clean Water Act [CWA]).

Migratory Bird Treaty Act of 1918. 16 USC 703, et seq.

National Environmental Policy Act of 1969 (NEPA). 42 USC 4321, et seq.

National Historic Preservation Act of 1966 (NHPA). 16 USC 470, et seq.

U.S. Environmental Protection Agency (EPA). 2002. "Notice of Availability of Environmental Impact Statements". Federal Register, Vol. 67, No. 81, pp. 20763-20764 (April 26, 2002).

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants.* NUREG-1437, Volumes 1 and 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants Main Report,* "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2000. *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal.* NUREG-1555, Supplement 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2001a. "Virginia Electric Power Company, North Anna, Units 1 and 2, and Surry, Units 1 and 2, Notice of Acceptance for Docketing of the Application and Notice of Opportunity for a Hearing Regarding Renewal of License Nos. NPF-4, NPF-7, DPR-32, and DPR-37 for an Additional 20-Year Period." Federal Register: Vol. 66, No. 145, pp. 39213-39214 (July 27, 2001).

U.S. Nuclear Regulatory Commission (NRC). 2001b. "Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process." Federal Register: Vol. 66, No. 158, pp. 42897-42898 (August 15, 2001).

U.S. Nuclear Regulatory Commission (NRC). 2002. *Environmental Impact Statement Scoping Process: Summary Report – Surry Power Station Units 1 & 2, Surry, Virginia.* Washington, D.C.

Virginia Electric and Power Company (VEPCo). 2001. *Application for License Renewal for Surry Power Station, Units 1 and 2,* "Appendix E, Environmental Report - Operating License Renewal Stage." Richmond, Virginia.

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

The Surry Power Station, Units 1 and 2, are located in Surry County, Virginia, on the south side of the James River, approximately 40 km (25 mi) upstream of the point where the river enters the Chesapeake Bay. The station consists of two units. Each unit includes a pressurized light-water reactor (LWR) and three steam-driven turbine generators manufactured by Westinghouse. The station and its environs are described in Section 2.1, and the plant's interaction with the environment is presented in Section 2.2.

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

Surry Power Station, Units 1 and 2, are operated by the Virginia Electric and Power Company (VEPCo) and are located on approximately 340 ha (840 ac) of VEPCo-owned land in Virginia on Gravel Neck Peninsula. Figures 2-1 and 2-2 show the site location and features within 80 km and 10 km (50 mi and 6 mi), respectively. The exclusion area, which is entirely within the site boundary, is bounded by a circle of 500-m (1650-ft) radius centered at the Unit 1 reactor containment building.

Gravel Neck Peninsula is at the upstream limit of saltwater incursion to the James River; upstream of Gravel Neck is tidal river and downstream is an estuary. The 340-ha (840-ac) site extends as a band across the peninsula. Steep bluffs drop to the river on either side and to the tip of the peninsula. Hog Island Wildlife Management Area (HIWMA), a Commonwealth wildlife management area, is located on the tip of the peninsula.

The site is 10 km (7 mi) south of Colonial Williamsburg and 13 km (8 mi) east-northeast of the town of Surry. Jamestown Island, part of the Colonial National Historic Park, is to the northwest on the northern shore of the James River. The area within 16 km (10 mi) of the site includes Surry, Isle of Wight, York, and James City Counties, and parts of the cities of Newport News and Williamsburg. The counties surrounding Surry are predominantly rural, characterized by farmland, woods, and marshy wetlands. East and south of the site, at distances between 16 and 48 km (10 and 30 mi), are the urban areas of Hampton, Newport News, Norfolk, and Portsmouth, Virginia, and others, collectively known as Hampton Roads.

The region surrounding Surry was identified in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, as being located in a high population area (NRC 1996, Appendix C, Table C.2).

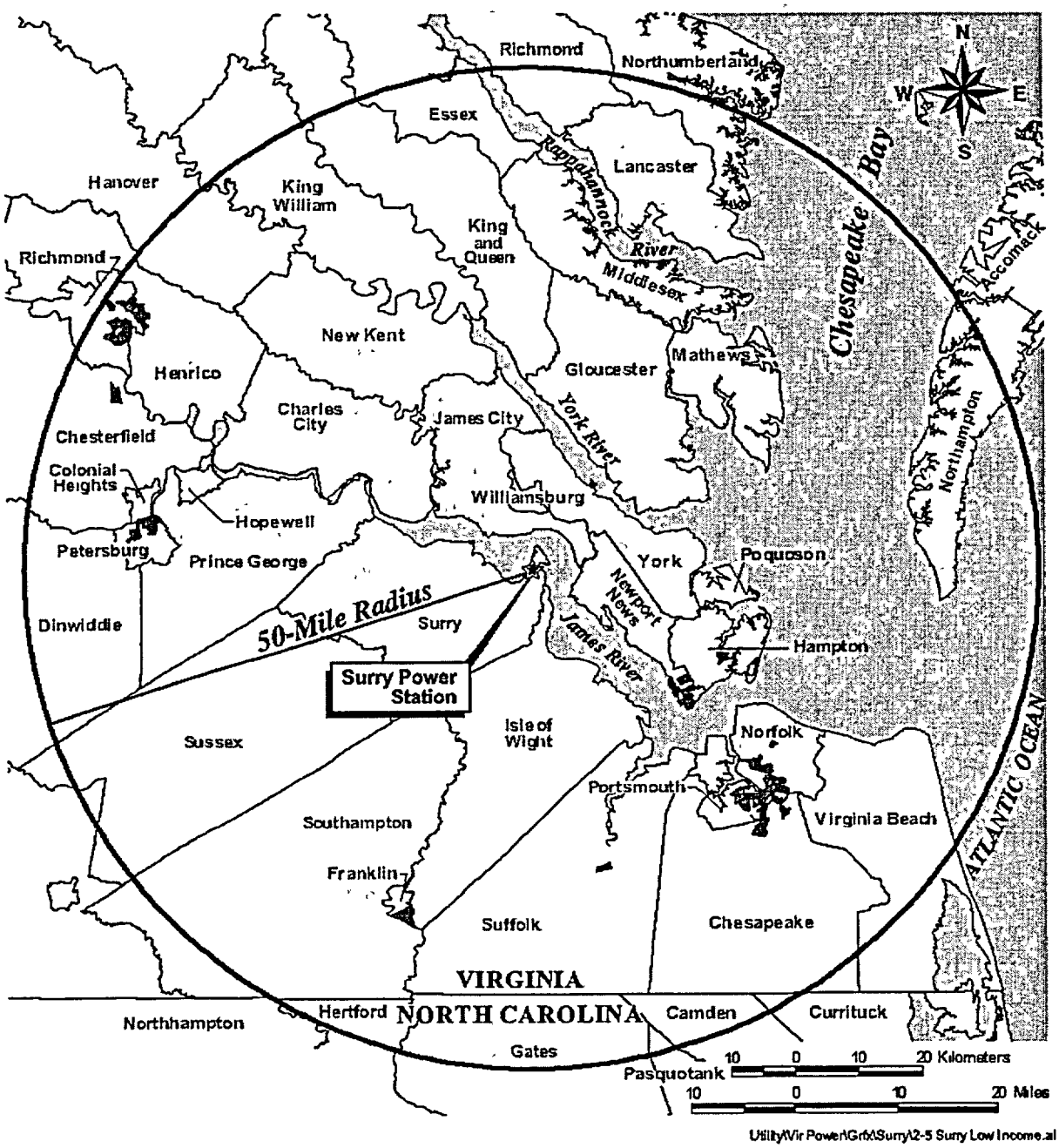

Figure 2-1. Location of Surry Power Station, 80-km (50-mi) Region

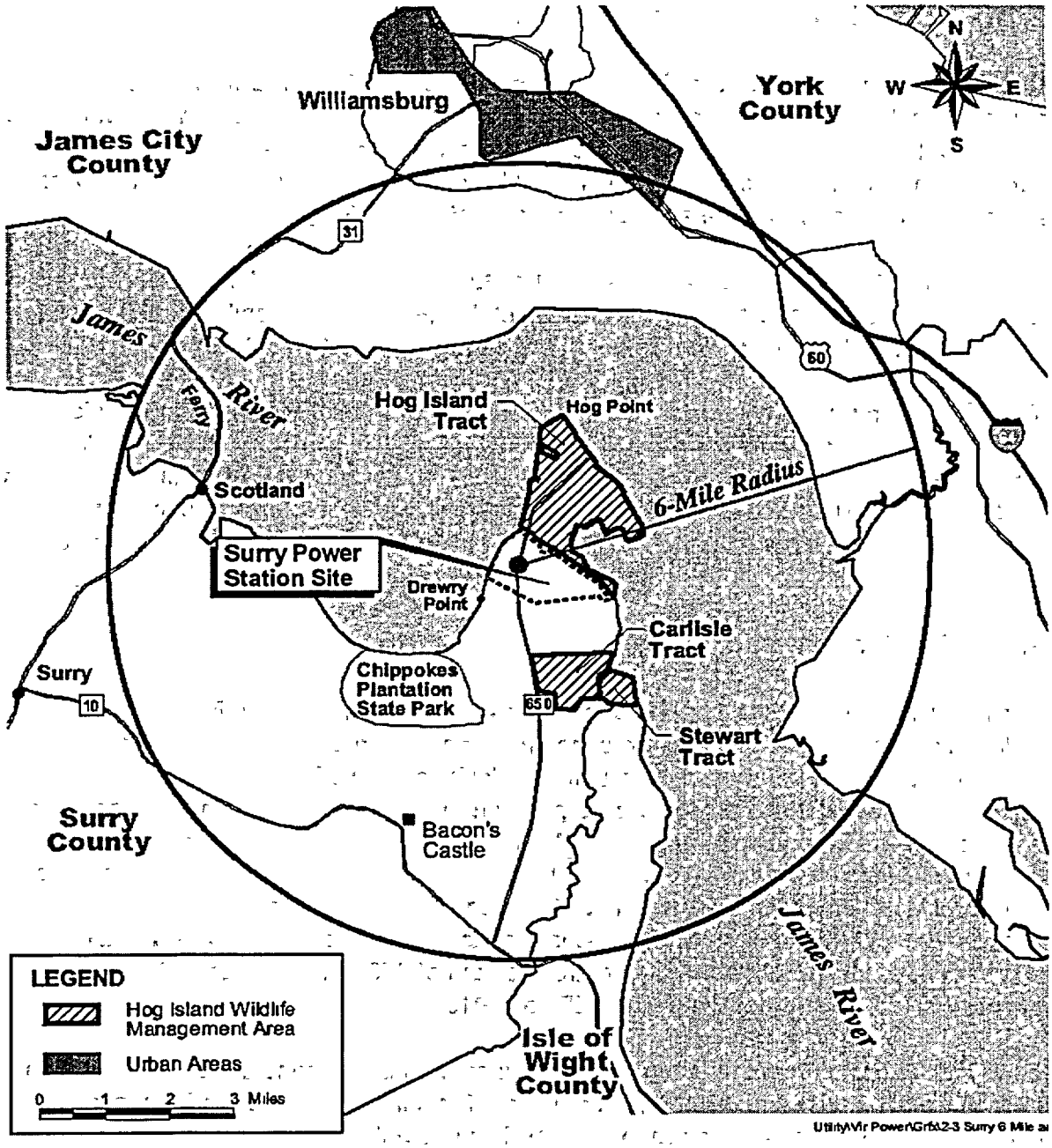

Figure 2-2. Location of Surry Power Station, 10-km (6-mi) Region

2.1.1 External Appearance and Setting

Distinctive features of the Surry Power Station include the 40-m (135-ft) diameter cylindrical containment buildings with hemispherical domes, and the cooling canal. When the plant was designed, there was a concern about the containment structures being visible from historic Jamestown Island; therefore, the containment buildings were designed so the elevation would be so low as to blend with the surrounding forest (VEPCo 1970).

In addition to the two nuclear reactors and their turbine building, intake and discharge canals, and auxiliary buildings, the site is the location of the Gravel Neck Combustion Turbines Station, a switchyard, and an Independent Spent Fuel Storage Installation (ISFSI) (Figure 2-3).

The geology around Surry Power Station lies within the Coastal Plain Physiographic Province and is underlain by approximately 400 m (1300 ft) of relatively unconsolidated Cretaceous to Holocene sand, silty sand, gravel, marl, and clay. There was no evidence of faulting during the exploratory drilling and construction of the facility. All available information indicates that the crystalline basement beneath the site has been tectonically dormant since the Cretaceous period.

2.1.2 Reactor Systems

Surry Power Station, Units 1 and 2, and support facilities are shown in Figure 2-4. Each unit includes a pressurized LWR and three steam-driven turbine generators manufactured by Westinghouse. The balance of each unit was designed by VEPCo, with the assistance of its agent, Stone & Webster Engineering Corporation (VEPCo 2000c). Each unit was designed for an output of 2441 megawatts-thermal (MW[t]), with a corresponding gross electrical output of 822.6 megawatts-electric (MW[e]). Units 1 and 2 achieved commercial operation in December 1972 and May 1973, respectively. In 1995, based on an NRC-prepared environmental assessment and a Finding of No Significant Impact, both units were up-rated to a core power output of 2546 MW[t] with a calculated gross output of 855.4 MW[e] each. Average net capacity is 1602 MW[e] for the plant (VEPCo 2001c).

Each reactor containment structure is a steel-lined, reinforced-concrete cylinder of 40 m (135 ft) diameter with a hemispheric dome and a flat reinforced-concrete foundation mat. Each containment structure is designed to withstand an internal pressure of 410 kPa (45 psig) above atmospheric pressure. Air pressure inside the containment structure is maintained at about 140 kPa (5 psig) below atmospheric pressure for routine operation. Together with its engineered safety features, each containment structure is designed to provide adequate radiation protection for both normal operation and unlikely accidents, such as earthquakes, tornadoes, or loss of coolant. Surry Power Station fuel is slightly enriched uranium dioxide;

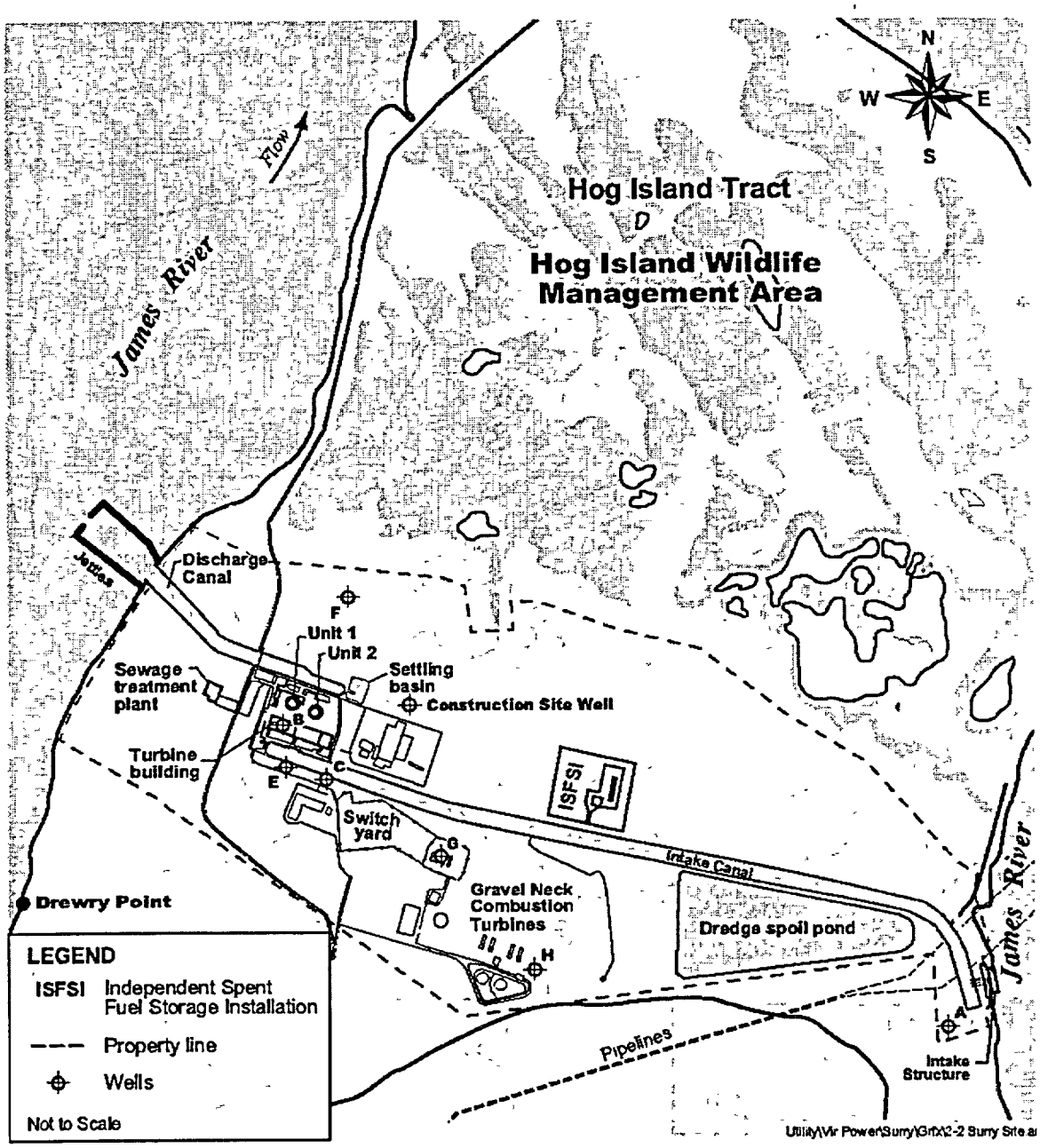

Figure 2-3. Site of Surry Power Station

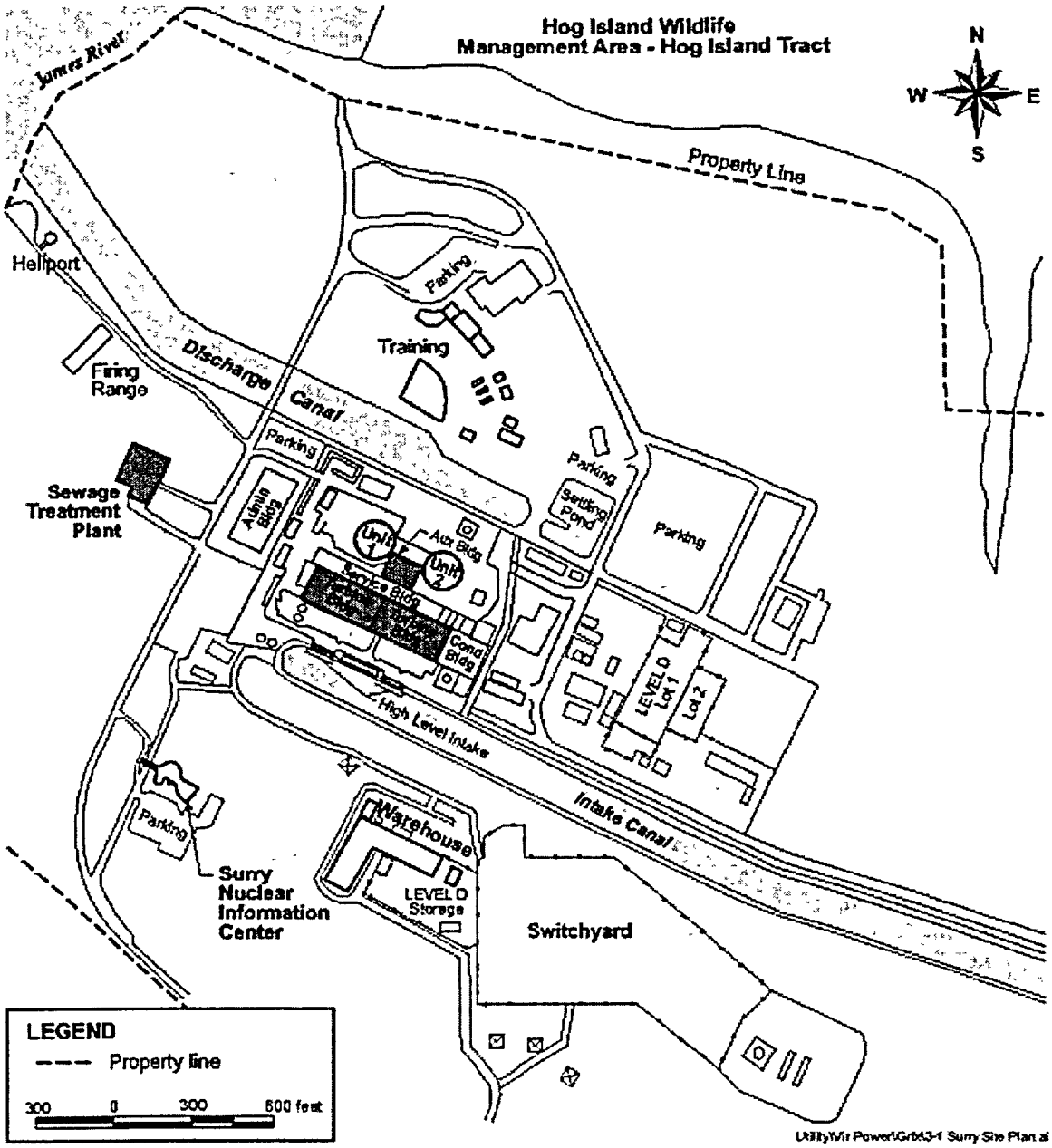

Figure 2-4. Surry Power Station, Showing Locations of Reactors and Other Buildings

the current enrichment is 3.20 percent by weight uranium-235. VEPCo operates the reactors at a region average fuel discharge burn-up rate of 45,000 megawatt-days per metric ton uranium (VEPCo 2001c).

2.1.3 Cooling and Auxiliary Water Systems

Surry Power Station has a once-through heat dissipation system that withdraws brackish water from the James River, pumps the water through the condenser, and returns heated water to the James River at a point about 10 km (6 mi) upriver from the withdrawal point. Two isolated, sealed cooling loops carry heat from the reactor to the condenser. Under normal conditions, there is no exchange of water between the two sealed loops or between the sealed loops and cooling water from the river.

Cooling water is withdrawn through a channel dredged in the bottom of the river between the main river channel and the eastern shore of Gravel Neck Peninsula and then into a low-level intake structure that has eight reinforced-concrete bays. When both Units 1 and 2 are operating at full power, eight pumps (one for each bay) pump a total of 106 m^3/s (1.68 million gpm) into the intake canal, which transports circulating water by gravity flow from the intake structure to the high-level intake structure at the reactors. This canal is about 3 km (2 mi) long. Cooling water then moves into two high-level four-bay structures and then passes through the turbine steam condensers. After passing through the condensers, the cooling water flows through a tunnel into the head of a 800-m (2900 ft) discharge canal, and from the canal flows back into the James River. A rock-filled jetty extends the discharge canal about 340 m (1100 ft) into the river.

The low-level intake structure is equipped with specially designed Ristroph traveling screens that rotate continuously to return impinged fish to the James River quickly. Use of a low-pressure spray to wash impinged fish from the screens into a return sluice to the river reduces injuries to the fish.

At full power, Surry Power Station discharges about 3490 MW (1.19×10^{10} Btu/hr) into the James River. The Surry Power Station National Pollutant Discharge Elimination System (NPDES) permit (VDEQ 2001a) does not require reporting of the discharge temperatures of the water. However, temperatures greater than 32°C (90°F) at the Surry Power Station outfall normally only occur during the months of June, July, August, and September when Surry Power Station, Units 1 and 2, are operating at full power. The highest water temperature in the discharge canal was 37.7°C (99.9°F), which was recorded in 1975. Even in extreme cases, temperatures in the James River decrease rapidly downstream of the canal outfall. At distances of about 900 m (3000 ft) or more from the outfall, the increase in temperature in river water is rarely greater than 2.8°C (5°F). The river water is fully mixed and has returned to ambient temperature by the time it returns to the vicinity of the plant intake.

Service water is diverted and withdrawn from the system before the water enters the condensers. It is used in a variety of applications, including component cooling (e.g., pump bearings and spent fuel pool water) and air conditioning.

Seven wells provide water for domestic uses, for the fire protection system, and for irrigation. Makeup water for the reactor cooling loops also comes from these wells.

2.1.4 Radioactive Waste Management Systems and Effluent Control Systems

VEPCo uses liquid, gaseous, and solid radioactive waste management systems to collect and process the liquid, gaseous, and solid wastes that are the by-products of the operation of Surry Power Station. These systems process radioactive liquid, gaseous, and solid effluents to maintain releases to the environment within regulatory limits. The Surry Power Station waste disposal system meets the design objectives of 10 CFR Part 50, Appendix I ("Numerical guides for design objective, and limiting conditions for operation to meet the criterion 'As Low as is Reasonably Achievable' for radioactive material in light-water-cooled nuclear power reactor effluents") and controls the processing, disposal, and release of radioactive liquid, gaseous, and solid wastes. Radioactive material in the reactor coolant is the source of gaseous, liquid, and solid radioactive wastes in LWRs. 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 from the fuel rods and contaminate the reactor coolant. Neutron activation of the primary coolant system is also responsible for coolant contamination.

Nonfuel 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 at a licensed burial site. Spent resins and filters are stored or packaged for shipment to a licensed offsite processing or disposal facility (VEPCo 2000c).

Fuel rods that have exhausted a certain percentage of their fuel and are removed from the reactor core for disposal are called spent fuel. Surry Power Station currently operates on a staggered 18-month refueling cycle per unit. Spent fuel is stored onsite in the spent fuel pool in the fuel handling building (VEPCo 2000c) or in containers located in the Surry ISFSI. Spent fuel has been stored in the Surry ISFSI since 1986 under a separate license.

The waste disposal system used for processing liquid, gaseous, and solid wastes is common to Units 1 and 2, with the exception of the primary drain transfer tanks and the gaseous drain system in each reactor containment (VEPCo 2000c).

The 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 Surry Power Station. 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; (1) 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 (2) 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 to areas at and beyond the site boundary shall be limited to (1) less than or equal to 5 mSv/yr (500 mrem/yr) to the total body and less than or equal to 30 mSv/yr (3000 mrem/yr) to the skin due to noble gases, and (2) less than or equal to 15 mSv/yr (1500 mrem/yr) to any organ due to iodine-131, iodine-133, tritium, and for all radioactive materials in particulate form with half-lives greater than 8 days (see 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 the design objectives of 10 CFR Part 50, Appendix I, of 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 the nuclear facility operations will not exceed the maximum limits of 40 CFR Part 190 (<0.25 mSv [25 mrem] in a year) and 10 CFR Part 20 (≤5 mSv [0.5 rem] in a year and ≤0.02 mSv [2 mrem] in any hour).

2.1.4.1 Liquid Waste Processing Systems and Effluent Controls

Potentially radioactive liquid wastes originating from the containment sump, auxiliary building sump, fuel building sump, safeguards building sump, component cooling water heat exchanger sump, decontamination building drains, and the laboratory drain are collected in waste drain tanks located in the auxiliary building (VEPCo 2000c). Liquid wastes in the waste drain tanks are transferred to liquid waste collection tanks in the Surry Radwaste Facility (VEPCo 2000c). Liquid wastes are then processed through the radwaste facility's liquid waste reverse osmosis and demineralizer system, which removes radioactive material and dissolved solids. The processed liquid waste is collected in one of two liquid-waste monitor tanks and sampled prior to release to the discharge canal via the radwaste facility liquid-effluent release line. A radiation monitor is located on this line (VEPCo 2000c).

Potentially radioactive liquid wastes originating from the laundry and personal decontamination shower and sink are collected in contaminated drain tanks located in the auxiliary building (VEPCo 2000c). From the contaminated drain tanks, liquid waste flows through the laundry drain filter in the Surry Radwaste Facility. Filtered waste is collected in one of two laundry waste monitor tanks where liquids are sampled and released to the discharge canal via the radwaste facility liquid-effluent release line (VEPCo 2000c).

The ODCM prescribes the alarm/trip setpoints for the liquid-effluent radiation monitors, which are derived from 10 times the effluent concentration limits provided in 10 CFR Part 20, Appendix B, Table 2, Column 2. There are liquid-effluent radiation monitors located on the radwaste facility liquid-effluent release line, the service water system effluent line, and the condenser circulating water line. The alarm/trip setpoint for each liquid-effluent monitor is based on the measurements of radioactivity in a batch of liquid to be released or in the continuous liquid discharge (VEPCo 2000b).

During 2000, there was a total volume of 2.82×10^8 L (7.45×10^7 gal) of liquid waste released prior to dilution for the two units (VEPCo 2001a). In this liquid waste, there was a total fission and activation product activity of 0.0044 TBq (0.12 Ci) and total tritium activity of 30 TBq (814 Ci). These volumes and activities are typical of past years. The liquid waste holdup capacity is approximately 1.7×10^5 L (45,000 gal) in four waste-holdup tanks located in the radwaste facility. The actual liquid waste generated is reported in the *Annual Radioactive Effluent Release Report for the Surry Power Station* (VEPCo 2001a).

VEPCo does not anticipate any increase in liquid waste releases during the renewal period.

2.1.4.2 Gaseous Waste Processing Systems and Effluent Controls

Potentially high-activity waste gases are regulated by the process vent subsystem of the gaseous waste disposal system and released to the environment through the process vent located on top of the Unit 1 containment structure (VEPCo 2000c). Gaseous wastes entering this subsystem originate from the waste gas decay tanks, the boron recovery system, the containment vacuum system, the vent and drain system, and various pressure relief valves (VEPCo 2000c). Waste gases collected in the waste gas decay tanks originate from reactor coolant letdown and include hydrogen, nitrogen, and small quantities of fission products gases (i.e., xenon and krypton) (VEPCo 2000c). These gases are allowed to decay in one of two double-walled waste decay tanks. Prior to release of gases from the waste decay tanks to the process vent, contents are sampled and released at a permissible rate and activity, as prescribed by the ODCM (VEPCo 2000b). Once released 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, vent and drain system, and various pressure relief valves). Prior to release to the environment, the combined-process vent waste stream is passed through a charcoal filter and high-efficiency particulate air (HEPA) filters and monitored by a particulate and gas monitor.

Potentially low-activity waste gases are regulated by either the ventilation vent or the radwaste facility vent subsystem of the gaseous waste disposal system.

- Gaseous wastes from the ventilation vent subsystem are released to the environment through either (1) ventilation vent no. 1 located on the top of the service building or (2) ventilation vent no. 2 located on the roof of the auxiliary building (VEPCo 2000c). Gases from laboratories, a counting room, and the decontamination area located in the service building are exhausted through ventilation vent no. 1. Air from common areas of the auxiliary building, fuel building, decontamination building, and safeguards area are exhausted through ventilation vent no. 2. Individual exhaust paths feeding into these vents are filtered or have the capability to be filtered (e.g., the fuel building exhaust will be diverted through a charcoal filter during refueling) (VEPCo 2000c). Both ventilation vents are continuously monitored for radioactivity (VEPCo 2000c).
- Gaseous wastes from the radwaste facility vent subsystem are released to the environment through the radwaste facility stack. Waste gases from the radwaste facility's tank vent system, process equipment vents, and general area are exhausted through the radwaste facility stack. Gaseous waste streams are filtered through either HEPA filters or a combination of HEPA filters and charcoal filters. The radwaste facility stack is continuously monitored for radioactivity (VEPCo 2000a).

As described above, radioactive gaseous wastes from Surry Power Station are released through four monitored release points: (1) the process vent located on top of the Unit 1 containment structure, (2) ventilation vent no. 1 located on top of the service building, (3) ventilation vent no. 2 located on the roof of the auxiliary building, and (4) the radwaste facility vent. These release points are continuously monitored for noble gases, radioiodines, and particulate activity (VEPCo 2000b). The ODCM prescribes alarm/trip setpoints for these effluent monitors and control instrumentation to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20 for gaseous effluents (VEPCo 2000b). These release points are continuously monitored and provide alarms with automatic valve closure when radiation levels exceed a preset level, thus terminating discharge (VEPCo 2000c).

In addition to the four monitored release points discussed above, a gross activity monitor is located on the Unit 1 and Unit 2 condenser air ejectors. Should a primary-to-secondary leak occur, elevated activity levels will be detected by the air ejector monitor and on a high-activity alarm, the flow is diverted to containment (VEPCo 2000c). The quantity of material discharged from such a release is accounted for using specific procedures in the ODCM (VEPCo 2000b).

During 2000, there was a total fission and activation gas activity of 0.13 TBq (3.57 Ci), a total iodine activity of 3.27×10^{-7} TBq (8.84×10^{-6} Ci), a total particulate activity of 1.40×10^{-6} TBq (3.78×10^{-5} Ci), and a total tritium activity of 1.03 TBq (27.7 Ci) released from the two units. These releases are typical of past years.

VEPCo does not anticipate any increase in gaseous releases during the renewal period.

2.1.4.3 Solid Waste Processing

Solid wastes from Surry Power Station consist of concentrated liquid sludge, spent resin, spent filter cartridges, solid noncompactible and compactible trash, and miscellaneous materials from station and radwaste facility operation and maintenance (VEPCo 2000c). Concentrated liquid sludge is segregated by type, flushed to storage tanks, slurried into an appropriate container, and stored onsite prior to shipment offsite for disposal. Spent resin from the plant's ion exchangers located in the auxiliary building is collected in tanks and then transferred to a high-integrity container for shipment to a burial site (VEPCo 2000c). Spent filter cartridges are placed in prefabricated metal containers and placed in an appropriately shielded location prior to shipment (VEPCo 2000c). Solid noncompactible and compactible trash is placed in appropriate containers and shipped offsite for compacting. Waste compacting is performed offsite by a licensed processing facility. A storage area in the radwaste facility serves as a staging area for waste ready for shipment to offsite processing and disposal facilities (VEPCo 2000c).

