North Anna 3 Combined License Application

Part 3: Applicants' Environmental Report - Combined License Stage

Revision 8

June 2016

REVISION SUMMARY

Revision 8

Section	Changes	Reason for Change
2.7.6, 5.4.2.2; Tables 2.7-2, 2.7-4 thru 2.7-12, 3.0-1, 3.0-2, 5.4-4 thru 5.4-8, & 10.4-2	RAI 02.03.05-05, Modeling of Radwaste Building Vent Stack Releases	

Revision 7

Section	Changes	Reason for Change
1.3.3	Revised list of new and significant information	Unit 3 technology change from US-APWR to ESBWR
	Added bullet indicating information added to ER Sections 2.6.2.2.1 and 2.4.4.2.1	Indicate information contained in ER Sections 2.6.2.2.1 and 2.6.4.2.1
	Added bullet indicating information added to ER Section 4.5	Response to US-APWR S-COLA RAIs 12.03-46 and 12.03-47
Section 2.2 Reference, Section 2.4 References, Section 4.1 Reference, Section 4.2 Reference, Section 9.4 References	Update reference for PJM study	Updated study completed
2.7	Updated atmospheric dispersion information	Unit 3 technology change from US-APWR to ESBWR; ESBWR DCD changes from R5 to R9
Tables 3.0-1 & 3.0-2	Updated Unit 3 Site Characteristic Values vs. ESP Values	Unit 3 technology change from US-APWR to ESBWR; ESBWR DCD changes from R5 to R9
Tables 3.0-3 thru 3.0-8	Revised accident activity release information	DCD R9
3.2	Revised reactor power conversion system information	Unit 3 technology change from US-APWR to ESBWR
3.3.2	Revised water treatment information	Unit 3 technology change from US-APWR to ESBWR; changed water treatment plan
Table 3.3-1	Revised Unit 3 chemical injection points	Unit 3 technology change from US-APWR to ESBWR

Revision 7 *(continued)*

Section	Changes	Reason for Change
3.6.1	Revised plant effluent discharge information	Blowdown sump removed from design
3.7.1	Revised citation to PJM system impact study	PJM study updated
Section 3.7 References	Updated Reference 1	PJM study updated
Section 4.3 References	Added references 9 thru 11	Additional plant surveys performed
4.3.1.1	Updated plant survey information	Additional plant surveys performed
4.5	Updated construction worker radiation exposure evaluation information	Updated evaluation performed to address US-APWR S-COLA RAIs 12.03-46 and 12.03-47
5.3	Reflected results of updated SACTI analysis	Unit 3 technology change from US-APWR to ESBWR
5.4	Updated normal operation radiological impacts information	Unit 3 technology change from US-APWR to ESBWR; ESBWR DCD changes from R5 to R9
5.8, Figure 5.8-2	Deleted reference to UHS cooling tower and revised visual impact survey figure	Unit 3 technology change from US-APWR to ESBWR
7.1.4	Deleted reference to "two" accidents	Editorial
Tables 7.1-2 thru 7.1-5, 7.1-7, 7.1-9, & 7.1-10	Revised design basis accident doses information	DCD R9
7.3	Changed "GE" to "GEH"	Editorial
7.3.1	Deleted (ESP-ER reference)	Updated analytical inputs
7.3.2	Clarified source of SAMDAs	NEDO-33306 Rev 4 clarified the source of SAMDAs
	Inserted NEDO-33306 averted risk benefit value	Updated GEH analysis
	Updated GEH conclusions	Updated GEH analysis
7.3.3	Updated Unit 3 SAMA analysis	Updated to reflect the current ESBWR PRA and SAMDA analysis, and current site information

Revision 7 *(continued)*

Section	Changes	Reason for Change
Section 7.3 References	Changed Reference 1 from Revision 1 to 4 and August 2007 to October 2010	NEDO-33306 is Revision 4, ML1029904331
	Added Reference 2	NEDO-33201 Revision 6, ML 102880548
10.4.2	Updated O&M and decommissioning costs; revised land use information	Unit 3 technology change from US-APWR to ESBWR
Tables 10.4-1 & 10.4-2	Revised peak number of construction workers, land use, hydrological and water use, doses, and expected traffic impacts	Consistency with updates in other chapters

Revision 6

Section	Changes	Reason for Change
Various	US-APWR narrative to ESBWR information	Unit 3 technology change from US-APWR to ESBWR
1.1	Revised Unit 3 megawatt thermal (MWt) value	Electrical output of an ESBWR plant is different than that of a US-APWR plant
1.1.6	Revised potential construction start and fuel load dates	Milestones dates no longer valid
Figure 1.1-1	Revised site utilization plan figure	Revised to reflect ESBWR design and North Anna specific information
Figure 1.1-2	Revised site plan with building legend	Revised to reflect ESBWR design and North Anna specific information
Table 1.2-1	Revised federal, state, and local authorizations	Revised to reflect updated agency consultation status
1.3.3	Added bullet indicating information added to ER Sections 2.6.2.2.1 and 2.6.4.2.1	Indicate information contained in ER Sections 2.6.2.2.1 and 2.6.4.2.1
1A	Revised Environmental Protection Plan (EPP)	Revised to reflect level of detail in Revision 2 of NA3 ESBWR COLA ER
2.4.1.6, 4.3.1.2, 4A.2, 4B.2.4	Revised endangered species surveys description	Revised to reflect 2012 survey results
2.4.1.7	Revised rare plant species surveys description	Revised to reflect 2012 survey results

Revision 6 *(continued)*

Section	Changes	Reason for Change
Section 2.4 References	Added information regarding additional surveys	Updated with recent survey documents
2.6	Added narrative to describe information associated with seismological conditions and impacts	Provide information stemming from the new CEUS SSC model and the August 2011 Mineral, VA earthquake.
3.1	Deleted narrative associated with US-APWR UHS cooling towers	Consistency with ESBWR design
3.6	Deleted content regarding the blowdown sump	Design has changed and feature is no longer planned
Section 3.6 References	Updated date of regulation in Reference 3	Effective date changed
4.1	Deleted statement that land-use and other impacts associated with transport of large components to NAPS site is small	Pending updated Large Component Transport Route evaluation, removed impact statement
4.2.1.2, 4A.6	Added information regarding groundwater wells for construction and operations	Revised to provide additional detail on planned groundwater withdrawal during construction
Section 4.3 References, 4A.8	Added information regarding additional survey	Update with recent survey document
4A.1, 4A.5, Figure 4A-1	Deleted figures and references to figure	Additional property site utilization plan is included in Figure 1.1-1
4A.1, 4A.5	Deleted narrative associated with batch plant on additional property	Batch plant now planned to be inside EAB
Section 4B.4 References	Added information regarding additional survey Changed "Reference" to "References"	Update with recent survey document Editorial
5.9	Revised to provide ESBWR-specific narrative on decommissioning	Reflect ESBWR information
8.0	Updated information regarding net electrical generation's benefits, fuel diversity/mitigated and enhanced reliability, and emissions avoidance	Updated information
8.0.1.1	Revised values	Updated information
Section 8.0 References	Updated references	Updated information
Table 8.0-1	Revised	Updated information

Revision 6 *(continued)*

Section	Changes	Reason for Change
Table 8.0-2	Deleted	Deleted
Figures 8.0-1 thru 8.0-4	Revised	Updated information
8.1, 8.1.1	Editorial changes	Clarified content
Section 8.1 References	Updated references	Updated information
8.1.3	Updated service territory information and added information about the Regulation Act	Updated information
8.1.4	Updated PJM, Virginia, SCC, and NCUC information	Updated information
Tables 8.1-1 & 8.1-3	Updated information	Updated information
Figures 8.1-1 & 8.1-4	Updated information	Updated information
Figure 8.1-6	New figure	Updated information
8.2	Updated PJM and DSM information	Revised to incorporate PJM's 2012 report
Section 8.2 References	Updated references	Updated information
Table 8.2-1	Updated information	Updated information
Figure 8.2-1	Updated information	Updated information
8.3	Updated generating capability and purchase and sales information	Updated information
Section 8.3 References	Updated references	Updated information
Table 8.3-2	Deleted	
Tables 8.3-3 thru 8.3-9	Updated information	Updated information
Figures 8.3-1 thru 8.3-5	Updated information	Updated information
8.4	Updated information to support need for power evaluation	Updated information
Section 8.4 References	Updated references	Updated information
Tables 8.4-1 & 8.4-2	Updated information	Updated information
Chapter 9, Introduction	Deleted information about Virginia City facility	Deleted information
9.1	Updated information about capacity additions	Updated information
9.2.1	Updated information	Updated information

Revision 6 *(continued)*

Section	Changes	Reason for Change
Section 9.2 References	Updated references	Updated information
9.4	Updated information	Updated information

Revision 5

Section	Changes	Reason for Change
Chapter 1, 1.1, 1.1.1, 8.0.1.1, 8.1, 8.1.1, 8.1.2, 8.1.4.5; Figure 8.1-2	ODEC terminated its ownership interest in North Anna Unit 3.	Revised to reflect the change in ODEC ownership interest in North Anna Unit 3.

Revision 4

Section	Changes	Reason for Change
Figures 1.1-1 & 1.1-2	Changed electrical building size and SGBD facility relocated.	Reflect new Site Utilization Plan changes
Table 1.2-1	Updated the status and expiration dates for existing authorizations; added/deleted authorizations.	Update federal, state, and local authorizations
	Permit number and status updates.	New permits issued and received
1A	Entirely replaced.	Adopt latest NEI template
Table 2.3-1	Changed to be consistent with current VPDES Permit.	VPDES Permit
2.4.1.6	Updated the status of survey results communications to regulatory agencies.	New information regarding endangered species surveys
2.4.1.7	Updated plant-specific identification follow-up survey for Epling’s hedgenettle.	New information regarding rare plant species surveys
Section 2.4 References	Added references 7 thru 10.	New references identified
2.5.3.5	Added the results of the survey conducted in 2011 of the LCTR.	New information regarding historical/cultural resources surveys
Section 2.5 References	Added reference 5.	New reference identified
2.7.6; Tables 2.7-1, 2.7-2 & 2.7-3	RAI MET-1, Meteorology/Air Quality; Revised distances to the EAB	
3.6.1	Deleted brackets around “essential.”	Editorial
3.6.1, 3.6.2; Table 3.3-1	Changed “cooling tower blowdown sump” to “blowdown sump.”	Editorial

Revision 4 *(continued)*

Section	Changes	Reason for Change
Table 3.0-1	Changed gaseous effluent dispersion site characteristic values and evaluation.	Consistency with response to RAI 11.03-4
	Changed EAB atmospheric dispersion factor evaluation.	Consistency with response to RAI MET-1
4.6	Editorial.	Editorial
4.7	Deleted.	Editorial
Table in 4A.2	Changed total acres from "95.6" to "95.5."	Editorial
4A.5	Deleted "areas."	Editorial
4B.1	Changed "lines" to "supplies" and "storm water" to "stormwater."	Editorial
4B.2.2	Changed "storm water" to "stormwater."	Editorial
Figure 4B-1	Added planned wells and Gen. Rewind Bldg.	New Site Separation Activities drawing changes
Tables 5.4-3, 5.4-4, 5.4-6 thru 5.4-8	See RAI 11.02-7, Cooling Tower Makeup Water Tritium	
9.3	Clarified SECY reference.	Editorial
Table 10.4-2	Changed "12.5 cfs" to "12.4 cfs."	Editorial

Revision 3

Section	Changes
1.1; Figures 1.1-1 & Figures 1.1-2	Revised to reflect the change from ESBWR to US-APWR technology. Added footnote to provide clarification for "msl" datum to "NGVD 29" datum.
Table 1.2-1	Revised to reflect the change from ESBWR to US-APWR technology.
1.3; Table 1.3-1	Revised to reflect the change from ESBWR to US-APWR technology. Revised 1.3.3 to update the list of new and significant information. Added 1.3.3.3 to described new and significant processes for ER revisions. Revised Table 1.3-1 to provide update to IFIM study description.
2.4	Revised to reflect the change from ESBWR to US-APWR technology. Revised 2.4.1.5 to reference a subsequent habitat survey. Revised 2.4.1.6 and 2.4.1.7 to discuss a letter regarding two plants of interest, and added related references.

Revision 3 *(continued)*

Section	Changes
2.7; Tables 2.7-1 thru 2.7-12	Revised to reflect the change from ESBWR to US-APWR technology. Updated to reflect the latest sensitive receptors and χ/Q inputs from US-APWR.
Chapter 3; Tables 3.0-1 thru 3.0-7	Revised to reflect the change from ESBWR to US-APWR technology. Changed values for site and design characteristics and accident analyses and results.
3.1	Revised to reflect the change from ESBWR to US-APWR technology. Clarified area required for UHS cooing tower basins and cooling towers' height.
3.2	Revised to reflect the change from ESBWR to US-APWR technology.
3.3; Table 3.3-1	Revised to reflect the change from ESBWR to US-APWR technology. Changed chemicals, applications (dosages) and subsystem descriptions.
3.6	Revised to reflect the change from ESBWR to US-APWR technology.
3.7	Revised to reflect the change from ESBWR to US-APWR technology. Deleted description of intermediate switchyard from Section 3.7.1.
3.8	Revised to reflect the change from ESBWR to US-APWR technology. Revised to include the RADTRAN results.
4.3	Revised to reflect the change from ESBWR to US-APWR technology. Revised 4.3.1.1 and 4.3.1.2 to discuss two plants of interest and added related references.
4.4	Revised to reflect the change from ESBWR to US-APWR technology. Revised to add commitment to address the communications plan.
Appendix 4A; Figures 4A-1 & 4A-2	Revised to reflect the change from ESBWR to US-APWR technology. Revised to add discussion of, and references to plant-specific habitat survey conducted for the additional property, and the planned identification survey. Revised Figure 4A-2 to include plant-specific habitat survey.
Appendix 4B; Figure 4B-1	Revised to reflect the change from ESBWR to US-APWR technology. Revised to include the results of the plant specific habitat survey that found a potential small whorled pogonia habitat on-site.
5.3	Revised to reflect the change from ESBWR to US-APWR technology. Added discussion of UHS visible plume length.

Revision 3 *(continued)*

Section	Changes
5.4; Tables 5.4-1 thru 5.4-8	Revised to reflect the change from ESBWR to US-APWR technology. Revised release activities, distances, dose calculation values.
5.8; Figures 5.8-1, 5.8-2, & 5.8-3	Revised to reflect the change from ESBWR to US-APWR technology.
5.9	Revised to reflect the change from ESBWR to US-APWR technology.
5.10; Tables 5.10-1 thru 5.10-6	Revised to reflect the change from ESBWR to US-APWR technology.
7.2	Revised to reflect the change from ESBWR to US-APWR technology. Revised to incorporate the severe accident analysis (MACCS2) for the US-APWR.
7.1; Tables 7.1-1 thru 7.1-12	Revised to reflect the change from ESBWR to US-APWR technology.
7.3	Revised to reflect the change from ESBWR to US-APWR technology.
10; Tables 10.1-1 thru 10.4-2	Revised to reflect the change from ESBWR to US-APWR technology.

Revision 2

Section	Changes
1.1.1, 1.3.3, Figure 1.1-1, 1A, 2.2.1, 2.2.2, 2.3.1, 2.4.1, 2.4.1.2, 2.4.1.3, 2.4.1.5, 2.4.1.6, 2.4.1.8, 4.1, 4.1.3, 4.2, 4.2.1.1, 4.2.1.2, 4.3, 4.3.1.3, 4.3.2.1, 4A, Figures 4A-1 & 4A-2, Table 10.1-1	Added information on additional property construction utilization and impacts to wetlands; revised Site Utilization Plan; added statements in associated sections to reference Appendix 4A.
1.1.1, 1.3.3, Table 1.2-1, 1A, 2.4.1.6, 2.5.3.3, Section 2.5 References, 3.4, 4.1, 4.1.2, 4.1.3, 4.2.1.1, 4.3.1.4, 4.4, 4A, 4B, 5.6.3.4, 5.10, 5.10.1.4, 5.10.1.5, 5.10.1.6, Section 5.10 Reference, Table 5.10-3, Tables 10.1-1 & 10.1-2	Editorial changes.
1.3.3, 2.2.1, 2.5, 2.5.1, 2.5.2, 2.5.3, 2.5.4, Section 2.5 References, 4.1.3	Added information on historic and cultural resources within the transmission corridor.
Table 1.2-1	Updated status of permitting activities.
Table 1.2-1	Completed definition of acronyms.

Revision 2 *(continued)*

Section	Changes
Table 1.3-1, 5.10.1.1	Updated status of IFIM study; added summary description of IFIM study.
1.3.3, 1A, 4.6, 3.7.2, 5.6.3.4, Table 10.1-1	Added description of mitigation measures associated with the transmission corridor.
1.3.3, 1A, 2.3.1, 2.4.1, 2.5, 4.1.3, 4.3.1.2, 4.4, 4.6, Table 10.1-1	Added new information on historic and cultural resources and wetlands within the heavy haul route and mitigation measures to prevent impacts to historic and cultural resources, and to wetlands.
1A, 2.4.1.8, 5.8, 5.10.1.4, 5.10.1.5, 5.10.1.6, 9.4, Table 10.1-2	Addressed nonhydrological impacts from mitigating actions based on the results of the IFIM study, including the 3-inch in lake level. Aligned narratives among EPP, 5.10, and 10.1.
1A, 4.6	Added mitigating actions identified in the Draft Supplemental Environmental Impact Statement
1A, 4.7, 4B	Added 4B to address site separation activities. Added 4.7, Cumulative Impacts. Corrected EPP Table 1 to be consistent with 4B.
Table 3.0-2	Updated the evaporation rate characteristic value.
3.4, 5.2, 5.3, 5.10, Tables 5.10-1 thru 5.10-6, Figures 5.10-1 thru 5.10-4, Tables 10.4-1 & 10.4-2	Added descriptions of mitigating actions based on the results of the IFIM study, including the 3-inch lake level increase.
1.1.6, 1A, 2.2.1, 2.3.1, Section 2.3 References, 2.4.1, 4.3.1.4, Section 4.3 References, 4A, 5.10.1.1, 5.10.1.4, 5.10.1.5, 5.10.1.6, Table 5.10-1	Updated construction start date information. Corrected EPP Table 1 to be consistent with 2.2.1 and 4A. Added reference to substantiate 2.3.1. Provided pointer in 2.4.1 to location of new information. Provided basis for section conclusion statement 4A.5. Incorporated IFIM comment into 5.10, clarifying statements of hydrologic alterations, aquatic ecology impact, future shoreline wetland mitigation evaluations, and added missing footnotes to Table 5.10-1.

Revision 1

Section	Changes
Section 1.1 References, EPP References; Section 2.3 References, Section 2.4 References, Section 3.6 References, Section 3.7 References, Section 3.8 Reference, Section 4.1 Reference, Section 4.2 Reference. Section 5.2 Reference, Section 5.6 References, Section 5.9 References, Section 7.1 References, Section 7.3 References, Section 8.0 References, Section 8.1 References, Section 8.2 References, Section 8.3 References, Section 8.4 References, Section 9.2 References, Section 10.4 References	Editorial changes.
1.1.6	Revised estimated key milestones.
Table 1.2-1, 1.3.4, Table 1.3-1, Chapter 3, Tables 3.0-1 thru 3.0-7, 3.1, 3.2, 7.3.3	Updated to reflect ESP-003; editorial and clarifying changes.
1.3.1	Updated to reflect ESP-003; editorial changes.
Table 1.3-1	Updated status of IFIM study.
Figures 1.1-1 & 1.1-2	Updated site utilization figures to align with DCD R5.
EPP, Table 1, 2.5, 8.0.1.1, 8.3.1.3	Editorial changes.
Table 2.3-1	Reflected new lake water sample data.
2.7, 2.7.6	RAI NA3 02.03.05-1, χ/Q and D/Q Values
2.7.6, Table 2.7-1	Updated source-to-receptor distances, χ/Q values.
2.7.6, Tables 2.7-1 & 2.7-2, 5.4.2.2, Tables 5.4-4 thru 5.4-6	RAI NA3 02.03.05-2, Clarification of χ/Q and D/Q Values
2.7.6, Tables 2.7-5 thru 2.7-12	RAI NA3 02.03.05-3, χ/Q and D/Q Values Out to 50 Miles
Table 3.0-1, Post-Accident	Corrected reference to DBA dose consequences.

Revision 1 *(continued)*

Section	Changes
Tables 3.0-1 & 5.4-4	Added "undepleted" or "depleted" to descriptions; editorial corrections; reflected new doses to MEI (Table 3.0-1). Editorial clarifications (Table 5.4-4).
Table 3.0-2, Structure Height	Updated tallest structure information.
Tables 3.0-2 thru 3.0-6a; 7.1.3, 7.1.4, Tables 7.1-1 thru 7.1-10	Updated source terms in plant parameter and activity release tables to align with DCD R5.
3.6.1	Clarified copper-presence explanation.
3.6.1, Table 3.6-1	Revised the copper and tributyltin values and the associated explanatory statement.
3.7.1	Revised 500 kV connection to Ladysmith line.
4.1.4, 4A	Revised to describe additional property per Dominion Letter NA3-08-108 (Proprietary).
4.3.1.1, Section 4.3 References	Reflect results of new wetlands impacts, wildlife and cultural resources assessments.
5.4.2.2, Tables 5.4-3, 5.4-4, 5.4-5, 5.4-6, 5.4-7, & 5.4-8	RAI NA3 12.02-1, Update Commitment to Final Version of NEI 07-03
5.4.2.3	Incorporated discussion of Units 1 & 2 direct radiation contribution.
5.4.2.3, Table 5.4-6	Changed ISFSI dose contribution, and changed existing units and site total doses.
5.4.3	Updated discussion of liquid and gaseous effluent dose impacts to MEI due to operation of Units 1, 2, and 3 and the ISFSI. Added discussion of Unit 3 operational liquid and gaseous effluents on the population within 50 miles.
Tables 5.4-4 & 5.4-7	RAI NA3 12.02-11, Clarify Information In Section 12 Tables
Table 5.4-6	RAI NA3 12.02-12, Dose Contributions
Section 5.6 References, Section 8.0 References, Section 8.1 References, Section 8.2 References, Section 8.3 References, Section 8.4 References, Section 9.2 References, Section 10.4 References	Editorial corrections (deleted web addresses).
7.1.4, Table 7.1-9	Editorial correction.
8.2.1.1, 8.2.1.2.1, 8.2.1.2.3, 8.2.1.2.4, 8.2.2.2.1, Section 8.2 References	Deleted references 9 and 17 and renumbered/corrected citations accordingly.

Revision 1 *(continued)*

Section	Changes
Table 9.2-4a	Added table from RAI response ER NA3-08-079R (coal combustion).
	Typographical correction. Updated PM10 emission rate.
Table 9.2-10	Typographical correction.
Tables 10.4-1 & 10.4-2	Incorporated revisions per RAI response ER NA3-08-079R (cost benefit).

PART 3 - ENVIRONMENTAL REPORT
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PART 3: ENVIRONMENTAL REPORT

Chapter 1 Introduction

This Applicants' Environmental Report-Combined License Stage is submitted pursuant to 10 CFR 51.50(c) to provide environmental information supporting the application of Virginia Electric and Power Company, doing business as Dominion Virginia Power (Dominion or DVP), for a combined construction permit and operating license for a third nuclear unit at the North Anna Power Station (NAPS).

The environmental impacts of constructing and operating new nuclear units at NAPS were previously assessed in North Anna Early Site Permit Application, Part 3, Environmental Report (ESP-ER) (Reference 1), and in NUREG-1811, Final Environmental Impact Statement for an Early Site Permit (ESP) at the North Anna Site (FEIS) (Reference 2). In accordance with 10 CFR 51.50(c)(1), this Applicants' Environmental Report - Combined License Stage incorporates by reference the assessment of environmental issues that were resolved in the ESP proceeding and provides, where necessary, the following supplemental information:

- Information demonstrating that the design of the facility falls within the ESP site characteristics and design parameters;
- Information resolving any significant environmental issue identified by the NRC that was not resolved in the early site permit proceeding;
- Any new and significant information for issues related to the impacts of construction and operation of the facility that were resolved in the early site permit proceeding;
- A description of the process used to identify new and significant information regarding the NRC's conclusions in the ESP environmental impact statement; and
- Demonstration that relevant environmental terms and conditions for the early site permit will be satisfied by the date of issuance of the combined license, or for requirements applicable to activities that may continue beyond COL issuance, would be appropriately included as terms and conditions of the combined license.

1.1 The Proposed Action

This section provides a description of the proposed action, the applicants, site location, and the selected design.

The proposed action is the issuance of a combined construction permit and operating license (COL) for a new nuclear unit (Unit 3) at the North Anna Power Station (NAPS). Unit 3 would be a 4500 megawatt thermal (MWt) ESBWR.

The purpose and need for the proposed action is to provide additional baseload power for residential and industrial customers in the region served by Dominion. Additional purposes of proposed Unit 3 are to maintain fuel diversity in this region, reduce dependence on imported power, leverage Dominion's existing nuclear facilities, and to promote the regional economy, while not contributing to CO_2 emissions.

1.1.1 The Applicant and the Owner

Dominion is the applicant for the COL addressed in this environmental report. Dominion holds sole title to the portion of NAPS on which Unit 3 will be located. The remainder of the NAPS site is owned by Dominion and Old Dominion Electric Cooperative as tenants in common. These companies also own all land outside the NAPS site boundary that forms Lake Anna, up to Elevation 255 ft msl[1]. Dominion is the licensed operator of the existing units, with control of the existing site and facilities and the authority to act as ODEC's agent. In addition, Dominion owns additional property contiguous with the NAPS site, which will provide additional space for Unit 3 construction support activities.

1.1.2 Site Location

The portion of the North Anna site on which Unit 3 will be located is the same as the ESP site described and evaluated in the ESP-ER and FEIS. The NAPS site is located on a peninsula on the southern shore of Lake Anna, approximately 5 miles upstream of the North Anna Dam. The NAPS site is located in Louisa County, Virginia, near the town of Mineral.

The portion of the NAPS site on which Unit 3 will be located is shown on ESP-ER Figure 1.1-1. Figures 1.1-1 and 1.1-2 show the location of Unit 3 buildings and equipment within the ESP proposed facility boundary (ESP plant parameter envelope) (see ESP-ER Figure 2.1-1) as well as the cooling tower area, switchyard expansion, spoils and overflow storage, temporary batch plant, construction laydown areas, and temporary construction parking.

1.1.3 Reactor Information

In the ESP-ER, the reactor technology to be used had not been selected. Since that time, Dominion has selected the ESBWR as the reactor technology to be constructed and operated at the ESP site. This ER addresses one unit (Unit 3) on the site. Details of the Unit 3 ESBWR design are provided in the FSAR.

1.1.4 Cooling System Information

As described in the ESP-ER, the cooling system for Unit 3 will be a closed-cycle, combination dry and wet cooling tower system, with make-up water supplied from Lake Anna. Make-up water will be withdrawn from the North Anna Reservoir through a new intake structure located on a cove on the south shore of the lake, originally planned for the intake of the never-constructed Units 3 and 4. This new structure will be adjacent to the existing units' intake structure. Cooling system discharges for

1. The designation msl (mean sea level) for water level is referenced to the National Geodetic Vertical Datum 1929 (NGVD29).

the existing units and the Unit 3 wet cooling tower blowdown will be sent to the Waste Heat Treatment Facility (WHTF) via the existing discharge canal.

1.1.5 Transmission System Information

At the ESP stage, it was expected based on an initial evaluation that any two of the existing 500 kV transmission lines, together with the 230 kV transmission line, would have sufficient capacity to carry the total output of the existing units and the new units. Subsequently, a system study (load flow study) has been performed that models these lines with the new unit's power contribution. The results of the load flow study and import/export studies indicate that a new 500 kV transmission line and other system reinforcements will be required for grid reliability in association with the interconnection of new Unit 3. The new line will be installed on new transmission towers in the existing corridor between the North Anna Substation and the Ladysmith Switching Substation. Further information is provided in Section 3.7.

1.1.6 Construction Start Date

Subject to required regulatory approvals and a decision to build, the following are estimated dates related to construction and operation of Unit 3:

Potential Safety Related Construction Start 2019

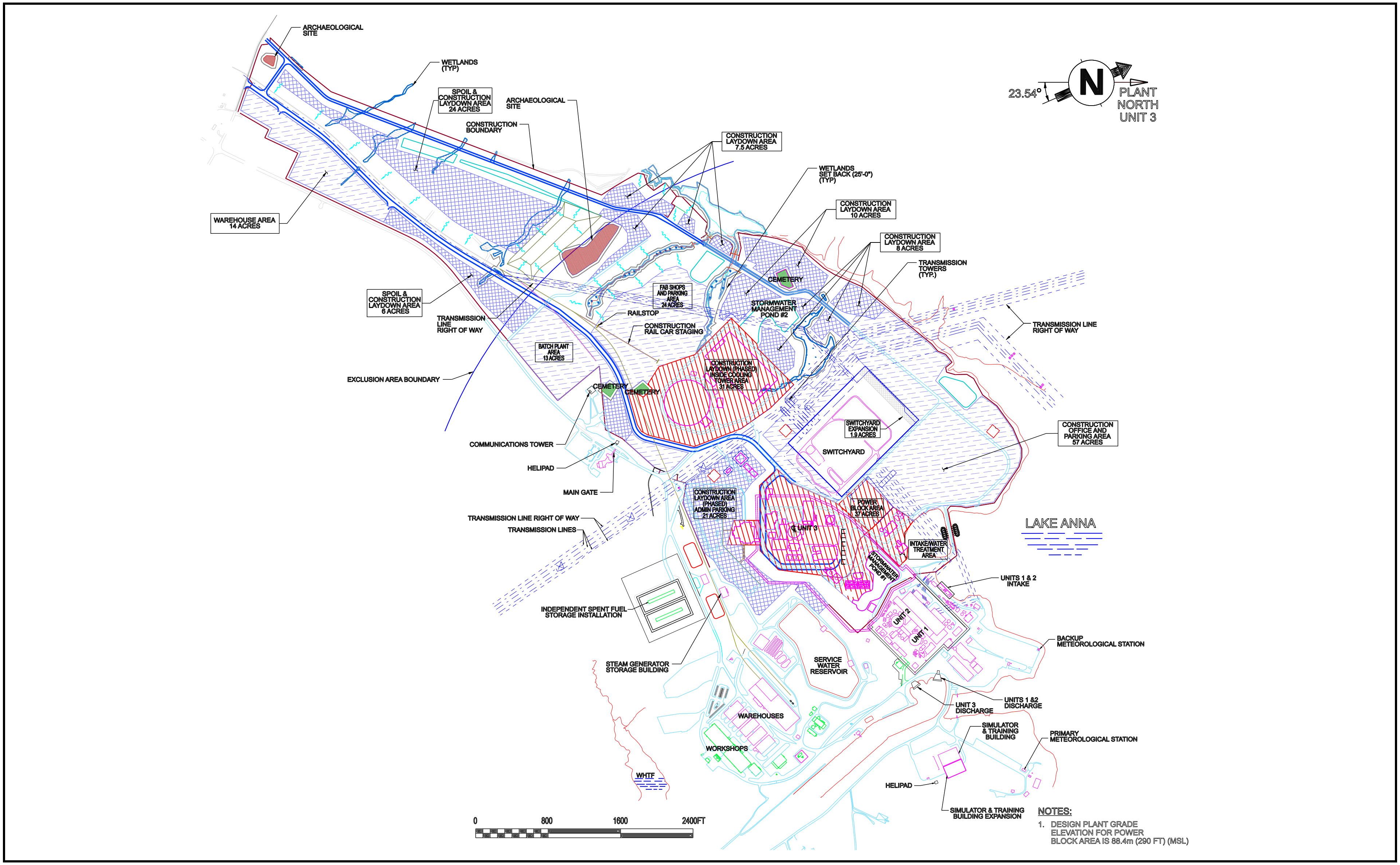
Fuel Load: 2023

Section 1.1 References

1. Dominion Nuclear North Anna, LLC, "North Anna Early Site Permit Application, Part 3 – Environmental Report," Revision 9, September 2006.

2. U.S. Nuclear Regulatory Commission, "Environmental Impact Statement for an Early Site Permit (ESP) at the North Anna ESP Site," NUREG-1811, December 2006.

Figure 1.1-1 Site Utilization Plan



Security-Related Information Withheld Under 10 CFR 2.390

Figure 1.1-2 Site Plan With Building Legend

1.2 Status of Reviews, Approvals, and Consultations

Numerous reviews, approvals, and consultations will be required for the construction and operation of new Unit 3. Table 1.2-1 provides a list of the environmental-related authorizations, permits, and certifications required by federal, state, regional, and local agencies for activities related to the construction and operation of Unit 3 at the NAPS site.

Table 1.2-1 Federal, State and Local Authorizations

Agency	Authority	Requirement	License/ Permit No. [a]	Expiration Date [a]	Activity Covered	Status
Federal Aviation Administration (FAA)	49 USC 1501	Construction Notice			Notice of erection of structures (if >200 feet) potentially impacting air navigation	Received “Determination of no hazard to air navigation” 4/13/08. Received antenna tower approval 2008. Other extensions or determinations to be applied for as needed.
Lake Anna Special Area Plan Committee	N/A	Conditional Land Use Approval	N/A	N/A	Local land use approval – Lake Overlay District, on as-needed basis only	Consultation with Lake Anna Advisory Committee expected to be conducted following issuance of COL.
Nuclear Regulatory Commission (NRC)	Atomic Energy Act (AEA), 10 CFR 51, 10 CFR 52.17	EIS	N/A	N/A	Environmental effects of construction and operation of a reactor	Under NRC Review
NRC	10 CFR 52, Subpart C	Combined License			Combined construction permit and operating license for a nuclear power facility	Under NRC Review
NRC	10 CFR 52, Subpart A	Early Site Permit	ESP-003	11/27/ 2027	Approval of the site for one or more nuclear power facilities, and approval of limited construction as per 10 CFR 50.10(e)(1)	Received November 2007
NRC	10 CFR 30	Byproduct Materials License			NRC license to possess special nuclear materials	To be issued with COL
NRC	10 CFR 70	Special Nuclear Materials License			NRC license to possess nuclear fuel	To be issued with COL
Virginia State Corporation Commission (SCC)	VA Code 56-265.2 and 56-46.1				Certificate of public convenience and necessity	Necessary for construction

Table 1.2-1 Federal, State and Local Authorizations

Agency	Authority	Requirement	License/ Permit No. [a]	Expiration Date [a]	Activity Covered	Status
U.S. Army Corps of Engineers (USACE)	Federal Water Pollution Control Act (FWPCA)	Section 404 Permit	10-V 1256/ NAO-2008-2534	9/30/26	Disturbance or crossing wetlands, streams or navigable waters	Received permit Sept 2011
USACE/Virginia Marine Resources Commission (VMRC)	Rivers and Harbors Act	Section 10 Permit	10-1256	9/27/16	Impacts to navigable waters of the U.S. (would also include overhead transmission line crossings)	Received permits Sept 2011
U.S. Fish & Wildlife Service (USFWS)/USACE	Endangered Species Act	Consultation regarding potential to adversely impact protected species	N/A	N/A	Concurrence with no adverse impact or consultation on appropriate mitigation measures	Concurrence received in connection with Section 404 permit issued Sept 2011
	Migratory Bird Treaty Act				Adverse impact on protected species (e.g., eagles, ospreys) and/or their nests, if applicable	
Virginia Department of Environmental Quality (VDEQ)	Clean Air Act 9 VAC 5-20-160	Registration (air emission)			Annual update report of air emissions	Expected to be submitted with (Air) Operating Permit application. Schedule being evaluated
VDEQ	9 VAC 5-80-800	State Operating Permit			Construction and operation of minor air emission sources	Schedule being evaluated
VDEQ	9 VAC 5-50-60 et seq.	Control and Abatement of Air Pollution			Fugitive dust control	Expected to be submitted with (Air) Operating Permit application. Schedule being evaluated

Table 1.2-1 Federal, State and Local Authorizations

Agency	Authority	Requirement	License/ Permit No. [a]	Expiration Date [a]	Activity Covered	Status
VDEQ	9 VAC 5-80-1100 et seq.	Permits for New and Modified Stationary Sources			Permit to install fuel burning equipment (e.g., boilers and generators)	Expected to be submitted with (Air) Operating Permit application. Schedule being evaluated
VDEQ	CWA, Section 402; 9 VAC 25-10/ 9 VAC 25-820/ 9 VAC 25-790	Virginia Pollutant Discharge Elimination System Permit (VPDES)/ Nutrient General permit/ Sewage treatment Certificates			Regulate limits of pollutants in liquid discharge to surface water	Expected to be submitted for construction sewage discharge permit and operational discharge permit, schedule being evaluated. Certificate to construct for site separation modifications to the existing Units 1/2 sewage treatment plant obtained 6/21/11; for certificates to construct & operate Unit 3 sewage treatment plants, schedule being evaluated
Virginia Department of Conservation & Recreation (VDCR)	FWPCA 4 VAC 50-60-10	Virginia Stormwater Management Program General Permit Registration Statement for stormwater discharges from Construction Activities	VAR 10-10-10574	06/30/14	General permit to discharge stormwater from land-disturbing and/or site construction activities	Received five-year general permit for site separation activities in 2009
VDEQ	9 VAC 25-210	Virginia Water Protection Permit	10-1256	4/14/26	Permit to dredge, fill, discharge pollutants into or adjacent to surface water. Joint Permit Application with USACE Section 404 permit	Received permit April 2011

Table 1.2-1 Federal, State and Local Authorizations

Agency	Authority	Requirement	License/ Permit No. [a]	Expiration Date [a]	Activity Covered	Status
VDEQ	FWPCA	Section 401 Certification (VWP Individual Permit serves as the 401 certification)	10-1256	4/14/26	Compliance with water quality standards	Received permit April 2011
VDEQ	9 VAC 25-210	Virginia Water Protection Individual Permit	10-1496	4/14/26	Permit to withdraw water from Lake Anna for construction	Received permit April 2011
VDEQ	9 VAC 25-210	Virginia Water Protection Individual Permit			Permit to withdraw water from Lake Anna for operation of Unit 3 & raise the lake level 3 inches	Received permit April 2012
VDEQ (lead agency)	Virginia Coastal Resources Management Program	Consistency determination (Coastal Zone Management Act)	N/A	N/A	Compliance with Virginia Coastal Program	Concurrence received May 2011
Virginia Department of Historic Resources (VDHR)	National Historic Preservation Act, 36 CFR 800	Cultural Resources Survey/Review	N/A	N/A	Evaluate area of potential effects for historic/cultural resources. If resources are present, complete Section 106 consultations as needed.	Large component transport route (LCTR) cultural resources evaluation submitted to VDHR July 2011. "No Adverse Effect" letter received July 2011 regarding eligible cultural resources at Walkerton Landing
Virginia Department of Transportation (VDOT)	24 VAC 30 et seq.	Consultation			Equipment transport routes, employee and/or public access routes, level-of-service review, transportation management plan	Began 2011, consultations continue with project needs and schedule

Table 1.2-1 Federal, State and Local Authorizations

Agency	Authority	Requirement	License/ Permit No. [a]	Expiration Date [a]	Activity Covered	Status
VMRC		VMRC Permit	10-1256	9/27/16	Permit to fill submerged land; Joint Permit Application with USACE Section 404 permit	Received permit Sept 2011
	VA Code 28.2-1280 et seq.				Submerged bottomlands	
	VA Code 28.2-1300 et seq.				Wetlands	
Virginia Department of Health (VDH)	12 VAC 5-590	Permit			Water supply well, as needed	Received permit Sept. 2010
Louisa County	Code of Ordinances Chap. 66	Permit		5/16/15	Water supply well, as needed	Received permit Nov. 2010
Louisa County	Code of Ordinances Chap. 38	Land Disturbing Permit	ESCP 30-80		Land disturbing activities associated with construction activities.	Renewal permit ESCP 30-80 for site separation in 2009
Louisa County	4 VAC 50-30					Received ESCP 30-80 in 2009 to support land disturbance beginning in 2010. Updated for additional phased construction-related activities in 2011
Louisa County	Code of Ordinances Chap. 18	Permit			Buildings and occupancies, as needed	Submitted and received for site separation in 2010-2013; others to be determined

Table 1.2-1 Federal, State and Local Authorizations

Agency	Authority	Requirement	License/ Permit No. [a]	Expiration Date [a]	Activity Covered	Status
King William Wetlands Board		Wetlands Permit	10-1256	2026	Wetlands impacts associated with off-loading facilities	Received permit June 2011

a. Licenses and permits will be applied for and received at the appropriate time, including renewals as appropriate.

N/A: Not applicable. No specific permit number or expiration date is associated with this consultation.

1.3 Report Contents

This report follows the same table of contents as the ESP-ER. Where a topic was previously addressed and resolved in the ESP proceeding, and no new and significant information has been identified, this report identifies the sections of the ESP-ER and FEIS that address the topic and states that no new and significant information has been identified. However, where new and significant information has been identified, the report provides the supplemental information required by 10 CFR 51.50(c)(1), as discussed in the following sections.

1.3.1 Information to Demonstrate That the Facility Design Falls Within the Site Characteristics and Design Parameters in the ESP

In accordance with the first row of FEIS Table J-1, Table 3.0-1 provides an evaluation of Unit 3 site characteristics against the ESP site characteristics identified in FEIS Table I-1.

In accordance with the second row of FEIS Table J-1, Table 3.0-2 provides an evaluation of Unit 3 design characteristics against the ESP plant parameters identified in FEIS Table I-2 and ESP Table D-1.

See also FSAR Table 2.0-201 which includes an evaluation of ESBWR DCD site parameters, ESP site characteristics, and ESP design parameters.

1.3.2 Information to Resolve any Significant Environmental Issues that Were Not Resolved in the ESP Proceeding

Several issues were not resolved in the ESP proceeding. The issues applicable to Unit 3 and previously identified as unresolved in the FEIS are listed below along with the section of this report in which they are addressed:

- Need for Power (Chapter 8)
- Energy Alternatives (Section 9.2)
- Water Quality (Sections 3.6, 5.2)
- Alternatives to Mitigate Severe Accidents (Sections 7.2, 7.3)
- Chronic Health Impacts of Electromagnetic Fields (Section 5.6)
- Decommissioning impacts (Section 5.9)
- Relationship Between Short-Term Uses and Long-Term Productivity of the Human Environment (Section 10.3)
- Benefit-Cost Balance (Section 10.4)

1.3.3 New and Significant Information

In accordance with 10 CFR 51.50(c)(1)(iii), this ER provides new and significant information for various issues related to the impacts of construction and operation of the facility that were resolved in the ESP proceeding:

- New 500 kV Transmission Line (Sections 1.1.5, 2.2.2, 2.4.1, 2.5.3.3, 3.7, 4.1.2, 4.1.3, 4.2.1, 4.3, 4.4, 4.6, 5.1.2, 5.6, 9.4, 10.1)
- Revised Long-Term χ/Q Values for Changes in Receptor Locations (Sections 2.7.6, 5.4)
- Offsite Road/Rail Transport of Large Components (Sections 2.3.1, 2.4.1, 2.4.1.8, 2.5, 2.5.3.5, 4.1.1, 4.1.3, 4.3.1.4, 4.6)
- Change in Potentially Impacted Ephemeral Streams (Section 4.2.1.1)
- Revised Liquid Effluent Release Activities (Section 5.4)
- Separate Sanitary Waste Facility for Unit 3 (Sections 3.6, 5.5)
- Revised Accident Source Terms (Sections 2.7.5, 7.1)
- Mitigating Actions Based on Results of IFIM study (5.10.1)
- Acquisition and use of additional property (Section 4.1.4, Appendix 4A)
- Site Separation Activities (Appendix 4B)
- Plant-specific habitat surveys (Sections 2.4.1.6, 2.4.1.7, 4.3.1.1, 4.3.1.2, Appendix 4A, Appendix 4B)
- Design Basis Accidents (Section 7.1)
- Seismological Conditions and Impacts (Sections 2.6.2.2.1 and 2.6.4.2.1)
- Radiation Exposure to Construction Workers (Section 4.5)

In accordance with 10 CFR 51.50(c)(1)(iv), a description of the process used to identify new and significant information regarding the NRC's conclusions in the FEIS is provided below.

1.3.3.1 **Definitions**

The following definitions apply to the new and significant process:

1. "Key inputs" means those assumptions and inputs, explicitly identified or implied, that were considered in the environmental review, either by the NRC Staff to support its findings and conclusions in the FEIS or in preparation of the ESP-ER.

   The FEIS is the primary document that was reviewed for key inputs used by the NRC Staff in its evaluations. These FEIS key inputs identify the main sources of information that were considered for whether or not there could be new information potentially affecting a finding or conclusion regarding an environmental impact. The representations and assumptions relied upon by the NRC Staff during its review of the ESP-ER and development of the FEIS are identified in each section of the FEIS and are also listed in FEIS Appendix J.

   In addition to the review of FEIS for key inputs, the ESP-ER was also reviewed to identify any relevant key inputs for which new information is available that may bear on the FEIS impact evaluations.

2. "New" in the phrase "new and significant information" is any information that was both: 1) not considered in preparing the ESP-ER or FEIS, and 2) not generally known or publicly available during the preparation of the FEIS. See 72 FR 49431.

3. For new information to be "significant," it must be material to the issue being considered, that is, it must have the potential to affect the finding or conclusions of the NRC Staff's evaluation of the issue. See 72 FR 49431.

The NRC has established three significance levels for environmental impacts: SMALL, MODERATE, and LARGE. In general, one of these three significance levels was assigned to each impact evaluated and resolved in the FEIS. New information was considered significant if it had the potential to change an NRC-assigned level of significance; that is, from SMALL to MODERATE or from MODERATE to LARGE for adverse impacts.

1.3.3.2 **Steps of the New and Significant Information Process**

The "new and significant information process" is a multi-step process used to identify new and significant information for inclusion in this ER per the requirements of 10 CFR 51.50(c)(1)(iii). The new and significant information process is documented in procedures and was implemented by qualified personnel including researchers, subject matter experts, licensing specialists, and engineering and environmental professionals.

Figure 1.3-1 is a flowchart that illustrates the steps of the new and significant information process. Process steps are described below.

Step 1: Identify issues that are resolved in the FEIS, and discussed in the ESP-ER, related to the topic being addressed.

Identify if the issue being reviewed was resolved in the FEIS. In general, an issue is resolved if an impact level of SMALL, MODERATE, or LARGE was assigned in the FEIS for the issue. In a few cases, the FEIS states conclusions in terms specific and appropriate to the subject area. (Issues that were identified as unresolved in the FEIS are identified in Section 1.3.2.)

Step 2: Document key inputs from the FEIS and ESP-ER.

For resolved issues, identify those FEIS sections and corresponding ESP-ER sections for the issue being addressed. Within these sections, identify the key inputs considered relevant to the resolved issue (used to make the FEIS determination). Document the identified key inputs.

Step 3a: Screen EIS key inputs.

Perform a screening of the FEIS key inputs to determine whether there is new information or whether there is a need to perform further research to determine if new information related to the key input exists. Give consideration to the potential for change of the input given the amount of time passage from FEIS completion to development of this ER. Document the results of the review by identifying whether or not new information exists for a given key input. If the existence of new information is not known, assume that new information may exist.

Screening reviews were performed by a review team consisting of subject matter experts, licensing specialists, engineering and environmental personnel, and other knowledgeable individuals.

Step 3b: Identify other and/or new key inputs.

Identify any other key inputs from the ESP-ER, subject matter expert's or review team's experience, or external documents, which were not otherwise identified in the Step 2 review for key inputs. Screen these key inputs in the same manner as described in Step 3a.

Step 4: Determine appropriate tasks to identify new information.

If it is not known whether new information exists for a key input, or the extent of the new information is not readily apparent, determine the appropriate actions to take to evaluate if new information exists for the key input.

Step 5: Perform actions identified in Step 4.

Perform the actions identified in Step 4, and document the resulting conclusion by identifying whether or not new information exists for a given key input. Describe the rationale used to arrive at this conclusion. Include references, as appropriate, to support the rationale used.

Step 6: Conduct significance evaluation.

If new information is found for any key input, evaluate the significance of the new information for the key input identified. Document the results of the significance evaluation, including whether or not the new information is determined to be significant. Refer to external documentation where appropriate.

Step 7: Address items identified as new and significant information in the appropriate section of the COLA ER.

For information identified as "new and significant" in Step 6, provide a description and evaluation of the information in the appropriate sections of this ER.

1.3.3.3 New and Significant Information Identified for COLA ER Revisions

New information which has the potential to affect the findings or conclusion of the NRC Staff's evaluation of an issue is evaluated to determine the significance of the new information relative to each applicable section. This process to document the assessment of new project-related information is implemented by qualified personnel similar to the process described in Section 1.3.3.2 unless the topic is clearly significant and appropriate for inclusion in a COLA ER revision.

1.3.4 Environmental Terms and Conditions

In accordance with 10 CFR 51.50(c)(1)(v), Table 1.3-1 identifies relevant environmental terms and conditions listed in the ESP (ESP-003 in Docket No. 52-008) and demonstrates that they will be satisfied by the date of issuance of the combined license or, for requirements applicable to activities that may continue beyond COL issuance, would be appropriately included as terms and conditions of the combined license. Table 1.3-1 also identifies those conditions that apply only to preconstruction activities if undertaken prior to COL issuance and are not prerequisites to COL issuance.

1.3.5 Commitments and Supplemental Information

In addition to the content requirements of 10 CFR 51.50(c)(1), the following information is provided in this ER to address commitments made in the ESP-ER or to provide supplemental information regarding items in the FEIS:

- Status of IFIM study (Table 1.3-1)
- Transmission system load flow study (Sections 3.7.2, 4.1.2)
- Visual impact study (Sections 3.1, 5.8)
- Description of switchyard upgrades (Section 3.7.1)

- Impacts of crud and activation products on spent fuel transportation accident risks (Section 3.8.2)
- Confirmatory evaluation of fogging, icing, and salt deposition (Sections 5.3, 5.8)
- Maximum annual occupational dose (Section 5.4)
- Confirmatory evaluation of cooling tower noise (Section 5.8)
- Description of Meteorological Monitoring Data Recording System (Section 6.4)
- Estimate of construction materials (Section 10.2)

Table 1.3-1 ESP Environmental Terms and Conditions Applicable to Unit 3

ESP Environmental Term or Condition		Evaluation
3.D	The values of plant parameters considered in the environmental review of the application and set forth in Appendix D to this ESP are hereby incorporated into this ESP.	The ESP plant parameters are described and evaluated against Unit 3 design characteristics in Table 3.0-2.
3.F(1)	The holder of this ESP may perform the activities authorized by 10 CFR 52.25, "Extent of Activities Permitted," only insofar as the site redress plan describes such activities. The holder of this ESP may perform activities not described in the site redress plan only with prior NRC approval. A request to perform such activities shall describe how such activities will be redressed, and, if the request is granted, the site redress plan shall be deemed to include this additional description of site redress.	This ESP condition applies only to preconstruction activities if undertaken prior to COL issuance and does not establish prerequisites to COL issuance. Activities after COL issuance will be authorized and governed by the COL.
3.F(2)	The holder of this ESP may change the site redress procedures set forth in the site redress plan in Appendix E without obtaining Commission approval provided that the changes do not decrease the effectiveness of the plan.	This ESP condition is applicable to activities that may continue beyond COL issuance, and is therefore appropriate for inclusion as a condition of the combined license.
3.F(3)	The permit holder shall obtain the right to implement the site redress plan set forth in Appendix E before initiating any activities authorized by 10 CFR 52.25.	As the owner of the Unit 3 site and entity in control of NAPS, Dominion possesses the right to implement the site redress plan. See FSAR Section 2.1.2.1.
3.G	The permit holder shall notify the NRC Regional Administrators for Region II and the operator of North Anna Power Station of the permit holder's plans to begin the site preparation and preliminary construction activities described in the site redress plan at least 120 days before commencement of such activities, and shall certify in that notification to the NRC that it has obtained all other permits, licenses, and certifications required for these activities;	This ESP condition applies only to preconstruction activities if undertaken prior to COL issuance and does not establish prerequisites to COL issuance. Activities after COL issuance will be authorized and governed by the COL.
3.H	The holder of this ESP shall not perform any site preparation or preliminary construction activities authorized by 10 CFR 52.25 unless such holder obtains the certification required pursuant to Section 401 of the Federal Water Pollution Control Act from the Commonwealth of Virginia, or obtains a determination by the Commonwealth of Virginia that no certification is required and submits the certification or determination to the NRC before commencement of any such activities.	This ESP condition applies only to preconstruction activities if undertaken prior to COL issuance and does not establish prerequisites to COL issuance. Activities after COL issuance will be authorized and governed by the COL.