Solid wastes from Surry Power Station are either shipped directly to an offsite licensed disposal facility (e.g., spent resins) or consigned to a licensed processing facility for volume-reduction and decontamination activities (e.g., compactible trash). The material that remains after volume reduction is transported by the processing facility to a final disposal facility, depending on the activity limits.

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

In 1999, Surry Power Station made 33 shipments of solid waste with a volume of 690 m^3 (24,400 ft^3) and a total activity of 250 TBq (6700 Ci) (VEPCo 2000a). In 2000, Surry Power Station made 18 shipments of solid waste with a volume of 394 m^3 (13,900 ft^3) and a total activity of 12.4 TBq (335 Ci) (VEPCo 2001a). 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

Nonradioactive solid waste generated at Surry Power Station is disposed of at an offsite landfill. Hazardous wastes (e.g., asbestos, oil-contaminated materials) are disposed of by a licensed contractor.

Sanitary wastes are treated by an onsite standard aeration 300-m^3 (80,000-gal) sewage treatment facility. Nonradioactive liquid wastes produced as a result of plant operations and maintenance activities (e.g., water treatment activities, stormwater runoff, housekeeping wastes) are sampled, treated in accordance with the site's NPDES permit (VDEQ 2001a) issued by the Virginia Department of Environmental Quality (VDEQ), and released into the James River. Chemicals used in water treatment activities to prevent accumulation of deposits in cooling system components include sodium hypochlorite, sodium bromide, lithium hydroxide, hydrogen peroxide, hydrazine, and sulfuric acid (VEPCo 2001c).

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 Surry Power Station 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 Surry 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 used for the 30- to 40-day refueling outage.

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 2001c). The IPA identified the programs and inspections that are managing the effects of aging at Surry. Previously, VEPCo performed some major construction activities at Surry Power Station (e.g., steam generator replacement) and the IPA did not identify any need for refurbishment or replacement activities. VEPCo is assuming there may be an additional 60 additional workers to perform all the necessary surveillance, monitoring, inspections, testing, trending, and recordkeeping activities during the license renewal period.

2.1.7 Power Transmission System

VEPCo built nine transmission lines to connect the Surry Power Station to the transmission system. These nine transmission lines leave the Surry Power Station in two corridors. One corridor contains two 230-kV lines to the Hopewell Substation, a 500-kV line to the Chickahominy Substation, and a 500-kV line to the Yadkin Substation. The other corridor contains 230-kV lines to the Chuckatuck, Churchland, Whealton, and Yadkin Substations, and a 500-kV line to the Septa Substation.

The transmission lines are shown in Figure 2-5. The transmission line corridors are primarily rights-of-way, with less than 1 percent owned by VEPCo (VEPCo 2001c). Where possible, the transmission lines share common corridors and even transmission line towers. As a result, the total corridor length of approximately 270 km (170 mi) is significantly less than the 480-km (300-mi) total length of the transmission lines. Transmission-line corridor lengths and widths are listed in Table 2-1. The approximate corridor area for the lines to Hopewell Substation is for the full length, while the areas for the line to the Chickahominy Substation and the 500-kV line to the Yadkin Substation are for the corridors after the lines leave the corridor leading to the Hopewell Substation. Similarly, the area for the corridor from the Surry Power Station to the Septa Substation is for the full length. The area listed for the Chuckatuck Substation is for the corridor from the Septa Substation to the Chuckatuck Substation; the areas listed for the Whealton and Churchland Substations are for the corridors leaving the Chuckatuck Substation, and the area listed for the 230-kV line to the Yadkin Substation is for the corridor leaving the Churchland Substation.

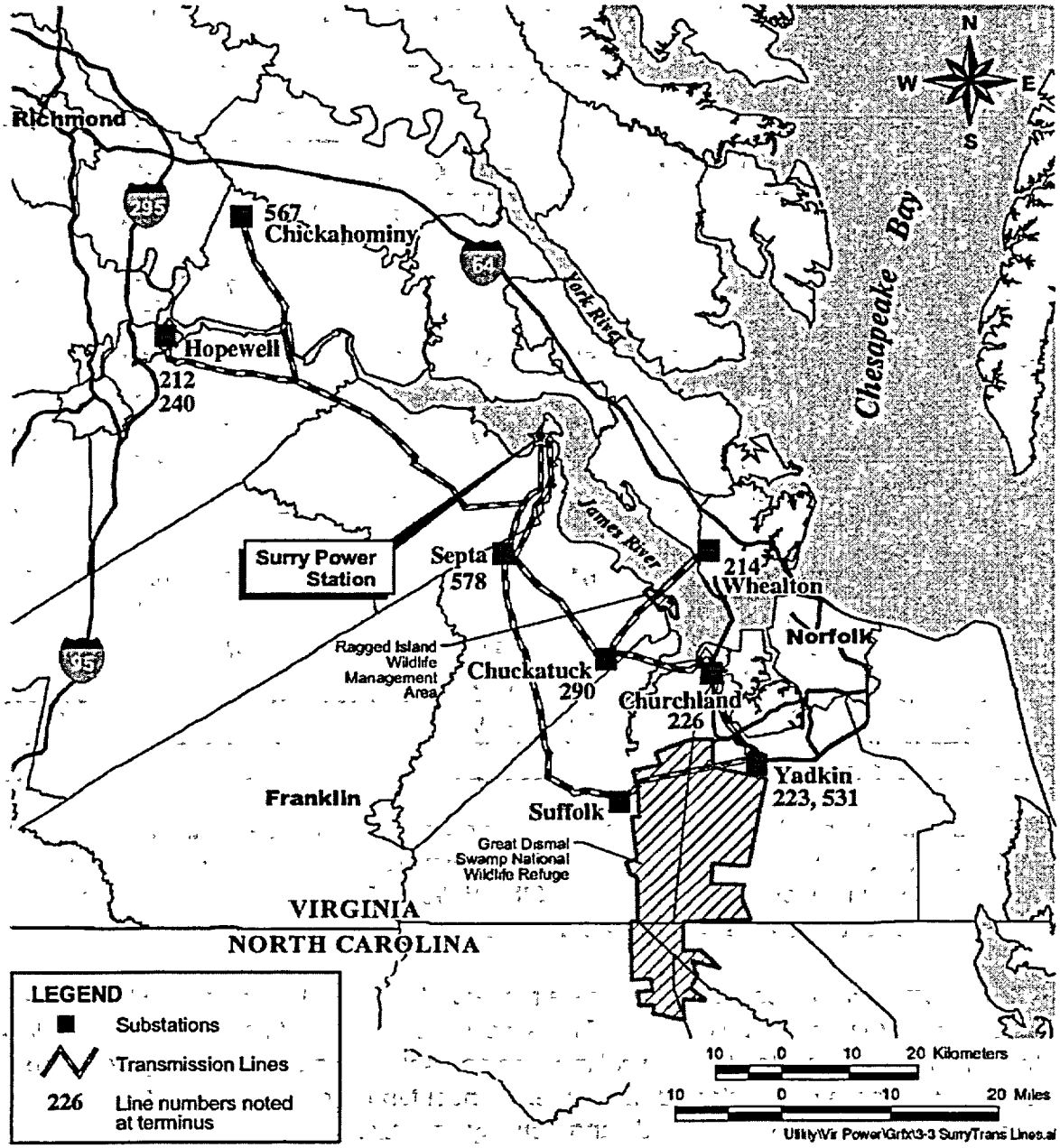

Figure 2-5. Transmission Lines Attributable to the Surry Power Station

Table 2-1. Surry Power Station Transmission Line Corridors

Substation	Number of Lines (line number)	kV	Approximate Distance km	(mi)	Corridor	Corridor Width m	(ft)	Approximate Corridor Area ha	(ac)
Chickahominy	1 (567)	500	87	(54)	1	46 to 107	(150 to 350)	110	(270)
Chuckatuck	1 (290)	230	39	(24)	2	90 to 137	(295 to 450)	270	(650)
Churchland	1 (226)	230	63	(39)	2	38 to 137	(125 to 450)	92	(230)
Hopewell	2 (212 and 240)	230	85	(53)	1	37 to 107	(120 to 350)	760	(1900)
Septa	1 (578)	500	19	(12)	2	73 to 107	(240 to 350)	200	(500)
Whealton	1 (214)	230	61	(38)	2	32 to 137	(105 to 450)	72	(180)
Yadkin	2 (223 and 531)	230 500	79 82	(49) (51)	2 1	38 to 137	(125 to 450)	61 330	(150) (820)
Total			480	(300)				2000	(5000)

Source: VEPCo 2001c

VEPCo plans to maintain these transmission lines indefinitely because they are integral to the larger transmission system. All transmission lines were designed and constructed in accordance with the sixth edition (1961) of the National Electrical Safety Code and industry guidance current when the lines were built (VEPCo 2001c).

The transmission line corridors traverse a mixture of cultivated land, grazing land, and managed timber lands (paper and pulp stock). Transmission corridor rights-of-way are generally maintained on a 3-year cycle. Mechanical mowing and selective herbicide applications are the standard methods of corridor maintenance. Handcutting and/or non-restricted use herbicides are used in areas such as wetlands and densely vegetated areas, where mowing is impractical or undesirable. VEPCo requires use of State-licensed applicators for herbicides. Selective handcutting is used in sensitive areas; herbicides are not used on the Suffolk-to-Yadkin corridor, within the Great Dismal Swamp National Wildlife Refuge, or in the Ragged Island Wildlife Management Area (VEPCo 2001c).

2.2 Plant Interaction with the Environment

Sections 2.2.1 through 2.2.8 provide general descriptions of the environment near Surry 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.

2.2.1 Land Use

Surry Power Station is located on Gravel Neck Peninsula in an unincorporated portion of Surry County, Virginia, on the south side of the James River. The site location is approximately 40 km (25 mi) upstream of the point where the river enters the Chesapeake Bay. The town of Surry is located approximately 13 km (8 mi) southwest of the plant site. Surry is the county seat of Surry County. Portions of the cities of Newport News and Williamsburg are within 16 km (10 mi) of Surry Power Station.

Surry Power Station occupies approximately 340 ha (840 ac). The site includes Units 1 and 2 and their associated structures and features, a switchyard, an ISFSI, and the Gravel Neck Combustion Turbines Station.

Surry Power Station is in a district classified as M-2 (General Industrial District) by Surry County (Surry County 1975). Location of nuclear power plants and associated radioactive waste-handling facilities is permitted as a conditional use in this district upon approval by the County Board of Supervisors. VEPCo has received such approval for Surry Units 1 and 2.

Section 307(c)(3)(A) of the Coastal Zone Management Act (16 USC 1456[c][3][A]) requires that applicants for Federal licenses who conduct an activity in a coastal zone are to provide a certification that the proposed activity complies with the enforceable policies of the State's Coastal Zone Program. Surry Power Station is within the Virginia coastal resources management area (VDEQ 2001b). VEPCo submitted a certification to VDEQ that renewal of the OLs for Surry Units 1 and 2 is consistent with the Virginia Coastal Management Program (VEPCo 2001d). VDEQ concurred in this certification in a letter dated February 20, 2002 (VDEQ 2002). A copy of the letter from VDEQ is included in Appendix E.

2.2.2 Water Use

Surry Power Station uses water from the James River for once-through cooling and the auxiliary cooling system. The water withdrawn from the James River represents about

3 percent of the tidal flow in the James River in the vicinity of the Surry Power Station. After passing through the condensers and service water system, most of the water is returned to the James River; less than 1.4 m^3/s (22,000 gpm) is lost to evaporation (approximately 1 percent of the initial intake) (AEC 1972a and 1972b).

Seven groundwater wells serve the Surry Power Station and another three wells serve the Gravel Neck Combustion Turbines Station. Surry Units 1 and 2 are permitted by VDEQ (Permit No. GW0003900) to withdraw a total of 585,600 m^3 (154.703 million gal) of water per year, or an average of 19 L/s (294 gpm), from the 10 wells. A monthly maximum of 60,200 m^3 (15.89 million gal) is authorized for use as domestic, process, and cooling water. VEPCo operates a non-community waterworks facility at Surry Units 1 and 2 under Permit No. 3181800, which was issued in 1978 and has no expiration date.

The 10 onsite groundwater wells vary in depth from 120 to 130 m (396 to 420 ft). They withdraw water from the upper zone of the Potomac aquifer. The sands of this aquifer are an excellent supply of water for many domestic and some industrial wells in the area. Groundwater use at Surry Units 1 and 2 for 1992 through 1999 averaged about 14 L/s (221 gpm). Three of the wells have a capacity of 12.6 L/s (200 gpm) and produce makeup, domestic, and fire-protection water at Surry Units 1 and 2. One well supplies the Surry Units 1 and 2 Training Center. It is capable of pumping 6.3 L/s (100 gpm). The other onsite wells are less productive. The three wells that supply the Gravel Neck Combustion Turbines Station generators withdraw a maximum of 18 million L (4.7 million gal) of water per year, or an average of about 0.57 L/s (9 gpm).

Sanitary wastes generated at the facility receive treatments provided by an onsite activated sludge treatment plant (design flow or 3.7 L/s [59 gpm]). The wastewater goes through flow equalization, screening, grinding, activated sludge treatment, settling, and disinfection. The treated wastewater is finally discharged into the effluent discharge canal. Sludge is aerobically digested, then pumped and hauled by a local contractor for final disposal.

2.2.3 Water Quality

The U.S. Environmental Protection Agency (EPA) authorized the Commonwealth of Virginia to implement the NPDES within the State. Discharge of cooling water from Surry Units 1 and 2 is currently authorized under NPDES Permit No. VA0004090. The permit, which is renewed every 5 years, expires November 1, 2006. The permit requires VEPCo to take immediate steps to achieve a nondetectable concentration in the final effluent if detectable chlorine concentrations are noted. If chlorine is detected in the effluent, the injection of sodium hypochlorite is discontinued and the concentration is allowed to return to nondetectable levels. Surry Units 1 and 2 are expected to remain in compliance with the permitted chlorine concentrations.

2.2.4 Air Quality

The Surry Power Station is located on the James River, midway between Norfolk and Richmond, Virginia. The site is in a climatological transition region between the maritime climate of Norfolk and the continental climate of Richmond. Daily maximum temperatures range from a low of about 8°C (46°F) in January to a high of about 31°C (87°F) in July, and daily minimum temperatures range from about -2°C (28°F) in January to a high of about 20°C (69°F) in July. Precipitation is rather uniformly distributed throughout the year, with an annual average of about 111 cm (44 in.).[(a)]

Thunderstorms are occasional in the site region, with a normal occurrence of about 37 per year. Most of these storms occur during the months of May through September. From 1886 through 1987, 34 tropical storms and 10 hurricanes passed within 185 km (100 nautical miles) of the site (VEPCo 2000c). Based on statistics for the 30 years from 1954 through 1983 for the 1-degree square containing the Surry Power Station (Ramsdell and Andrews 1986), the probability of a tornado striking the site is expected to be about 4×10^{-6} per year.

The wind-energy resource in the vicinity of the site is limited, with the annual average wind power rated as 2 on a scale of 1 to 7 (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.

The Surry Power Station is located within the State Capital 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; EPA 1997b), both promulgated by EPA in 1997. $PM_{2.5}$ is an acronym for particles with a diameter of 2.5 micrometers or less. After several years of litigation, the $PM_{2.5}$ and 8-hour ozone standards have recently been upheld. 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). There are no areas designated as mandatory Class 1 Federal areas in which visibility is an important value within 80 km (50 mi) of the site.

Diesel generators, boilers, and other activities and facilities associated with the Surry Power Station emit various pollutants. Installation and operation of the station blackout diesel

(a) Climatological data for Norfolk and Richmond are available at http://www.ncdc.noaa.gov/ol/climate/ climatedata.html (Accessed October 4, 2001).

generators are regulated by a permit issued by VDEQ, dated September 27, 1993. An application has been submitted to VDEQ for a Title V permit for operation of three emergency diesel generators, which have been operating as a grandfathered use. Emissions from other sources are registered with and regulated by the VDEQ (Registration No. 50336). These sources are recertified annually.

The Gravel Neck Combustion Turbines Station is located on the Surry Power Station property and is operated for peaking power. Typically, its operations are limited to a few days each year. It does not affect Surry Units 1 and 2 operations.

2.2.5 Aquatic Resources

Aquatic resources in the vicinity of the Surry Power Station are associated with portions of the James River adjacent to the Surry site, with the once-through cooling system intake channel on the east side of the Gravel Neck Peninsula and the discharge canal on the west side of the Peninsula. The James River is used for a variety of purposes, including navigation, recreation, tourism, and conservation.

The site is located approximately 40 km (25 mi) upstream of the river's confluence with Chesapeake Bay. Around the Gravel Neck Peninsula, the river is approximately 4 km (2.5 mi) wide. The river's flow in the vicinity of the site is complex and composed of three basic components. In decreasing order of volume, the flows include (1) tidal flows, (2) upstream flow of saline water along the river bottom and downstream flow of less-saline water at the river surface, and (3) the outflow of freshwater from the James River Watershed (VEPCo 2001c). The Gravel Neck Peninsula is considered the upstream limit of saltwater incursion into the James River, but this may shift several miles upstream or downstream, depending on river flow conditions (VEPCo 1980). In general, salinities in the vicinity of the discharge canal are between 0.0 and 9.2 ppt, while salinities near the Surry intakes, 10 river km (6 river mi) downstream of the discharge canal, range up to 17 ppt (VEPCo 2001c).

Approximately 80 fish species are known to inhabit the brackish portion of the river downstream of the Surry Power Station and approximately 40 species have been recorded for the freshwater portion of the river upstream (VEPCo 1977). Important commercial and recreational fish species in the James River were described in a letter from J. E. Olney, Virginia Institute of Marine Sciences, to Tony Banks, VEPCo, April 4, 2001 (Olney 2001b). The species include striped bass *(Morone saxatilis)*, Atlantic croaker *(Micropogonias undulatus)*, weakfish *(Cynoscion regalis)*, spot *(Leiostomus xanthurus)*, American eel *(Anguilla rostrata)*, and white perch (*Morone americana*) (VEPCo 2001c). Primarily recreational fish include the silver perch *(Bairdiella chrysoura)*, American shad *(Alosa sapidissima)*, Atlantic menhaden *(Brevoortia tyrannus)*, blue catfish *(Ictalurus furcatus)*, channel catfish *(I. punctatus)*, common carp *(Cyprinus carpio)*, and inland silverside *(Menidia beryllina)*. This diverse mixture of fishes is

typical for upper estuarine habitat due to the seasonal changes in salinity that occur. In addition to finfish, numerous aquatic invertebrate species are found in the vicinity of Surry Power Station. These include zooplankton (primarily copepods), amphipods (dominated by the scud, *Gammerus* sp.), and benthic organisms (e.g., polychaetes and shellfish) (VEPCo 1977). Shellfish near the Surry Power Station include *Rangia cuneata,* a brackish water clam capable of tolerating a wide range of salinities, and larval stages of *Crassostrea virginica,* the American oyster (AEC 1972a, 1972b). Recent trawl surveys conducted between 1996 and 2000 collected oysters, blue crabs *(Callinectes sapidus)*, spider crabs *(Libinia emarginata)*, eight shrimp species, and five species of clams (Olney 2001a).

Currently, no Federally listed aquatic species is known to occur in the lower James River. Twenty fish species are listed as threatened or endangered by the Commonwealth of Virginia, but only one of these is reported to occur in Surry County (Table 2-2). This species, the blackbanded sunfish *(Enneacanthus chaetodon)*, is listed as endangered by the Commonwealth of Virginia.[a] However, this sunfish primarily inhabits thickly vegetated ponds, swamps, and pools and is not reported to occur in the James River drainage (Jenkins and Burkhead 1994).

Burkhead and Jenkins (1991) listed only one fish that should be considered for Federal protection in the James River drainage: the orangefin madtom *(Noturus gilberti)*, a relict species native to the upper Roanoke drainage in Virginia and North Carolina and (probably introduced) to the upper James River drainage. This fish is currently listed as threatened by the Commonwealth of Virginia, but occurs only in the James River headwaters and is not present in the vicinity of Surry Power Station (Jenkins and Burkhead 1994).

Table 2-2. Aquatic Species Potentially Occurring in the Lower James River that are Listed Federally and by the Commonwealth of Virginia

Common Name	Scientific Name	Federal Status	State Status
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered	Endangered
Atlantic sturgeon	*Acipenser oxyrhynchus*	Candidate for Federal Listing	Species of Special Concern

The Atlantic sturgeon *(Acipenser oxyrhynchus)* was reported in the vicinity of Surry Power Station site in the early 1970s (AEC 1972a, 1972b). The population declined dramatically, due largely to overfishing, in the early 1900s. Limited spawning has been reported in the James

(a) Virginia Department of Conservation and Recreation National Heritage Program. Available URL: http://www.dcr.state.va.us.dnh/surr.htm

and York Rivers (Murdy et al. 1997). A recent report by the U.S. Fish and Wildlife Service (FWS) also indicated that the Atlantic sturgeon is present in the James, York, and Rappahannock Rivers (FWS 1998).

The shortnose sturgeon (*Acipenser brevirostrum*) is a Federally-listed endangered species and appears on the Virginia Department of Conservation and Recreation (VDCR) list of "Extinct and Extirpated Animals of Virginia" (Table 2-2). It remains on Virginia's list because it is relatively common in drainages to the north and south of the Chesapeake Bay (Dadeswell et al. 1984; Murdy et al. 1997) and could potentially repopulate the region if current restoration efforts are successful. However, it is not known at present nor historically from the James or York River drainages. Although not otherwise recorded in Virginia in over 100 years, a single specimen of shortnose sturgeon was collected in the Rappahannock River, a tributary to the Chesapeake Bay north of the James River, during a recent FWS study (FWS 1998).

2.2.6 Terrestrial Resources

The terrestrial ecosystem of the Surry Power Station and vicinity contains communities similar to those of the majority of the Virginia and North Carolina coastal plain. Forest typical of Surry County has been characterized as loblolly (*Pinus taeda*) and shortleaf pine (*P. echinata*), consisting of 50 percent coniferous species, with oaks, hickory, and gum as broadleaf associates (AEC 1972a, 1972b). The primary terrestrial plant community on the Surry Power Station site consists of remnants of mixed pine-hardwood forest that were used for timber production prior to acquisition by VEPCo (VEPCo 2001c). Loblolly pine and white oak (*Quercus alba*) are the dominant canopy species in this mixed pine-hardwood community, with dogwood (*Cornus florida*) and sourwood (*Oxydendrum arboreum*) as important understory species (AEC 1972a, 1972b).

Of minor importance in the vicinity of the Surry Power Station are marshy forests with swamp communities dominated by black gum (*Nyssa sylvatica*) and bald cypress (*Taxodium distichum*), with ash (*Fraxinus* spp.), elm (*Ulmus* spp.), and red cedar (*Juniperus virginiana*) as common associates. Freshwater reed-marsh communities often occur at the edge of wetland forests, dominated by bulrush (*Scirpus* spp.) and plume grass (*Erianthus* spp.). Along streams and rivers, above the influence of brackish waters, are cattail (*Typha* spp.) and arrowhead (*Sagittaris* spp.) communities (AEC 1972a, 1972b). Major terrestrial flora that occur on and in the vicinity of the Surry Power Station are listed in the Surry Final Environmental Statements (AEC 1972a, 1972b).

Wildlife in the mixed pine-hardwood associations are typical of the upland forests of coastal Virginia (VEPCo 2001c). The most recreationally important species on the Surry Power Station site is the white-tailed deer (*Odocoileus virginianus virginianus*). Forest predators include the gray fox (*Urocyon cinereoargenteus cinereoargenteus*). Small mammals, especially rodents,

occupy more open habitats, as do birds of prey (e.g., hawks and owls). A total of 37 mammal, 194 bird (the majority of which are associated with forest or forest-edge communities), 43 reptile, and 34 amphibian species have been identified as present on, or whose range might include, the Surry Power Station site (AEC 1972a, 1972b).

The Hog Island Tract (HIT) of the HIWMA is adjacent to the northern boundary of the Surry Power Station (Figure 2-2) at the tip of the Gravel Neck Peninsula. The 1200 ha (2900 ac) of the HIT consist primarily of tidal marshes and diked impoundments interspersed with pine forests. The Carlisle and Stewart Tracts of the HIWMA, approximately 410 ha (1000 ac) in extent, are located southeast of the Surry Power Station (Figure 2-2). These consist primarily of upland forested areas, but also contain tidal marshes along Lawnes Creek. All three tracts of the HIWMA are managed by the Virginia Department of Game and Inland Fisheries (VDGIF) and support a rich variety of wildlife. The tidal flats and marshes provide habitat for large numbers and numerous species of migratory shore birds, wading birds, and waterfowl. For example, large numbers of Canada geese (*Branta canadensis*) use the HIWMA as a wintering area. In addition, the HIT provides habitat for numerous amphibians, reptiles, mammals, and upland game birds (VEPCo 2001c).

The transmission corridors (Figure 2-5) described in Section 2.1.7 are situated within the Coastal Plain physiographic province. The transmission lines traverse land-use categories typical of coastal Virginia, such as row crops, pasture, pine plantations, and old fields. In addition, the transmission corridors pass through more natural habitat types, such as pine-hardwood forests, bottomland hardwood forests, and shrub bogs. The Suffolk-to-Yadkin transmission corridor traverses a 4-km (2-mi) portion of the Great Dismal Swamp National Wildlife Refuge, where hardwood swamp comprises the transmission corridor habitat. The Chuckatuck-to-Whealton corridor crosses a 304-m (1000-ft) portion of the Ragged Island Wildlife Management Area, a 622-ha (1537-ac) tract along the lower James River that consists of brackish marsh and pine-covered islands (VEPCo 2001c).

Table 2-3 shows listed species in Surry County and nearby counties that host transmission lines from Surry Power Station. Five Federally-listed and 18 State-listed threatened or endangered species, or species of special concern, that have been reported within 8 km (5 mi) of the site or transmission corridors, are also listed.

There are four active bald eagle (*Haliaeetus leucocephalus*) nests in the vicinity of Surry Power Station or its transmission corridors. Three are within 4 km (2.5 mi) of the Surry Power Station and one is within 100 m (330 ft) of the transmission corridors and 48 km (30 mi) from the Surry Station. In addition, as many as 50 eagles may forage within the HIWMA and vicinity during spring migration. However, there are no eagle concentration areas (e.g., roost sites, shoreline foraging areas, etc.) currently known on the Surry Power Station site or along the related transmission corridors.

Table 2-3. Federal- and State-Listed Terrestrial Species Potentially Occurring in Surry County and in Counties Crossed by Transmission Lines Associated with Surry Power Station

Scientific Name	Common Name	Federal Status	State Status	Charles City	City of Chesapeake	City of Hampton	City of Portsmouth	City of Suffolk	Isle of Wight	Prince George	Surry
Amphibians											
Ambystoma mabeei	Mabee's salamander		T			X		X	X		
Ambystoma tigrinum	tiger salamander		E						X		
Bufo quercicus	oak toad		SC		X			X			X
Hyla gratiosa	barking tree frog		T						X		X
Birds											
Charadrius melodus	piping plover	T	T			X	X				
Ardea alba	great egret		SC		X	X	X				
Falco peregrinus	peregrine falcon		T	X			X			X	
Haliaeetus leucocephalus	bald eagle	T	T	X		X	X	X	X	X	X
Lanius ludovicianus	loggerhead shrike		T							X	
Limnothlypis swainsonii	Swainson's warbler		SC					X			
Nyctanassa violacea	yellow-crowned night-heron		SC			X					
Picoides borealis	red-cockaded woodpecker	E	E					X			
Sterna antillarum	least tern		SC			X	X				
Insects											
Cicindela dorsalis dorsalis	northeastern beach tiger beetle	T				X					
Mammals											
Corynorhinus rafinesquii macrotis	eastern big-eared bat		E		X			X	X		
Sorex longirostris fisheri	Dismal Swamp southeastern shrew		T		X			X			
Plants											
Aeschynomene virginica	sensitive joint-vetch	T		X							
Bacopa innominata	tropical water-hyssop		E	X						X	X
Helonias bullata	swamp pink			X							
Isotria medeoloides	small whorled pogonia			X							
Reptiles											
Crotalus horridus atricaudatus	canebreak rattlesnake		E		X	X		X			
Deirochelys reticularia	chicken turtle		E						X		

E = Endangered, T = Threatened, SC = Special Concern, i.e., animals that merit special concern according to VDGIF (not a regulatory category), X = Known to Occur in Region.
Source: Based on the August 22, 2001, version of the VDCR Internet site. Available URL: http://www.dcr.state.va.us/dnh/.

Besides the bald eagle, none of the other animal or plant species in Table 2-3 are currently known to occur on the Surry Power Station site or along the related transmission corridors (VEPCo 2001c).

2.2.7 Radiological Impacts

VEPCo has conducted a radiological environmental monitoring program (REMP) around the Surry Power Station site since 1970 (AEC 1972a, 1972b). The radiological impacts to workers, the public, and the environment have been carefully monitored, documented, and compared to 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 and

- to 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 two annual reports: *Annual Radiological Environmental Operating Report Surry Power Station* (VEPCo 2001b) and *Annual Radioactive Effluent Release Report Surry Power Station* (VEPCo 2000a, 2001a). The limits for all radiological releases are specified in the Surry 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., well water and river water), aquatic exposure pathway (i.e., silt and shoreline sediments), and ingestion exposure pathway (i.e., milk, crabs, fish, clams, oysters, and crops) in a 32-km (20-mi) radius of the station (VEPCo 2001b) . 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 Surry Power Station site were a small fraction of the limits specified in the EPA's environmental radiation standards in 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 1 x 10^{-5} mSv (0.001 mrem) (VEPCo 2001b). A breakdown of doses by pathway for the year 2000 is as follows:

- Total body dose from liquid effluents was 3.16 x 10^{-6} mSv (3.16 x 10^{-4} mrem), which is 0.005 percent of the 0.06 mSv (6 mrem) dose limit.[a] The critical organ doses to the gastrointestinal tract and thyroid from liquid effluents were 1.74 x 10^{-5} mSv (1.74 x 10^{-3} mrem) and 1.59 x 10^{-6} mSv (1.59 x 10^{-4} mrem), respectively. These doses were 0.009 percent and 8 x 10^{-4} percent of the 0.20 mSv (20 mrem) dose limit[a] (VEPCo 2001a).

- The air dose due to noble gases in gaseous effluents was 9.26 x 10^{-6} mSv (9.26 x 10^{-4} mrad) gamma (0.005 percent of the 0.20 mGy [20 mrad] gamma dose limit[a]) and 2.41 x 10^{-5} mGy (2.41 x 10^{-3} mrad) beta (0.006 percent of the 0.40 mGy [40 mrad] beta dose limit[a]) (VEPCo 2001a).

- The critical organ dose from gaseous effluents due to iodine-131, iodine-133, tritium, and particulates with half-lives greater than 8 days was 4.06 x 10^{-5} mSv (4.06 x 10^{-3} mrem), which is 0.01 percent of the 0.30 mSv (30 mrem) dose limit[a] (VEPCo 2001a).

VEPCo does not anticipate any significant changes to the radioactive effluent releases or exposures from Surry Power Station operations during the renewal period and, therefore, the impacts to the environment are not expected to change.

2.2.8 Socioeconomic Factors

The staff reviewed the applicant's Environmental Report (ER; VEPCO 2001c) and information obtained from several county, city, and economic development staff during a site visit to the vicinity of Surry Units 1 and 2, from September 17 through 21, 2001. The following information describes the economy, population, and communities near Surry Power Station.

2.2.8.1 Housing

Approximately 990 employees work at Surry Units 1 and 2, (about 110 contract employees and 880 permanent employees). Approximately 60 percent of these employees live in Isle of Wight, James City, Surry Counties, or the independent city of Newport News.[b] This analysis will focus on these areas as the Surry Power Station area of impact. The remaining 40 percent of permanent Surry Power Station employees are spread over 23 other counties and independent

(a) The dose limit is twice the 10 CFR Part 50, Appendix I, dose limit because the limit is per unit and Surry has two operating units.

(b) Independent cities are not considered to be within the boundaries of counties.

cities. Some independent cities are urban areas, and others are not. The residency of permanent employees is shown in Table 2-4 by county and independent city. Transportation, offsite land use, demography, housing, and economics are similar in those areas south of the James River, which are somewhat isolated from the more populous areas to the north.

Table 2-4. Surry Power Station, Units 1 and 2, Permanent Employee Residence by County/Independent City

County/Independent City	Number of Personnel	Percentage of Total Personnel	Cumulative Percentage
Isle of Wight	212	24	24
James City	98	11	35
Newport News*	97	11	46
Surry	90	10	57
Hampton*	71	8	65
Suffolk*	52	6	71
Chesapeake*	42	5	75
Chesterfield	25	3	78
Portsmouth*	23	3	81
Virginia Beach*	21	2	83
York	20	2	85
Prince George	19	2	88
Sussex	18	2	90
Southampton	11	1	91
Others	79	9	100
Total	878	100	

* Independent City
Source: NRC 2001b.

Census data for 2000 describing housing in the study area are presented in Table 2-5. the local governments all have comprehensive land use plans, but they do not otherwise impose growth control measures that limit housing development. Surry County stands out with relatively high owner and rental vacancy rates compared to the surrounding counties.

VEPCo refuels each nuclear unit at Surry Power Station on an 18-month staggered schedule. During these refueling outages, site employment increases by as many as 700 temporary workers for 30 to 40 days. The residences of the temporary workers are assumed to be similarly distributed through the region as Surry Power Station permanent employees.