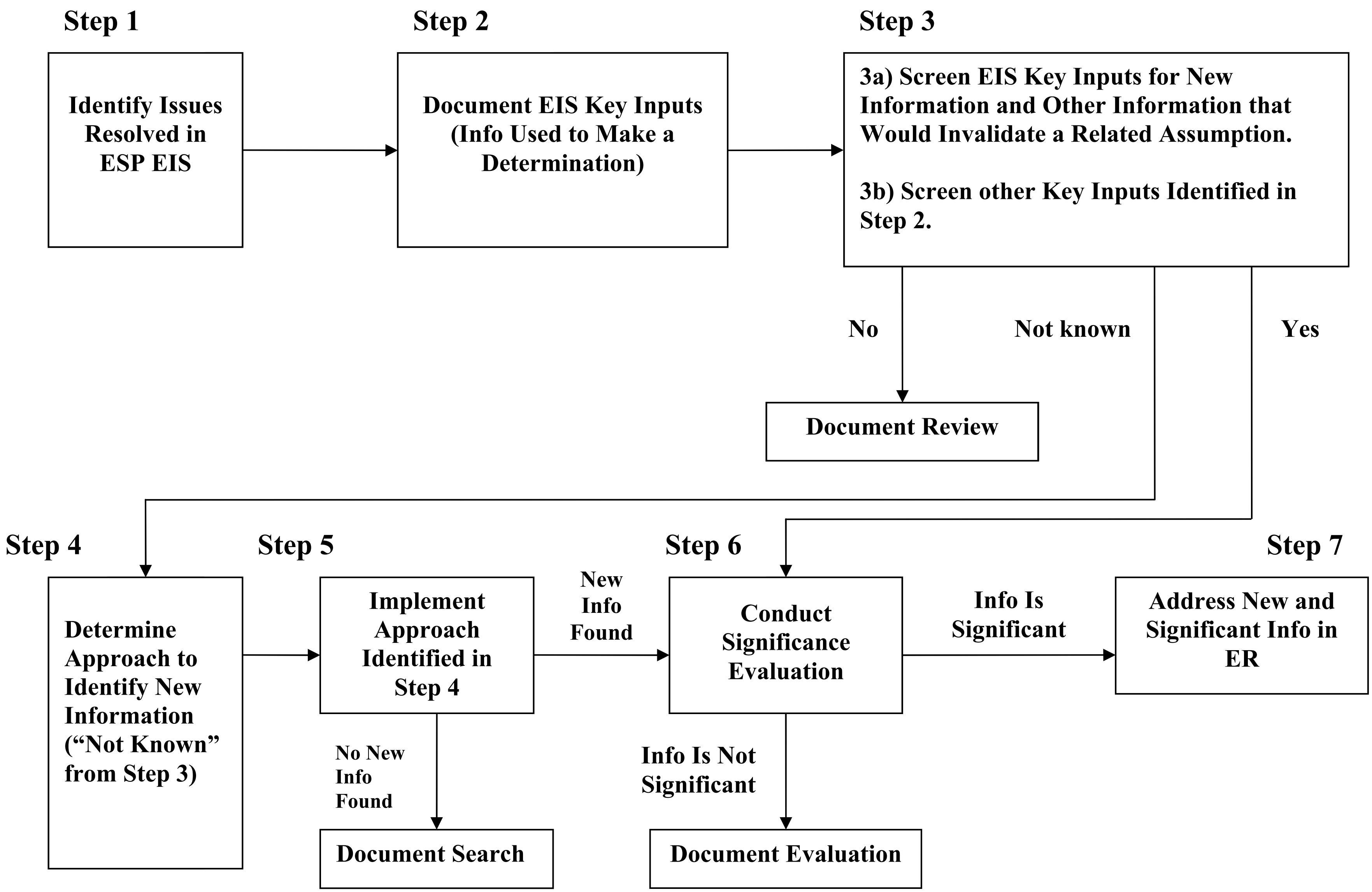
Table 1.3-1 ESP Environmental Terms and Conditions Applicable to Unit 3

ESP Environmental Term or Condition		Evaluation
3.I (1)	Any activities performed pursuant to 10 CFR 52.25 are subject to the conditions for the protection of the environment set forth in the Environmental Protection Plan attached as Appendix F to this ESP.	This ESP condition applies only to preconstruction activities if undertaken prior to COL issuance and does not establish prerequisites to COL issuance. Activities after COL issuance will be controlled by the Environmental Protection Plan (EPP) proposed in this Application for the COL.
3.I (2)	Dominion shall conduct a comprehensive Instream Flow Incremental Methodology study (IFIM), designed and monitored in cooperation and consultation with the VDGIF and the VDEQ, to address potential impacts of the proposed Units 3 and 4 on the fishes and other aquatic resources of Lake Anna and downstream waters. Development of the scope of work for the IFIM study shall begin in 2007, and the IFIM study shall be completed before issuance of a combined license (COL) for this project. Dominion agrees to consult with VDGIF and VDEQ regarding analysis and interpretation of the results of that study, and to abide by surface water management, release, and instream flow conditions prescribed by VDGIF and VDEQ upon review of the completed IFIM study, and implemented through appropriate State or Federal permits or licenses.	Work on the IFIM study began in January 2006. The final IFIM study report was submitted to VDEQ in October 2009. The IFIM Study Plan had four major components and was focused on a single new unit: 1. IFIM Study Plan Design. The study plan design was conducted in collaboration with Virginia Resource Agencies. The study scope included: a. designated North Anna River and Pamunkey River mileage and zones affected; b. species of concern and habitat parameters needed for life stages; c. a wide range of flows with parameters monitored and modeled; d. river recreational impact; and e. Lake Anna water level impacts on shoreline and wetlands. 2. Field Data Collection. Field data collection began in Summer 2007 and was completed in Spring 2008. 3. Analysis Methodology. The analysis methodology was developed in collaboration with state agencies following data collection. The analysis began in Summer 2008 and was completed in Spring 2009. 4. Interpretation of Analysis and Reporting. This was performed in collaboration with state agencies following completion of the analysis. Mitigating actions based on the results of the IFIM study are described in Section 5.10.1 and support permitting actions listed in Table 1.2-1.

Table 1.3-1 ESP Environmental Terms and Conditions Applicable to Unit 3

ESP Environmental Term or Condition		Evaluation
3.I (3)	The CP or COL applicant will conduct an instream flow incremental methodology study pursuant to the Coastal Zone Management Act consistency determination.	See the description for Condition 3.I (2) above.
3.J	An applicant for a CP or COL referencing this ESP shall develop an Environmental Protection Plan (EPP) for construction and operation of the proposed reactor and include the EPP in the application. The portion of the EPP directed to operation shall include any environmental conditions derived in accordance with 10 CFR 50.36b, “Environmental Conditions.”	The Environmental Protection Plan (EPP) is provided as Appendix 1A to this ER.

Figure 1.3-1 Flowchart of the New and Significant Information Process



1.4 Conformance with Division 4 Regulatory Guides

The supplemental analyses presented in this ER were prepared using the guidance provided in NUREG-1555, “Standard Review Plans for Environmental Reviews for Nuclear Power Plants.” NUREG-1555 is the document that guides the NRC Staff’s reviews of the information contained in Environmental Reports. The content guidelines outlined in NUREG-1555 are generally consistent with the guidance contained in Regulatory Guide 4.2.

None of the other Division 4 regulatory guides is applicable to the supplemental analyses presented in this ER.

Appendix 1A Environmental Protection Plan

APPENDIX C

TO FACILITY COMBINED LICENSE NO. [XXX-XX]

NORTH ANNA - UNIT NO. 3

DOMINION VIRGINIA POWER

DOCKET NO. 52-017

ENVIRONMENTAL PROTECTION PLAN

(NONRADIOLOGICAL)

[DATE]

Table of Contents

1. Objectives of the Environmental Protection Plan

The purpose of the Environmental Protection Plan (EPP) is to provide for protection of nonradiological environmental resources during construction and operation of Unit 3. The principal objectives of the EPP are as follows:

(a) To ensure that the facility is constructed and operated in an environmentally acceptable manner, as established by the ESP Final Environmental Impact Statement (FEIS) and COL Supplemental EIS (SEIS) (Reference 1) and (Reference 2)

(b) Coordinate NRC requirements and maintain consistency with other Federal, State, and local requirements for environmental protection

(c) Keep NRC informed of the environmental effects of facility construction and operation and of actions taken to control those effects

Environmental concerns identified in the FEIS and SEIS that relate to water quality matters or other matters regulated under the Federal Water Pollution Control Act will be governed by the licensee's Virginia Pollutant Discharge Elimination System (VPDES) permit.

2. Environmental Protection Issues

In the ESP FEIS, the staff considered the environmental impacts associated with the construction and operation of reactors at the North Anna ESP site. In the SEIS, the staff supplemented the ESP FEIS to consider issues that were not previously resolved or were affected by significant new information. The objective of this EPP is to ensure that environmental impacts associated with construction and operation of Unit 3 and in accordance with the facility Combined Construction Permit and Operating License (COL) will not exceed in any significant respect the impacts assessed in the FEIS and SEIS.

3. Consistency Requirements

3.1 Construction Activities

The licensee shall take the mitigating actions identified in EPP Table 1 to avoid any unnecessary adverse environmental impacts from construction activities. These mitigating actions are also identified in the following documents:

- ESP-ER (Reference 3)
- Chapter 4.0 of the FEIS (as summarized in FEIS Section 4.10)
- COL ER (Reference 4)
- Chapter 4.0 of the SEIS (as summarized in SEIS Section 4.10)

The licensee shall maintain records of construction activities. These records shall include an assessment of whether the environmental impact of construction activities is consistent with that evaluated in the FEIS and SEIS.

3.2 Operations

The licensee shall take the mitigating actions identified in EPP Table 2 to avoid any unnecessary adverse environmental impacts from facility operation. These mitigating actions are also identified in the following documents:

- ESP-ER
- Chapter 5.0 of the FEIS (as summarized in FEIS Section 5.11)
- COL ER
- Chapter 5.0 of the SEIS (as summarized in SEIS Section 5.12)

3.3 Reporting Related to the VPDES Permit and State Certification

Violations of the VPDES Permit or the State certification (pursuant to Section 401 of the Clean Water Act) shall be reported to the NRC by submittal of copies of the reports required by the VPDES Permit or certification.

Changes and additions to the VPDES Permit or the State certification shall be reported to the NRC within 30 days following the date the change is approved. If a permit or certification, in part or in its entirety, is appealed and stayed, the NRC shall be notified within 30 days following the date the stay is granted.

The NRC shall be notified of changes to the effective VPDES Permit proposed by the licensee by providing NRC with a copy of the proposed change at the same time it is submitted to the permitting agency. The notification of a licensee-initiated change shall include a copy of the requested revision submitted to the permitting agency. The licensee shall provide the NRC a copy of the application for renewal of the VPDES permit at the same time the application is submitted to the permitting agency.

3.4 Changes

The licensee may make changes in construction activities, make changes in station design or operation, or perform tests or experiments affecting the environment provided such changes, tests, or experiments do not involve an unreviewed environmental question, and do not constitute a decrease in the effectiveness of this EPP to meet the objectives specified in Section 1. Changes in construction activities, changes in plant design or operation, or performance of tests or experiments which do not affect the environment are not subject to the requirements of this EPP. Activities governed by EPP Section 3.5 are not subject to the requirements of this section.

A proposed change, test, or experiment shall be deemed to involve an unreviewed environmental question if it concerns: a) a matter which may result in a significant increase in any adverse environmental impact previously evaluated in the Final Environmental Impact Statement (FEIS) and supplements as modified by staff's testimony to the Atomic Safety and Licensing Board, environmental impact appraisals, or in any decisions of the Atomic Safety and Licensing Board; or b) a significant change in effluents or power level; or c) a matter not previously reviewed and evaluated in the documents specified in a) of this section, which may have a significant adverse environmental impact.

Before engaging in additional construction or operational activities which may significantly affect the environment, the licensee shall prepare and record an environmental evaluation of such activity. Activities are excluded from this requirement if all measurable nonradiological environmental effects are confined to the onsite areas previously disturbed during site preparation and plant construction. When the evaluation indicates that such activity involves an unreviewed environmental question or constitutes a decrease in the effectiveness of this EPP to meet the objectives specified in Section 1, the licensee shall provide prior written notification to the NRC.

The licensee shall maintain records of changes in construction activities, changes in facility design or operation, and of tests and experiments carried out pursuant to this section. These records shall include a written evaluation which provides bases for the determination that the change, test, or experiment does not involve an unreviewed environmental question nor constitute a decrease in the effectiveness of this EPP to meet the objectives specified in Section 1. The licensee shall include as part of their Annual Environmental Operating Report (per EPP Section 5.4.1) brief descriptions, analyses, interpretations, and evaluations of such changes, tests, and experiments.

3.5 Changes Required for Compliance with Other Environmental Law

Changes in plant design or operation and performance of tests or experiments which are required to achieve compliance with other Federal, State, or local environmental statutes, regulations, permits, or orders are not subject to the requirements of EPP Section 3.4.

4. Environmental Conditions

4.1 Unusual or Important Environmental Events

The licensee shall evaluate and report to the NRC Operations Center within 24 hours in accordance with 10 CFR 50.72(b)(2)(vi) (followed by a written report in accordance with EPP Section 5.4) any occurrence of an unusual or important event that indicates or could result in significant environmental impact causally related to construction activities or plant operation under this license. The following are examples of unusual or important environmental events: excessive bird impaction events, onsite plant or animal disease outbreaks, mortality or unusual occurrence of any species protected by the Endangered Species Act of 1973, fish kills, unusual increase in nuisance organisms or conditions, and unanticipated or emergency discharge of waste water or chemical substances.

Routine monitoring programs are not required to implement this condition.

5. Administrative Procedures

5.1 Review and Audit

The licensee shall provide for review and audit of compliance with the EPP. The audits shall be conducted independently and shall not be conducted by the individual or groups responsible for performing the specific activity. A description of the organization structure used to achieve the independent review and audit function and results of the audit activities shall be maintained and made available for inspection.

5.2 Records Retention

The licensee shall make and retain records associated with this EPP in a manner convenient for review and inspection and shall make them available to the NRC on request.

The licensee shall retain records of construction and operation activities determined to potentially affect the continued protection of the environment until the date of termination of the license. Records of modifications to station structures, systems and components determined to potentially affect the continued protection of the environment shall be retained for the life of the plant. All other records, data and logs relating to this EPP shall be retained for five years or, where applicable, in accordance with the requirements of other agencies.

5.3 Changes in Environmental Protection Plan

Requests for changes in the EPP shall include an assessment of the environmental impact of the proposed change and a supporting justification. Implementation of such changes in the EPP shall not commence prior to NRC approval of the proposed changes in the form of a license amendment incorporating the appropriate revisions to the EPP.

5.4 Reporting Requirements

5.4.1 Routine Reports

An Annual Environmental Operating Report describing implementation of this EPP for the previous year shall be submitted to the NRC prior to May 1 of each year. The period for the first report shall begin with the date of issuance of the Combined License, and the initial report shall be submitted prior to May 1 of the year following issuance of the Combined License. At the discretion of the licensee, the Annual Environmental Operating Report for Unit 3 may be combined with the Annual Operating Report submitted for Units 1 & 2.

The report shall include summaries and analyses of the results of the environmental protection activities required by EPP for the report period, including a comparison with related preoperational studies, operational controls (as appropriate), and previous nonradiological environmental monitoring reports, and an assessment of the observed impacts of the plant operation on the environment. If unexpected harmful effects or evidence of trends toward irreversible damage to the environment are observed, the licensee shall provide a detailed analysis of the data and a proposed course of mitigating action.

The Annual Environmental Operating Report shall also include:

(a) A list of EPP noncompliances and the corrective actions taken to remedy them

(b) A list of changes in station design or operation, tests, and experiments made in accordance with EPP Section 3.4 which involved a potentially significant unreviewed environmental issue

(c) A list of nonroutine reports submitted in accordance with EPP Section 5.4.2

In the event that some results are not available by the report due date, the report shall be submitted noting and explaining the missing results. The missing results shall be submitted as soon as possible in a supplementary report.

5.4.2 Non-Routine Reports

A written report shall be submitted to the NRC within 60 days of occurrence of a nonroutine event that has a significant unanalyzed impact on the environment. The report shall: a) describe, analyze, and evaluate the event, including extent and magnitude of the impact, and plant operating characteristics; b) describe the probable cause of the event; c) indicate the action taken to correct the reported event; d) indicate the corrective action taken to preclude repetition of the event and to prevent similar occurrences involving similar components or systems; and e) indicate the agencies notified and their preliminary responses.

Events reportable under this section which also require reports to other Federal, State, or local agencies shall be reported in accordance with those reporting requirements in lieu of the requirements of this subsection. The NRC shall be provided with a copy of such report at the same time it is submitted to the other agency.

References

1. U.S. Nuclear Regulatory Commission, “Environmental Impact Statement for an Early Site Permit (ESP) at the North Anna ESP Site,” NUREG-1811, December 2006.
2. U.S. Nuclear Regulatory Commission, “Supplemental Environmental Impact Statement for the Combined License (COL) for North Anna Power Station Unit 3, “NUREG-1917, Draft Report for Comment, December 2008.
3. Dominion Nuclear North Anna, LLC, “North Anna Early Site Permit Application, Part 3 – Environmental Report,” Revision 9, September 2006.
4. Dominion Virginia Power, “North Anna 3 Combined License Application, Part 3 – Environmental Report,” Revision 6, July 2013.

Table 1. Mitigating Actions for Construction Activities

1. Mitigating Actions Identified in ESP-ER Section 4.6

ESP-ER Section 4.1.1

- Conduct ground disturbing activities in accordance with regulatory and permit requirements.
- Use adequate erosion controls and stabilization measures to reduce impacts to the extent practicable.
- Reduce potential impacts to wetlands and intermittent streams on the NAPS site through avoidance and compliance with applicable permitting requirements.

ESP-ER Section 4.1.3

- Conduct sub-surface testing prior to initiating ground disturbing activities to identify buried historic or archaeological resources.
- Take appropriate actions (e.g., stop work) following discovery of potential historic or archaeological resources.
- Use existing Virginia Power procedures that require contacting the appropriate regulatory agencies following a discovery of potential historic or archaeological resources.

ESP-ER Section 4.2.1

- Design and install appropriate barrier (e.g., turbidity curtain in the North Anna Reservoir near cofferdam work location) to impede turbid water from migrating into the lake.
- Perform activities under applicable regulations and permit requirements with regard to seasonal restrictions for in-water work, installation of appropriate erosion control measures, drainage controls to convey stream flow, and construction storm water management.
- Use Best Management Practices (BMP) described in the Virginia Erosion and Sediment Control Handbook to control erosion and maintain the sediment load from the construction zone as low as practicable.
- Use wells unaffected by dewatering activities to maintain needed capacity for the NAPS site. Not all wells are expected to be affected by dewatering activities.

ESP-ER Section 4.2.2

- Develop and implement a construction Stormwater Pollution Prevention Plan (SWPPP) and spill response plan during construction at the NAPS site.
- Implement an Erosion and Sediment Control Plan that describes use of approved/recognized Best Management Practices (BMP).
- Limit dewatering activities to only those necessary for construction.
- Use offsite sources of potable water, if necessary, to temporarily supplement onsite water resources.

Table 1. Mitigating Actions for Construction Activities

ESP-ER Section 4.3.2

- Develop and implement a construction Stormwater Pollution Prevention Plan (SWPPP) and spill response plan during construction in the transmission corridor.
- Implement an Erosion and Sediment Control Plan that describes use of approved/recognized BMPs.
- Design and install appropriate barrier (e.g., turbidity curtain in the North Anna Reservoir near cofferdam work location) to impede turbid water from migrating into the lake.
- Adhere to seasonal restrictions on in-water construction activities. Following temporary construction disturbance, intake channel cove will likely be re-colonized by benthic organisms and fish.

ESP-ER Section 4.4.1

- Train and appropriately protect NAPS site and temporary construction personnel (i.e., those most directly and frequently affected by construction noise, dust and gaseous emissions) to reduce the risk of potential harmful exposures from noise, dust, and gaseous emissions.
- Provide onsite services for emergency first aid care and conduct regular health and safety monitoring for affected personnel on site.
- Make public announcements and/or notifications prior to undertaking atypical or noisy construction activities.
- Use normal dust control measures (e.g., watering, stabilizing disturbed areas, covering truck loads).
- Manage concerns from adjacent residents, business owners, or landowners, on a case-by-case basis through a Dominion prepared concern resolution process.
- Post signs at or near construction site entrances and exits to make the public aware of potentially high construction traffic areas.
- Design and install appropriate barrier (e.g., turbidity curtain in the North Anna Reservoir near cofferdam work location) to impede turbid water from migrating into the lake.

Table 1. Mitigating Actions for Construction Activities

ESP-ER Section 4.4.2 • Develop a construction traffic management plan prior to construction to address potential impacts on local roadways. • Encourage the use of shared (e.g., carpooling) and multi-person transport (e.g., buses) of construction personnel to the ESP site. • Coordinate schedules during workforce shift changes to limit impacts on local roads. • Schedule delivery of larger pieces of equipment or structures on off-peak traffic hours (e.g., at night) or through other transportation modes (e.g., rail). • Consider/coordinate, if necessary, with local planning authorities the upgrading of local roads, intersections, and signals to handle increased traffic loads.

Table 1. Mitigating Actions for Construction Activities

2. Mitigating Actions Identified in FEIS Section 4.10
• Incorporation of environmental requirements into construction contracts (ESP-ER Section 4.6).
• Avoid watercourses and wetlands to the extent practical during any construction (ESP-ER Sections 4.1.1.6.2, and 4.3.1.2).
• Develop a dust control plan to mitigate the impacts of emissions from construction activities (ESP-ER Section 4.4.1.4).
• Develop a construction traffic management plan to include several traffic mitigating measures (ESP-ER Section 4.4.2.2.1).
• Mitigate potential impacts for materials delivery. Methods include: 1) avoiding routes that could adversely affect sensitive areas (e.g., housing, hospitals, schools, retirement communities, businesses) to the extent possible and 2) restricting delivery times activities to daylight hours (ESP-ER Section 4.4.1.1.3).
• Repair damage to public roads, markings, or signs caused by construction activities (ESP-ER Section 4.4.1.1.3).
• Build and maintain new access road on the NAPS site to support construction activities (by Virginia Power personnel as needed) (ESP-ER Section 4.4.1.1.3).
• Maintain emissions from heavy construction equipment as low as reasonably practicable by scheduled equipment maintenance procedures (ESP-ER Section 4.3.1.2).
• Implement a Spill Prevention Control and Countermeasure Plan (ESP-ER Section 4.3.2).
• Manage nuisances and concerns from adjacent residents, business owners, or landowners on a case-by-case basis through a Dominion prepared concern resolution process (ESP-ER Section 4.4.1).
• Coordinate with the VDHR regarding the potential presence of historic and cultural resources within planned disturbed areas and notify VDHR in the event of any unanticipated discovery (ESP-ER Section 4.1.3).

Table 1. Mitigating Actions for Construction Activities

3. Mitigating Actions Identified in COL-ER Section 4.6

- Upon completion of the transports, temporary structures will be removed, interferences will be reinstalled, and disturbed areas will be restored. (Section 4.1.1)
- The new transmission line will be located in an existing corridor and constructed under practices and procedures applicable to the existing transmission lines (Sections 4.1.2, 4.2.1.1 and 4.3.1.1).
- Land clearing necessary to accommodate the new transmission tower foundations will be controlled by existing transmission line procedures, good construction practices, and established best management practices (Section 4.3.1.1), as well as all applicable regulations.
- Clearing methods for small trees, bushes and vegetation will be performed to protect natural resources and control erosion of the landscape and siltation of streams. Trees and brush located within an approximately 100-foot buffer of a stream or ditch with running water will be hand-cleared and material approximately three inches in diameter and above will be removed from the buffer, leaving material less than three inches undisturbed (Sections 4.1.2, 4.2.1.1, and 4.3.1.1).
- Once all the construction of transmission lines has been completed, Dominion will restore disturbed areas by means such as: 1) rehabilitating land by discing, fertilizing, seeding, and installing erosion control devices (e.g., water bars and mulch); 2) properly removing and disposing debris left or caused by construction; and 3) restoring damaged property (Sections 4.1.2 and 4.3.1.1).
- Appropriate actions (e.g., stop work) will be taken following discovery of potential historic or archaeological resources (Sections 4.1.2 and 4.1.3).
- While the goal is zero impacts to historic properties and cultural resources located adjacent to the proposed large component transport route, appropriate actions for potential impacts include rehabilitation of land, removal of debris, and restoration of damaged property (Section 4.1.3).
- Potential impacts to streams and creeks will be mitigated by performing work related to stream crossings in accordance with state standards and specifications. In addition, streams and creeks will be crossed at right angles at one location on the corridor using culverts, temporary bridges, or large aggregate stone. Materials will be removed from the temporary crossing at the completion of the project (Sections 4.2.1.1 and 4.3.1.1).

Table 1. Mitigating Actions for Construction Activities

- Soil disturbances will be avoided or reduced to the extent practicable within an approximately 100-foot buffer of streams and ditches with running water. Erosion and sedimentation control measures and buffer zone maintenance around water bodies will be implemented to reduce runoff and erosion. These measures will be left in place, until stabilization of the area is achieved. Work sites will be stabilized prior to moving to the next area (Sections 4.2.1.1, 4.3.1.1, and 4.3.1.4).
- To the extent practicable, construction will avoid alterations to shorelines and wetland areas. Should wetlands be impacted, the U.S. Army Corps of Engineers (and other appropriate agencies) will be consulted, and permits and approvals will be obtained as necessary (Sections 4.2.1.1 and 4.3.2).
- Dust suppression techniques will be utilized and equipment maintenance employed to reduce airborne emissions (Section 4.3.1.1).
- For wetlands along the proposed large component transportation route, temporary erosion and sedimentation controls will be maintained until permanent stabilization is achieved, debris is removed, and disturbed lands will be rehabilitated (Section 4.3.1.4).
- As a safety precaution, during installation of the transmission lines, access to the area will be temporarily restricted from recreational use (Section 4.4).
- To help avoid impacts to the archaeological resource along the transmission corridor, the identified archaeological site will be marked and/or flagged prior to and during construction of the new transmission line (Section 4.1.3).
- Impacts to wetlands within the additional property may be addressed through preservation of other onsite streams or through purchasing offset credits from an approved mitigation bank (Appendix 4A).
- The additional property area will be stabilized and structures will be removed upon completion of the construction of Unit 3 (Appendix 4A).

4. Mitigating Actions Identified in SEIS Section 4.10

- The new transmission lines would be located in an existing transmission line right-of-way and constructed under current practices and applicable procedures.
- Land-clearing activities to accommodate construction of the new transmission tower foundations would be controlled by existing Dominion transmission line procedures, good construction practices, established BMPs, and applicable regulations.

Table 1. Mitigating Actions for Construction Activities

• Once construction of the transmission lines has been completed, Dominion would restore disturbed areas by appropriate means, including restoring damaged property to its original condition to the satisfaction of the property owner. • As a safety precaution, during the construction of the transmission lines, access to the transmission line right-of-way will be restricted. • Clearing methods will be conducted in a manner to protect natural resources and control erosion and siltation of streams. Special procedures would be used for clearing trees and brush within 30 m (100 ft) of a stream or ditch with running water. • Potential impacts to streams and creeks would be mitigated by performing work related to stream crossings pursuant to standards and specifications by the Commonwealth of Virginia. Materials used for temporary crossings of streams and creeks would be removed and the landscape restored upon completion of the construction activities. • Soil disturbances would be avoided or reduced to the extent practicable within 30 m (100 ft) of streams and ditches with running water. Erosion and sedimentation control measures would be implemented to reduce runoff and erosion. • To the extent practicable, construction would avoid alterations to shoreline and wetland areas. If wetland areas will be impacted, appropriate Commonwealth and Federal agencies will be contacted and necessary permits and approvals will be obtained prior to construction activities that would impact the wetland areas. • Dust suppression techniques would be utilized along with good equipment maintenance practices to reduce airborne emissions from construction-related activities. • The discovery of potential historic or cultural resources will result in a stop work and appropriate procedures will be followed to notify the Virginia Department of Historic Resources.

Table 2. Mitigating Actions for Operation

1. Mitigating Actions Identified in ESP-ER Section 5.10

ESP-ER Section 5.1.1

- Water discharges from operation of the new unit will be governed by VPDES permit requirements.
- Potential increases in traffic will be mitigated through traffic management.

ESP-ER Section 5.2.1

- Practices to minimize the hydrologic alterations may be implemented.
- During periods of extended drought, dry cooling towers will be put into service to dissipate a portion of waste heat from Unit 3 to minimize the make-up water requirements.

ESP-ER Section 5.2.2

- During periods of extended drought, dry cooling towers will be put into service to dissipate a portion of waste heat from Unit 3 to minimize the make-up water requirements.

ESP-ER Section 5.3.1.1

- Stabilizing the banks of the channel to the screen house and pump house will be considered.

ESP-ER Section 5.3.1.2

- The intake structure for Unit 3 will meet such requirements as the VDEQ may impose under Section 316(b) of the Clean Water Act and the implementing regulations, as applicable.
- A fish return system based on the latest technology available during detailed engineering will be considered for incorporation into the intake system.

ESP-ER Section 5.3.2.2

- Cooling water discharges to the North Anna Reservoir will be governed by VPDES water quality standards and permitted discharge limits.

ESP-ER Section 5.4.1

- Sources of radiation at the new units will be contained similar to the existing units.

Table 2. Mitigating Actions for Operation

ESP-ER Section 5.5.1

- Water availability issues regarding the North Anna River are addressed via regulated releases from the North Anna Dam.
- Comply with applicable VPDES water quality standards for any discharge from Dike 3.
- Prepare and implement a new operational Stormwater Pollution Prevention Plan to avoid and/or minimize releases of contaminated stormwater.
- Use approved transporters and offsite landfills for disposal of solid waste. Continue existing units' program for reuse and recycling of nonradwastes.
- Operate any new minor air emission sources in accordance with applicable regulations and permits.
- Modify (if necessary) existing sanitary waste treatment systems to accommodate increased volume.

ESP-ER Section 5.5.2

- Limit need to manage and dispose of mixed waste through: 1) source reduction; 2) recycling options; 3) treatment.
- Develop a Waste Minimization Program, to address mixed waste inventory management; equipment maintenance; recycling and reuse; segregation; treatment (decay in storage); work planning; waste tracking; and awareness training.
- Implement a program to manage wastes stored onsite in compliance with applicable EPA and NRC regulatory requirements.
- Implement spill prevention and response plans and procedures to address hazards associated with managing mixed wastes. Include in plans and procedures measures for response personnel training and protective equipment.

Table 2. Mitigating Actions for Operation

ESP-ER Section 5.8.1

- Comply with applicable VDEQ permit limits and regulations when installing and operating air emission sources.
- Perform noise study as part of final design for dry cooling towers.
- Perform visual impact study for new structures on site, including dry and wet cooling towers, as part of final design.

ESP-ER Section 5.8.2

- Perform noise study as part of final design for dry and wet cooling towers.
- Perform visual impact study for new structures on site, including dry and wet cooling towers, as part of final design.

ESP-ER Section 5.9

- The significance of the impacts is unknown because the decommissioning methods have not been chosen. No mitigation measures or controls are proposed at this time.

2. Mitigating Actions Identified in FEIS Section 5.11

- Current transmission line maintenance practices will continue if two new units were built at the ESP site (ESP-ER Section 5.6.1.1).
- A system study modeling the transmission lines with new units' contribution will be conducted (ESP-ER Section 5.1.2).
- Take reasonable steps to identify locations of rare or sensitive plant species within transmission line corridors so modified treatment practices can be used in these areas to avoid adverse impacts (ESP-ER Section 5.6.1.1).
- Demonstrate that the fogging and salt deposition analysis of the cooling system remains bounding (May 24, 2006, response to RAI).
- The intake structure for the proposed new units at the ESP site will meet Section 316(b) of the Clean Water Act and the implementing regulations, as applicable (ESP-ER Section 5.3.1.2).
- Vegetative shielding will block a clear view of the new units from most nearby residences (ESP-ER Section 5.8.1.5, ESP-ER Table 5.10-1).
- Noise levels will be controlled in accordance with applicable local county regulations (ESP-ER Section 5.3.1.2).
- Although the operation of the new units are not expected to require changes in land use (ESP-ER Section 5.1), any ground-disturbing activities necessary for operations will be conducted in coordination with the VDHR and professional archaeological practices consistent with the process established for construction activities (ESP-ER Section 4.1.3).

Table 2. Mitigating Actions for Operation

3. Mitigating Actions Identified in COLA ER Section 5.10

- Non radioactive effluents, including sanitary waste and blowdown from Unit 3 cooling towers, will be controlled by the limits established in VPDES permit (Sections 5.2.2 and 5.5.1).
- The new and separate Unit 3 sanitary waste treatment systems will be governed by applicable regulations and permits (Section 5.5.1).
- Operation of a dechlorination system to neutralize chlorine in the circulating water and plant service water cooling tower blowdown before discharge to the WHTF and eventually to the North Anna Reservoir (Section 5.2.2).
- Increase the normal pool level of Lake Anna (North Anna Reservoir) by 3 inches from Elevation 250.0 ft msl to 250.25 ft msl to reduce the potential frequency of occurrence and duration of low flow conditions, and to reduce impacts on the ecology, wetlands, and recreation in Lake Anna and downstream (Section 5.10.1).
- Continue collaboration with Virginia resource agencies to address long-term enhancements within the watershed (Section 5.10.1).

4. Mitigating Actions Identified in SEIS Section 5.12

- Non-radioactive effluents, including sanitary waste and blowdown from the proposed Unit 3 cooling towers, will be controlled by limits established in the VPDES permit.
- The new and separate Unit 3 sanitary waste treatment systems will be governed by applicable regulations and permits.
- Operate a dechlorination system to neutralize chlorine in the circulating water and plant service water cooling tower blowdown before discharge to the WHTF and eventually to the North Anna Reservoir.

Chapter 2 Environmental Description

2.1 Site Location

The information for this section is provided in ESP-ER Section 2.1 and in FEIS Section 2.1. Figure 1.1-1 shows the layout of Unit 3 within the ESP site.

No new and significant information has been identified for this section.

2.2 Land

The information for this section is provided in ESP-ER Section 2.2 and in FEIS Section 2.2. Supplemental information is provided below.

2.2.1 The Site and Vicinity

Dominion owns additional property contiguous with the NAPS site. The additional property will provide alternative space for Unit 3 construction-related activities and facilities such as laydown areas, spoils storage, and access roads, but will not be part of the NAPS site. Further information is provided in Appendix 4A.

The additional property area will be stabilized and structures will be removed upon completion of the construction of Unit 3. The additional property will not become part of the North Anna Power Station.

2.2.2 Transmission Line Rights-of-Way and Offsite Areas

Based on an initial evaluation, the ESP-ER indicated that the existing transmission lines were expected to have sufficient capacity to carry the output of the new units at NAPS. However, a commitment was made to perform a load flow study to confirm that conclusion. In June 2007, PJM completed an impact study to determine the required system reinforcements associated with a new unit at North Anna. The study was updated in 2013 (Reference). Based on the results of this study, a new 15-mile long 500 kV line from the North Anna Substation to the Ladysmith Switching Substation will be installed on new transmission towers, within the existing transmission corridor. The location of this corridor is identified as "Line 575" on ESP-ER Figure 2.2-4, beginning at NAPS and heading east. Further information is provided in Section 3.7.

Additional property contiguous with the NAPS site will be utilized for Unit 3 project construction support. Additional information is provided in Appendix 4A.

2.2.3 The Region

No new and significant information has been identified for this section.

Section 2.2 Reference

PJM System Planning Division, "PJM Generator Interconnection Q65 North Anna 500kV (1570 MW Capacity/1594 Energy) Revised System Impact Study & Facilities Study Report Resulting from Necessary Studies," September 2013.

2.3 Water

The information for this section is provided in ESP-ER Section 2.3 and in FEIS Section 2.6. Supplemental information is provided below.

2.3.1 Hydrology

Based upon a field analysis (Reference 3) in accordance with the "Corps of Engineers Wetlands Delineation Manual", there were 31 wetlands and 26 waterways scattered along a proposed large component transport route.

Information on the hydrology of the additional property acquired for construction support is provided in Appendix 4A.

2.3.2 Water Use

No new and significant information has been identified for this section.

2.3.3 Water Quality

2.3.3.1 Surface Water

FEIS Section 5.3.3 identified the need to provide the chemical constituents of effluents in waste streams. This section provides information on surface water quality that is used (in conjunction with information in Section 3.3 concerning the chemical additives used in plant water systems) to determine the expected plant waste stream effluent discussed in Section 3.6.

Table 2.3-1 contains surface water quality data collected in the vicinity of the intake since submittal of the ESP-ER. The table provides the maximum value reported for each constituent. The parameters for which the samples were collected included the "126 Priority Pollutants" (Reference 1) as well as water temperature, suspended solids, total dissolved solids, hardness, turbidity, color, odor, conductivity, biological oxygen demand, chemical oxygen demand, phosphorus forms, nitrogen forms, alkalinity, chlorides, sulfate, sodium, potassium, calcium, magnesium, heavy metals, and pH. This surface water quality data is used in Section 3.6 in the discussion of the nonradioactive liquid wastes. Environmental impacts on surface water quality from station operation are discussed in Section 5.2.

2.3.3.2 Groundwater Aquifers

No new and significant information has been identified for this section.

Section 2.3 References

1. U.S. Environmental Protection Agency, "EPA Steam Electric Generating Point Source Category, 126 Priority Pollutants," 40 CFR 423, Appendix A.

2. Commonwealth of Virginia, State Water Control Board, "Virginia Water Quality Standards," 9 VAC 25-260 (et seq.), August 14, 2007.

3. EA Engineering, Science, and Technology, Inc., "Dominion North Anna Power Station Wetland Delineation Report for the Proposed Unit 3 Heavy Haul Route," June 2009.

Table 2.3-1 Lake Anna Water Quality Data

Priority Pollutant Number *(Note 1)*	Constituent Name	Reported Level (mg/L) *(Note 2)*	Water Quality Criteria (mg/L) *(Notes 2, 3, and 9)*	Detection Limit (mg/L) *(Note 2)*	Notes
011	1,1,1-Trichloroethane	0.00	N/A	3.80E-03	4 & 5
015	1,1,2,2-Tetrachloroethane	0.00	1.10E-01	6.90E-03	4
014	1,1,2-Trichloroethane	0.00	4.20E-01	5.00E-03	4
013	1,1-Dichloroethane	0.00	N/A	4.70E-03	4 & 5
029	1,1-Dichloroethylene	0.00	17.00	2.80E-03	4
008	1,2,4-Trichlorobenzene	0.00	9.40E-01	7.90E-03	4
	1,2-Dichlorobenzene	0.00	17.00	4.00E-03	4
010	1,2-Dichloroethane	0.00	9.90E-01	2.80E-03	4
032	1,2-Dichloropropane	0.00	3.90E-01	6.00E-03	4
037	1,2-Diphenylhydrazine	0.00	5.40E-03	8.80E-03	4
030	1,2-Trans-dichloroethylene	0.00	140.00	1.60E-03	4
	1,3-Dichlorobenzene	0.00	2.60	3.10E-03	4
	1,3-Dichloropropene	0.00	1.70	5.9E-03	4
	1,4 Dichlorobenzene	0.00	2.60	4.4E-03	4
	2 Methyl-4,6, Dinitrophenol	0.00	7.70E-01	2.58E-04	4
129	2,3,7,8-TCDD	0.00	N/A	9.30E-09	4 & 8
021	2,4,6-Trichlorophenol	0.00	6.50E-02	5.54E-04	4
031	2,4-Dichlorophenol	0.00	7.90E-01	4.24E-04	4
034	2,4-Dimethylphenol	0.00	2.30	3.19E-04	4
059	2,4-Dinitrophenol	0.00	14.00	3.54E-04	4
035	2,4-Dinitrotoluene	0.00	9.10E-02	5.70E-03	4
036	2,6-Dinitrotoluene	0.00	N/A	3.40E-03	4 & 5
019	2-Chloroethylvinyl Ether	0.00	N/A	1.20E-03	4 & 5
020	2-Chloronaphthalene	0.00	4.30	4.60E-03	4
024	2-Chlorophenol	0.00	4.00E-01	3.51E-04	4
057	2-Nitrophenol	0.00	N/A	4.75E-04	5
028	3,3'-Dichlrobenzidine	0.00	7.70E-04	1.65E-02	4
094	4,4-DDD	0.00	8.40E-06	2.1E-05	4

Table 2.3-1 Lake Anna Water Quality Data

Priority Pollutant Number *(Note 1)*	Constituent Name	Reported Level (mg/L) *(Note 2)*	Water Quality Criteria (mg/L) *(Notes 2, 3, and 9)*	Detection Limit (mg/L) *(Note 2)*	Notes
093	4,4-DDE	0.00	5.90E-06	1.7E-05	4
092	4,4-DDT	0.00	5.90E-06	1.7E-05	4
041	4-Bromophenyl-phenylether	3.00E-03	N/A	3.00E-03	5
040	4-Chlorophenyl-phenylether	0.00	N/A	4.20E-03	4 & 5
058	4-Nitrophenol	0.00	N/A	6.12E-04	4 & 5
001	Acenapthene	0.00	2.70	3.00E-03	4
077	Acenapthylene	0.00	N/A	3.50E-03	4 & 5
002	Acrolein	0.00	7.80E-01	1.0E-02	4
003	Acrylonitrile	0.00	6.60E-03	1.50E-03	4
089	Aldrin	0.00	1.40E-06	1.6E-05	4
102	Alpha BHC	0.00	1.30E-04	7.0E-06	4
095	Alpha-Endosulfan	0.00	2.40E-01	1.4E-05	4
	Ammonia as N	4.00E-02	1.20	1.0E-02	
078	Anthracene	0.00	110.00	1.90E-03	4
114	Antimony	0.00	4.30	1.00E-03	4
115	Arsenic	0.00	1.50E-01	3.00E-03	4
116	Asbestos (MF/L)	7.10E-01	N/A	1.80E-01	4 & 5
	Barium	3.20E-02	NAWQC	3.0E-03	6
004	Benzene	0.00	7.10E-01	4.40E-03	4
005	Benzidine	0.00	5.40E-06	6.30E-02	4
072	Benzo (a) Anthracene	0.00	4.90E-04	7.80E-03	4
073	Benzo (a) pyrene	0.00	4.90E-04	2.50E-03	4
074	Benzo (b) Fluoranthene	0.00	4.90E-04	4.80E-03	4
079	Benzo (g h i) perylene	0.00	N/A	4.10E-03	4 & 5
075	Benzo (k) Fluoranthene	0.00	4.90E-04	2.50E-03	4
117	Beryllium	0.00	N/A	2.00E-04	4 & 5
103	Beta BHC	0.00	4.60E-04	1.3E-05	4
096	Beta-Endosulfan	0.00	2.40E-01	1.7E-05	4

Table 2.3-1 Lake Anna Water Quality Data

Priority Pollutant Number *(Note 1)*	Constituent Name	Reported Level (mg/L) *(Note 2)*	Water Quality Criteria (mg/L) *(Notes 2, 3, and 9)*	Detection Limit (mg/L) *(Note 2)*	Notes
043	Bis (-2-Chloroethoxy) Methane	0.00	N/A	5.30E-03	4 & 5
018	Bis (-2-chloroethyl) Ether	0.00	1.40E-02	5.70E-03	4
	Bis (2-Chloroisopropyl) Ether	0.00	170.00	5.70E-03	4
066	Bis (2-ethylhexyl) Phthalate	0.00	5.90E-02	2.50E-03	4 & 5
	BOD	5.36	N/A	2.00	5
	Bromide	0.00	N/A	2.00E-01	4 & 5
047	Bromoform	0.00	3.60	4.70E-03	4
067	Butylbenzylphthalate	0.00	5.20	2.50E-03	4
118	Cadmium	0.00	3.80E-04	3.00E-04	4
	Calcium	3.68	N/A	9.0E-02	5
006	Carbon tetrachloride	0.00	4.40E-02	2.80E-03	4
091	Chlordane	0.00	2.20E-05	1.4E-05	4
	Chloride	5.07	230.00	5.0E-02	
007	Chlorobenzene	0.00	21.00	6.00E-03	4
051	Chlorodibromomethane	0.00	3.40E-01	3.10E-03	4
016	Chloroethane	0.00	N/A	1.10E-03	4 & 5
023	Chloroform	0.00	29.00	1.60E-03	4
	Chlorpyrifos	0.00	4.10E-05	1.38E-05	4
119	Chromium	0.00	N/A	1.00E-03	4, 5 & 7
	Chromium +6	0.00	1.10E-02	1.00E-02	4
076	Chrysene	0.00	4.90E-04	2.50E-03	4
	COD	15.64	N/A	5.0	5
	Color (Chloroplatinate Units)	20.00	N/A	N/A	5
	Conductivity (µmhos/cm)	70.00	N/A	N/A	5
120	Copper	3.00E-03	2.70E-03	1.0E-03	
121	Cyanide as CN	0.00	220.00	1.00E-02	4
105	Delta BHC	0.00	N/A	1.5E-05	4 & 5
	Demeton	0.00	1.00E-04	5.206E-04	4

Table 2.3-1 Lake Anna Water Quality Data

Priority Pollutant Number *(Note 1)*	Constituent Name	Reported Level (mg/L) *(Note 2)*	Water Quality Criteria (mg/L) *(Notes 2, 3, and 9)*	Detection Limit (mg/L) *(Note 2)*	Notes
083	Dibenzo (a h) anthracene	0.00	4.90E-04	2.50E-03	4
048	Dichlorobromomethane	0.00	4.60E-01	2.20E-03	4
090	Dieldrin	0.00	1.40E-06	1.00E-05	4
070	Diethylphthalate	0.00	120.00	7.40E-03	4
071	Dimethyl Phthalate	0.00	2900.00	7.50E-03	4
	Di-n-Butylphthalate	0.00	12.00	6.40E-03	4
069	Di-n-octyl Phthalate	0.00	N/A	2.50E-03	4 & 5
097	Endosulfan sulfate	0.00	2.40E-01	9.0E-6	4
098	Endrin	0.00	8.10E-04	2.0E-05	4
099	Endrin aldehyde	0.00	8.10E-04	1.9E-05	4
038	Ethylbenzene	0.00	29.00	7.20E-03	4
039	Fluoranthene	0.00	3.70E-01	2.20E-03	4
080	Fluorene	0.00	14.00	2.20E-03	4
104	Gamma BHC (Lindane)	0.00	6.30E-04	1.1E-05	4
	Gross Alpha (pCi/L)	0.00	15.00	<1.62	4
	Gross Beta (pCi/L)	2.64	4 mrem/yr	N/A	
	Guthion	0.00	1.00E-05	3.577E-04	4
	Hardness (ppm as $CaCO_3$)	29.07	N/A	3.0	5
100	Heptachlor	0.00	2.10E-06	1.6E-05	4
101	Heptachlor epoxide	0.00	1.10E-06	1.2E-05	4
009	Hexachlorobenzene	0.00	7.70E-06	3.10E-03	4
052	Hexachlorobutadiene	0.00	5.00E-01	1.80E-03	4
053	Hexachlorocyclopentadiene	0.00	17.00	1.00E-02	4
012	Hexachloroethane	0.00	8.90E-02	2.40E-03	4
	Hydrogen Sulfide	0.00	2.00E-03	5.00E-02	4
083	Indeno (1 2 3-CD) pyrene	0.00	4.90E-04	3.70E-03	4
054	Isophorone	0.00	26.00	5.10E-03	4
122	Lead	0.00	2.30E-03	1.00E-03	4

Table 2.3-1 Lake Anna Water Quality Data

Priority Pollutant Number *(Note 1)*	Constituent Name	Reported Level (mg/L) *(Note 2)*	Water Quality Criteria (mg/L) *(Notes 2, 3, and 9)*	Detection Limit (mg/L) *(Note 2)*	Notes
	Magnesium	2.63	N/A	1.0E-02	5
	Malathion	0.00	1.00E-04	1.227E-04	4
	M-Alkalinity (ppm as $CaCO_3$)	23.12	N/A	N/A	5
123	Mercury	1.01E-06	5.10E-05	2.0E-04	
	Methoxychlor	0.00	3.00E-05	1.7E-05	4
046	Methyl Bromide	0.00	4.00	1.40E-03	4
045	Methyl Chloride	0.00	N/A	1.10E-03	4 & 5
044	Methylene Chloride	0.00	16.00	2.80E-03	4
	Molybdenum	1.90E-02	N/A	1.0E-03	5
055	Naphthalene	0.00	N/A	3.80E-03	4 & 5
124	Nickel	0.00	4.60	5.00E-03	4
	Nitrate as N	1.70E-01	NAWQC	1.0E-02	6
	Nitrite as N	0.00	N/A	1.00E-02	4 & 5
056	Nitrobenzene	0.00	1.90	4.20E-03	4
061	N-Nitrosodimethylamine	0.00	8.10E-02	6.20E-03	4
063	N-nitroso-Di-n-propylamine	0.00	1.40E-02	3.60E-03	4
062	N-nitrosodiphenylamine	0.00	1.60E-01	2.70E-03	4
	Odor	Not reported	N/A	N/A	5
	Parathion	0.00	1.30E-05	1.21E-04	4
112	PCB 1016	0.00	1.40E-05	5.00E-02	4
108	PCB 1221	0.00	1.40E-05	3.00E-02	4
109	PCB 1232	0.00	1.40E-05	5.00E-02	4
106	PCB 1242	0.00	1.40E-05	5.00E-02	4
110	PCB 1248	0.00	1.40E-05	5.00E-02	4
107	PCB 1254	0.00	1.40E-05	3.60E-02	4
111	PCB 1260	0.00	1.40E-05	5.00E-02	4
064	Pentachlorophenol	0.00	8.20E-02	6.85E-04	4
	pH (standard units)	7.50	N/A	N/A	5

Table 2.3-1 Lake Anna Water Quality Data

Priority Pollutant Number *(Note 1)*	Constituent Name	Reported Level (mg/L) *(Note 2)*	Water Quality Criteria (mg/L) *(Notes 2, 3, and 9)*	Detection Limit (mg/L) *(Note 2)*	Notes
081	Phenanthrene	0.00	N/A	5.40E-03	4 & 5
065	Phenol	0.00	4600.00	4.8E-04	4
	Phosphate as P	Not reported	N/A	1.0E-02	5
	Phosphorous as P	1.90E-01	N/A	1.0E-02	5
	Potassium	2.86	N/A	1.0E-02	5
084	Pyrene	0.00	11.00	3.80E-03	4
125	Selenium	0.00	11.00	3.00E-03	4
126	Silver	0.00	3.20E-04	1.00E-04	4
	Sodium	4.00	N/A	1.0E-01	5
	Strontium (pCi/L)	0.00	8.00	N/A	
	Sulfate	7.42	NAWQC	6.0E-02	6
	Sulfide	2.0E-02	N/A	1.00E-02	4 & 5
	TDS	71.5	NAWQC	10.0	6
	Temperature (°C)	29.9	N/A	N/A	5
085	Tetrachloroethylene	0.00	8.90E-02	4.10E-03	4
127	Thallium	2.0E-04	6.30E-03	2.00E-04	4
	Tin	0.00	N/A	5.00E-03	4 & 5
086	Toluene	0.00	200.00	6.00E-03	4
	Total Kjeldahl Nitrogen, as N	3.9E-01	N/A	1.0E-02	5
	Total PCBs	4.70E-08	1.70E-06	N/A	
	Total Residual Chlorine	0.00	1.10E-02	1.00E-01	4
113	Toxaphene	0.00	7.50E-06	5.7E-05	4
	Trans-1,2 Dichloroethylene	0.00	140.00	1.6E-03	4
	Trans-1,3-Dichloropropene	Not reported	1.70	9.0E-04	
	Tributyltin	6.30E-05	6.30E-05	3.0E-05	
087	Trichloroethylene	0.00	8.10E-01	1.90E-03	4
	Tritium (pCi/L)	7,460.00	20,000.00	N/A	
	TSS	4.8	N/A	1.0	5

Table 2.3-1 Lake Anna Water Quality Data

Priority Pollutant Number *(Note 1)*	Constituent Name	Reported Level (mg/L) *(Note 2)*	Water Quality Criteria (mg/L) *(Notes 2, 3, and 9)*	Detection Limit (mg/L) *(Note 2)*	Notes
	Turbidity (NTU)	3.40	N/A	N/A	5
088	Vinyl Chloride	0.00	6.10E-02	1.80E-03	4
128	Zinc	1.30E-02	69.00	1.0E-02	

Notes to Table 2.3-1:

1. The Priority Pollutant Numbers are in accordance with 40 CFR 423, Appendix A, EPA Steam Electric Generating Point Source Category (Reference 1).
2. Each constituent's Reported Level, Water Quality Criteria, and Detection Limit are specified in milligrams of constituent as ion per liter of water, unless specified otherwise.
3. The Water Quality Criteria listed are the human health surface water criteria applicable to Units 1 and 2 VPDES Permit. When human health surface water criterion is not defined for a particular constituent, the aquatic life criterion is used.
4. Many of the constituents were reported below the detection limit. These constituents are listed with a "Reported Level" of "0.00".
5. A Water Quality Criteria specified as "N/A" indicates that Virginia does not have numeric water quality criteria for that constituent.
6. A Water Quality Criteria specified as "NAWQC" means that the only existing Virginia numeric criterion for that parameter is for the protection of Public Water Supplies. Lake Anna is not a designated Public Water Supply.
7. The Water Quality Criterion presented is for Trivalent Chromium, which was not directly measured.
8. The Units 1 and 2 VPDES Permit does not have numeric water quality criteria for this constituent.
9. The Water Quality Criteria are based on existing VPDES Permit Water Quality for Units 1 and 2. New state water criteria, based on Virginia Water Quality Standards Regulation (9 VAC 25-260), effective February 2010, will be incorporated into station permits, as necessary and applicable. Any additional sampling will be performed as required.

2.4 Ecology

The information for this section is provided in ESP-ER Section 2.4 and in FEIS Sections 2.2, 2.4, and 2.7. Supplemental information is provided below.

2.4.1 Terrestrial Ecology

As described in Section 3.7, the PJM System Impact Study (Reference 1) determined that an additional 500 kV transmission line from the North Anna Substation to the Ladysmith Switching Substation is required for grid stability associated with the interconnection of Unit 3. The new line will be installed on new transmission towers along the existing corridor between the North Anna Substation and the Ladysmith Switching Substation (NAPS-to-Ladysmith corridor). Information concerning terrestrial ecology in the NAPS transmission corridors is provided in ESP-ER Sections 2.2 and 2.4. Supplemental information regarding wetlands and water bodies in the NAPS-to-Ladysmith transmission corridor is provided in Section 2.4.1.8.

Additionally, there are wetlands along a proposed large component transport route, which are described in Section 2.4.1.8. Regional road improvements will be made to the transport route, as necessary, to facilitate the delivery of large components.

Information on the terrestrial ecology of the additional property acquired for construction support is provided in Appendix 4A.

2.4.1.1 Terrain

No new and significant information has been identified for this section.

2.4.1.2 Wildlife Species

An assessment for wildlife species in the additional property acquired for construction support is provided in Appendix 4A.

2.4.1.3 Common Bird Species

An assessment for bird species in the additional property acquired for construction support is provided in Appendix 4A.

2.4.1.4 Wading Birds and Waterfowl

No new and significant information has been identified for this section.

2.4.1.5 Critical Habitat

A habitat assessment for the additional property acquired for construction support is provided in Appendix 4A. A subsequent habitat survey was performed as described in Sections 2.4.1.6 and 2.4.1.7, and Appendix 4A.

2.4.1.6 Endangered Species

An assessment for rare, threatened and endangered species in the additional property acquired for construction support was conducted in May 2008 and is provided in Appendix 4A.

In September 2009 (Reference 4), the VDCR determined that the North Anna ESP site, transmission corridor and the additional property may support habitat appropriate for small whorled pogonia (*Isotria medeoloides*) and, therefore, recommended that a site inventory be conducted. The small whorled pogonia grows in a variety of woodland habitats in Virginia, but tends to favor mid-aged woodland habitats on gently north or northeast favoring slopes often within small draws. This plant is listed as federally-threatened by the USFWS and as state-endangered by the Virginia Department of Agriculture and Consumer Services (VDACS). In November 2009, a plant-specific habitat survey was performed on the North Anna ESP site, the additional property and in the Blantons Powerline Conservation Site (Conservation Site) (through which the NAPS-to-Ladysmith transmission corridor runs). The survey, which was conducted in accordance with habitat criteria specific to the species, identified the presence of potential small whorled pogonia habitat on the North Anna ESP site (Reference 5). Follow-up plant-specific identification surveys, conducted on the site and additional property during the 2010 and 2012 flowering seasons (Reference 11), determined that the small whorled pogonia was not present. Survey results were communicated to appropriate regulatory agencies (Reference 7). The Virginia Department of Conservation and Recreation (VDCR) reviewed the 2010 survey report and concurred with the methodology and findings (Reference 8).

Potential habitat for the small whorled pogonia was also identified in the Conservation Site (Reference 6), however, none was found in the transmission corridor itself due to the plant species preferred habitat of forested areas and the disturbed nature of this habitat. As described in Section 3.7, no expansion of the corridor is required to accommodate the proposed new line.

2.4.1.7 Rare Plant Species

According to the VDCR, the Conservation Site supports Epling's hedgenettle (*Stachys eplingii*) as a natural heritage resource of concern, and the VDCR recommends the avoidance of this species. The Epling's hedgenettle, while neither a federally- nor state-listed species, is considered rare by the Commonwealth of Virginia.

A plant-specific habitat survey (Reference 6) performed in November 2009 identified potential habitat for the Epling's hedgenettle in the Conservation Site. Follow-up plant-specific identification surveys, conducted during the 2010 and 2012 flowering seasons (Reference 9) (Reference 12), determined that the Epling's hedgenettle was present. Survey results were communicated to appropriate regulatory agencies (Reference 10).

2.4.1.8 **Wetlands**

The new 500 kV transmission line will be installed on new towers in the existing NAPS-to-Ladysmith corridor. This corridor is identified as "Line 575" on ESP-ER Figure 2.2-4 (beginning at NAPS and heading east) and is 84 m (275 ft) wide and approximately 15 miles long. The NAPS-to-Ladysmith corridor crosses the following jurisdictional water bodies and wetlands, identified on the USGS Ladysmith (VA) Quadrangle (Reference 2):

- Lake Anna
- Five tributaries to Lake Anna
- Nine tributaries to Northeast Creek, which is a tributary of the North Anna River below the Lake Anna dam
- Five tributaries to the South River
- One tributary to the Motto River

The two largest areas of wetlands in the corridor are along Northeast Creek, approximately 3 miles north of the dam, and along a tributary of the South River, approximately 3 miles west of the Ladysmith Switching Substation.

There were 31 wetlands identified along a proposed large component transport route. Seven are in the areas expected to be impacted by construction. Two of these are potential tidal wetlands, including one area designated as shoreline. The other five are non-tidal wetlands (Reference 3).

Supplemental information on wetland impacts is provided in Section 5.10.1.5 that addresses specifically the lake mitigating actions resulting from the IFIM study.

Within the additional property, nine nontidal wetlands have been identified, as described in Appendix 4A.

2.4.1.9 **Important Species**

Additional surveys for important species are addressed in Sections 2.4.1.6 and 2.4.1.7.

2.4.1.10 **Proposed Site**

No new and significant information has been identified for this section.

2.4.2 **Aquatic Ecology**

No new and significant information has been identified for this section.

Section 2.4 References

1. PJM System Planning Division, "PJM Generator Interconnection Q65 North Anna 500kV (1570 MW Capacity/1594 Energy) Revised System Impact Study & Facilities Study Report Resulting from Necessary Studies," September 2013.
2. U.S. Geological Survey (USGS), "Ladysmith (VA) Quadrangle," UTM 18 274527E 4214449N.
3. EA Engineering, Science, and Technology, Inc., "Dominion North Anna Power Station Wetland Delineation Report for the Proposed Unit 3 Heavy Haul Route," June 2009.
4. Virginia Department of Conservation and Recreation, letter from Rene Hypes to Michael Sackschewky, Pacific Northwest National Laboratory, dated September 29, 2009.
5. Williamsburg Environmental Group Inc., "Habitat Survey for the Small Whorled Pogonia (*Isotria medeoloides*) North Anna Power Station, Louisa County, Virginia," November 2009.
6. Williamsburg Environmental Group Inc., "Habitat Survey for the Epling's Hedge-nettle (*Stachys eplingii*) and Small Whorled Pogonia (*Isotria medeoloides*) Blantons Powerline Conservation Site, Caroline County, Virginia," November 2009.
7. Dominion Resources Services, Inc., "Supplemental Coastal Zone Management Act Federal Consistency Certification," September 30, 2010.
8. Virginia Department of Environmental Quality, "Federal Consistency Certification for a Combined Construction and Operation License and U.S. Army Corps of Engineers Permit for the North Anna Power Station Unit 3, Virginia Power, DEQ-10-167F," May 16, 2011.
9. Williamsburg Environmental Group Inc., "Detailed Survey for the Epling's Hedge-nettle (*Stachys eplingii*) Blantons Powerline Conservation Site, Caroline County, Virginia," July 2010.
10. Dominion Resources Services, Inc., "Transmittal of Epling's Hedgenettle Survey Report Virginia Electric and Power Company (Dominion) North Anna Power Station - Proposed Unit 3 Louisa County, Virginia," March 7, 2011.
11. Williamsburg Environmental Group Inc., "Detailed Survey for the Small Whorled Pogonia (*Isotria medeoloides*) North Anna Power Station, Louisa County, Virginia," August 3, 2012.
12. Williamsburg Environmental Group Inc., "Detailed survey for the Epling's Hedge-nettle (*Stachys eplingii*) Blantons Powerline Conservation Site, Caroline County, Virginia," July 20, 2012.

2.5 Socioeconomics

The information for this section is provided in ESP-ER Section 2.5 and in FEIS Sections 2.8 and 2.9. Supplemental information concerning historic properties is provided in Sections 2.5.3.3 and 2.5.3.5.

2.5.1 Demography

No new and significant information has been identified for this section.

2.5.2 Community Characteristics

No new and significant information has been identified for this section.

2.5.3 Historic Properties

No new and significant information has been identified for this section.

2.5.3.1 Description of Historic Properties Near the NAPS Site

No new and significant information has been identified for this section.

2.5.3.2 Description of Historic Properties Within the NAPS Site

No new and significant information has been identified for this section.

2.5.3.3 Transmission Rights-of-Way

The Louis Berger Group, Inc. completed a cultural resource assessment (ESP-ER Section 2.5, Reference 21) of the NAPS site and a 1-mile radius surrounding the existing units (study area) during the Units 1 & 2 license renewal project time period. The assessment included the following activities:

- A background investigation of related information to compile known information about the NAPS study area; and
- The delineation of areas within the study area containing potential archaeological resources.

An additional archaeological survey was completed for the NAPS-to-Ladysmith corridor in 2009 (Reference 1). The survey was conducted in accordance with the National Historic Preservation Act of 1966, the Archaeological and Historic Preservation Act of 1974, Executive Order 11593, and Title 36 of the Code of Federal Regulations, Part 60-66 and 800 (as appropriate).

The objectives of the archaeological survey were: 1) to document previously recorded cultural resources within the area of potential effects, 2) to identify any previously unrecorded archaeological sites within the project corridor, and 3) to evaluate the possible eligibility of any such sites for inclusion in the National Register of Historic Places. The fieldwork portion of the survey included a pedestrian reconnaissance of the transmission line right-of-way augmented with subsurface testing at selected locations. Excluding the submerged portions of the project corridor, the total area surveyed for archaeological resources measures approximately 464 acres (188 hectares). The survey resulted in the identification of one site, the presumed remains of a mid-nineteenth-century structure, which has potential to yield significant archaeological information relative to the Domestic, and possibly the Agriculture/Subsistence themes during the Antebellum Period (1830–1860) through the Reconstruction and Growth (1865–1917) time periods in the Upper Coastal Plain region of Virginia. This site will be avoided during any future development or modification of the transmission line corridor. If avoidance of a cultural resources site is deemed impractical, consultation with VDHR will be re-initiated to determine other appropriate treatment measures.

The Louis Berger Group also completed a Phase I architectural study of the areas within a one-half mile radius of the NAPS-to-Ladysmith corridor (Reference 2). Following the *Guidelines for Assessing Impacts of Proposed Electric Transmission Lines and Associated Facilities on Historic Resources in the Commonwealth of Virginia* (Reference 3), the architectural area of potential effects for the 14.5-mile (23.3-kilometer) NAPS-to-Ladysmith 500 kV transmission line was defined to include any architectural resources approximately 50 years or older within 0.5-mile (0.8 kilometer) on either side of the existing corridor centerline, owing to a greater than 10 percent increase in tower height.

The objectives of the architectural survey were to: 1) review and update existing information on previously recorded architectural resources within the Area of Potential Effects; 2) identify and record, at a reconnaissance level, any previously unrecorded architectural resources within the area of potential effects; and 3) evaluate the eligibility of these resources for inclusion in the National Register of Historic Places. Thirty-six previously unrecorded architectural resources were surveyed within the area of potential effects, the majority of which were examples of common mid-nineteenth-century to mid-twentieth-century single dwellings and vernacular farm buildings. Berger recommends 35 of the 36 newly surveyed architectural resources and 14 of the 17 previously recorded architectural resources in the surveyed area as not eligible for inclusion in the National Register of Historic Places. Of the properties surveyed, one newly surveyed resource, a farm on Blantons Road, is recommended as eligible for inclusion in the National Register of Historic Places. Three of the 17 previously recorded resources within the area of potential effects could not be surveyed.

2.5.3.4 **Native American Sites**

No new and significant information has been identified for this section.

2.5.3.5 **Large Component Transport Route**

The proposed large component transport route begins in King William County at a historic ferry landing on the Mattaponi River near the town of Walkerton, and ends at NAPS. Historic site impacts could occur at the following locations: the ferry landing roll-off location, the North Anna River crossing, the Beaverdam Depot, and the I-95 crossing (Reference 4).

The historic ferry landing near Walkerton is planned as the beginning of the preferred large component transport route. It is adjacent to a multi-component prehistoric and historic archaeological site recorded in 1991. The area near the ferry landing, which is the preferred off-load location, was evaluated in 1993 and recommended eligible for inclusion in the National Register of Historic Places.

In June of 2011, an archaeological survey (Reference 5) of the route was completed: 1) to document previously recorded cultural resources within the area of potential effects; 2) to identify any previously unrecorded archaeological sites within the area of potential effects; and 3) to evaluate the potential eligibility of any such sites for listing in the National Register of Historic Places. The survey included both terrestrial and underwater investigations.

The terrestrial survey identified three artifact locations along the route, and relocated and expanded the boundaries of the previously recorded Walkerton Landing Site, also known as the Enfield Plantation. The Walkerton Landing Site has been determined to be eligible for listing in the National Register of Historic Places.

An underwater survey, consisting of side-scan sonar investigations, concluded that there were no submerged cultural features associated either with the Walkerton Ferry or a wharf at the Site. The VDHR reviewed the results of the terrestrial and underwater survey and found that the large component transport route would not adversely affect historic properties (Reference 6). Based upon these results, a Ground Disturbance Plan for the Site will be implemented to avoid and protect cultural resources.

The proposed North Anna River crossing occurs near identified historic sites. The proposed construction of a bridge may occur in a previously recorded archaeological site. Five additional archaeological sites and one architectural resource have been identified along the eastern bank of the North Anna River in the vicinity of the existing Route 30 bridges. Some of these historic properties have been evaluated for National Register eligibility. There could also be deeply-buried deposits along the western bank of the North Anna River.

The historic Beaverdam Depot in the town of Beaverdam, was built in 1866 and has been recommended as eligible for inclusion in the National Register of Historic Places.

The I-95 crossing is difficult to assess without detailed plans. Although the general area has been extensively altered by highway and railroad construction, the optional I-95 crossings are located within the North Anna Battlefield. This large battlefield spreads across northern Hanover and southern Caroline counties. Preliminary survey data indicates that this Civil War battlefield is likely eligible for inclusion in the National Register.

2.5.4 Environmental Justice

No new and significant information has been identified for this section.

Section 2.5 References

1. The Louis Berger Group, Inc., "Archaeological Survey as Part of a Cultural Resource Survey of the Proposed North Anna-Ladysmith 500 kV Transmission Line," June 2009.
2. The Louis Berger Group, Inc., "Architectural Survey of the Proposed North Anna-Ladysmith 500 kV Transmission Line," June 2009.
3. Guidelines for Assessing Impacts of Proposed Electric Transmission Lines and Associated Facilities on Historic Resources in the Commonwealth of Virginia, Virginia Department of Historic Resources, Richmond, VA, 2008.
4. The Louis Berger Group, Inc., "Cultural Resource Assessment of a Proposed Heavy Haul Route to the North Anna Power Station ESP Site," June 2009.
5. Dominion Energy, Inc., "Dominion Virginia Power, North Anna Power Station, Unit 3, Large Component Transport Route, VDHR File No.: 2000-1200," July 7, 2011.
6. Virginia Department of Historic Resources, "Terrestrial and Underwater Archaeological Survey of the Proposed Large Component Transport Route, King William, Hanover, and Louisa Counties, Virginia DHR File No. 2000-1210," July 29, 2011.

2.6 Geology

The information for this section is provided in ESP-ER Section 2.6 and in FEIS Section 2.4. Supplemental information concerning site geology is provided in Sections 2.6.2.2.1 and 2.6.4.2.1.

2.6.1 Geological Conditions

No new and significant information has been identified for this section.

2.6.2 Seismological Conditions

2.6.2.1 Tectonic Setting

No new and significant information has been identified for this section.

2.6.2.2 Seismic Sources

No new and significant information has been identified for this section.

2.6.2.2.1 Seismic Source Zones

The Central and Eastern United States Seismic Source Characterization (CEUS SSC) host seismotectonic source for the Unit 3 site is the Extended Continental Crust-Atlantic Margin Zone (ECC-AM), which includes the region characterized by the presence of extended continental crust developed during Mesozoic rifting along the Atlantic Ocean basin margin (Reference 1).

The 200-mile radius site region encompasses two areas of elevated seismic activity. These seismically active areas, which had previously been considered seismic source zones, consist of the Central Virginia Seismic Zone (CVSZ) and the Giles County Seismic Zone (References 2 and 3).

The August 23, 2011, moment magnitude (M) 5.8 Mineral, Virginia earthquake was the largest historical seismic event in the CVSZ, surpassing an earthquake that occurred in Goochland County, Virginia in 1875 that had an estimated magnitude of about M 4.8 based on felt reports and damage (Reference 4). The largest known earthquake to occur in the Giles County Seismic Zone was the May 31, 1897 M 5.9 Giles County event.

2.6.2.2.2 Tectonic Surfaces (Faults)

No new and significant information has been identified for this section.

2.6.3 Geotechnical Conditions

No new and significant information has been identified for this section.

2.6.4 Environmental Impact Evaluation

2.6.4.1 Geological Impacts

No new and significant information has been identified for this section.

2.6.4.2 Seismological Impacts

2.6.4.2.1 Ground Shaking

The CEUS SSC earthquake catalog was updated to include the last three years of seismicity data from 2009 through mid-December 2011, including the **M** 5.8 Mineral, Virginia earthquake. Including the update, the maximum magnitude distribution ranges from the lower bound of **M** 6.0 to the upper bound of **M** 8.1 with a mean of **M** 7.2 for the ECC-AM.

2.6.4.2.2 Surface Fault Rupture

No new and significant information has been identified for this section.

2.6.4.3 Geotechnical Impacts

No new and significant information has been identified for this section.

Section 2.6 References

1. U.S. NRC, U.S. DOE, and EPRI, NUREG-2115, "Central and Eastern United States Seismic Source Characterization for Nuclear Facilities," January 2012.

2. Bingham, E., "The Physiographic Provinces of Virginia," Virginia Geographer, Volume 23 (2), Fall-Winter 1991.

3. Rader, E.K., and N.H. Evans, editors. "Geologic Map of Virginia-Expanded Explanations," Virginia Division of Mineral Resources, 1993.

4. USGS, Website, Earthquake Hazards Program, Magnitude 5.8--Virginia, 2011 August 23, 17:51:04 UTC, available at http://earthquake.usgs.gov/earthquakes/recenteqsww/Quakes/se082311a.php, accessed on May 8, 2012.

2.7 Meteorology and Air Quality

The information for this section is provided in ESP-ER Section 2.7 and in FEIS Section 2.3. Supplemental information concerning atmospheric dispersion coefficients is provided in Sections 2.7.5 and 2.7.6.

2.7.1 General Climate

No new and significant information has been identified for this section.

2.7.2 Regional Air Quality

No new and significant information has been identified for this section.

2.7.3 Severe Weather

No new and significant information has been identified for this section.

2.7.4 Local Meteorology

No new and significant information has been identified for this section.

2.7.5 Short-Term Diffusion Estimates

For the short-term atmospheric dispersion coefficients (used in the evaluation of doses due to design basis accidents, in Section 7.1), the ESP values listed in FEIS Table 5-14 are used for this ER.

2.7.6 Long-Term (Routine) Diffusion Estimates

As a part of the preparation of this ER, the annual Radiological Environmental Monitoring Program was reviewed to determine if the distances to any of the nearest sensitive receptors, modeled for the ESP-ER have changed. The results are documented in Table 2.7-1 based on a field survey and plotting of receptor locations using Geographic Information System (GIS) technology. This process provided improved distance accuracy for these receptors. The results show the closest receptor to be a residence in the NW direction at a distance of 1.28 km (4207 feet). For the purposes of the atmospheric dispersion analysis and the subsequent dose evaluations, it was conservatively assumed that each sensitive receptor (meat animal, vegetable garden, residence) is at the distance to the closest receptor and that the closest receptor is the residence in the NW direction at the previously determined distance of 1.20 km (3930 ft). Therefore, one of each type of receptor was assumed to be at 1.20 km (3930 feet) in each compass direction. For releases originating from within the plant facility boundary (i.e., from the Reactor Building, Turbine Building, and Radwaste Building), the maximum annual average χ/Q value calculated for the nearest residence, vegetable garden, and meat animal, all assumed at 1.20 km (0.74 mi), is 4.2E-06 sec/m^3 in the ESE direction. The maximum D/Q for those receptors is 1.1E-08 m^{-2} in the NNE direction. In the evaluation performed for this ER, the maximum annual χ/Q (no decay, undepleted) at the EAB is 3.3E-06 sec/m^3, based on a distance of 1.42 km (0.88 mile) to the ESE of the facility boundary from ESP-ER Table 2.7-16 and a minimum Turbine Building cross-sectional area of 3098 m^2 (33,347 ft^2). The results are summarized in Table 2.7-2. This table presents the maximum calculated χ/Qs and D/Qs at sensitive receptors.

Long-term (annual average) χ/Q and D/Q estimates generated by the XOQDOQ model for the sensitive receptors and at distances between 0.25 mile to 50 miles, as well as for various segment boundaries, are also presented. Table 2.7-4 presents χ/Q and D/Q estimates at the specific points of interest.

Table 2.7-5 presents the no decay and undepleted χ/Q estimates at various downwind distances between 0.4 km (0.25 mi) and 80.5 km (50 mi). Table 2.7-6 presents the no decay and undepleted χ/Q estimates for various distance segments out to 80.5 km (50 mi).

Table 2.7-7 presents the 2.26 day decay (for short-lived noble gases) and undepleted χ/Q estimates at the same downwind distances. Table 2.7-8 presents the 2.26 day decay and undepleted χ/Q estimates for the same distance segments.

Table 2.7-9 presents the 8 day decay (for all iodines released to the atmosphere) and depleted χ/Q estimates at the same downwind distances. Table 2.7-10 presents the 8 day decay and depleted χ/Q estimates for the same distance segments.

Table 2.7-11 presents the D/Q estimates for the same downwind distances. Table 2.7-12 presents the D/Q estimates for the same distance segments.

The methodology used to determine the long-term dispersion and deposition coefficients (used in the evaluation of doses due to normal operating releases) remains the same as that described in ESP-ER Section 2.7.6.

The following input data and assumptions were used in the XOQDOQ modeling of routine releases from the vent stacks of the Reactor Building (RB-VS), Turbine Building (TB-VS), and Radwaste Building (RW-VS); and from the CIRC cooling tower:

- Meteorological Data: Three-year combined (1996–1998) onsite joint frequency distribution of wind speed, wind direction, and atmospheric stability.
- Type of Release: Mixed mode (RB-VS and TB-VS) and ground level (RW-VS and CIRC cooling tower).
- Wind Sensor Height: 10 m (33 ft).
- Vertical Temperature Difference from instruments at: 10 m (33 ft) - 48.4 m (158.9 ft).
- Number of Wind Speed Categories: 7.
- Release Height: 52.77 m (173.09 ft) for RB-VS, 71.3 m (234 ft) for TB-VS, 0.0 m (0.0 ft) for RW-VS, 0.0 m (0.0 ft) for CIRC cooling tower.
- Building Height: 46.1 m (151.2 ft) effective height of Turbine Building (TB) for RB-VS, TB-VS, and RW-VS releases, and 0.0 m (0.0 ft) for CIRC Cooling Tower.
- Minimum Turbine Building Cross-Sectional Area: 3098 m^2 (33,347 ft^2).
- Stack Average Velocity: 17.78 m/s (58.33 ft/s) for RB-VS and TB-VS.
- Stack Inside Diameter: 2.40 m (7.9 ft) for RB, 1.95 m (6.4 ft) for TB, 0.0 m (0.0 ft) for RW, 0.0 m (0.0 ft) for CIRC cooling tower.
- Distances from the release point to the nearest point on the site boundary: See Tables 2.7-1 and 2.7-4, which provide the same distances as ESP-ER Table 2.7-16.
- The distance for each sensitive receptor in each direction was assumed to occur at the distance for the nearest residence for releases from the RB, TB, and RW vent stacks.

For releases from the RB-VS, TB-VS, and RW-VS, χ/Q and D/Q calculations at the EAB were computed using distances from the plant facility boundary (FSAR Figure 2.0-205) to the EAB in each sector. For releases from the CIRC cooling tower, which lies outside the plant facility boundary, χ/Q and D/Q calculations at the EAB were computed using distances from the CIRC cooling tower to the EAB in each sector.

For the RB-VS, TB-VS, and RW-VS dispersion analyses, the Turbine Building was used to determine the minimum building cross-sectional area for evaluating building downwash effects. The height of this building is approximately 52 m (170.6 ft), and as the tallest building within the plant facility boundary, this building creates the largest wake. Because the Turbine Building is close enough to each of the three stacks, each will experience wake effects (dispersion) due to the

Turbine Building. Also, because the Turbine Building is taller than the other buildings within the plant facility boundary, the building-induced turbulence for the Turbine Building effectively envelops the wakes from the other lower height structures. Therefore, only the Turbine Building wake was considered and was based on the Turbine Building cross-sectional area. A width of 67.2 m (220.5 ft) at the base of the building, and a minimum building cross-sectional area of 3098 m^2 (33,347 ft^2) were used to determine χ/Q and D/Q estimates. This minimum Turbine Building area was divided by the width at the base to obtain the effective height, which accounts for the irregular shape of the top of the Turbine Building. An effective Turbine Building height of 46.1 m (151.2 ft) was used for modeling the releases from the RB-VS, TB-VS, and RW-VS. For Unit 3, the χ/Q and D/Q values were found to depend on building height but not cross-sectional area.

ESP-ER Tables 2.7-13 through 2.7-20 have been replaced in this ER by Tables 2.7-1 through 2.7-12.

No other new and significant information has been identified for this section.

Table 2.7-1 Source to Sensitive Receptor Distances

Type (Note 3)	Direction from Unit 3	Distance from Plant Facility Boundary (ft) *(Note 1)*	Distance from Plant Facility Boundary (miles/km) *(Note 1)*
Vegetation			
Veg	S	5605	1.06/1.71
Veg	SSW	22877	4.33/6.97
Veg	SW	17254	3.27/5.26
Veg	WSW	No Receptor	
Veg	W	14891	2.82/4.54
Veg	WNW	7608	1.44/2.32
Veg	NW	No Receptor	
Veg	NNW	11399	2.16/3.47
Veg	N	13672	2.59/4.17
Veg	NNE	17318	3.28/5.28
Veg	NE	5029	0.95/1.53
Veg	ENE	13272	2.51/4.05
Veg	E	8519	1.61/2.60
Veg	ESE	11826	2.24/3.60
Veg	SE	4658	0.88/1.42
Veg	SSE	4609	0.87/1.40
Meat Animal			
Meat	S	8712	1.65/2.66
Meat	SSW	9476	1.79/2.89
Meat	SW	6468	1.23/1.97
Meat	WSW	No Receptor	
Meat	W	20424	3.87/6.23
Meat	WNW	21339	4.04/6.50
Meat	NW	No Receptor	
Meat	NNW	No Receptor	
Meat	N	11441	2.17/3.49

Table 2.7-1 Source to Sensitive Receptor Distances *(continued)*

Type (Note 3)	Direction from Unit 3	Distance from Plant Facility Boundary (ft) *(Note 1)*	Distance from Plant Facility Boundary (miles/km) *(Note 1)*
Meat Animal (continued)			
Meat	NNE	7868	1.49/2.40
Meat	NE	7940	1.50/2.42
Meat	ENE	14428	2.73/4.40
Meat	E	19631	3.72/5.98
Meat	ESE	7058	1.34/2.15
Meat	SE	7711	1.46/2.35
Meat	SSE	10445	1.98/3.18
Resident			
Res	S	4339	0.82/1.32
Res	SSW	4575	0.87/1.39
Res	SW	6468	1.23/1.97
Res	WSW	6107	1.16/1.86
Res	W	5263	1.00/1.60
Res	WNW	5421	1.03/1.65
Res	NW	4207	0.80/1.28
Res	NNW	4587	0.87/1.40
Res	N	4846	0.92/1.48
Res	NNE	5695	1.08/1.74
Res	NE	5029	0.95/1.53
Res	ENE	8748	1.66/2.67
Res	E	7158	1.36/2.18
Res	ESE	7506	1.42/2.29
Res	SE	4830	0.91/1.47
Res	SSE	4394	0.83/1.34

Table 2.7-1 Source to Sensitive Receptor Distances *(continued)*

Type (Note 3)	Direction from Unit 3	Distance from Plant Facility Boundary (ft) *(Note 1)*	Distance from Plant Facility Boundary (miles/km) *(Note 1)*
Site Boundary (Exclusion Area Boundary)			
EAB	S	3274	0.62/1.00
EAB	SSW	3009	0.57/0.92
EAB	SW	2851	0.54/0.87
EAB	WSW	2903	0.55/0.88
EAB	W	2851	0.54/0.87
EAB	WNW	2956	0.56/0.90
EAB	NW	3274	0.62/1.00
EAB	NNW	3802	0.72/1.16
EAB	N	4593	0.87/1.40
EAB	NNE	4646	0.88/1.42
EAB	NE	4751	0.90/1.45
EAB	ENE	4806	0.91/1.46
EAB	E	4698	0.89/1.43
EAB	ESE	4646	0.88/1.42
EAB	SE	4383	0.83/1.34

Notes:
1. Distances are from the plant facility boundary. See FSAR Figure 2.0-205.
2. Not used.
3. No milk cows or goats within a 5-mile radius of NAPS.

Table 2.7-1 Source to Sensitive Receptor Distances *(continued)*

Type (Note 3)	Direction from Unit 3	Distance from Plant Facility Boundary (ft) *(Note 1)*	Distance from Plant Facility Boundary (miles/km) *(Note 1)*
Site Boundary (Exclusion Area Boundary)			

Notes:

1. Distances are from the plant facility boundary. See FSAR Figure 2.0-205.
2. Not used.
3. No milk cows or goats within a 5-mile radius of NAPS.

Table 2.7-2 XOQDOQ Predicted Maximum χ/Q and D/Q Values at Specific Points of Interest

Type of Location	Structure	Release Type	Direction from Site (True North)	Distance (miles)	χ/Q (No Decay, Undepleted)	χ/Q (2.26 Day Decay, Undepleted)	χ/Q (8 Day Decay, Depleted)	D/Q
Residence	RB	Mixed	NNE	0.74	6.8E-08	6.8E-08	6.6E-08	1.8E-09 [b]
EAB	RB	Mixed	NNE	0.88	7.1E-08	7.1E-08	6.9E-08	1.7E-09 [a]
Meat Animal	RB	Mixed	NNE	0.74	6.8E-08	6.8E-08	6.6E-08	1.8E-09 [b]
Veg. Garden	RB	Mixed	NNE	0.74	6.8E-08	6.8E-08	6.6E-08	1.8E-09 [b]
Residence	TB	Mixed	NNE	0.74	5.5E-08	5.5E-08	5.3E-08	1.8E-09
EAB	TB	Mixed	NNE	0.88	5.2E-08	5.2E-08	5.0E-08	1.6E-09 [c]
Meat Animal	TB	Mixed	NNE	0.74	5.5E-08	5.5E-08	5.3E-08	1.8E-09
Veg. Garden	TB	Mixed	NNE	0.74	5.5E-08	5.5E-08	5.3E-08	1.8E-09
Residence	RW	Ground	ESE	0.74	4.2E-06	4.2E-06	3.8E-06	1.1E-08 [e]
EAB	RW	Ground	ESE	0.88	3.3E-06	3.3E-06	2.9E-06	1.1E-08 [d]
Meat Animal	RW	Ground	ESE	0.74	4.2E-06	4.2E-06	3.8E-06	1.1E-08 [e]
Veg. Garden	RW	Ground	ESE	0.74	4.2E-06	4.2E-06	3.8E-06	1.1E-08 [e]
Residence	CIRC CT	Ground	ESE	0.74	6.3E-06	6.2E-06	5.6E-06	1.1E-08 [g]
EAB	CIRC CT	Ground	W	0.34	6.4E-06	6.4E-06	6.0E-06	2.1E-08 [f]
Meat Animal	CIRC CT	Ground	ESE	0.74	6.3E-06	6.2E-06	5.6E-06	1.1E-08 [g]
Veg. Garden	CIRC CT	Ground	ESE	0.74	6.3E-06	6.2E-06	5.6E-06	1.1E-08 [g]

Table 2.7-2 XOQDOQ Predicted Maximum χ/Q and D/Q Values at Specific Points of Interest

Notes:

χ/Q – sec/m^3

D/Q – 1/m^2

RB – Reactor Building
TB – Turbine Building
RW – Radwaste Building
CIRC CT – CIRC Cooling Tower

a - Direction South and South-Southeast at distances of 0.62 and 0.73 mi, respectively, for maximum D/Q for EAB.

b - Direction North-Northeast and Southeast at distances of 0.74 mi for maximum D/Q for Residence, Meat Animal and Veg. Garden.

c - Direction North-Northeast and South-Southeast at distances of 0.88 and 0.73 mi, respectively, for maximum D/Q for EAB.

d – Direction South at distance of 0.62 mi for maximum D/Q for EAB.

e - Direction North-Northeast at distance of 0.74 mi for maximum D/Q for Residence, Meat Animal and Veg. Garden.

f - Direction South at distance of 0.43 mi for maximum D/Q for EAB.

g - Direction North-Northeast at distance of 0.74 mi for maximum D/Q for Residence, Meat Animal and Veg. Garden.

Table 2.7-3 [Deleted]

Table 2.7-4 Long-Term Average χ/Q (sec/m^3) for Routine Releases at Specific Points of Interest (Sheet 1 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 8/28/2014

0XOQDOQ - North Anna COL (1996-98 Met Data)

EXIT RB - MIXED MODE RELEASE - NO PURGE RELEASES
SPECIFIC POINTS OF INTEREST

0RELEASE ID	TYPE OF LOCATION	DIRECTION FROM SITE	DISTANCE (MILES)	DISTANCE (METERS)	X/Q (SEC/CUB.METER) NO DECAY UNDEPLETED	X/Q (SEC/CUB.METER) 2.260 DAY DECAY UNDEPLETED	X/Q (SEC/CUB.METER) 8.000 DAY DECAY DEPLETED	D/Q (PER SQ.METER)
A	RESIDENCE	S	0.74	1198.	6.5E-08	6.5E-08	6.2E-08	1.5E-09
A	RESIDENCE	SSW	0.74	1198.	3.2E-08	3.2E-08	3.1E-08	7.7E-10
A	RESIDENCE	SW	0.74	1198.	2.4E-08	2.4E-08	2.3E-08	6.1E-10
A	RESIDENCE	WSW	0.74	1198.	2.3E-08	2.3E-08	2.3E-08	5.9E-10
A	RESIDENCE	W	0.74	1198.	2.8E-08	2.8E-08	2.7E-08	7.3E-10
A	RESIDENCE	WNW	0.74	1198.	3.5E-08	3.5E-08	3.4E-08	8.6E-10
A	RESIDENCE	NW	0.74	1198.	1.9E-08	1.9E-08	1.8E-08	5.1E-10
A	RESIDENCE	NNW	0.74	1198.	1.3E-08	1.3E-08	1.3E-08	3.9E-10
A	RESIDENCE	N	0.74	1198.	3.5E-08	3.5E-08	3.4E-08	1.0E-09
A	RESIDENCE	NNE	0.74	1198.	6.8E-08	6.8E-08	6.6E-08	1.8E-09
A	RESIDENCE	NE	0.74	1198.	4.8E-08	4.8E-08	4.6E-08	1.3E-09
A	RESIDENCE	ENE	0.74	1198.	2.7E-08	2.7E-08	2.6E-08	7.3E-10
A	RESIDENCE	E	0.74	1198.	2.5E-08	2.4E-08	2.4E-08	8.0E-10
A	RESIDENCE	ESE	0.74	1198.	3.9E-08	3.9E-08	3.8E-08	1.2E-09
A	RESIDENCE	SE	0.74	1198.	5.7E-08	5.7E-08	5.5E-08	1.8E-09
A	RESIDENCE	SSE	0.74	1198.	6.3E-08	6.3E-08	6.1E-08	1.7E-09
A	EAB	S	0.62	998.	6.3E-08	6.3E-08	6.0E-08	1.7E-09
A	EAB	SSW	0.57	917.	2.9E-08	2.9E-08	2.8E-08	7.9E-10
A	EAB	SW	0.54	869.	2.2E-08	2.2E-08	2.1E-08	6.3E-10
A	EAB	WSW	0.55	885.	2.1E-08	2.1E-08	2.1E-08	6.4E-10
A	EAB	W	0.54	869.	2.7E-08	2.7E-08	2.6E-08	8.1E-10
A	EAB	WNW	0.56	901.	3.5E-08	3.5E-08	3.4E-08	1.0E-09
A	EAB	NW	0.62	998.	1.8E-08	1.8E-08	1.7E-08	5.5E-10
A	EAB	NNW	0.72	1159.	1.3E-08	1.3E-08	1.3E-08	4.0E-10
A	EAB	N	0.87	1400.	3.8E-08	3.8E-08	3.8E-08	9.3E-10
A	EAB	NNE	0.88	1416.	7.1E-08	7.1E-08	6.9E-08	1.6E-09
A	EAB	NE	0.90	1448.	5.3E-08	5.3E-08	5.2E-08	1.1E-09
A	EAB	ENE	0.91	1465.	2.9E-08	2.9E-08	2.8E-08	6.3E-10
A	EAB	E	0.89	1432.	2.6E-08	2.6E-08	2.6E-08	6.8E-10
A	EAB	ESE	0.88	1416.	4.0E-08	4.0E-08	3.9E-08	1.0E-09
A	EAB	SE	0.83	1336.	5.4E-08	5.4E-08	5.3E-08	1.6E-09
A	EAB	SSE	0.73	1175.	6.3E-08	6.3E-08	6.1E-08	1.7E-09
A	MEAT ANIMAL	S	0.74	1198.	6.5E-08	6.5E-08	6.2E-08	1.5E-09
A	MEAT ANIMAL	SSW	0.74	1198.	3.2E-08	3.2E-08	3.1E-08	7.7E-10
A	MEAT ANIMAL	SW	0.74	1198.	2.4E-08	2.4E-08	2.3E-08	6.1E-10
A	MEAT ANIMAL	WSW	0.74	1198.	2.3E-08	2.3E-08	2.3E-08	5.9E-10
A	MEAT ANIMAL	W	0.74	1198.	2.8E-08	2.8E-08	2.7E-08	7.3E-10
A	MEAT ANIMAL	WNW	0.74	1198.	3.5E-08	3.5E-08	3.4E-08	8.6E-10
A	MEAT ANIMAL	NW	0.74	1198.	1.9E-08	1.9E-08	1.8E-08	5.1E-10
A	MEAT ANIMAL	NNW	0.74	1198.	1.3E-08	1.3E-08	1.3E-08	3.9E-10
A	MEAT ANIMAL	N	0.74	1198.	3.5E-08	3.5E-08	3.4E-08	1.0E-09
A	MEAT ANIMAL	NNE	0.74	1198.	6.8E-08	6.8E-08	6.6E-08	1.8E-09
A	MEAT ANIMAL	NE	0.74	1198.	4.8E-08	4.8E-08	4.6E-08	1.3E-09
A	MEAT ANIMAL	ENE	0.74	1198.	2.7E-08	2.7E-08	2.6E-08	7.3E-10
A	MEAT ANIMAL	E	0.74	1198.	2.5E-08	2.4E-08	2.4E-08	8.0E-10
A	MEAT ANIMAL	ESE	0.74	1198.	3.9E-08	3.9E-08	3.8E-08	1.2E-09
A	MEAT ANIMAL	SE	0.74	1198.	5.7E-08	5.7E-08	5.5E-08	1.8E-09
A	MEAT ANIMAL	SSE	0.74	1198.	6.3E-08	6.3E-08	6.1E-08	1.7E-09
A	VEG. GARDEN	S	0.74	1198.	6.5E-08	6.5E-08	6.2E-08	1.5E-09
A	VEG. GARDEN	SSW	0.74	1198.	3.2E-08	3.2E-08	3.1E-08	7.7E-10
A	VEG. GARDEN	SW	0.74	1198.	2.4E-08	2.4E-08	2.3E-08	6.1E-10
A	VEG. GARDEN	WSW	0.74	1198.	2.3E-08	2.3E-08	2.3E-08	5.9E-10
A	VEG. GARDEN	W	0.74	1198.	2.8E-08	2.8E-08	2.7E-08	7.3E-10
A	VEG. GARDEN	WNW	0.74	1198.	3.5E-08	3.5E-08	3.4E-08	8.6E-10
A	VEG. GARDEN	NW	0.74	1198.	1.9E-08	1.9E-08	1.8E-08	5.1E-10
A	VEG. GARDEN	NNW	0.74	1198.	1.3E-08	1.3E-08	1.3E-08	3.9E-10
A	VEG. GARDEN	N	0.74	1198.	3.5E-08	3.5E-08	3.4E-08	1.0E-09
A	VEG. GARDEN	NNE	0.74	1198.	6.8E-08	6.8E-08	6.6E-08	1.8E-09
A	VEG. GARDEN	NE	0.74	1198.	4.8E-08	4.8E-08	4.6E-08	1.3E-09
A	VEG. GARDEN	ENE	0.74	1198.	2.7E-08	2.7E-08	2.6E-08	7.3E-10
A	VEG. GARDEN	E	0.74	1198.	2.5E-08	2.4E-08	2.4E-08	8.0E-10
A	VEG. GARDEN	ESE	0.74	1198.	3.9E-08	3.9E-08	3.8E-08	1.2E-09
A	VEG. GARDEN	SE	0.74	1198.	5.7E-08	5.7E-08	5.5E-08	1.8E-09
A	VEG. GARDEN	SSE	0.74	1198.	6.3E-08	6.3E-08	6.1E-08	1.7E-09

0VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	52.77	REP. WIND HEIGHT	(METERS)	10.0
DIAMETER	(METERS)	2.40	BUILDING HEIGHT	(METERS)	46.1
EXIT VELOCITY	(METERS)	17.78	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	3098.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0

0AT THE RELEASE HEIGHT:

VENT RELEASE MODE	WIND SPEED (METERS/SEC)
ELEVATED	LESS THAN 3.556
MIXED	BETWEEN 3.556 AND 17.780
GROUND LEVEL	ABOVE 17.780

AT THE MEASURED WIND HEIGHT (10.0 METERS):

VENT RELEASE MODE	WIND SPEED (METERS/SEC) STABLE CONDITIONS	WIND SPEED (METERS/SEC) UNSTABLE/NEUTRAL CONDITIONS
ELEVATED	LESS THAN 3.556	LESS THAN 3.556
MIXED	BETWEEN 3.556 AND 17.780	BETWEEN 3.556 AND 17.780
GROUND LEVEL	ABOVE 17.780	ABOVE 17.780

Note: Directions are True North.