Table 2-5. Housing Units and Housing Units Vacant (Available) by County During 1990 and 2000

	1990	2000	Approximate Change (%)
		ISLE OF WIGHT COUNTY	
Housing Units	9753	12,066	24
Occupied Units	9032	11,319	25
Vacant Units	721	747	4
Percent Vacant	7%	6%	-16
		JAMES CITY COUNTY	
Housing Units	14,330	20,772	45
Occupied Units	12,968	19,003	47
Vacant Units	1362	1769	30
Percent Vacant	10%	9%	-10
		NEWPORT NEWS INDEPENDENT CITY	
Housing Units	69,728	74,117	6
Occupied Units	63,952	69,686	9
Vacant Units	5776	4431	-23
Percent Vacant	8%	6%	-28
		SURRY COUNTY	
Housing Units	2982	3294	10
Occupied Units	2283	2619	15
Vacant Units	699	675	-3
Percent Vacant	23%	20%	-13

Sources: U.S. Census Bureau (USCB 1990, 2000).

2.2.8.2 Public Services

- **Water Supply**

Surry Power Station gets potable water from a series of groundwater wells and is not connected with a municipal system (VEPCo 2001c). Sixty percent of the permanent employees reside in Isle of Wight, James City, or Surry Counties or the City of Newport News; therefore, discussion of public water supply systems will focus on these four areas. Table 2-6 summarizes the characteristics of the water supply systems in these areas.

Isle of Wight County has municipal water supply systems in the towns of Windsor, Smithfield, and Franklin. Permitted groundwater wells supply these systems; Surry County has municipal water supply systems in the towns of Claremont, Dendron, and Surry. A fourth system is under construction at the County's industrial park, 3 km (2 mi) west of the town of Surry, off State Highway 10. These systems are supplied by permitted groundwater wells.

Table 2-6. Major Public Water Supply Systems in Isle of Wight, James City, and Surry Counties, and City of Newport News

Water System	Source	Average Daily Use 1000 L/d	Average Daily Use 1000 gpd	Maximum Daily Capacity 1000 L/d	Maximum Daily Capacity 1000 gpd	Area Served
Windsor	Groundwater	30	9	2000	530	Windsor
Smithfield	Groundwater	110	30	12,000	3200	Smithfield
Franklin	Groundwater	250	65	5700	1500	Franklin
SURRY COUNTY						
Claremont	Groundwater	95	25	190	50	Claremont
Dendron	Groundwater	76	20	230	60	Dendron
Surry	Groundwater	150	40	380	100	Surry
Surry Industrial Park	Groundwater	300	80	570	150	Surry Industrial Park
JAMES CITY COUNTY						
James City Service Authority	Groundwater	14,000	3700	18,000	4780	James City County
CITY OF NEWPORT NEWS						
Newport News Waterworks	Chickahominy River, Descant Creek Reservoir, Little Creek Reservoir, Skiffe's Creek Reservoir, Lee Hall Reservoir, Harwood's Mill Reservoir	170,000	45,000	320,000	85,000	Newport News and James City County

Source: VEPCo 2001c; Virginia Electric and Power Co May 2001; Update of ER data provided by Larry Foster, James City County Service Authority, September 2001, Dave Morris, Newport News Waterworks, telephone communication, January 2002.

The municipal water supply for James City County is provided by the Newport News Waterworks (Waterworks), described below, and the James City Service Authority (JCSA). JCSA's water system consists of the central system with 29 well facilities and six independent water systems with five well facilities. Approximately 443 km (275 mi) of transmission and distribution lines supply about 14 million L/d (3.7 million gpd) to 12,500 customers.[a] The JCSA has a groundwater withdrawal permit for 18 million L/d

(a) Personal Communication, Larry Foster, James City County Service Authority, September 2001.

(4.78 million gpd). This amount of water will meet the County's needs through 2008, and an additional 15 million L/d (4 million gpd) will be needed to meet demand through 2040.

The JCSA is pursuing an initiative to meet its long-term water demand by participating in a regional effort to supplement the JCSA groundwater with surface water. James City County has joined Newport News in pursuing the construction of a water supply reservoir on Cohoke Creek in King William County to supply 87 million L/d (23 million gpd). This project is scheduled to be completed in 2010. James City County intends to contract with Newport News to obtain the rights to at least 7.5 million L/d (2 million gpd) and possibly 15 million L/d (4 million gpd) from the project. Water supply needs in the intermediate term will be met with three replacement wells and two new wells to provide an additional 7.5 million L/d (2 million gpd). As an interim measure, a reverse osmosis membrane treatment facility has been constructed. This facility will treat brackish groundwater from two deep confined aquifers within the coastal plain of Virginia. Six production wells will supply 23 million L/d (6 million gpd). The Waterworks has implemented a program aimed at fostering water conservation by system users and has helped to form a regional water conservation team as additional ways to meet future water demands.

Public water supply for Newport News is provided by the Waterworks, one of the 100 largest water utilities in the United States and one of the three largest in the Commonwealth of Virginia. Water is supplied to nearly 400,000 residents of Poquoson, Hampton, and Newport News, and to portions of York and James City Counties. The primary source of raw water is the Chickahominy River. Secondary sources and storage include five reservoirs: Descant Creek, Little Creek, Skiffe's Creek, Lee Hall, and Harwood's Mill. A sixth reservoir is proposed on Cohoke Creek in King William County, as discussed above. The Waterworks operates two water treatment plants: Lee Hall, which has a maximum rated treatment capacity of 204 million L/d (54 million gpd), and Harwood's Mill, which is currently rated to treat 117 million L/d (31 million gpd). Average daily usage is 170 million L/d (45 million gpd). Newport News Waterworks is planning increased capacity, as noted above.

- **Education**

The Surry County School system has just over 1200 students in the 2001-2002 academic year. There currently is no overcrowding in the system. The school system is healthy financially in terms of bonded indebtedness.[a] VEPCo partners with the Surry County

(a) Personal Communication with Dr. Marion H. Wilkins, Assistance Superintendent of Schools, Surry County School System, September 2001.

School system in a variety of ways, providing funds and technical help with disabled students, volunteers, computers, and internships.

Institutes of high education in the region include Hampton University, Virginia State University, Norfolk State University, Old Dominion University, William and Mary College, and the Virginia Institute of Marine Science.

- **Transportation**

There are 49 counties and independent cities within an 80-km (50-mi) radius of Surry Power Station, 44 in Virginia and 5 in North Carolina. In two of the latter counties, the 80-km (50-mi) ring just overlaps a 5-km (3-mi) triangular corner (see Figure 2-1). The area around Surry Power Station is served by several major freeways including Interstate 64, which together with U.S. Highway 60, connects the Newport News, Portsmouth, Norfolk area with Richmond, and Interstate 95, which runs in a north-south direction west of Surry County through the region and connects Richmond to Washington, D.C. to the north and North Carolina to the south. See Figure 2-6 for a regional view of major highways and other features in the vicinity of Surry Power Station.

The area is traversed by several other Commonwealth and Federal highways, including U.S. Highway 58, running southwest from Newport News. U.S. Highway 460 connects the Suffolk, Portsmouth, and Norfolk areas with Interstate 95 at Petersburg. U.S. Highway 13 runs approximately north-south and connects the eastern shore of Maryland and Virginia to eastern North Carolina, passing through Norfolk and Portsmouth.

The most direct vehicular access to Surry Power Station from the more populous cities and counties on the north bank of the James River (Williamsburg, Newport News, Hampton, York, and James City County) is via State Highway 31 and the James River Ferry service, operated by the Virginia Department of Transportation 24 hours a day at no cost to motorists. The major northwest-southeast route is State Highway 10 through Prince George, Surry, and Isle of Wight counties; this is the main route between the towns of Surry and Smithfield. Access from the southwest is via State Highways 40 and 31 from Sussex, Southampton, and the surrounding counties.

Part of the isolation of Surry County is the limited-capacity access to the more developed areas to the north via the James River Ferry, operated by the Virginia Department of Transportation between Scotland and Jamestown. Two ferries run 7 days a week and a third ferry is added during the summer months. Ferry traffic has been increasing over the last several years. The Virginia Department of Transportation has implemented schedule adjustments to accommodate the increased use; further adjustments are possible to accommodate future growth in ferry traffic (VEPCo 2001c).

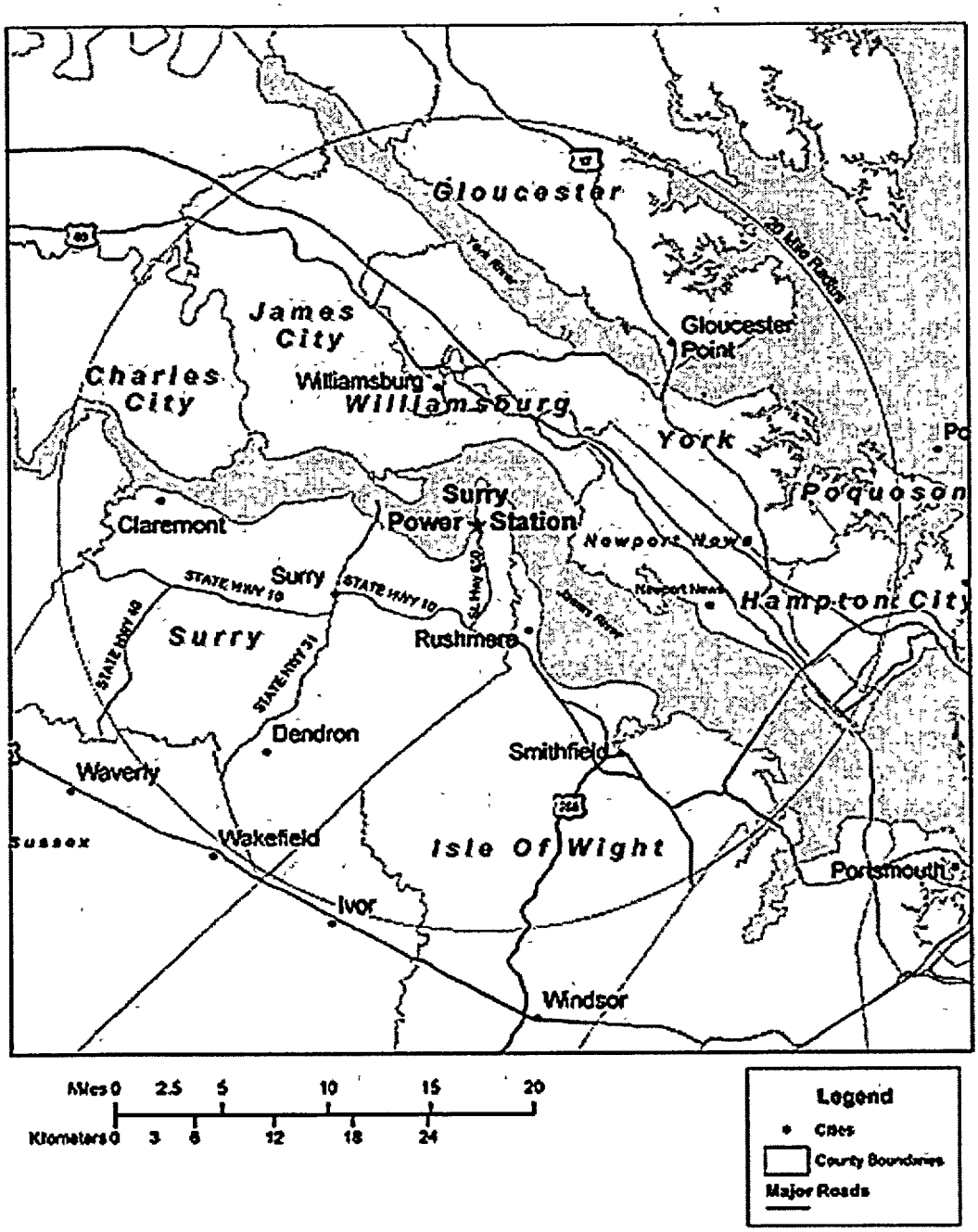

Figure 2-6. Area Within 32-km (20-mi) Radius of Surry Power Station

The principal road access to the Surry Power Station is via State Highway 650, which is a two-lane paved road. State Highway 650 intersects State Highway 10 approximately 8 km (5 mi) from the plant. Much of the road network in Surry and surrounding counties consists of hilly, winding two-lane roads, which are also used as commuting routes to the Surry Power Station.

The Virginia Department of Transportation is addressing the intersection of State Highways 10 and 650, where line-of-sight restrictions exist and where a $1.3-million road-improvement project is scheduled that involves installing turn lanes and other improvements to alleviate this problem.[a]

2.2.8.3 Offsite Land Use

The focus of this section is on Surry, Isle of Wight, and James City counties and the independent city of Newport News because 60 percent of the Surry Power Station workforce lives in these four areas.

The Commonwealth of Virginia mandates that cities and counties have comprehensive land use plans. The discussion of demography (Section 2.2.8.5, below) will reinforce that Surry County, along with the counties south of the James River, have experienced isolation and very slow, even at times negative, population growth over many decades.

Surry and surrounding counties south of the James River are predominantly agricultural and rural and characterized by gently rolling hills and some swamp areas. The elevation of Surry County varies from about 30 to 37 m (100 to 120 ft) above sea level (Surry County 1981). The County has 720 km^2 (280 mi^2) of land area and 67 km^2 (26 mi^2) of inland waterways (Surry County 1981). An estimated 75 percent of the county drains through the Blackwater River to the Chowan River and Albemarle Sound on the coast of North Carolina. Streams in the county are very slow running and generally have swampy bottoms (Surry County 1981).

The most recent Surry County Zoning District Map (Surry County 1980) shows that the vast majority of the land area of the county is zoned A-R, or Agricultural-Rural Residence District. The remainder is designated other zones, such as R-2 (Vacation Residence District), H-P (Historic Preservation), R-1 (Urban Residence District), B-1 (Local Business District), B-2 (General Business District), M-1 (Light Industrial District), and M-2 (General Industrial District). The Surry Power Station is in the sole M-2 zone in the county.

(a) Personal communication with Bill Richardson, Mike Tardy, Ron Pierce, and MacFarland Neiblett, Virginia Department of Transportation, September 2001.

In the year 2000, three towns in Surry County (Surry, Dendron, and Claremont) had populations of 262, 297, and 343, respectively, according to the U.S. Census Bureau.

There are several parks and preserves in Surry County, primarily along the south bank of the James River. Immediately adjacent to Surry Power Station is the Hog Island Tract of HIWMA (zoned A-R), at the north end of the peninsula on which Surry Power Station is located. In addition, south of Surry Power Station are the Carlisle and Stewart tracts of HIWMA. To the west, bordering the James River, is Chippokes Plantation State Park, and further west are Swanns Point and Pipsico Reservation, the site of a Boy Scouts of America camp.

Also in the vicinity of Surry Power Station and across the James River are two national parks: 5 km (3 mi) northwest is the Jamestown Colonial National Historical Park, and 14 km (9 mi) east-northeast is the Yorktown Colonial National Historical Park. Both of these parks have adjacent attractions that are not part of the national park system. Other major tourist attractions also across the James River include Busch Gardens (8 km [5 mi] north-northeast), Colonial Williamsburg (11 km [7mi] north), the College of William and Mary (11 km [7 mi] north), and Water Country (13 km [8 mi] north-northeast).

2.2.8.4 Visual Aesthetics and Noise

The Surry Power Station is clearly an industrial site. However, its structures are not visually obtrusive from any vantage point, even from across the James River (see Section 2.1.1). The Surry Power Station is a minimum of 5 km (3 mi) from any point across the James River, and the dense tree stands surrounding the site effectively screen it from all but a few locations. From a distance of 3 to 5 km (2 to 3 mi), Surry Power Station would only become prominent from vessels relatively close toward the south shore of the James River. There is no noise other than from minimal onsite traffic and from materials-handling and construction equipment, when these are in use.

2.2.8.5 Demography

Population was estimated in the region of the Surry Power Station out to 80 km (50 mi) in 16-km (10-mi) concentric rings. Population estimates for the 80-km (50-mi) area surrounding the site are based on information from the Updated Final Safety Analysis Report for Units 1 and 2 (VEPCo 2000c).

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

  Table 2-7 presents the population distribution within 80 km (50 mi) of Surry Power Station for population estimates in 10-year increments, starting with 1990 and ending with 2030. In 2000, there were 2,378,353 people living within 80 km (50 mi) of Surry Power Station

(USCB 2000). Between 1990 and 2000, the total population within the 80-km (50-mi) radius increased by 21 percent. Between 2000 and 2010, the population is expected to increase by 13.4 percent and continue thereafter in a slight downward trend in growth between 2020 and 2030 at 10.8 percent (VEPCo 2000c). Most of the population is concentrated north of the James River and in the Suffolk/Virginia Beach/Norfolk/Portsmouth/Chesapeake area, east of Isle of Wight County.

Table 2-7. Population Distribution 1990 to 2030 Within 80 km (50 mi) of the Surry Power Station, Based on 1990 Census Data

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(a)	102,343	249,532	331,536	686,069	600,819	1,970,119
2000 (b)	120,709	297,875	380,774	835,137	743,888	2,387,353
2010 (est.)(a)	139,242	338,472	415,202	944,420	869,648	2,706,984
2020 (est.)(a)	157,775	379,069	449,659	1,053,802	995,707	3,036,012
2030 (est.)(a)	176,308	419,666	484,117	1,163,183	1,121,767	3,365,040

Source: (a) VEPCo 2000c; (b) USCB 2000.

All or parts of 49 counties, and 8 major cities with a population over 50,000, are located within 80 km (50 mi) of Surry Power Station in Virginia and North Carolina. The largest population centers within the 16-km (10-mi) area are the cities of Williamsburg, which lies to the north of Surry Power Station and parts of the city of Newport News, which lies to the northeast. The populations of Williamsburg and Newport News for 2000 were 11,998 and 108,150, respectively (USCB 2000).

Nearly all of the city of Newport News falls within the 32-km (20-mi) radius. The town of Poquoson (population 11,566) lying east of the site, and the cities of Hampton (population 146,437) lying to the east, Portsmouth (population 100,565) lying to the southeast, and Norfolk (population 234,403) lying to the southeast, fall within or on the edge of the 48-km (30-mi) radius. Suffolk (population 63,677), south of Surry Power Station, the Petersburg area including Colonial Heights and Hopewell (population 72,991) lying to the west, Chesapeake (population 199,184) lying to the southeast, and Virginia Beach (population 425,257) also to the southeast, lie within or on the edge of the 64-km (40-mi) radius. The Richmond area, including the adjoining communities of Bon Air, Chester, East Highland

Park, and Highland Springs (population 259,487), lies to the northwest at the edge of the 80-km (50-mi) radius (USCB 2000).

The counties and communities south of the James River are isolated from the more populated areas north of the James River and are rural and very low in population density. Table 2-8 shows the actual (1990 census data) and estimated changes in population for Surry, Isle of Wight, and James City Counties, and the city of Newport News, from 1980 to 2030. Over the past century, Surry County population decreased 19 percent (8469 in 1900; 6829 in 2000 [USCB 2000]).

Table 2-8. Estimated Populations and Annual Growth Rates in Isle of Wight, James City, and Surry Counties, and City of Newport News, 1980-2030, Based on 1990 Census Data

	Surry County		Isle of Wight County		James City County		City of Newport News	
Year	Population	Average Annual Growth (%)	Population	Average Annual Growth (%)	Population	Average Annual Growth (%)	Population	Average Annual Growth (%)
1980	6046	0.3	21,603	1.8	22,763	2.8	144,903	0.5
1990	6145	0.2	25,053	1.6	34,859	5.3	170,045	1.7
2000	6599	0.7	29,499	1.8	48,000	3.8	180,999	0.6
2010	7095	0.8	34,098	1.6	60,000	2.5	189,998	0.5
2020	7594	0.7	38,726	1.3	72,076	2.0	199,054	0.5
2030	8090	0.7	43,325	1.2	84,076	1.7	208,053	0.5

Source: VEPCo 2001c.

- **Transient Population**

The area within the first 16 km (10 mi) of the Surry Power Station is predominantly rural and characterized by farmland, wooded tracts of land, and marshy wetlands. Since there are no significant industrial or commercial facilities in these directions, and none are anticipated, the transient employment population is likely to be out of, rather than into, the area.

Large employers within 16 km (10 mi) of the Surry Power Station site are listed in Table 2-9. Transient population estimates for the tourist attractions, parks, and recreational areas to the north, northeast, and southeast are provided in Table 2-10. These figures were obtained by VEPCo in 1993 from the individual attractions and the Virginia Division of Tourism. Total tourist figures in the Williamsburg area have not changed significantly over the last 10 years. Ticket purchases at Colonial Williamsburg and Jamestown and Yorktown National Historic Parks have collectively decreased. Busch Gardens, located 8 km (5 mi) north-northeast of the Surry Power Station site, with an annual attendance of 2.1 million, is

the largest single tourist attraction in the 16-km (10-mi) area. The resulting estimated total peak daily transient population in the Surry Power Station vicinity is 50,000.

Table 2-9. Major Employment Facilities Within 16 km (10 mi) of the Surry Power Station

Firm	Number of Employees
Fort Eustis	18,200
Anheuser Busch Brewery	1100
Busch Gardens	3000
U.S. Naval Weapons Storage Facility	2650
Colonial Williamsburg	3000

Source: VEPCo 2000c.

Table 2-10. Visitors to Major Events Within 16 km (10 mi) of the Surry Power Station

Facility	Daily Peak Transient Population[a]	Annual Usage[a]
Busch Gardens	18,000	2,100,000
Jamestown Settlement	1750	373,000
Jamestown Colonial National Historical Park	1400	300,000
Colonial Williamsburg	4000	909,000
Water Country	5000	460,000
Yorktown Colonial National Historical Park	1450	310,000
Chippokes Plantation State Park[b]	14,000	115,552
Hog Island Wildlife Management Area[c]	N/A	25,000
Hog Island Waterfowl Refuge[c]	N/A	4000
Bacon's Castle	50	6500
Carter's Grove Plantation	2000	259,000

(a) Substantial overlap in annual attendance very likely because of close proximity of attractions.
(b) Peak daily use is during 2-day annual Pork, Peanut, and Pine Festival (July)
(c) Peak daily use during winter

Source: VEPCo 2000c.

2.2.8.6 Economy

Forest resources play an important role in the Surry County economy and environment. According to the Surry County Comprehensive Plan, 75 percent of the land area is commercial forestland, of which 99.25 percent is private and the rest is public (Surry County 1980). The dominant land use remains commercial forest. The dominant forest types on these acres are loblolly-shortleaf pine, oak-pine, oak-hickory, and oak-gum-cypress. The County's economic base also includes agricultural production, with peanuts, soybeans, and corn as the primary crops.

The latest (1997) Census of Agriculture data (USDA 1999) show that Surry County, like most of the surrounding counties, is experiencing a consolidation of farms (making fewer, larger farms) and a slight reduction in farmland overall, similar to Sussex and Southampton counties, both of which show similar population and agricultural patterns.

Surry County is in both the Crater Planning and the Hampton Roads Economic Planning District Commissions. According to the VEPCo ER (VEPCo 2001c), the Hampton Roads area has experienced steady growth in population and economic activity during the last decade, as has Surry County to a lesser extent. The Hampton Roads area is the 27th largest metropolitan statistical area in the United States with more than 1.5 million people. It has a transportation network of trucking and railroad terminals, interstate highway access to main east-west and north-south routes, international airports, and an international deepwater, ice-free seaport, giving the area access to both domestic and international markets. Historically, there was a heavy reliance in Hampton Roads on defense-related industry, particularly shipbuilding. In recent years, the regional economy has become more diversified with major business, financial, and health care components, as well as a growing high-tech sector. Regionally, service is now the largest employment sector.

The unemployment rates for the Commonwealth of Virginia, Surry County, and surrounding localities are shown in Table 2-11. The unemployment rates in Surry County and the immediate neighboring counties south of the James River are higher than in localities north of the James River, Virginia, and the U.S. as a whole, a finding consistent with other economic indicators. VEPCo is the major employer in Surry County.

Surry County had a fiscal year 2000-2001 operating budget of $21.8 million, of which $15.6 million came from local property tax (Surry County 2000). For the years 1995 to 2001, the Surry Power Station's property taxes provided between 70 and 76 percent of Surry County's total property tax revenue. Property taxes cover about 68 percent of Surry County's total operating budget. VEPCo projects that the Surry Power Station's annual property taxes will remain constant at about $10 million through the license renewal period (VEPCo 2001c).

Table 2-11. Percent Unemployment, Individual Poverty, and Median Household Income for Surry, Isle of Wight, and James City Counties and City of Newport News

	Unemployment, % of Population (2000)	Poverty, % of Population (Estimated 1997)	Median Household Income (1997 $)
Surry County	4.1	16.0	31,097
Isle of Wight County	2.2	11.6	39,331
James City County	1.8	7.8	51,424
Newport News City	3.7	16.7	54,306

Sources: Virginia Employment Commission (VEC) 2001; USCB 1997.

Table 2-12 shows Surry Power Station's tax payments relative to Surry County property tax revenues and operating budget for the tax years 1995-2001.

Table 2-12. Property Tax Revenues Generated in Surry County by Surry Power Station and Surry County Operating Budgets, 1995-2001

Tax or Fiscal Year	Total Surry County Property Tax Revenues ($)	Property Tax Paid to Surry County for Surry Power Station ($)[a]	Property Taxes as a Percentage of Total County Property Tax Revenues	Total County Operating Budget	Property Taxes as a Percentage of Total County Operating Budget
1995	10,929,247	8,339,169	76	16,737,107	50
1996	11,763,226	8,994,835	76	16,818,954	53
1997	12,463,315	9,428,802	76	18,156,965	52
1998	12,208,208	9,154,251	75	18,589,528	49
1999	13,815,798	10,030,159	73	20,409,114	47
2000	14,270,205	10,025,094	70	21,166,592	47
2001	15,567,176	10,944,588	70	21,792,587	50

(a) Includes Surry Power Station, Units 1 and 2, and the Gravel Neck Combustion Turbines Station. Personal communication with Norma Roach, Commissioner of Revenue, Surry County, January 2002.

Source: VEPCo 2001c; updated with data from Melissa D. Rollins, Surry County Tax Collector's Office, January 2002.

At present, due to the location of the Surry Power Station in Surry County, VEPCo has a significant impact on the economic well-being of the County, paying well over 70 percent of the property taxes between 1996 and 2000. The schools within the county have benefitted from the taxes paid by the Surry Power Station and have seen their infrastructure substantially upgraded. If the County were to lose the Surry Power Station tax base, the impacts would be consequential.

2.2.9 Historic and Archaeological Resources

This section discusses the cultural background and the known historic and archaeological resources at the site of Surry Power Station, Units 1 and 2, and in the surrounding area. This section draws heavily on information contained in a report prepared for VEPCo, by the Louis Berger Group, Inc. (2001), as well as from archives and records stored at the Virginia Department of Historic Resources.

2.2.9.1 Cultural Background

This area is part of a region rich in terms of prehistoric and early historic Native American resources, and likewise in terms of historic Euroamerican resources (Bense 1994; Louis Berger Group, Inc. 2001). Virginia has an archaeological sequence that extends back at least 12,000 years before the present. Virginia's cultural history can be divided into four major periods: Paleoindian (10,000 B.C., and perhaps as early as 13,000 B.C., to around 8000 B.C.), Archaic (8000 to 1000 B.C.), Woodland (1000 B.C. to around A.D. 1600), and Historic (A.D. 1607 to the present).

During the Paleoindian period, the native peoples seemingly were organized into small mobile bands with a hunting- and a fishing-based economy. The environment of the Paleoindian period was significantly different from the present. This was at the end of the last ice age, in which the climate was cooler than at present and glaciers covered much of the northern portion of North America.

The subsequent Archaic period witnessed substantial environmental change. As glaciers began to melt, sea levels began to rise. A number of now-submerged Archaic archaeological sites have been documented around the coastal margins of the Chesapeake Bay, including at the mouth of the James River (Blanton 1996). These changing environmental conditions led to a greater dependance on river systems and the beginnings of the use of domesticated plants. Middle and late Archaic archaeological sites typically exhibit greater evidence of sedentary economies, such as the presence of storage pits, extensive refuse middens, and large quantities of fire-cracked rock.

In the Woodland period, Native American cultures reached their modern configurations as noted at the time of initial European contact in the 16th and 17th centuries. The middle of the Woodland period witnessed the establishment of large sedentary base camps in river valleys, with associated smaller resource gathering sites being established in surrounding areas. During the latter half of the Woodland period, Native American villages in southeastern Virginia apparently were organized into chiefdom-level societies (Rountree 1989). The use of long-houses, pallisades, and designated burial grounds are hallmarks of the late Woodland period. By the period of around 1500-1600, the Algonquian-speaking Powhatan chiefdom had become

the dominant center of power in the lower James River area. A large number of Powhatan villages are depicted in Captain John Smith's 1612 map of Virginia (Cumming 1998, Figure 3), including several along the James River. At the time of the founding of Jamestown in 1607, Wahunsonacock (known to the Colonists as "Powhatan") was the leader of the Powhatan confederation, and maintained nominal control over some 30 individual tribes represented by more than 200 individual villages.

The Historic period in Virginia begins with the settlement of Jamestown Island by Captain John Smith of the London Company in 1607. Jamestown Island is approximately 6 km (3.7 mi) to the northwest of Surry Power Station. It is close enough that in 1608, a few settlers moved from Jamestown to Hog Island, in part to manage swine herds, thus giving rise to the name of the island. The area south of Hog Island, including the present location of Surry Power Station, was referred to as the "Maine," that is, the main or non-island portion of the Gravel Neck Peninsula. Settlers moved to this area about the same time as that for Hog Island. In 1619, a small settlement was established adjacent to Lawnes Creek.

Displacement of Native Americans began almost immediately upon the arrival of the Euro-american Colonists. In 1622, Opechancanough, the successor to Wahunsonacock as chief of the Powhatan confederation, staged a general uprising against Euroamerican settlers, which led to the deaths of approximately 350 Colonists. The original attack on the Colonists led to the consolidation of the Euroamerican population closer to Jamestown, including moving some of the survivors to Hog Island. In the Virginia muster records of 1624 and 1625 (Jamestown 1624/1625 Muster Records), a total of 53 individuals (primarily servants) were listed as living at Hog Island in a least four separate houses. The figures for the Maine were 35 individuals and three houses.

Opechancanough and the Powhatan confederation staged a second major attack on the Euroamerican Colonists in 1644, but were themselves quickly routed. In 1646, his successor agreed to a treaty of submission by which the Powhatans abandoned all of their lands below the falls of the James River (near modern Richmond) and Pamunkey River, including the entire region around the vicinity of Jamestown and Gravel Neck Peninsula.

During the remainder of the 17th century and the early part of the 18th century, Hog Island and the Maine were divided into various plantation parcels. Also during this period of time, Lawne's Creek Parish Church, the first church in Surry County, was constructed near Hog Island Creek on a hill that overlooked the James River. The first church structure was used during the period of 1628 to 1650, and was rebuilt and relocated nearby to be used during the period of 1650 to around 1695. At that time, the church was relocated near Bacon's Castle, which is still a standing building, a portion of which was constructed in 1655. Bacon's Castle has the distinction of being among the oldest Euroamerican structures still standing anywhere in the United States today. Also, during the 17th and 18th centuries, a ferry operated across the

James River to Hog Island. As part of the license for this ferry, the operators were required to maintain a bridge across Hog Island Creek, in order to provide easier access from Hog Island to the Maine, where the Surry Power Station is now located.

During the period of 1750 through 1865, Hog Island saw sporadic use for plantations and played at least a small role in some of the key events of the Revolutionary and Civil Wars. Americans crossed the James River at Hog Island in pursuit of British troops immediately before the battle of Yorktown, and Hog Island itself was used as a commissary depot by French and American forces during the siege of Yorktown. During the Civil War, the Confederate military used Hog Island for a signal station.

After the Civil War, a residence was established on the northern portion of Hog Island, that eventually developed into the small postal "town" of Homewood, a town that seemingly never had more than a few residences and other buildings. Between World War I and World War II, a portion of Hog Island was purchased by the Newport News Yacht Club. Shortly after World War II, the Hog Island Waterfowl Refuge was designated by the Commonwealth of Virigina, eventually to become part of the current HIWMA.

Construction of Surry Power Station began in the late 1960s, with Unit 1 starting commercial operation in December 1972, followed by Unit 2 in May 1973. The containment structures at Surry Power Station were purposely constructed partially below grade in order to reduce the visual impact to Jamestown Colonial National Historic Park.

2.2.9.2 Historic and Archaeological Resources at Surry Power Station

Historic and archaeological site file searches were conducted at the Virginia Department of Historic Resources to determine what historic cultural resources may be present at Surry Power Station. Record searches were also conducted for nearby locations such as Chippokes Plantation State Park and the HIWMA (see Figure 2-2) to gain a perspective on the types of historic resources that may be present in the previously undeveloped and unsurveyed portions of the grounds of Surry Power Station.

Sample archaeological surveys conducted at Chippokes Plantation State Park, before its 1986 nomination as a National Register of Historic Places historic district, resulted in the discovery of 19 prehistoric Native American archaeological sites. These sites included stone-tool manufacturing workshops, small short-term encampments, and base camps. One site dates to the Late Archaic period, while the remainder are from the Woodland period or could not be assigned to a temporal period. In addition to these 19 Native American archaeological sites, there were 37 buildings and structures standing on the property. These included two plantation houses, one dating to approximately 1829-1830 and the other to 1860, outbuildings and slave quarters, as well as a number of early 20th century farm buildings and sharecropper dwellings.