Table 2.7-4 Long-Term Average χ/Q (sec/m³) for Routine Releases at Specific Points of Interest (Sheet 2 of 4)

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1USNRC COMPUTER CODE - XOQDOQ,  VERSION 2.0         RUN DATE:  8/28/2014

0XOQDOQ - North Anna COL (1996-98 Met Data)

 EXIT TB - MIXED MODE RELEASE - NO PURGE RELEASES
 SPECIFIC POINTS OF INTEREST
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RELEASE ID	TYPE OF LOCATION	DIRECTION FROM SITE	DISTANCE (MILES)	DISTANCE (METERS)	X/Q (SEC/CUB.METER) NO DECAY UNDEPLETED	X/Q (SEC/CUB.METER) 2.260 DAY DECAY UNDEPLETED	X/Q (SEC/CUB.METER) 8.000 DAY DECAY DEPLETED	D/Q (PER SQ.METER)
B	RESIDENCE	S	0.74	1198.	4.7E-08	4.7E-08	4.5E-08	1.5E-09
B	RESIDENCE	SSW	0.74	1198.	2.3E-08	2.3E-08	2.2E-08	7.4E-10
B	RESIDENCE	SW	0.74	1198.	1.7E-08	1.7E-08	1.6E-08	6.0E-10
B	RESIDENCE	WSW	0.74	1198.	1.7E-08	1.7E-08	1.7E-08	5.8E-10
B	RESIDENCE	W	0.74	1198.	2.2E-08	2.2E-08	2.1E-08	7.1E-10
B	RESIDENCE	WNW	0.74	1198.	2.9E-08	2.9E-08	2.8E-08	8.5E-10
B	RESIDENCE	NW	0.74	1198.	1.4E-08	1.4E-08	1.4E-08	5.1E-10
B	RESIDENCE	NNW	0.74	1198.	1.1E-08	1.1E-08	1.1E-08	3.9E-10
B	RESIDENCE	N	0.74	1198.	2.9E-08	2.9E-08	2.8E-08	1.0E-09
B	RESIDENCE	NNE	0.74	1198.	5.5E-08	5.5E-08	5.3E-08	1.8E-09
B	RESIDENCE	NE	0.74	1198.	3.7E-08	3.7E-08	3.5E-08	1.2E-09
B	RESIDENCE	ENE	0.74	1198.	2.1E-08	2.1E-08	2.1E-08	7.2E-10
B	RESIDENCE	E	0.74	1198.	1.9E-08	1.9E-08	1.9E-08	7.9E-10
B	RESIDENCE	ESE	0.74	1198.	3.2E-08	3.2E-08	3.0E-08	1.1E-09
B	RESIDENCE	SE	0.74	1198.	4.7E-08	4.7E-08	4.6E-08	1.7E-09
B	RESIDENCE	SSE	0.74	1198.	5.0E-08	5.0E-08	4.8E-08	1.6E-09
B	EAB	S	0.62	998.	4.9E-08	4.9E-08	4.7E-08	1.5E-09
B	EAB	SSW	0.57	917.	2.4E-08	2.4E-08	2.3E-08	7.5E-10
B	EAB	SW	0.54	869.	1.9E-08	1.9E-08	1.8E-08	6.1E-10
B	EAB	WSW	0.55	885.	1.8E-08	1.8E-08	1.7E-08	6.2E-10
B	EAB	W	0.54	869.	2.4E-08	2.4E-08	2.3E-08	7.9E-10
B	EAB	WNW	0.56	901.	3.1E-08	3.1E-08	3.0E-08	1.0E-09
B	EAB	NW	0.62	998.	1.5E-08	1.5E-08	1.5E-08	5.5E-10
B	EAB	NNW	0.72	1159.	1.1E-08	1.1E-08	1.1E-08	4.0E-10
B	EAB	N	0.87	1400.	2.7E-08	2.7E-08	2.7E-08	9.3E-10
B	EAB	NNE	0.88	1416.	5.2E-08	5.2E-08	5.0E-08	1.6E-09
B	EAB	NE	0.90	1448.	3.6E-08	3.6E-08	3.5E-08	1.1E-09
B	EAB	ENE	0.91	1465.	2.0E-08	2.0E-08	1.9E-08	6.2E-10
B	EAB	E	0.89	1432.	1.8E-08	1.8E-08	1.7E-08	6.7E-10
B	EAB	ESE	0.88	1416.	2.9E-08	2.9E-08	2.8E-08	9.8E-10
B	EAB	SE	0.83	1336.	4.4E-08	4.4E-08	4.2E-08	1.5E-09
B	EAB	SSE	0.73	1175.	5.1E-08	5.1E-08	4.9E-08	1.6E-09
B	MEAT ANIMAL	S	0.74	1198.	4.7E-08	4.7E-08	4.5E-08	1.5E-09
B	MEAT ANIMAL	SSW	0.74	1198.	2.3E-08	2.3E-08	2.2E-08	7.4E-10
B	MEAT ANIMAL	SW	0.74	1198.	1.7E-08	1.7E-08	1.6E-08	6.0E-10
B	MEAT ANIMAL	WSW	0.74	1198.	1.7E-08	1.7E-08	1.7E-08	5.8E-10
B	MEAT ANIMAL	W	0.74	1198.	2.2E-08	2.2E-08	2.1E-08	7.1E-10
B	MEAT ANIMAL	WNW	0.74	1198.	2.9E-08	2.9E-08	2.8E-08	8.5E-10
B	MEAT ANIMAL	NW	0.74	1198.	1.4E-08	1.4E-08	1.4E-08	5.1E-10
B	MEAT ANIMAL	NNW	0.74	1198.	1.1E-08	1.1E-08	1.1E-08	3.9E-10
B	MEAT ANIMAL	N	0.74	1198.	2.9E-08	2.9E-08	2.8E-08	1.0E-09
B	MEAT ANIMAL	NNE	0.74	1198.	5.5E-08	5.5E-08	5.3E-08	1.8E-09
B	MEAT ANIMAL	NE	0.74	1198.	3.7E-08	3.7E-08	3.5E-08	1.2E-09
B	MEAT ANIMAL	ENE	0.74	1198.	2.1E-08	2.1E-08	2.1E-08	7.2E-10
B	MEAT ANIMAL	E	0.74	1198.	1.9E-08	1.9E-08	1.9E-08	7.9E-10
B	MEAT ANIMAL	ESE	0.74	1198.	3.2E-08	3.2E-08	3.0E-08	1.1E-09
B	MEAT ANIMAL	SE	0.74	1198.	4.7E-08	4.7E-08	4.6E-08	1.7E-09
B	MEAT ANIMAL	SSE	0.74	1198.	5.0E-08	5.0E-08	4.8E-08	1.6E-09
B	VEG. GARDEN	S	0.74	1198.	4.7E-08	4.7E-08	4.5E-08	1.5E-09
B	VEG. GARDEN	SSW	0.74	1198.	2.3E-08	2.3E-08	2.2E-08	7.4E-10
B	VEG. GARDEN	SW	0.74	1198.	1.7E-08	1.7E-08	1.6E-08	6.0E-10
B	VEG. GARDEN	WSW	0.74	1198.	1.7E-08	1.7E-08	1.7E-08	5.8E-10
B	VEG. GARDEN	W	0.74	1198.	2.2E-08	2.2E-08	2.1E-08	7.1E-10
B	VEG. GARDEN	WNW	0.74	1198.	2.9E-08	2.9E-08	2.8E-08	8.5E-10
B	VEG. GARDEN	NW	0.74	1198.	1.4E-08	1.4E-08	1.4E-08	5.1E-10
B	VEG. GARDEN	NNW	0.74	1198.	1.1E-08	1.1E-08	1.1E-08	3.9E-10
B	VEG. GARDEN	N	0.74	1198.	2.9E-08	2.9E-08	2.8E-08	1.0E-09
B	VEG. GARDEN	NNE	0.74	1198.	5.5E-08	5.5E-08	5.3E-08	1.8E-09
B	VEG. GARDEN	NE	0.74	1198.	3.7E-08	3.7E-08	3.5E-08	1.2E-09
B	VEG. GARDEN	ENE	0.74	1198.	2.1E-08	2.1E-08	2.1E-08	7.2E-10
B	VEG. GARDEN	E	0.74	1198.	1.9E-08	1.9E-08	1.9E-08	7.9E-10
B	VEG. GARDEN	ESE	0.74	1198.	3.2E-08	3.2E-08	3.0E-08	1.1E-09
B	VEG. GARDEN	SE	0.74	1198.	4.7E-08	4.7E-08	4.6E-08	1.7E-09
B	VEG. GARDEN	SSE	0.74	1198.	5.0E-08	5.0E-08	4.8E-08	1.6E-09

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0VENT AND BUILDING PARAMETERS:
     RELEASE HEIGHT  (METERS)   71.30               REP. WIND HEIGHT       (METERS)       10.0
     DIAMETER        (METERS)    1.95               BUILDING HEIGHT        (METERS)       46.1
     EXIT VELOCITY   (METERS)   17.78               BLDG.MIN.CRS.SEC.AREA  (SQ.METERS)  3098.0
                                                    HEAT EMISSION RATE     (CAL/SEC)       0.0
0AT THE RELEASE HEIGHT:                         /  AT THE MEASURED WIND HEIGHT ( 10.0 METERS):
 VENT RELEASE MODE   WIND SPEED (METERS/SEC)    /  VENT RELEASE MODE   WIND SPEED (METERS/SEC)       WIND SPEED (METERS/SEC)
                                              /                      STABLE CONDITIONS            UNSTABLE/NEUTRAL CONDITIONS
     ELEVATED        LESS THAN  3.556           /      ELEVATED        LESS THAN  3.556               LESS THAN  3.556
     MIXED          BETWEEN    3.556 AND 17.780 /     MIXED           BETWEEN    3.556 AND 17.780  BETWEEN    3.556 AND 17.780
     GROUND LEVEL    ABOVE      17.780          /      GROUND LEVEL    ABOVE      17.780              ABOVE      17.780
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Note: Directions are True North.

Table 2.7-4 Long-Term Average χ/Q (sec/m^3) for Routine Releases at Specific Points of Interest (Sheet 3 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 7/ 8/2013

0XOQDOQ - North Anna COL (1996-98 Met Data)

EXIT ONE - GROUND LEVEL RELEASE - NO PURGE RELEASES
SPECIFIC POINTS OF INTEREST

0RELEASE ID	TYPE OF LOCATION	DIRECTION FROM SITE	DISTANCE (MILES)	DISTANCE (METERS)	X/Q (SEC/CUB.METER) NO DECAY UNDEPLETED	X/Q (SEC/CUB.METER) 2.260 DAY DECAY UNDEPLETED	X/Q (SEC/CUB.METER) 8.000 DAY DECAY DEPLETED	D/Q (PER SQ.METER)
A	RESIDENCE	S	0.74	1198.	1.6E-06	1.6E-06	1.5E-06	8.5E-09
A	RESIDENCE	SSW	0.74	1198.	1.3E-06	1.3E-06	1.2E-06	5.6E-09
A	RESIDENCE	SW	0.74	1198.	1.2E-06	1.2E-06	1.0E-06	4.6E-09
A	RESIDENCE	WSW	0.74	1198.	1.1E-06	1.1E-06	9.6E-07	4.0E-09
A	RESIDENCE	W	0.74	1198.	1.3E-06	1.3E-06	1.2E-06	4.7E-09
A	RESIDENCE	WNW	0.74	1198.	1.1E-06	1.1E-06	1.0E-06	4.4E-09
A	RESIDENCE	NW	0.74	1198.	1.2E-06	1.2E-06	1.0E-06	3.9E-09
A	RESIDENCE	NNW	0.74	1198.	9.9E-07	9.9E-07	8.8E-07	2.9E-09
A	RESIDENCE	N	0.74	1198.	2.5E-06	2.5E-06	2.3E-06	7.6E-09
A	RESIDENCE	NNE	0.74	1198.	3.2E-06	3.2E-06	2.9E-06	1.1E-08
A	RESIDENCE	NE	0.74	1198.	2.6E-06	2.6E-06	2.3E-06	8.9E-09
A	RESIDENCE	ENE	0.74	1198.	1.6E-06	1.6E-06	1.4E-06	4.8E-09
A	RESIDENCE	E	0.74	1198.	3.0E-06	2.9E-06	2.6E-06	6.7E-09
A	RESIDENCE	ESE	0.74	1198.	4.2E-06	4.2E-06	3.8E-06	9.0E-09
A	RESIDENCE	SE	0.74	1198.	3.0E-06	3.0E-06	2.7E-06	8.0E-09
A	RESIDENCE	SSE	0.74	1198.	1.7E-06	1.7E-06	1.5E-06	7.2E-09
A	EAB	S	0.62	998.	2.2E-06	2.2E-06	2.0E-06	1.1E-08
A	EAB	SSW	0.57	917.	2.0E-06	1.9E-06	1.8E-06	8.7E-09
A	EAB	SW	0.54	869.	1.9E-06	1.9E-06	1.7E-06	7.9E-09
A	EAB	WSW	0.55	885.	1.7E-06	1.7E-06	1.6E-06	6.6E-09
A	EAB	W	0.54	869.	2.1E-06	2.1E-06	1.9E-06	8.0E-09
A	EAB	WNW	0.56	901.	1.7E-06	1.7E-06	1.6E-06	7.0E-09
A	EAB	NW	0.62	998.	1.5E-06	1.5E-06	1.4E-06	5.3E-09
A	EAB	NNW	0.72	1159.	1.0E-06	1.0E-06	9.3E-07	3.0E-09
A	EAB	N	0.87	1400.	2.0E-06	2.0E-06	1.8E-06	5.8E-09
A	EAB	NNE	0.88	1416.	2.5E-06	2.5E-06	2.2E-06	8.3E-09
A	EAB	NE	0.90	1448.	2.0E-06	2.0E-06	1.7E-06	6.4E-09
A	EAB	ENE	0.91	1465.	1.2E-06	1.2E-06	1.0E-06	3.4E-09
A	EAB	E	0.89	1432.	2.3E-06	2.3E-06	2.0E-06	5.0E-09
A	EAB	ESE	0.88	1416.	3.3E-06	3.3E-06	2.9E-06	6.8E-09
A	EAB	SE	0.83	1336.	2.5E-06	2.5E-06	2.2E-06	6.7E-09
A	EAB	SSE	0.73	1175.	1.7E-06	1.7E-06	1.5E-06	7.4E-09
A	MEAT ANIMAL	S	0.74	1198.	1.6E-06	1.6E-06	1.5E-06	8.5E-09
A	MEAT ANIMAL	SSW	0.74	1198.	1.3E-06	1.3E-06	1.2E-06	5.6E-09
A	MEAT ANIMAL	SW	0.74	1198.	1.2E-06	1.2E-06	1.0E-06	4.6E-09
A	MEAT ANIMAL	WSW	0.74	1198.	1.1E-06	1.1E-06	9.6E-07	4.0E-09
A	MEAT ANIMAL	W	0.74	1198.	1.3E-06	1.3E-06	1.2E-06	4.7E-09
A	MEAT ANIMAL	WNW	0.74	1198.	1.1E-06	1.1E-06	1.0E-06	4.4E-09
A	MEAT ANIMAL	NW	0.74	1198.	1.2E-06	1.2E-06	1.0E-06	3.9E-09
A	MEAT ANIMAL	NNW	0.74	1198.	9.9E-07	9.9E-07	8.8E-07	2.9E-09
A	MEAT ANIMAL	N	0.74	1198.	2.5E-06	2.5E-06	2.3E-06	7.6E-09
A	MEAT ANIMAL	NNE	0.74	1198.	3.2E-06	3.2E-06	2.9E-06	1.1E-08
A	MEAT ANIMAL	NE	0.74	1198.	2.6E-06	2.6E-06	2.3E-06	8.9E-09
A	MEAT ANIMAL	ENE	0.74	1198.	1.6E-06	1.6E-06	1.4E-06	4.8E-09
A	MEAT ANIMAL	E	0.74	1198.	3.0E-06	2.9E-06	2.6E-06	6.7E-09
A	MEAT ANIMAL	ESE	0.74	1198.	4.2E-06	4.2E-06	3.8E-06	9.0E-09
A	MEAT ANIMAL	SE	0.74	1198.	3.0E-06	3.0E-06	2.7E-06	8.0E-09
A	MEAT ANIMAL	SSE	0.74	1198.	1.7E-06	1.7E-06	1.5E-06	7.2E-09
A	VEG. GARDEN	S	0.74	1198.	1.6E-06	1.6E-06	1.5E-06	8.5E-09
A	VEG. GARDEN	SSW	0.74	1198.	1.3E-06	1.3E-06	1.2E-06	5.6E-09
A	VEG. GARDEN	SW	0.74	1198.	1.2E-06	1.2E-06	1.0E-06	4.6E-09
A	VEG. GARDEN	WSW	0.74	1198.	1.1E-06	1.1E-06	9.6E-07	4.0E-09
A	VEG. GARDEN	W	0.74	1198.	1.3E-06	1.3E-06	1.2E-06	4.7E-09
A	VEG. GARDEN	WNW	0.74	1198.	1.1E-06	1.1E-06	1.0E-06	4.4E-09
A	VEG. GARDEN	NW	0.74	1198.	1.2E-06	1.2E-06	1.0E-06	3.9E-09
A	VEG. GARDEN	NNW	0.74	1198.	9.9E-07	9.9E-07	8.8E-07	2.9E-09
A	VEG. GARDEN	N	0.74	1198.	2.5E-06	2.5E-06	2.3E-06	7.6E-09
A	VEG. GARDEN	NNE	0.74	1198.	3.2E-06	3.2E-06	2.9E-06	1.1E-08
A	VEG. GARDEN	NE	0.74	1198.	2.6E-06	2.6E-06	2.3E-06	8.9E-09
A	VEG. GARDEN	ENE	0.74	1198.	1.6E-06	1.6E-06	1.4E-06	4.8E-09
A	VEG. GARDEN	E	0.74	1198.	3.0E-06	2.9E-06	2.6E-06	6.7E-09
A	VEG. GARDEN	ESE	0.74	1198.	4.2E-06	4.2E-06	3.8E-06	9.0E-09
A	VEG. GARDEN	SE	0.74	1198.	3.0E-06	3.0E-06	2.7E-06	8.0E-09
A	VEG. GARDEN	SSE	0.74	1198.	1.7E-06	1.7E-06	1.5E-06	7.2E-09

0VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	0.00	REP. WIND HEIGHT	(METERS)	10.0
DIAMETER	(METERS)	0.00	BUILDING HEIGHT	(METERS)	46.1
EXIT VELOCITY	(METERS)	0.00	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	3098.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0

0ALL GROUND LEVEL RELEASES.

Note: Directions are True North. The results on this page are applicable to releases from the RW-VS.

Table 2.7-4 Long-Term Average χ/Q (sec/m^3) for Routine Releases at Specific Points of Interest (Sheet 4 of 4)

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1USNRC COMPUTER CODE - XOQDOQ,  VERSION 2.0          RUN DATE:  7/16/2013
0XOQDOQ - North Anna COL (1996-98 Met Data)
 EXIT TWR - GROUND LEVEL RELEASE - NO PURGE RELEASES
 SPECIFIC POINTS OF INTEREST
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0RELEASE ID	TYPE OF LOCATION	DIRECTION FROM SITE	DISTANCE (MILES)	DISTANCE (METERS)	X/Q (SEC/CUB.METER) NO DECAY UNDEPLETED	X/Q (SEC/CUB.METER) + 2.260 DAY DECAY UNDEPLETED	X/Q (SEC/CUB.METER) + 8.000 DAY DECAY DEPLETED	D/Q (PER SQ.METER)
H	RESIDENCE	S	0.74	1198.	2.0E-06	1.9E-06	1.7E-06	8.5E-09
H	RESIDENCE	SSW	0.74	1198.	1.6E-06	1.5E-06	1.4E-06	5.6E-09
H	RESIDENCE	SW	0.74	1198.	1.4E-06	1.4E-06	1.2E-06	4.6E-09
H	RESIDENCE	WSW	0.74	1198.	1.3E-06	1.3E-06	1.2E-06	4.0E-09
H	RESIDENCE	W	0.74	1198.	1.6E-06	1.6E-06	1.5E-06	4.7E-09
H	RESIDENCE	WNW	0.74	1198.	1.4E-06	1.4E-06	1.3E-06	4.4E-09
H	RESIDENCE	NW	0.74	1198.	1.5E-06	1.5E-06	1.3E-06	3.9E-09
H	RESIDENCE	NNW	0.74	1198.	1.3E-06	1.2E-06	1.1E-06	2.9E-09
H	RESIDENCE	N	0.74	1198.	3.2E-06	3.2E-06	2.8E-06	7.6E-09
H	RESIDENCE	NNE	0.74	1198.	4.0E-06	4.0E-06	3.6E-06	1.1E-08
H	RESIDENCE	NE	0.74	1198.	3.3E-06	3.3E-06	3.0E-06	8.9E-09
H	RESIDENCE	ENE	0.74	1198.	2.1E-06	2.1E-06	1.9E-06	4.8E-09
H	RESIDENCE	E	0.74	1198.	4.1E-06	4.1E-06	3.7E-06	6.7E-09
H	RESIDENCE	ESE	0.74	1198.	6.3E-06	6.2E-06	5.6E-06	9.0E-09
H	RESIDENCE	SE	0.74	1198.	4.3E-06	4.3E-06	3.9E-06	8.0E-09
H	RESIDENCE	SSE	0.74	1198.	2.2E-06	2.2E-06	1.9E-06	7.2E-09
H	EAB	S	0.43	687.	5.2E-06	5.2E-06	4.8E-06	2.1E-08
H	EAB	SSW	0.37	589.	5.4E-06	5.4E-06	5.0E-06	1.8E-08
H	EAB	SW	0.34	552.	5.5E-06	5.5E-06	5.1E-06	1.6E-08
H	EAB	WSW	0.34	552.	5.1E-06	5.1E-06	4.8E-06	1.4E-08
H	EAB	W	0.34	552.	6.4E-06	6.4E-06	6.0E-06	1.7E-08
H	EAB	WNW	0.37	589.	4.9E-06	4.9E-06	4.6E-06	1.4E-08
H	EAB	NW	0.42	675.	4.0E-06	4.0E-06	3.7E-06	1.0E-08
H	EAB	NNW	0.53	859.	2.2E-06	2.2E-06	2.0E-06	5.0E-09
H	EAB	N	0.71	1135.	3.5E-06	3.5E-06	3.1E-06	8.3E-09
H	EAB	NNE	0.95	1534.	2.7E-06	2.6E-06	2.3E-06	7.2E-09
H	EAB	NE	1.20	1939.	1.5E-06	1.5E-06	1.3E-06	3.9E-09
H	EAB	ENE	1.39	2240.	7.5E-07	7.4E-07	6.4E-07	1.6E-09
H	EAB	E	1.21	1945.	1.9E-06	1.8E-06	1.6E-06	2.9E-09
H	EAB	ESE	0.98	1577.	4.0E-06	3.9E-06	3.5E-06	5.6E-09
H	EAB	SE	0.74	1184.	4.4E-06	4.4E-06	4.0E-06	8.2E-09
H	EAB	SSE	0.55	878.	3.8E-06	3.7E-06	3.4E-06	1.2E-08
H	MEAT ANIMAL	SSW	0.74	1198.	1.6E-06	1.5E-06	1.4E-06	5.6E-09
H	MEAT ANIMAL	SW	0.74	1198.	1.4E-06	1.4E-06	1.2E-06	4.6E-09
H	MEAT ANIMAL	WSW	0.74	1198.	1.3E-06	1.3E-06	1.2E-06	4.0E-09
H	MEAT ANIMAL	W	0.74	1198.	1.6E-06	1.6E-06	1.5E-06	4.7E-09
H	MEAT ANIMAL	WNW	0.74	1198.	1.4E-06	1.4E-06	1.3E-06	4.4E-09
H	MEAT ANIMAL	NW	0.74	1198.	1.5E-06	1.5E-06	1.3E-06	3.9E-09
H	MEAT ANIMAL	NNW	0.74	1198.	1.3E-06	1.2E-06	1.1E-06	2.9E-09
H	MEAT ANIMAL	N	0.74	1198.	3.2E-06	3.2E-06	2.8E-06	7.6E-09
H	MEAT ANIMAL	NNE	0.74	1198.	4.0E-06	4.0E-06	3.6E-06	1.1E-08
H	MEAT ANIMAL	NE	0.74	1198.	3.3E-06	3.3E-06	3.0E-06	8.9E-09
H	MEAT ANIMAL	ENE	0.74	1198.	2.1E-06	2.1E-06	1.9E-06	4.8E-09
H	MEAT ANIMAL	E	0.74	1198.	4.1E-06	4.1E-06	3.7E-06	6.7E-09
H	MEAT ANIMAL	ESE	0.74	1198.	6.3E-06	6.2E-06	5.6E-06	9.0E-09
H	MEAT ANIMAL	SE	0.74	1198.	4.3E-06	4.3E-06	3.9E-06	8.0E-09
H	MEAT ANIMAL	SSE	0.74	1198.	2.2E-06	2.2E-06	1.9E-06	7.2E-09
H	VEG. GARDEN	S	0.74	1198.	2.0E-06	1.9E-06	1.7E-06	8.5E-09
H	VEG. GARDEN	SSW	0.74	1198.	1.6E-06	1.5E-06	1.4E-06	5.6E-09
H	VEG. GARDEN	SW	0.74	1198.	1.4E-06	1.4E-06	1.2E-06	4.6E-09
H	VEG. GARDEN	WSW	0.74	1198.	1.3E-06	1.3E-06	1.2E-06	4.0E-09
H	VEG. GARDEN	W	0.74	1198.	1.6E-06	1.6E-06	1.5E-06	4.7E-09
H	VEG. GARDEN	WNW	0.74	1198.	1.4E-06	1.4E-06	1.3E-06	4.4E-09
H	VEG. GARDEN	NW	0.74	1198.	1.5E-06	1.5E-06	1.3E-06	3.9E-09
H	VEG. GARDEN	NNW	0.74	1198.	1.3E-06	1.2E-06	1.1E-06	2.9E-09
H	VEG. GARDEN	N	0.74	1198.	3.2E-06	3.2E-06	2.8E-06	7.6E-09
H	VEG. GARDEN	NNE	0.74	1198.	4.0E-06	4.0E-06	3.6E-06	1.1E-08
H	VEG. GARDEN	NE	0.74	1198.	3.3E-06	3.3E-06	3.0E-06	8.9E-09
H	VEG. GARDEN	ENE	0.74	1198.	2.1E-06	2.1E-06	1.9E-06	4.8E-09
H	VEG. GARDEN	E	0.74	1198.	4.1E-06	4.1E-06	3.7E-06	6.7E-09
H	VEG. GARDEN	ESE	0.74	1198.	6.3E-06	6.2E-06	5.6E-06	9.0E-09
H	VEG. GARDEN	SE	0.74	1198.	4.3E-06	4.3E-06	3.9E-06	8.0E-09
H	VEG. GARDEN	SSE	0.74	1198.	2.2E-06	2.2E-06	1.9E-06	7.2E-09

```
0VENT AND BUILDING PARAMETERS:
     RELEASE HEIGHT  (METERS)    0.00              REP. WIND HEIGHT       (METERS)       10.0
     DIAMETER        (METERS)    0.00              BUILDING HEIGHT        (METERS)        0.0
     EXIT VELOCITY   (METERS)    0.00              BLDG.MIN.CRS.SEC.AREA  (SQ.METERS)     0.0
                                                   HEAT EMISSION RATE     (CAL/SEC)       0.0
0ALL GROUND LEVEL RELEASES.
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Note: Directions are True North.

Table 2.7-5 Long-Term χ/Q (sec/m^3) for Routine Releases at Distances Between 0.25 to 50 Miles, No Decay, Undepleted (Sheet 1 of 4)

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1USNRC COMPUTER CODE - XOQDOQ,  VERSION 2.0          RUN DATE:  8/28/2014
0XOQDOQ - North Anna COL (1996-98 Met Data)
 EXIT RB - MIXED MODE RELEASE - NO PURGE RELEASES
 NO DECAY,  UNDEPLETED
```

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	1.215E-07	6.850E-08	6.533E-08	7.487E-08	8.482E-08	8.163E-08	7.439E-08	6.675E-08	5.975E-08	5.363E-08	4.836E-08
SSW	5.450E-08	3.120E-08	3.230E-08	4.172E-08	5.403E-08	5.532E-08	5.227E-08	4.804E-08	4.377E-08	3.981E-08	3.628E-08
SW	4.108E-08	2.332E-08	2.410E-08	3.227E-08	4.374E-08	4.576E-08	4.381E-08	4.064E-08	3.728E-08	3.411E-08	3.122E-08
WSW	3.446E-08	2.254E-08	2.357E-08	2.932E-08	3.737E-08	3.866E-08	3.708E-08	3.459E-08	3.193E-08	2.937E-08	2.703E-08
W	4.658E-08	2.971E-08	2.844E-08	3.446E-08	4.328E-08	4.447E-08	4.252E-08	3.961E-08	3.656E-08	3.366E-08	3.100E-08
WNW	4.676E-08	3.794E-08	3.545E-08	3.894E-08	4.490E-08	4.478E-08	4.207E-08	3.868E-08	3.533E-08	3.224E-08	2.949E-08
NW	2.899E-08	2.013E-08	1.912E-08	2.602E-08	3.864E-08	4.243E-08	4.170E-08	3.930E-08	3.643E-08	3.358E-08	3.093E-08
NNW	3.068E-08	1.997E-08	1.382E-08	1.696E-08	2.674E-08	3.105E-08	3.171E-08	3.072E-08	2.908E-08	2.724E-08	2.542E-08
N	8.469E-08	4.920E-08	3.659E-08	4.590E-08	7.175E-08	8.282E-08	8.430E-08	8.149E-08	7.702E-08	7.208E-08	6.720E-08
NNE	1.495E-07	8.914E-08	6.988E-08	7.852E-08	1.039E-07	1.125E-07	1.110E-07	1.054E-07	9.853E-08	9.149E-08	8.481E-08
NE	1.070E-07	5.723E-08	4.874E-08	5.915E-08	8.211E-08	8.991E-08	8.903E-08	8.467E-08	7.917E-08	7.353E-08	6.817E-08
ENE	7.397E-08	3.692E-08	2.785E-08	3.128E-08	4.206E-08	4.634E-08	4.640E-08	4.461E-08	4.213E-08	3.948E-08	3.688E-08
E	8.171E-08	3.661E-08	2.533E-08	3.063E-08	4.870E-08	5.852E-08	6.186E-08	6.179E-08	6.007E-08	5.760E-08	5.485E-08
ESE	1.130E-07	5.568E-08	4.030E-08	4.415E-08	6.015E-08	6.798E-08	6.973E-08	6.847E-08	6.586E-08	6.273E-08	5.948E-08
SE	1.522E-07	8.406E-08	5.817E-08	5.493E-08	5.937E-08	5.990E-08	5.768E-08	5.439E-08	5.084E-08	4.738E-08	4.416E-08
SSE	1.199E-07	7.853E-08	6.419E-08	6.486E-08	6.805E-08	6.486E-08	5.942E-08	5.379E-08	4.862E-08	4.404E-08	4.005E-08

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	4.383E-08	2.875E-08	2.063E-08	1.253E-08	8.675E-09	6.485E-09	5.099E-09	4.155E-09	3.477E-09	2.970E-09	2.579E-09
SSW	3.316E-08	2.233E-08	1.624E-08	1.000E-08	6.972E-09	5.232E-09	4.125E-09	3.367E-09	2.822E-09	2.413E-09	2.097E-09
SW	2.865E-08	1.954E-08	1.432E-08	8.907E-09	6.247E-09	4.710E-09	3.726E-09	3.051E-09	2.563E-09	2.196E-09	1.912E-09
WSW	2.492E-08	1.730E-08	1.281E-08	8.065E-09	5.702E-09	4.323E-09	3.434E-09	2.822E-09	2.378E-09	2.043E-09	1.782E-09
W	2.862E-08	2.000E-08	1.491E-08	9.498E-09	6.780E-09	5.182E-09	4.145E-09	3.426E-09	2.902E-09	2.505E-09	2.195E-09
WNW	2.707E-08	1.862E-08	1.378E-08	8.734E-09	6.239E-09	4.774E-09	3.823E-09	3.164E-09	2.682E-09	2.318E-09	2.033E-09
NW	2.853E-08	1.985E-08	1.477E-08	9.404E-09	6.722E-09	5.144E-09	4.121E-09	3.409E-09	2.890E-09	2.497E-09	2.189E-09
NNW	2.370E-08	1.706E-08	1.293E-08	8.397E-09	6.059E-09	4.665E-09	3.752E-09	3.114E-09	2.646E-09	2.289E-09	2.010E-09
N	6.261E-08	4.498E-08	3.404E-08	2.206E-08	1.590E-08	1.223E-08	9.824E-09	8.145E-09	6.913E-09	5.977E-09	5.244E-09
NNE	7.870E-08	5.597E-08	4.222E-08	2.732E-08	1.970E-08	1.516E-08	1.219E-08	1.012E-08	8.598E-09	7.440E-09	6.533E-09
NE	6.325E-08	4.493E-08	3.387E-08	2.189E-08	1.578E-08	1.214E-08	9.763E-09	8.102E-09	6.884E-09	5.958E-09	5.232E-09
ENE	3.446E-08	2.515E-08	1.931E-08	1.280E-08	9.376E-09	7.306E-09	5.933E-09	4.965E-09	4.248E-09	3.698E-09	3.265E-09
E	5.207E-08	4.012E-08	3.186E-08	2.202E-08	1.657E-08	1.317E-08	1.086E-08	9.196E-09	7.949E-09	6.982E-09	6.211E-09
ESE	5.632E-08	4.337E-08	3.468E-08	2.442E-08	1.871E-08	1.511E-08	1.263E-08	1.083E-08	9.467E-09	8.399E-09	7.540E-09
SE	4.125E-08	3.040E-08	2.370E-08	1.623E-08	1.225E-08	9.805E-09	8.151E-09	6.963E-09	6.069E-09	5.374E-09	4.817E-09
SSE	3.660E-08	2.486E-08	1.831E-08	1.157E-08	8.267E-09	6.338E-09	5.090E-09	4.224E-09	3.593E-09	3.114E-09	2.739E-09

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0VENT AND BUILDING PARAMETERS:
     RELEASE HEIGHT  (METERS)   52.77                 REP. WIND HEIGHT       (METERS)       10.0
     DIAMETER        (METERS)    2.40                 BUILDING HEIGHT        (METERS)       46.1
     EXIT VELOCITY   (METERS)   17.78                 BLDG.MIN.CRS.SEC.AREA  (SQ.METERS)  3098.0
                                                      HEAT EMISSION RATE     (CAL/SEC)       0.0
0AT THE RELEASE HEIGHT:                        /  AT THE MEASURED WIND HEIGHT ( 10.0 METERS):
 VENT RELEASE MODE   WIND SPEED (METERS/SEC)     /  VENT RELEASE MODE   WIND SPEED (METERS/SEC)       WIND SPEED (METERS/SEC)
                                                 /                      STABLE CONDITIONS              UNSTABLE/NEUTRAL CONDITIONS
     ELEVATED        LESS THAN  3.556            /      ELEVATED        LESS THAN  3.556               LESS THAN  3.556
     MIXED           BETWEEN    3.556 AND 17.780 /      MIXED           BETWEEN    3.556 AND 17.780    BETWEEN    3.556 AND 17.780
     GROUND LEVEL    ABOVE     17.780            /      GROUND LEVEL    ABOVE     17.780               ABOVE     17.780
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Note: Directions are True North.

Table 2.7-5 Long-Term χ/Q (sec/m^3) for Routine Releases at Distances Between 0.25 to 50 Miles, No Decay, Undepleted (Sheet 2 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 8/28/2014
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT TB - MIXED MODE RELEASE - NO PURGE RELEASES
NO DECAY, UNDEPLETED

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	1.147E-07	5.912E-08	4.785E-08	5.254E-08	6.329E-08	6.493E-08	6.190E-08	5.730E-08	5.244E-08	4.784E-08	4.366E-08
SSW	5.197E-08	2.729E-08	2.301E-08	2.804E-08	3.902E-08	4.298E-08	4.271E-08	4.064E-08	3.793E-08	3.511E-08	3.241E-08
SW	3.866E-08	2.069E-08	1.738E-08	2.166E-08	3.127E-08	3.515E-08	3.541E-08	3.402E-08	3.200E-08	2.980E-08	2.765E-08
WSW	3.221E-08	1.974E-08	1.770E-08	2.053E-08	2.708E-08	2.984E-08	3.005E-08	2.900E-08	2.742E-08	2.567E-08	2.393E-08
W	4.366E-08	2.686E-08	2.209E-08	2.471E-08	3.166E-08	3.437E-08	3.432E-08	3.299E-08	3.113E-08	2.912E-08	2.714E-08
WNW	4.287E-08	3.378E-08	2.939E-08	2.983E-08	3.313E-08	3.400E-08	3.304E-08	3.124E-08	2.916E-08	2.707E-08	2.508E-08
NW	2.612E-08	1.808E-08	1.485E-08	1.724E-08	2.515E-08	2.947E-08	3.062E-08	3.006E-08	2.873E-08	2.710E-08	2.541E-08
NNW	2.768E-08	1.883E-08	1.150E-08	1.104E-08	1.605E-08	2.010E-08	2.199E-08	2.242E-08	2.203E-08	2.123E-08	2.025E-08
N	7.522E-08	4.563E-08	2.991E-08	2.954E-08	4.271E-08	5.325E-08	5.813E-08	5.918E-08	5.811E-08	5.597E-08	5.335E-08
NNE	1.330E-07	8.002E-08	5.611E-08	5.368E-08	6.653E-08	7.601E-08	7.916E-08	7.836E-08	7.555E-08	7.187E-08	6.789E-08
NE	9.706E-08	5.066E-08	3.734E-08	3.839E-08	5.136E-08	6.011E-08	6.316E-08	6.278E-08	6.065E-08	5.775E-08	5.459E-08
ENE	6.623E-08	3.337E-08	2.189E-08	2.066E-08	2.601E-08	3.028E-08	3.202E-08	3.209E-08	3.127E-08	3.002E-08	2.859E-08
E	7.219E-08	3.341E-08	2.009E-08	1.895E-08	2.721E-08	3.485E-08	3.916E-08	4.096E-08	4.122E-08	4.060E-08	3.951E-08
ESE	1.009E-07	5.030E-08	3.241E-08	2.978E-08	3.669E-08	4.301E-08	4.613E-08	4.694E-08	4.640E-08	4.515E-08	4.354E-08
SE	1.348E-07	7.571E-08	4.873E-08	4.191E-08	4.236E-08	4.353E-08	4.323E-08	4.185E-08	3.992E-08	3.779E-08	3.563E-08
SSE	1.092E-07	6.871E-08	5.128E-08	4.905E-08	5.158E-08	5.106E-08	4.843E-08	4.502E-08	4.149E-08	3.815E-08	3.508E-08

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	3.995E-08	2.689E-08	1.951E-08	1.196E-08	8.316E-09	6.229E-09	4.903E-09	3.997E-09	3.346E-09	2.859E-09	2.482E-09
SSW	2.993E-08	2.072E-08	1.526E-08	9.498E-09	6.653E-09	5.007E-09	3.954E-09	3.231E-09	2.710E-09	2.319E-09	2.016E-09
SW	2.563E-08	1.800E-08	1.336E-08	8.405E-09	5.927E-09	4.483E-09	3.553E-09	2.913E-09	2.450E-09	2.101E-09	1.830E-09
WSW	2.229E-08	1.590E-08	1.191E-08	7.578E-09	5.384E-09	4.093E-09	3.258E-09	2.680E-09	2.260E-09	1.943E-09	1.697E-09
W	2.528E-08	1.812E-08	1.366E-08	8.782E-09	6.297E-09	4.825E-09	3.866E-09	3.199E-09	2.712E-09	2.342E-09	2.054E-09
WNW	2.328E-08	1.654E-08	1.244E-08	8.012E-09	5.772E-09	4.440E-09	3.569E-09	2.961E-09	2.515E-09	2.177E-09	1.912E-09
NW	2.378E-08	1.728E-08	1.313E-08	8.545E-09	6.177E-09	4.761E-09	3.832E-09	3.181E-09	2.704E-09	2.341E-09	2.056E-09
NNW	1.922E-08	1.457E-08	1.134E-08	7.563E-09	5.537E-09	4.303E-09	3.483E-09	2.904E-09	2.477E-09	2.150E-09	1.893E-09
N	5.061E-08	3.835E-08	2.983E-08	1.989E-08	1.456E-08	1.131E-08	9.148E-09	7.625E-09	6.499E-09	5.638E-09	4.961E-09
NNE	6.398E-08	4.769E-08	3.687E-08	2.450E-08	1.793E-08	1.393E-08	1.128E-08	9.413E-09	8.031E-09	6.974E-09	6.141E-09
NE	5.145E-08	3.831E-08	2.958E-08	1.962E-08	1.434E-08	1.113E-08	9.008E-09	7.512E-09	6.407E-09	5.562E-09	4.897E-09
ENE	2.713E-08	2.078E-08	1.637E-08	1.115E-08	8.300E-09	6.534E-09	5.346E-09	4.498E-09	3.866E-09	3.378E-09	2.992E-09
E	3.818E-08	3.112E-08	2.549E-08	1.825E-08	1.401E-08	1.128E-08	9.389E-09	8.010E-09	6.965E-09	6.146E-09	5.490E-09
ESE	4.180E-08	3.354E-08	2.737E-08	1.966E-08	1.522E-08	1.237E-08	1.039E-08	8.942E-09	7.839E-09	6.972E-09	6.273E-09
SE	3.358E-08	2.532E-08	1.988E-08	1.363E-08	1.028E-08	8.212E-09	6.817E-09	5.816E-09	5.066E-09	4.483E-09	4.017E-09
SSE	3.235E-08	2.250E-08	1.672E-08	1.064E-08	7.612E-09	5.835E-09	4.683E-09	3.884E-09	3.300E-09	2.858E-09	2.512E-09

0VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	71.30	REP. WIND HEIGHT	(METERS)	10.0
DIAMETER	(METERS)	1.95	BUILDING HEIGHT	(METERS)	46.1
EXIT VELOCITY	(METERS)	17.78	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	3098.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0

0AT THE RELEASE HEIGHT: / AT THE MEASURED WIND HEIGHT (10.0 METERS):

VENT RELEASE MODE	WIND SPEED (METERS/SEC)	/	VENT RELEASE MODE	WIND SPEED (METERS/SEC) STABLE CONDITIONS	WIND SPEED (METERS/SEC) UNSTABLE/NEUTRAL CONDITIONS
ELEVATED	LESS THAN 3.556	/	ELEVATED	LESS THAN 3.556	LESS THAN 3.556
MIXED	BETWEEN 3.556 AND 17.780	/	MIXED	BETWEEN 3.556 AND 17.780	BETWEEN 3.556 AND 17.780
GROUND LEVEL	ABOVE 17.780	/	GROUND LEVEL	ABOVE 17.780	ABOVE 17.780

Note: Directions are True North.

Table 2.7-5 Long-Term χ/Q (sec/m^3) for Routine Releases at Distances Between 0.25 to 50 Miles, No Decay, Undepleted (Sheet 3 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 7/ 8/2013
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT ONE - GROUND LEVEL RELEASE - NO PURGE RELEASES
NO DECAY, UNDEPLETED

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	8.557E-06	3.035E-06	1.618E-06	1.035E-06	5.561E-07	3.586E-07	2.555E-07	1.939E-07	1.538E-07	1.258E-07	1.055E-07
SSW	6.692E-06	2.387E-06	1.281E-06	8.219E-07	4.431E-07	2.864E-07	2.044E-07	1.553E-07	1.233E-07	1.010E-07	8.472E-08
SW	5.993E-06	2.128E-06	1.143E-06	7.348E-07	3.972E-07	2.571E-07	1.838E-07	1.399E-07	1.111E-07	9.113E-08	7.654E-08
WSW	5.628E-06	1.979E-06	1.062E-06	6.824E-07	3.695E-07	2.396E-07	1.715E-07	1.307E-07	1.039E-07	8.530E-08	7.169E-08
W	7.005E-06	2.408E-06	1.286E-06	8.272E-07	4.513E-07	2.943E-07	2.117E-07	1.619E-07	1.292E-07	1.063E-07	8.961E-08
WNW	6.098E-06	2.086E-06	1.117E-06	7.181E-07	3.907E-07	2.544E-07	1.828E-07	1.397E-07	1.115E-07	9.173E-08	7.729E-08
NW	6.083E-06	2.108E-06	1.143E-06	7.395E-07	4.052E-07	2.651E-07	1.912E-07	1.465E-07	1.172E-07	9.661E-08	8.154E-08
NNW	5.158E-06	1.787E-06	9.783E-07	6.369E-07	3.503E-07	2.297E-07	1.659E-07	1.274E-07	1.019E-07	8.414E-08	7.108E-08
N	1.311E-05	4.572E-06	2.516E-06	1.640E-06	8.999E-07	5.891E-07	4.249E-07	3.257E-07	2.605E-07	2.148E-07	1.813E-07
NNE	1.674E-05	5.775E-06	3.165E-06	2.064E-06	1.134E-06	7.425E-07	5.358E-07	4.109E-07	3.287E-07	2.711E-07	2.289E-07
NE	1.366E-05	4.720E-06	2.583E-06	1.683E-06	9.262E-07	6.076E-07	4.390E-07	3.370E-07	2.698E-07	2.227E-07	1.881E-07
ENE	8.564E-06	2.868E-06	1.566E-06	1.025E-06	5.709E-07	3.777E-07	2.747E-07	2.120E-07	1.705E-07	1.412E-07	1.197E-07
E	1.674E-05	5.376E-06	2.919E-06	1.921E-06	1.089E-06	7.297E-07	5.356E-07	4.165E-07	3.371E-07	2.808E-07	2.391E-07
ESE	2.574E-05	8.002E-06	4.182E-06	2.707E-06	1.560E-06	1.059E-06	7.848E-07	6.153E-07	5.012E-07	4.200E-07	3.595E-07
SE	1.829E-05	5.731E-06	2.952E-06	1.888E-06	1.080E-06	7.295E-07	5.392E-07	4.218E-07	3.430E-07	2.870E-07	2.453E-07
SSE	9.435E-06	3.165E-06	1.663E-06	1.062E-06	5.835E-07	3.829E-07	2.767E-07	2.126E-07	1.703E-07	1.406E-07	1.189E-07

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	9.015E-08	4.946E-08	3.242E-08	1.799E-08	1.191E-08	8.665E-09	6.692E-09	5.384E-09	4.462E-09	3.783E-09	3.265E-09
SSW	7.245E-08	3.984E-08	2.616E-08	1.453E-08	9.620E-09	6.999E-09	5.404E-09	4.346E-09	3.601E-09	3.053E-09	2.634E-09
SW	6.551E-08	3.614E-08	2.379E-08	1.327E-08	8.809E-09	6.424E-09	4.969E-09	4.003E-09	3.321E-09	2.819E-09	2.435E-09
WSW	6.141E-08	3.400E-08	2.243E-08	1.256E-08	8.366E-09	6.116E-09	4.741E-09	3.827E-09	3.180E-09	2.703E-09	2.338E-09
W	7.695E-08	4.302E-08	2.860E-08	1.619E-08	1.087E-08	7.997E-09	6.232E-09	5.053E-09	4.217E-09	3.596E-09	3.121E-09
WNW	6.637E-08	3.714E-08	2.470E-08	1.401E-08	9.435E-09	6.957E-09	5.432E-09	4.410E-09	3.685E-09	3.146E-09	2.733E-09
NW	7.011E-08	3.938E-08	2.626E-08	1.493E-08	1.005E-08	7.411E-09	5.785E-09	4.695E-09	3.922E-09	3.347E-09	2.906E-09
NNW	6.116E-08	3.445E-08	2.302E-08	1.311E-08	8.831E-09	6.512E-09	5.083E-09	4.126E-09	3.445E-09	2.940E-09	2.553E-09
N	1.559E-07	8.755E-08	5.837E-08	3.315E-08	2.228E-08	1.640E-08	1.278E-08	1.036E-08	8.642E-09	7.367E-09	6.390E-09
NNE	1.969E-07	1.107E-07	7.388E-08	4.201E-08	2.827E-08	2.083E-08	1.625E-08	1.318E-08	1.100E-08	9.388E-09	8.147E-09
NE	1.618E-07	9.115E-08	6.089E-08	3.468E-08	2.336E-08	1.722E-08	1.344E-08	1.091E-08	9.112E-09	7.777E-09	6.751E-09
ENE	1.033E-07	5.889E-08	3.967E-08	2.286E-08	1.552E-08	1.152E-08	9.035E-09	7.365E-09	6.174E-09	5.287E-09	4.603E-09
E	2.072E-07	1.199E-07	8.167E-08	4.776E-08	3.276E-08	2.450E-08	1.934E-08	1.585E-08	1.335E-08	1.148E-08	1.003E-08
ESE	3.130E-07	1.843E-07	1.270E-07	7.556E-08	5.246E-08	3.960E-08	3.150E-08	2.599E-08	2.201E-08	1.902E-08	1.669E-08
SE	2.134E-07	1.253E-07	8.621E-08	5.120E-08	3.553E-08	2.681E-08	2.133E-08	1.760E-08	1.491E-08	1.288E-08	1.131E-08
SSE	1.024E-07	5.791E-08	3.884E-08	2.228E-08	1.512E-08	1.122E-08	8.804E-09	7.181E-09	6.023E-09	5.162E-09	4.498E-09

0VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	0.00	REP. WIND HEIGHT	(METERS)	10.0
DIAMETER	(METERS)	0.00	BUILDING HEIGHT	(METERS)	46.1
EXIT VELOCITY	(METERS)	0.00	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	3098.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0

0ALL GROUND LEVEL RELEASES.

Note: Directions are True North. The results on this page are applicable to releases from the RW-VS.

Table 2.7-5 Long-Term χ/Q (sec/m^3) for Routine Releases at Distances Between 0.25 to 50 Miles, No Decay, Undepleted (Sheet 4 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 7/16/2013
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT TWR - GROUND LEVEL RELEASE - NO PURGE RELEASES
NO DECAY, UNDEPLETED

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	1.356E-05	3.928E-06	1.928E-06	1.186E-06	6.109E-07	3.861E-07	2.719E-07	2.048E-07	1.615E-07	1.316E-07	1.100E-07
SSW	1.072E-05	3.119E-06	1.534E-06	9.444E-07	4.874E-07	3.084E-07	2.175E-07	1.640E-07	1.294E-07	1.056E-07	8.827E-08
SW	9.638E-06	2.807E-06	1.381E-06	8.500E-07	4.390E-07	2.781E-07	1.963E-07	1.481E-07	1.170E-07	9.552E-08	7.994E-08
WSW	9.049E-06	2.632E-06	1.293E-06	7.957E-07	4.111E-07	2.606E-07	1.841E-07	1.391E-07	1.099E-07	8.978E-08	7.518E-08
W	1.131E-05	3.284E-06	1.608E-06	9.898E-07	5.127E-07	3.260E-07	2.310E-07	1.749E-07	1.386E-07	1.134E-07	9.519E-08
WNW	9.801E-06	2.841E-06	1.391E-06	8.537E-07	4.413E-07	2.803E-07	1.984E-07	1.502E-07	1.190E-07	9.738E-08	8.172E-08
NW	1.001E-05	2.927E-06	1.439E-06	8.852E-07	4.593E-07	2.927E-07	2.078E-07	1.576E-07	1.251E-07	1.026E-07	8.620E-08
NNW	8.566E-06	2.510E-06	1.236E-06	7.606E-07	3.954E-07	2.524E-07	1.794E-07	1.363E-07	1.083E-07	8.887E-08	7.474E-08
N	2.178E-05	6.394E-06	3.154E-06	1.940E-06	1.007E-06	6.422E-07	4.561E-07	3.462E-07	2.749E-07	2.254E-07	1.895E-07
NNE	2.770E-05	8.114E-06	3.995E-06	2.457E-06	1.276E-06	8.135E-07	5.778E-07	4.386E-07	3.483E-07	2.857E-07	2.401E-07
NE	2.271E-05	6.664E-06	3.282E-06	2.020E-06	1.050E-06	6.701E-07	4.763E-07	3.618E-07	2.874E-07	2.358E-07	1.983E-07
ENE	1.437E-05	4.211E-06	2.067E-06	1.274E-06	6.647E-07	4.261E-07	3.040E-07	2.317E-07	1.846E-07	1.519E-07	1.281E-07
E	2.851E-05	8.354E-06	4.085E-06	2.521E-06	1.323E-06	8.528E-07	6.116E-07	4.683E-07	3.746E-07	3.094E-07	2.617E-07
ESE	4.394E-05	1.279E-05	6.200E-06	3.832E-06	2.022E-06	1.310E-06	9.443E-07	7.261E-07	5.831E-07	4.832E-07	4.100E-07
SE	3.069E-05	8.874E-06	4.292E-06	2.651E-06	1.396E-06	9.027E-07	6.494E-07	4.986E-07	3.999E-07	3.311E-07	2.807E-07
SSE	1.522E-05	4.392E-06	2.139E-06	1.316E-06	6.834E-07	4.359E-07	3.097E-07	2.352E-07	1.868E-07	1.533E-07	1.289E-07

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	9.375E-08	5.103E-08	3.332E-08	1.841E-08	1.216E-08	8.834E-09	6.815E-09	5.478E-09	4.538E-09	3.845E-09	3.318E-09
SSW	7.529E-08	4.107E-08	2.685E-08	1.486E-08	9.810E-09	7.126E-09	5.497E-09	4.417E-09	3.658E-09	3.099E-09	2.673E-09
SW	6.823E-08	3.733E-08	2.446E-08	1.358E-08	8.993E-09	6.547E-09	5.058E-09	4.071E-09	3.376E-09	2.863E-09	2.472E-09
WSW	6.421E-08	3.523E-08	2.314E-08	1.289E-08	8.560E-09	6.247E-09	4.836E-09	3.900E-09	3.239E-09	2.751E-09	2.378E-09
W	8.145E-08	4.505E-08	2.977E-08	1.675E-08	1.120E-08	8.224E-09	6.399E-09	5.181E-09	4.319E-09	3.681E-09	3.192E-09
WNW	6.993E-08	3.872E-08	2.561E-08	1.444E-08	9.687E-09	7.127E-09	5.556E-09	4.506E-09	3.761E-09	3.209E-09	2.785E-09
NW	7.385E-08	4.103E-08	2.720E-08	1.537E-08	1.031E-08	7.585E-09	5.911E-09	4.792E-09	3.999E-09	3.410E-09	2.959E-09
NNW	6.408E-08	3.570E-08	2.372E-08	1.343E-08	9.014E-09	6.632E-09	5.169E-09	4.191E-09	3.497E-09	2.982E-09	2.587E-09
N	1.624E-07	9.026E-08	5.985E-08	3.379E-08	2.264E-08	1.663E-08	1.295E-08	1.048E-08	8.738E-09	7.445E-09	6.453E-09
NNE	2.058E-07	1.145E-07	7.596E-08	4.294E-08	2.880E-08	2.117E-08	1.649E-08	1.337E-08	1.115E-08	9.502E-09	8.241E-09
NE	1.700E-07	9.468E-08	6.287E-08	3.558E-08	2.388E-08	1.757E-08	1.369E-08	1.110E-08	9.260E-09	7.897E-09	6.851E-09
ENE	1.101E-07	6.187E-08	4.138E-08	2.365E-08	1.599E-08	1.183E-08	9.261E-09	7.538E-09	6.311E-09	5.398E-09	4.696E-09
E	2.255E-07	1.283E-07	8.651E-08	5.006E-08	3.414E-08	2.543E-08	2.002E-08	1.638E-08	1.377E-08	1.182E-08	1.032E-08
ESE	3.544E-07	2.039E-07	1.388E-07	8.136E-08	5.602E-08	4.206E-08	3.333E-08	2.741E-08	2.316E-08	1.997E-08	1.749E-08
SE	2.424E-07	1.391E-07	9.455E-08	5.536E-08	3.810E-08	2.859E-08	2.266E-08	1.863E-08	1.574E-08	1.357E-08	1.190E-08
SSE	1.106E-07	6.173E-08	4.110E-08	2.339E-08	1.580E-08	1.168E-08	9.150E-09	7.450E-09	6.241E-09	5.341E-09	4.650E-09

0VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	0.00	REP. WIND HEIGHT	(METERS)	10.0
DIAMETER	(METERS)	0.00	BUILDING HEIGHT	(METERS)	0.0
EXIT VELOCITY	(METERS)	0.00	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	0.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0

Note: Directions are True North.

Table 2.7-6 Long-Term χ/Q (sec/m^3) for Routine Releases Along Various Distance Segments, No Decay, Undepleted (Sheet 1 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 8/28/2014
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT RB - MIXED MODE RELEASE - NO PURGE RELEASES
NO DECAY, UNDEPLETED
0CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

SEGMENT BOUNDARIES IN MILES FROM THE SITE

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	7.027E-08	8.119E-08	7.326E-08	5.942E-08	4.824E-08	2.849E-08	1.261E-08	6.515E-09	4.166E-09	2.975E-09
SSW	3.625E-08	5.187E-08	5.139E-08	4.348E-08	3.617E-08	2.203E-08	1.004E-08	5.253E-09	3.376E-09	2.417E-09
SW	2.756E-08	4.209E-08	4.306E-08	3.703E-08	3.112E-08	1.925E-08	8.929E-09	4.726E-09	3.058E-09	2.200E-09
WSW	2.590E-08	3.616E-08	3.651E-08	3.171E-08	2.694E-08	1.700E-08	8.069E-09	4.335E-09	2.828E-09	2.045E-09
W	3.140E-08	4.185E-08	4.188E-08	3.633E-08	3.090E-08	1.965E-08	9.493E-09	5.193E-09	3.432E-09	2.508E-09
WNW	3.756E-08	4.352E-08	4.144E-08	3.511E-08	2.941E-08	1.835E-08	8.746E-09	4.784E-09	3.169E-09	2.320E-09
NW	2.241E-08	3.752E-08	4.093E-08	3.616E-08	3.083E-08	1.952E-08	9.404E-09	5.155E-09	3.415E-09	2.499E-09
NNW	1.658E-08	2.648E-08	3.114E-08	2.885E-08	2.532E-08	1.670E-08	8.366E-09	4.672E-09	3.118E-09	2.291E-09
N	4.353E-08	7.093E-08	8.278E-08	7.642E-08	6.694E-08	4.404E-08	2.199E-08	1.225E-08	8.155E-09	5.983E-09
NNE	7.800E-08	1.021E-07	1.092E-07	9.783E-08	8.453E-08	5.491E-08	2.724E-08	1.518E-08	1.013E-08	7.447E-09
NE	5.525E-08	8.047E-08	8.752E-08	7.859E-08	6.794E-08	4.409E-08	2.184E-08	1.216E-08	8.112E-09	5.963E-09
ENE	3.139E-08	4.157E-08	4.567E-08	4.183E-08	3.676E-08	2.462E-08	1.272E-08	7.309E-09	4.968E-09	3.701E-09
E	3.019E-08	4.905E-08	6.094E-08	5.962E-08	5.463E-08	3.910E-08	2.179E-08	1.315E-08	9.195E-09	6.983E-09
ESE	4.543E-08	6.008E-08	6.876E-08	6.541E-08	5.927E-08	4.239E-08	2.417E-08	1.508E-08	1.083E-08	8.397E-09
SE	6.248E-08	5.862E-08	5.695E-08	5.053E-08	4.404E-08	2.983E-08	1.612E-08	9.797E-09	6.962E-09	5.374E-09
SSE	6.768E-08	6.592E-08	5.862E-08	4.835E-08	3.995E-08	2.456E-08	1.160E-08	6.353E-09	4.231E-09	3.117E-09

0AVERAGE EFFECTIVE STACK HEIGHT IN METERS FOR EACH SEGMENT

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	1.039E+02	1.039E+02	1.039E+02	1.039E+02	1.039E+02	1.039E+02	1.039E+02	1.039E+02	1.039E+02	1.039E+02
SSW	1.091E+02	1.091E+02	1.091E+02	1.091E+02	1.091E+02	1.091E+02	1.091E+02	1.091E+02	1.091E+02	1.091E+02
SW	1.111E+02	1.111E+02	1.111E+02	1.111E+02	1.111E+02	1.111E+02	1.111E+02	1.111E+02	1.111E+02	1.111E+02
WSW	1.144E+02	1.144E+02	1.144E+02	1.144E+02	1.144E+02	1.144E+02	1.144E+02	1.144E+02	1.144E+02	1.144E+02
W	1.138E+02	1.139E+02	1.139E+02	1.139E+02	1.139E+02	1.139E+02	1.139E+02	1.139E+02	1.139E+02	1.139E+02
WNW	1.100E+02	1.100E+02	1.100E+02	1.100E+02	1.100E+02	1.100E+02	1.100E+02	1.100E+02	1.100E+02	1.100E+02
NW	1.061E+02	1.061E+02	1.061E+02	1.061E+02	1.061E+02	1.061E+02	1.061E+02	1.061E+02	1.061E+02	1.061E+02
NNW	1.090E+02	1.090E+02	1.090E+02	1.090E+02	1.090E+02	1.090E+02	1.090E+02	1.090E+02	1.090E+02	1.090E+02
N	1.069E+02	1.069E+02	1.069E+02	1.069E+02	1.069E+02	1.069E+02	1.069E+02	1.069E+02	1.069E+02	1.069E+02
NNE	1.023E+02	1.023E+02	1.023E+02	1.023E+02	1.023E+02	1.023E+02	1.023E+02	1.023E+02	1.023E+02	1.023E+02
NE	1.005E+02	1.005E+02	1.005E+02	1.005E+02	1.005E+02	1.005E+02	1.005E+02	1.005E+02	1.005E+02	1.005E+02
ENE	9.853E+01	9.854E+01	9.854E+01	9.854E+01	9.854E+01	9.854E+01	9.854E+01	9.854E+01	9.854E+01	9.854E+01
E	9.598E+01	9.599E+01	9.599E+01	9.599E+01	9.599E+01	9.599E+01	9.599E+01	9.599E+01	9.599E+01	9.599E+01
ESE	9.461E+01	9.461E+01	9.461E+01	9.461E+01	9.461E+01	9.461E+01	9.461E+01	9.461E+01	9.461E+01	9.461E+01
SE	1.016E+02	1.016E+02	1.016E+02	1.016E+02	1.016E+02	1.016E+02	1.016E+02	1.016E+02	1.016E+02	1.016E+02
SSE	1.050E+02	1.050E+02	1.050E+02	1.050E+02	1.050E+02	1.050E+02	1.050E+02	1.050E+02	1.050E+02	1.050E+02

Note: Directions are True North.

Table 2.7-6 Long-Term χ/Q (sec/m^3) for Routine Releases Along Various Distance Segments, No Decay, Undepleted (Sheet 2 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 8/28/2014
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT TB - MIXED MODE RELEASE - NO PURGE RELEASES
NO DECAY, UNDEPLETED
0CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

SEGMENT BOUNDARIES IN MILES FROM THE SITE

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	5.244E-08	6.163E-08	6.087E-08	5.207E-08	4.352E-08	2.651E-08	1.202E-08	6.255E-09	4.008E-09	2.864E-09
SSW	2.619E-08	3.834E-08	4.196E-08	3.763E-08	3.229E-08	2.034E-08	9.513E-09	5.025E-09	3.239E-09	2.322E-09
SW	2.002E-08	3.086E-08	3.479E-08	3.174E-08	2.754E-08	1.763E-08	8.405E-09	4.496E-09	2.920E-09	2.104E-09
WSW	1.941E-08	2.685E-08	2.957E-08	2.721E-08	2.384E-08	1.555E-08	7.566E-09	4.103E-09	2.686E-09	1.946E-09
W	2.431E-08	3.132E-08	3.380E-08	3.089E-08	2.704E-08	1.773E-08	8.760E-09	4.834E-09	3.204E-09	2.345E-09
WNW	3.056E-08	3.279E-08	3.258E-08	2.896E-08	2.500E-08	1.621E-08	8.000E-09	4.447E-09	2.965E-09	2.179E-09
NW	1.663E-08	2.532E-08	3.009E-08	2.849E-08	2.531E-08	1.688E-08	8.512E-09	4.767E-09	3.185E-09	2.343E-09
NNW	1.292E-08	1.673E-08	2.166E-08	2.184E-08	2.016E-08	1.417E-08	7.502E-09	4.304E-09	2.907E-09	2.152E-09
N	3.324E-08	4.447E-08	5.725E-08	5.760E-08	5.311E-08	3.729E-08	1.973E-08	1.131E-08	7.631E-09	5.643E-09
NNE	6.034E-08	6.788E-08	7.800E-08	7.495E-08	6.762E-08	4.650E-08	2.433E-08	1.394E-08	9.420E-09	6.979E-09
NE	4.076E-08	5.237E-08	6.220E-08	6.015E-08	5.436E-08	3.735E-08	1.949E-08	1.114E-08	7.519E-09	5.566E-09
ENE	2.389E-08	2.672E-08	3.159E-08	3.103E-08	2.847E-08	2.023E-08	1.104E-08	6.530E-09	4.500E-09	3.380E-09
E	2.254E-08	2.877E-08	3.873E-08	4.091E-08	3.934E-08	3.019E-08	1.798E-08	1.125E-08	8.006E-09	6.146E-09
ESE	3.522E-08	3.796E-08	4.562E-08	4.608E-08	4.337E-08	3.263E-08	1.940E-08	1.234E-08	8.935E-09	6.970E-09
SE	5.170E-08	4.278E-08	4.276E-08	3.966E-08	3.551E-08	2.474E-08	1.353E-08	8.206E-09	5.816E-09	4.483E-09
SSE	5.416E-08	5.079E-08	4.777E-08	4.123E-08	3.498E-08	2.212E-08	1.065E-08	5.848E-09	3.890E-09	2.861E-09

0AVERAGE EFFECTIVE STACK HEIGHT IN METERS FOR EACH SEGMENT

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	1.130E+02	1.131E+02	1.131E+02	1.131E+02	1.131E+02	1.131E+02	1.131E+02	1.131E+02	1.131E+02	1.131E+02
SSW	1.174E+02	1.174E+02	1.174E+02	1.174E+02	1.174E+02	1.174E+02	1.174E+02	1.174E+02	1.174E+02	1.174E+02
SW	1.190E+02	1.190E+02	1.190E+02	1.190E+02	1.190E+02	1.190E+02	1.190E+02	1.190E+02	1.190E+02	1.190E+02
WSW	1.217E+02	1.217E+02	1.217E+02	1.217E+02	1.217E+02	1.217E+02	1.217E+02	1.217E+02	1.217E+02	1.217E+02
W	1.214E+02	1.214E+02	1.214E+02	1.214E+02	1.214E+02	1.214E+02	1.214E+02	1.214E+02	1.214E+02	1.214E+02
WNW	1.184E+02	1.184E+02	1.184E+02	1.184E+02	1.184E+02	1.184E+02	1.184E+02	1.184E+02	1.184E+02	1.184E+02
NW	1.155E+02	1.155E+02	1.155E+02	1.155E+02	1.155E+02	1.155E+02	1.155E+02	1.155E+02	1.155E+02	1.155E+02
NNW	1.180E+02	1.180E+02	1.180E+02	1.180E+02	1.180E+02	1.180E+02	1.180E+02	1.180E+02	1.180E+02	1.180E+02
N	1.163E+02	1.163E+02	1.163E+02	1.163E+02	1.163E+02	1.163E+02	1.163E+02	1.163E+02	1.163E+02	1.163E+02
NNE	1.124E+02	1.124E+02	1.124E+02	1.124E+02	1.124E+02	1.124E+02	1.124E+02	1.124E+02	1.124E+02	1.124E+02
NE	1.110E+02	1.110E+02	1.110E+02	1.110E+02	1.110E+02	1.110E+02	1.110E+02	1.110E+02	1.110E+02	1.110E+02
ENE	1.094E+02	1.094E+02	1.094E+02	1.094E+02	1.094E+02	1.094E+02	1.094E+02	1.094E+02	1.094E+02	1.094E+02
E	1.077E+02	1.077E+02	1.077E+02	1.077E+02	1.077E+02	1.077E+02	1.077E+02	1.077E+02	1.077E+02	1.077E+02
ESE	1.065E+02	1.065E+02	1.065E+02	1.065E+02	1.065E+02	1.065E+02	1.065E+02	1.065E+02	1.065E+02	1.065E+02
SE	1.118E+02	1.118E+02	1.118E+02	1.118E+02	1.118E+02	1.118E+02	1.118E+02	1.118E+02	1.118E+02	1.118E+02
SSE	1.141E+02	1.141E+02	1.141E+02	1.141E+02	1.141E+02	1.141E+02	1.141E+02	1.141E+02	1.141E+02	1.141E+02

Note: Directions are True North.

Table 2.7-6 Long-Term χ/Q (sec/m^3) for Routine Releases Along Various Distance Segments, No Decay, Undepleted (Sheet 3 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 7/ 8/2013
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT ONE - GROUND LEVEL RELEASE - NO PURGE RELEASES
NO DECAY, UNDEPLETED
0CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	1.674E-06	5.747E-07	2.584E-07	1.546E-07	1.058E-07	5.093E-08	1.850E-08	8.741E-09	5.406E-09	3.792E-09
SSW	1.323E-06	4.576E-07	2.066E-07	1.239E-07	8.500E-08	4.101E-08	1.493E-08	7.060E-09	4.365E-09	3.060E-09
SW	1.181E-06	4.100E-07	1.858E-07	1.117E-07	7.678E-08	3.718E-08	1.363E-08	6.478E-09	4.019E-09	2.825E-09
WSW	1.097E-06	3.813E-07	1.733E-07	1.045E-07	7.191E-08	3.495E-08	1.289E-08	6.166E-09	3.842E-09	2.709E-09
W	1.331E-06	4.651E-07	2.138E-07	1.298E-07	8.988E-08	4.415E-08	1.658E-08	8.057E-09	5.071E-09	3.604E-09
WNW	1.155E-06	4.029E-07	1.847E-07	1.120E-07	7.752E-08	3.811E-08	1.435E-08	7.008E-09	4.426E-09	3.153E-09
NW	1.178E-06	4.172E-07	1.930E-07	1.177E-07	8.177E-08	4.038E-08	1.528E-08	7.465E-09	4.712E-09	3.354E-09
NNW	1.006E-06	3.604E-07	1.675E-07	1.024E-07	7.127E-08	3.530E-08	1.341E-08	6.558E-09	4.140E-09	2.946E-09
N	2.583E-06	9.262E-07	4.290E-07	2.617E-07	1.818E-07	8.977E-08	3.392E-08	1.652E-08	1.040E-08	7.383E-09
NNE	3.256E-06	1.166E-06	5.410E-07	3.303E-07	2.296E-07	1.135E-07	4.299E-08	2.098E-08	1.323E-08	9.407E-09
NE	2.658E-06	9.528E-07	4.432E-07	2.710E-07	1.886E-07	9.341E-08	3.547E-08	1.735E-08	1.095E-08	7.793E-09
ENE	1.615E-06	5.860E-07	2.771E-07	1.712E-07	1.200E-07	6.023E-08	2.333E-08	1.159E-08	7.389E-09	5.296E-09
E	3.022E-06	1.114E-06	5.397E-07	3.383E-07	2.397E-07	1.223E-07	4.863E-08	2.464E-08	1.590E-08	1.149E-08
ESE	4.375E-06	1.592E-06	7.900E-07	5.029E-07	3.602E-07	1.874E-07	7.673E-08	3.979E-08	2.605E-08	1.904E-08
SE	3.097E-06	1.104E-06	5.430E-07	3.442E-07	2.458E-07	1.275E-07	5.201E-08	2.694E-08	1.764E-08	1.290E-08
SSE	1.730E-06	6.008E-07	2.794E-07	1.711E-07	1.192E-07	5.931E-08	2.278E-08	1.129E-08	7.204E-09	5.171E-09

Note: Directions are True North. The results on this page are applicable to releases from the RW-VS.

Table 2.7-6 Long-Term χ/Q (sec/m^3) for Routine Releases Along Various Distance Segments, No Decay, Undepleted (Sheet 4 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 7/16/2013
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT TWR - GROUND LEVEL RELEASE - NO PURGE RELEASES
NO DECAY, UNDEPLETED
0CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	2.043E-06	6.387E-07	2.755E-07	1.625E-07	1.104E-07	5.265E-08	1.895E-08	8.913E-09	5.502E-09	3.855E-09
SSW	1.624E-06	5.094E-07	2.203E-07	1.302E-07	8.859E-08	4.235E-08	1.528E-08	7.190E-09	4.436E-09	3.107E-09
SW	1.462E-06	4.588E-07	1.988E-07	1.177E-07	8.022E-08	3.848E-08	1.396E-08	6.604E-09	4.088E-09	2.870E-09
WSW	1.370E-06	4.297E-07	1.865E-07	1.106E-07	7.544E-08	3.629E-08	1.324E-08	6.300E-09	3.915E-09	2.757E-09
W	1.706E-06	5.358E-07	2.339E-07	1.394E-07	9.550E-08	4.635E-08	1.718E-08	8.288E-09	5.201E-09	3.689E-09
WNW	1.474E-06	4.614E-07	2.010E-07	1.197E-07	8.199E-08	3.983E-08	1.481E-08	7.181E-09	4.522E-09	3.215E-09
NW	1.523E-06	4.799E-07	2.104E-07	1.258E-07	8.648E-08	4.218E-08	1.575E-08	7.643E-09	4.810E-09	3.417E-09
NNW	1.308E-06	4.130E-07	1.816E-07	1.089E-07	7.498E-08	3.668E-08	1.375E-08	6.682E-09	4.206E-09	2.988E-09
N	3.334E-06	1.052E-06	4.618E-07	2.764E-07	1.901E-07	9.277E-08	3.463E-08	1.676E-08	1.052E-08	7.461E-09
NNE	4.227E-06	1.333E-06	5.850E-07	3.502E-07	2.409E-07	1.177E-07	4.399E-08	2.133E-08	1.341E-08	9.522E-09
NE	3.473E-06	1.097E-06	4.822E-07	2.890E-07	1.990E-07	9.728E-08	3.644E-08	1.770E-08	1.114E-08	7.914E-09
ENE	2.191E-06	6.940E-07	3.076E-07	1.856E-07	1.285E-07	6.347E-08	2.418E-08	1.191E-08	7.563E-09	5.409E-09
E	4.338E-06	1.380E-06	6.186E-07	3.765E-07	2.624E-07	1.313E-07	5.108E-08	2.559E-08	1.642E-08	1.184E-08
ESE	6.611E-06	2.108E-06	9.547E-07	5.859E-07	4.111E-07	2.084E-07	8.285E-08	4.229E-08	2.748E-08	2.000E-08
SE	4.581E-06	1.456E-06	6.566E-07	4.019E-07	2.814E-07	1.423E-07	5.639E-08	2.875E-08	1.868E-08	1.360E-08
SSE	2.274E-06	7.140E-07	3.135E-07	1.879E-07	1.294E-07	6.342E-08	2.395E-08	1.177E-08	7.475E-09	5.352E-09

Note: Directions are True North.

Table 2.7-7 Long-Term χ/Q (sec/m^3) for Routine Releases at Distances Between 0.25 to 50 Miles, 2.260 Day Decay, Undepleted (Sheet 1 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 8/28/2014
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT RB - MIXED MODE RELEASE - NO PURGE RELEASES
2.260 DAY DECAY, UNDEPLETED

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	1.215E-07	6.844E-08	6.524E-08	7.472E-08	8.453E-08	8.122E-08	7.390E-08	6.619E-08	5.915E-08	5.299E-08	4.769E-08
SSW	5.448E-08	3.117E-08	3.226E-08	4.163E-08	5.383E-08	5.501E-08	5.188E-08	4.759E-08	4.327E-08	3.928E-08	3.571E-08
SW	4.106E-08	2.330E-08	2.407E-08	3.220E-08	4.356E-08	4.548E-08	4.345E-08	4.022E-08	3.682E-08	3.361E-08	3.070E-08
WSW	3.445E-08	2.252E-08	2.353E-08	2.925E-08	3.721E-08	3.842E-08	3.677E-08	3.422E-08	3.151E-08	2.892E-08	2.655E-08
W	4.656E-08	2.967E-08	2.839E-08	3.437E-08	4.309E-08	4.418E-08	4.215E-08	3.919E-08	3.609E-08	3.314E-08	3.045E-08
WNW	4.674E-08	3.789E-08	3.538E-08	3.883E-08	4.469E-08	4.447E-08	4.169E-08	3.825E-08	3.485E-08	3.173E-08	2.895E-08
NW	2.897E-08	2.010E-08	1.908E-08	2.594E-08	3.845E-08	4.213E-08	4.131E-08	3.884E-08	3.593E-08	3.304E-08	3.036E-08
NNW	3.066E-08	1.994E-08	1.379E-08	1.690E-08	2.658E-08	3.078E-08	3.134E-08	3.028E-08	2.859E-08	2.671E-08	2.485E-08
N	8.464E-08	4.913E-08	3.651E-08	4.575E-08	7.132E-08	8.212E-08	8.336E-08	8.037E-08	7.576E-08	7.071E-08	6.574E-08
NNE	1.494E-07	8.904E-08	6.976E-08	7.831E-08	1.034E-07	1.117E-07	1.099E-07	1.041E-07	9.707E-08	8.990E-08	8.312E-08
NE	1.070E-07	5.717E-08	4.866E-08	5.900E-08	8.171E-08	8.926E-08	8.817E-08	8.365E-08	7.802E-08	7.229E-08	6.685E-08
ENE	7.393E-08	3.688E-08	2.780E-08	3.120E-08	4.185E-08	4.598E-08	4.592E-08	4.403E-08	4.147E-08	3.875E-08	3.611E-08
E	8.167E-08	3.657E-08	2.528E-08	3.054E-08	4.840E-08	5.798E-08	6.112E-08	6.087E-08	5.900E-08	5.641E-08	5.356E-08
ESE	1.130E-07	5.562E-08	4.024E-08	4.404E-08	5.982E-08	6.741E-08	6.895E-08	6.751E-08	6.475E-08	6.149E-08	5.814E-08
SE	1.522E-07	8.396E-08	5.807E-08	5.479E-08	5.909E-08	5.946E-08	5.710E-08	5.370E-08	5.006E-08	4.653E-08	4.324E-08
SSE	1.199E-07	7.844E-08	6.409E-08	6.472E-08	6.778E-08	6.447E-08	5.895E-08	5.325E-08	4.802E-08	4.340E-08	3.937E-08

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	4.314E-08	2.803E-08	1.991E-08	1.185E-08	8.047E-09	5.896E-09	4.543E-09	3.627E-09	2.975E-09	2.490E-09	2.119E-09
SSW	3.258E-08	2.170E-08	1.561E-08	9.408E-09	6.415E-09	4.709E-09	3.631E-09	2.900E-09	2.377E-09	1.988E-09	1.690E-09
SW	2.810E-08	1.896E-08	1.373E-08	8.344E-09	5.717E-09	4.210E-09	3.253E-09	2.601E-09	2.135E-09	1.787E-09	1.520E-09
WSW	2.442E-08	1.674E-08	1.225E-08	7.522E-09	5.187E-09	3.835E-09	2.972E-09	2.381E-09	1.957E-09	1.640E-09	1.396E-09
W	2.804E-08	1.936E-08	1.426E-08	8.857E-09	6.165E-09	4.594E-09	3.583E-09	2.888E-09	2.384E-09	2.007E-09	1.715E-09
WNW	2.652E-08	1.802E-08	1.318E-08	8.154E-09	5.684E-09	4.244E-09	3.317E-09	2.679E-09	2.217E-09	1.869E-09	1.600E-09
NW	2.794E-08	1.921E-08	1.412E-08	8.781E-09	6.127E-09	4.577E-09	3.579E-09	2.891E-09	2.392E-09	2.018E-09	1.727E-09
NNW	2.311E-08	1.641E-08	1.227E-08	7.750E-09	5.441E-09	4.076E-09	3.190E-09	2.576E-09	2.130E-09	1.794E-09	1.533E-09
N	6.108E-08	4.329E-08	3.233E-08	2.039E-08	1.430E-08	1.070E-08	8.372E-09	6.757E-09	5.584E-09	4.701E-09	4.017E-09
NNE	7.693E-08	5.401E-08	4.022E-08	2.535E-08	1.781E-08	1.336E-08	1.047E-08	8.466E-09	7.011E-09	5.913E-09	5.062E-09
NE	6.187E-08	4.340E-08	3.230E-08	2.036E-08	1.430E-08	1.073E-08	8.414E-09	6.808E-09	5.642E-09	4.762E-09	4.079E-09
ENE	3.364E-08	2.422E-08	1.834E-08	1.182E-08	8.422E-09	6.382E-09	5.042E-09	4.103E-09	3.415E-09	2.893E-09	2.485E-09
E	5.070E-08	3.849E-08	3.012E-08	2.022E-08	1.477E-08	1.140E-08	9.126E-09	7.507E-09	6.303E-09	5.377E-09	4.648E-09
ESE	5.489E-08	4.166E-08	3.283E-08	2.244E-08	1.669E-08	1.308E-08	1.062E-08	8.837E-09	7.498E-09	6.457E-09	5.628E-09
SE	4.028E-08	2.927E-08	2.250E-08	1.497E-08	1.098E-08	8.532E-09	6.888E-09	5.714E-09	4.837E-09	4.159E-09	3.621E-09
SSE	3.591E-08	2.411E-08	1.754E-08	1.082E-08	7.546E-09	5.644E-09	4.422E-09	3.580E-09	2.970E-09	2.510E-09	2.154E-09

0VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS) 52.77	REP. WIND HEIGHT	(METERS)	10.0
DIAMETER	(METERS) 2.40	BUILDING HEIGHT	(METERS)	46.1
EXIT VELOCITY	(METERS) 17.78	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	3098.0
		HEAT EMISSION RATE	(CAL/SEC)	0.0

0AT THE RELEASE HEIGHT:		AT THE MEASURED WIND HEIGHT (10.0 METERS):		
VENT RELEASE MODE	WIND SPEED (METERS/SEC)	VENT RELEASE MODE	WIND SPEED (METERS/SEC) STABLE CONDITIONS	WIND SPEED (METERS/SEC) UNSTABLE/NEUTRAL CONDITIONS
ELEVATED	LESS THAN 3.556	ELEVATED	LESS THAN 3.556	LESS THAN 3.556
MIXED	BETWEEN 3.556 AND 17.780	MIXED	BETWEEN 3.556 AND 17.780	BETWEEN 3.556 AND 17.780
GROUND LEVEL	ABOVE 17.780	GROUND LEVEL	ABOVE 17.780	ABOVE 17.780

Note: Directions are True North.

Table 2.7-7 Long-Term χ/Q (sec/m^3) for Routine Releases at Distances Between 0.25 to 50 Miles, 2.260 Day Decay, Undepleted (Sheet 2 of 4)

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1USNRC COMPUTER CODE - XOQDOQ,  VERSION 2.0          RUN DATE:  8/28/2014
0XOQDOQ - North Anna COL (1996-98 Met Data)
 EXIT TB - MIXED MODE RELEASE - NO PURGE RELEASES
   2.260 DAY DECAY,  UNDEPLETED
0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED)                 DISTANCE INMILES FROM THE SITE
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SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	1.147E-07	5.906E-08	4.779E-08	5.244E-08	6.308E-08	6.462E-08	6.150E-08	5.682E-08	5.191E-08	4.727E-08	4.306E-08
SSW	5.195E-08	2.726E-08	2.297E-08	2.798E-08	3.888E-08	4.275E-08	4.240E-08	4.026E-08	3.750E-08	3.464E-08	3.192E-08
SW	3.865E-08	2.067E-08	1.735E-08	2.161E-08	3.114E-08	3.495E-08	3.513E-08	3.368E-08	3.161E-08	2.937E-08	2.719E-08
WSW	3.220E-08	1.972E-08	1.767E-08	2.048E-08	2.697E-08	2.966E-08	2.980E-08	2.870E-08	2.707E-08	2.529E-08	2.351E-08
W	4.364E-08	2.683E-08	2.204E-08	2.464E-08	3.153E-08	3.415E-08	3.404E-08	3.264E-08	3.073E-08	2.867E-08	2.666E-08
WNW	4.285E-08	3.373E-08	2.932E-08	2.974E-08	3.298E-08	3.378E-08	3.276E-08	3.090E-08	2.878E-08	2.665E-08	2.464E-08
NW	2.610E-08	1.806E-08	1.482E-08	1.719E-08	2.503E-08	2.927E-08	3.034E-08	2.972E-08	2.834E-08	2.668E-08	2.496E-08
NNW	2.766E-08	1.880E-08	1.147E-08	1.100E-08	1.596E-08	1.993E-08	2.175E-08	2.211E-08	2.167E-08	2.083E-08	1.981E-08
N	7.517E-08	4.557E-08	2.985E-08	2.945E-08	4.247E-08	5.282E-08	5.750E-08	5.839E-08	5.718E-08	5.492E-08	5.221E-08
NNE	1.329E-07	7.992E-08	5.602E-08	5.354E-08	6.623E-08	7.548E-08	7.841E-08	7.743E-08	7.447E-08	7.065E-08	6.658E-08
NE	9.702E-08	5.061E-08	3.728E-08	3.830E-08	5.114E-08	5.971E-08	6.258E-08	6.205E-08	5.980E-08	5.680E-08	5.356E-08
ENE	6.620E-08	3.333E-08	2.186E-08	2.061E-08	2.589E-08	3.006E-08	3.171E-08	3.170E-08	3.080E-08	2.949E-08	2.801E-08
E	7.216E-08	3.338E-08	2.006E-08	1.890E-08	2.706E-08	3.455E-08	3.871E-08	4.037E-08	4.051E-08	3.979E-08	3.860E-08
ESE	1.009E-07	5.025E-08	3.236E-08	2.971E-08	3.651E-08	4.268E-08	4.564E-08	4.631E-08	4.566E-08	4.429E-08	4.259E-08
SE	1.348E-07	7.561E-08	4.865E-08	4.181E-08	4.218E-08	4.324E-08	4.282E-08	4.135E-08	3.934E-08	3.713E-08	3.492E-08
SSE	1.092E-07	6.862E-08	5.119E-08	4.894E-08	5.138E-08	5.077E-08	4.806E-08	4.458E-08	4.100E-08	3.761E-08	3.451E-08

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0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED)                 DISTANCE INMILES FROM THE SITE
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SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	3.932E-08	2.622E-08	1.884E-08	1.132E-08	7.721E-09	5.670E-09	4.375E-09	3.497E-09	2.870E-09	2.404E-09	2.047E-09
SSW	2.941E-08	2.015E-08	1.467E-08	8.940E-09	6.127E-09	4.512E-09	3.486E-09	2.787E-09	2.287E-09	1.915E-09	1.629E-09
SW	2.516E-08	1.746E-08	1.282E-08	7.880E-09	5.430E-09	4.012E-09	3.108E-09	2.489E-09	2.045E-09	1.714E-09	1.459E-09
WSW	2.185E-08	1.539E-08	1.139E-08	7.074E-09	4.904E-09	3.637E-09	2.824E-09	2.267E-09	1.865E-09	1.564E-09	1.333E-09
W	2.478E-08	1.755E-08	1.307E-08	8.198E-09	5.735E-09	4.286E-09	3.350E-09	2.704E-09	2.235E-09	1.883E-09	1.610E-09
WNW	2.282E-08	1.602E-08	1.190E-08	7.488E-09	5.266E-09	3.954E-09	3.103E-09	2.513E-09	2.084E-09	1.761E-09	1.510E-09
NW	2.330E-08	1.673E-08	1.257E-08	7.987E-09	5.638E-09	4.242E-09	3.334E-09	2.703E-09	2.244E-09	1.897E-09	1.627E-09
NNW	1.875E-08	1.403E-08	1.076E-08	6.986E-09	4.976E-09	3.763E-09	2.964E-09	2.406E-09	1.997E-09	1.687E-09	1.446E-09
N	4.939E-08	3.693E-08	2.834E-08	1.839E-08	1.310E-08	9.908E-09	7.805E-09	6.334E-09	5.257E-09	4.442E-09	3.806E-09
NNE	6.258E-08	4.606E-08	3.515E-08	2.276E-08	1.623E-08	1.229E-08	9.702E-09	7.890E-09	6.562E-09	5.555E-09	4.769E-09
NE	5.035E-08	3.703E-08	2.824E-08	1.826E-08	1.301E-08	9.851E-09	7.775E-09	6.324E-09	5.261E-09	4.455E-09	3.827E-09
ENE	2.651E-08	2.002E-08	1.556E-08	1.032E-08	7.469E-09	5.720E-09	4.553E-09	3.727E-09	3.117E-09	2.650E-09	2.284E-09
E	3.719E-08	2.988E-08	2.413E-08	1.677E-08	1.251E-08	9.778E-09	7.905E-09	6.552E-09	5.534E-09	4.745E-09	4.118E-09
ESE	4.077E-08	3.225E-08	2.594E-08	1.810E-08	1.361E-08	1.074E-08	8.760E-09	7.322E-09	6.234E-09	5.384E-09	4.705E-09
SE	3.282E-08	2.441E-08	1.890E-08	1.260E-08	9.240E-09	7.173E-09	5.787E-09	4.798E-09	4.061E-09	3.493E-09	3.042E-09
SSE	3.175E-08	2.183E-08	1.604E-08	9.965E-09	6.964E-09	5.212E-09	4.084E-09	3.306E-09	2.742E-09	2.318E-09	1.989E-09

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0VENT AND BUILDING PARAMETERS:
     RELEASE HEIGHT  (METERS)   71.30                  REP. WIND HEIGHT       (METERS)       10.0
     DIAMETER        (METERS)    1.95                  BUILDING HEIGHT        (METERS)       46.1
     EXIT VELOCITY   (METERS)   17.78                  BLDG.MIN.CRS.SEC.AREA  (SQ.METERS)  3098.0
                                                       HEAT EMISSION RATE     (CAL/SEC)       0.0
0AT THE RELEASE HEIGHT:                          /  AT THE MEASURED WIND HEIGHT ( 10.0 METERS):
 VENT RELEASE MODE   WIND SPEED (METERS/SEC)     /  VENT RELEASE MODE   WIND SPEED (METERS/SEC)       WIND SPEED (METERS/SEC)
                                                 /                      STABLE CONDITIONS             UNSTABLE/NEUTRAL CONDITIONS
     ELEVATED        LESS THAN  3.556            /      ELEVATED        LESS THAN  3.556              LESS THAN  3.556
     MIXED           BETWEEN    3.556 AND 17.780 /      MIXED           BETWEEN    3.556 AND 17.780   BETWEEN    3.556 AND 17.780
     GROUND LEVEL    ABOVE     17.780            /      GROUND LEVEL    ABOVE     17.780              ABOVE     17.780
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Note: Directions are True North.

Table 2.7-7 Long-Term χ/Q (sec/m^3) for Routine Releases at Distances Between 0.25 to 50 Miles, 2.260 Day Decay, Undepleted (Sheet 3 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 7/ 8/2013

0XOQDOQ - North Anna COL (1996-98 Met Data)

EXIT ONE - GROUND LEVEL RELEASE - NO PURGE RELEASES

2.260 DAY DECAY, UNDEPLETED

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	8.548E-06	3.029E-06	1.613E-06	1.031E-06	5.527E-07	3.556E-07	2.528E-07	1.915E-07	1.515E-07	1.237E-07	1.035E-07
SSW	6.685E-06	2.381E-06	1.276E-06	8.183E-07	4.402E-07	2.838E-07	2.021E-07	1.532E-07	1.213E-07	9.914E-08	8.299E-08
SW	5.986E-06	2.123E-06	1.139E-06	7.314E-07	3.944E-07	2.547E-07	1.816E-07	1.379E-07	1.093E-07	8.938E-08	7.488E-08
WSW	5.620E-06	1.974E-06	1.058E-06	6.790E-07	3.667E-07	2.372E-07	1.693E-07	1.287E-07	1.021E-07	8.355E-08	7.004E-08
W	6.996E-06	2.402E-06	1.281E-06	8.230E-07	4.478E-07	2.913E-07	2.089E-07	1.593E-07	1.268E-07	1.041E-07	8.749E-08
WNW	6.090E-06	2.081E-06	1.112E-06	7.145E-07	3.878E-07	2.519E-07	1.805E-07	1.376E-07	1.095E-07	8.986E-08	7.552E-08
NW	6.075E-06	2.103E-06	1.138E-06	7.358E-07	4.022E-07	2.625E-07	1.888E-07	1.443E-07	1.151E-07	9.466E-08	7.969E-08
NNW	5.151E-06	1.782E-06	9.742E-07	6.333E-07	3.473E-07	2.271E-07	1.636E-07	1.252E-07	9.994E-08	8.224E-08	6.928E-08
N	1.309E-05	4.559E-06	2.505E-06	1.631E-06	8.925E-07	5.826E-07	4.190E-07	3.203E-07	2.554E-07	2.100E-07	1.768E-07
NNE	1.672E-05	5.760E-06	3.153E-06	2.053E-06	1.125E-06	7.347E-07	5.287E-07	4.044E-07	3.226E-07	2.654E-07	2.234E-07
NE	1.364E-05	4.708E-06	2.573E-06	1.674E-06	9.190E-07	6.013E-07	4.333E-07	3.317E-07	2.649E-07	2.180E-07	1.837E-07
ENE	8.552E-06	2.860E-06	1.559E-06	1.019E-06	5.660E-07	3.734E-07	2.707E-07	2.083E-07	1.670E-07	1.380E-07	1.166E-07
E	1.671E-05	5.360E-06	2.906E-06	1.909E-06	1.079E-06	7.206E-07	5.273E-07	4.088E-07	3.298E-07	2.739E-07	2.325E-07
ESE	2.570E-05	7.976E-06	4.162E-06	2.690E-06	1.545E-06	1.045E-06	7.722E-07	6.033E-07	4.899E-07	4.091E-07	3.491E-07
SE	1.826E-05	5.713E-06	2.938E-06	1.876E-06	1.069E-06	7.203E-07	5.306E-07	4.137E-07	3.353E-07	2.796E-07	2.383E-07
SSE	9.423E-06	3.157E-06	1.657E-06	1.057E-06	5.790E-07	3.789E-07	2.731E-07	2.092E-07	1.671E-07	1.376E-07	1.160E-07

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	8.824E-08	4.788E-08	3.104E-08	1.684E-08	1.090E-08	7.753E-09	5.854E-09	4.605E-09	3.732E-09	3.094E-09	2.612E-09
SSW	7.080E-08	3.847E-08	2.496E-08	1.354E-08	8.750E-09	6.215E-09	4.685E-09	3.680E-09	2.977E-09	2.464E-09	2.077E-09
SW	6.393E-08	3.483E-08	2.264E-08	1.231E-08	7.970E-09	5.666E-09	4.274E-09	3.357E-09	2.716E-09	2.248E-09	1.894E-09
WSW	5.983E-08	3.268E-08	2.128E-08	1.160E-08	7.521E-09	5.353E-09	4.040E-09	3.175E-09	2.569E-09	2.127E-09	1.792E-09
W	7.492E-08	4.132E-08	2.709E-08	1.492E-08	9.740E-09	6.971E-09	5.285E-09	4.169E-09	3.385E-09	2.809E-09	2.373E-09
WNW	6.468E-08	3.572E-08	2.345E-08	1.295E-08	8.492E-09	6.099E-09	4.638E-09	3.669E-09	2.986E-09	2.485E-09	2.103E-09
NW	6.834E-08	3.789E-08	2.494E-08	1.382E-08	9.062E-09	6.510E-09	4.952E-09	3.917E-09	3.189E-09	2.653E-09	2.246E-09
NNW	5.944E-08	3.300E-08	2.174E-08	1.203E-08	7.877E-09	5.646E-09	4.284E-09	3.381E-09	2.746E-09	2.280E-09	1.925E-09
N	1.516E-07	8.395E-08	5.519E-08	3.047E-08	1.992E-08	1.426E-08	1.081E-08	8.529E-09	6.923E-09	5.744E-09	4.849E-09
NNE	1.916E-07	1.063E-07	6.999E-08	3.874E-08	2.537E-08	1.820E-08	1.382E-08	1.092E-08	8.878E-09	7.377E-09	6.237E-09
NE	1.576E-07	8.759E-08	5.773E-08	3.201E-08	2.100E-08	1.508E-08	1.146E-08	9.064E-09	7.375E-09	6.134E-09	5.190E-09
ENE	1.004E-07	5.635E-08	3.741E-08	2.093E-08	1.380E-08	9.941E-09	7.575E-09	5.999E-09	4.886E-09	4.065E-09	3.440E-09
E	2.009E-07	1.144E-07	7.670E-08	4.347E-08	2.891E-08	2.096E-08	1.605E-08	1.276E-08	1.042E-08	8.692E-09	7.371E-09
ESE	3.029E-07	1.754E-07	1.189E-07	6.846E-08	4.600E-08	3.362E-08	2.590E-08	2.069E-08	1.698E-08	1.421E-08	1.209E-08
SE	2.065E-07	1.193E-07	8.072E-08	4.639E-08	3.115E-08	2.276E-08	1.753E-08	1.400E-08	1.149E-08	9.618E-09	8.181E-09
SSE	9.963E-08	5.557E-08	3.674E-08	2.049E-08	1.351E-08	9.741E-09	7.431E-09	5.893E-09	4.806E-09	4.005E-09	3.394E-09

0VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	0.00	REP. WIND HEIGHT	(METERS)	10.0
DIAMETER	(METERS)	0.00	BUILDING HEIGHT	(METERS)	46.1
EXIT VELOCITY	(METERS)	0.00	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	3098.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0

0ALL GROUND LEVEL RELEASES.

Note: Directions are True North. The results on this page are applicable to releases from the RW-VS.

Table 2.7-7 Long-Term χ/Q (sec/m^3) for Routine Releases at Distances Between 0.25 to 50 Miles, 2.260 Day Decay, Undepleted (Sheet 4 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 7/16/2013
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT TWR - GROUND LEVEL RELEASE - NO PURGE RELEASES
2.260 DAY DECAY, UNDEPLETED

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	1.354E-05	3.920E-06	1.922E-06	1.181E-06	6.070E-07	3.828E-07	2.690E-07	2.022E-07	1.591E-07	1.293E-07	1.079E-07
SSW	1.071E-05	3.111E-06	1.529E-06	9.401E-07	4.840E-07	3.056E-07	2.150E-07	1.617E-07	1.273E-07	1.036E-07	8.644E-08
SW	9.627E-06	2.800E-06	1.376E-06	8.459E-07	4.358E-07	2.754E-07	1.939E-07	1.460E-07	1.150E-07	9.365E-08	7.819E-08
WSW	9.038E-06	2.625E-06	1.288E-06	7.916E-07	4.079E-07	2.580E-07	1.817E-07	1.369E-07	1.079E-07	8.792E-08	7.343E-08
W	1.130E-05	3.275E-06	1.602E-06	9.845E-07	5.087E-07	3.226E-07	2.279E-07	1.721E-07	1.360E-07	1.110E-07	9.290E-08
WNW	9.788E-06	2.834E-06	1.385E-06	8.494E-07	4.379E-07	2.774E-07	1.959E-07	1.479E-07	1.168E-07	9.538E-08	7.982E-08
NW	9.995E-06	2.919E-06	1.433E-06	8.807E-07	4.558E-07	2.897E-07	2.051E-07	1.552E-07	1.229E-07	1.005E-07	8.422E-08
NNW	8.554E-06	2.503E-06	1.231E-06	7.563E-07	3.920E-07	2.495E-07	1.769E-07	1.340E-07	1.061E-07	8.686E-08	7.284E-08
N	2.175E-05	6.376E-06	3.141E-06	1.929E-06	9.987E-07	6.351E-07	4.498E-07	3.405E-07	2.695E-07	2.204E-07	1.848E-07
NNE	2.766E-05	8.092E-06	3.979E-06	2.444E-06	1.265E-06	8.048E-07	5.701E-07	4.316E-07	3.418E-07	2.796E-07	2.344E-07
NE	2.268E-05	6.646E-06	3.269E-06	2.009E-06	1.042E-06	6.630E-07	4.700E-07	3.561E-07	2.821E-07	2.309E-07	1.936E-07
ENE	1.435E-05	4.199E-06	2.058E-06	1.266E-06	6.589E-07	4.211E-07	2.996E-07	2.277E-07	1.809E-07	1.484E-07	1.247E-07
E	2.847E-05	8.328E-06	4.066E-06	2.505E-06	1.311E-06	8.421E-07	6.021E-07	4.595E-07	3.665E-07	3.017E-07	2.544E-07
ESE	4.386E-05	1.274E-05	6.169E-06	3.807E-06	2.002E-06	1.293E-06	9.289E-07	7.118E-07	5.698E-07	4.706E-07	3.980E-07
SE	3.064E-05	8.845E-06	4.271E-06	2.633E-06	1.382E-06	8.910E-07	6.389E-07	4.889E-07	3.908E-07	3.225E-07	2.725E-07
SSE	1.520E-05	4.380E-06	2.131E-06	1.309E-06	6.779E-07	4.312E-07	3.055E-07	2.313E-07	1.833E-07	1.500E-07	1.258E-07

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	9.173E-08	4.938E-08	3.188E-08	1.722E-08	1.112E-08	7.895E-09	5.954E-09	4.679E-09	3.790E-09	3.140E-09	2.649E-09
SSW	7.355E-08	3.964E-08	2.561E-08	1.383E-08	8.917E-09	6.323E-09	4.761E-09	3.736E-09	3.020E-09	2.499E-09	2.105E-09
SW	6.657E-08	3.596E-08	2.327E-08	1.259E-08	8.130E-09	5.770E-09	4.346E-09	3.411E-09	2.758E-09	2.281E-09	1.921E-09
WSW	6.254E-08	3.385E-08	2.194E-08	1.190E-08	7.690E-09	5.463E-09	4.117E-09	3.232E-09	2.614E-09	2.162E-09	1.820E-09
W	7.927E-08	4.324E-08	2.818E-08	1.542E-08	1.003E-08	7.162E-09	5.420E-09	4.270E-09	3.463E-09	2.871E-09	2.423E-09
WNW	6.813E-08	3.722E-08	2.429E-08	1.334E-08	8.713E-09	6.243E-09	4.739E-09	3.744E-09	3.044E-09	2.531E-09	2.141E-09
NW	7.197E-08	3.946E-08	2.583E-08	1.421E-08	9.290E-09	6.658E-09	5.055E-09	3.994E-09	3.248E-09	2.700E-09	2.284E-09
NNW	6.227E-08	3.420E-08	2.239E-08	1.232E-08	8.038E-09	5.749E-09	4.356E-09	3.434E-09	2.786E-09	2.311E-09	1.950E-09
N	1.579E-07	8.654E-08	5.658E-08	3.106E-08	2.024E-08	1.446E-08	1.095E-08	8.628E-09	6.998E-09	5.803E-09	4.896E-09
NNE	2.003E-07	1.099E-07	7.195E-08	3.958E-08	2.584E-08	1.849E-08	1.402E-08	1.107E-08	8.989E-09	7.464E-09	6.306E-09
NE	1.655E-07	9.096E-08	5.959E-08	3.283E-08	2.146E-08	1.537E-08	1.167E-08	9.215E-09	7.491E-09	6.225E-09	5.263E-09
ENE	1.069E-07	5.919E-08	3.900E-08	2.164E-08	1.420E-08	1.020E-08	7.760E-09	6.135E-09	4.990E-09	4.148E-09	3.507E-09
E	2.185E-07	1.223E-07	8.122E-08	4.555E-08	3.011E-08	2.175E-08	1.660E-08	1.317E-08	1.074E-08	8.946E-09	7.577E-09
ESE	3.428E-07	1.940E-07	1.299E-07	7.367E-08	4.910E-08	3.568E-08	2.738E-08	2.181E-08	1.785E-08	1.491E-08	1.266E-08
SE	2.345E-07	1.324E-07	8.849E-08	5.012E-08	3.338E-08	2.425E-08	1.860E-08	1.481E-08	1.212E-08	1.012E-08	8.597E-09
SSE	1.076E-07	5.919E-08	3.885E-08	2.148E-08	1.410E-08	1.013E-08	7.711E-09	6.103E-09	4.970E-09	4.136E-09	3.501E-09

0VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT (METERS) 0.00 REP. WIND HEIGHT (METERS) 10.0
DIAMETER (METERS) 0.00 BUILDING HEIGHT (METERS) 0.0
EXIT VELOCITY (METERS) 0.00 BLDG.MIN.CRS.SEC.AREA (SQ.METERS) 0.0
HEAT EMISSION RATE (CAL/SEC) 0.0

Note: Directions are True North.