The Hog Island Tract of the HIWMA has not been systematically surveyed for archaeological and historic resources, but does contain four known archaeological sites, along with the remains of a brick smokestack from the Homewood town site. The archaeological sites include two sites with 17th and 18th century domestic artifacts, and two sites with combined historic and prehistoric components. The prehistoric component of one of these sites includes late Archaic and Woodland period artifacts suggestive of habitation. A scatter of eroding prehistoric stone artifacts, referred to as "Area 1" (Louis Berger Group, Inc. 2001) is present along the base of the earthen dike and associated road that forms the western boundary of the Hog Island Creek maintained marshland. These artifacts may be secondarily deposited. Part of the fill removed from the original construction of Surry Power Station was used in roads and dikes at HIWMA to assist in flood and soil management for the waterfowl.[a]

An archaeological survey of Gravel Neck Peninsula was not conducted before the original construction of Surry Power Station. However, at least one archaeological site has been identified within the boundaries of the station, while two others are present outside but immediately adjacent to the southern boundary of the station. The site on the grounds of Surry Power Station itself was initially thought to be the location of the original Lawne's Creek Church. However, extensive testing conducted in 1967 suggests that the structure was instead a domestic house and associated well, seemingly dating to the 18th or 19th centuries. This site has not yet been evaluated for its eligibility for the National Register of Historic Places. The two sites immediately south of the southern boundary of Surry Power Station appear to represent two historic brick kilns of unknown date.

A property plat by W. W. LaPadre and Brothers, dated January 26, 1950, and depicting the area encompassed by the future Surry Power Station, was examined during the preparation of the cultural resource assessment by the Louis Berger Group, Inc. (2001). The plat indicated that with the exception of a shed that stood along the present Route 650 near the entrance to the property, the area that eventually became Surry Power Station was then described as wooded and contained no buildings.

While at present there are no Federally recognized Native American tribes in the Commonwealth of Virginia, there are eight tribes that have received state recognition. These include the Nasemonds, Pamunkeys, Mattaponis (and Upper Mattaponis), Chickahominys (and Eastern Chickahominys), and the Rappahannocks, who all originally belonged to the Powhatan confederation, along with the Siouan-speaking Monacans. The original Powhatan tribes present when Europeans first arrived in Surry County and the Gravel Neck Peninsula area, such as the Weanocks and the Tappahannas, have since become extinct as tribes. The eight

(a) See the transcript of the September 19, 2001, public scoping meetings, attached to the meeting summary dated October 10, 2001 (NRC 2001a).

tribes recognized by the Commonwealth of Virginia are serviced by the Virginia Council on Indians, a body that formally reports on an annual basis to the Virginia Governor and General Assembly.

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 OLs for Surry Units 1 and 2. Any such activities could result in cumulative environmental impacts and the possible need for the Federal agency to become a cooperating agency for preparing this supplemental environmental impact statement (SEIS) (10 CFR 51.10[b][2]).

The Colonial National Historical Park is the closest Federal site to the Surry Power Station. There are also a number of Department of Defense (DoD) facilities in relatively close proximity to the plant site, the closest major facilities being Fort Eustis and the Yorktown Naval Weapons Station. Smaller DoD facilities are the Cheatham Annex Naval Supply Center, adjacent to the Yorktown portion of Colonial National Historical Park, and the Naval Fuel Terminal in Yorktown. The U.S. Coast Guard operates a training center adjacent to the Naval Supply Center. Other major DoD facilities nearby include the Langley Air Force Base in Hampton, Virginia; the Navy fuel terminal on Craney Island in Portsmouth, Virginia; and the Norfolk Naval Station.

The Colonial National Historical Park encompasses five units, including Jamestown, the first permanent English settlement in North America, and the Yorktown Battlefield, the final major battle of the American Revolutionary War. The Park covers approximately 3800 ha (9300 ac). The closest portion of the Park to Surry Power Station is Jamestown Island, which is located approximately 6 km (4 mi) northwest of the Station.

Fort Eustis is the home of the U.S. Army Transportation Corps. Army officers and enlisted soldiers receive military education and on-the-job training at the Fort in all modes of transportation, aviation maintenance, logistics, and deployment doctrine and research. Fort Eustis is located approximately 8 km (5 mi) east of Surry Power Station.

The Yorktown Naval Weapons Station provides logistic, technical, and materiel support to the Navy fleet in the areas of combat subsystems, equipment, components, and retail ammunition management; it also maintains and operates an explosive outloading facility and provides homeporting services. The Station is located approximately 11 km (7 mi) northeast of Surry Power Station.

The U.S. Central Intelligence Agency operates a training facility at Camp Peary, which is located approximately 16 km (10 mi) north of Surry Power Station.

After reviewing the Federal activities in the vicinity of the Surry Power Station, the staff determined there were no Federal project activities that would make it desirable for another Federal agency to become a cooperating agency for preparing the SEIS.

NRC is required under Section 102 of 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. During the preparation of this SEIS, NRC staff consulted with the National Marine Fisheries Service and is currently in consultation with the U.S. Fish and Wildlife Service. 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."

Plant and the Environment

Bense, J. A. 1994. *Archaeology of the Southeastern United States.* Academic Press, New York.

Blanton, D. B. 1996. "Accounting for Submerged Mid-Holocene Archaeological Sites in the Southeast: A Case Study from the Chesapeake Bay Estuary, Virginia." In *Archaeology of the Mid-Holocene Southeast,* eds. K. E. Sassaman and D. G. Anderson, pp. 200-217. University Press of Florida, Gainesville, Florida.

Burkhead, N. M., and R.E. Jenkins. 1991. "Fishes," in *Virginia's Endangered Species.* K. Terwilliger, ed. McDonald and Woodward, Blacksburg, Virginia.

Coastal Zone Management Act, 16 USC 1451, et seq.

Cumming, W. P. 1998. *The Southeast in Early Maps.* 3rd ed. University of North Carolina Press, Chapel Hill, North Carolina.

Dadeswell, M. J., B. D. Taubert, T. S. Squires, D. Marchette, and J. Buckley. 1984. Synopsis of biological data on shortnose sturgeon, *Acipencer brevirostrum* Lesueur 1818. National Marine Fisheries Service.

Elliott, D. L., C. G. Holladay, W. R. Barchet, H. P. Foote, and W. F. Sandusky. 1986. *Wind Energy Resource Atlas of the United States.* DOE/CH 10093-4, U.S. Department of Energy, Washington, D. C.

Jamestown 1624/5 Muster Records, Virtual Jamestown, Virginia Center for Digital History, University of Virginia.
Available URL: http://jefferson.village.virginia.edu/vcdh/jamestown/Musters/muster24.html

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

The Louis Berger Group, Inc. 2001. *Cultural Resource Assessment, Surry Power Station, Surry County, Virginia.* Prepared for Dominion Resources, Inc.

Murdy, E. O., R. S. Birdsong, and J. A. Musik. 1997. *Fishes of Chesapeake Bay.* Smithsonian Institution Press, Washington, D.C.

Olney, J. E. 2001a. "Table 1. Pooled catch data (1996-2000) by the VIMS trawl survey in the James River near Surry Nuclear Power Plant." Virginia Institute of Marine Sciences, provided by electronic mail to Tony Banks, VEPCo. April 3, 2001.

Olney, J. E. 2001b. "Evaluation of potential impacts of operation of Surry Power Station on Federally managed species." Letter to Tony Banks, VEPCo. April 4, 2001.

Ramsdell, J. V., and G. L. Andrews. 1986. *Tornado Climatography of the Contiguous United States.* NUREG/CR-4461, Nuclear Regulatory Commission, Washington, D.C.

Rountree, H. L. 1989. *The Powhatan Indians of Virginia.* University of Oklahoma Press, Norman, Oklahoma.

Surry County. 1975. "Surry County Land Development Ordinance." Surry County Planning Commission and Board of Supervisors, Surry, Virginia.

Surry County. 1980. *Surry County, Virginia Zoning District Map.* A part of the Surry County Zoning Ordinance, prepared by Harland, Bartholomew, and Associates, Richmond, Virginia, adopted by the Surry County Board of Supervisors, September 4, 1975.

Surry County. 1981. *Comprehensive Plan*, June 1980, Revised March 1981. Surry, Virginia.

Surry County. 2000. *Surry County Proposed Consolidated Budget, Fiscal Year 2000-2001* (July 1, 2000-June 30, 2001), May 18, 2000. Surry, Virginia.

U.S. Atomic Energy Commission (AEC). 1972a. *Final Environmental Statement Related to Operation of Surry Power Station Unit 1, Virginia Electric and Power Company.* Docket No. 50-280. Washington, D.C.

U.S. Atomic Energy Commission (AEC). 1972b. *Final Environmental Statement Related to Operation of Surry Power Station Unit 2, Virginia Electric and Power Company,* Docket No. 50-281. Washington, D.C.

U.S. Census Bureau (USCB). 1990. *American Fact Finder - Census 1990 Quick Tables - Housing Occupancy and Tenure.* Available URL: http://factfinder.census.gov/servlet/BasicFactsServlet (Accessed December 28, 2001).

U.S. Census Bureau (USCB). 1997. *State and County Quick Facts. Virginia.* Available URL: http://quickfacts.census.gov/qfd/states/51000.html (Accessed December 28, 2001).

U.S. Census Bureau (USCB). 2000. *American Fact Finder - Census 2000 Quick Tables - Population and Housing.* Available URL: http://factfinder.census.gov/servlet/BasicFactsServlet (Accessed December 28, 2001).

U.S. Census Bureau (USCB). 2001. *Census CD(R) 2000 Redistricting.* Release 1.1. GeoLytics, Inc., East Brunswick, New Jersey.

U.S. Department of Agriculture (USDA). 1999. *National Agricultural Statistics Service, 1997 Census of Agriculture, March 1999.* Available URL: http://govinfo.kerr.orst.edu/agstateis.html (Accessed December 19, 2001).

U.S. Environmental Protection Agency (EPA). 1997a. National Ambient Air Quality Standards for Ozone. Federal Register: Vol. 62, No. 138, pp. 38856-38896 (July 18, 1997).

U.S. Environmental Protection Agency (EPA). 1997b. National Ambient Air Quality Standards for Particulate Matter. Federal Register: Vol. 62, No. 138, pp. 38651-38701 (July 18, 1997).

U.S. Fish and Wildlife Service (FWS). 1998. *Atlantic sturgeon population evaluation utilizing a fishery dependent reward program in Virginia's major western shore tributaries to the Chesapeake Bay,* by Albert J. Spells. Charles City, Virginia.

U.S. Nuclear Regulatory Commission (NRC). 1991. *Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors.* NUREG-1301, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants.* NUREG-1437, Volumes 1 and 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2001a. "Summary of September 19, 2001, public scoping meetings for the Surry Power Station, Units 1 and 2, license renewal application." Accession No. ML012830412, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2001b. NRC Memo to file dated December 26, 2001, socioeconomic and aquatic information provided by VEPCo. Washington, DC.

Virginia Department of Environmental Quality (VDEQ). 2001a. NPDES permit VA0004090, Department of Environmental Quality. Glen Allen, Virginia.

Virginia Department of Environmental Quality (VDEQ). 2001b. "Virginia's Coastal Environment." Available URL: http://www.deq.state.va.us/coastal/thezone.html

Virginia Department of Environmental Quality (VDEQ). 2002. Letter from Ellie Irons, Office of Environmental Impact Review, to J. W. White, VEPCO. (February 20, 2002).

Virginia Department of Health (VDH). 2001. *2000 Environmental Radiation Program Annual Report.* Department of Health, Radiological Health Program. Richmond, Virginia.

Virginia Electric and Power Company (VEPCo). 1970. *VEPCo Surry Power Station, Units 1 and 2 Environmental Report.* Richmond, Virginia.

Virginia Electric and Power Company (VEPCo). 1977. *Section 316(a) Demonstration (Type I) — Surry Power Station — Units 1 and 2.* Richmond, Virginia.

Virginia Electric and Power Company (VEPCo). 1980. *Surry Power Station — Units 1 and 2 Cooling Water Intake Studies.* Richmond, Virginia.

Virginia Electric and Power Company (VEPCo). 2000a. *Annual Radioactive Effluent Release Report for the Surry Power Station (January 1, 1999 through December 31, 1999).* Richmond, Virginia.

Virginia Electric and Power Company (VEPCo). 2000b. *Offsite Dose Calculation Manual (Surry),* Procedure Number VPAP-2103S, Rev. 3. Richmond, Virginia.

Virginia Electric and Power Company (VEPCo). 2000c. *Surry Power Station Units 1 and 2 Updated Final Safety Analysis Reports,* Rev. 32. Richmond, Virginia

Virginia Electric and Power Company (VEPCo). 2001a. *Annual Radioactive Effluent Release Report for the Surry Power Station (January 1, 2000 through December 31, 2000).* Richmond, Virginia.

Virginia Electric and Power Company (VEPCo). 2001b. *Annual Radiological Environmental Operating Report Surry Power Station (January 1, 2000 to December 31, 2000).* Richmond, Virginia.

Virginia Electric and Power Company (VEPCo). 2001c. *Application for License Renewal for Surry Power Station, Units 1 and 2,* "Appendix E, Environmental Report - Operating License Renewal Stage." Richmond, Virginia.

Virginia Electric and Power Company (VEPCo). 2001d. October 26, 2001, letter to VDEQ requesting concurrence in a Coastal Zone Management certification for license renewal of Surry Units 1 and 2. Richmond, Virginia.

Virginia Employment Commission (VEC). 2001. Local Area Unemployment Statistics. October 2001. Available URL: http://www.vec.state.va.us/index.cfm?loc=lbrmkt&info=lmi (Accessed December 28, 2001).

3.0 Environmental Impacts of Refurbishment

Environmental issues associated with refurbishment activities are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).[a] The GEIS includes a determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1, and, therefore, additional plant-specific review of these issues is required.

License renewal actions may require refurbishment activities for the extended plant life. These actions may have an impact on the environment that requires evaluation, depending on the type of action and the plant-specific design. Environmental issues associated with refurbishment that were determined to be Category 1 issues are listed in Table 3-1.

Environmental issues related to refurbishment considered in the GEIS for which these conclusions could not be reached for all plants, or for specific classes of plants, are Category 2 issues. These are listed in Table 3-2.

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

Table 3-1. Category 1 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
SURFACE-WATER QUALITY, HYDROLOGY, AND USE (FOR ALL PLANTS)	
Impacts of refurbishment on surface-water quality	3.4.1
Impacts of refurbishment on surface-water use	3.4.1
AQUATIC ECOLOGY (FOR ALL PLANTS)	
Refurbishment	3.5
GROUNDWATER USE AND QUALITY	
Impacts of refurbishment on groundwater use and quality	3.4.2
LAND USE	
Onsite land use	3.2
HUMAN HEALTH	
Radiation exposures to the public during refurbishment	3.8.1
Occupational radiation exposures during refurbishment	3.8.2
SOCIOECONOMICS	
Public services: public safety, social services, and tourism and recreation	3.7.4; 3.7.4.3; 3.7.4.4; 3.7.4.6
Aesthetic impacts (refurbishment)	3.7.8

Category 1 and Category 2 issues related to refurbishment that are not applicable to Surry Power Station, Units 1 and 2, because they are related to plant design features or site characteristics not found at Surry Power Station are listed in Appendix F.

The potential environmental effects of refurbishment actions would be identified, and the analysis would be summarized within this section, if such actions were planned. The Virginia Electric and Power Company (VEPCo) indicated that it has performed an evaluation of structures and components pursuant to 10 CFR 54.21 to identify activities that are necessary to continue operation of Surry Power Station, Units 1 and 2, during the requested 20-year period of extended operation. These activities include replacement of certain components as well as new inspection activities and are described in the VEPCo Environmental Report (ER; VEPCo 2001).

Table 3-2. Category 2 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53 (c)(3)(ii) Subparagraph
TERRESTRIAL RESOURCES		
Refurbishment impacts	3.6	E
THREATENED OR ENDANGERED SPECIES (FOR ALL PLANTS)		
Threatened or endangered species	3.9	E
AIR QUALITY		
Air quality during refurbishment (nonattainment and maintenance areas)	3.3	F
SOCIOECONOMICS		
Housing impacts	3.7.2	I
Public services: public utilities	3.7.4.5	I
Public services: education (refurbishment)	3.7.4.1	I
Offsite land use (refurbishment)	3.7.5	I
Public services, transportation	3.7.4.2	J
Historic and archaeological resources	3.7.7	K
ENVIRONMENTAL JUSTICE		
Environmental justice	Not addressed[a]	Not addressed[a]

(a) Guidance related to environmental justice was not in place at the time the GEIS and the associated revision to 10 CFR Part 51 were prepared. If an applicant plans to undertake refurbishment activities for license renewal, environmental justice must be addressed in the applicant's environmental report and the staff's environmental impact statement.

However, VEPCo stated that the replacement of these components and the additional inspection activities are within the bounds of normal plant component replacement and inspections; therefore, they are not expected to affect the environment outside the bounds of plant operations as evaluated in the final environmental statement (AEC 1972a, 1972b). In addition, VEPCo's evaluation of structures and components as required by 10 CFR 54.21 did not identify any major plant refurbishment activities or modifications necessary to support the continued operation of Surry Power Station, Units 1 and 2, beyond the end of the existing operating licenses. Therefore, refurbishment is not considered in this supplemental environmental impact statement.

3.1 References

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."

U.S. Atomic Energy Commission (AEC). 1972a. *Final Environmental Statement Related to Operation of Surry Power Station, Unit 1.* Docket No. 50-250, AEC, Washington, D.C.

U.S. Atomic Energy Commission (AEC). 1972b. *Final Environmental Statement Related to Operation of Surry Power Station, Unit 2.* Docket No. 50-281, AEC, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants.* NUREG-1437, Volumes 1 and 2, NRC, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report,* "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, NRC, Washington, D.C.

Virginia Electric and Power Company (VEPCo). 2001. *Application for License Renewal for Surry Power Station, Units 1 and 2,* "Appendix E, Environmental Report - Operating License Renewal Stage." VEPCo, Richmond, Virginia.

4.0 Environmental Impacts of Operation

Environmental issues associated with operation of a nuclear power plant during the renewal term are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).[a] The GEIS includes a determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic.

(2) A single significance level (i.e., SMALL, MODERATE, OR LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1, and therefore, additional plant-specific review of these issues is required.

This chapter of the supplemental environmental impact statement (SEIS) addresses the issues related to operation during the renewal term that are listed in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, and are applicable to the Surry Power Station, Units 1 and 2. Section 4.1 addresses issues applicable to the Units 1 and 2 cooling system. Section 4.2 addresses issues related to transmission lines and onsite land use. Section 4.3 addresses the radiological impacts of normal operation, and Section 4.4 addresses issues related to the socioeconomic impacts of normal operation during the renewal term. Section 4.5 addresses issues related to groundwater use and quality, while Section 4.6 discusses the impacts of renewal-term operations on threatened and endangered species. Section 4.7 addresses new information that was raised during the scoping period. The results of the evaluation of environmental issues

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

related to operation during the renewal term are summarized in Section 4.8. Finally, Section 4.9 lists the references for Chapter 4. Category 1 and Category 2 issues that are not applicable to Surry Units 1 and 2 because they are related to plant design features or site characteristics not found there are listed in Appendix F.

4.1 Cooling System

Category 1 issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, that are applicable to the Surry Power Station cooling system operation during the renewal term are listed in Table 4-1. The Virginia Electric and Power Company (VEPCo) stated in its Environmental Report (ER; VEPCo 2001b) that it is not aware of any new and significant information associated with the renewal of the Surry Units 1 and 2 operating licenses (OLs). The staff has not identified any significant new information during its independent review of the ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of the issues, the GEIS concluded that the impacts are small, and plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-1. Category 1 Issues Applicable to the Operation of the Surry Power Station Cooling System During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
SURFACE WATER QUALITY, HYDROLOGY, AND USE (FOR ALL PLANTS)	
Altered current patterns at intake and discharge structures	4.2.1.1; 4.3.2.2; 4.4.2
Altered salinity gradients	4.2.1.2
Temperature effects on sediment transport capacity	4.2.1.2.3; 4.4.2.2
Scouring caused by discharged cooling water	4.4.1.2.3; 4.4.2.2
Eutrophication	4.2.1.2.3; 4.4.2.2
Discharge of chlorine or other biocides	4.2.1.2.4; 4.4.2.2
Discharge of sanitary wastes and minor chemical spills	4.2.1.2.4; 4.4.2.2
Discharge of other metals in wastewater	4.2.1.2.4; 4.3.2.2; 4.4.2.2
Water use conflicts (plants with once-through cooling systems)	4.2.1.2.4
Accumulation of contaminants in sediments or biota	4.2.1.2.4; 4.3.3; 4.4.3; 4.4.2.2
Entrainment of phytoplankton and zooplankton	4.2.2.1.1; 4.3.3; 4.4.3
Cold shock	4.2.2.1.5; 4.3.3; 4.4.3
Thermal plume barrier to migrating fish	4.2.2.1.6; 4.4.3

Table 4-1. (contd)

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
AQUATIC ECOLOGY (FOR ALL PLANTS)	
Distribution of aquatic organisms	4.2.2.1.6; 4.4.3
Premature emergence of aquatic insects	4.2.2.1.7; 4.4.3
Gas supersaturation (gas bubble disease)	4.2.2.1.8; 4.4.3
Low dissolved oxygen in the discharge	4.2.2.1.9; 4.3.3; 4.4.3
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	4.2.2.1.10; 4.4.3
Stimulation of nuisance organisms	4.2.2.1.11; 4.4.3
HUMAN HEALTH	
Noise	4.3.7

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, for each of these issues follows:

- Altered current patterns at intake and discharge structures. Based on information in the GEIS, the Commission found that

  > Altered current patterns have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, its review of monitoring programs, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS.

- Altered salinity gradients. Based on information in the GEIS, the Commission found that

  > Salinity gradients have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, its review of monitoring programs, or its evaluation of other available information. Therefore, the staff

concludes that there are no impacts related to these issues beyond those discussed in the GEIS.

- Temperature effects on sediment transport capacity. Based on information in the GEIS, the Commission found that

  > Temperature effects on sediment transport capacity have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, its review of monitoring programs, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS.

- Scouring caused by discharged cooling water. Based on information in the GEIS, the Commission found that

  > Scouring has not been found to be a problem at most operating nuclear power plants and has caused only localized effects at a few plants. It is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, its review of monitoring programs, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of scouring during the renewal term beyond those discussed in the GEIS.

- Eutrophication. Based on information in the GEIS, the Commission found that

  > Eutrophication has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS.

- Discharge of chlorine or other biocides. Based on information in the GEIS, the Commission found that

> Effects are not a concern among regulatory and resource agencies, and are not expected to be a problem during the license renewal term.

The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, its evaluation of other available information, including the National Pollutant Discharge Elimination System (NPDES) permit for Surry Power Station (Permit No. VA0004090; Virginia Department of Environmental Quality [VDEQ] 2001), or consultation with the NPDES compliance office. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS.

- Discharge of sanitary wastes and minor chemical spills. Based on information in the GEIS, the Commission found that

> Effects are readily controlled through NPDES permit and periodic modifications, if needed, and are not expected to be a problem during the license renewal term.

The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, its evaluation of other available information, including the NPDES permit for Surry Power Station (Permit No. VA0004090; VDEQ 2001) or consultation with the NPDES compliance office. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS.

- Discharge of other metals in wastewater. Based on information in the GEIS, the Commission found that

> These discharges have not been found to be a problem at operating nuclear power plants with cooling-tower-based heat dissipation systems and have been satisfactorily mitigated at other plants. They are not expected to be a problem during the license renewal term.

The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information, including the NPDES permit for Surry Power Station (Permit No. VA0004090; VDEQ 2001), or consultation with the NPDES compliance office. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS.

- Water-use conflicts (plants with once-through cooling systems). Based on information in the GEIS, the Commission found that

> These conflicts have not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems.

The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS.

- Accumulation of contaminants in sediments or biota. Based on information in the GEIS, the Commission found that

> Accumulation of contaminants has been a concern at a few nuclear power plants but has been satisfactorily mitigated by replacing copper alloy condenser tubes with those of another metal. It is not expected to be a problem during the license renewal term.

The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of accumulation of contaminants in sediments or biota during the renewal term beyond those discussed in the GEIS.

- Entrainment of phytoplankton and zooplankton. Based on information in the GEIS, the Commission found that

> Entrainment of phytoplankton and zooplankton has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.

The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of entrainment of phytoplankton and zooplankton during the renewal term beyond those discussed in the GEIS.

- Cold shock. Based on information in the GEIS, the Commission found that

> Cold shock has been satisfactorily mitigated at operating nuclear plants with once-through cooling systems, has not endangered fish populations or been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds, and is not expected to be a problem during the license renewal term.

The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of cold shock during the renewal term beyond those discussed in the GEIS.

- Thermal plume barrier to migrating fish. Based on information in the GEIS, the Commission found that

  > Thermal plumes have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of thermal plumes on migrating fish during the renewal term beyond those discussed in the GEIS.

- Distribution of aquatic organisms. Based on information in the GEIS, the Commission found that

  > Thermal discharge may have localized effects but is not expected to effect the larger geographical distribution of aquatic organisms.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of thermal discharge on aquatic organisms during the renewal term beyond those discussed in the GEIS.

- Premature emergence of aquatic insects. Based on information in the GEIS, the Commission found that

  > Premature emergence has been found to be a localized effect at some operating nuclear power plants but has not been a problem and is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts concerning premature emergence of aquatic insects during the renewal term beyond those discussed in the GEIS.

- Gas supersaturation (gas bubble disease). Based on information in the GEIS, the Commission found that

  > Gas supersaturation was a concern at a small number of operating nuclear power plants with once-through cooling systems but has been satisfactorily mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of gas supersaturation during the renewal term beyond those discussed in the GEIS.

- Low dissolved oxygen in the discharge. Based on information in the GEIS, the Commission found that

  > Low dissolved oxygen has been a concern at one nuclear power plant with a once-through cooling system but has been effectively mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of low dissolved oxygen during the renewal term beyond those discussed in the GEIS.

- Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses. Based on information in the GEIS, the Commission found that

  > These types of losses have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of losses from predation, parasitism, and disease among organisms exposed to sub-lethal stresses during the renewal term beyond those discussed in the.GEIS.

- Stimulation of nuisance organisms. Based on information in the GEIS, the Commission found that

  > Stimulation of nuisance organisms has been satisfactorily mitigated at the single nuclear power plant with a once-through cooling system where previously it was a problem. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts involving the stimulation of nuisance organisms during the renewal term beyond those discussed in the GEIS.

- Noise. Based on information in the GEIS, the Commission found that

  > Noise has not been found to be a problem at operating plants and is not expected to be a problem at any plant during the license renewal term.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of noise during the renewal term beyond those discussed in the GEIS.

The Category 2 issues related to cooling system operation during the renewal term that are applicable to Surry Units 1 and 2 are listed in Table 4-2 and are discussed below in Sections 4.1.1, 4.1.2, and 4.1.3.

Table 4-2. Category 2 Issues Applicable to the Operation of the Surry Power Station Cooling System During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
AQUATIC ECOLOGY (FOR PLANTS WITH COOLING POND HEAT-DISSIPATION SYSTEMS)			
Entrainment of fish and shellfish in early life stages	4.2.2.1.2; 4.3.3	B	4.1.1
Impingement of fish and shellfish	4.2.2.1.3; 4.3.3	B	4.1.2
Heat shock	4.2.2.1.4; 4.3.3	B	4.1.3

4.1.1 Entrainment of Fish and Shellfish in Early Life Stages

For plants with once-through cooling systems, entrainment of fish and shellfish in early life stages into cooling-water systems associated with nuclear power plants is considered a Category 2 issue, requiring a site-specific assessment prior to license renewal. The staff independently reviewed the VEPCo ER (VEPCo 2001b), visited the site, and reviewed the NPDES Permit No. VA0004090, issued by the Virginia Department of Environmental Quality (VDEQ) on November 2, 2001, that expires November 1, 2006 (VDEQ 2001).

In response to requirements set by the Virginia State Water Control Board, VEPCo submitted a Clean Water Act (CWA) Section 316(b) demonstration for Surry Power Station on November 1, 1980 (VEPCo 1980).

Fish egg and larval entrainment studies were conducted by the Virginia Institute of Marine Sciences (VIMS) for VEPCo from April 1975 through December 1978, although the first year was devoted primarily to investigating appropriate sampling gear and standardizing sampling techniques. Studies were designed to assess the species and quantities of ichthyoplankton entrained into the intake cooling-water flow and passed through the power station. Samples were collected at surface, midwater, and bottom depths in the low-level intake forebay, and at mid-channel in the discharge canal.

The tidal James River contains meroplanktonic forms of marine, estuarine, and freshwater fish and shellfish species. Relatively few fish eggs and larvae, however, are found in the vicinity of Surry Power Station. True estuarine species generally spawn in waters with a salinity greater than 5 ppt, while freshwater forms generally spawn in waters less than 0.5 ppt (VEPCo 1977). Salinities in the vicinity of Surry Power Station are usually between these two values, although they can vary from 0 ppt to 17 ppt. Freshwater inflow and tidal action, however, result in the presence of limited numbers of both estuarine and freshwater eggs and larvae in this transition zone. Of those found, numbers and individuals of species are generally at their highest during late summer and early fall. Shellfish, including the American oyster *(Crassostrea virginica)* and hard clam *(Mercenaria mercenaria),* occur primarily in higher saline areas downstream of Surry Power Station. Larval stages of these species may be transported by tidal action to the transition zone in the vicinity of Surry Power Station, but this represents a very limited number of organisms (VEPCo 1977). Freshwater inflow may also contribute limited numbers of the introduced Asiatic clam *(Corbicula* sp.) to the transition zone. The indigenous brackish water clam *(Rangia cuneata)* does spawn in the transition zone, with egg and larval stages tending to cluster within the zone of salinity tolerance, which ranges between 0 and 5 ppt (VEPCo 1977). *R. cuneata* dominate the benthic community in the vicinity of Surry Power Station, indicating that their population is not severely impacted by entrainment of larval forms.

During the 3-year sampling period, a total of 45 ichthyoplankton taxa were sampled, with 38 identified to species. No threatened or endangered species were recorded (VEPCo 1980). The greatest concentrations of both eggs and larvae were recorded at midwater and bottom depths. Egg and larvae of the bay anchovy *(Anchoa mitchilli)* and larvae of the naked goby *(Gobiosoma bosci)* were the most abundant ichthyoplankton in the vicinity of Surry Power Station, comprising 64.5 percent and 26.6 percent respectively, of all samples collected between 1976 and 1978. Both species have centers of abundance downstream of Surry Power Station. Other species collected regularly in entrainment samples include the Atlantic croaker *(Micropogon undulatus)*, spot *(Leiostomus xanthurus)*, Atlantic menhaden *(Brevoortia tyrannus)*, Atlantic silverside *(Menidia menidia)*, inland silverside *(M. beryllina)*, rough silverside *(Membras marinica)*, striped bass *(Morone saxatilis)*, and white perch *(M. americana)*. Generally, ichthyoplankton entrainment by the Surry Power Station cooling-water intake system was determined to be seasonal. Maximum concentrations of eggs were collected between mid-May and late July. Maximum concentrations of larvae were collected between late July and mid-August. Bay anchovy eggs were collected at a mean maximum concentration of 62.6/m^3 (1.8/ft^3) during the 3-year study, while the mean maximum larval concentration was 7/m^3 (0.2/ft^3). The mean maximum naked goby larval concentration during the study period was 25.7/m^3 (0.7/ft^3). Other regularly collected species did not occur in concentrations approaching those of the bay anchovy and naked goby. In general, most other species were captured in concentrations less than 2/m^3 (0.06/ft^3).

To put the entrainment of these species in perspective, it is important to note that most of the species entrained spawn well outside the region associated with the Surry Power Station cooling-water intake system. For example, bay anchovy exhibit peak spawning activity at salinities between 10 and 20 ppt and have little spawning success at salinities less than 5 ppt (Wang and Kernehan 1979). During the primary spawning season at Surry Power Station, salinities were typically well below 10 ppt. This indicates that the major spawning ground of the bay anchovy lies well downstream of Surry Power Station, and the Surry cooling-water intake system should have little effect on the mortality of bay anchovy eggs. The same is true for naked goby spawning areas. Thus, even though eggs and larvae were entrained at Surry Power Station, the ichthyoplankton likely did not originate from the primary spawning areas and represented a very small portion of the James River population as a whole. In addition, the low salinities in the vicinity of the Surry Power Station cooling-water intake may even indicate that many of the eggs entrained were already dead or would soon have died (VEPCo 1980). Overall, based on supplementary data (monthly haul seine, monthly otter trawl, and special haul seine studies) on James River fish populations, any losses due to entrainment have resulted in no detectable effect on juvenile and adult fish populations in the vicinity of Surry Power Station (VEPCo 1980).

The staff has reviewed the available information and, based on the results of entrainment studies and operating history of the Surry Power Station intake, the staff concludes that the

potential impacts of the cooling-water intake system's entrainment of fish and shellfish in the early life stages are SMALL and mitigation is not warranted.

4.1.2 Impingement of Fish and Shellfish

For plants with once-through cooling systems, impingement of fish and shellfish on debris screens of cooling-water systems associated with nuclear power plants is considered a Category 2 issue, requiring a site-specific assessment.

The staff independently reviewed the VEPCo ER (VEPCo 2001b), visited the site, and reviewed NPDES Permit No. VA0004090 (VDEQ 2001).

In 1974, approximately 2 years after Unit 1 came on line, VEPCo upgraded its traveling screen system at Surry to incorporate specially designed Ristroph traveling screens. Each of the eight low-level bays, located at the shoreline (western) end of the dredged intake channel, is equipped with a Ristroph screen that consists of 47 panels. Each panel is 4.5 m by 0.6 m (15 ft by 2 ft) and has a rectangular screen mesh size of 0.5 cm by 1.3 cm (3/16 in. by 1/2 in.) (VEPCo 1980, VEPCo 2002). The Ristroph screens rotate continuously at a speed of 3 m/min (10 ft/min). A low-pressure spray system gently washes fish from the screen into an underwater pipe, through which they are returned to the river. Thus, impinged fish and shellfish are quickly removed and mortality is reduced. All of the original carbon steel trash racks have been replaced with stainless steel units with fiberglass buckets. All eight screen structures are being refurbished to incorporate new fish deflectors and troughs to update the system to the current best technology to minimize adverse environmental impacts (VEPCo 2001b).