Table 2.7-8 Long-Term χ/Q (sec/m^3) for Routine Releases Along Various Distance Segments, 2.260 Day Decay, Undepleted (Sheet 1 of 2)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 8/28/2014
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT RB - MIXED MODE RELEASE - NO PURGE RELEASES
2.260 DAY DECAY, UNDEPLETED
0CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	7.017E-08	8.088E-08	7.277E-08	5.882E-08	4.758E-08	2.778E-08	1.195E-08	5.928E-09	3.640E-09	2.496E-09
SSW	3.618E-08	5.164E-08	5.100E-08	4.298E-08	3.561E-08	2.141E-08	9.457E-09	4.733E-09	2.909E-09	1.993E-09
SW	2.751E-08	4.189E-08	4.270E-08	3.657E-08	3.060E-08	1.867E-08	8.374E-09	4.229E-09	2.610E-09	1.791E-09
WSW	2.585E-08	3.598E-08	3.619E-08	3.130E-08	2.646E-08	1.645E-08	7.534E-09	3.850E-09	2.388E-09	1.643E-09
W	3.133E-08	4.164E-08	4.151E-08	3.585E-08	3.035E-08	1.902E-08	8.861E-09	4.609E-09	2.895E-09	2.010E-09
WNW	3.747E-08	4.329E-08	4.105E-08	3.463E-08	2.888E-08	1.776E-08	8.173E-09	4.258E-09	2.685E-09	1.873E-09
NW	2.236E-08	3.730E-08	4.054E-08	3.566E-08	3.026E-08	1.889E-08	8.789E-09	4.591E-09	2.898E-09	2.021E-09
NNW	1.654E-08	2.629E-08	3.077E-08	2.836E-08	2.476E-08	1.606E-08	7.728E-09	4.085E-09	2.581E-09	1.797E-09
N	4.342E-08	7.044E-08	8.183E-08	7.515E-08	6.549E-08	4.237E-08	2.034E-08	1.073E-08	6.772E-09	4.709E-09
NNE	7.784E-08	1.015E-07	1.081E-07	9.636E-08	8.284E-08	5.298E-08	2.530E-08	1.339E-08	8.484E-09	5.923E-09
NE	5.515E-08	8.002E-08	8.665E-08	7.744E-08	6.662E-08	4.257E-08	2.032E-08	1.076E-08	6.822E-09	4.770E-09
ENE	3.133E-08	4.132E-08	4.518E-08	4.116E-08	3.598E-08	2.370E-08	1.176E-08	6.390E-09	4.109E-09	2.897E-09
E	3.013E-08	4.869E-08	6.018E-08	5.855E-08	5.335E-08	3.748E-08	2.000E-08	1.139E-08	7.511E-09	5.381E-09
ESE	4.534E-08	5.969E-08	6.796E-08	6.429E-08	5.793E-08	4.068E-08	2.220E-08	1.306E-08	8.835E-09	6.458E-09
SE	6.237E-08	5.830E-08	5.637E-08	4.975E-08	4.312E-08	2.871E-08	1.487E-08	8.527E-09	5.716E-09	4.161E-09
SSE	6.756E-08	6.563E-08	5.814E-08	4.775E-08	3.928E-08	2.381E-08	1.086E-08	5.662E-09	3.588E-09	2.515E-09

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 8/28/2014
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT TB - MIXED MODE RELEASE - NO PURGE RELEASES
2.260 DAY DECAY, UNDEPLETED
0CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	5.236E-08	6.140E-08	6.046E-08	5.155E-08	4.292E-08	2.585E-08	1.139E-08	5.699E-09	3.509E-09	2.410E-09
SSW	2.615E-08	3.818E-08	4.164E-08	3.720E-08	3.180E-08	1.977E-08	8.964E-09	4.532E-09	2.796E-09	1.919E-09
SW	1.998E-08	3.072E-08	3.450E-08	3.135E-08	2.708E-08	1.711E-08	7.888E-09	4.028E-09	2.497E-09	1.718E-09
WSW	1.937E-08	2.672E-08	2.932E-08	2.685E-08	2.342E-08	1.505E-08	7.069E-09	3.650E-09	2.273E-09	1.568E-09
W	2.426E-08	3.116E-08	3.351E-08	3.049E-08	2.656E-08	1.716E-08	8.185E-09	4.298E-09	2.710E-09	1.886E-09
WNW	3.049E-08	3.262E-08	3.229E-08	2.857E-08	2.456E-08	1.570E-08	7.482E-09	3.964E-09	2.518E-09	1.764E-09
NW	1.659E-08	2.517E-08	2.981E-08	2.810E-08	2.485E-08	1.634E-08	7.960E-09	4.251E-09	2.708E-09	1.900E-09
NNW	1.289E-08	1.662E-08	2.141E-08	2.148E-08	1.972E-08	1.362E-08	6.932E-09	3.767E-09	2.409E-09	1.690E-09
N	3.317E-08	4.418E-08	5.661E-08	5.666E-08	5.197E-08	3.588E-08	1.825E-08	9.919E-09	6.344E-09	4.448E-09
NNE	6.023E-08	6.752E-08	7.724E-08	7.386E-08	6.630E-08	4.488E-08	2.261E-08	1.231E-08	7.902E-09	5.562E-09
NE	4.070E-08	5.209E-08	6.160E-08	5.930E-08	5.333E-08	3.608E-08	1.814E-08	9.863E-09	6.333E-09	4.461E-09
ENE	2.386E-08	2.657E-08	3.126E-08	3.056E-08	2.789E-08	1.948E-08	1.022E-08	5.719E-09	3.731E-09	2.653E-09
E	2.250E-08	2.858E-08	3.826E-08	4.020E-08	3.843E-08	2.895E-08	1.651E-08	9.756E-09	6.551E-09	4.746E-09
ESE	3.516E-08	3.774E-08	4.512E-08	4.532E-08	4.242E-08	3.134E-08	1.785E-08	1.071E-08	7.318E-09	5.385E-09
SE	5.160E-08	4.257E-08	4.234E-08	3.907E-08	3.480E-08	2.383E-08	1.251E-08	7.170E-09	4.800E-09	3.494E-09
SSE	5.406E-08	5.056E-08	4.739E-08	4.073E-08	3.440E-08	2.146E-08	9.981E-09	5.228E-09	3.313E-09	2.322E-09

Note: Directions are True North.

Table 2.7-8 Long-Term χ/Q (sec/m^3) for Routine Releases Along Various Distance Segments, 2.260 Day Decay, Undepleted (Sheet 2 of 2)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 7/ 8/2013
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT ONE - GROUND LEVEL RELEASE - NO PURGE RELEASES
2.260 DAY DECAY, UNDEPLETED
0CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	1.669E-06	5.713E-07	2.557E-07	1.523E-07	1.038E-07	4.936E-08	1.735E-08	7.832E-09	4.629E-09	3.104E-09
SSW	1.318E-06	4.547E-07	2.043E-07	1.220E-07	8.326E-08	3.965E-08	1.395E-08	6.279E-09	3.699E-09	2.473E-09
SW	1.177E-06	4.072E-07	1.836E-07	1.099E-07	7.512E-08	3.588E-08	1.268E-08	5.723E-09	3.375E-09	2.256E-09
WSW	1.093E-06	3.785E-07	1.712E-07	1.026E-07	7.026E-08	3.365E-08	1.194E-08	5.406E-09	3.191E-09	2.134E-09
W	1.326E-06	4.616E-07	2.110E-07	1.275E-07	8.776E-08	4.246E-08	1.532E-08	7.035E-09	4.189E-09	2.818E-09
WNW	1.151E-06	4.000E-07	1.824E-07	1.100E-07	7.576E-08	3.670E-08	1.330E-08	6.152E-09	3.686E-09	2.492E-09
NW	1.174E-06	4.143E-07	1.907E-07	1.157E-07	7.992E-08	3.890E-08	1.418E-08	6.567E-09	3.935E-09	2.661E-09
NNW	1.002E-06	3.574E-07	1.652E-07	1.004E-07	6.947E-08	3.387E-08	1.234E-08	5.696E-09	3.397E-09	2.286E-09
N	2.573E-06	9.189E-07	4.231E-07	2.567E-07	1.773E-07	8.619E-08	3.127E-08	1.439E-08	8.570E-09	5.762E-09
NNE	3.243E-06	1.158E-06	5.339E-07	3.242E-07	2.241E-07	1.091E-07	3.974E-08	1.836E-08	1.097E-08	7.399E-09
NE	2.648E-06	9.457E-07	4.375E-07	2.661E-07	1.842E-07	8.988E-08	3.283E-08	1.521E-08	9.106E-09	6.152E-09
ENE	1.608E-06	5.811E-07	2.731E-07	1.678E-07	1.169E-07	5.771E-08	2.142E-08	1.002E-08	6.025E-09	4.077E-09
E	3.008E-06	1.104E-06	5.315E-07	3.310E-07	2.330E-07	1.169E-07	4.438E-08	2.111E-08	1.281E-08	8.715E-09
ESE	4.355E-06	1.577E-06	7.774E-07	4.915E-07	3.497E-07	1.786E-07	6.969E-08	3.383E-08	2.076E-08	1.424E-08
SE	3.083E-06	1.094E-06	5.344E-07	3.365E-07	2.388E-07	1.215E-07	4.725E-08	2.290E-08	1.405E-08	9.640E-09
SSE	1.724E-06	5.963E-07	2.757E-07	1.679E-07	1.164E-07	5.699E-08	2.100E-08	9.822E-09	5.918E-09	4.016E-09

Note: The results on the top half of this page are applicable to releases from the RW-VS.

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 7/16/2013
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT TWR - GROUND LEVEL RELEASE - NO PURGE RELEASES
2.260 DAY DECAY, UNDEPLETED
0CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	2.037E-06	6.349E-07	2.726E-07	1.601E-07	1.083E-07	5.101E-08	1.776E-08	7.978E-09	4.705E-09	3.151E-09
SSW	1.619E-06	5.061E-07	2.179E-07	1.281E-07	8.675E-08	4.094E-08	1.427E-08	6.390E-09	3.756E-09	2.507E-09
SW	1.457E-06	4.556E-07	1.965E-07	1.157E-07	7.847E-08	3.712E-08	1.298E-08	5.830E-09	3.430E-09	2.289E-09
WSW	1.365E-06	4.265E-07	1.841E-07	1.086E-07	7.369E-08	3.493E-08	1.226E-08	5.519E-09	3.249E-09	2.169E-09
W	1.699E-06	5.317E-07	2.308E-07	1.368E-07	9.322E-08	4.455E-08	1.586E-08	7.230E-09	4.291E-09	2.881E-09
WNW	1.469E-06	4.580E-07	1.984E-07	1.175E-07	8.010E-08	3.834E-08	1.372E-08	6.300E-09	3.762E-09	2.538E-09
NW	1.518E-06	4.764E-07	2.077E-07	1.236E-07	8.450E-08	4.063E-08	1.461E-08	6.719E-09	4.013E-09	2.708E-09
NNW	1.303E-06	4.096E-07	1.791E-07	1.067E-07	7.308E-08	3.519E-08	1.266E-08	5.802E-09	3.450E-09	2.318E-09
N	3.321E-06	1.044E-06	4.555E-07	2.711E-07	1.854E-07	8.907E-08	3.192E-08	1.460E-08	8.671E-09	5.821E-09
NNE	4.211E-06	1.323E-06	5.773E-07	3.437E-07	2.351E-07	1.131E-07	4.066E-08	1.866E-08	1.112E-08	7.487E-09
NE	3.460E-06	1.088E-06	4.759E-07	2.837E-07	1.943E-07	9.359E-08	3.372E-08	1.551E-08	9.259E-09	6.243E-09
ENE	2.182E-06	6.882E-07	3.032E-07	1.819E-07	1.251E-07	6.081E-08	2.219E-08	1.029E-08	6.163E-09	4.160E-09
E	4.319E-06	1.368E-06	6.091E-07	3.684E-07	2.551E-07	1.254E-07	4.661E-08	2.192E-08	1.323E-08	8.971E-09
ESE	6.580E-06	2.088E-06	9.392E-07	5.726E-07	3.991E-07	1.986E-07	7.524E-08	3.594E-08	2.189E-08	1.495E-08
SE	4.560E-06	1.442E-06	6.461E-07	3.928E-07	2.732E-07	1.356E-07	5.120E-08	2.442E-08	1.487E-08	1.015E-08
SSE	2.265E-06	7.085E-07	3.094E-07	1.843E-07	1.262E-07	6.090E-08	2.206E-08	1.022E-08	6.131E-09	4.148E-09

Note: Directions are True North.

Table 2.7-9 Long-Term χ/Q (sec/m^3) for Routine Releases at Distances Between 0.25 to 50 Miles, 8.000 Day Decay, Depleted (Sheet 1 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 8/28/2014
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT RB - MIXED MODE RELEASE - NO PURGE RELEASES
8.000 DAY DECAY, DEPLETED

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	1.169E-07	6.545E-08	6.291E-08	7.283E-08	8.268E-08	7.920E-08	7.173E-08	6.394E-08	5.687E-08	5.072E-08	4.545E-08
SSW	5.238E-08	2.982E-08	3.120E-08	4.080E-08	5.294E-08	5.395E-08	5.066E-08	4.627E-08	4.190E-08	3.788E-08	3.432E-08
SW	3.959E-08	2.234E-08	2.331E-08	3.159E-08	4.291E-08	4.468E-08	4.253E-08	3.922E-08	3.578E-08	3.254E-08	2.962E-08
WSW	3.339E-08	2.178E-08	2.287E-08	2.867E-08	3.659E-08	3.771E-08	3.598E-08	3.337E-08	3.064E-08	2.804E-08	2.566E-08
W	4.527E-08	2.876E-08	2.756E-08	3.364E-08	4.231E-08	4.331E-08	4.121E-08	3.820E-08	3.507E-08	3.212E-08	2.944E-08
WNW	4.579E-08	3.709E-08	3.445E-08	3.789E-08	4.373E-08	4.352E-08	4.076E-08	3.734E-08	3.397E-08	3.089E-08	2.815E-08
NW	2.863E-08	1.976E-08	1.866E-08	2.553E-08	3.800E-08	4.165E-08	4.081E-08	3.833E-08	3.542E-08	3.255E-08	2.988E-08
NNW	3.052E-08	1.970E-08	1.349E-08	1.662E-08	2.634E-08	3.058E-08	3.118E-08	3.014E-08	2.846E-08	2.660E-08	2.476E-08
N	8.413E-08	4.846E-08	3.569E-08	4.497E-08	7.066E-08	8.158E-08	8.291E-08	7.999E-08	7.544E-08	7.044E-08	6.552E-08
NNE	1.470E-07	8.704E-08	6.779E-08	7.656E-08	1.019E-07	1.103E-07	1.087E-07	1.030E-07	9.602E-08	8.894E-08	8.225E-08
NE	1.043E-07	5.532E-08	4.706E-08	5.765E-08	8.057E-08	8.823E-08	8.722E-08	8.275E-08	7.718E-08	7.150E-08	6.613E-08
ENE	7.254E-08	3.586E-08	2.692E-08	3.048E-08	4.127E-08	4.549E-08	4.551E-08	4.368E-08	4.116E-08	3.849E-08	3.589E-08
E	8.066E-08	3.577E-08	2.455E-08	2.993E-08	4.796E-08	5.771E-08	6.099E-08	6.087E-08	5.910E-08	5.659E-08	5.382E-08
ESE	1.108E-07	5.409E-08	3.891E-08	4.291E-08	5.893E-08	6.672E-08	6.843E-08	6.712E-08	6.449E-08	6.134E-08	5.808E-08
SE	1.496E-07	8.197E-08	5.625E-08	5.319E-08	5.771E-08	5.823E-08	5.599E-08	5.268E-08	4.912E-08	4.566E-08	4.245E-08
SSE	1.164E-07	7.604E-08	6.198E-08	6.287E-08	6.605E-08	6.277E-08	5.726E-08	5.159E-08	4.639E-08	4.183E-08	3.786E-08

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	4.095E-08	2.620E-08	1.841E-08	1.081E-08	7.278E-09	5.311E-09	4.087E-09	3.265E-09	2.682E-09	2.259E-09	1.926E-09
SSW	3.119E-08	2.052E-08	1.463E-08	8.732E-09	5.932E-09	4.354E-09	3.365E-09	2.698E-09	2.223E-09	1.877E-09	1.603E-09
SW	2.704E-08	1.805E-08	1.299E-08	7.841E-09	5.368E-09	3.963E-09	3.077E-09	2.477E-09	2.047E-09	1.733E-09	1.484E-09
WSW	2.354E-08	1.599E-08	1.163E-08	7.113E-09	4.910E-09	3.646E-09	2.843E-09	2.296E-09	1.904E-09	1.615E-09	1.387E-09
W	2.705E-08	1.853E-08	1.359E-08	8.425E-09	5.883E-09	4.411E-09	3.469E-09	2.822E-09	2.355E-09	2.008E-09	1.733E-09
WNW	2.575E-08	1.744E-08	1.274E-08	7.897E-09	5.533E-09	4.162E-09	3.281E-09	2.676E-09	2.237E-09	1.909E-09	1.650E-09
NW	2.748E-08	1.888E-08	1.390E-08	8.694E-09	6.119E-09	4.619E-09	3.654E-09	2.987E-09	2.503E-09	2.141E-09	1.855E-09
NNW	2.303E-08	1.640E-08	1.232E-08	7.868E-09	5.597E-09	4.253E-09	3.379E-09	2.772E-09	2.328E-09	1.994E-09	1.731E-09
N	6.091E-08	4.330E-08	3.248E-08	2.073E-08	1.473E-08	1.118E-08	8.879E-09	7.278E-09	6.109E-09	5.228E-09	4.535E-09
NNE	7.613E-08	5.356E-08	4.003E-08	2.549E-08	1.812E-08	1.377E-08	1.094E-08	8.976E-09	7.541E-09	6.459E-09	5.607E-09
NE	6.120E-08	4.301E-08	3.212E-08	2.044E-08	1.453E-08	1.104E-08	8.777E-09	7.205E-09	6.055E-09	5.190E-09	4.507E-09
ENE	3.347E-08	2.420E-08	1.843E-08	1.205E-08	8.718E-09	6.715E-09	5.394E-09	4.466E-09	3.781E-09	3.260E-09	2.847E-09
E	5.102E-08	3.905E-08	3.082E-08	2.107E-08	1.570E-08	1.234E-08	1.008E-08	8.455E-09	7.237E-09	6.296E-09	5.546E-09
ESE	5.492E-08	4.201E-08	3.340E-08	2.326E-08	1.764E-08	1.410E-08	1.167E-08	9.917E-09	8.583E-09	7.543E-09	6.705E-09
SE	3.955E-08	2.881E-08	2.225E-08	1.500E-08	1.118E-08	8.833E-09	7.260E-09	6.133E-09	5.288E-09	4.635E-09	4.109E-09
SSE	3.445E-08	2.295E-08	1.663E-08	1.024E-08	7.161E-09	5.388E-09	4.254E-09	3.476E-09	2.912E-09	2.492E-09	2.160E-09

0VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS) 52.77		REP. WIND HEIGHT	(METERS)	10.0
DIAMETER	(METERS) 2.40		BUILDING HEIGHT	(METERS)	46.1
EXIT VELOCITY	(METERS) 17.78		BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	3098.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0

0AT THE RELEASE HEIGHT: / AT THE MEASURED WIND HEIGHT (10.0 METERS):

VENT RELEASE MODE	WIND SPEED (METERS/SEC)	/	VENT RELEASE MODE	WIND SPEED (METERS/SEC) STABLE CONDITIONS	WIND SPEED (METERS/SEC) UNSTABLE/NEUTRAL CONDITIONS
ELEVATED	LESS THAN 3.556	/	ELEVATED	LESS THAN 3.556	LESS THAN 3.556
MIXED	BETWEEN 3.556 AND 17.780	/	MIXED	BETWEEN 3.556 AND 17.780	BETWEEN 3.556 AND 17.780
GROUND LEVEL	ABOVE 17.780	/	GROUND LEVEL	ABOVE 17.780	ABOVE 17.780

Note: Directions are True North.

Table 2.7-9 Long-Term χ/Q (sec/m^3) for Routine Releases at Distances Between 0.25 to 50 Miles, 8.000 Day Decay, Depleted (Sheet 2 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 8/28/2014
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT TB - MIXED MODE RELEASE - NO PURGE RELEASES
8.000 DAY DECAY, DEPLETED

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	1.101E-07	5.617E-08	4.555E-08	5.062E-08	6.141E-08	6.281E-08	5.953E-08	5.475E-08	4.978E-08	4.512E-08	4.092E-08
SSW	4.985E-08	2.592E-08	2.194E-08	2.715E-08	3.807E-08	4.179E-08	4.128E-08	3.902E-08	3.619E-08	3.329E-08	3.055E-08
SW	3.718E-08	1.972E-08	1.661E-08	2.101E-08	3.053E-08	3.420E-08	3.426E-08	3.272E-08	3.059E-08	2.832E-08	2.612E-08
WSW	3.114E-08	1.900E-08	1.703E-08	1.990E-08	2.638E-08	2.900E-08	2.905E-08	2.788E-08	2.621E-08	2.440E-08	2.262E-08
W	4.234E-08	2.592E-08	2.124E-08	2.392E-08	3.078E-08	3.333E-08	3.313E-08	3.167E-08	2.972E-08	2.765E-08	2.564E-08
WNW	4.190E-08	3.296E-08	2.843E-08	2.882E-08	3.204E-08	3.284E-08	3.183E-08	2.999E-08	2.788E-08	2.579E-08	2.381E-08
NW	2.576E-08	1.773E-08	1.442E-08	1.677E-08	2.457E-08	2.877E-08	2.981E-08	2.918E-08	2.779E-08	2.614E-08	2.443E-08
NNW	2.752E-08	1.857E-08	1.118E-08	1.072E-08	1.568E-08	1.968E-08	2.151E-08	2.189E-08	2.146E-08	2.063E-08	1.963E-08
N	7.467E-08	4.492E-08	2.905E-08	2.866E-08	4.172E-08	5.214E-08	5.688E-08	5.781E-08	5.665E-08	5.444E-08	5.177E-08
NNE	1.305E-07	7.802E-08	5.413E-08	5.183E-08	6.470E-08	7.406E-08	7.707E-08	7.614E-08	7.325E-08	6.950E-08	6.549E-08
NE	9.437E-08	4.883E-08	3.575E-08	3.698E-08	5.000E-08	5.864E-08	6.155E-08	6.105E-08	5.883E-08	5.588E-08	5.268E-08
ENE	6.483E-08	3.235E-08	2.101E-08	1.989E-08	2.530E-08	2.953E-08	3.122E-08	3.125E-08	3.039E-08	2.912E-08	2.767E-08
E	7.116E-08	3.261E-08	1.936E-08	1.828E-08	2.654E-08	3.415E-08	3.840E-08	4.015E-08	4.037E-08	3.972E-08	3.859E-08
ESE	9.879E-08	4.878E-08	3.109E-08	2.861E-08	3.559E-08	4.190E-08	4.498E-08	4.575E-08	4.519E-08	4.391E-08	4.229E-08
SE	1.322E-07	7.376E-08	4.693E-08	4.029E-08	4.085E-08	4.203E-08	4.170E-08	4.029E-08	3.833E-08	3.618E-08	3.402E-08
SSE	1.058E-07	6.637E-08	4.921E-08	4.719E-08	4.978E-08	4.920E-08	4.648E-08	4.300E-08	3.944E-08	3.608E-08	3.302E-08

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	3.721E-08	2.442E-08	1.734E-08	1.027E-08	6.938E-09	5.070E-09	3.903E-09	3.119E-09	2.563E-09	2.159E-09	1.840E-09
SSW	2.805E-08	1.895E-08	1.368E-08	8.246E-09	5.626E-09	4.139E-09	3.203E-09	2.571E-09	2.119E-09	1.790E-09	1.530E-09
SW	2.409E-08	1.653E-08	1.205E-08	7.354E-09	5.059E-09	3.746E-09	2.913E-09	2.348E-09	1.942E-09	1.645E-09	1.410E-09
WSW	2.095E-08	1.461E-08	1.075E-08	6.638E-09	4.602E-09	3.426E-09	2.675E-09	2.163E-09	1.795E-09	1.524E-09	1.308E-09
W	2.377E-08	1.668E-08	1.235E-08	7.727E-09	5.415E-09	4.068E-09	3.203E-09	2.608E-09	2.177E-09	1.858E-09	1.604E-09
WNW	2.202E-08	1.539E-08	1.142E-08	7.193E-09	5.082E-09	3.841E-09	3.039E-09	2.484E-09	2.081E-09	1.779E-09	1.540E-09
NW	2.279E-08	1.634E-08	1.229E-08	7.856E-09	5.592E-09	4.251E-09	3.378E-09	2.772E-09	2.329E-09	1.997E-09	1.734E-09
NNW	1.858E-08	1.394E-08	1.074E-08	7.053E-09	5.091E-09	3.905E-09	3.123E-09	2.574E-09	2.171E-09	1.865E-09	1.623E-09
N	4.900E-08	3.675E-08	2.833E-08	1.860E-08	1.343E-08	1.030E-08	8.235E-09	6.786E-09	5.721E-09	4.914E-09	4.276E-09
NNE	6.156E-08	4.540E-08	3.477E-08	2.274E-08	1.641E-08	1.259E-08	1.007E-08	8.310E-09	7.013E-09	6.030E-09	5.251E-09
NE	4.952E-08	3.648E-08	2.791E-08	1.822E-08	1.313E-08	1.007E-08	8.059E-09	6.647E-09	5.611E-09	4.826E-09	4.204E-09
ENE	2.621E-08	1.989E-08	1.554E-08	1.045E-08	7.679E-09	5.976E-09	4.837E-09	4.028E-09	3.426E-09	2.966E-09	2.599E-09
E	3.724E-08	3.017E-08	2.457E-08	1.740E-08	1.322E-08	1.054E-08	8.686E-09	7.341E-09	6.323E-09	5.529E-09	4.892E-09
ESE	4.054E-08	3.231E-08	2.621E-08	1.862E-08	1.427E-08	1.148E-08	9.552E-09	8.144E-09	7.072E-09	6.234E-09	5.555E-09
SE	3.198E-08	2.381E-08	1.850E-08	1.248E-08	9.274E-09	7.312E-09	5.997E-09	5.058E-09	4.357E-09	3.817E-09	3.382E-09
SSE	3.030E-08	2.066E-08	1.510E-08	9.344E-09	6.535E-09	4.910E-09	3.871E-09	3.158E-09	2.642E-09	2.259E-09	1.955E-09

0VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS) 71.30	REP. WIND HEIGHT	(METERS)	10.0
DIAMETER	(METERS) 1.95	BUILDING HEIGHT	(METERS)	46.1
EXIT VELOCITY	(METERS) 17.78	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	3098.0
		HEAT EMISSION RATE	(CAL/SEC)	0.0

0AT THE RELEASE HEIGHT: / AT THE MEASURED WIND HEIGHT (10.0 METERS):

VENT RELEASE MODE	WIND SPEED (METERS/SEC)	/	VENT RELEASE MODE	WIND SPEED (METERS/SEC) STABLE CONDITIONS	WIND SPEED (METERS/SEC) UNSTABLE/NEUTRAL CONDITIONS
ELEVATED	LESS THAN 3.556	/	ELEVATED	LESS THAN 3.556	LESS THAN 3.556
MIXED	BETWEEN 3.556 AND 17.780	/	MIXED	BETWEEN 3.556 AND 17.780	BETWEEN 3.556 AND 17.780
GROUND LEVEL	ABOVE 17.780	/	GROUND LEVEL	ABOVE 17.780	ABOVE 17.780

Note: Directions are True North.

Table 2.7-9 Long-Term χ/Q (sec/m^3) for Routine Releases at Distances Between 0.25 to 50 Miles, 8.000 Day Decay, Depleted (Sheet 3 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 7/ 8/2013
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT ONE - GROUND LEVEL RELEASE - NO PURGE RELEASES
8.000 DAY DECAY, DEPLETED

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	8.096E-06	2.770E-06	1.441E-06	9.047E-07	4.714E-07	2.962E-07	2.064E-07	1.535E-07	1.195E-07	9.613E-08	7.933E-08
SSW	6.331E-06	2.178E-06	1.140E-06	7.185E-07	3.756E-07	2.365E-07	1.650E-07	1.229E-07	9.576E-08	7.711E-08	6.368E-08
SW	5.670E-06	1.942E-06	1.018E-06	6.424E-07	3.366E-07	2.124E-07	1.484E-07	1.107E-07	8.631E-08	6.958E-08	5.751E-08
WSW	5.324E-06	1.806E-06	9.450E-07	5.965E-07	3.132E-07	1.979E-07	1.384E-07	1.033E-07	8.069E-08	6.509E-08	5.385E-08
W	6.627E-06	2.197E-06	1.145E-06	7.231E-07	3.824E-07	2.430E-07	1.708E-07	1.280E-07	1.003E-07	8.114E-08	6.730E-08
WNW	5.769E-06	1.903E-06	9.940E-07	6.277E-07	3.311E-07	2.101E-07	1.475E-07	1.105E-07	8.654E-08	7.001E-08	5.806E-08
NW	5.755E-06	1.924E-06	1.017E-06	6.464E-07	3.434E-07	2.189E-07	1.543E-07	1.159E-07	9.097E-08	7.373E-08	6.125E-08
NNW	4.880E-06	1.630E-06	8.708E-07	5.566E-07	2.968E-07	1.896E-07	1.339E-07	1.007E-07	7.910E-08	6.417E-08	5.335E-08
N	1.240E-05	4.172E-06	2.239E-06	1.433E-06	7.625E-07	4.863E-07	3.428E-07	2.575E-07	2.021E-07	1.638E-07	1.361E-07
NNE	1.584E-05	5.270E-06	2.817E-06	1.804E-06	9.605E-07	6.130E-07	4.324E-07	3.249E-07	2.551E-07	2.069E-07	1.719E-07
NE	1.292E-05	4.307E-06	2.299E-06	1.471E-06	7.849E-07	5.017E-07	3.543E-07	2.665E-07	2.094E-07	1.699E-07	1.413E-07
ENE	8.102E-06	2.617E-06	1.394E-06	8.958E-07	4.837E-07	3.118E-07	2.216E-07	1.676E-07	1.323E-07	1.077E-07	8.985E-08
E	1.583E-05	4.905E-06	2.598E-06	1.679E-06	9.225E-07	6.021E-07	4.320E-07	3.291E-07	2.614E-07	2.140E-07	1.794E-07
ESE	2.435E-05	7.301E-06	3.722E-06	2.365E-06	1.321E-06	8.734E-07	6.328E-07	4.860E-07	3.886E-07	3.200E-07	2.695E-07
SE	1.730E-05	5.229E-06	2.627E-06	1.650E-06	9.144E-07	6.019E-07	4.348E-07	3.332E-07	2.659E-07	2.187E-07	1.840E-07
SSE	8.926E-06	2.888E-06	1.481E-06	9.287E-07	4.945E-07	3.161E-07	2.233E-07	1.681E-07	1.322E-07	1.073E-07	8.926E-08

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	6.679E-08	3.455E-08	2.151E-08	1.098E-08	6.780E-09	4.644E-09	3.396E-09	2.598E-09	2.054E-09	1.666E-09	1.378E-09
SSW	5.366E-08	2.781E-08	1.734E-08	8.857E-09	5.468E-09	3.743E-09	2.735E-09	2.091E-09	1.653E-09	1.340E-09	1.108E-09
SW	4.849E-08	2.521E-08	1.576E-08	8.078E-09	4.999E-09	3.429E-09	2.509E-09	1.921E-09	1.520E-09	1.233E-09	1.020E-09
WSW	4.544E-08	2.370E-08	1.485E-08	7.637E-09	4.739E-09	3.257E-09	2.388E-09	1.831E-09	1.450E-09	1.177E-09	9.751E-10
W	5.693E-08	2.998E-08	1.892E-08	9.834E-09	6.151E-09	4.254E-09	3.135E-09	2.413E-09	1.919E-09	1.563E-09	1.298E-09
WNW	4.911E-08	2.589E-08	1.635E-08	8.520E-09	5.346E-09	3.707E-09	2.737E-09	2.111E-09	1.681E-09	1.372E-09	1.141E-09
NW	5.188E-08	2.746E-08	1.739E-08	9.081E-09	5.699E-09	3.951E-09	2.917E-09	2.250E-09	1.791E-09	1.461E-09	1.215E-09
NNW	4.522E-08	2.399E-08	1.521E-08	7.956E-09	4.992E-09	3.459E-09	2.552E-09	1.967E-09	1.565E-09	1.276E-09	1.060E-09
N	1.153E-07	6.099E-08	3.860E-08	2.012E-08	1.260E-08	8.718E-09	6.425E-09	4.946E-09	3.931E-09	3.202E-09	2.659E-09
NNE	1.456E-07	7.716E-08	4.888E-08	2.553E-08	1.601E-08	1.109E-08	8.181E-09	6.305E-09	5.015E-09	4.088E-09	3.397E-09
NE	1.197E-07	6.354E-08	4.029E-08	2.108E-08	1.323E-08	9.173E-09	6.772E-09	5.222E-09	4.157E-09	3.390E-09	2.818E-09
ENE	7.639E-08	4.100E-08	2.621E-08	1.386E-08	8.764E-09	6.109E-09	4.530E-09	3.505E-09	2.798E-09	2.288E-09	1.906E-09
E	1.531E-07	8.343E-08	5.390E-08	2.891E-08	1.846E-08	1.296E-08	9.668E-09	7.517E-09	6.026E-09	4.944E-09	4.132E-09
ESE	2.311E-07	1.281E-07	8.375E-08	4.568E-08	2.950E-08	2.090E-08	1.570E-08	1.228E-08	9.898E-09	8.158E-09	6.845E-09
SE	1.576E-07	8.710E-08	5.684E-08	3.095E-08	1.998E-08	1.415E-08	1.063E-08	8.316E-09	6.701E-09	5.524E-09	4.636E-09
SSE	7.572E-08	4.035E-08	2.568E-08	1.353E-08	8.548E-09	5.960E-09	4.421E-09	3.423E-09	2.735E-09	2.238E-09	1.867E-09

0VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	0.00	REP. WIND HEIGHT	(METERS)	10.0
DIAMETER	(METERS)	0.00	BUILDING HEIGHT	(METERS)	46.1
EXIT VELOCITY	(METERS)	0.00	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	3098.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0

0ALL GROUND LEVEL RELEASES.

Note: Directions are True North. The results on this page are applicable to releases from the RW-VS.

Table 2.7-9 Long-Term χ/Q (sec/m³) for Routine Releases at Distances Between 0.25 to 50 Miles, 8.000 Day Decay, Depleted (Sheet 4 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 7/16/2013
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT TWR - GROUND LEVEL RELEASE - NO PURGE RELEASES
8.000 DAY DECAY, DEPLETED
0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	1.283E-05	3.585E-06	1.717E-06	1.037E-06	5.179E-07	3.189E-07	2.196E-07	1.621E-07	1.255E-07	1.005E-07	8.270E-08
SSW	1.014E-05	2.846E-06	1.366E-06	8.256E-07	4.131E-07	2.547E-07	1.756E-07	1.297E-07	1.005E-07	8.060E-08	6.635E-08
SW	9.119E-06	2.562E-06	1.229E-06	7.430E-07	3.720E-07	2.296E-07	1.585E-07	1.172E-07	9.086E-08	7.292E-08	6.006E-08
WSW	8.561E-06	2.402E-06	1.151E-06	6.955E-07	3.484E-07	2.152E-07	1.486E-07	1.100E-07	8.532E-08	6.851E-08	5.647E-08
W	1.070E-05	2.996E-06	1.432E-06	8.651E-07	4.345E-07	2.692E-07	1.864E-07	1.383E-07	1.075E-07	8.654E-08	7.147E-08
WNW	9.272E-06	2.593E-06	1.238E-06	7.462E-07	3.739E-07	2.314E-07	1.601E-07	1.188E-07	9.236E-08	7.432E-08	6.137E-08
NW	9.468E-06	2.671E-06	1.281E-06	7.737E-07	3.892E-07	2.417E-07	1.677E-07	1.247E-07	9.713E-08	7.829E-08	6.475E-08
NNW	8.104E-06	2.291E-06	1.100E-06	6.647E-07	3.350E-07	2.083E-07	1.447E-07	1.077E-07	8.402E-08	6.778E-08	5.610E-08
N	2.060E-05	5.834E-06	2.807E-06	1.695E-06	8.533E-07	5.301E-07	3.680E-07	2.737E-07	2.133E-07	1.720E-07	1.422E-07
NNE	2.621E-05	7.404E-06	3.556E-06	2.147E-06	1.081E-06	6.716E-07	4.663E-07	3.468E-07	2.703E-07	2.179E-07	1.803E-07
NE	2.148E-05	6.081E-06	2.921E-06	1.766E-06	8.896E-07	5.532E-07	3.844E-07	2.861E-07	2.231E-07	1.800E-07	1.489E-07
ENE	1.360E-05	3.842E-06	1.840E-06	1.113E-06	5.631E-07	3.516E-07	2.452E-07	1.831E-07	1.432E-07	1.159E-07	9.612E-08
E	2.697E-05	7.622E-06	3.635E-06	2.203E-06	1.121E-06	7.037E-07	4.932E-07	3.700E-07	2.905E-07	2.358E-07	1.963E-07
ESE	4.156E-05	1.166E-05	5.517E-06	3.348E-06	1.713E-06	1.081E-06	7.614E-07	5.735E-07	4.520E-07	3.682E-07	3.074E-07
SE	2.904E-05	8.096E-06	3.820E-06	2.316E-06	1.182E-06	7.447E-07	5.236E-07	3.938E-07	3.100E-07	2.523E-07	2.104E-07
SSE	1.440E-05	4.007E-06	1.904E-06	1.150E-06	5.791E-07	3.598E-07	2.499E-07	1.859E-07	1.450E-07	1.170E-07	9.681E-08

0ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE INMILES FROM THE SITE

SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	6.945E-08	3.564E-08	2.211E-08	1.123E-08	6.921E-09	4.733E-09	3.457E-09	2.643E-09	2.088E-09	1.693E-09	1.400E-09
SSW	5.575E-08	2.866E-08	1.780E-08	9.052E-09	5.575E-09	3.810E-09	2.781E-09	2.125E-09	1.678E-09	1.359E-09	1.123E-09
SW	5.051E-08	2.604E-08	1.620E-08	8.266E-09	5.102E-09	3.494E-09	2.554E-09	1.953E-09	1.544E-09	1.252E-09	1.035E-09
WSW	4.751E-08	2.456E-08	1.531E-08	7.834E-09	4.848E-09	3.326E-09	2.435E-09	1.865E-09	1.476E-09	1.198E-09	9.915E-10
W	6.025E-08	3.139E-08	1.969E-08	1.017E-08	6.339E-09	4.373E-09	3.217E-09	2.474E-09	1.965E-09	1.599E-09	1.327E-09
WNW	5.174E-08	2.699E-08	1.695E-08	8.777E-09	5.488E-09	3.797E-09	2.799E-09	2.156E-09	1.715E-09	1.399E-09	1.162E-09
NW	5.465E-08	2.861E-08	1.801E-08	9.346E-09	5.845E-09	4.043E-09	2.980E-09	2.296E-09	1.826E-09	1.488E-09	1.237E-09
NNW	4.738E-08	2.487E-08	1.568E-08	8.147E-09	5.095E-09	3.523E-09	2.596E-09	1.998E-09	1.588E-09	1.294E-09	1.074E-09
N	1.201E-07	6.288E-08	3.957E-08	2.052E-08	1.281E-08	8.843E-09	6.508E-09	5.005E-09	3.975E-09	3.235E-09	2.685E-09
NNE	1.522E-07	7.978E-08	5.025E-08	2.609E-08	1.630E-08	1.127E-08	8.303E-09	6.391E-09	5.080E-09	4.138E-09	3.436E-09
NE	1.258E-07	6.599E-08	4.160E-08	2.162E-08	1.352E-08	9.356E-09	6.896E-09	5.311E-09	4.223E-09	3.442E-09	2.860E-09
ENE	8.136E-08	4.307E-08	2.733E-08	1.434E-08	9.026E-09	6.274E-09	4.642E-09	3.586E-09	2.860E-09	2.336E-09	1.944E-09
E	1.666E-07	8.921E-08	5.708E-08	3.030E-08	1.923E-08	1.345E-08	1.001E-08	7.764E-09	6.213E-09	5.091E-09	4.250E-09
ESE	2.617E-07	1.417E-07	9.148E-08	4.918E-08	3.150E-08	2.220E-08	1.661E-08	1.295E-08	1.041E-08	8.564E-09	7.173E-09
SE	1.790E-07	9.672E-08	6.233E-08	3.346E-08	2.142E-08	1.509E-08	1.129E-08	8.802E-09	7.075E-09	5.820E-09	4.875E-09
SSE	8.178E-08	4.300E-08	2.717E-08	1.420E-08	8.929E-09	6.206E-09	4.593E-09	3.550E-09	2.832E-09	2.315E-09	1.928E-09

0VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	0.00	REP. WIND HEIGHT	(METERS)	10.0
DIAMETER	(METERS)	0.00	BUILDING HEIGHT	(METERS)	0.0
EXIT VELOCITY	(METERS)	0.00	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	0.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0

Note: Directions are True North.

Table 2.7-10 Long-Term χ/Q (sec/m^3) for Routine Releases Along Various Distance Segments, 8.000 Day Decay, Depleted (Sheet 1 of 2)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 8/28/2014
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT RB - MIXED MODE RELEASE - NO PURGE RELEASES
8.000 DAY DECAY, DEPLETED
0CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	6.788E-08	7.894E-08	7.061E-08	5.655E-08	4.535E-08	2.602E-08	1.093E-08	5.346E-09	3.278E-09	2.261E-09
SSW	3.516E-08	5.069E-08	4.978E-08	4.162E-08	3.421E-08	2.027E-08	8.799E-09	4.379E-09	2.708E-09	1.878E-09
SW	2.678E-08	4.118E-08	4.178E-08	3.553E-08	2.953E-08	1.780E-08	7.886E-09	3.983E-09	2.485E-09	1.734E-09
WSW	2.521E-08	3.533E-08	3.540E-08	3.043E-08	2.558E-08	1.573E-08	7.138E-09	3.662E-09	2.303E-09	1.616E-09
W	3.053E-08	4.083E-08	4.056E-08	3.484E-08	2.935E-08	1.823E-08	8.443E-09	4.427E-09	2.829E-09	2.009E-09
WNW	3.656E-08	4.234E-08	4.013E-08	3.376E-08	2.808E-08	1.720E-08	7.922E-09	4.175E-09	2.681E-09	1.910E-09
NW	2.196E-08	3.685E-08	4.004E-08	3.516E-08	2.979E-08	1.858E-08	8.707E-09	4.633E-09	2.993E-09	2.143E-09
NNW	1.626E-08	2.607E-08	3.060E-08	2.823E-08	2.466E-08	1.606E-08	7.847E-09	4.262E-09	2.776E-09	1.995E-09
N	4.265E-08	6.981E-08	8.139E-08	7.484E-08	6.527E-08	4.241E-08	2.067E-08	1.121E-08	7.290E-09	5.232E-09
NNE	7.597E-08	1.000E-07	1.069E-07	9.532E-08	8.197E-08	5.256E-08	2.544E-08	1.380E-08	8.991E-09	6.464E-09
NE	5.360E-08	7.888E-08	8.570E-08	7.661E-08	6.590E-08	4.221E-08	2.041E-08	1.107E-08	7.216E-09	5.193E-09
ENE	3.049E-08	4.075E-08	4.477E-08	4.086E-08	3.576E-08	2.370E-08	1.199E-08	6.721E-09	4.470E-09	3.262E-09
E	2.944E-08	4.829E-08	6.007E-08	5.865E-08	5.360E-08	3.806E-08	2.085E-08	1.233E-08	8.455E-09	6.297E-09
ESE	4.406E-08	5.883E-08	6.745E-08	6.404E-08	5.787E-08	4.105E-08	2.301E-08	1.407E-08	9.911E-09	7.541E-09
SE	6.060E-08	5.694E-08	5.526E-08	4.882E-08	4.233E-08	2.828E-08	1.491E-08	8.828E-09	6.133E-09	4.633E-09
SSE	6.550E-08	6.388E-08	5.646E-08	4.614E-08	3.777E-08	2.270E-08	1.029E-08	5.407E-09	3.483E-09	2.493E-09

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 8/28/2014
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT TB - MIXED MODE RELEASE - NO PURGE RELEASES
8.000 DAY DECAY, DEPLETED
0CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	5.017E-08	5.964E-08	5.849E-08	4.942E-08	4.079E-08	2.412E-08	1.036E-08	5.101E-09	3.131E-09	2.160E-09
SSW	2.514E-08	3.730E-08	4.052E-08	3.590E-08	3.044E-08	1.863E-08	8.289E-09	4.161E-09	2.579E-09	1.791E-09
SW	1.925E-08	3.005E-08	3.363E-08	3.033E-08	2.602E-08	1.622E-08	7.377E-09	3.763E-09	2.355E-09	1.646E-09
WSW	1.874E-08	2.611E-08	2.857E-08	2.600E-08	2.253E-08	1.431E-08	6.647E-09	3.439E-09	2.169E-09	1.524E-09
W	2.347E-08	3.039E-08	3.260E-08	2.949E-08	2.554E-08	1.633E-08	7.728E-09	4.082E-09	2.614E-09	1.859E-09
WNW	2.961E-08	3.168E-08	3.136E-08	2.769E-08	2.373E-08	1.510E-08	7.194E-09	3.851E-09	2.489E-09	1.780E-09
NW	1.620E-08	2.470E-08	2.928E-08	2.756E-08	2.433E-08	1.597E-08	7.835E-09	4.259E-09	2.777E-09	1.998E-09
NNW	1.262E-08	1.635E-08	2.117E-08	2.127E-08	1.954E-08	1.355E-08	7.001E-09	3.908E-09	2.577E-09	1.866E-09
N	3.240E-08	4.345E-08	5.599E-08	5.614E-08	5.153E-08	3.573E-08	1.846E-08	1.031E-08	6.794E-09	4.917E-09
NNE	5.842E-08	6.600E-08	7.590E-08	7.265E-08	6.522E-08	4.427E-08	2.260E-08	1.260E-08	8.320E-09	6.032E-09
NE	3.920E-08	5.095E-08	6.057E-08	5.834E-08	5.246E-08	3.557E-08	1.811E-08	1.008E-08	6.656E-09	4.828E-09
ENE	2.303E-08	2.598E-08	3.078E-08	3.015E-08	2.756E-08	1.936E-08	1.035E-08	5.975E-09	4.030E-09	2.967E-09
E	2.182E-08	2.809E-08	3.797E-08	4.006E-08	3.843E-08	2.925E-08	1.713E-08	1.051E-08	7.337E-09	5.528E-09
ESE	3.392E-08	3.684E-08	4.447E-08	4.486E-08	4.212E-08	3.143E-08	1.837E-08	1.145E-08	8.138E-09	6.231E-09
SE	4.994E-08	4.125E-08	4.122E-08	3.807E-08	3.390E-08	2.327E-08	1.239E-08	7.309E-09	5.059E-09	3.816E-09
SSE	5.213E-08	4.895E-08	4.581E-08	3.918E-08	3.292E-08	2.033E-08	9.374E-09	4.928E-09	3.165E-09	2.260E-09

Note: Directions are True North.

Table 2.7-10 Long-Term χ/Q (sec/m³) for Routine Releases Along Various Distance Segments, 8.000 Day Decay, Depleted (Sheet 2 of 2)

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1USNRC COMPUTER CODE - XOQDOQ,  VERSION 2.0         RUN DATE:  7/ 8/2013
0XOQDOQ - North Anna COL (1996-98 Met Data)
 EXIT ONE - GROUND LEVEL RELEASE - NO PURGE RELEASES
   8.000 DAY DECAY,    DEPLETED
0CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT
                                            SEGMENT BOUNDARIES IN MILES FROM THE SITE
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DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	1.498E-06	4.898E-07	2.092E-07	1.203E-07	7.966E-08	3.592E-08	1.145E-08	4.714E-09	2.619E-09	1.675E-09
SSW	1.183E-06	3.900E-07	1.672E-07	9.641E-08	6.395E-08	2.890E-08	9.236E-09	3.800E-09	2.108E-09	1.346E-09
SW	1.056E-06	3.493E-07	1.504E-07	8.689E-08	5.775E-08	2.619E-08	8.417E-09	3.480E-09	1.936E-09	1.239E-09
WSW	9.814E-07	3.249E-07	1.402E-07	8.122E-08	5.407E-08	2.460E-08	7.952E-09	3.305E-09	1.845E-09	1.183E-09
W	1.191E-06	3.962E-07	1.729E-07	1.009E-07	6.756E-08	3.105E-08	1.022E-08	4.312E-09	2.431E-09	1.570E-09
WNW	1.033E-06	3.432E-07	1.494E-07	8.709E-08	5.829E-08	2.681E-08	8.850E-09	3.756E-09	2.126E-09	1.378E-09
NW	1.054E-06	3.554E-07	1.562E-07	9.153E-08	6.148E-08	2.841E-08	9.424E-09	4.004E-09	2.266E-09	1.468E-09
NNW	8.999E-07	3.069E-07	1.354E-07	7.958E-08	5.355E-08	2.481E-08	8.251E-09	3.505E-09	1.981E-09	1.282E-09
N	2.310E-06	7.888E-07	3.469E-07	2.034E-07	1.366E-07	6.310E-08	2.088E-08	8.836E-09	4.982E-09	3.217E-09
NNE	2.912E-06	9.935E-07	4.376E-07	2.567E-07	1.725E-07	7.981E-08	2.649E-08	1.124E-08	6.350E-09	4.107E-09
NE	2.377E-06	8.115E-07	3.585E-07	2.107E-07	1.418E-07	6.570E-08	2.186E-08	9.295E-09	5.259E-09	3.406E-09
ENE	1.444E-06	4.989E-07	2.240E-07	1.330E-07	9.016E-08	4.229E-08	1.434E-08	6.185E-09	3.529E-09	2.298E-09
E	2.702E-06	9.482E-07	4.362E-07	2.627E-07	1.799E-07	8.579E-08	2.982E-08	1.311E-08	7.563E-09	4.964E-09
ESE	3.914E-06	1.354E-06	6.382E-07	3.903E-07	2.703E-07	1.313E-07	4.695E-08	2.112E-08	1.235E-08	8.187E-09
SE	2.771E-06	9.390E-07	4.387E-07	2.671E-07	1.845E-07	8.932E-08	3.183E-08	1.430E-08	8.362E-09	5.544E-09
SSE	1.548E-06	5.117E-07	2.260E-07	1.329E-07	8.959E-08	4.169E-08	1.402E-08	6.035E-09	3.446E-09	2.248E-09

Note: Directions are True North. The results on this page are applicable to releases from the RW-VS.

Table 2.7-11 Long-Term D/Q ($1/m^2$) for Routine Releases at Distances Between 0.25 to 50 Miles (Sheet 1 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 8/28/2014

0XOQDOQ - North Anna COL (1996-98 Met Data)

EXIT RB - MIXED MODE RELEASE - NO PURGE RELEASES

******************** RELATIVE DEPOSITION PER UNIT AREA (M**-2) AT FIXED POINTS BY DOWNWIND SECTORS ********************

DIRECTION	DISTANCES IN MILES										
FROM SITE	0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50
S	3.039E-09	1.897E-09	1.544E-09	1.381E-09	9.561E-10	7.176E-10	5.564E-10	4.416E-10	3.568E-10	2.926E-10	2.429E-10
SSW	1.184E-09	8.178E-10	7.730E-10	7.624E-10	5.636E-10	4.356E-10	3.431E-10	2.746E-10	2.229E-10	1.832E-10	1.522E-10
SW	9.372E-10	6.500E-10	6.118E-10	6.036E-10	4.461E-10	3.453E-10	2.723E-10	2.182E-10	1.772E-10	1.457E-10	1.211E-10
WSW	9.115E-10	6.612E-10	5.927E-10	5.590E-10	3.989E-10	3.047E-10	2.386E-10	1.905E-10	1.545E-10	1.269E-10	1.055E-10
W	1.177E-09	8.409E-10	7.241E-10	6.617E-10	4.609E-10	3.485E-10	2.715E-10	2.161E-10	1.749E-10	1.436E-10	1.194E-10
WNW	1.599E-09	1.131E-09	8.545E-10	6.923E-10	4.326E-10	3.125E-10	2.376E-10	1.867E-10	1.501E-10	1.229E-10	1.022E-10
NW	8.198E-10	6.218E-10	5.076E-10	4.401E-10	2.918E-10	2.171E-10	1.677E-10	1.330E-10	1.075E-10	8.820E-11	7.334E-11
NNW	6.798E-10	5.102E-10	3.870E-10	3.116E-10	1.924E-10	1.386E-10	1.052E-10	8.265E-11	6.647E-11	5.445E-11	4.527E-11
N	1.856E-09	1.373E-09	1.030E-09	8.202E-10	5.015E-10	3.593E-10	2.720E-10	2.132E-10	1.713E-10	1.403E-10	1.166E-10
NNE	3.560E-09	2.438E-09	1.794E-09	1.422E-09	8.718E-10	6.231E-10	4.708E-10	3.686E-10	2.959E-10	2.420E-10	2.011E-10
NE	2.590E-09	1.685E-09	1.262E-09	1.031E-09	6.560E-10	4.753E-10	3.617E-10	2.843E-10	2.285E-10	1.870E-10	1.553E-10
ENE	1.563E-09	1.011E-09	7.263E-10	5.695E-10	3.472E-10	2.473E-10	1.865E-10	1.459E-10	1.170E-10	9.566E-11	7.944E-11
E	1.739E-09	1.149E-09	7.962E-10	5.938E-10	3.412E-10	2.359E-10	1.748E-10	1.354E-10	1.080E-10	8.816E-11	7.321E-11
ESE	2.690E-09	1.708E-09	1.179E-09	8.812E-10	5.117E-10	3.535E-10	2.616E-10	2.023E-10	1.612E-10	1.314E-10	1.090E-10
SE	4.132E-09	2.588E-09	1.758E-09	1.306E-09	7.562E-10	5.218E-10	3.859E-10	2.984E-10	2.378E-10	1.938E-10	1.608E-10
SSE	3.761E-09	2.348E-09	1.690E-09	1.343E-09	8.385E-10	5.999E-10	4.530E-10	3.544E-10	2.841E-10	2.322E-10	1.926E-10

0DIRECTION	DISTANCES IN MILES										
FROM SITE	5.00	7.50	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
S	2.039E-10	1.064E-10	6.729E-11	3.511E-11	2.201E-11	1.548E-11	1.157E-11	9.015E-12	7.245E-12	5.959E-12	4.994E-12
SSW	1.278E-10	6.671E-11	4.218E-11	2.193E-11	1.370E-11	9.571E-12	7.116E-12	5.523E-12	4.426E-12	3.634E-12	3.043E-12
SW	1.016E-10	5.310E-11	3.361E-11	1.750E-11	1.094E-11	7.653E-12	5.695E-12	4.423E-12	3.545E-12	2.911E-12	2.438E-12
WSW	8.857E-11	4.636E-11	2.938E-11	1.535E-11	9.618E-12	6.771E-12	5.058E-12	3.937E-12	3.159E-12	2.594E-12	2.171E-12
W	1.003E-10	5.251E-11	3.329E-11	1.742E-11	1.094E-11	7.730E-12	5.793E-12	4.522E-12	3.637E-12	2.993E-12	2.509E-12
WNW	8.597E-11	4.526E-11	2.887E-11	1.531E-11	9.709E-12	7.023E-12	5.352E-12	4.228E-12	3.432E-12	2.843E-12	2.396E-12
NW	6.167E-11	3.245E-11	2.066E-11	1.090E-11	6.881E-12	4.927E-12	3.728E-12	2.930E-12	2.369E-12	1.957E-12	1.646E-12
NNW	3.812E-11	2.013E-11	1.286E-11	6.844E-12	4.350E-12	3.164E-12	2.421E-12	1.918E-12	1.560E-12	1.295E-12	1.093E-12
N	9.823E-11	5.187E-11	3.316E-11	1.766E-11	1.124E-11	8.190E-12	6.273E-12	4.977E-12	4.052E-12	3.365E-12	2.842E-12
NNE	1.692E-10	8.908E-11	5.684E-11	3.019E-11	1.918E-11	1.392E-11	1.064E-11	8.438E-12	6.872E-12	5.710E-12	4.829E-12
NE	1.305E-10	6.840E-11	4.348E-11	2.293E-11	1.450E-11	1.042E-11	7.920E-12	6.264E-12	5.102E-12	4.245E-12	3.601E-12
ENE	6.685E-11	3.515E-11	2.244E-11	1.192E-11	7.574E-12	5.497E-12	4.206E-12	3.338E-12	2.722E-12	2.266E-12	1.919E-12
E	6.169E-11	3.256E-11	2.086E-11	1.118E-11	7.159E-12	5.289E-12	4.105E-12	3.301E-12	2.724E-12	2.290E-12	1.961E-12
ESE	9.178E-11	4.820E-11	3.076E-11	1.639E-11	1.046E-11	7.674E-12	5.925E-12	4.742E-12	3.899E-12	3.268E-12	2.790E-12
SE	1.353E-10	7.108E-11	4.539E-11	2.423E-11	1.547E-11	1.132E-11	8.704E-12	6.921E-12	5.648E-12	4.696E-12	3.968E-12
SSE	1.619E-10	8.467E-11	5.379E-11	2.837E-11	1.795E-11	1.288E-11	9.768E-12	7.686E-12	6.221E-12	5.141E-12	4.321E-12

Note: Directions are True North.

Table 2.7-11 Long-Term D/Q ($1/m^2$) for Routine Releases at Distances Between 0.25 to 50 Miles (Sheet 2 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 8/28/2014
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT TB - MIXED MODE RELEASE - NO PURGE RELEASES
******************** RELATIVE DEPOSITION PER UNIT AREA (M**-2) AT FIXED POINTS BY DOWNWIND SECTORS ********************

DIRECTION FROM SITE	DISTANCES IN MILES 0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50
S	2.773E-09	1.735E-09	1.452E-09	1.325E-09	9.255E-10	7.018E-10	5.477E-10	4.364E-10	3.534E-10	2.901E-10	2.411E-10
SSW	1.144E-09	7.743E-10	7.406E-10	7.410E-10	5.524E-10	4.299E-10	3.400E-10	2.728E-10	2.218E-10	1.824E-10	1.516E-10
SW	9.066E-10	6.276E-10	5.977E-10	5.947E-10	4.413E-10	3.429E-10	2.710E-10	2.174E-10	1.767E-10	1.453E-10	1.208E-10
WSW	8.970E-10	6.425E-10	5.782E-10	5.494E-10	3.938E-10	3.022E-10	2.373E-10	1.897E-10	1.539E-10	1.265E-10	1.052E-10
W	1.159E-09	8.155E-10	7.041E-10	6.484E-10	4.539E-10	3.450E-10	2.696E-10	2.150E-10	1.742E-10	1.431E-10	1.190E-10
WNW	1.572E-09	1.114E-09	8.449E-10	6.864E-10	4.294E-10	3.108E-10	2.367E-10	1.861E-10	1.498E-10	1.227E-10	1.020E-10
NW	8.198E-10	6.218E-10	5.076E-10	4.401E-10	2.918E-10	2.171E-10	1.677E-10	1.330E-10	1.075E-10	8.820E-11	7.334E-11
NNW	6.798E-10	5.102E-10	3.870E-10	3.116E-10	1.924E-10	1.386E-10	1.052E-10	8.265E-11	6.647E-11	5.445E-11	4.527E-11
N	1.855E-09	1.372E-09	1.029E-09	8.195E-10	5.011E-10	3.591E-10	2.719E-10	2.132E-10	1.713E-10	1.403E-10	1.166E-10
NNE	3.456E-09	2.381E-09	1.765E-09	1.405E-09	8.619E-10	6.180E-10	4.679E-10	3.669E-10	2.947E-10	2.412E-10	2.005E-10
NE	2.440E-09	1.597E-09	1.214E-09	1.002E-09	6.398E-10	4.670E-10	3.571E-10	2.815E-10	2.267E-10	1.857E-10	1.543E-10
ENE	1.486E-09	9.816E-10	7.164E-10	5.649E-10	3.441E-10	2.457E-10	1.855E-10	1.453E-10	1.166E-10	9.536E-11	7.923E-11
E	1.675E-09	1.123E-09	7.869E-10	5.892E-10	3.383E-10	2.344E-10	1.739E-10	1.348E-10	1.077E-10	8.789E-11	7.301E-11
ESE	2.520E-09	1.613E-09	1.129E-09	8.516E-10	4.951E-10	3.449E-10	2.568E-10	1.994E-10	1.593E-10	1.301E-10	1.080E-10
SE	3.739E-09	2.416E-09	1.688E-09	1.269E-09	7.340E-10	5.100E-10	3.792E-10	2.942E-10	2.350E-10	1.918E-10	1.593E-10
SSE	3.371E-09	2.148E-09	1.593E-09	1.288E-09	8.067E-10	5.833E-10	4.437E-10	3.487E-10	2.804E-10	2.295E-10	1.906E-10

0DIRECTION FROM SITE	DISTANCES IN MILES 5.00	7.50	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
S	2.024E-10	1.060E-10	6.722E-11	3.516E-11	2.204E-11	1.553E-11	1.161E-11	9.033E-12	7.244E-12	5.946E-12	4.971E-12
SSW	1.272E-10	6.655E-11	4.214E-11	2.195E-11	1.371E-11	9.580E-12	7.115E-12	5.513E-12	4.408E-12	3.611E-12	3.014E-12
SW	1.014E-10	5.304E-11	3.360E-11	1.751E-11	1.094E-11	7.656E-12	5.691E-12	4.413E-12	3.530E-12	2.892E-12	2.415E-12
WSW	8.834E-11	4.629E-11	2.936E-11	1.536E-11	9.625E-12	6.777E-12	5.061E-12	3.938E-12	3.158E-12	2.592E-12	2.167E-12
W	9.994E-11	5.240E-11	3.327E-11	1.743E-11	1.094E-11	7.735E-12	5.792E-12	4.515E-12	3.625E-12	2.978E-12	2.492E-12
WNW	8.581E-11	4.522E-11	2.886E-11	1.532E-11	9.710E-12	7.022E-12	5.343E-12	4.212E-12	3.409E-12	2.816E-12	2.365E-12
NW	6.167E-11	3.245E-11	2.066E-11	1.090E-11	6.879E-12	4.923E-12	3.719E-12	2.917E-12	2.353E-12	1.939E-12	1.626E-12
NNW	3.812E-11	2.013E-11	1.286E-11	6.844E-12	4.349E-12	3.160E-12	2.412E-12	1.906E-12	1.545E-12	1.278E-12	1.074E-12
N	9.821E-11	5.186E-11	3.316E-11	1.766E-11	1.123E-11	8.178E-12	6.251E-12	4.944E-12	4.010E-12	3.318E-12	2.789E-12
NNE	1.687E-10	8.896E-11	5.682E-11	3.021E-11	1.918E-11	1.391E-11	1.061E-11	8.378E-12	6.788E-12	5.611E-12	4.714E-12
NE	1.297E-10	6.819E-11	4.345E-11	2.296E-11	1.450E-11	1.041E-11	7.882E-12	6.191E-12	4.998E-12	4.121E-12	3.456E-12
ENE	6.668E-11	3.513E-11	2.244E-11	1.193E-11	7.570E-12	5.493E-12	4.189E-12	3.307E-12	2.679E-12	2.214E-12	1.860E-12
E	6.153E-11	3.253E-11	2.086E-11	1.119E-11	7.149E-12	5.267E-12	4.058E-12	3.226E-12	2.627E-12	2.178E-12	1.834E-12
ESE	9.096E-11	4.799E-11	3.073E-11	1.642E-11	1.047E-11	7.671E-12	5.889E-12	4.670E-12	3.795E-12	3.143E-12	2.644E-12
SE	1.342E-10	7.084E-11	4.538E-11	2.428E-11	1.549E-11	1.137E-11	8.738E-12	6.935E-12	5.639E-12	4.673E-12	3.932E-12
SSE	1.603E-10	8.429E-11	5.374E-11	2.844E-11	1.799E-11	1.295E-11	9.824E-12	7.727E-12	6.244E-12	5.151E-12	4.322E-12

Note: Directions are True North.

Table 2.7-11 Long-Term D/Q ($1/m^2$) for Routine Releases at Distances Between 0.25 to 50 Miles (Sheet 3 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 7/ 8/2013

0XOQDOQ - North Anna COL (1996-98 Met Data)

EXIT ONE - GROUND LEVEL RELEASE - NO PURGE RELEASES

******************** RELATIVE DEPOSITION PER UNIT AREA (M**-2) AT FIXED POINTS BY DOWNWIND SECTORS ********************

DIRECTION	DISTANCES IN MILES										
FROM SITE	0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50
S	4.819E-08	1.630E-08	8.367E-09	5.138E-09	2.561E-09	1.553E-09	1.050E-09	7.611E-10	5.787E-10	4.559E-10	3.691E-10
SSW	3.194E-08	1.080E-08	5.546E-09	3.405E-09	1.698E-09	1.030E-09	6.961E-10	5.045E-10	3.836E-10	3.022E-10	2.446E-10
SW	2.633E-08	8.902E-09	4.571E-09	2.807E-09	1.399E-09	8.486E-10	5.738E-10	4.158E-10	3.161E-10	2.491E-10	2.016E-10
WSW	2.286E-08	7.732E-09	3.970E-09	2.438E-09	1.215E-09	7.371E-10	4.983E-10	3.611E-10	2.746E-10	2.163E-10	1.751E-10
W	2.691E-08	9.101E-09	4.673E-09	2.869E-09	1.430E-09	8.676E-10	5.866E-10	4.251E-10	3.232E-10	2.546E-10	2.061E-10
WNW	2.495E-08	8.438E-09	4.333E-09	2.660E-09	1.326E-09	8.044E-10	5.439E-10	3.941E-10	2.997E-10	2.361E-10	1.911E-10
NW	2.242E-08	7.583E-09	3.893E-09	2.391E-09	1.192E-09	7.229E-10	4.887E-10	3.542E-10	2.693E-10	2.122E-10	1.718E-10
NNW	1.628E-08	5.504E-09	2.826E-09	1.735E-09	8.652E-10	5.247E-10	3.548E-10	2.571E-10	1.955E-10	1.540E-10	1.247E-10
N	4.309E-08	1.457E-08	7.481E-09	4.594E-09	2.290E-09	1.389E-09	9.391E-10	6.805E-10	5.175E-10	4.077E-10	3.300E-10
NNE	6.257E-08	2.116E-08	1.086E-08	6.671E-09	3.326E-09	2.017E-09	1.364E-09	9.882E-10	7.514E-10	5.920E-10	4.793E-10
NE	5.046E-08	1.706E-08	8.761E-09	5.379E-09	2.682E-09	1.627E-09	1.100E-09	7.969E-10	6.059E-10	4.774E-10	3.865E-10
ENE	2.720E-08	9.199E-09	4.723E-09	2.900E-09	1.446E-09	8.769E-10	5.929E-10	4.296E-10	3.267E-10	2.574E-10	2.084E-10
E	3.824E-08	1.293E-08	6.640E-09	4.077E-09	2.033E-09	1.233E-09	8.335E-10	6.040E-10	4.593E-10	3.618E-10	2.929E-10
ESE	5.097E-08	1.724E-08	8.849E-09	5.434E-09	2.709E-09	1.643E-09	1.111E-09	8.050E-10	6.121E-10	4.822E-10	3.904E-10
SE	4.574E-08	1.547E-08	7.942E-09	4.877E-09	2.431E-09	1.475E-09	9.970E-10	7.225E-10	5.493E-10	4.328E-10	3.504E-10
SSE	4.085E-08	1.381E-08	7.092E-09	4.355E-09	2.171E-09	1.317E-09	8.902E-10	6.451E-10	4.905E-10	3.865E-10	3.129E-10

0DIRECTION	DISTANCES IN MILES										
FROM SITE	5.00	7.50	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
S	3.053E-10	1.496E-10	9.388E-11	4.745E-11	2.872E-11	1.926E-11	1.380E-11	1.036E-11	8.056E-12	6.435E-12	5.252E-12
SSW	2.024E-10	9.917E-11	6.222E-11	3.145E-11	1.904E-11	1.276E-11	9.145E-12	6.867E-12	5.339E-12	4.265E-12	3.481E-12
SW	1.668E-10	8.174E-11	5.129E-11	2.592E-11	1.569E-11	1.052E-11	7.538E-12	5.660E-12	4.401E-12	3.515E-12	2.869E-12
WSW	1.449E-10	7.099E-11	4.454E-11	2.251E-11	1.363E-11	9.136E-12	6.547E-12	4.916E-12	3.822E-12	3.053E-12	2.492E-12
W	1.705E-10	8.356E-11	5.243E-11	2.650E-11	1.604E-11	1.075E-11	7.706E-12	5.786E-12	4.499E-12	3.594E-12	2.933E-12
WNW	1.581E-10	7.748E-11	4.861E-11	2.457E-11	1.487E-11	9.971E-12	7.145E-12	5.365E-12	4.171E-12	3.332E-12	2.720E-12
NW	1.421E-10	6.962E-11	4.369E-11	2.208E-11	1.336E-11	8.961E-12	6.421E-12	4.821E-12	3.749E-12	2.994E-12	2.444E-12
NNW	1.031E-10	5.054E-11	3.171E-11	1.603E-11	9.701E-12	6.504E-12	4.661E-12	3.500E-12	2.721E-12	2.174E-12	1.774E-12
N	2.730E-10	1.338E-10	8.394E-11	4.243E-11	2.568E-11	1.722E-11	1.234E-11	9.264E-12	7.203E-12	5.754E-12	4.697E-12
NNE	3.964E-10	1.943E-10	1.219E-10	6.161E-11	3.729E-11	2.500E-11	1.792E-11	1.345E-11	1.046E-11	8.355E-12	6.820E-12
NE	3.197E-10	1.567E-10	9.830E-11	4.968E-11	3.007E-11	2.016E-11	1.445E-11	1.085E-11	8.435E-12	6.738E-12	5.500E-12
ENE	1.724E-10	8.446E-11	5.300E-11	2.679E-11	1.621E-11	1.087E-11	7.789E-12	5.849E-12	4.548E-12	3.633E-12	2.965E-12
E	2.423E-10	1.187E-10	7.451E-11	3.766E-11	2.279E-11	1.528E-11	1.095E-11	8.223E-12	6.393E-12	5.107E-12	4.168E-12
ESE	3.229E-10	1.583E-10	9.929E-11	5.019E-11	3.038E-11	2.037E-11	1.459E-11	1.096E-11	8.520E-12	6.806E-12	5.555E-12
SE	2.898E-10	1.420E-10	8.912E-11	4.504E-11	2.726E-11	1.828E-11	1.310E-11	9.835E-12	7.647E-12	6.108E-12	4.986E-12
SSE	2.588E-10	1.268E-10	7.957E-11	4.022E-11	2.434E-11	1.632E-11	1.170E-11	8.782E-12	6.828E-12	5.454E-12	4.452E-12

Note: Directions are True North. The results on this page are applicable to releases from the RW-VS.

Table 2.7-11 Long-Term D/Q (1/m^2) for Routine Releases at Distances Between 0.25 to 50 Miles (Sheet 4 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 7/16/2013
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT TWR - GROUND LEVEL RELEASE - NO PURGE RELEASES
******************** RELATIVE DEPOSITION PER UNIT AREA (M**-2) AT FIXED POINTS BY DOWNWIND SECTORS ********************

DIRECTION FROM SITE	DISTANCES IN MILES 0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50
S	4.819E-08	1.630E-08	8.367E-09	5.138E-09	2.561E-09	1.553E-09	1.050E-09	7.611E-10	5.787E-10	4.559E-10	3.691E-10
SSW	3.194E-08	1.080E-08	5.546E-09	3.405E-09	1.698E-09	1.030E-09	6.961E-10	5.045E-10	3.836E-10	3.022E-10	2.446E-10
SW	2.633E-08	8.902E-09	4.571E-09	2.807E-09	1.399E-09	8.486E-10	5.738E-10	4.158E-10	3.161E-10	2.491E-10	2.016E-10
WSW	2.286E-08	7.732E-09	3.970E-09	2.438E-09	1.215E-09	7.371E-10	4.983E-10	3.611E-10	2.746E-10	2.163E-10	1.751E-10
W	2.691E-08	9.101E-09	4.673E-09	2.869E-09	1.430E-09	8.676E-10	5.866E-10	4.251E-10	3.232E-10	2.546E-10	2.061E-10
WNW	2.495E-08	8.438E-09	4.333E-09	2.660E-09	1.326E-09	8.044E-10	5.439E-10	3.941E-10	2.997E-10	2.361E-10	1.911E-10
NW	2.242E-08	7.583E-09	3.893E-09	2.391E-09	1.192E-09	7.229E-10	4.887E-10	3.542E-10	2.693E-10	2.122E-10	1.718E-10
NNW	1.628E-08	5.504E-09	2.826E-09	1.735E-09	8.652E-10	5.247E-10	3.548E-10	2.571E-10	1.955E-10	1.540E-10	1.247E-10
N	4.309E-08	1.457E-08	7.481E-09	4.594E-09	2.290E-09	1.389E-09	9.391E-10	6.805E-10	5.175E-10	4.077E-10	3.300E-10
NNE	6.257E-08	2.116E-08	1.086E-08	6.671E-09	3.326E-09	2.017E-09	1.364E-09	9.882E-10	7.514E-10	5.920E-10	4.793E-10
NE	5.046E-08	1.706E-08	8.761E-09	5.379E-09	2.682E-09	1.627E-09	1.100E-09	7.969E-10	6.059E-10	4.774E-10	3.865E-10
ENE	2.720E-08	9.199E-09	4.723E-09	2.900E-09	1.446E-09	8.769E-10	5.929E-10	4.296E-10	3.267E-10	2.574E-10	2.084E-10
E	3.824E-08	1.293E-08	6.640E-09	4.077E-09	2.033E-09	1.233E-09	8.335E-10	6.040E-10	4.593E-10	3.618E-10	2.929E-10
ESE	5.097E-08	1.724E-08	8.849E-09	5.434E-09	2.709E-09	1.643E-09	1.111E-09	8.050E-10	6.121E-10	4.822E-10	3.904E-10
SE	4.574E-08	1.547E-08	7.942E-09	4.877E-09	2.431E-09	1.475E-09	9.970E-10	7.225E-10	5.493E-10	4.328E-10	3.504E-10
SSE	4.085E-08	1.381E-08	7.092E-09	4.355E-09	2.171E-09	1.317E-09	8.902E-10	6.451E-10	4.905E-10	3.865E-10	3.129E-10

0DIRECTION FROM SITE	DISTANCES IN MILES 5.00	7.50	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
S	3.053E-10	1.496E-10	9.388E-11	4.745E-11	2.872E-11	1.926E-11	1.380E-11	1.036E-11	8.056E-12	6.435E-12	5.252E-12
SSW	2.024E-10	9.917E-11	6.222E-11	3.145E-11	1.904E-11	1.276E-11	9.145E-12	6.867E-12	5.339E-12	4.265E-12	3.481E-12
SW	1.668E-10	8.174E-11	5.129E-11	2.592E-11	1.569E-11	1.052E-11	7.538E-12	5.660E-12	4.401E-12	3.515E-12	2.869E-12
WSW	1.449E-10	7.099E-11	4.454E-11	2.251E-11	1.363E-11	9.136E-12	6.547E-12	4.916E-12	3.822E-12	3.053E-12	2.492E-12
W	1.705E-10	8.356E-11	5.243E-11	2.650E-11	1.604E-11	1.075E-11	7.706E-12	5.786E-12	4.499E-12	3.594E-12	2.933E-12
WNW	1.581E-10	7.748E-11	4.861E-11	2.457E-11	1.487E-11	9.971E-12	7.145E-12	5.365E-12	4.171E-12	3.332E-12	2.720E-12
NW	1.421E-10	6.962E-11	4.369E-11	2.208E-11	1.336E-11	8.961E-12	6.421E-12	4.821E-12	3.749E-12	2.994E-12	2.444E-12
NNW	1.031E-10	5.054E-11	3.171E-11	1.603E-11	9.701E-12	6.504E-12	4.661E-12	3.500E-12	2.721E-12	2.174E-12	1.774E-12
N	2.730E-10	1.338E-10	8.394E-11	4.243E-11	2.568E-11	1.722E-11	1.234E-11	9.264E-12	7.203E-12	5.754E-12	4.697E-12
NNE	3.964E-10	1.943E-10	1.219E-10	6.161E-11	3.729E-11	2.500E-11	1.792E-11	1.345E-11	1.046E-11	8.355E-12	6.820E-12
NE	3.197E-10	1.567E-10	9.830E-11	4.968E-11	3.007E-11	2.016E-11	1.445E-11	1.085E-11	8.435E-12	6.738E-12	5.500E-12
ENE	1.724E-10	8.446E-11	5.300E-11	2.679E-11	1.621E-11	1.087E-11	7.789E-12	5.849E-12	4.548E-12	3.633E-12	2.965E-12
E	2.423E-10	1.187E-10	7.451E-11	3.766E-11	2.279E-11	1.528E-11	1.095E-11	8.223E-12	6.393E-12	5.107E-12	4.168E-12
ESE	3.229E-10	1.583E-10	9.929E-11	5.019E-11	3.038E-11	2.037E-11	1.459E-11	1.096E-11	8.520E-12	6.806E-12	5.555E-12
SE	2.898E-10	1.420E-10	8.912E-11	4.504E-11	2.726E-11	1.828E-11	1.310E-11	9.835E-12	7.647E-12	6.108E-12	4.986E-12
SSE	2.588E-10	1.268E-10	7.957E-11	4.022E-11	2.434E-11	1.632E-11	1.170E-11	8.782E-12	6.828E-12	5.454E-12	4.452E-12

Note: Directions are True North.

Table 2.7-12 Long-Term D/Q (1/m^2) for Routine Releases Along Various Distance Segments (Sheet 1 of 4)

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1USNRC COMPUTER CODE - XOQDOQ,  VERSION 2.0         RUN DATE:  8/28/2014
0XOQDOQ - North Anna COL (1996-98 Met Data)
 EXIT RB - MIXED MODE RELEASE - NO PURGE RELEASES
0************************     RELATIVE DEPOSITION PER UNIT AREA (M**-2) BY DOWNWIND SECTORS     ************************
                                              SEGMENT BOUNDARIES IN MILES
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DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	1.550E-09	9.444E-10	5.535E-10	3.566E-10	2.432E-10	1.107E-10	3.644E-11	1.566E-11	9.071E-12	5.982E-12
SSW	7.782E-10	5.509E-10	3.404E-10	2.226E-10	1.524E-10	6.937E-11	2.277E-11	9.689E-12	5.560E-12	3.650E-12
SW	6.166E-10	4.363E-10	2.701E-10	1.769E-10	1.211E-10	5.522E-11	1.816E-11	7.746E-12	4.452E-12	2.924E-12
WSW	5.929E-10	3.926E-10	2.370E-10	1.543E-10	1.056E-10	4.819E-11	1.592E-11	6.845E-12	3.961E-12	2.605E-12
W	7.223E-10	4.556E-10	2.699E-10	1.748E-10	1.195E-10	5.458E-11	1.807E-11	7.810E-12	4.548E-12	3.005E-12
WNW	8.439E-10	4.369E-10	2.372E-10	1.502E-10	1.023E-10	4.702E-11	1.583E-11	7.071E-12	4.246E-12	2.852E-12
NW	5.030E-10	2.915E-10	1.670E-10	1.074E-10	7.342E-11	3.370E-11	1.128E-11	4.968E-12	2.944E-12	1.964E-12
NNW	3.808E-10	1.950E-10	1.051E-10	6.651E-11	4.534E-11	2.090E-11	7.073E-12	3.183E-12	1.925E-12	1.299E-12
N	1.013E-09	5.091E-10	2.718E-10	1.715E-10	1.168E-10	5.386E-11	1.825E-11	8.236E-12	4.995E-12	3.375E-12
NNE	1.772E-09	8.836E-10	4.705E-10	2.961E-10	2.014E-10	9.256E-11	3.122E-11	1.401E-11	8.472E-12	5.728E-12
NE	1.254E-09	6.591E-10	3.610E-10	2.286E-10	1.555E-10	7.114E-11	2.375E-11	1.051E-11	6.294E-12	4.260E-12
ENE	7.199E-10	3.522E-10	1.865E-10	1.171E-10	7.958E-11	3.654E-11	1.233E-11	5.535E-12	3.351E-12	2.273E-12
E	7.846E-10	3.505E-10	1.754E-10	1.083E-10	7.337E-11	3.383E-11	1.154E-11	5.314E-12	3.311E-12	2.297E-12
ESE	1.164E-09	5.235E-10	2.624E-10	1.616E-10	1.093E-10	5.014E-11	1.695E-11	7.718E-12	4.759E-12	3.278E-12
SE	1.741E-09	7.741E-10	3.872E-10	2.383E-10	1.611E-10	7.394E-11	2.504E-11	1.138E-11	6.945E-12	4.708E-12
SSE	1.682E-09	8.446E-10	4.527E-10	2.844E-10	1.930E-10	8.811E-11	2.939E-11	1.299E-11	7.722E-12	5.157E-12

```
0VENT AND BUILDING PARAMETERS:
     RELEASE HEIGHT  (METERS)   52.77                 REP. WIND HEIGHT       (METERS)       10.0
     DIAMETER        (METERS)    2.40                 BUILDING HEIGHT        (METERS)       46.1
     EXIT VELOCITY   (METERS)   17.78                 BLDG.MIN.CRS.SEC.AREA  (SQ.METERS)  3098.0
                                                      HEAT EMISSION RATE     (CAL/SEC)       0.0
0AT THE RELEASE HEIGHT:                          /  AT THE MEASURED WIND HEIGHT ( 10.0 METERS):
 VENT RELEASE MODE   WIND SPEED (METERS/SEC)     /  VENT RELEASE MODE   WIND SPEED (METERS/SEC)       WIND SPEED (METERS/SEC)
                                                 /                      STABLE CONDITIONS             UNSTABLE/NEUTRAL CONDITIONS
     ELEVATED        LESS THAN  3.556            /      ELEVATED        LESS THAN  3.556              LESS THAN  3.556
     MIXED           BETWEEN    3.556 AND 17.780 /      MIXED           BETWEEN    3.556 AND 17.780   BETWEEN    3.556 AND 17.780
     GROUND LEVEL    ABOVE     17.780            /      GROUND LEVEL    ABOVE     17.780              ABOVE     17.780
```

Note: Directions are True North.

Table 2.7-12 Long-Term D/Q ($1/m^2$) for Routine Releases Along Various Distance Segments (Sheet 2 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 8/28/2014

0XOQDOQ - North Anna COL (1996-98 Met Data)

EXIT TB - MIXED MODE RELEASE - NO PURGE RELEASES

0************************ RELATIVE DEPOSITION PER UNIT AREA (M**-2) BY DOWNWIND SECTORS ************************

SEGMENT BOUNDARIES IN MILES

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	1.458E-09	9.148E-10	5.442E-10	3.530E-10	2.413E-10	1.102E-10	3.646E-11	1.570E-11	9.087E-12	5.969E-12
SSW	7.483E-10	5.399E-10	3.371E-10	2.214E-10	1.517E-10	6.919E-11	2.278E-11	9.696E-12	5.550E-12	3.626E-12
SW	6.030E-10	4.316E-10	2.687E-10	1.763E-10	1.209E-10	5.514E-11	1.817E-11	7.747E-12	4.442E-12	2.904E-12
WSW	5.796E-10	3.876E-10	2.355E-10	1.537E-10	1.053E-10	4.811E-11	1.592E-11	6.850E-12	3.961E-12	2.602E-12
W	7.041E-10	4.487E-10	2.679E-10	1.740E-10	1.191E-10	5.447E-11	1.807E-11	7.814E-12	4.541E-12	2.990E-12
WNW	8.343E-10	4.338E-10	2.362E-10	1.498E-10	1.021E-10	4.697E-11	1.583E-11	7.067E-12	4.229E-12	2.825E-12
NW	5.030E-10	2.915E-10	1.670E-10	1.074E-10	7.342E-11	3.370E-11	1.128E-11	4.963E-12	2.931E-12	1.945E-12
NNW	3.808E-10	1.950E-10	1.051E-10	6.651E-11	4.534E-11	2.090E-11	7.072E-12	3.178E-12	1.913E-12	1.282E-12
N	1.012E-09	5.088E-10	2.717E-10	1.715E-10	1.168E-10	5.385E-11	1.825E-11	8.222E-12	4.962E-12	3.327E-12
NNE	1.742E-09	8.741E-10	4.675E-10	2.950E-10	2.008E-10	9.241E-11	3.122E-11	1.400E-11	8.410E-12	5.627E-12
NE	1.205E-09	6.435E-10	3.562E-10	2.267E-10	1.545E-10	7.087E-11	2.375E-11	1.049E-11	6.219E-12	4.134E-12
ENE	7.080E-10	3.494E-10	1.855E-10	1.167E-10	7.936E-11	3.650E-11	1.233E-11	5.525E-12	3.320E-12	2.221E-12
E	7.737E-10	3.479E-10	1.744E-10	1.079E-10	7.317E-11	3.379E-11	1.154E-11	5.285E-12	3.236E-12	2.184E-12
ESE	1.113E-09	5.075E-10	2.573E-10	1.596E-10	1.082E-10	4.987E-11	1.696E-11	7.704E-12	4.685E-12	3.152E-12
SE	1.664E-09	7.533E-10	3.801E-10	2.355E-10	1.596E-10	7.360E-11	2.506E-11	1.142E-11	6.957E-12	4.685E-12
SSE	1.581E-09	8.143E-10	4.429E-10	2.805E-10	1.909E-10	8.761E-11	2.942E-11	1.304E-11	7.761E-12	5.168E-12

```
0VENT AND BUILDING PARAMETERS:
    RELEASE HEIGHT  (METERS)   71.30              REP. WIND HEIGHT       (METERS)       10.0
    DIAMETER        (METERS)    1.95              BUILDING HEIGHT        (METERS)       46.1
    EXIT VELOCITY   (METERS)   17.78              BLDG.MIN.CRS.SEC.AREA  (SQ.METERS)  3098.0
                                                  HEAT EMISSION RATE     (CAL/SEC)       0.0
0AT THE RELEASE HEIGHT:                      /  AT THE MEASURED WIND HEIGHT ( 10.0 METERS):
 VENT RELEASE MODE   WIND SPEED (METERS/SEC) /  VENT RELEASE MODE   WIND SPEED (METERS/SEC)      WIND SPEED (METERS/SEC)
                                             /                      STABLE CONDITIONS            UNSTABLE/NEUTRAL CONDITIONS
    ELEVATED         LESS THAN  3.556        /    ELEVATED          LESS THAN  3.556             LESS THAN  3.556
    MIXED            BETWEEN     3.556 AND 17.780 / MIXED           BETWEEN     3.556 AND 17.780 BETWEEN     3.556 AND 17.780
    GROUND LEVEL     ABOVE      17.780       /    GROUND LEVEL      ABOVE      17.780            ABOVE      17.780
```

Note: Directions are True North.