Studies regarding potential impacts from operation of the Surry Power Station cooling-water intake system were conducted between 1970 and 1978 as required for submission of the CWA Section 316(b) demonstration that was submitted by VEPCo to the Virginia State Water Control Board in 1980 and approved based on issuance of the Surry Power Station NPDES permit (VDEQ 2001). Studies were conducted by academic and private research organizations, as well as by in-house scientific staff. Research focused on ichthyofauna of the James River in the vicinity of Surry Power Station and included monthly haul seine, monthly otter trawl, special haul seine, impingement, and entrainment programs. Specifically, the impingement program provided almost daily sampling data from May 1974 through December 1978 and characterized the number, biomass, and diversity of the finfishes, principally young-of-the-year, impinged by the Surry cooling-water intake structure. The impingement studies indicated that approximately 94 percent of all finfishes impinged on the Ristroph traveling screens were returned alive to the James River (VEPCo 1980). Only five species displayed survival rates of less than 80 percent, and none of these species occurred with any regularity in the study area (VEPCo 1980). Five species were most commonly impinged and accounted for 70 percent of all fish impinged between 1974 and 1978. These five species included the spot *(Leiostomus xanthurus)*

(21.8 percent of the estimated total fish sampled), Atlantic menhaden *(Brevoortia tyrannus)* (18.7 percent), blueback herring *(Alosa aestivalis)* (11.1 percent), threadfin shad *(Dorosoma petenense)* (11.0 percent), and bay anchovy *(Anchoa mitchilli)* (7.4 percent). An additional 68 species made up the remaining 30 percent of fish sampled. The five major species exhibited a 91.9-percent survival rate, but also accounted for a total of 79.1 percent of all dead fish collected at the low-level intake structure. Some species were obviously hardier than others when subjected to impingement. Delayed mortality was studied (with recovery periods up to 96 hours) and found not to be significant (VEPCo 1980). No threatened or endangered species were collected from the low-level intake structure between 1974 and 1978 (VEPCo 1980).

To assess the impact of impingement mortality by the Surry cooling-water intake system, impingement losses were related to known fish population data and commercial stock data (VEPCo 1980). Specifically, relative losses of three of the five major species (blueback herring, Atlantic menhaden, and spot) were investigated. The other two species are not of commercial value and sufficient data were not available to analyze the impact of their impingement losses. It was estimated that Surry Power Station accounted for a loss of 0.0033 percent of the James River standing crop of blueback herring in 1975, 0.0003 percent of the total Virginia commercial landings of Atlantic menhaden in 1976, and 0.1 percent of total Virginia commercial landings of spot in 1976. While the loss of any fish is undesirable, the loss of these three most numerous species can be considered of minimal significance to the overall James River fishery.

After nearly 5 years of impingement sampling at Surry Power Station, no consistent seasonal and/or annual trend in the number of fish impinged was evident. Natural population fluctuations, as reported in the impingement and other fish-sampling studies, are to be expected and are characteristic of the natural variability inherent in this transitional area and in the occurring species.

VIMS researcher, J. Olney, reported that Army Corps of Engineers data collected during a study at Goose Hill Channel in 2000 were consistent with VIMS data (1996-2000) regarding the distribution and abundance of fish in the vicinity of the Surry Power Station. He did not consider impingement of fishes to be a significant issue at the Surry Power Station (VEPCo 2001b).

Several crab and shrimp species may be found in the vicinity of the Surry Power Station cooling- water intake structure; however, they occur only sporadically in the transition zone, with populations concentrated downstream in more saline waters. Thus, it is unlikely that individuals impinged on the intake screens constitute a significant portion of the population.

The staff has reviewed the available information relative to potential impacts of the cooling-water intake on the impingement of fish and shellfish, and based on these data, concludes that the potential impacts are SMALL and mitigation is not warranted.

4.1.3 Heat Shock

For plants with once-through cooling systems, the effects of heat shock are listed as a Category 2 issue and require plant-specific evaluation.

The staff independently reviewed the VEPCo ER (VEPCo 2001b), visited the site, and reviewed NPDES Permit No. VA0004090 (VDEQ 2001). This permit limits the amount of waste heat discharged to the James River by Surry Power Station to 12.6 × 10^9 Btu/hr, but does not require reporting of discharge temperatures. The maximum temperature elevation of the water as a result of passing through the condensers is approximately 7.8°C (14°F) (VEPCo 1980). Upon discharge, the heated water mixes with river water in a 335-m (1100-ft) discharge canal lined with concrete and surrounded by a rock-filled groin with a reduced-size exit that guarantees the water will be discharged with a jetting action of 1.8 m/s (5.9 ft/s) at the end of the rock groin. The CWA Section 316(a) report produced by VEPCo in 1977 stated the highest temperature recorded in the Surry Power Station discharge canal was 37.7°C (99.9°F). Temperatures between 33.8° and 37.7°C (92.8° and 99.9°F) are considered typical of those observed in the discharge canal in summer (June through September) when Surry Power Station is running at or near full power. Outside the discharge canal, however, the effluent loses approximately 0.5° to 1.0°C (1° to 2°F) every 305 m (1000 ft) away from the mouth of the discharge canal, with thermal plume patterns dependent on the current flow regime of the estuary, and the associated water densities and temperature, wind velocity, ambient air temperature, and relative humidity.

VEPCo submitted a CWA Section 316(a) demonstration for Surry Power Station to the Virginia State Water Control Board on September 1, 1977 (VEPCo 1977). Part I.C.16 of the current Surry Power Station NPDES (VDEQ 2001) permit refers to this submittal, indicating effluent limitations that are "more stringent than the thermal limitations included in the permit are not necessary to assure the protection and propagation of a balanced indigenous community of shellfish, fish, and wildlife in the James River."

The site layout for Surry Power Station is different from that of other nuclear plants with once-through cooling systems. At Surry Power Station, the heated water effluent is discharged approximately 10 km (6 mi) upstream of the cooling-water intake structure. This design was implemented to protect oyster beds, located downstream from the current intake structure and in more saline water, from being affected by the thermal plume.

Surry Power Station began preoperational field studies in 1969 to examine fish populations, benthic communities, fouling organisms, zooplankton, and phytoplankton. The studies continued through several years of station operation (startup in 1972), with sample frequency ranging from daily to annually, based on the trophic level investigated. The studies were designed to indicate if the thermal effluent from Surry Power Station caused appreciable harm

to the fish, shellfish, and wildlife in the James River. Fish were sampled using beach seines and otter trawls on a monthly basis during preoperational monitoring. Postoperative studies also sampled fish at the low-level cooling-water intake screens, usually 5 days per week between 1972 and 1976. Benthic macroinvertebrates, including shellfish, were sampled using a Van Veen grab.

In addition, a comprehensive, 5-year study (2 years preoperational and 3 years operational) was conducted by VIMS to document the thermal effects of Surry Power Station (Fang and Parker 1976). Temperature distribution in the James River in the vicinity of Surry Power Station was measured with stationary recorders affixed to towers or buoys in the river and by a monthly boat survey that measured water temperatures just downstream of the intake to the vicinity of Jamestown Island, located upstream of the discharge. The results indicated that the thermal plume stays close to shore and extends around Hog Point on an ebb tide, and moves upstream and offshore on flood tide (Fang and Parker 1976). Excess temperatures always covered less than 30 percent of the river surface in the survey area adjacent to the discharge point. All excess temperatures (defined as 2.8°C [5°F] or more above ambient) decreased rapidly with increased distance from the outfall, and temperatures outside the mixing zone (914 m [3000 ft] from the outfall) were rarely greater than this limit (Fang and Parker 1976).

The fisheries research conducted by VIMS concluded that the fish community around Surry Power Station is diverse and dynamic, changing monthly and seasonally between species and sizes of individuals within species (VEPCo 1977). A nonparametric comparison between preoperational and postoperational diversity indices showed either no significant difference in the means or that preoperational means were significantly ($p < 0.05$) less than postoperational means. Over an extended period of time, natural and man-made disturbances resulted in relatively short-term changes to fish populations in the transition zone around Surry Power Station, and the young fish population has remained relatively diverse and stable. Thus, it was concluded that the operation of Surry Power Station, in particular the discharge of heated effluent, caused no appreciable harm to the fish community in the area.

Based on the results of post-operational studies, the noncommercial clam *(Rangia cuneata)* was found in abundance in the James River near Surry Power Station. The American oyster *(Crassostrea virginica)* was found downstream of the site in more saline waters, and the blue crab *(Callinectes sapidus)* occurred only sporadically in the vicinity of the site. Consequently, these species were not significantly affected by thermal discharges resulting from operation of Surry Units 1 and 2. Studies by VIMS (Jordan et al. 1976, 1977) concluded that *R. cuneata* showed no preference or avoidance of the cooling water discharge region, but instead revealed a preference for silty-clay substrates (VEPCo 1977).

The staff concludes that the potential heat shock impacts resulting from operation of the plant's cooling-water discharge system to the aquatic environment on or in the vicinity of the site are SMALL and that mitigation is not warranted.

4.2 Transmission Lines

VEPCo's ER (VEPCo 2001b) discussed nine transmission lines with a total length of 480 km (300 mi) that connect Surry Power Station to eight substations within the local transmission system. These lines are located on 270 km (170 mi) of corridor on approximately 1900 ha (5000 ac). Transmission corridor rights-of-way are generally maintained on a 3-year cycle. Mechanical mowing and selective herbicide application are the standard methods of corridor maintenance. Hand-cutting and/or nonrestricted-use herbicides are used in areas where mowing is impractical or undesirable (e.g., wetlands and densely vegetated areas). However, herbicides are not used in corridors crossing the Great Dismal Swamp National Wildlife Refuge or the Ragged Island Wildlife Management Area. VEPCo cooperates with the Virginia Department of Conservation and Recreation's Natural Heritage Program to identify rare and sensitive plant species along the transmission corridors so that adverse impacts to these may be avoided during corridor maintenance (VEPCo 2001b).

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to the Surry transmission lines are listed in Table 4-3. VEPCo stated in its ER that it is not aware of any new and significant information associated with the renewal of the Surry Units 1 and 2 OLs. The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of those issues, the GEIS concluded that the impacts are SMALL, and plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

A brief description of the staff's review and GEIS conclusions, as codified in Table B-1, for each of these issues follows:

- Power line right-of-way management (cutting and herbicide application). Based on information in the GEIS, the Commission found that

  > The impacts of right-of-way maintenance on wildlife are expected to be of small significance at all sites.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, discussions with the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS), or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of power line right-of-way management during the renewal term beyond those discussed in the GEIS.

Table 4-3. Category 1 Issues Applicable to the Surry Power Station Transmission Lines During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
TERRESTRIAL RESOURCES	
Power line right-of-way management (cutting and herbicide application)	4.5.6.1
Bird collisions with power lines	4.5.6.2
Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	4.5.6.3
Flood plains and wetland on power line right-of-way	4.5.7
AIR QUALITY	
Air-quality effects of transmission lines	4.5.2
LAND USE	
Onsite land use	4.5.3
Power line right-of-way	4.5.3

- Bird collisions with power lines. Based on information in the GEIS, the Commission found that

  > Impacts are expected to be of small significance at all sites.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of bird collisions with power lines during the renewal term beyond those discussed in the GEIS.

- Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock). Based on information in the GEIS, the Commission found that

  > No significant impacts of electromagnetic fields on terrestrial flora and fauna have been identified. Such effects are not expected to be a problem during the license renewal term.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of

electromagnetic fields on flora and fauna during the renewal term beyond those discussed in the GEIS.

- Flood plains and wetlands on power line right-of-way. Based on information in the GEIS, the Commission found that

  > Periodic vegetation control is necessary in forested wetlands underneath power lines and can be achieved with minimal damage to the wetland. No significant impact is expected at any nuclear power plant during the license renewal term.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, discussions with FWS, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts on flood plains and wetland on the power line right-of-way during the renewal term beyond those discussed in the GEIS.

- Air-quality effects of transmission lines. Based on the information in the GEIS, the Commission found that

  > Production of ozone and oxides of nitrogen is insignificant and does not contribute measurably to ambient levels of these gases.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no air-quality impacts of transmission lines during the renewal term beyond those discussed in the GEIS.

- Onsite land use. Based on the information in the GEIS, the Commission found that

  > Projected onsite land use changes required during ... the renewal period would be a small fraction of any nuclear power plant site and would involve land that is controlled by the applicant.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no onsite land-use impacts during the renewal term beyond those discussed in the GEIS.

- Power line right-of-way (land use). Based on information in the GEIS, the Commission found that

Ongoing use of power line right of ways would continue with no change in restrictions. The effects of these restrictions are of small significance.

The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of restriction on use of power line rights-of-way during the renewal term beyond those discussed in the GEIS.

There is one Category 2 issue related to transmission lines, and another issue related to transmission lines is being treated as a Category 2 issue. These issues are listed in Table 4-4 and are discussed in Sections 4.2.1 and 4.2.2.

Table 4-4. Category 2 and Uncategorized Issues Applicable to the Surry Power Station Transmission Lines During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
HUMAN HEALTH			
Electromagnetic fields, acute effects (electric shock)	4.5.4.1	H	4.2.1
Electromagnetic fields, chronic effects	4.5.4.2	NA	4.2.2

4.2.1 Electromagnetic Fields—Acute Effects

In the GEIS (NRC 1996), the staff found that without a review of the conformance of each nuclear plant transmission line with National Electrical Safety Code (NESC 1997) criteria, it is not possible to determine the significance of the electric shock potential. Evaluation of individual plant transmission lines is necessary because the issue of electric shock safety was not addressed in the licensing process for some plants. For other plants, land use in the vicinity of transmission lines may have changed, or power distribution companies may have chosen to upgrade line voltage. To comply with 10 CFR 51.53(c)(3)(ii)(H), an applicant must provide an assessment of the potential shock hazard if the transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the NESC for preventing electric shock from induced currents.

There are nine transmission lines that were built to connect Surry Power Station to the transmission system. Six of these lines are 230-kV transmission lines, and the remaining three lines are 500-kV transmission lines. The current NESC (1997) requires that transmission lines be designed to limit the steady-state current due to electrostatic effects to 5 mA root mean square (rms). At the time they were constructed, the lines were designed in accordance with

the 6th edition of the National Electric Safety Code (NESC 1961). Therefore, to check compliance with NESC 1997, VEPCo calculated the field strength and induced current for the limiting case for each transmission line. Finding the limiting case involved consideration of rights-of-way, number of lines at each location, and ground clearance.

For each line, VEPCo calculated the field strength and induced current for the limiting case using a computer code called ENG01814, developed by Cincinnati Gas and Electric Company (1991). For five of the transmission lines, the limiting-case induced currents listed in the ER (VEPCo 2001b) were within the 5-mA rms limit of the current NESC. The calculated induced currents for the remaining four lines reported in the ER were 5.07 mA. All of these calculations were made assuming voltages 5 percent above the nominal value. When the nominal voltages are assumed, all limiting-case induced currents are within the 5-mA rms limit of the current NESC.

The staff notes that the industry standard setting for ground-fault circuit interrupters is 6 mA and that the uncertainty in the calculated currents is larger than the amount by which the limiting-case induced currents exceed the NESC limits. Therefore, the staff concludes that the impact of the potential for electric shock is SMALL, and mitigation is not warranted.

4.2.2 Electromagnetic Fields—Chronic Effects

In the GEIS, the chronic effects of 60-Hz electromagnetic fields from power lines were not designated as Category 1 or 2, and will not be until a scientific consensus is reached on the health implications of these fields.

The potential for chronic effects from these fields continues to be studied and is not known at this time. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the U.S. Department of Energy (DOE). A recent report (NIEHS 1999) contains the following conclusion:

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

This statement is not sufficient to cause the staff to change its position with respect to the chronic effects of electromagnetic fields. The staff considers the GEIS finding of "not applicable" still appropriate and will continue to follow developments on this issue.

4.3 Radiological Impacts of Normal Operations

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to Surry Units 1 and 2 with regard to radiological impacts are listed in Table 4-5. VEPCo stated in its ER (VEPCo 2001b) that it is not aware of any new and significant information associated with the renewal of the Surry OLs. No significant new information has been identified by the staff during its independent review. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the GEIS concluded that the impacts are SMALL, and plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-5. Category 1 Issues Applicable to Radiological Impacts of Normal Operations During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
HUMAN HEALTH	
Radiation exposures to public (license renewal term)	4.6.2
Occupational radiation exposures (license renewal term)	4.6.3

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, for each of these issues follows:

- Radiation exposures to public (license renewal term). Based on information in the GEIS, the Commission found that

  > Radiation doses to the public will continue at current levels associated with normal operations.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of radiation exposures to the public during the renewal term beyond those discussed in the GEIS.

- Occupational radiation exposures (license renewal term). Based on information in the GEIS, the Commission found that

  > Projected maximum occupational doses during the license renewal term are within the range of doses experienced during normal operations and normal maintenance outages, and would be well below regulatory limits.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of occupational radiation exposures during the renewal term beyond those discussed in the GEIS.

There are no Category 2 issues related to radiological impacts of routine operations.

4.4 Socioeconomic Impacts of Plant Operations During the License Renewal Term

Category 1 socioeconomic issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 during the renewal term are listed in Table 4-6. These do not require further analysis of impacts unless significant new information is developed about them. VEPCo stated in its ER (VEPCo 2001b) that it is not aware of any new and significant information associated with the renewal of Surry Units 1 and 2. The staff in their independent review has identified no significant new information. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of those issues, the GEIS concluded that the impacts are SMALL, and plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-6. Category 1 Socioeconomic Issues Applicable to the Operation of the Surry Power Station During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
Public services, public safety, social services, and tourism and recreation	4.7.3; 4.7.3.3; 4.7.3.4; 4.7.3.6
Public services, education (license renewal term)	4.7.3.1
Aesthetic impacts (license renewal term)	4.7.6
Aesthetic impacts of transmission lines (license renewal term)	4.5.8

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, for each of these issues follows:

- Public services-public safety, social services, and tourism and recreation. Based on information in the GEIS, the Commission found that

  > Impacts to public safety, social services, and tourism and recreation are expected to be of small significance at all sites.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts on public safety, social services, and tourism and recreation during the renewal term beyond those discussed in the GEIS.

- Public services-education (license renewal term). Based on information in the GEIS, the Commission found that

  > Only impacts of small significance are expected.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts on education during the renewal term beyond those discussed in the GEIS.

- Aesthetic impacts (license renewal term). Based on information in the GEIS, the Commission found that

  > No significant impacts are expected during the license renewal term.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no aesthetic impacts during the renewal term beyond those discussed in the GEIS.

- Aesthetic impacts of transmission lines (license renewal term). Based on information in the GEIS, the Commission found that

  > No significant impacts are expected during the license renewal term.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of

other available information. Therefore, the staff concludes that there are no aesthetic impacts of transmission lines during the renewal term beyond those discussed in the GEIS.

Table 4-7 lists the Category 2 socioeconomic issues, which require an analysis of potential plant-specific impacts and an analysis of environmental justice, which was not addressed in the GEIS.

Table 4-7. Environmental Justice and Category 2 Issues Applicable to Socioeconomics During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
Housing impacts	4.7.1	I	4.4.1
Public service, public utilities	4.7.3.5	I	4.4.2
Offsite land use (license renewal term)	4.7.4	I	4.4.3
Public services, transportation	4.7.3.2	J	4.4.4
Historic and archaeological resources	4.7.7	K	4.4.5
Environmental justice	Not addressed	Not applicable	4.4.6

4.4.1 Housing Impacts During Operations

10 CFR Part 51, Subpart A, Appendix B, Table B-1, states that impacts on housing availability are expected to be of small significance at plants located in a high-population area where growth-control measures are not in effect. SMALL impacts result when no discernible change in housing availability occurs, changes in rental rates and housing values are similar to those occurring statewide, and no housing construction or conversion is required to meet new demand (NRC 1996). Increases in rental rates or housing values in these areas would be expected to equal or slightly exceed the statewide inflation rate. No extraordinary construction or conversion of housing would occur where SMALL impacts are foreseen.

The impacts on housing are considered to be of MODERATE significance when there is a discernible, but short-lived, reduction in available housing units because of project-induced in-migration. The impacts on housing are considered to be of LARGE significance when project-related demand for housing units would result in very limited housing availability and would increase rental rates and housing values well above normal inflationary increases in the state. MODERATE and LARGE impacts are possible at sites located in rural and remote areas, at sites located in areas that have experienced extremely slow population growth (and thus slow

or no growth in housing), or where growth control measures that limit housing development are in existence or have been recently lifted. Because impact significance depends on local conditions, housing is a Category 2 issue (NRC 1996).

The NRC has developed a method of characterizing population that is based on two factors: sparseness and proximity (NRC 1996, Section C.1.4). Sparseness measures population density and city size within 32 km (20 mi) of the site. Proximity measures population density and city size within 80 km (50 mi) of the site. In these calculations, the density is averaged over the land area covered by the ring; large water bodies are excluded. Each factor has categories of density and size (NRC 1996, Table C.1), and a matrix is used to rank the population category as low, medium, or high (NRC 1996, Figure C.1).

When the ER was prepared by VEPCo, the 2000 census data were not yet published, so 1990 data was used to determine demographic characteristics in the vicinity of Surry Power Station. The Census 2000 PL-94 and SF-1 general population characteristics data have become available since publication of the ER, and the staff has used these data in its analysis. Income data are still not available for the 2000 census, so 1990 census data were used.

An analysis of the 2000 census data[(a)] indicates that 416,284 people live within a 32-km (20-mi) radius of Surry Power Station, with an average population density of 171 persons per km^2 (442 persons per mi^2). There are also two communities of 25,000 or more in this area. This population density and number of cities corresponds to sparseness Category 4, "least sparse." An analysis of the 2000 census data also indicates that 2,183,481 people live within 80 km (50 mi) of Surry Power Station, with an average population density of 143 persons per km^2 (371 persons per mi^2). There are six cities with populations of 100,000 or more in this area. This population density and number of cities correspond to proximity Category 4, "in close proximity." According to the GEIS (NRC 1996), these sparseness and proximity scores indicate that the Surry Power Station is located in a high-population area. In addition, neither Surry County nor the surrounding counties (Isle of Wight and James City) nor the city of Newport News are subject to growth-control measures that would limit housing development. Based on these factors, the NRC staff would expect the housing impacts to be SMALL during continued operation.

VEPCo (VEPCo 2001b) has made the case for considering only 60 new employees total for both Surry Units 1 and 2 for the license renewal term, rather than the standard GEIS

(a) Using geographic information systems software to identify Block Groups from Census 2000 that are within a radius of 32 km (20 mi) and 80 km (50 mi) of Surry Power Station and dividing the total population in these Block Groups by the land area (major water bodies excluded) in them.

assumption of 60 new employees per unit.[a] Adding full-time employees to the plant workforce for the license renewal operating term would have the potential indirect effect of creating additional jobs and related population growth in the community. VEPCo has used an employment multiplier of 1.9 (VEPCo 2001b) to calculate the total direct and indirect jobs in service industries that would be supported by the spending of the Surry Power Station workforce. The addition of 60 license- renewal employees would generate approximately 54 indirect jobs, assumed for purposes of this analysis to be distributed in the potentially impacted communities of Isle of Wight, James City, and Surry Counties and the City of Newport News. This number was calculated as follows:

60 (additional employees) × 1.9 (regional multiplier) = 114 (total employees). Of these, 60 would be direct employees and 54 would be indirect (VEPCo 2001b). This multiplier was confirmed by the staff as appropriate for the Surry County area.[b]

Surry County has a higher housing unit vacancy rate in every category than surrounding counties, as reported by Census 2000 (USCB 2000), indicating that a modest increase in employment would not negatively impact housing in the area. The assumed population increase associated with license renewal will not create a discernible change in housing availability, change in rental rates or housing values, or spur new construction or conversion. VEPCo concluded that impacts to housing availability resulting from plant-related population growth would be small and would not warrant mitigation (VEPCo 2001b).

The staff reviewed the available information relative to housing impacts and VEPCo's conclusions. Based on this review, the staff concludes that the impact on housing during the license renewal period would be SMALL, and mitigation is not warranted.

(a) VEPCo expects the existing "surge" capabilities for routine activities, such as outages, will enable VEPCo to perform the increased surveillance, (online) monitoring, inspections, testing, trending, and recordkeeping (SMITTR) workload without adding Surry Power Station staff. For the purpose of performing its own analyses in this environmental report, VEPCo is adopting the GEIS approach with one alteration. Plant modifications during license renewal would be SMITTR activities that would be performed mostly during outages, and VEPCo would generally stagger Surry Power Station outage schedules so that both units would not be down at the same time. No plant facility modifications are anticipated. Therefore, VEPCo believes it is unreasonable to assume that each unit would need an additional 60 workers. Instead, VEPCo is assuming that Surry Power Station would require no more than a total of 60 additional permanent workers to perform all license renewal SMITTR activities.

(b) Personal communication with John W. Whaley, Deputy Executive Director—Economics, Hampton Roads Planning District Commission staff, December 2001.

4.4.2 Public Services: Public Utility Impacts During Operations

Impacts on public utility services are considered SMALL if there is little or no change in the ability of the system to respond to the level of demand, and, thus, there is no need to add capital facilities. Impacts are considered MODERATE if overtaxing of service capabilities occurs during periods of peak demand. Impacts are considered LARGE if existing levels of service (e.g., water or sewer services) are substantially degraded and additional capacity is needed to meet ongoing demands for services. The GEIS indicates that, in the absence of new and significant information to the contrary, the only impacts on public utilities that could be significant are impacts on public water supplies (NRC 1996).

Analysis of impacts on the public water supply system considered both plant demand and plant-related population growth. Section 2.2.2 describes the Surry Units 1 and 2 permitted withdrawal rate and actual use of water. Because the Surry Power Station does not use water from a municipal system, VEPCo does not expect it to have an effect on local water supplies. No refurbishment is planned for the Surry Power Station and no refurbishment impacts are, therefore, expected.

VEPCo estimated (VEPCo 2001b) that a potential total increase of 60 license renewal employees could generate 114 new jobs[(a)], and a net overall population increase of 307 as a result of these jobs.[(b)] Using Census 2000 data for persons per household in the counties and independent cities in which Surry Power Station employees live and developing Surry Power Station composite persons per household using the percent of Surry Power Station employees in each jurisdiction, the actual persons per household is 2.58 (rounded to 2.6). The 114 potential new jobs could then mean a total of 296 (rounded to 300) new residents. The plant-related population increase would require an additional 95,000 liters per day (25,000 gpd) of potable water[(c)]. If it were assumed that this increase is distributed across the area of impact and other communities in which Surry Power Station employees live in proportion to current employee trends, the increase in water demand would represent an insignificant percentage of capacity for the water supply systems in these communities (see Section 2.2.8.2). As a result, VEPCo concludes that impacts resulting from plant-related population growth to public water supplies would be SMALL and mitigation measures would not be necessary (VEPCo 2001b).

(a) The VEPCo estimate of 114 housing units is likely to be an "upper bound" estimate. Most of the new jobs would likely be filled by existing area residents, thus creating little net demand for housing.

(b) Calculated assuming that the average number of persons per household is 2.69 (114 jobs × 2.69 = 307).

(c) Calculated assuming the average American uses 80 gallons of water for personal use per day; 307 people × 80 gallons per person/day = 24,560 gpd, or approximately 25,000 gpd.

The staff reviewed the available information relative to public utility impacts and VEPCo's conclusions. Based on this review, the staff concludes that the impact on public utilities during the license renewal period would be SMALL and mitigation is not warranted.

4.4.3 Offsite Land Use During Operations

Offsite land use during the license renewal term is a Category 2 issue (10 CFR 51, Subpart A, Appendix B, Table B-1). Table B-1 of 10 CFR 51 Subpart A, Appendix B, notes that "significant changes in land use may be associated with population and tax revenue changes resulting from license renewal."

Sections 3.7.5 and 4.7.4 of the GEIS define the magnitude of land-use changes as a result of plant operation during the license renewal term as follows:

SMALL – Little new development and minimal changes to an area's land-use pattern.

MODERATE – Considerable new development and some changes to the land-use pattern.

LARGE – Large-scale new development and major changes in the land-use pattern.

Land use and population in the Surry Power Station area of impact (Surry, Isle of Wight, and James City Counties, and the city of Newport News), particularly the areas south of the James River, have not been affected by the Surry Power Station since its installation in 1972. Since the early 1970s, when the Surry Power Station was placed on line, the city of Newport News and James City County, north of the James River, and Isle of Wight County, south of the James River and immediately east of Surry County, have shown positive growth, though at varying rates that more dramatically mirror the Commonwealth of Virginia's growth. Surry, Sussex, South Hampton, and Charles City Counties have shown more inconsistent, even negative growth during this 50-year period. Prince George County has also had both positive and negative growth and is probably influenced more by the development of Petersburg/Colonial Heights/Hopewell than any other influence. Surry Power Station has had no discernable influence on population or population-driven land-use effects in the area.

NRC concludes that all new population-driven land-use changes during the license renewal term at all nuclear plants would be small because population growth caused by license renewal would represent a much smaller percentage of the local area's total population than has operations-related growth (NRC 1996).

Tax revenue can affect land use because it enables local jurisdictions to be able to provide the public services (e.g., transportation and utilities) necessary to support development. Section 4.7.4.1 of the GEIS (NRC 1996) states that the assessment of tax-driven land-use

impacts during the license renewal term should consider (1) the size of the plant's payments relative to the community's total revenues; (2) the nature of the community's existing land-use pattern; and (3) the extent to which the community already has public services in place to support and guide development.

In general, if the plant's tax payments are projected to be small relative to the community's total revenue, new, tax-driven land-use changes during the license renewal period would be SMALL. If the plant's tax payments are projected to be medium to large relative to the community's total revenue, new tax-driven land-use changes would be MODERATE. If the tax payments are projected to be a dominant source of the community's total revenue, new, tax-driven land-use changes would be LARGE (NRC 1996).

Sections 3.7.3 and 4.7.2.1 of the GEIS (NRC 1996) state that if tax payments by the plant owner are less than 10 percent of the taxing jurisdictions revenue, the significance level would be SMALL, MODERATE if the plant tax payments represent 10 to 20 percent, and LARGE if the payments are over 20 percent of the jurisdiction's revenues.

For the 6-year period from 1995 through 2001, VEPCo's tax payments to Surry County represented nearly 75 percent of the County's annual property tax revenue and approximately 50 percent of Surry County's total annual operating budget. VEPCo does not anticipate refurbishment or construction during the license renewal period, and, therefore, does not anticipate any increase in the assessed value of Surry Power Station due to refurbishment related improvements or any related tax-increase-driven changes to offsite land-use and development patterns.

Surry Power Station has been, and will probably continue to be, the dominant source of tax revenue for Surry County. However, despite having this income source since plant construction in 1972, Surry County has not experienced large land-use changes. The Surry Power Station environs have remained largely rural, county population growth rates after Surry Power Station construction have been minimal, and county planners are not projecting large changes. Consequently, VEPCo does not anticipate large land-use changes as a result of these tax revenues (VEPCo 2001b).

The staff reviewed the available information relative to land-use impacts and VEPCo's conclusions. Based on this review, the staff concludes that the impact on land use during the license renewal period would be SMALL, and mitigation is not warranted.

4.4.4 Public Services: Transportation Impacts During Operations

On October 4, 1999, 10 CFR 51.53(c)(3)(ii)(J) and 10 CFR Part 51, Subpart A, Appendix B, Table B-1, were revised to clearly state that "Public Services: Transportation Impacts During

Operations" is a Category 2 issue (see NRC 1999 for more discussion of this clarification). The issue is treated as such in this SEIS.

Access to Surry Power Station is via State Route 650 and State Route 10. The level of service of State Route 650 is characterized as free flow of traffic stream and users are unaffected by the presence of others. At this level, no delays occur and no improvements are needed. A portion of State Route 10 is characterized as having stable flow that marks the beginning of the range of flow in which the operation of individual users is significantly affected by interactions with the traffic stream.

VEPCo projected that up to 60 additional employees might be associated with license renewal for Surry Power Station. This would represent less than a 7 percent increase in the current number of employees. Although the GEIS (NRC 1996) states that a Level of Service C is associated with moderate impacts and upgrades of the roadway or control system may be required, the Virginia Department of Transportation (VDOT) considers that the addition of 60 additional cars daily on State Highways 650 and 10 would not affect the roads' level of service or their operational condition. Consequently, no improvements are needed. In fact, VDOT is initiating a $1.3 million dollar project to widen the lanes and install a left-turn lane at the junction of Highways 10 and 650. In addition, one to two times a year, as many as 700 additional workers join the permanent workforce during periodic refueling. During these times, the meat-packing plants in Smithfield (Isle of Wight County) direct their truck drivers to avoid Highway 10.[(a)]

The staff reviewed VEPCo's assumptions and resulting conclusions. The staff concludes that any impact of Surry Power Station on transportation service degradation is likely to be SMALL and would not require mitigation.

4.4.5 Historic and Archaeological Resources

The National Historic Preservation Act (NHPA) requires Federal agencies to take into account the effects of their undertakings on historic properties. The historic preservation review process mandated by Section 106 of the NHPA is outlined in regulations issued by the Advisory Council on Historic Preservation at 36 CFR Part 800 as amended through 1999. Renewal of an OL could potentially affect historic properties that may be located at the site. Therefore, according to the NHPA, the NRC is required to make a reasonable effort to identify historic properties in the areas of potential effects. If no historic properties are present or affected, the NRC is required to notify the State Historic Preservation Officer (SHPO) before proceeding. If it is determined that historic properties are present, the NRC is required to assess possible adverse

(a) Personal communication with Bill Richardson, Mike Tardy, Ron Pierce, and MacFarland Neiblett, VDOT, September 2001.

effects of the undertaking and consider alternatives to avoid, minimize, or mitigate any adverse effects.

In April 2000, VEPCo wrote to the SHPO with the Virginia Department of Historic Resources (VDHR), requesting their comment on the license renewal process on cultural resources for both the Surry and North Anna Power Stations (VEPCo 2000). Meetings by VEPCo which directly involved VDHR were held during the period of November 2000 through February 2001. On January 11, 2001, VEPCo sent copies of the draft ER to VDHR for review and comment (VEPCo 2001a).

In response, VDHR sent a letter in February 2001 to VEPCo (VDHR 2001). This response letter indicated "there are no recorded historic districts, structures or archaeological sites located within the footprint of either facility." However, the letter also raised several issues of concern to VDHR specific to the Surry Power Station. These issues included a request for more direct involvement by the NRC in the Section 106 consultation process, a request for a more detailed definition of the Area of Potential Effect covered by the license renewal application, the suggestion that a further archaeological survey of the station grounds may be warranted, and the suggestion that a Programmatic Agreement by the NRC would be necessary pursuant to Section 106.

Based on this letter from VDHR, VEPCo authorized a professional cultural resource assessment of Surry Power Station (Louis Berger Group, Inc. 2001). VDHR was invited and accepted an invitation by NRC to join in a tour of Surry Power Station on September 19, 2001. On September 21, 2001, NRC representatives met with Dr. Ethel Eaton, Project Review Team Leader for VDHR, to discuss the concerns of VDHR. On January 3, 2002, NRC sent a formal response letter to VDHR addressing their concerns (NRC 2002a). The staff concluded that while there is a moderate to high potential for intact significant historic and archaeological resources to be present in the undeveloped portions of Surry Power Station, it is unlikely that such resources still exist in the developed portions of Surry Power Station.

In Section 3.2 of the VEPCo ER (VEPCo 2001b), the licensee stated that major refurbishment of Surry Power Station is not required during the license renewal period and that it is anticipated there will be no need to utilize the currently undeveloped portions of Surry Power Station for operations during the renewal period. Continued operation of Surry Power Station would have a beneficial effect on any potential unknown or undiscovered historic or archaeological resources in undisturbed areas for the duration of the license renewal period by protecting the natural landscape and vegetation and by providing restricted access to the plant.

However, care should be taken by the licensee while undertaking normal operational and

roads through the plant site. The environmental impacts on historic and archaeological resources of activities undertaken by VEPCo are managed through a Station Administrative Procedure on notifications and reports and through several General Maintenance Procedures (GMP).[a] In addition, pre-job briefings include specific discussion of actions that the workers should take if they inadvertently discover historic or archaeological resources.

Based on the staff's cultural resources analysis and VEPCo's conclusion that major refurbishment activities are not needed to support the renewal of Surry Units 1 and 2 OLs and that operation will continue within the bounds of plant operations as evaluated in the Final Environmental Statements (AEC 1972a, 1972b), the staff concludes that the potential impacts on historic and archaeological resources are expected to be SMALL, and mitigation is not warranted. The staff also concludes that it is unnecessary at this time to enter into a cultural resources programmatic agreement to protect cultural resources (NRC 2002a).

4.4.6 Environmental Justice

Environmental justice refers to a Federal policy requiring that Federal agencies identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its actions on minority[b] or low-income populations. The memorandum accompanying Executive Order 12898 (59 FR 7629) directs Federal executive agencies to consider environmental justice under the National Environmental Policy Act of 1969 (NEPA). The Council on Environmental Quality (CEQ) has provided guidance for addressing environmental justice issues (CEQ 1997). Although the Executive Order is not mandatory for independent agencies, the NRC has voluntarily committed to undertake environmental justice reviews. Specific guidance is provided in the NRC Office of Nuclear Reactor Regulation Office Instruction LIC-203, "Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues" (NRC 2001).

For the purpose of the staff's review, a minority population is defined to exist if the percentage of each minority or aggregated minority category within the census block groups[c] potentially

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(a) Three GMP, covering roadway maintenance, excavation, and grading, specifically state that "IF there is inadvertent discovery of archaeological, historic, or other cultural resource, THEN STOP work and notify Environmental Compliance Coordinator or designee."

(b) The NRC guidance for performing environmental justice reviews defines "minority" as American Indian or Alaskan Native; Asian; Native Hawaiian or other Pacific Islander; or Black races; or Hispanic ethnicity. "Other" races and multi-racial individuals may be considered as separate minority categories. (NRC 2001).

(c) A census block group is a combination of census blocks, which are statistical subdivisions of a census tract. A census block is the smallest geographic entity for which the Census Bureau collects and tabulates decennial census information. A census tract is a small, relatively permanent statistical subdivision of counties delineated by local committees of census data

affected by the license renewal of Surry Units 1 and 2 exceeds the corresponding percentage of minorities in a comparison area by 20 percentage points, or if the corresponding percentage of minorities within the census block group is at least 50 percent. By convention, the comparison area is the State. A low-income population is defined to exist if the percentage of low-income population within a census block group exceeds the corresponding percentage of low-income population in the comparison area by 20 percentage points, or if the corresponding percentage of low-income population within a census block group is at least 50 percent.

Figure 4-1 shows the distribution of minority populations (shaded areas) within the 80-km (50-mi) radius based on Census 2000 data at the census block group level. Figure 4-2 shows the distribution of low-income populations by Census 1990 block groups within the 80-km (50-mi) radius of Surry Power Station.[a]

With the locations of minority and low-income populations identified, the staff proceeded to evaluate whether any of the environmental impacts of the proposed action could affect these populations in a disproportionately high and adverse manner. Based on staff guidance (NRC 2001), air, land, and water resources within about 80 km (50 mi) of the Surry Power Station site were examined. Within that area, potential environmental impacts that could affect human populations were evaluated. All of these were considered SMALL for the general population.

The pathways through which the environmental impacts associated with Surry Units 1 and 2 license renewal can affect human populations are discussed in each associated section (e.g., Section 4.4.3 for offsite land use). The staff evaluated whether minority and low-income populations could be disproportionately affected by these impacts.

The staff found no unusual resource dependencies or practices, such as subsistence agriculture, hunting, or fishing, through which the minority and low-income populations could experience disproportionately high and adverse impacts. In addition, the staff did not identify any location-dependent disproportionately high and adverse impacts affecting these minority and low-income populations. The staff concludes that offsite impacts from Surry Units 1 and 2 to minority and low-income populations would be SMALL, and no special mitigation actions are warranted.

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users in accordance with Census Bureau guidelines for the purpose of collecting and presenting decennial census data. Census block groups are subsets of census tracts.

(a) Census 2000 general demographic data, including ethnicity, were used to produce Figure 4-1. However, at the time this SEIS was prepared, income data for the 2000 data were not yet available; so 1990 data were used to produce Figure 4-2.

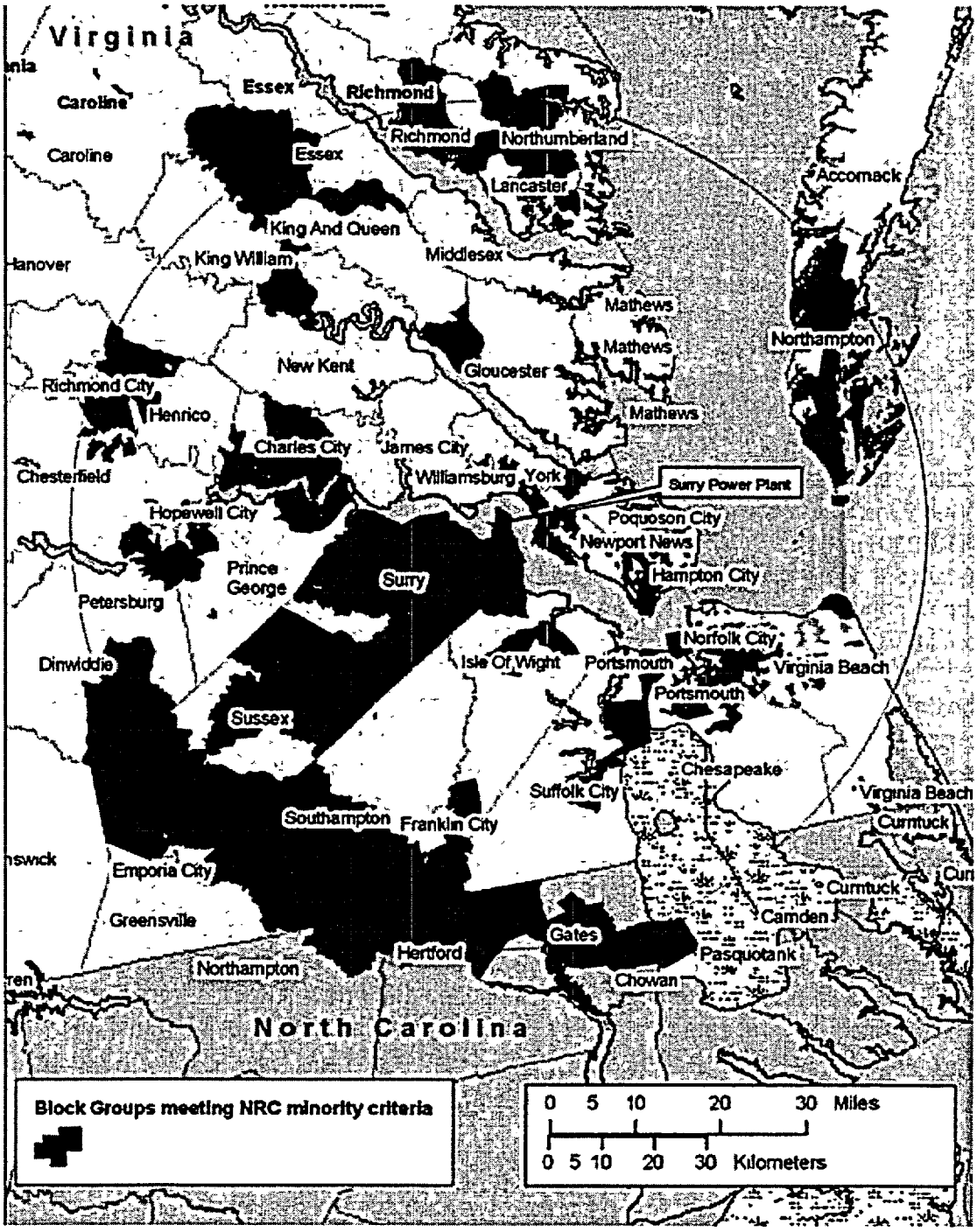

Figure 4-1. Census 2000 Block Groups Identified as Meeting NRC Criteria for Minority Status in an 80-km (50-mi) Area Around Surry Power Station

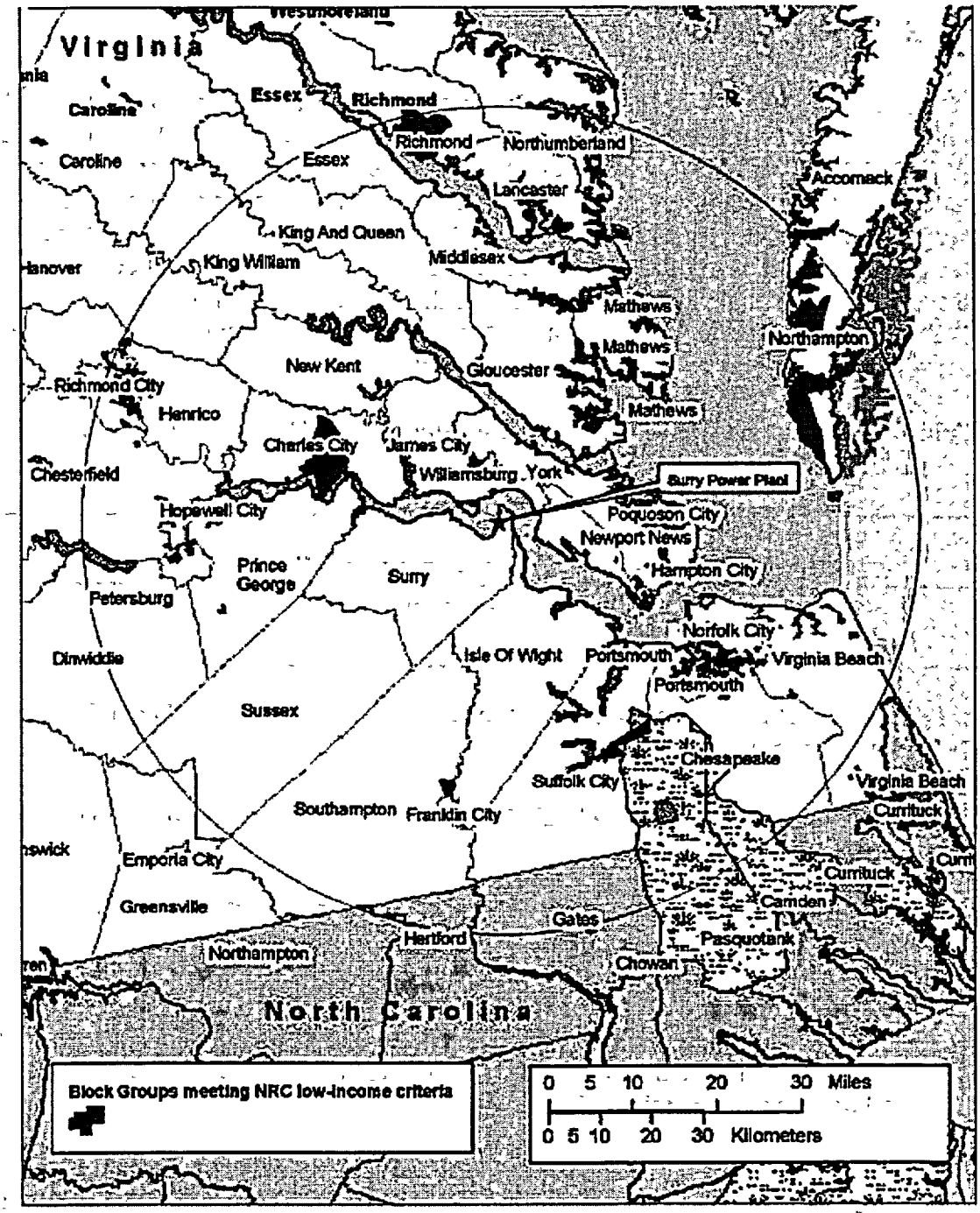

Figure 4-2. Census 1990 Block Groups Identified as Meeting NRC Criteria for Low-Income Status in an 80-km (50-mi) Area Around Surry Power Station

4.5 Groundwater Use and Quality

One Category 1 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that is applicable to Surry Power Station groundwater use and quality is listed in Table 4-8. VEPCo stated in its ER (VEPCo 2001b) that it is not aware of any new and significant information associated with the renewal of the Surry Units 1 and 2 OLs. The staff has not identified any significant new information during its independent review of the VEPCo ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to this issue beyond those discussed in the GEIS. For this issue, the GEIS concluded that the impacts are SMALL, and plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-8. Category 1 Issue Applicable to Groundwater Use and Quality During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
GROUNDWATER USE AND QUALITY	
Groundwater quality degradation (saltwater intrusion)	4.8.2.1

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, 10 CFR Part 51, follows:

- Groundwater quality degradation (saltwater intrusion). Based on information in the GEIS, the Commission found that

  > Nuclear power plants do not contribute significantly to saltwater intrusion.

  The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001b), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no groundwater quality degradation impacts associated with saltwater intrusion during the renewal term beyond those discussed in the GEIS.

The Category 2 issue related to groundwater use and quality that is applicable to Surry Power Station is discussed in the section that follows. This issue, listed in Table 4-9, requires plant-specific analysis.

Table 4-9. Category 2 Issue Applicable to Groundwater Use and Quality During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
GROUNDWATER USE AND QUALITY			
Groundwater-use conflicts (potable and service water; plants that use > 100 gpm)	4.8.1.1 4.8.2.1	C	4.5.1

4.5.1 Groundwater Use Conflicts (Plants that Use >100 gpm)

The Surry Power Station has seven wells that provide water for a variety of plant uses. There are an additional three wells at the site that provide water for the Gravel Neck Combustion Turbines Station. These wells, which vary in depth from about 120 to 130 m (396 to 420 ft) and draw water from the upper zone of the Potomac aquifer, are permitted by VDEQ (Permit No. GW0003900; VDEQ 1999). The water permit limits total water withdrawal to 585,600 m^3/yr (154.7 million gal/yr) or about 18.6 L/s (294 gpm) with a maximum of 60,200 m^3 (15.89 million gal) in a calendar month or an average of about 23.2 L/s (368 gpm). According to the ER (VEPCo 2001b), no single site well is capable of pumping at these rates. Three of the Surry Power Station wells are capable of pumping at 13.9 L/s (220 gpm), and another well is capable of pumping 6.3 L/s (100 gpm). The remaining wells are less productive. For the 8-year period from 1992 through 1999, the average withdrawal for the site was about 13.9 L/s (221 gpm).

Existing wells near the site have relatively small yields, about 2.2 L/s (35 gpm), and are thought to pump from Aquia aquifer. The Hog Island Wildlife Management Area to the north and south of the Surry Power Station site and the Chippokes Plantation State Park to the southwest of the site will limit development and water usage in the area adjacent to Surry Power Station. The Town of Surry has the closest municipal water system that uses wells. Its wells have a maximum yield of about 4.4 L/s (69 gpm) and an average yield of about 1.8 L/s (28 gpm).

The VEPCo ER (VEPCo 2001b) contains an assessment of the impacts of withdrawal at the annual average permitted rate on water levels at the site boundary and at the nearest offsite wells. In this assessment, all of the water was assumed to be withdrawn from the onsite well closest to the two nearest offsite wells. The maximum drawdown at the northern site boundary was calculated to be less than 1.2 m (3.8 ft); the drawdown at the closest well to the north, which provides domestic water for the facilities in the wildlife management area, was calculated to be less than 0.43 m (1.4 ft). Similarly, the drawdown at the southwest site boundary was calculated to be about 1.1 m (3.5 ft), and the drawdown at the closest well to the southwest, at a vacation cottage, was calculated to be less than 0.15 m (0.5 ft). Calculations made assuming

the maximum pumping capacity of any well resulted in smaller drawdowns. With this assumption, the calculated drawdowns at the nearest offsite wells were less than 0.3 m (1 ft) for the well to the north and less than 0.15 m (0.5 ft) for the well to the southwest. The impact of Surry Power Station groundwater use on the Town of Surry water system would be smaller than the impacts calculated for the nearest wells.

The groundwater withdrawal permit requires VEPCo to determine whether impacts to preexisting users exist and to mitigate these if possible. It also requires VEPCo to develop a water-conservation and management plan, to use water-saving processes, and to initiate a water-loss reduction program. VEPCo plans to submit these studies to VDEQ as part of the groundwater withdrawal permit-renewal process in 2009.

Based on the above considerations, the staff concludes that the impact of Surry Power Station ground waste water usage is SMALL and that no mitigation is warranted.

4.6 Threatened or Endangered Species

Threatened or endangered species are listed as a Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue is listed in Table 4-10.

Table 4-10. Category 2 Issue Applicable to Threatened or Endangered Species During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
THREATENED OR ENDANGERED SPECIES (FOR ALL PLANTS)			
Threatened or endangered species	4.1	E	4.6

This issue requires consultation with appropriate agencies to determine whether threatened or endangered species are present and whether they would be adversely affected.

4.6.1 Aquatic Species

VEPCo initiated correspondence with FWS, NMFS, and the Virginia Department of Game and Inland Fisheries (VDGIF) regarding the potential effects of renewing the Surry licenses on Federal- and Commonwealth-listed species. The FWS and NMFS responses to VEPCo are compiled in Appendix C of the ER (VEPCo 2001b).

NMFS responded to VEPCo's request in a letter dated March 23, 2001, stating that ". . . no federally listed or proposed threatened or endangered species and/or designated critical habitat

for listed species under the jurisdiction of the National Marine Fisheries Service are known to exist in the project area. No further consultation pursuant to Section 7 of the Endangered Species Act of 1973, as amended, is required."

The NRC initiated consultation with FWS under Section 7 of the Endangered Species Act by letter dated January 24, 2002, with a request for information concerning species potentially occurring near the Surry Power Station site and related transmission corridors (NRC 2002b). A copy of the NRC's letter is provided in Appendix E.

The FWS Virginia Field Office responded in a letter dated May 22, 2002 (FWS 2002), by providing a table of Federally-listed or proposed endangered or threatened species and designated critical habitat that are documented or may occur in the vicinity of the Surry Power Station or in the counties through which the related transmission corridors pass. No Federally-listed threatened or endangered aquatic species or associated critical habitats were identified. VDGIF did not respond individually to VEPCo's request for information, but was provided with a copy of the letter from FWS.

Based on these considerations, the staff has determined that the continued operation of Surry Power Station and the continued maintenance of transmission lines will not adversely affect Federally-listed aquatic species.

4.6.2 Terrestrial Species

With the exception of the bald eagle, no other threatened or endangered species are currently known to occur at the Surry Power Station site or along the related transmission corridors. Based on a review of the applicant's report and its independent analysis, the NRC staff has concluded that continued operation of the Surry Power Station and related transmission corridors during the license renewal period will not impact the bald eagle population. This conclusion is based on the continued compliance of plant operations with the Bald Eagle Protection Guidelines of Virginia (FWS and VDGIF 2000). The NRC staff documented the basis for its conclusion in a biological assessment dated November 6, 2002. An informal consultation with FWS on this issue is ongoing. If FWS provides any additional comments, they will be resolved as operating plant issues because any impacts to the bald eagles that may occur as a result of plant and transmission line operation in the period of extended operation are also occurring now.

Plant species identified by the FWS as potentially occurring in the transmission corridors have not been found in these areas. Furthermore, maintenance practices using spot herbicide applications will not adversely affect these species should they invade the area.

Therefore, it is the staff's determination that the impact on Federally-listed threatened or endangered terrestrial species of an additional 20 years of operation of Surry Power Station and maintenance activities for the transmission lines would be SMALL, and that further mitigation is not warranted.

4.7 Evaluation of Potential New and Significant Information on Impacts of Operations During the Renewal Term

The staff has not identified new and significant information on environmental issues listed in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, related to operation during the renewal term. The staff reviewed the discussion of environmental impacts associated with operation during the renewal term in the GEIS and the licensee's program for determining new and significant impacts and conducted its own independent review, including public scoping meetings, to identify issues with significant new information. Processes for identification and evaluation of new information are described in Chapter 1 under "License Renewal Evaluation Process."

4.8 Summary of Impacts of Operations During the Renewal Term

Neither VEPCo nor the staff is aware of information that is both new and significant related to any of the applicable Category 1 issues associated with the Surry Power Station operation during the renewal term. Consequently, the staff concludes that the environmental impacts associated with these issues are bounded by the impacts described in the GEIS. For each of these issues, the GEIS concluded that the impacts would be SMALL and that plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

Plant-specific environmental evaluations were conducted for 11 Category 2 issues applicable to Surry Power Station operation during the renewal term, and for environmental justice and chronic effects of electro-magnetic fields. For the 11 issues and environmental justice, the staff concluded that the potential environmental impact of renewal term operations of Surry Power Station would be of SMALL significance in the context of the standards set forth in the GEIS and that further mitigation would not be warranted. In addition, the staff determined that a consensus has not been reached by appropriate Federal health agencies regarding chronic adverse effects from electromagnetic fields. Therefore, no evaluation of this issue is required.

4.9 References

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

59 FR 7629. Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority and Low-Income Populations." *Federal Register.* Vol. 59, No. 32. February 16, 1994.

Cincinnati Gas and Electric Company. 1991. *Electrodynamic Induction Calculations.* Cincinnati, Ohio.

Clean Water Act (CWA). 33 USC 1251, et seq. (Also known as the Federal Water Pollution Control Act [FWPCA].)

Council on Environmental Quality (CEQ). 1997. *Environmental Justice: Guidance under the National Environmental Policy Act.* Executive Office of the President, Washington, D.C.

Fang, C. S., and G. C. Parker. 1976. *Thermal Effects of the Surry Nuclear Power Plant on the James River, Virginia. Part VI: Results of Monitoring Physical Parameters.* Virginia Institute of Marine Science, Gloucester Point, Virginia. Special Report in *Applied Marine Science and Ocean Engineering,* Number 109. ERDA Report No. ORO-4067-7.

Jordan, R. A., R. K. Carpenter, P. A. Goodwin, C. G. Becker, M. S. Ho, G. C. Grant, B. B. Bryan, J. V. Merriner, and A. D . Est. 1976. *Ecological Study of the Tidal Segment of the James River Encompassing Hog Point.* Final Technical Report submitted to Virginia Electric and Power Company by Virginia Institute of Marine Science, Gloucester Point, Virginia.

Jordan, R. A., R. K. Carpenter, P. A. Goodwin, C. G. Becker, M. S. Ho, G. C. Grant, B. B. Bryan, J. V. Merriner, and A. D. Est. 1977. *Ecological Study of the Tidal Segment of the James River Encompassing Hog Point.* Final Technical Report submitted to Virginia Electric and Power Company by Virginia Institute of Marine Science, Gloucester Point, Virginia.

The Louis Berger Group, Inc. 2001. *Cultural Resource Assessment, Surry Power Station, Surry County, Virginia.* Prepared for Dominion Resources, Inc.

National Electrical Safety Code (NESC). 1961. Institute of Electrical and Electronics Engineering, New York.

National Electrical Safety Code (NESC). 1997. Institute of Electrical and Electronics Engineers, New York.

National Environmental Policy Act (NEPA) of 1969. 42 USC 4321, et seq.

National Historic Preservation Act (NHPA). 16 USC 470, et seq.

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

U.S. Atomic Energy Commission (AEC). 1972a. *Final Environmental Statement Related to the Operation of Surry Power Station Unit 1, Virginia Electric and Power Company.* Docket No. 50-280, AEC, Washington, D.C.

U.S. Atomic Energy Commission (AEC). 1972b. *Final Environmental Statement Related to Operation of Surry Power Station Unit 2, Virginia Electric and Power Company.* Docket No. 50-281, AEC, Washington, D.C.

U.S. Census Bureau (USCB). 2000. *American Fact Finder - Census 2000 Quick Tables - Population and Housing.* Available URL: http://factfinder.census.gov/servlet/BasicFactsServlet (Accessed December 28, 2001).

U.S. Fish and Wildlife Service (FWS) and Virginia Department of Game and Inland Fisheries (VDGIF). 2000. *Bald Eagle Protection Guidelines for Virginia.* FWS Virginia Field Office, Gloucester, and VDGIF Office, Richmond, Virginia.

U.S. Fish and Wildlife Service (FWS). 2002. Letter from U.S. Fish and Wildlife to U.S. Nuclear Regulatory Commission regarding Federally-listed or proposed endangered and threatened species for Surry and North Anna Power Stations. FWS Field Office, Gloucester, Virginia.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants.* NUREG-1437, Volumes 1 and 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report,* "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2001. "Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues." NRC Office of Nuclear Reactor Regulation Office Instruction, LIC-203, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2002a. Letter from U.S. Nuclear Regulatory Commission to C. H. Metz, Director, Division of Resource Services and Review, Virginia Department of Historic Resources. (January 2002).

U.S. Nuclear Regulatory Commission (NRC). 2002b. Letter from U.S. Nuclear Regulatory Commission to K. Mayne, Supervisor, Virginia Field Office, U.S. Fish and Wildlife Service. (January 2002).

U.S. Nuclear Regulatory Commission (NRC). 2002c. Letter from U.S. Nuclear Regulatory Commission to Mr. John P. Wolflin, Chesapeake Bay Field Office, U.S. Fish and Wildlife Service. (November 6, 2002).

Virginia Department of Environmental Quality (VDEQ). 1999. Permit GW0003900 Department of Environmental Quality, Glen Allen, Virginia.

Virginia Department of Environmental Quality (VDEQ). 2001. NPDES Permit VA0004090 Department of Environmental Quality, Glen Allen, Virginia.

Virginia Department of Historic Resources (VDHR). 2001. Letter from C. Metz, Director, Division of Resource Services and Review, Virginia Department of Historic Resources, to W. W. Corbin, Project Manager, VEPCo. (February 13, 2001).

Virginia Electric and Power Company (VEPCo). 1977. *Section 316(a) Demonstration (Type L); Surry Power Station - Units 1 and 2.* Submitted to Virginia State Water Control Board. Richmond, Virginia.

Virginia Electric and Power Company (VEPCo). 1980. *Surry Power Station - Units 1 and 2; Cooling Water Intake Studies.* Submitted to Virginia State Water Control Board. Richmond, Virginia.

Virginia Electric and Power Company (VEPCo). 2000. Letter from P.F. Faggert, VEPCo, to A. Wise, Director, Virginia Department of Historic Resources. (April 12, 2000).

Virginia Electric and Power Company (VEPCo). 2001a. Letter from W. D. Corbin, VEPCo, to Dr. E. Eaton, State Historic Preservation Office, Virginia Department of Historic Resources. (January 11, 2001).

Virginia Electric and Power Company (VEPCo). 2001b. *Application for License Renewal for Surry Power Station, Units 1 and 2,* "Appendix E, Environmental Report - Operating License Renewal Stage." Richmond, Virginia.

Virginia Electric and Power Company (VEPCo). 2002. Email from T. Banks concerning river intake structure screen mesh size. September 9, 2002.

Wang, J. C. S. and R. J. Kernehan. 1979. *Fishes of the Delaware Estuaries: A Guide to the Early Life Histories.* EA Communications, Towson, Maryland.

5.0 Environmental Impacts of Postulated Accidents

Environmental issues associated with postulated accidents are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).[a] The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic.

(2) Single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1, and therefore, additional plant-specific review of these issues is required.

This chapter describes the environmental impacts from postulated accidents that might occur during the license renewal term.

5.1 Postulated Plant Accidents

Two classes of accidents are evaluated in the GEIS. These are design-basis accidents (DBAs) and severe accidents, as discussed below.

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

5.1.1 Design-Basis Accidents

In order to receive NRC approval to operate a nuclear power facility, an applicant must submit a safety analysis report (SAR) as part of its application. The SAR presents the design criteria and design information for the proposed reactor and comprehensive data on the proposed site. The SAR also discusses various hypothetical accident situations and the safety features that are provided to prevent and mitigate accidents. The NRC staff reviews the application to determine whether the plant design meets the Commission's regulations and requirements and includes, in part, the nuclear plant design and its anticipated response to an accident.

DBAs are those accidents that both the licensee and the NRC staff evaluate to ensure that the plant can withstand normal and abnormal transients, and a broad spectrum of postulated accidents without undue hazard to the health and safety of the public. A number of these postulated accidents are not expected to occur during the life of the plant, but are evaluated to establish the design basis for the preventive and mitigative safety systems of the facility. The acceptance criteria for DBAs are described in 10 CFR Part 50 and 10 CFR Part 100.
The environmental impacts of DBAs are evaluated during the initial license process, and the ability of the plant to withstand these accidents is demonstrated to be acceptable before issuance of the operating license (OL). The results of these evaluations are found in license documentation such as the staff's Safety Evaluation Report (SER), the Final Environmental Statement (FES), the licensee's Updated Final Safety Analysis Report (UFSAR), and Section 5.1 of this supplemental environmental impact statement (SEIS). The licensee is required to maintain the acceptable design and performance criteria throughout the life of the plant including any extended-life operation. The consequences for these events are evaluated for the hypothetical maximum exposed individual; as such, changes in the plant environment will not affect these evaluations. Because of the requirements that continuous acceptability of the consequences and aging management programs be in effect for license renewal, the environmental impacts as calculated for DBAs should not differ significantly from initial licensing assessments over the life of the plant, including the license renewal period. Accordingly, the design of the plant relative to DBAs during the extended period is considered to remain acceptable and the environmental impacts of those accidents were not examined further in the GEIS.

The Commission has determined that the environmental impacts of DBAs are of SMALL significance for all plants because the plants were designed to successfully withstand these accidents. Therefore, for the purposes of license renewal, design-basis events are designated as a Category 1 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. The early resolution of the DBAs make them a part of the current licensing basis of the plant; the current licensing basis of the plant is to be maintained by the licensee under its current license and, therefore, under the provisions of 10 CFR 54.30, is not subject to review under license renewal. This issue, applicable to Surry Power Station, Units 1 and 2, is listed in Table 5-1.

Table 5-1. Category 1 Issue Applicable to Postulated Accidents During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
POSTULATED ACCIDENTS	
Design-basis accidents (DBAs)	5.3.2; 5.5.1

Based on information in the GEIS, the Commission found that

> The NRC staff has concluded that the environmental impacts of design basis accidents are of small significance for all plants.

The Virginia Electric and Power Company (VEPCo) stated in its Environmental Report (ER; VEPCo 2001a) that it is not aware of any new and significant information associated with the renewal of the Surry Units 1 and 2 OLs. The staff has not identified any significant new information during its independent review of the VEPCo ER, the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to this issue beyond those discussed in the GEIS.

5.1.2 Severe Accidents

Severe nuclear accidents are those that are more severe than DBAs because they could result in substantial damage to the reactor core, whether or not there are serious offsite consequences. In the GEIS, the staff assessed the impacts of severe accidents during the license renewal period, using the results of existing analyses and site-specific information to conservatively predict the environmental impacts of severe accidents for each plant during the renewal period.

Based on information in the GEIS, the Commission found that

> The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives.

Therefore, the Commission has designated mitigation of severe accidents as a Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. This issue, applicable to Surry Units 1 and 2, is listed in Table 5-2.

Table 5-2. Category 2 Issue Applicable to Postulated Accidents During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
	POSTULATED ACCIDENTS		
Severe Accidents	5.3.3; 5.3.3.2; 5.3.3.3; 5.3.3.4; 5.3.3.5; 5.4; 5.5.2	L	5.2

The staff has not identified any significant new information with regard to the consequences from severe accidents during its independent review of the VEPCo ER (VEPCo 2001a), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of severe accidents beyond those discussed in the GEIS. However, in accordance with 10 CFR 51.53(c)(3)(ii)(L), the staff has reviewed severe accident mitigation alternatives (SAMAs) for Surry Units 1 and 2. The results of its review are discussed in Section 5.2.

5.2 Severe Accident Mitigation Alternatives

10 CFR 51.53(c)(3)(ii)(L) requires that license renewal applicants consider alternatives to mitigate severe accidents if the staff has not previously evaluated SAMAs for the applicant's plant in an environmental impact statement (EIS) or related supplement or in an environmental assessment. The purpose of this consideration is to ensure that plant changes (i.e., hardware, procedures, and training) with the potential for improving severe accident safety performance are identified and evaluated. SAMAs have not been previously considered for Surry Power Station, Units 1 and 2; therefore, the following sections address those alternatives.

5.2.1 Introduction

VEPCo submitted an assessment of SAMAs for Surry Units 1 and 2 as part of the ER (VEPCo 2001a). The assessment was based on the Surry Probabilistic Risk Assessment (PRA), which is an updated version of the Surry Individual Plant Examination (IPE) for internal events (VEPCo 1991), the Surry Individual Plant Examination for External Events (IPEEE) (VEPCo 1994), and supplemental analyses of offsite consequences and economic impacts performed specifically for the SAMA analysis. VEPCo generated a list of 160 candidate SAMAs based on a review of previous SAMA analyses in support of original plant licensing and license renewal, NRC and industry reports discussing potential plant improvements, dominant risk contributors in the plant-specific risk study, and insights provided by VEPCo's PRA staff. VEPCo assessed

the costs and benefits associated with each of the potential SAMAs and concluded that none of the candidate SAMAs evaluated were cost-beneficial for Surry Power Station.

Based on a review of the applicant's SAMA assessment, the NRC issued a request for additional information (RAI) to VEPCo by letter dated October 17, 2001 (NRC 2001). Key questions concerned the modifications to the Surry PRA made subsequent to the IPE, treatment of external events in the SAMA analysis, the use of the plant-specific risk study in the SAMA identification process, and the evaluation of costs and benefits for certain SAMAs. VEPCo submitted additional information by letter dated December 10, 2001 (VEPCo 2001b) and by e-mails dated January 15 and January 22, 2002 (NRC 2002) in response to the staff's RAIs. These responses addressed the staff's concerns and reaffirmed the conclusion that none of the SAMAs would be cost-beneficial.

The staff's assessment of SAMAs for Surry Power Station follows.

5.2.2 Estimate of Risk for Surry Power Station

VEPCo's estimates of offsite risk at Surry Power Station are summarized below. The summary is followed by the staff's review of VEPCo's risk estimates.

5.2.2.1 VEPCo's Risk Estimates

Two distinct analyses are combined to form the basis for the risk estimates used in the SAMA analysis: (1) the Surry Level 1 and 2 PRA models, which is an updated version of the IPE, and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PRA model) developed specifically for the SAMA analysis. The Surry PRA Level 1 and 2 models were originally developed in response to the request for an IPE contained in Generic Letter 88-20 (NRC 1988). The Level 1 model was updated in 1994 before performing the IPEEE fire analysis, and again in 1997 to support implementation of the maintenance rule. In addition, before performing the SAMA analysis, a number of changes were made to the Level 2 model to reflect new experimental results, and to provide more consistency with the Level 2 model for VEPCo's North Anna Power Station.

The baseline core damage frequency (CDF) for the purpose of SAMA evaluation is approximately 3.8×10^{-5} per reactor-year, based on the risk assessment for internally initiated events. Although VEPCo did not include the contribution of risk from external events within the Surry Power Station risk estimates, it did account for the potential risk-reduction benefits associated with external events by doubling the estimated benefits for internal events. This is discussed further in Section 5.2.2.2. A breakdown of the CDF is provided in Table 5-3. As shown in this table, loss-of-coolant accidents (LOCAs) contribute about 58 percent, while transients

Table 5-3. Surry Power Station Core Damage Frequency

Initiating Event	Frequency (per reactor-year)
Loss-of-coolant accident (LOCA)	2.2×10^{-5}
Transients	9.3×10^{-6}
Loss of offsite power/station blackout (LOOP/SBO)	2.5×10^{-6}
Steam generator tube rupture (SGTR)	2.3×10^{-6}
Interfacing system LOCA (ISLOCA)	1.6×10^{-6}
Anticipated transient without scram (ATWS)	4.5×10^{-9}
Total CDF from internal events	3.8×10^{-5}

contribute about 25 percent of the total internal events CDF. Anticipated transients without scram (ATWS) are negligible contributors to CDF for Surry Power Station. The frequency associated with the largest releases (i.e., interfacing system LOCA [ISLOCA] and steam generator tube rupture [SGTR]) for Surry Power Station is estimated to be about 3.9×10^{-6} per reactor-year. The station blackout (SBO) contribution to the transients was not explicitly provided in the submittal; however, in response to an RAI, VEPCo provided the frequency and contribution to the total frequency (see Table 5-3). The CDFs cited here and used in the SAMA analysis are best-estimate values. The uncertainty analysis for the updated PRA indicates a 95 percent confidence-level (upper) CDF value of 1.16×10^{-4} per reactor-year, or about three times the best-estimate value. The impact of this uncertainty on the SAMA analysis is discussed in Section 5.2.6.2.

The offsite consequences and economic impact analyses use the MELCOR Accident Consequence Code System 2 (MACCS2), Version 1.12, to determine the offsite risk impacts on the surrounding environment and public. Inputs for this analysis include plant/ site-specific input values for core radionuclide inventory, source term and release fractions, meteorological data, projected population distribution, emergency response evacuation modeling, and economic data. The magnitude of the onsite impacts (in terms of clean-up and decontamination costs and occupational dose) is based on information provided in NUREG/BR-0184 (NRC 1997b).

VEPCo estimated the dose to the population within 80 km (50 mi) of the Surry Power Station from internal initiators to be about 0.18 person-Sv (18 person-rem) per year. Table 5-4 shows the contributions to population dose by containment release mode. SGTRs and ISLOCAs together account for approximately 95 percent of the population dose although they collectively comprise only about 10 percent of the total internal events CDF. This is due to the relatively

Table 5-4. Risk Profile for Surry Power Station

Containment Release Mode	Contribution to Release Frequency[a] (%)	Contribution to Population Dose[b] (%)
Containment intact	59	<0.1
Early containment failure	1	1
Late containment failure	30	4
Containment bypass - SGTR	6	65
Containment bypass - ISLOCA	4	30

(a) Total release frequency for internal events = 3.8×10^{-5} per reactor-year.
(b) Total population dose = 0.18 person-Sv (18 person-rem) per reactor-year.

high fission-product releases in these sequences. Early and late containment failure contribute about 5 percent of the population dose. About 60 percent of the core melt accidents at Surry Power Station do not result in containment failure and have only a minimal contribution to population dose.

5.2.2.2 Review of VEPCo's Risk Estimates

VEPCo's determination of offsite risk at Surry Power Station is based on the following three major elements of analysis:

- the Level 1 and 2 risk models for Surry Power Station that form the basis for the 1991 IPE submittal and the 1994 IPEEE submittal
- the major modifications to the risk model subsequent to the IPE that distinguish the current PRA from the IPE
- the MACCS2 analyses performed to translate fission-product release frequencies from the Level 2 PRA model into offsite consequence measures.

Each of these analyses was reviewed to determine the acceptability of VEPCo's risk estimates for the SAMA analysis, as summarized below.

The staff's review of the Surry IPE is described in a staff report dated December 16, 1993 (NRC 1993). In that review, the staff evaluated the methodology, models, data, and assumptions used to estimate the CDF and characterize containment performance and fission product releases. The staff concluded that VEPCo's analysis met the intent of Generic Letter 88-20

(NRC 1988); that is, the IPE was of adequate quality to be used to look for design or operational vulnerabilities. Although the staff reviewed certain aspects of the IPE in more detail than others, it primarily focused on the licensee's ability to examine Surry Power Station for severe accident vulnerabilities and not specifically on the detailed findings or quantification estimates. Overall, the staff believed that the Surry IPE was of adequate quality to be used as a tool in searching for areas with high potential for risk reduction and to assess such risk reductions, especially when the risk models are used in conjunction with insights, sensitivity, and uncertainty analyses. It is important to note that some changes have been made to the Surry risk model since the original IPE was completed and reviewed by the NRC staff. These include both modifications to the models and changes due to plant modification, as discussed below.

A comparison of CDF profiles between the IPE and the updated PRA indicates that the estimate of the CDF for internal events has been reduced from 7.4×10^{-5} per reactor-year to 3.8×10^{-5} per reactor-year. The lower values in the updated PRA are attributed to plant and modeling improvements which have been implemented at Surry Power Station since the IPE was submitted.

The original Level 1 model documented in the 1991 Surry IPE submittal had a CDF of 7.4×10^{-5} per reactor-year (from internally initiated events, including internal flooding). A minor update to the Level 1 model was performed before the licensee completed the IPEEE fire analysis in December 1994.

A significant update to the Level 1 model occurred in 1997 to support implementation of the maintenance rule. A third update to the PRA model occurred in late 1997/early 1998. These updates were performed to incorporate significant plant modifications, correct model errors, and enhance the model with state-of-the-art improvements. Among the individual fault tree models changed or added were those involving auxiliary feedwater, the swing diesel, the station blackout diesel, the ATWS mitigating systems actuation circuitry, the component cooling water system, station service and switchyard buses, and various support systems for balance-of-plant components and backup mitigating functions. Modeling for the loss of emergency switchgear room (ESGR) and loss of 4160-V emergency bus initiating events were also modified, and the human error probability was modified to account for reduced time to hot leg recirculation during large LOCA events. The modified baseline CDF, as of the most recent model changes, is 3.8×10^{-5} per reactor-year.

A comprehensive peer review of the Level 1 and 2 PRA model used in the IPE was completed in August 1991. This review was conducted by a team composed of both VEPCo personnel and outside contractors. In addition, the updated Level 1 PRA model used as a basis for the SAMA analysis was reviewed as the pilot in the Westinghouse Owners Group peer certification effort.

The updated CDF value is lower than most of the original IPE values estimated for other pressurized water reactors (PWRs) with large dry containments. Figure 11.6 of NUREG-1560 (NRC 1997c) shows that the IPE-based total internal events CDF for Westinghouse three-loop plants range from 6×10^{-5} to 4×10^{-4} per reactor-year. However, many of these CDF estimates have similarly been reduced due to modeling and hardware changes subsequent to the respective IPE submittals. Thus, this observation may no longer be significant.

As noted in Table 5-4, SGTR and ISLOCA contribute 6 percent and 4 percent, respectively, to the total release frequency in internal events. Because of the large fission product releases for bypass sequences relative to other release modes, these sequences dominate the Surry Power Station risk profile. The conditional probability of early containment failure is approximately 1 percent, and about 30 percent of core damage sequences are expected to lead to late containment failure. Due to the sub-atmospheric design of the containment, containment isolation failures are relatively insignificant (about 0.3 percent of CDF). With the exception of the somewhat high CDF associated with bypass of the containment, and the lack of credit in the PRA for scrubbing releases from SGTRs, the results of the updated Surry PRA appear to be consistent with those of other IPEs for PWRs with large dry or subatmospheric containments insofar as the general CDF, containment response, and release and risk profiles are concerned.

VEPCo submitted an IPEEE by letter dated December 14, 1994 (VEPCo 1994). VEPCo did not identify any fundamental weaknesses or vulnerabilities to severe accident risk in regard to the external events related to seismic, fire, high winds, floods, transportation and nearby facility accidents, and other external hazards. In the associated safety evaluation report (NRC 2000), the staff concluded that the IPEEE met the intent of Supplement 4 to Generic Letter 88-20 (NRC 1991).

Although VEPCo used probabilistic risk methods for the seismic and fire portions of the IPEEE, in their SAMA analysis they chose to capture the potential risk benefits associated with external events by doubling the calculated internal events benefits for each SAMA. In assessing the reasonableness of this assumption, the staff considered the relative contribution to the total risk from the various external events based on best available information. The Surry Power Station high winds and external flooding analyses show that the plant is adequately designed to protect against the effects of these natural events. Transportation and nearby facility accidents were not considered to be potential sources of damage at the plant because of the plant's rural location. Other external events were evaluated and found to be insignificant contributors to CDF. Even though VEPCo's doubling of CDF to account for the benefits of a SAMA in external events provides a reasonable numerical estimate of the potential impact, this approach may potentially fail to capture the benefits that could result from specific SAMAs aimed at particular external events. In response to an RAI, VEPCo reasoned that since no external event

vulnerabilities in terms of containment bypass or isolation failure were identified in the IPEEE, the offsite consequences can be bounded by the use of an internal events profile. In addition, the CDF cited by VEPCo from external events – approximately 1.3×10^{-5} per reactor-year – is considerably lower than the CDF for internal events (3.8×10^{-5} per reactor-year). Therefore, the approach used by VEPCo is considered to be acceptable.

The Surry Power Station Level 2 IPE model (VEPCo 1991) that was reviewed by NRC in 1993 has been modified to make the model consistent with that for VEPCo's North Anna Power Station. Both plants' models were converted to large early release frequency (LERF) models shortly after the IPE/IPEEE process was completed. The models remained unchanged until the beginning of the SAMA analysis, at which time a unified source-term category (STC) grouping was implemented that essentially used the approach presented in the North Anna IPE. The general containment event tree (CET) was also modified to reflect recent experimental results in severe accident analysis research (e.g., the resolution of the direct containment heating issue). The revision in the Level 2 PRA model, as a result of the aforementioned changes, resulted in a reduction in the overall contribution to early containment failure. This has a relatively small impact on the overall risk of severe accidents at Surry Power Station since the contribution to risk from early containment failure was already small. The staff concludes that the use of the Surry Power Station Level 2 model provides a sufficiently detailed characterization of containment response to support a license renewal SAMA analysis.

The staff reviewed the process used by VEPCo to extend the containment performance (Level 2) portion of the PRA to an assessment of offsite consequences (essentially a Level 3 PRA). This included consideration of the source terms used to characterize fission product releases for each of 24 source-term categories and consideration of the major inputs and assumptions used in the offsite consequence analyses. VEPCo used the severe accident source terms presented in the Surry IPE as input to the NRC-developed MACCS2 code. For radionuclides not reported in the IPE, releases were set to zero. VEPCo's source terms were reviewed and found to be consistent with the source terms provided in other plants' submittals and are considered reasonable.

VEPCo used site-specific meteorological data processed from hourly measurements for one full year (1998) as input to the MACCS2 code. All data was collected at the Surry Power Station meteorology tower. Hourly meteorological data for two additional years (1996 and 1997) was also used for sensitivity comparison. The use of data from either 1996 or 1997 results in only a few percent change in the total benefit of the candidate SAMAs. Year-to-year weather variations are not significant in the SAMA analysis because (1) weather variations are diminished in the MACCS2 analyses due to its weather-sampling scheme, and (2) the same meteorological assumptions are used in estimating both the base-case consequences and the SAMA-case consequences.

The population distribution the applicant used as input to the MACCS2 analysis was initially prepared using the computer program SECPOP90 (NRC 1997a). The output from SECPOP90 is a file based on a reference database for the specified site. The SECPOP90-prepared population data was then modified and updated using the Surry Power Station UFSAR, Section 2.1.3, 50-mile population distribution for the year 2030 in place of the SECPOP90 1990 Census data. The methods and assumptions for estimating population are considered reasonable and acceptable for purposes of the SAMA evaluation.

VEPCo's emergency evacuation modeling was based on a single evacuation zone extending out 16 km (10 mi) from the plant. VEPCo assumed that the people within the evacuation zone would move at an average evacuation speed of 1.8 m/s (4 mph) with a 7200-second delay between the alarm and start of evacuation. The applicant's base-case analysis assumed 100 percent of the population within the emergency planning zone would participate in the evacuation. In contrast, in NUREG-1150 (NRC 1990a) the staff assumed evacuation of 99.5 percent of the population. VEPCo performed a sensitivity analysis in which only 95 percent of the population evacuates. The result was only about a 1-percent change in the total benefit of the candidate SAMAs. Additional sensitivity analyses were also performed in which MACCS2 parameters relating to the time and duration of release and evacuation delay times were increased and decreased by 50 percent. The result was about a 10-percent change in the total benefit of the candidate SAMAs. This change is small and would not alter the outcome of the SAMA analysis. Accordingly, the evacuation assumptions and analysis are deemed reasonable and acceptable for purposes of the SAMA evaluation.

Much of the site-specific economic data were provided by SECPOP90 (NRC 1997a) and used in the MACCS2 analyses. SECPOP90 contains a database extracted from U.S. Census Bureau CD-ROMs (1990 census data), the 1992 Census of Agriculture CD-ROM Series 1B, the 1994 U.S. Census County and City Data Book CD-ROM, the 1993 and 1994 Statistical Abstract of the United States, and other sources. These regional economic values were updated to 1999 using cost-of-living and other data from the U.S. Census Bureau and the Department of Agriculture. VEPCo performed a sensitivity analysis in which the farmland and non-farmland decontamination costs were increased by 25 percent. The result was about a 6 percent or less increase in the total benefit of the candidate SAMAs.

The staff concludes that the methodology used by VEPCo to estimate the CDF and offsite consequences for Surry Power Station provides an acceptable basis from which to proceed with an assessment of the risk reduction potential for candidate SAMAs. Accordingly, the staff based its assessment of offsite risk on the CDF and offsite doses reported by VEPCo.

5.2.3 Potential Design Improvements

The process for identifying potential plant improvements, an evaluation of that process, and the improvements evaluated in detail by VEPCo are discussed in this section.

5.2.3.1 Process for Identifying Potential Design Improvements

VEPCo's process for identifying potential plant improvements consisted of the following elements:

- a review of SAMA analyses submitted in support of original licensing and license renewal activities for other operating nuclear power plants and advanced light water reactor plants,
- a review of other NRC and industry reports discussing potential plant improvements, e.g., NUREG-1560 (NRC 1997c), and NUREG/CR-5575 (NRC 1990b)
- a review of plant-specific improvements identified in the Surry IPE and IPEEE
- a review of the top 100 cutsets of the updated Surry PRA, and survey of Surry PRA staff for additional insights.

VEPCo's initial list of 160 candidate improvements was extracted from the process and is reported in Table G.2-1 in Appendix G of the ER (VEPCo 2001a).

VEPCo performed a qualitative screening on the initial list of 160 SAMAs using the following criteria:

- The SAMA is not applicable to Surry Power Station either because (1) the enhancement is only for boiling water reactors, the Westinghouse AP600 design, or ice condenser containments, or (2) it is a plant-specific enhancement that does not apply at Surry Power Station, or
- The SAMA has already been implemented at Surry Power Station (or the Surry Power Station design meets the intent of the SAMA), or
- The SAMA is related to a reactor coolant pump (RCP) seal vulnerability at many PWRs, stemming from charging pump dependency on component cooling water (CCW). The Surry plants do not have this vulnerability because the charging pumps do not rely on

CCW. However, other RCP seal LOCA improvements are considered, such as installing improved RCP seals.

Based on the qualitative screening, 107 SAMAs were eliminated. Of these 107 SAMAs, 38 were eliminated because they had already been implemented at Surry Power Station (or the design met the intent of the SAMA). The 53 remaining SAMAs are listed in Table G.2-2 of Appendix G of the ER (VEPCo 2001a), and were subjected to a final screening and evaluation process. The final screening process involved identifying and eliminating those SAMAs whose cost exceeded their benefit by at least a factor of two. All of the 53 remaining SAMAs were eliminated in this final screening.

5.2.3.2 Staff Evaluation

The preliminary review of VEPCo's SAMA identification process raised several questions regarding the set of SAMAs identified. The staff requested clarification regarding the portion of risk represented by the top 100 cutsets, and whether an importance analysis was used to confirm the adequacy of the SAMA identification process, since a review of the importance ranking of basic events in the PRA has the potential to identify SAMAs that may not be apparent from a review of the top cutsets.

VEPCo chose to review the top 100 cutsets for identification of potential SAMAs because they contain the dominant contributors to risk. The applicant states that the top 100 cutsets examined account for the majority (about 60 percent) of the CDF for internal events and contain all of the ISLOCA and much of the SGTR contribution to offsite consequences. The cutsets appearing below the 100th cutset have an individual frequency of 4.8×10^{-8} per reactor-year or less, and a collective frequency of approximately 1.5×10^{-5} per reactor-year. VEPCo also noted that since none of the SAMAs identified from the top 100 cutsets were found to be cost-beneficial, it is not likely that SAMAs from the cutsets below the top 100 would be either.

VEPCo indicated that an importance analysis was not used in the initial SAMA identification process. However, an importance analysis was performed as part of the model update. The importance list contained 131 basic events with a risk reduction worth (RRW) above 1.005. VEPCo performed a limited review of the importance list and verified that the risk-significant basic events were contained in the top 100 cutsets.

The staff notes that SAMAs with the greatest risk reduction potential should be revealed through the cutset screening because the top cutsets include the majority of the CDF and the risk-significant sequences, and all elements of their contribution are examined. Further, since the individual frequency of cutsets below the cutoff is 4.8×10^{-8} per reactor-year or less, and the collective frequency of cutsets below the cutoff is about 1.5×10^{-5} per reactor-year, it is unlikely

that consideration of additional cutsets or further importance analyses would identify additional SAMAs that offer similar or greater risk reduction potential than those identified through cutset screening. The staff concludes that the process used to identify candidate SAMAs is sufficient to identify potential plant improvements that can significantly reduce risk.

VEPCo's efforts to identify potential SAMAs focused primarily on areas associated with internal initiating events. This is reasonable since external events only contribute a small amount to the total CDF and the containment response to external events was found to be similar to that from internal events in the IPE. The list of 53 SAMAs generally addressed the accident categories that are dominant CDF contributors or issues that tend to have a large impact on a number of accident sequences at Surry Power Station. The potential SAMA candidates included a balance of hardware, procedure, and training enhancements, as in the following examples:

- for loss of offsite power sequences, SAMAs included providing a hardwired connection to alternate offsite power (SAMA 77), and a lower-cost alternative of developing procedures to repair or change out failed 4-kV breakers (SAMA 69),

- for sequences with loss of heating, ventilation, and air conditioning, SAMAs included providing a non-safety-related, redundant train of switchgear ventilation (SAMA 25), and a lower-cost alternative of developing procedures for opening doors and using fans to limit temperature increases (SAMA 26), the latter of which is already implemented at Surry Power Station, and

- for sequences involving loss of support systems, SAMAs included adding a third component cooling water pump (SAMA 15), and a lower-cost alternative of enhancing training and procedures for loss of component cooling water or service water (SAMA 21).

The set of SAMAs submitted is not all-inclusive because additional, possibly even less-expensive, design alternatives can always be postulated. However, the staff concludes that the benefits of any additional modifications are unlikely to exceed the benefits of the modifications evaluated and that the alternative improvements would not likely cost less than the least expensive alternatives evaluated, when the subsidiary costs associated with maintenance, procedures, and training are considered.

The staff concludes that VEPCo used a systematic and comprehensive process for identifying potential plant improvements for Surry Power Station. While explicit treatment of external events in the SAMA identification process was limited, VEPCo doubled the estimated benefit for internal events to account for any unmodelled risk reduction that could be attributed to external events. Therefore, the staff concludes that this limited treatment of external events is acceptable.

5.2.4 Risk Reduction Potential of Design Improvements

VEPCo evaluated each of the 53 SAMAs remaining after the initial screening using a bounding technique. Thirty-three bounding analysis cases were developed to accomplish this effort. Table 5-5 lists the remaining SAMAs, the bounding analyses performed to estimate the risk reduction for each SAMA, the estimated risk reduction in terms of percent reduction in CDF and person-sievert (person-rem) dose, and the estimated total benefit (present value) of the averted risk. As discussed previously, VEPCo doubled the estimated benefit for internal events to account for any unmodelled risk reduction that could also occur in external events. The total benefit values reported in Table 5-5 incorporate this doubling. The determination of the benefits for the various SAMAs is discussed in Section 5.2.6.

The staff has reviewed VEPCo's bases for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the staff based its estimates of averted risk for the various SAMAs on VEPCo's risk-reduction estimates. The estimated risk reduction for several of the SAMAs was negligible or zero, and in one case was slightly negative. In these instances, the SAMA either affects sequences or phenomena that do not contribute to risk at Surry Power Station or represents an ineffective plant improvement. As such, a minimal impact on risk is not unreasonable in those cases.

5.2.5 Cost Impacts of Candidate Design Improvements

VEPCo estimated the costs of implementing each SAMA through the application of engineering judgment, estimates from other applicants' submittals, and site-specific cost estimates. The SAMA cost analyses were prepared by VEPCo staff experienced in estimating the cost of performing work at a nuclear plant. Cost estimates were made as order-of-magnitude approximations. The depth of analysis performed varied depending on the magnitude of the expected benefit. For most of the SAMAs considered, because the cost estimates were sufficiently greater than the benefits calculated, no detailed evaluation was required. In these cases, the applicant indicated that the implementation costs would exceed twice the benefit. Detailed cost estimating was only applied in those situations in which the benefit was significant and application of judgement would be questioned. Detailed cost estimates were developed for the eight SAMAs listed in Table 5-6.

VEPCo assumed the minimum cost of generating a new procedure, including its implementation, to be $30,000. If the SAMA involved a hardware modification, it was assumed that the cost would be at least $100,000.

Table 5-5. SAMA Cost/Benefit Screening Analysis

Analysis Case and Applicable SAMAs	Analysis Assumption	Percent Reduction		Total Benefit ($)
		CDF	Dose	
IMPROVEMENTS RELATED TO EX-VESSEL ACCIDENT MITIGATION/CONTAINMENT PHENOMENA				
Qualitative Assessment 39-Create a concrete crucible with heat-removal potential under the basemat to contain molten debris 40-Create a water-cooled rubble bed on the pedestal 47-Create a core melt source reduction system 55-Create another building, maintained at a vacuum to be connected to containment	Eliminate all offsite releases.	0.0	100.0	1.64 million
SCB[a] 42-Enhance fire-protection system and/or standby gas treatment system hardware and procedures 54-Provide a reactor vessel exterior cooling system	Set the frequencies for source-term categories 1 through 16, 19 and 20, to zero.	0.0	4.9	45,000
HYD 37-Create/enhance hydrogen igniters with independent power supply 38-Create a passive hydrogen ignition system 48-Provide containment inerting capability	Set the probability of late containment failure due to hydrogen burn to zero.	0.0	0.02	1,000
DEB 43-Create reactor cavity flooding system 44-Create other options for reactor cavity flooding 154-Enhance reactor coolant system depressurization ability	Modify the CET failure probabilities for debris cooling.	0.0	0.0	0
No analysis case 46-Provide core-debris control system	This failure mode was zero in the Surry Level 2 analysis, so no further calculation was required.	0.0	0.0	0

Table 5-5. (contd)

Analysis Case and Applicable SAMAs	Analysis Assumption	Percent Reduction		Total Benefit ($)
		CDF	Dose	
CSP 30-Install containment spray throttle valves 32-Install a redundant containment spray system 33-Enhance the existing containment spray system 49-Use fire-water spray pump for containment spray 50-Install a passive containment spray system	Replace event tree functional equations related to containment and recirculation sprays with an event that has an unavailability of zero.	0.0	0.00	0
IMPROVEMENTS RELATED TO RCP SEAL LOCAS				
SWP 9-Provide an additional service water (SW) pump	Add logic for a new pump to fault trees CW1 and CW2.	2.0	0.3	34,000
SLO 10-Create independent RCP seal injection system with dedicated diesel 11-Create independent RCP seal injection system without dedicated diesel 14-Install improved RCP seals	Change event tree functional equations to eliminate the RCP seal LOCA contribution.	4.0	0.3	63,000
CCP[(a)] 15-Add a third component cooling water (CCW) pump 21-Enhance training and procedures for loss of CCW or SW	Add logic for a new pump to fault tree CC1.	0.02	0.3	5,000
IMPROVEMENTS RELATED TO SECONDARY/SUPPORT SYSTEMS				
CWV 23-Alter circulating water valve power-supply arrangement	Revise SWN0IC1 fault tree at four gates to provide a redundant 480-V power supply.	-0.5	-0.08	-4,000

Table 5-5. (contd)

Analysis Case and Applicable SAMAs	Analysis Assumption	Percent Reduction		Total Benefit ($)
		CDF	Dose	
BCC				
81-Alter electric power dependency to BC and CC service water valves	Replace the motor-operated isolation-valve basic events with air-operated valve basic events, and remove power dependencies for each of the motor-operated valves.	0.7	0.5	17,000
IMPROVEMENTS IN AC/DC POWER RELIABILITY AND AVAILABILITY				
BCH				
61-Use fuel cells instead of lead-acid batteries 64-Provide alternate battery-charging capability	Set battery failure basic events to zero.	5.4	0.8	88,000
OSP				
77-Provide a connection to alternate offsite power source	Reduce loss of offsite power frequency by a factor of 5.	5.5	1.5	105,000
OPR				
70-Emphasize steps in recovery of offsite power after SBO	Reduce offsite power recovery basic events by 25 percent.	1.8	0.5	33,000
4 kV				
69-Develop procedures to repair or change out failed 4-kV breakers	Reduce basic events for all 4-kV breaker failures by a factor of 4.	1.9	2.0	62,000
IMPROVEMENTS RELATED TO HEATING, VENTILATION, AND AIR CONDITIONING (HVAC)				
HVC				
25-Provide a non-safety-related, redundant train of switchgear ventilation	Change the initiating events frequency of the loss of HVAC to zero, and eliminate conditional ESGR failure by setting unavailability to zero.	13.9	5.0	278,000

Table 5-5. (contd)

Analysis Case and Applicable SAMAs	Analysis Assumption	Percent Reduction		Total Benefit ($)
		CDF	Dose	
HVA				
27-Add a switchgear room high temperature alarm	Reduce operator error for failure to recover HVAC by a factor of 10.	0.02	0.00	<1,000
IMPROVEMENTS RELATED TO DECAY HEAT REMOVAL CAPABILITY				
DHR				
34-Install a containment vent large enough to remove ATWS decay heat	Replace event-tree functional equations related to containment heat removal with an event that has an unavailability of zero.	4.9	1.6	90,000
35-Install a filtered containment vent to remove decay heat		4.9	5.5	135,000
36-Install an unfiltered containment vent to remove decay heat		4.9	1.6	90,000
FWS				
111-Install accumulators for turbine-driven auxiliary feedwater (TDAFW) pump flow control valves 115-Provide portable generators to be hooked in to the TDAFW after battery depletion	Modify event-tree functional equations related to auxiliary feedwater (AFW) in an SBO to use a basic event whose unavailability is zero.	0.1	0.04	4,000
FDW				
122-Create passive secondary side coolers	Modify event-tree functional equations related to main feedwater or AFW to use a basic event whose unavailability is zero.	12.8	17.2	490,000
SGP				
123-Automate air bottle swap for steam generator power-operated relief valves	Set basic event REC-INAIR-LOCAL to zero.	0.0	0.03	<1,000
SLB				
158-Install secondary side guard pipes up to the main steam isolation valves	Set the main steam line break initiating event frequencies to zero.	0.0	0.0	0

Table 5-5. (contd)

Analysis Case and Applicable SAMAs	Analysis Assumption	Percent Reduction		Total Benefit ($)
		CDF	Dose	
CND				
124-Utilize bypass around the main steam trip valves to use condenser dump after safety injection	Remove house event XHOS-NO-CND-DUMP from five fault trees and gates.	2.2	0.01	33,000
IMPROVEMENTS FOR COPING WITH/IDENTIFYING CONTAINMENT BYPASS				
SGI				
86-Install improved instrumentation and control circuits to detect and respond to SGTR	Set human error probabilities for isolating the faulted steam generator to zero.	2.8	27	256,000
SGR				
88-Increase secondary side-pressure such that a SGTR would not cause the relief valves to lift 89-Replace steam generators with new design	Set the frequency of Plant Damage State 25 to zero.	5.7	60	576,000
ISS				
101-Add remotely operated firewater line that could be used to scrub ISLOCA releases	Transfer the entire frequency of CET endstate 23 (unscrubbed ISLOCA) to CET endstate 22 (scrubbed ISLOCA).	0.0	5.3	40,000
ISL				
103-Add a check valve downstream of the low head safety injection pumps on cold leg injection line to reduce ISLOCA frequency	Reduce ISLOCA frequency to zero.	4.3	30	253,000

Table 5-5. (contd)

Analysis Case and Applicable SAMAs	Analysis Assumption	Percent Reduction		Total Benefit ($)
		CDF	Dose	
IMPROVEMENTS RELATED TO ECCS				
LHI 125-Provide capability for diesel-driven, low-pressure vessel makeup	Use unavailability of zero for all "late" low head safety injection and recirculation events in the event trees, and credit the fire protection connection to low head safety injection and recirculation in the fault trees.	5.0	0.01	76,000
HPI 126/127-Provide an additional high-pressure injection pump with independent diesel	Add new pump logic to all charging and high head safety injection fault trees.	3.5	2.1	89,000
IMPROVEMENTS RELATED TO REDUCING INITIATING EVENT FREQUENCY				
ATW 145/146-Install motor generator (MG) set trip breakers in control room	Set the frequency of ATWS initiating events to zero.	0.01	0.0	<1,000
LLO 159-Add digital large break LOCA protection	Reduce the large LOCA initiating event frequency by 25 percent.	3.3	0.01	25,000
RTB 82-Relocate transfer buses to different room	Add the entire fire CDF (1.9×10^{-6}) to STC 19 (SBO).	5.0	0.7	41,000
MGB 83-Install fast-acting MG breaker	Reduce the transient initiating event frequency by 25 percent.	0.1	0.04	3,000

(a) Requires both plant hardware and procedure modifications.

Table 5-6. Surry Power Station SAMAs with Detailed Cost Estimates

SAMA No.	Description	Cost ($)
24	Provide a non-safety-related, redundant train of switchgear ventilation	15-25 million
64	Provide a portable, diesel-driven battery charger and associated disconnects	1.5-3 million
77	Provide a hard-wired connection to alternate offsite power source (Gravel Neck Combustion Turbines Station) and associated switchgear and disconnects	2-5 million
81	Replace service-water isolation valves with air-operated, fail close design	0.9-1.5 million
86	Provide improved instrumentation and control circuits to detect and respond to SGTR	1.5-3 million
101	Add remotely operated firewater line that could be used to scrub ISLOCA releases	125,000
103	Add check valve in each cold leg injection path to reduce ISLOCA frequency	0.75-1.25 million
125	Add a line to permit low-pressure vessel makeup from firewater header	350,000-600,000

The staff requested additional justification for several of the detailed cost estimates provided by VEPCo, including SAMAs 64, 77, and 86. VEPCo provided this information by e-mail, dated January 22, 2002 (NRC 2002). The staff reviewed the bases for the applicant's cost estimates. For certain improvements, the staff also compared the quantitative or qualitative cost estimates provided in Table 4-6 of the ER to estimates developed elsewhere for similar improvements, including estimates developed as part of other applicants' analyses of SAMAs for operating reactors and advanced light-water reactors. Based on this audit, the detailed cost estimates were judged to reflect valid bases and assumptions, with the exception of some labor estimates, which appear high. However, even if such estimates were lowered by an order of magnitude, the cost of the alternative would not be altered to the extent that it would become cost-beneficial. The qualitative cost estimates in Table 4-6 of the ER were found to be consistent with previous estimates and reasonable for the SAMAs under consideration. The NRC staff concludes that the cost estimates are sufficient and appropriate for use in the SAMA evaluations.

5.2.6 Cost-Benefit Comparison

The cost-benefit comparison as evaluated by VEPCo and the NRC staff evaluation of the cost-benefit analysis are described in the following sections.

5.2.6.1 VEPCo Evaluation

The methodology used by VEPCo was based primarily on NRC's guidance for performing cost-benefit analysis, i.e., NUREG/BR-0184, *Regulatory Analysis Technical Evaluation Handbook* (NRC 1997b). The guidance involves determining the net value for each SAMA according to the following formula:

$$\text{Net Value} = (\$APE + \$AOC + \$AOE + \$AOSC) - COE$$

where
- $APE = present value of averted public exposure ($)
- $AOC = present value of averted offsite property damage costs ($)
- $AOE = present value of averted occupational exposure ($)
- $AOSC = present value of averted onsite costs ($)
- COE = cost of enhancement ($).

If the net value of a SAMA is negative, the cost of implementing the SAMA is larger than the benefit associated with the SAMA and it is not considered cost-beneficial. VEPCo's derivation of each of the associated costs is summarized below.

<u>Averted Public Exposure (APE) Costs</u>

The APE costs were calculated using the following formula:

APE = Annual reduction in public exposure (Δperson-rem/reactor-year)
x monetary equivalent of unit dose ($2000 per person-rem)
x present value conversion factor (10.76, based on a 20-year period with a 7-percent discount rate).

As stated in NUREG/BR-0184 (NRC 1997b), it is important to note that the monetary value of the public health risk after discounting does not represent the expected reduction in public health risk due to a single accident. Rather, it is the present value of a stream of potential losses extending over the remaining lifetime (in this case, the renewal period) of the facility. Thus, it reflects the expected annual loss due to a single accident, the possibility that such an accident could occur at any time over the renewal period, and the effect of discounting these

potential future losses to present value. For the purposes of determining the maximum attainable benefit, VEPCo calculated an APE of $392,000.

Averted Offsite Property Damage Costs (AOC)

The AOCs were calculated using the following formula:

AOC = Annual CDF reduction
x offsite economic costs associated with a severe accident (on a per-event basis)
x present value conversion factor.

VEPCo cited an annual offsite economic risk of $39,585 based on the Level 3 risk analysis. This value appears to be higher than values for other sites and those presented in NUREG/BR-0184 (NRC 1997b). This higher value is primarily due to the relatively high frequency of SGTRs in the Surry PRA (2.33×10^{-6} per reactor-year, including both SGTR initiators and induced ruptures), which contribute 75 percent of the total offsite economic risk. For the purposes of determining the maximum attainable benefit, VEPCo calculated an AOC of $426,000.

Averted Occupational Exposure (AOE) Costs

The AOE costs were calculated using the following formula:

AOE = Annual CDF reduction
x occupational exposure per core damage event
x monetary equivalent of unit dose
x present value conversion factor.

VEPCo derived the values for averted occupational exposure based on information provided in Section 5.7.3 of NUREG/BR-0184 (NRC 1997b). Best estimate values provided for immediate occupational dose [33 person-Sv (3300 person-rem)] and long-term occupational dose [200 person-Sv (20,000 person-rem over a 10-year cleanup period)] were used. The present value of these doses was calculated using the equations provided in NUREG/BR-0184 in conjunction with a monetary equivalent of unit dose of $2000 per person-rem, a real discount rate of 7 percent, and a time period of 20 years to represent the license renewal period. For the purposes of determining the maximum attainable benefit, VEPCo calculated an AOE of $14,400.

Averted Onsite Costs (AOSC)

The AOSCs include averted cleanup and decontamination costs and averted power replacement costs. Repair and refurbishment costs are considered for recoverable accidents only and not for severe accidents. VEPCo derived the values for AOSC based on information provided in Section 5.7.6 of NUREG/BR-0184 (NRC 1997b).

Averted cleanup and decontamination costs (ACC) are calculated using the following formula:

ACC = Annual CDF reduction
x present value of cleanup costs per core damage event
x present value conversion factor.

The total cost of cleanup and decontamination subsequent to a severe accident is estimated in NUREG/BR-0184 (NRC 1997b) as $\$1.5 \times 10^9$ (undiscounted). This value was converted to present costs over a 10-year cleanup period and integrated over the term of the proposed license extension.

Averted power replacement costs (RPC) are calculated using the following formula:

RPC = Annual CDF reduction
x present value of replacement power for a single event
x factor to account for remaining service years for which replacement power is required
x reactor power scaling factor.

Each of the units at Surry Power Station has a gross electrical output of 855.4 MWe, which is lower than the reference rating in NUREG/BR-0184 (NRC 1997b). Thus, a scaling factor (855.4/910) of 0.94 could be applied to the corresponding formulae. However, a scaling factor of 1.0 was conservatively used. For the purposes of determining the maximum attainable benefit, VEPCo calculated an AOSC (combination of ACC and RPC) of $738,000.

Using the above equations, VEPCo estimated the total present dollar value equivalent associated with completely eliminating internally initiated severe accidents at Surry Power Station is $1.57 million for each unit. This value was then doubled to account for additional risk reduction associated with also eliminating external events. This results in a maximum attainable benefit of $3.2 million for eliminating all severe accident risk.

VEPCo Results

The total benefit associated with each of the 53 SAMAs remaining after the initial screening is provided in column 5 of Table 5-5. These values were determined based on the above equations for the various averted costs together with the estimated annual reductions in CDF and person-Sv (person-rem) dose (columns 3 and 4 of Table 5-5). The estimated benefits were then doubled to account for additional risk reduction in external events. The values for total benefit reported in Table 5-5 include this doubling.

In determining the net value of each SAMA, VEPCo applied an additional factor of 2 multiplier to account for uncertainties in the cost-benefit methodology. Specifically, for each SAMA, they compared the total benefit[(a)] (doubled to account for external events) to the estimated cost of the enhancement and screened out the SAMA only if the cost of the enhancement was at least twice the benefit. All 53 SAMAs were eliminated because the estimated costs are expected to exceed the total benefit by at least a factor of 2. The end result was that no SAMA candidates were found to be cost-beneficial.

VEPCo performed sensitivity analyses to evaluate the impact of parameter choices on the analysis results. The sensitivity analyses included the calculation of candidate SAMA benefits using a 3-percent discount rate as recommended in NUREG/BR-0184 (NRC 1997b). The sensitivity cases resulted in less than a factor of 2 increase in the benefit calculation, and, therefore, all SAMAs were still screened out. Thus, the conclusion that none of the candidate SAMAs would be cost-beneficial remains unchanged.

5.2.6.2 Staff Evaluation

The cost-benefit analysis performed by VEPCo was based primarily on NUREG/BR-0184 (NRC 1997b) and was executed appropriately. The risk profile for Surry Power Station is observed to be dominated by containment bypass events (primarily SGTRs). With the exception of six costly modifications that are not properly applicable to an existing plant (e.g., redesign of the reactor cavity to accommodate a water-cooled rubble bed), the analysis found a maximum benefit of $278,000 with most changes resulting in a benefit of less than about $100,000.

The staff questioned the evaluation of several SAMAs in an RAI (NRC 2001). One SAMA in particular, SAMA 70, appeared to be cost-beneficial. This alternative involves a change to procedures for recovery of offsite power after a station blackout. According to Table 4-6 of the ER (VEPCo 2001a), a benefit of $33,000 was calculated. VEPCo estimated the minimum cost

(a) The benefit can be due to a reduction in CDF and/or a reduction in person-Sv (person-rem) dose resulting from the alternative being implemented.

of a procedure change to be $30,000. Because this amount is less than the estimated benefit, the SAMA appears to be cost-beneficial. However, in their RAI response (NRC 2002), VEPCo indicated that the benefit was calculated assuming a 25 percent reduction in the offsite power nonrecovery terms, and that this is very optimistic because training for offsite power recovery is already given, and failure to recover offsite power is more likely attributed to actual failures of the grid and not to personnel error. Operator training has no impact on these types of failure. VEPCo indicated that the benefit in this area is actually quite small and would realistically be 1 or 2 percent as opposed to the 25 percent presented in the SAMA analysis. Based on this assessment, the total benefit would be at least an order of magnitude less than that provided in Table 4-6 of the ER. VEPCo further stated that it would not be practical to eliminate or trade off any of the current training material given the heavily loaded training schedule. Based on the rationale, the staff agrees that this SAMA does not appear to be warranted.

The staff believes that the costs of the 53 candidate SAMAs assessed would be considerably higher than the associated benefits. This conclusion is upheld despite a number of uncertainties and nonquantifiable factors in the calculations, noted as follows:

- External events were accounted for in the analysis by doubling the risk-benefits found considering internal events only. This was justified on the basis of the fact that the externally initiated CDF (1.3×10^{-5} per reactor-year) at Surry Power Station is less than the internally initiated CDF (3.8×10^{-5} per reactor-year), and the observation that there are no particular containment vulnerabilities in the external event risk profile.

- Uncertainty in the internal events CDF was not explicitly included in the calculations, which employed best-estimate values. The 95-percent confidence level for the internal events CDF is approximately three times the best estimate, and the results of the analysis show that no SAMA is found to be cost-beneficial within a factor of 3 or 4. Therefore, consideration of CDF uncertainty is not expected to alter the conclusions of the analysis.

- Risk reduction and cost estimates were generally found to be conservative. As such, uncertainty in the costs of any of the contemplated changes would not likely have the effect of making them cost-beneficial.

- A number of sensitivity risk-benefit calculations were performed with respect to the discount rate (as low as 3 percent) and various MACCS2 parameters, including evacuation time and completeness, meteorological data, source-term energy, and sheltering. The results of these calculations showed that none of the risk benefits were increased by more than a factor of 2. Because this is less than the margin between cost

and benefit for most of the SAMAs considered, the staff concludes that uncertainties in these parameters would not alter the conclusions.

5.2.7 Conclusions

VEPCo compiled a list of 160 SAMA candidates based on the SAMA analyses submitted in support of licensing activities for other nuclear power plants, NRC and industry reports discussing potential plant improvements, and the plant-specific insights from the VEPCo IPE, IPEEE, and PRA model. Candidate SAMAs were identified by a thorough and systematic process that included examination of the Surry IPE and IPEEE, the top cutsets from the updated Surry PRA, and review of SAMA analyses for other operating nuclear power plants and other NRC and industry documentation. While few SAMAs were identified with a view towards external events, the IPEEE revealed no containment vulnerabilities particular to external events, and the staff judges that the process could be effectively carried out by considering primarily internal events. A qualitative screening removed SAMA candidates that did not apply to Surry Power Station for various reasons. A total of 107 SAMA candidates were either eliminated or combined with other potential improvements during the initial screening process, leaving only 53 SAMA candidates subject to the final screening process.

Using guidance in NUREG/BR-0184 (NRC 1997b), the updated Surry PRA model, and a Level 3 analysis developed specifically for SAMA evaluation, VEPCo estimated the total benefits for each of the 53 remaining SAMAs based on consideration of internal events, and then doubled the benefits for each SAMA to account for additional risk reduction in external events. In determining the net value of each SAMA, VEPCo applied an additional factor of 2 multiplier to account for uncertainties in the cost-benefit methodology. Specifically, for each SAMA, they compared the total benefit (which had been doubled to account for external events) to the estimated cost of the enhancement, and screened out the SAMA only if the cost of the enhancement was at least twice the benefit. All 53 SAMAs were eliminated because the estimated costs are expected to exceed the total benefit by at least a factor of 2. The end result was that no SAMA candidates were found to be cost-beneficial.

The staff reviewed the VEPCo analysis and concluded that the methods used and the implementation of those methods were sound. Based on its review, the staff concurs that none of the candidate SAMAs are cost beneficial. This conclusion is consistent with the low residual level of risk indicated in the Surry PRA and the fact that VEPCo has already implemented many plant improvements identified from the IPE and IPEEE process at the Surry Power Station.

5.3 References

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

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

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

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

U.S. Nuclear Regulatory Commission (NRC). 1988. "Individual Plant Examination for Severe Accident Vulnerabilities," Generic Letter 88-20, November 23, 1988.

U.S. Nuclear Regulatory Commission (NRC). 1990a. *Severe Accident Risks - An Assessment for Five U.S. Nuclear Power Plants.* NUREG-1150, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1990b. *Quantitative Analysis of Potential Performance Improvements for the Dry PWR Containment.* NUREG/CR-5575, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1991. "Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities," Supplement 4 to Generic Letter 88-20, June 28, 1991.

U.S. Nuclear Regulatory Commission (NRC). 1993. Letter from B. C. Buckley, Nuclear Regulatory Commission, to W. L. Stewart, Virginia Electric and Power Company. Subject: NRC Staff Evaluation of the Surry Power Station (SPS) Units 1 and 2 Individual Plant Examination (IPE) Internal Events Submittal (TAC Nos. M74476 and M74477). Dated December 16, 1993.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants.* NUREG-1437, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1997a. *SECPOP90: Sector Population, Land Fraction, and Economic Estimation Program.* NUREG/CR-6525, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1997b. *Regulatory Analysis Technical Evaluation Handbook.* NUREG/BR-0184, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1997c. *Individual Plant Examination Program: Perspectives on Reactor Safety and Plant Performance.* NUREG-1560, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants Main Report,* "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2000. Letter from G. E. Edison, Nuclear Regulatory Commission, to D. A. Christian, Virginia Electric and Power Company. Subject: Surry Power Station, Units 1 and 2–Review of Individual Plant Examination of External Events (IPEEE) (TAC Nos. M83681 and M83682). Dated June 29, 2000.

U.S. Nuclear Regulatory Commission (NRC). 2001. Letter from Andrew Kugler, Nuclear Regulatory Commission, to David Christian, Virginia Electric and Power Company (Dominion). Subject: Request for Additional Information Related to the Staff's Review of Severe Accident Mitigation Alternatives for the Surry and North Anna Power Stations, Units 1 and 2 (TAC Nos. MB1992, MB1993, MB1994, and MB1995). Dated October 17, 2001.

U.S. Nuclear Regulatory Commission (NRC). 2002. Note to file from Andrew Kugler, Nuclear Regulatory Commission. Subject: Information Provided by Virginia Electric And Power Company in Relation to Severe Accident Mitigation Alternatives in Its License Renewal Application For the Surry Power Station, Units 1 And 2. Dated January 23, 2002.

Virginia Electric and Power Company (VEPCo). 1991. Letter from W.L. Stewart, Virginia Electric and Power Company, to U. S. Nuclear Regulatory Commission. Subject: Individual Plant Examination--Surry Power Station Units 1 and 2. Dated August 30, 1991.

Virginia Electric and Power Company (VEPCo). 1994. Letter from J. P. O'Hanlon, Virginia Electric and Power Company, to U. S. Nuclear Regulatory Commission. Subject: Individual Plant Examination of Non-Seismic External Events and Fires--Surry Power Station Units 1 and 2. Dated December 14, 1994.

Virginia Electric and Power Company (VEPCo). 2001a. *Application for License Renewal for Surry Power Station, Units 1 and 2,* "Appendix E, Environmental Report - Operating License Renewal Stage." Richmond, Virginia.

Virginia Electric and Power Company (VEPCo). 2001b. Letter from David A. Christian, Virginia Electric and Power Company (Dominion), to U.S. Nuclear Regulatory Commission. Subject: Request for Additional Information, License Renewal Applications. Dated December 10, 2001.

6.0 Environmental Impacts of the Uranium Fuel Cycle and Solid Waste Management

Environmental issues associated with the uranium fuel cycle and solid waste management are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437; Volumes 1 and 2 (NRC 1996; 1999.)[(a)]. The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental, impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste [HLW] and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1, and, therefore, additional plant-specific review of these issues is required.

This chapter addresses the issues that are related to the uranium fuel cycle and solid waste management during the license renewal term that are listed in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, and are applicable to Surry Power Station, Units 1 and 2. The generic potential impacts of the radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes are described in detail in the GEIS, based, in part, on the generic impacts provided in 10 CFR 51.51(b), Table S-3, "Table of Uranium Fuel Cycle Environmental Data," and in 10 CFR 51.52(c), Table S-4, "Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear

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

Power Reactor." The GEIS also addresses the impacts from radon-222 and technetium-99. There are no Category 2 issues for the uranium fuel cycle and solid waste management.

6.1 The Uranium Fuel Cycle

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to Surry Power Station, Units 1 and 2 from the uranium fuel cycle and solid waste management are listed in Table 6-1.

Table 6-1. Category 1 Issues Applicable to the Uranium Fuel Cycle and Solid Waste Management During the Renewal Term

ISSUE-10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
URANIUM FUEL CYCLE AND WASTE	
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and HLW)	6.1; 6.2.1; 6.2.2.1,; 6.2.2.3; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (collective effects)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (spent fuel and HLW)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6
Nonradiological impacts of the uranium fuel cycle	6.1; 6.2.2.6; 6.2.2.7; 6.2.2.8; 6.2.2.9; 6.2.3; 6.2.4; 6.6
Low-level waste storage and disposal	6.1; 6.2.2.2; 6.4.2; 6.4.3; 6.4.3.1; 6.4.3.2; 6.4.3.3; 6.4.4; 6.4.4.1; 6.4.4.2; 6.4.4.5.1; 6.4.4.5.2; 6.4.4.5.3; 6.4.4.5.4; 6.4.4.6; 6.6
Mixed waste storage and disposal	6.4.5.1; 6.4.5.2; 6.4.5.3; 6.4.5.4; 6.4.5.5; 6.4.5.6; 6.4.5.6.1; 6.4.5.6.2; 6.4.5.6.3; 6.4.5.6.4; 6.6
Onsite spent fuel	6.1; 6.4.6; 6.4.6.1; 6.4.6.2; 6.4.6.3; 6.4.6.4; 6.4.6.5; 6.4.6.6; 6.4.6.7; 6.6
Nonradiological waste	6.1; 6.5; 6.5.1; 6.5.2; 6.5.3; 6.6
Transportation	6.1; 6.3.1; 6.3.2.3; 6.3.3; 6.3.4; 6.6, Addendum 1

The Virginia Electric and Power Company (VEPCo) stated in its Environmental Report (ER; VEPCo 2001) that it is not aware of any new and significant information associated with the renewal of the Surry Power Station, Units 1 and 2, operating licenses. No significant new information has been identified by the staff in the review process and in the staff's independent review. Therefore, the staff concludes that there are no impacts related to these issues beyond

those discussed in the GEIS. For all of those issues, the staff concluded in the GEIS that the impacts are SMALL except for the collective offsite radiological impacts from the fuel cycle and from HLW and spent fuel disposal, as discussed below, and that plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

A brief description of the staff review and the GEIS conclusions, as codified in Table B-1, 10 CFR 51, for each of these issues follows:

- Offsite radiological impacts (individual effects from other than the disposal of spent fuel and HLW . Based on information in the GEIS, the Commission found that

  > Off-site impacts of the uranium fuel cycle have been considered by the Commission in Table S-3 of this part [10 CFR 51.51(b)]. Based on information in the GEIS, impacts on individuals from radioactive gaseous and liquid releases including radon-222 and technetium-99 are small.

  The staff has not identified any new and significant information during its independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no offsite radiological impacts (individual effects from other than the disposal of spent fuel and HLW) of the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Offsite radiological impacts (collective effects). Based on information in the GEIS, the Commission found that

  > The 100 year environmental dose commitment to the U.S. population from the fuel cycle, high level waste and spent fuel disposal excepted, is calculated to be about 14,800 person rem [148 person Sv], or 12 cancer fatalities, for each additional 20-year power reactor operating term. Much of this, especially the contribution of radon releases from mines and tailing piles, consists of tiny doses summed over large populations. This same dose calculation can theoretically be extended to include many tiny doses over additional thousands of years as well as doses outside the U.S. The result of such a calculation would be thousands of cancer fatalities from the fuel cycle, but this result assumes that even tiny doses have some statistical adverse health effect, which will not ever be mitigated (for example no cancer cure in the next thousand years), and that these doses projected over thousands of years are meaningful. However, these assumptions are questionable. In particular, science cannot rule out the possibility that there will be no cancer fatalities from these tiny doses. For perspective, the doses are

> very small fractions of regulatory limits and even smaller fractions of natural background exposure to the same populations.
>
> Nevertheless, despite all the uncertainty, some judgement as to the regulatory NEPA [National Environmental Policy Act] implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective effects of the fuel cycle, this issue is considered Category 1.

The staff has not identified any new and significant information during its independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no offsite radiological impacts (collective effects) from the uranium fuel cycle during the renewal term beyond those discussed in the GEIS

- Offsite radiological impacts (spent fuel and HLW disposal). Based on information in the GEIS, the Commission found that

> For the high level waste and spent fuel disposal component of the fuel cycle, there are no current regulatory limits for offsite releases of radionuclides for the current candidate repository site. However, if we assume that limits are developed along the lines of the 1995 National Academy of Sciences (NAS) report, 'Technical Bases for Yucca Mountain Standards," and that in accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository can and likely will be developed at some site which will comply with such limits, peak doses to virtually all individuals will be 100 millirem [1 mSv] per year or less. However, while the Commission has reasonable confidence that these assumptions will prove correct, there is considerable uncertainty since the limits are yet to be developed, no repository application has been completed or reviewed, and uncertainty is inherent in the models used to evaluate possible pathways to the human environment. The NAS report indicated that 100 millirem [1 mSv] per year should be considered as a starting point for limits for individual doses, but notes that some measure of consensus exists among national and international bodies that the limits should be a fraction of the 100 millirem [1 mSv] per year. The lifetime individual risk from 100 millirem [1 mSv] annual dose limit is about $3x10^{-3}$.

Estimating cumulative doses to populations over thousands of years is more problematic. The likelihood and consequences of events that could seriously compromise the integrity of a deep geologic repository were evaluated by the Department of Energy in the "Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste," October 1980 [DOE 1980]. The evaluation estimated the 70-year whole-body dose commitment to the maximum individual and to the regional population resulting from several modes of breaching a reference repository in the year of closure, after 1,000 years, after 100,000 years, and after 100,000,000 years. Subsequently, the NRC and other federal agencies have expended considerable effort to develop models for the design and for the licensing of a high level waste repository, especially for the candidate repository at Yucca Mountain. More meaningful estimates of doses to population may be possible in the future as more is understood about the performance of the proposed Yucca Mountain repository. Such estimates would involve very great uncertainty, especially with respect to cumulative population doses over thousands of years. The standard proposed by the NAS is a limit on maximum individual dose. The relationship of potential new regulatory requirements, based on the NAS report, and cumulative population impacts has not been determined, although the report articulates the view that protection of individuals will adequately protect the population for a repository at Yucca Mountain. However, EPA's [the Environmental Protection Agency's) generic repository standards in 40 CFR part 191 generally provide an indication of the order of magnitude of cumulative risk to population that could result from the licensing of a Yucca Mountain repository, assuming the ultimate standards will be within the range of standards now under consideration. The standards in 40 CFR part 191 protect the population by imposing "containment requirements" that limit the cumulative amount of radioactive material released over 10,000 years. Reporting performance standards that will be required by EPA are expected to result in releases and associated health consequences in the range between 10 and 100 premature cancer deaths with an upper limit of 1,000 premature cancer deaths world-wide for a 100,000 metric tonne (MTHM) repository.

Nevertheless, despite all the uncertainty, some judgement as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of

significance for the impacts of spent fuel and high level waste disposal, this issue is considered Category 1.

Since the GEIS was originally issued in 1996, EPA published radiation protection standards for Yucca Mountain, Nevada, at 40 CFR Part 197, "Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada," on June 13, 2001 (66 FR 32132). The Energy Policy Act of 1992 directs the NRC to adopt these standards into its regulations for reviewing and licensing the repository. NRC published its regulations at 10 CFR Part 63, "Disposal of High-Level Radioactive Wastes in Geologic Repository at Yucca Mountain, Nevada," on November 2, 2001 (66 FR 55792). These standards include the following: (1) a 0.15 mSv/yr (15 mrem/yr) dose limit for members of the public during the storage period prior to repository closure, (2) a 0.15 mSv/yr (15 mrem/yr) dose limit for the reasonably maximally exposed individual from the undisturbed repository for 10,000 years following disposal, (3) a 0.15 mSv/yr (15 mrem/yr) dose limit for the reasonably maximally exposed individual as a result of a human intrusion at or before 10,000 years after disposal, and (4) a ground-water protection standard that states that for 10,000 years of undisturbed performance after disposal, radioactivity in a representative volume of groundwater will not exceed (a) 0.2 Bq/L (5 pCi/L) for radium-226 and radium-228, (b) 0.56 Bq/L (15 pCi/L) for gross alpha activity, and (c) 0.04 mSv/yr (4 mrem/yr) to the whole body or any organ (from combined beta- and photon-emitting radionuclides, assuming consumption of 2 Lpd of the affected water).

On February 15, 2002, subsequent to receipt of a recommendation by Secretary Abraham, U.S. Department of Energy, the President recommended the Yucca Mountain site for the development of a repository for the geologic disposal of spent nuclear fuel and high-level nuclear waste. The U.S. Congress approved this recommendation on July 9, 2002. This development does not represent new and significant information with respect to the offsite radiological impacts related to spent fuel and HLW disposal during the renewal term.

The staff has not identified any new and significant information during its independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no offsite radiological impacts related to spent fuel and HLW disposal during the renewal term beyond those discussed in the GEIS.

- Nonradiological impacts of the uranium fuel cycle. Based on information in the GEIS, the Commission found that

  The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an operating license for any plant are found to be small.

The staff has not identified any new and significant information during its independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no nonradiological impacts of the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Low-level waste storage and disposal. Based on information in the GEIS, the Commission found that

  > The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts to the environment will remain small during the term of a renewed license. The maximum additional on-site land that may be required for low-level waste storage during the term of a renewed license and associated impacts will be small. Nonradiological impacts on air and water will be negligible. The radiological and nonradiological environmental impacts of long-term disposal of low-level waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient low-level waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

  The staff has not identified any new and significant information during its independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of low-level waste storage and disposal associated with the renewal term beyond those discussed in the GEIS.

- Mixed waste storage and disposal. Based on information in the GEIS, the Commission found that

  > The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal will not increase the small, continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient mixed waste

> disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

The staff has not identified any new and significant information during its independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of mixed waste storage and disposal associated with the renewal term beyond those discussed in the GEIS.

- Onsite spent fuel. Based on information in the GEIS, the Commission found that

> The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated on site with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage is not available.

The staff has not identified any new and significant information during its independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of onsite spent fuel associated with license renewal beyond those discussed in the GEIS.

- Nonradiological waste. Based on information in the GEIS, the Commission found that

> No changes to generating systems are anticipated for license renewal. Facilities and procedures are in place to ensure continued proper handling and disposal at all plants.

The staff has not identified any new and significant information during its independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no nonradiological waste impacts during the renewal term beyond those discussed in the GEIS.

- Transportation. Based on information contained in the GEIS, the Commission found that

> The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with average burnup for the peak rod to current levels approved by NRC; up to 62,000 MWd/MTU and the cumulative impacts of transporting high-level waste to

a single repository, such as Yucca Mountain, Nevada are found to be consistent with the impact values contained in 10 CFR 51.52(c), Summary Table S-4 Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor. If fuel enrichment or burnup conditions are not met, the applicant must submit an assessment of the implications for the environmental impact values reported in § 51.52.

Surry Power Station, Units 1 and 2 meet the fuel-enrichment and burnup conditions set forth in Addendum 1 to the GEIS. The staff has not identified any new and significant information during its independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of transportation associated with license renewal beyond those discussed in the GEIS.

6.2 References

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 63. Code of Federal Regulations, Title 10, Energy, Part 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada."

40 CFR Part 191. Code of Federal Regulations, Title 40, *Protection of Environment,* Part 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level, and Transuranic Radioactive Waste."

40 CFR Part 197. Code of Federal Regulations, Title 40, *Protection of Environment,* Part 197, "Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada."

Energy Policy Act of 1992. 42 USC 10101, et seq.

National Academy of Sciences (NAS). 1995. *Technical Bases for Yucca Mountain Standards.* Washington, D.C.

National Environmental Policy Act (NEPA) of 1969, as amended. 42 USC 4321, et seq.

U.S. Department of Energy (DOE). 1980. *Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste.* DOE/EIS-0046F, DOE, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants.* NUREG-1437, Volumes land 2, NRC, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report, "Section 6.3 - Transportation, Table 9.1, "Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report."* NUREG-1437, Volume 1, Addendum 1, NRC, Washington, D.C.

Virginia Electric and Power Company (VEPCo). 2001. Application for license Renewal for Surly Power Station, Units 1 and 2, "Appendix E, Environmental Report - Operating License Renewal Stage." Richmond, Virginia.

7.0 Environmental Impacts of Decommissioning

Environmental issues associated with decommissioning, which result from continued plant operation during the renewal terms are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).[a] The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1, and therefore, additional plant-specific review of these issues is required. There are no Category 2 issues related to decommissioning Surry Power Station, Units 1 and 2.

Category 1 issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B that are applicable to Surry Power Station, Units 1 and 2, decommissioning following the renewal term are listed in Table 7-1. The Virginia Electric and Power Company (VEPCo) stated in its Environmental Report (ER; VEPCo 2001) that it is aware of no new and significant information regarding the environmental impacts of Surry Power Station, Units 1 and 2, license renewal. The staff has not identified any significant new information during its independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping process, or its evaluation of other available information.

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

Table 7-1. Category 1 Issues Applicable to the Decommissioning of Surry Power Station Following the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
DECOMMISSIONING	
Radiation Doses	7.3.1; 7.4
Waste Management	7.3.2; 7.4
Air Quality	7.3.3; 7.4
Water Quality	7.3.4; 7.4
Ecological Resources	7.3.5; 7.4
Socioeconomic Impacts	7.3.7; 7.4

Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For all of these issues, the staff concluded in the GEIS that the impacts are SMALL, and plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, for each of the issues follows:

- Radiation doses. Based on information in the GEIS, the Commission found that

  > Doses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem [0.01 person-Sv] caused by buildup of long-lived radionuclides during the license renewal term.

  The staff has not identified any new and significant information during its independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no radiation doses associated with decommissioning following license renewal beyond those discussed in the GEIS.

- Waste management. Based on information in the GEIS, the Commission found that

  > Decommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected.

The staff has not identified any new and significant information during its independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of solid waste associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Air quality. Based on information in the GEIS, the Commission found that

  > Air quality impacts of decommissioning are expected to be negligible either at the end of the current operating term or at the end of the license renewal term.

  The staff has not identified any new and significant information during its independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of license renewal on air quality during decommissioning beyond those discussed in the GEIS.

- Water quality. Based on information in the GEIS, the Commission found that

  > The potential for significant water quality impacts from erosion or spills is no greater whether decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts.

  The staff has not identified any new and significant information during its independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of the license renewal term on water quality during decommissioning beyond those discussed in the GEIS.

- Ecological resources. Based on information in the GEIS, the Commission found that

  > Decommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts.

  The staff has not identified any new and significant information during its independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of the license renewal term on ecological resources during decommissioning beyond those discussed in the GEIS.

- Socioeconomic Impacts. Based on information in the GEIS, the Commission found that

  > Decommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year relicense period, but they might be decreased by population and economic growth.

  The staff has not identified any new and significant information during its independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts of license renewal on the socioeconomic impacts of decommissioning beyond those discussed in the GEIS.

7.1 References

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

U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants.* NUREG-1437, Volumes 1 and 2, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report,* "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

Virginia Electric and Power Company (VEPCo). 2001. *Application for License Renewal for Surry Power Station, Units 1 and 2,* "Appendix E, Environmental Report - Operating License Renewal Stage." Richmond, Virginia.