Table 2.7-12 Long-Term D/Q ($1/m^2$) for Routine Releases Along Various Distance Segments (Sheet 3 of 4)

```
1USNRC COMPUTER CODE - XOQDOQ,  VERSION 2.0         RUN DATE:  7/ 8/2013
0XOQDOQ - North Anna COL (1996-98 Met Data)
 EXIT ONE - GROUND LEVEL RELEASE - NO PURGE RELEASES
0************************     RELATIVE DEPOSITION PER UNIT AREA (M**-2) BY DOWNWIND SECTORS     ************************
                                            SEGMENT BOUNDARIES IN MILES
 DIRECTION   .5-1         1-2         2-3         3-4         4-5         5-10        10-20       20-30       30-40       40-50
 FROM SITE
    S      8.694E-09   2.686E-09   1.069E-09   5.841E-10   3.712E-10   1.594E-10   4.944E-11   1.960E-11   1.046E-11   6.477E-12
   SSW     5.762E-09   1.780E-09   7.084E-10   3.871E-10   2.460E-10   1.057E-10   3.277E-11   1.299E-11   6.936E-12   4.293E-12
    SW     4.749E-09   1.467E-09   5.839E-10   3.191E-10   2.028E-10   8.710E-11   2.701E-11   1.071E-11   5.717E-12   3.538E-12
   WSW     4.125E-09   1.274E-09   5.071E-10   2.771E-10   1.761E-10   7.565E-11   2.346E-11   9.298E-12   4.965E-12   3.073E-12
    W      4.855E-09   1.500E-09   5.969E-10   3.262E-10   2.073E-10   8.905E-11   2.761E-11   1.094E-11   5.844E-12   3.617E-12
   WNW     4.502E-09   1.391E-09   5.534E-10   3.024E-10   1.922E-10   8.256E-11   2.560E-11   1.015E-11   5.419E-12   3.354E-12
    NW     4.045E-09   1.250E-09   4.973E-10   2.718E-10   1.727E-10   7.420E-11   2.301E-11   9.119E-12   4.870E-12   3.014E-12
   NNW     2.937E-09   9.072E-10   3.610E-10   1.973E-10   1.254E-10   5.386E-11   1.670E-11   6.619E-12   3.535E-12   2.188E-12
    N      7.773E-09   2.402E-09   9.557E-10   5.222E-10   3.319E-10   1.426E-10   4.421E-11   1.752E-11   9.357E-12   5.792E-12
   NNE     1.129E-08   3.487E-09   1.388E-09   7.583E-10   4.820E-10   2.070E-10   6.420E-11   2.544E-11   1.359E-11   8.410E-12
    NE     9.103E-09   2.812E-09   1.119E-09   6.115E-10   3.887E-10   1.669E-10   5.177E-11   2.052E-11   1.096E-11   6.782E-12
   ENE     4.908E-09   1.516E-09   6.033E-10   3.297E-10   2.095E-10   9.001E-11   2.791E-11   1.106E-11   5.907E-12   3.656E-12
    E      6.899E-09   2.132E-09   8.482E-10   4.635E-10   2.946E-10   1.265E-10   3.924E-11   1.555E-11   8.305E-12   5.140E-12
   ESE     9.195E-09   2.841E-09   1.130E-09   6.177E-10   3.926E-10   1.686E-10   5.230E-11   2.073E-11   1.107E-11   6.851E-12
    SE     8.252E-09   2.550E-09   1.015E-09   5.544E-10   3.524E-10   1.514E-10   4.693E-11   1.860E-11   9.934E-12   6.149E-12
   SSE     7.369E-09   2.277E-09   9.059E-10   4.950E-10   3.146E-10   1.351E-10   4.191E-11   1.661E-11   8.870E-12   5.490E-12
0VENT AND BUILDING PARAMETERS:
     RELEASE HEIGHT  (METERS)    0.00                 REP. WIND HEIGHT       (METERS)       10.0
     DIAMETER        (METERS)    0.00                 BUILDING HEIGHT        (METERS)       46.1
     EXIT VELOCITY   (METERS)    0.00                 BLDG.MIN.CRS.SEC.AREA  (SQ.METERS)  3098.0
                                                      HEAT EMISSION RATE     (CAL/SEC)       0.0
                                                      HEAT EMISSION RATE     (CAL/SEC)       0.0
0ALL GROUND LEVEL RELEASES.
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Note: Directions are True North. The results on this page are applicable to releases from the RW-VS.

Table 2.7-12 Long-Term D/Q ($1/m^2$) for Routine Releases Along Various Distance Segments (Sheet 4 of 4)

1USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATE: 7/16/2013
0XOQDOQ - North Anna COL (1996-98 Met Data)
EXIT TWR - GROUND LEVEL RELEASE - NO PURGE RELEASES
0************************ RELATIVE DEPOSITION PER UNIT AREA (M**-2) BY DOWNWIND SECTORS ************************

SEGMENT BOUNDARIES IN MILES

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	8.694E-09	2.686E-09	1.069E-09	5.841E-10	3.712E-10	1.594E-10	4.944E-11	1.960E-11	1.046E-11	6.477E-12
SSW	5.762E-09	1.780E-09	7.084E-10	3.871E-10	2.460E-10	1.057E-10	3.277E-11	1.299E-11	6.936E-12	4.293E-12
SW	4.749E-09	1.467E-09	5.839E-10	3.191E-10	2.028E-10	8.710E-11	2.701E-11	1.071E-11	5.717E-12	3.538E-12
WSW	4.125E-09	1.274E-09	5.071E-10	2.771E-10	1.761E-10	7.565E-11	2.346E-11	9.298E-12	4.965E-12	3.073E-12
W	4.855E-09	1.500E-09	5.969E-10	3.262E-10	2.073E-10	8.905E-11	2.761E-11	1.094E-11	5.844E-12	3.617E-12
WNW	4.502E-09	1.391E-09	5.534E-10	3.024E-10	1.922E-10	8.256E-11	2.560E-11	1.015E-11	5.419E-12	3.354E-12
NW	4.045E-09	1.250E-09	4.973E-10	2.718E-10	1.727E-10	7.420E-11	2.301E-11	9.119E-12	4.870E-12	3.014E-12
NNW	2.937E-09	9.072E-10	3.610E-10	1.973E-10	1.254E-10	5.386E-11	1.670E-11	6.619E-12	3.535E-12	2.188E-12
N	7.773E-09	2.402E-09	9.557E-10	5.222E-10	3.319E-10	1.426E-10	4.421E-11	1.752E-11	9.357E-12	5.792E-12
NNE	1.129E-08	3.487E-09	1.388E-09	7.583E-10	4.820E-10	2.070E-10	6.420E-11	2.544E-11	1.359E-11	8.410E-12
NE	9.103E-09	2.812E-09	1.119E-09	6.115E-10	3.887E-10	1.669E-10	5.177E-11	2.052E-11	1.096E-11	6.782E-12
ENE	4.908E-09	1.516E-09	6.033E-10	3.297E-10	2.095E-10	9.001E-11	2.791E-11	1.106E-11	5.907E-12	3.656E-12
E	6.899E-09	2.132E-09	8.482E-10	4.635E-10	2.946E-10	1.265E-10	3.924E-11	1.555E-11	8.305E-12	5.140E-12
ESE	9.195E-09	2.841E-09	1.130E-09	6.177E-10	3.926E-10	1.686E-10	5.230E-11	2.073E-11	1.107E-11	6.851E-12
SE	8.252E-09	2.550E-09	1.015E-09	5.544E-10	3.524E-10	1.514E-10	4.693E-11	1.860E-11	9.934E-12	6.149E-12
SSE	7.369E-09	2.277E-09	9.059E-10	4.950E-10	3.146E-10	1.351E-10	4.191E-11	1.661E-11	8.870E-12	5.490E-12

0VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	0.00	REP. WIND HEIGHT	(METERS)	10.0
DIAMETER	(METERS)	0.00	BUILDING HEIGHT	(METERS)	0.0
EXIT VELOCITY	(METERS)	0.00	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	0.0
			HEAT EMISSION RATE	(CAL/SEC)	0.0

2.8 Related Federal Project Activities

The information for this section is provided in ESP-ER Section 2.8 and in FEIS Section 2.11.

No new and significant information has been identified for this section. Dominion has identified no past, present, or reasonably foreseeable Federal or non-Federal action that would result in new and significant cumulative impacts.

Chapter 3 Plant Description

Per 10 CFR 51.50(c)(1)(i), an application at the Combined License Stage, referencing an early site permit, must contain "information to demonstrate that the design of the facility falls within the site characteristics and design parameters specified in the early site permit."

ESP-ER Table 3.1-9 identifies the bounding site characteristics and design parameter values for assessing the environmental impacts of constructing and operating nuclear power plants at the North Anna ESP site. These site characteristic and design parameter values (i.e., plant parameter values) were used by the NRC in its independent evaluation of impacts and, in some cases, the NRC substituted values based on its own analysis. FEIS Table I-1 presents the ESP site characteristic values used by the NRC. The ESP, Appendix D, identifies values of plant parameters considered in the environmental review of the application.

In accordance with 10 CFR 51.50(c)(1)(i) and FEIS Table J-1 (Rows 1 and 2), Table 3.0-1 and Table 3.0-2 provide an evaluation of the design of the Unit 3 ESBWR facility to determine if it falls within the ESP site characteristic values specified in the FEIS and the plant parameter values identified in ESP, Appendix D.

- Table 3.0-1 evaluates site characteristics. For each site characteristic listed in FEIS Table I-1, Table 3.0-1 identifies the ESP site characteristic value, the corresponding Unit 3 value, and provides an evaluation of whether the Unit 3 site characteristic value falls within the FEIS site characteristic value. Evaluations are included to provide clarification or additional information where needed, or to provide reference to other sections where further evaluation is provided. The environmental impacts documented in the FEIS, based on the site characteristic values in FEIS Table I-1, are considered bounding, and therefore resolved, when the ESP site characteristic value bounds the Unit 3 site characteristic value.
- Table 3.0-2 evaluates design parameters. For each plant parameter value listed in ESP Table D-1, Table 3.0-2 identifies the ESP plant parameter value, the corresponding Unit 3 design characteristic value, and provides an evaluation of whether the Unit 3 design characteristic value falls within the ESP plant parameter value. Evaluations are included to provide clarification or additional information where needed, or to provide reference to other sections where further evaluation is provided. The environmental impacts documented in the FEIS, based on the plant parameter values provided in ESP Table D-1 and FEIS Table I-2, are considered bounding, and therefore resolved, when the ESP plant parameter value bounds the Unit 3 design characteristic value.

10 CFR 51.50(c)(1) also requires that this ER address environmental issues that were not resolved in the ESP proceeding, or that are affected by new and significant information. This chapter provides additional plant description to the extent necessary to support these supplemental analyses.

Table 3.0-1 Evaluation of ESP Site Characteristics

	ESP Site Characteristics (From FEIS Table I-1)			
Item	**ESP Value**	**Description and References**	**Unit 3 Site Characteristic Value**	**Evaluation**
Atmospheric Dispersion (χ/Q) (Design Basis Accident)		Time-dependent values as listed in FEIS Table 5-14		
Exclusion Area Boundary (EAB)	3.34×10^{-5} sec/m^3	0 to 2 hr interval	3.34×10^{-5} sec/m^3	The Unit 3 site characteristic value for the 0–2 hr short term (accident release) atmospheric dispersion factor, χ/Q, at the EAB is taken from ESP-ER Table 3.1-9 and FEIS Table 5-14. The Unit 3 site characteristic value falls within (is equal to) the ESP value identified in FEIS Table I-1. See Section 7.1 for the analysis of radiological consequences of accident airborne releases.

Table 3.0-1 Evaluation of ESP Site Characteristics

Item	ESP Site Characteristics (From FEIS Table I-1)		Unit 3 Site Characteristic Value	Evaluation
	ESP Value	Description and References		
Atmospheric Dispersion (χ/Q) (Design Basis Accident) (continued)				
Low Population Zone (LPZ)	2.17×10^{-6} sec/m^3	0 to 8 hr interval	2.17×10^{-6} sec/m^3	The Unit 3 site characteristic value for the 0–8 hr short term (accident release) atmospheric dispersion factor, χ/Q, at the LPZ is taken from FEIS Table 5-14. The Unit 3 site characteristic value falls within (is equal to) the ESP value identified in FEIS Table I-1. See Section 7.1 for the analysis of radiological consequences of accident airborne releases.
	1.5×10^{-6} sec/m^3	8 to 24 hr interval	1.5×10^{-6} sec/m^3	The Unit 3 site characteristic value for the 8-24 hr short term (accident release) atmospheric dispersion factor, χ/Q, at the LPZ is taken from FEIS Table 5-14. The Unit 3 site characteristic value falls within (is equal to) the ESP value identified in FEIS Table I-1. See Section 7.1 for the analysis of radiological consequences of accident airborne releases.
	1.2×10^{-6} sec/m^3	1 to 4 day interval	1.2×10^{-6} sec/m^3	The Unit 3 site characteristic value for the 1-4 day short term (accident release) atmospheric dispersion factor, χ/Q, at the LPZ is taken from FEIS Table 5-14. The Unit 3 site characteristic value falls within (is equal to) the ESP value identified in FEIS Table I-1. See Section 7.1 for the analysis of radiological consequences of accident airborne releases.
	9.0×10^{-7} sec/m^3	4 to 30 day interval	9.0×10^{-7} sec/m^3	The Unit 3 site characteristic value for the 4-30 day short term (accident release) atmospheric dispersion factor, χ/Q, at the LPZ is taken from FEIS Table 5-14. The Unit 3 site characteristic value falls within (is equal to) the ESP value identified in FEIS Table I-1. See Section 7.1 for the analysis of radiological consequences of accident airborne releases.

Table 3.0-1 Evaluation of ESP Site Characteristics

Item	ESP Site Characteristics (From FEIS Table I-1): ESP Value	ESP Site Characteristics (From FEIS Table I-1): Description and References	Unit 3 Site Characteristic Value	Evaluation
Gaseous Effluents Dispersion, Deposition (Annual Average)				
Atmospheric Dispersion (χ/Q)	χ/Q values presented in ESP-ER Table 2.7-14	The atmospheric dispersion coefficients used to estimate dose consequences of normal airborne releases.		
Residence	2.4×10^{-6} sec/m^3	No decay, undepleted	RB-VS: 6.8×10^{-8} sec/m^3 TB-VS: 5.5×10^{-8} sec/m^3 RW-VS: 4.2×10^{-6} sec/m^3	The Unit 3 site characteristic values for the no decay, undepleted long-term (annual average) atmospheric dispersion factor, χ/Q, for the nearest residence are provided in Table 2.7-2. The Unit 3 site characteristic value for the Radwaste Building vent stack release does not fall within (is not equal to or less than) the ESP value identified in FEIS Table I-1 and the ESP, Appendix A. See Section 5.4 for the analysis of radiological consequences of routine airborne releases.
	2.4×10^{-6} sec/m^3	2.26-day decay, undepleted	RB-VS: 6.8×10^{-8} sec/m^3 TB-VS: 5.5×10^{-8} sec/m^3 RW-VS: 4.2×10^{-6} sec/m^3	The Unit 3 site characteristic values for the 2.26-day decay, undepleted long-term (annual average) atmospheric dispersion factor, χ/Q, for the nearest residence are provided in Table 2.7-2. The Unit 3 site characteristic value for the Radwaste Building vent stack release does not fall within (is not equal to or less than) the ESP value identified in FEIS Table I-1 and the ESP, Appendix A. See Section 5.4 for the analysis of radiological consequences of routine airborne releases.
	2.1×10^{-6} sec/m^3	8-day decay, depleted	RB-VS: 6.6×10^{-8} sec/m^3 TB-VS: 5.3×10^{-8} sec/m^3 RW-VS: 3.8×10^{-6} sec/m^3	The Unit 3 site characteristic values for the 8-day decay, depleted long-term (annual average) atmospheric dispersion factor, χ/Q, for the nearest residence are provided in Table 2.7-2. The Unit 3 site characteristic value for the Radwaste Building vent stack release does not fall within (is not equal to or less than) the ESP value identified in FEIS Table I-1 and the ESP, Appendix A. See Section 5.4 for the analysis of radiological consequences of routine airborne releases.

Table 3.0-1 Evaluation of ESP Site Characteristics

Item	ESP Site Characteristics (From FEIS Table I-1): ESP Value	Description and References	Unit 3 Site Characteristic Value	Evaluation
Gaseous Effluents Dispersion, Deposition (Annual Average) (continued)				
EAB	3.7×10^{-6} sec/m^3	No decay, undepleted	RB-VS: 7.1×10^{-8} sec/m^3 TB-VS: 5.2×10^{-8} sec/m^3 RW-VS: 3.3×10^{-6} sec/m^3	The Unit 3 site characteristic values for the no decay, undepleted long term (annual average) atmospheric dispersion factors, χ/Qs, for the EAB are taken from Table 2.7-4. The Unit 3 site characteristic values fall within (are less than) the ESP value identified in FEIS Table I-1 and the ESP, Appendix A. See Section 5.4 for the analysis of radiological consequences of routine airborne releases.
	3.7×10^{-6} sec/m^3	2.26-day decay, undepleted	RB-VS: 7.1×10^{-8} sec/m^3 TB-VS: 5.2×10^{-8} sec/m^3 RW-VS: 3.3×10^{-6} sec/m^3	The Unit 3 site characteristic values for the 2.26-day decay, undepleted long term (annual average) atmospheric dispersion factors, χ/Qs, for the EAB are taken from Table 2.7-4. The Unit 3 site characteristic values fall within (are less than) the ESP value identified in FEIS Table I-1 and the ESP, Appendix A. See Section 5.4 for the analysis of radiological consequences of routine airborne releases.
	3.3×10^{-6} sec/m^3	8-day decay, depleted	RB-VS: 6.9×10^{-8} sec/m^3 TB-VS: 5.0×10^{-8} sec/m^3 RW-VS: 2.9×10^{-6} sec/m^3	The Unit 3 site characteristic values for the 8-day decay, depleted long term (annual average) atmospheric dispersion factors, χ/Qs, for the EAB are taken from Table 2.7-4. The Unit 3 site characteristic values fall within (are less than) the ESP value identified in FEIS Table I-1 and the ESP, Appendix A. See Section 5.4 for the analysis of radiological consequences of routine airborne releases.

Table 3.0-1 Evaluation of ESP Site Characteristics

Item	ESP Site Characteristics (From FEIS Table I-1): ESP Value	ESP Site Characteristics (From FEIS Table I-1): Description and References	Unit 3 Site Characteristic Value	Evaluation
Gaseous Effluents Dispersion, Deposition (Annual Average) (continued)				
Meat animal	1.4×10^{-6} sec/m^3	No decay, undepleted	RB-VS: 6.8×10^{-8} sec/m^3 TB-VS: 5.5×10^{-8} sec/m^3 RW-VS: 4.2×10^{-6} sec/m^3	The Unit 3 site characteristic values for the no decay, undepleted long-term (annual average) atmospheric dispersion factors, χ/Qs, for the nearest meat animal are provided in Table 2.7-2. The Unit 3 site characteristic value for the Radwaste Building vent stack release does not fall within (is not equal to or less than) the ESP value identified in FEIS Table I-1 and the ESP, Appendix A. See Section 5.4 for the analysis of radiological consequences of routine airborne releases.
	1.4×10^{-6} sec/m^3	2.26-day decay, undepleted	RB-VS: 6.8×10^{-8} sec/m^3 TB-VS: 5.5×10^{-8} sec/m^3 RW-VS: 4.2×10^{-6} sec/m^3	The Unit 3 site characteristic values for the 2.26-day decay, undepleted long-term (annual average) atmospheric dispersion factors, χ/Qs, for the nearest meat animal are provided in Table 2.7-2. The Unit 3 site characteristic value for the Radwaste Building vent stack release does not fall within (is not equal to or less than) the ESP value identified in FEIS Table I-1 and the ESP, Appendix A. See Section 5.4 for the analysis of radiological consequences of routine airborne releases.
	1.2×10^{-6} sec/m^3	8-day decay, depleted	RB-VS: 6.6×10^{-8} sec/m^3 TB-VS: 5.3×10^{-8} sec/m^3 RW-VS: 3.8×10^{-6} sec/m^3	The Unit 3 site characteristic values for the 8-day decay, depleted long-term (annual average) atmospheric dispersion factors, χ/Qs, for the nearest meat animal are provided in Table 2.7-2. The Unit 3 site characteristic value for the Radwaste Building vent stack release does not fall within (is not equal to or less than) the ESP value identified in FEIS Table I-1 and the ESP, Appendix A. See Section 5.4 for the analysis of radiological consequences of routine airborne releases.

Table 3.0-1 Evaluation of ESP Site Characteristics

Item	ESP Site Characteristics (From FEIS Table I-1): ESP Value	ESP Site Characteristics (From FEIS Table I-1): Description and References	Unit 3 Site Characteristic Value	Evaluation
Gaseous Effluents Dispersion, Deposition (Annual Average) (continued)				
Vegetable garden	2.0×10^{-6} sec/m^3	No decay, undepleted	RB-VS: 6.8×10^{-8} sec/m^3 TB-VS: 5.5×10^{-8} sec/m^3 RW-VS: 4.2×10^{-6} sec/m^3	The Unit 3 site characteristic values for the no decay, undepleted long-term (annual average) atmospheric dispersion factors, χ/Qs, for the nearest vegetable garden are provided in Table 2.7-2. The Unit 3 site characteristic value for the Radwaste Building vent stack release does not fall within (is not equal to or less than) the ESP value identified in FEIS Table I-1 and the ESP, Appendix A. See Section 5.4 for the analysis of radiological consequences of routine airborne releases.
	2.0×10^{-6} sec/m^3	2.26-day decay, undepleted	RB-VS: 6.8×10^{-8} sec/m^3 TB-VS: 5.5×10^{-8} sec/m^3 RW-VS: 4.2×10^{-6} sec/m^3	The Unit 3 site characteristic values for the 2.26-day decay, undepleted long-term (annual average) atmospheric dispersion factors, χ/Qs, for the nearest vegetable garden are provided in Table 2.7-2. The Unit 3 site characteristic value for the Radwaste Building vent stack release does not fall within (is not equal to or less than) the ESP value identified in FEIS Table I-1 and the ESP, Appendix A. See Section 5.4 for the analysis of radiological consequences of routine airborne releases.
	1.8×10^{-6} sec/m^3	8-day decay, depleted	RB-VS: 6.6×10^{-8} sec/m^3 TB-VS: 5.3×10^{-8} sec/m^3 RW-VS: 3.8×10^{-6} sec/m^3	The Unit 3 site characteristic values for the 8-day decay, depleted long-term (annual average) atmospheric dispersion factors, χ/Qs, for the nearest vegetable garden are provided in Table 2.7-2. The Unit 3 site characteristic value for the Radwaste Building vent stack release does not fall within (is not equal to or less than) the ESP value identified in FEIS Table I-1 and the ESP, Appendix A. See Section 5.4 for the analysis of radiological consequences of routine airborne releases.

Table 3.0-1 Evaluation of ESP Site Characteristics

ESP Site Characteristics (From FEIS Table I-1)			Unit 3 Site Characteristic Value	Evaluation
Item	**ESP Value**	**Description and References**		
Gaseous Effluents Dispersion, Deposition (Annual Average) (continued)				
Ground Deposition (D/Q)	D/Q values presented in ESP-ER Table 2.7-14 and the ESP, Appendix A	The ground deposition coefficients used to estimate dose consequences of normal airborne releases		
Residence	7.2×10^{-9} /m^2		RB-VS: 1.8×10^{-9} 1/m^2 TB-VS: 1.8×10^{-9} 1/m^2 RW-VS: 1.1×10^{-8} 1/m^2	The Unit 3 site characteristic values for the long-term (annual average) ground deposition factors, D/Qs, for the nearest residence are provided in Table 2.7-2. The Unit 3 site characteristic value for the Radwaste Building vent stack release does not fall within (is not equal to or less than) the ESP value identified in FEIS Table I-1 and the ESP, Appendix A. See Section 5.4 for the analysis of radiological consequences of routine airborne releases.
EAB	1.2×10^{-8} /m^2		RB-VS: 1.7×10^{-9} 1/m^2 TB-VS: 1.6×10^{-9} 1/m^2 RW-VS: 1.1×10^{-8} 1/m^2	The Unit 3 site characteristic values for the long-term (annual average) ground deposition factors, D/Qs, for the EAB are taken from Table 2.7-4. The Unit 3 site characteristic values fall within (are less than) the ESP value identified in FEIS Table I-1 and the ESP, Appendix A. See Section 5.4 for the analysis of radiological consequences of routine airborne releases.

Table 3.0-1 Evaluation of ESP Site Characteristics

Item	ESP Site Characteristics (From FEIS Table I-1): ESP Value	ESP Site Characteristics (From FEIS Table I-1): Description and References	Unit 3 Site Characteristic Value	Evaluation
Gaseous Effluents Dispersion, Deposition (Annual Average) (continued)				
Meat animal	3.1×10^{-9} /m^2		RB-VS: 1.8×10^{-9} 1/m^2 TB-VS: 1.8×10^{-9} 1/m^2 RW-VS: 1.1×10^{-8} 1/m^2	The Unit 3 site characteristic values for the long-term (annual average) ground deposition factors, D/Qs, for the nearest meat animal are provided in Table 2.7-2. The Unit 3 site characteristic value for the Radwaste Building vent stack release does not fall within (is not equal to or less than) the ESP value identified in FEIS Table I-1 and the ESP, Appendix A. See Section 5.4 for the analysis of radiological consequences of routine airborne releases. See also FSAR Section 1.8 and FSAR Table 12.2-201 for NAPS ESP VAR 2.0-1.
Vegetable garden	6.0×10^{-9} /m^2		RB-VS: 1.8×10^{-9} 1/m^2 TB-VS: 1.8×10^{-9} 1/m^2 RW-VS: 1.1×10^{-8} 1/m^2	The Unit 3 site characteristic values for the long-term (annual average) ground deposition factors, D/Qs, for the nearest vegetable garden are provided in Table 2.7-2. The Unit 3 site characteristic value for the Radwaste Building vent stack release does not fall within (is not equal to or less than) the ESP value identified in FEIS Table I-1 and the ESP, Appendix A. See Section 5.4 for the analysis of radiological consequences of routine airborne releases.

Table 3.0-1 Evaluation of ESP Site Characteristics

	ESP Site Characteristics (From FEIS Table I-1)			
Item	**ESP Value**	**Description and References**	**Unit 3 Site Characteristic Value**	**Evaluation**
Dose Consequences				
Normal	10 CFR 20; 10 CFR 50, Appendix I, Dose Objectives; and 40 CFR 190 dose limits	Radiological dose consequences due to gaseous and liquid releases from normal operation of the plant	10 CFR 20; 10 CFR 50, Appendix I, Dose Objectives; and 40 CFR 190 dose limits	
Liquid effluent	1.6 mrem/yr	Total body (Value for two units, see ESP-ER Table 5.4-11)	0.079 mrem/yr	The Unit 3 site characteristic value is the total body dose to the Maximally Exposed Individual (MEI) from Unit 3 liquid effluents as shown in Table 5.4-6. The Unit 3 site characteristic value falls within (is less than) the ESP value identified in FEIS Table I-1 for two units. See also FSAR Tables 12.2-20bR and 12.2-202.
	1.4 mrem/yr	Thyroid (Value for two units, see ESP-ER Table 5.4-11)	0.26 mrem/yr	The Unit 3 site characteristic value is the thyroid dose to the MEI from Unit 3 liquid effluents as shown in Table 5.4-6. The Unit 3 site characteristic value falls within (is less than) the ESP value identified in FEIS Table I-1 for two units. See FSAR Table 12.2-20bR.
	5.0 mrem/yr	Other organ/bone (Value for two units, see ESP-ER Table 5.4-11)	1.1 mrem/yr	The Unit 3 site characteristic value is the other organ dose to the MEI from Unit 3 liquid effluents as shown in Table 5.4-2. The Unit 3 site characteristic value falls within (is less than) the ESP value identified in FEIS Table I-1 for two units for other organ/bone dose. See also FSAR Tables 12.2-20bR and 12.2-202.

Table 3.0-1 Evaluation of ESP Site Characteristics

ESP Site Characteristics (From FEIS Table I-1)			Unit 3 Site Characteristic Value	Evaluation
Item	ESP Value	Description and References		
Dose Consequences (continued)				
Gaseous effluent	4.8 mrem/yr	Total body (Value for two units, see ESP-ER Table 5.4-11)	0.48mrem/yr	The Unit 3 site characteristic value is the highest total body dose to the MEI from Unit 3 gaseous effluents as shown in Tables 5.4-4 and 5.4-6. The Unit 3 site characteristic value falls within (is less than) the ESP value identified in FEIS Table I-1 for two units. See also FSAR Tables 12.2-18bR and 12.2-203.
	25 mrem/yr	Thyroid (Value for two units, see ESP-ER Table 5.4-11)	4.7 mrem/yr	The Unit 3 site characteristic value is the highest thyroid dose to the MEI from Unit 3 gaseous effluents as shown in Tables 5.4-4 and 5.4-6. The Unit 3 site characteristic value falls within (is less than) the ESP value identified in FEIS Table I-1 for two units and is well below the 40 CFR 190 limit. See also FSAR Tables 12.2-18bR and 12.2-203.
	6.5 mrem/yr	Other organ (Value for two units, see ESP-ER Table 5.4-11)	0.57mrem/yr	The Unit 3 site characteristic value is the highest other organ (liver) dose to the MEI from Unit 3 gaseous effluents. The Unit 3 site characteristic value falls within (is less than) the ESP value identified in FEIS Table I-1 for two units.
	6.2 mrem/yr	Skin (Value for one unit, see ESP-ER Table 5.4-10)	0.59mrem/yr	The Unit 3 site characteristic value is the highest skin dose to the MEI from Unit 3 gaseous effluents as shown in Tables 5.4-4 and 5.4-5. It represents the summation of plume and ground shine doses. The Unit 3 site characteristic value falls within (is less than) the ESP value identified in FEIS Table I-1. See also FSAR Tables 12.2-18bR and 12.2-201.

Table 3.0-1 Evaluation of ESP Site Characteristics

Item	ESP Site Characteristics (From FEIS Table I-1): ESP Value	Description and References	Unit 3 Site Characteristic Value	Evaluation
Dose Consequences (continued)				
Total	6.4 mrem/yr	Total body (Value for two units, see ESP-ER Table 5.4-11)	0.56 mrem/yr	The Unit 3 site characteristic value is the total total-body dose to the MEI from Unit 3 liquid and gaseous effluents as shown in Table 5.4-6. The Unit 3 site characteristic value falls within (is less than) the ESP value identified in FEIS Table I-1 for two units. See also FSAR Table 12.2-203.
	27 mrem/yr	Thyroid (Value for two units, see ESP-ER Table 5.4-11)	5.0 mrem/yr	The Unit 3 site characteristic value is the total thyroid dose to the MEI from Unit 3 liquid and gaseous effluents as shown in Table 5.4-6. The Unit 3 site characteristic value falls within (is less than) the ESP value identified in FEIS Table I-1 for two units. See also FSAR Table 12.2-203.
	11 mrem/yr	Other organ (Value for two units, see ESP-ER Table 5.4-11)	1.6 mrem/yr	The Unit 3 site characteristic value is the total other organ dose to the MEI from Unit 3 liquid and gaseous effluents as shown in Table 5.4-6. The Unit 3 site characteristic value falls within (is less than) the ESP value identified in FEIS Table I-1 for two units. See also FSAR Table 12.2-203.
	6.2 mrem/yr	Skin (Value for one unit, see ESP-ER Table 5.4-10)	0.59 mrem/yr	This Unit 3 site characteristic value is the total skin dose to the MEI from Unit 3 gaseous effluents as shown in Table 5.4-5. The Unit 3 site characteristic value falls within (is less than) the ESP value identified in FEIS Table I-1. See also FSAR Table 12.2-201.

Table 3.0-1 Evaluation of ESP Site Characteristics

Item	ESP Site Characteristics (From FEIS Table I-1) ESP Value	Description and References	Unit 3 Site Characteristic Value	Evaluation
Dose Consequences (continued)				
Post-Accident	10 CFR 50.34(a)(1) and 10 CFR 100 dose limits	Radiological dose consequences due to gaseous releases from postulated plant accidents Design basis accidents (DBA) as listed in FEIS Tables 5-15, 5-16, and 5-17 Severe accidents as listed in FEIS Tables 5-18, 5-19, and 5-20	10 CFR 50.34(a)(1) and 10 CFR 100 dose limits	The Unit 3 site characteristic criteria are taken from ESP-ER Table 3.1-9. The Unit 3 site characteristic criteria for Unit 3 fall within (are equal to) the ESP criteria specified in FEIS Table I-1. FEIS Tables 5-15 and 5-18 (ABWR) and FEIS Tables 5-16 and 5-19 (AP1000) apply to a non-ESBWR plant and hence are not applicable to Unit 3. ESP-ER Table 7.1-2 and FEIS Table 5-17 identify Design Basis Accident (DBA) dose consequences for the ESBWR at the EAB and LPZ. Table 7.1-2 provides DBA dose consequences for Unit 3. All Unit 3 DBA doses are lower than and bounded by the ESP DBA dose values for the ESBWR except for LOCA, which remains a small fraction of the regulatory limit. In addition, a new DBA, RWCU/SDC system line failure (pre-incident iodine spike), was added to the evaluation, which was not considered in the ESP-ER. Environmental risk values for the ESBWR are identified in FEIS Table 5-20.
Minimum Distance to Site Boundary	2854.9 ft	Minimum lateral distance from the ESP PPE boundaries to the EAB	2854.9 ft	The Unit 3 site characteristic value is taken from ESP-ER Table 3.1-9. See also ESP-ER Figure 2.1-1. The Unit 3 site characteristic value falls within (is equal to) the ESP value identified in FEIS Table I-1.

Table 3.0-1 Evaluation of ESP Site Characteristics

Item	ESP Site Characteristics (From FEIS Table I-1): ESP Value	ESP Site Characteristics (From FEIS Table I-1): Description and References	Unit 3 Site Characteristic Value	Evaluation
Liquid Radwaste System				
Normal Dose Consequences	10 CFR 20; 10 CFR 50, Appendix I, Dose Objectives; and 40 CFR 190 dose limits		10 CFR 20; 10 CFR 50, Appendix I, Dose Objectives; and 40 CFR 190 dose limits	
	1.6 mrem/yr	Total body (Value for two units, see ESP-ER Table 5.4-11)	0.079 mrem/yr	The Unit 3 site characteristic value is the total body dose to the MEI from Unit 3 liquid effluents as shown in Table 5.4-6. The Unit 3 site characteristic value falls within (is less than) the ESP value identified in FEIS Table I-1 for two units. See also FSAR Tables 12.2-20bR and 12.2-202.
	1.4 mrem/yr	Thyroid (Value for two units, see ESP-ER Table 5.4-11)	0.26 mrem/yr	The Unit 3 site characteristic value is the thyroid dose to the MEI from Unit 3 liquid effluents as shown in Table 5.4-6. The Unit 3 site characteristic value falls within (is less than) the ESP value identified in FEIS Table I-1 for two units. See also FSAR Table 12.2-20bR.
	5.0 mrem/yr	Other organ (Value for two units, see ESP-ER Table 5.4-11)	1.1 mrem/yr	The Unit 3 site characteristic value is the other organ dose to the MEI from Unit 3 liquid effluents as shown in Table 5.4-2. The Unit 3 site characteristic value falls within (is less than) the ESP value identified in FEIS Table I-1 for two units. See also FSAR Tables 12.2-20bR and 12.2-202.

Table 3.0-1 Evaluation of ESP Site Characteristics

ESP Site Characteristics (From FEIS Table I-1)				
Item	ESP Value	Description and References	Unit 3 Site Characteristic Value	Evaluation
Population Density				
Population density at the time of initial site approval and within about 5 years thereafter	Population density meets the guidance of RS-002, Section 2.1.3 for RG 4.7, Regulatory Position C.4	At the time of initial site approval and within about 5 years hereafter, the population densities, including weighted transient population, averaged over any radial distance out to 20 miles (cumulative population at a distance divided by the circular area at that distance), would not exceed 500 persons per square mile.	Population density meets the guidance of RS-002, Section 2.1.3 for RG 4.7, Regulatory Position C.4	Based on ESP-ER Table 3.1-9, the Unit 3 site characteristic criterion is, that at the time of initial site approval and within about 5 years hereafter, the population densities, including weighted transient population, averaged over any radial distance out to 20 miles (cumulative population at a distance divided by the circular area at that distance), would not exceed 500 persons per square mile. The Unit 3 site characteristic criterion falls within (is the same as) the ESP criterion specified in FEIS Table I-1. Time dependent population densities are provided in ESP-ER Section 2.5.1 which refers to ESP-ER Figure 2.5-13. That figure shows the projected population density at 5 years meets the requirement.

Table 3.0-1 Evaluation of ESP Site Characteristics

ESP Site Characteristics (From FEIS Table I-1)				
Item	**ESP Value**	**Description and References**	**Unit 3 Site Characteristic Value**	**Evaluation**
Population Density (continued)				
Population density at the time of initial operation	Population density meets the guidance of RS-002, Section 2.1.3	The population densities, including weighted transient population, averaged over any radial distance out to 30 miles (cumulative population at a distance divided by the area at that distance), would not exceed 500 persons per square mile at the time of initial operation.	Population density meets the guidance of RS-002, Section 2.1.3	Based on ESP-ER Table 3.1-9, the Unit 3 site characteristic criterion is that the population densities, including weighted transient population, averaged over any radial distance out to 30 miles (cumulative population at a distance divided by the area at that distance), would not exceed 500 persons per square mile at the time of initial operation. The Unit 3 site characteristic criterion falls within (is the same as) the ESP criterion identified in FEIS Table I-1. Time dependent population densities are provided in ESP-ER Section 2.5.1 which refers to ESP-ER Figure 2.5-13. That figure shows the projected population density at the time of initial operation meets the requirement.

Table 3.0-1 Evaluation of ESP Site Characteristics

ESP Site Characteristics (From FEIS Table I-1)			Unit 3 Site Characteristic Value	Evaluation
Item	**ESP Value**	**Description and References**		
Population Density (continued)				
Population density over the lifetime of the new units until 2065	Population density meets the guidance of RS-002, Section 2.1.3	The population densities, including weighted transient population, averaged over any radial distance out to 30 miles (cumulative population at a distance divided by the area at that distance), would not exceed 1000 persons per square mile over the lifetime of new units.	Population density meets the guidance of RS-002, Section 2.1.3	Based on ESP-ER Table 3.1-9, the Unit 3 site characteristic criterion is that the population densities, including weighted transient population, averaged over any radial distance out to 30 miles (cumulative population at a distance divided by the area at that distance), would not exceed 1000 persons per square mile over the lifetime of Unit 3. The Unit 3 site characteristic criterion falls within (is the same as) the ESP criterion identified in FEIS Table I-1. Time dependent population densities are provided in ESP-ER Section 2.5.1 which refers to ESP-ER Figure 2.5-13. That figure shows the projected population density over the lifetime of Unit 3 meets the requirement.

Table 3.0-1 Evaluation of ESP Site Characteristics

Item	ESP Site Characteristics (From FEIS Table I-1) ESP Value	Description and References	Unit 3 Site Characteristic Value	Evaluation
Population Density (continued)				
Population Center Distance	10 CFR 100.21(b) Meets requirement	The distance from the ESP PPE to the nearest boundary of a densely populated center containing more than about 25,000 residents is not less than one and one-third times the distance from the ESP PPE to the outer boundary of the LPZ.	10 CFR 100.21(b) Meets requirement	The Unit 3 site characteristic value is that the nearest population center to Unit 3 with more than 25,000 residents is the City of Charlottesville which is 36 miles away as described in ESP-ER Section 2.5.1.2 and ESP-ER Table 3.1-9. The Unit 3 site characteristic value falls within (meets) the ESP criterion identified in FEIS Table I-1 and the ESP, Appendix A. (Note that the ESP site characteristic value for minimum population center distance is 8 miles as provided in ESP, Appendix A).
EAB	10 CFR 100.21(a) Meets requirement	The exclusion area boundary is the perimeter of a 5,000-ft-radius circle from the center of the originally-planned NAPS Unit 3 containment.	10 CFR 100.21(a) Meets requirement	The Unit 3 site characteristic value is a 5,000-ft-radius circle from the center of the originally-planned NAPS Unit 3 containment as described in ESP-ER Table 3.1-9. The Unit 3 site characteristic value falls within (meets) the ESP criterion and is equal to the ESP value of a 5,000 ft-radius circle identified in FEIS Table I-1 and the ESP, Appendix A.

Table 3.0-1 Evaluation of ESP Site Characteristics

	ESP Site Characteristics (From FEIS Table I-1)			
Item	**ESP Value**	**Description and References**	**Unit 3 Site Characteristic Value**	**Evaluation**
Population Density (continued)				
LPZ	10 CFR 100.21(a) Meets requirement	The LPZ is a 6-mile-radius circle centered at the NAPS Unit 1 containment building.	10 CFR 100.21(a) Meets requirement	The Unit 3 site characteristic value is a 6-mile-radius circle centered at the center of the Unit 1 containment building as described in ESP-ER Table 3.1-9. The Unit 3 site characteristic value falls within (meets) the ESP criterion and is equal to the ESP value of a 6-mile-radius circle identified in FEIS Table I-1 and the ESP, Appendix A.

Except where specifically noted, the values provided from FEIS Table I-1 are for one unit.

Table 3.0-2 Evaluation of ESP Design Parameters

Item	ESP Plant Parameters [From ESP Table D-1]: ESP Value	Description and References	Unit 3 Design Characteristic Value	Evaluation
Structure Height	≤ 234 ft	The height from finished grade to the top of the tallest power block structure, excluding cooling towers	234 ft	The tallest power block structure is the Turbine Building vent stack (see DCD Table 2B-1) at 71.3 m (234 ft) above finished grade. This is the Unit 3 design characteristic value. The Unit 3 design characteristic value falls within (is equal to) the ESP plant parameter value identified in ESP Table D-1.
Structure Foundation Embedment	≤ 140 ft	The depth from finished grade to the bottom of the basemat for the most deeply embedded power block structure	20 m (65.6 ft) Nominal	The Unit 3 design characteristic value for structure foundation embedment is based on the bottom of the deepest power block structure basemat, which is the reactor building at 20 m (65.62 ft) nominal, below finished ground level grade (El. 88.24 m (289.50 ft NAVD88 (290.36 ft NGVD29))). The embedment of 20 m (65.62 ft) is based on the lowest elevation of -15.5 m (50.85 ft) and a finished ground level grade of +4.5 m (14.76 ft), yielding a depth of 20 m (65.62 ft), not including concrete fill below the basemat. This Unit 3 design characteristic value is shown in FSAR Figure 2.5.4-206. The Unit 3 design characteristic value falls within (is less than) the ESP design parameter value identified in ESP Table D-1.
Normal Plant Heat Sink				
Condenser/Heat Exchanger Duty	≤ 1.03×10^{10} Btu/hr	Waste heat rejected from the main condenser and the auxiliary heat exchangers during normal plant operation at full station load	≤ 1.03×10^{10} Btu/hr	The Unit 3 design characteristic value is 1.03×10^{10} Btu/hr maximum waste heat rejected from the main condenser and auxiliary heat exchangers. The main condenser heat rate of 1.0×10^{10} Btu/hr and the plant service water system heat rate of 3×10^{8} Btu/hr (based on one of two redundant trains operating) are shown in the appropriate FSAR tables. The Unit 3 design characteristic value falls within (is equal to) the ESP plant parameter value identified in ESP Table D-1.
Maximum Inlet Temperature Condenser/Heat Exchanger	100°F	Maximum intake temperature at condenser and heat exchanger inlet	100°F	The Unit 3 design characteristic value is a maximum inlet water temperature of 100°F for the condenser as identified in FSAR Table 10.4-3R. The Unit 3 design characteristic value falls within (is equal to) the ESP plant parameter value identified in ESP Table D-1.

Table 3.0-2 Evaluation of ESP Design Parameters

Item	ESP Plant Parameters [From ESP Table D-1] ESP Value	ESP Plant Parameters [From ESP Table D-1] Description and References	Unit 3 Design Characteristic Value	Evaluation
Unit 3 Closed-Cycle, Dry and Wet Tower				
Height	≤ 180 ft	The height above finished grade of the cooling towers	180 ft	The Unit 3 design characteristic value is the hybrid cooling tower height of 55 m (180 ft) above finished grade. The Unit 3 design characteristic value falls within (is equal to) the ESP plant parameter value identified in ESP Table D-1.
Make-Up Flow Rate	15,384 gpm, maximum (MWC mode) 22,268 gpm, maximum (EC mode)	The expected rate of removal of water from Lake Anna to replace water losses from the closed-cycle cooling water system	15,376 gpm (MWC mode) 22,260 gpm (EC mode)	The Unit 3 design characteristic values for the hybrid cooling tower makeup rate are the expected rates of water withdrawal from Lake Anna to replace water lost from the operation of the tower. These losses are from evaporation, blowdown, and drift. The hybrid cooling tower has two modes of operation, Maximum Water Conservation (MWC) and Energy Conservation (EC). The Unit 3 design characteristic values for the MWC and EC modes of operation fall within (are less than) the ESP plant parameter values identified in ESP Table D-1.

Table 3.0-2 Evaluation of ESP Design Parameters

	ESP Plant Parameters [From ESP Table D-1]		Unit 3 Design Characteristic Value	
Item	**ESP Value**	**Description and References**		**Evaluation**
Unit 3 Closed-Cycle, Dry and Wet Tower (continued)				
Evaporation Rate	8707 gpm, 365-day rolling average[a]	Maximum rates at which water is lost by evaporation resulting from operation of the plant cooling towers.	8977 gpm, average without mitigating action of 3-inch rise in pool level; 9695 gpm, average with mitigating action of 3-inch rise in pool level (96% plant capacity factor with wet tower cooling)	The ESP design parameter value of 8707 gpm presented in ESP Table D-1 was used by the NRC Staff to characterize the average evaporation rate over a 365 day period and does not include a 96% capacity factor. See the description in the 5th paragraph of FEIS Section 5.3.2. The Unit 3 design characteristics value of 8977 gpm (20 cfs) (without mitigating action) and 9695 gpm (21.6 cfs) (with the mitigating action of raising the normal pool level in the Lake Anna (North Anna Reservoir) by 3 inches) are estimates from the extended water budget model performed as part of the Instream Flow Incremental Methodology (IFIM) study discussed in Section 5.10.1.1. These are the expected long-term cooling tower evaporation rates using a 96% capacity factor. The Unit 3 evaporation rate of 8977 gpm value exceeds the 8707 gpm evaluated in FEIS Section 5.3.2 because it was based on the water budget model that was extended to 2007 to cover the more recent climatic conditions. The Unit 3 evaporation rate with the mitigating action is higher because of the extended model period, and because the mitigating action of raising the pool level increases the frequency at which the lake level would be greater or equal to 250 ft msl. Consequently, the increased frequency of higher lake level would result in an increased frequency when the Unit 3 cooling towers would be operating in the EC mode. While the estimated evaporation rate would be higher, the frequency of reduced lake level (248 ft msl and lower) and downstream flow at 20 cfs would decrease because of the increased pool level. The hydrologic evaluation with respect to water-use impact of the plant with and without mitigating action is discussed in Section 5.10.1.3, which shows that the impacts of Unit 3

(continued)

Table 3.0-2 Evaluation of ESP Design Parameters

Item	ESP Plant Parameters [From ESP Table D-1] ESP Value	Description and References	Unit 3 Design Characteristic Value	Evaluation
Unit 3 Closed-Cycle, Dry and Wet Tower (continued)				
Evaporation Rate *(continued)*				on downstream flow and on lake levels are SMALL, and the lake mitigating action of raising the normal pool level to Elevation 250.25 ft msl would further reduce the impact.
	None[b]		11,532 gpm (MWC)	The Unit 3 design characteristic value of 11,532 gpm is taken from ESP-ER Table 3.1-9 for the MWC mode. The Unit 3 design characteristic value for the MWC mode of operation falls within (is equal to) the ESP design parameter value identified in FEIS Table I-2.
	16,695 gpm, maximum (EC mode)		16,695 gpm (EC)	The Unit 3 design characteristic value of 16,695 gpm is taken from ESP-ER Table 3.1-9 for the EC mode. The Unit 3 design characteristic value for the mode of operation falls within (is equal to) the ESP plant parameter value identified in ESP Table D-1.
Drift Rate	8 gpm, maximum (MWC mode) 8 gpm, maximum (EC mode)	Expected rates at which water is lost by drift resulting from operation of the plant cooling towers based on 0.001% of cooling water flow	8 gpm (MWC) 8 gpm (EC)	The Unit 3 design characteristic values of 8 gpm for the MWC and EC modes are taken from ESP-ER Table 3.1-9. The Unit 3 hybrid cooling tower drift rate is the expected rate at which water is lost through drift from operation of the tower. The Unit 3 design characteristic values for the MWC and EC modes of operation falls within (are equal to) the ESP plant parameter values identified in ESP Table D-1.
Blowdown Flow Rate	3844 gpm, maximum (MWC mode) 5565 gpm, maximum (EC mode)	Flow rate of the blowdown stream from the closed-cycle cooling water system to the WHTF	3837 gpm (MWC) 5558 gpm (EC)	The Unit 3 design characteristic value for the hybrid cooling tower blowdown rate is the expected rate at which water is lost through blowdown flow from the cooling tower system to the WHTF. The Unit 3 design characteristic values for the MWC and EC modes of operation falls within (are less than) the ESP plant parameter values identified in ESP Table D-1.

Table 3.0-2 Evaluation of ESP Design Parameters

Item	ESP Plant Parameters [From ESP Table D-1] ESP Value	Description and References	Unit 3 Design Characteristic Value	Evaluation
Unit 3 Closed-Cycle, Dry and Wet Tower (continued)				
Blowdown Temperature	100°F, maximum	The maximum expected temperature of the cooling tower blowdown stream to the WHTF	100°F, maximum	The Unit 3 design characteristic value of 100°F is taken from ESP-ER Table 3.1-9. The maximum Unit 3 cooling tower blowdown temperature is the same as the maximum condenser inlet water temperature. The Unit 3 design characteristic value falls within (is equal to) the ESP plant parameter value identified in ESP Table D-1.
Blowdown Constituents and Concentrations		The maximum expected concentrations for anticipated constituents in the cooling water system blowdown to the WHTF		
Free Available Chlorine	< 0.3 ppm		Less than detectable (< 0.1 ppm)	The Unit 3 design characteristic value for maximum free chlorine concentration (based on 9 cycles of concentration) in the Unit 3 cooling tower blowdown flow to the WHTF is “less than detectable,” (<0.1 ppm). The Unit 3 design characteristic value falls within (is less than) the ESP plant parameter value identified in ESP Table D-1.
Copper	<1 ppm		≤ 0.03 ppm	The Unit 3 design characteristic value for maximum Unit 3 copper concentration (based on 9 cycles of concentration) in the Unit 3 cooling tower blowdown flow to the WHTF is 0.03 ppm. The Unit 3 design characteristic value falls within (is less than) the ESP plant parameter value identified in ESP Table D-1.

Table 3.0-2 Evaluation of ESP Design Parameters

Item	ESP Plant Parameters [From ESP Table D-1]: ESP Value	ESP Plant Parameters [From ESP Table D-1]: Description and References	Unit 3 Design Characteristic Value	Evaluation
Unit 3 Closed-Cycle, Dry and Wet Tower (continued)				
Iron	< 1 ppm		≤ 2.4 ppm	The Unit 3 design characteristic value for maximum expected iron concentration (based on 9 cycles of concentration) in the Unit 3 cooling tower blowdown flow to the WHTF is 2.4 ppm. The Unit 3 design characteristic value does not fall within (is not equal to or less than) the ESP plant parameter value identified in ESP Table D-1. Although the Unit 3 value exceeds the ESP plant parameter, iron is not a priority pollutant in 40 CFR 423, Appendix A, and the Virginia Department of Environmental Quality has no water quality standard for it. Upon dilution in the WHTF, the iron concentration falls within the ESP plant parameter. See also Section 3.6.
Sulfate	< 300 ppm		≤ 65 ppm	The Unit 3 design characteristic value for maximum sulfate concentration (based on 9 cycles of concentration) in the Unit 3 cooling tower blowdown flow to the WHTF is 65 ppm. The Unit 3 design characteristic value falls within (is less than) the ESP plant parameter value identified in ESP Table D-1.
Total Dissolved Solids	< 3000 ppm		≤ 550 ppm	The Unit 3 design characteristic value for maximum concentration (based on 9 cycles of concentration) of total dissolved solids (TDS) contained in the Unit 3 cooling tower blowdown flow to the WHTF is 550 ppm. The Unit 3 design characteristic value falls within (is less than) the ESP plant parameter value identified in ESP Table D-1.
Heat Rejection Rate	≤1.03E10 Btu/hr	The expected maximum heat rejection rate to the atmosphere during normal operation at full station load.	$\leq 1.03 \times 10^{10}$ Btu/hr	The Unit 3 design characteristic value is 1.03×10^{10} Btu/hr maximum waste heat rejected from the main condenser and auxiliary heat exchangers. The main condenser heat rate of 1.0×10^{10} Btu/hr and the plant service water system heat rate of 3×10^{8} Btu/hr (based on one of two redundant trains operating) are shown in the appropriate FSAR tables. The Unit 3 design characteristic value falls within (is equal to) the ESP plant parameter value identified in ESP Table D-1.

Table 3.0-2 Evaluation of ESP Design Parameters

Item	ESP Plant Parameters [From ESP Table D-1] ESP Value	Description and References	Unit 3 Design Characteristic Value	Evaluation
Noise	< 65 dBA EAB	Maximum expected sound level at the EAB from operation of the cooling towers	< 65 dBA EAB	The Unit 3 site characteristic value is less than 65 dBA based on the confirmatory analysis described in Section 5.8. This analysis demonstrates that the maximum expected sound level of operation of the Unit 3 Circulating Water and Plant Service Water system cooling towers is less than 65 dBA. The Unit 3 design characteristic value falls within (is equal to) the ESP plant parameter value identified in ESP Table D-1.
Unit 4 Dry Cooling Towers				
Evaporation Rate	None or negligible (on the order of 1 gpm, average)	The expected rate at which water is lost by evaporation from the cooling water system	Not applicable	This design parameter is not applicable because Unit 4 is not included in this ER.
Height	≤180 ft	The vertical height above finished grade of the cooling towers	Not applicable	This design parameter is not applicable because Unit 4 is not included in this ER.
Makeup Flow Rate	None or negligible (on the order of 1 gpm, average)	The expected rate of removal of water from Lake Anna to replace evaporative water losses from the cooling water system	Not applicable	This design parameter is not applicable because Unit 4 is not included in this ER.
Noise	< 60 dBA at EAB	Maximum expected sound level at the EAB from operation of the cooling towers	Not applicable	This design parameter is not applicable because Unit 4 is not included in this ER.

Table 3.0-2 Evaluation of ESP Design Parameters

	ESP Plant Parameters [From ESP Table D-1]			
Item	**ESP Value**	**Description and References**	**Unit 3 Design Characteristic Value**	**Evaluation**
Heat Rejection Rate	$\leq 1.03 \times 10^{10}$ Btu/hr	Waste heat rejected to the atmosphere from the cooling water system, during normal plant operation at full station load	Not applicable	This design parameter is not applicable because Unit 4 is not included in this ER.
Ultimate Heat Sink (UHS)				
Mechanical Draft Cooling Towers				
Blowdown Constituents and Concentrations		The maximum expected concentrations for anticipated constituents in the UHS blowdown to the WHTF		
Free Available Chlorine	< 0.3 ppm		Not Applicable	This design parameter is not applicable because the UHS for the passive Unit 3 ESBWR design does not use mechanical draft cooling towers.
Copper	< 1 ppm		Not Applicable	This design parameter is not applicable because the UHS for the passive Unit 3 ESBWR design does not use mechanical draft cooling towers.
Iron	< 1 ppm		Not Applicable	This design parameter is not applicable because the UHS for the passive Unit 3 ESBWR design does not use mechanical draft cooling towers.
Sulfate	< 300 ppm		Not Applicable	This design parameter is not applicable because the UHS for the passive Unit 3 ESBWR design does not use mechanical draft cooling towers.
Total Dissolved Solids	< 3000 ppm		Not Applicable	This design parameter is not applicable because the UHS for the passive Unit 3 ESBWR design does not use mechanical draft cooling towers.

Table 3.0-2 Evaluation of ESP Design Parameters

Item	ESP Plant Parameters [From ESP Table D-1] ESP Value	Description and References	Unit 3 Design Characteristic Value	Evaluation
Ultimate Heat Sink (UHS) (continued) **Mechanical Draft Cooling Towers (continued)**				
Blowdown Flow Rate	144 gpm expected, 850 gpm maximum	The normal expected and maximum flow rate of the blowdown stream from the UHS system to the WHTF	Not Applicable	This design parameter is not applicable because the UHS for the passive Unit 3 ESBWR design does not use mechanical draft cooling towers.
Evaporation Rate	411 gpm normal, 850 gpm shutdown	The expected (and maximum) rate at which water is lost by evaporation from the UHS System	Not Applicable	This design parameter is not applicable because the UHS for the passive Unit 3 ESBWR design does not use mechanical draft cooling towers.
Height	≤60 ft	The vertical height above finished grade of mechanical draft cooling towers associated with the UHS system	Not Applicable	This design parameter is not applicable because the UHS for the passive Unit 3 ESBWR design does not use mechanical draft cooling towers.
Maximum Consumption of Raw Water	850 gpm, nominal	The expected maximum short-term consumptive use of water from Lake Anna by the UHS system (evaporation and drift losses)	Not Applicable	This design parameter is not applicable because the UHS for the passive Unit 3 ESBWR design does not use mechanical draft cooling towers.
Monthly Average Consumption of Raw Water	411 gpm	The expected normal operating consumption of water from Lake Anna by the UHS system (evaporation and drift losses)	Not Applicable	This design parameter is not applicable because the UHS for the passive Unit 3 ESBWR design does not use mechanical draft cooling towers.

Table 3.0-2 Evaluation of ESP Design Parameters

Item	ESP Plant Parameters [From ESP Table D-1]		Unit 3 Design Characteristic Value	Evaluation
	ESP Value	Description and References		
Release Point				
Elevation	Ground Level	The elevation above finished grade of the release point for routine operational and accident sequence releases	Mixed mode and ground level (routine operational releases); ground level (accident sequence releases)	This Unit 3 design characteristic value for routine operational releases includes mixed mode release points from the vent stacks of the Turbine Building and Reactor Building along with ground level releases from the vent stack of the Radwaste Building and the CIRC cooling tower. The Unit 3 design characteristic value for routine operational releases does not fall within (is not the same as) the ESP plant parameter value identified in ESP Table D-1. The Unit 3 design characteristic value for accident sequence releases is a ground level release. The Unit 3 design characteristic value for accident sequence releases falls within (is the same as) the ESP plant parameter value identified in ESP Table D-1.
Source Term				
Gaseous (Normal)	Maximum values presented in Tables D-2 and D-3	The annual activity, by isotope, contained in routine plant airborne effluent streams	Values presented in Table 5.4-3	The Unit 3 design characteristic source term values for normal gaseous releases are provided in Table 5.4-3. All Unit 3 design characteristic values fall within (are less than) the ESP plant parameter values identified in ESP Table D-1. See Section 5.4 for the analysis of radiological consequences of routine airborne releases.

Table 3.0-2 Evaluation of ESP Design Parameters

Item	ESP Plant Parameters [From ESP Table D-1] ESP Value	Description and References	Unit 3 Design Characteristic Value	Evaluation
Source Term (continued)				
Atmospheric (Design Basis Accidents)	Ci as indicated in			
	Table D-4	AP1000 Main Steam Line Break, Pre-existing Iodine Spike	Not Applicable	This design parameter is not applicable because it is related to a non-ESBWR plant.
	Table D-5	AP1000 Main Steam Line Break, Accident-Initiated Iodine Spike	Not Applicable	This design parameter is not applicable because it is related to a non-ESBWR plant.
	Table D-6	ABWR Cleanup Water Line Break	Not Applicable	This design parameter is not applicable because it is related to a non-ESBWR plant.
	Table D-7	ESBWR Feedwater System Pipe Break	MBq values presented in DCD Table 15.4-15	The Unit 3 design characteristic source term values for a FSPB are provided in DCD Table 15.4-15. The Unit 3 design characteristic values do not fall within (are not equal to or less than) the ESP plant parameter values identified in ESP Table D-7. Some source term activities have increased and additional radionuclides have been identified. A comparison of each ESP and Unit 3 source term value is provided in Table 3.0-6a. See Section 7.1 for the analysis of radiological consequences of accidental releases. As described in Section 7.1, Unit 3 FSPB doses are higher than those shown in ESP-ER Table 7.1-6d; however, they remain well below regulatory limits.

Table 3.0-2 Evaluation of ESP Design Parameters

Item	ESP Plant Parameters [From ESP Table D-1] ESP Value	Description and References	Unit 3 Design Characteristic Value	Evaluation
Source Term (continued)				
Atmospheric (Design Basis Accidents) *(continued)*	Table D-8	AP1000 Locked Rotor Accident	Not Applicable	This design parameter is not applicable because it is related to a non-ESBWR plant.
	Table D-9	AP1000 Rod Ejection Accident	Not Applicable	This design parameter is not applicable because it is related to a non-ESBWR plant.
	Table D-10	ABWR Failure of Small Lines Carrying Primary Coolant Outside Containment	Not Applicable	This design parameter is not applicable because it is related to a non-ESBWR plant.
	Table D-13	AP1000 Steam Generator Tube Rupture, Accident Initiated Iodine Spike	Not Applicable	This design parameter is not applicable because it is related to a non-ESBWR plant.
	Table D-14	ABWR Main Steam Line Break	Not Applicable	This design parameter is not applicable because it is related to a non-ESBWR plant.
	Table D-15	ESBWR Main Steam Line Break	MBq values presented in DCD Table 15.4-12	The Unit 3 design characteristic source term values for an MSLB are provided in DCD Table 15.4-12. The Unit 3 design characteristic values do not fall within (are not equal to or less than) the ESP plant parameter values identified in ESP Table D-15. Not only have the source terms listed in ESP Table D-15 changed, but additional radionuclides have been identified. A comparison of each ESP and Unit 3 source term value is provided in Table 3.0-4. See Section 7.1 for the analysis of radiological consequences of accidental releases. As shown in Section 7.1, the LPZ dose for MSLB equilibrium iodine is marginally higher than that shown in ESP-ER Table 7.1-20c, but all MSLB doses remain well below regulatory limits.

Table 3.0-2 Evaluation of ESP Design Parameters

Item	ESP Plant Parameters [From ESP Table D-1] ESP Value	Description and References	Unit 3 Design Characteristic Value	Evaluation
Source Term (continued)				
Atmospheric (Design Basis Accidents) *(continued)*	Table D-16	AP1000 Loss-of-Coolant Accident	Not Applicable	This design parameter is not applicable because it is related to a non-ESBWR plant.
	Table D-17	ABWR Loss-of-Coolant Accident	Not Applicable	This design parameter is not applicable because it is related to a non-ESBWR plant.
	Table D-18	ESBWR Loss-of Coolant Accident	MBq values presented in DCD Table 15.4-7	The Unit 3 design characteristic source term values for a LOCA are provided in DCD Table 15.4-7. The Unit 3 design characteristic values do not fall within (are not equal to or less than) the ESP plant parameter values identified in ESP Table D-18. Some source term activities have increased and additional radionuclides have been identified. A comparison of each ESP and Unit 3 source term value is provided in Table 3.0-5. See Section 7.1 for the analysis of radiological consequences of accidental releases. As described in Section 7.1, the resultant LOCA doses, though marginally higher than those shown in ESP-ER Table 7.1-24b, remain well below 10 CFR 50.34(a)(1) and SRP limits.
	Table D-19	AP1000 Fuel Handling Accident	Not Applicable	This design parameter is not applicable because it is related to a non-ESBWR plant.
	Table D-20	ABWR Fuel Handling Accident	Not Applicable	This design parameter is not applicable because it is related to a non-ESBWR plant.
	Table D-21	ESBWR Fuel Handling Accident	MBq values presented in DCD Table 15.4-3a	The Unit 3 design characteristic source term values for an FHA are provided in DCD Table 15.4-3a. The Unit 3 design characteristic values fall within (are less than) the ESP plant parameter values identified in ESP Table D-21. See Section 7.1 for the analysis of radiological consequences of accidental releases.

Table 3.0-2 Evaluation of ESP Design Parameters

Item	ESP Plant Parameters [From ESP Table D-1] ESP Value	Description and References	Unit 3 Design Characteristic Value	Evaluation
Source Term (continued)				
Atmospheric (Design Basis Accidents) *(continued)*	Table D-22	ESBWR Cleanup Water Line Break	MBq values presented in DCD Table 15.4-22	The Unit 3 design characteristic source term values for CWLB are provided in DCD Table 15.4-22. The Unit 3 design characteristic values do not fall within (are not equal to or less than) the ESP plant parameter values identified in ESP Table D-22. Some source term activities have increased and additional radionuclides have been identified. A comparison of each ESP and Unit 3 source term value is provided in Table 3.0-6. See Section 7.1 for the analysis of radiological consequences of accidental releases. As described in Section 7.1, some Unit 3 CWLB doses are marginally higher than those shown in ESP-ER Table 7.1-32; however, they remain well below regulatory limits.
	Table D-11	ESBWR Failure of Small Lines Carrying Primary Coolant Outside Containment	MBq values presented in DCD Tables 15.4-18a and 15.4-18b	The Unit 3 design characteristic source term values for an FSLCPCOC are provided in DCD Tables 15.4-18a and 15.4-18b. The Unit 3 design characteristic values do not fall within (are not equal to or less than) the ESP plant parameter values identified in ESP Table D-11. Some source term activities have increased and additional radionuclides have been identified. A comparison of each ESP and Unit 3 source term value is provided in Table 3.0-3. See Section 7.1 for the analysis of radiological consequences of accidental releases. As shown in Section 7.1, the resultant FSLCPCOC dose at the LPZ is marginally higher than that shown in ESP-ER Table 7.1-13b, but all FSLCPCOC doses remain well below regulatory limits.
	Table D-12	AP1000 Steam Generator Tube Rupture, Pre-Existing Iodine Spike	Not Applicable	This design parameter is not applicable because it is related to a non-ESBWR plant.

Table 3.0-2 Evaluation of ESP Design Parameters

ESP Plant Parameters [From ESP Table D-1]			Unit 3 Design Characteristic Value	Evaluation
Item	**ESP Value**	**Description and References**		
Source Term (continued)				
Tritium	3500 Ci/yr (maximum values)	The annual activity of tritium contained in routine plant airborne effluent streams	250 Ci/yr	The Unit 3 design characteristic annual activity of tritium contained in routine plant airborne effluent streams is 250 Ci/yr and is shown in Table 5.4-3. The Unit 3 design characteristic value falls within (is less than) the ESP plant parameter value identified in ESP Table D-1.

Table 3.0-2 Evaluation of ESP Design Parameters

Item	ESP Plant Parameters [From ESP Table D-1] ESP Value	Description and References	Unit 3 Design Characteristic Value	Evaluation
Liquid Radwaste System				
Release Point Dilution Factor	1000 (minimum)	The ratio of liquid potentially radioactive effluent streams to liquid nonradioactive effluent streams from plant systems to the WHTF through the discharge canal used for NAPS Units 1 and 2	1000	The Unit 3 dilution factor is shown in FSAR Table 12.2-20aR, which indicates a minimum dilution factor requirement of 1000 as the basis for liquid effluent dose calculations. Unit 3 effluent streams (both radiological and nonradiological) are directed to the Discharge Canal. At the Discharge Canal, the Unit 3 effluents are further mixed and diluted with the much larger quantity of water there. This dilution process is further described in Section 5.2. The resulting design characteristic dilution factor for Unit 3 effluents is therefore greater than 1000. The Unit 3 design characteristic value falls within (is equal to or greater than) the ESP plant parameter value identified in ESP Table D-1.
Liquid	Values presented in Tables D-23 and D-24 (maximum values)	The annual activity, by isotope, contained in routine plant liquid effluent streams	Values presented in Table 5.4-1	The Unit 3 design characteristic source term values for normal liquid effluent releases are provided in Table 5.4-1. The Unit 3 design characteristic values do not fall within (are not equal to or less than) the ESP plant parameter values identified in ESP Tables D-23 and D-24. Some source term activities have increased, and others are no longer present. A comparison of each ESP and Unit 3 source term value is provided in Table 3.0-7. The sum of the activity releases falls within the sum of activities in ESP Tables D-23 and D-24.
Tritium	≤850 Ci/yr	The annual activity of tritium contained in routine plant liquid effluent streams	14 Ci/yr	The Unit 3 design characteristic annual activity of tritium contained in routine plant liquid effluent streams is 14 Ci/yr as shown in Table 5.4-1. The Unit 3 design characteristic value falls within (is less than) the single unit value identified in ESP Table D-1.

Table 3.0-2 Evaluation of ESP Design Parameters

Item	ESP Plant Parameters [From ESP Table D-1] ESP Value	Description and References	Unit 3 Design Characteristic Value	Evaluation
Solid Radwaste System				
Activity	≤ 2700 Ci/yr	The annual activity contained in solid radioactive wastes generated during routine plant operations	1718] Ci/yr	The Unit 3 design characteristic annual activity contained in solid radioactive wastes generated during routine plant operations is 1718 Ci/yr. The Unit 3 design characteristic value falls within (is less than) the ESP plant parameter value identified in ESP Table D-1.
Volume	≤ 9041 cu ft/yr (Per Unit)	The expected volume of solid radioactive wastes generated during routine plant operations	16,742 cu ft/yr	This Unit 3 design characteristic expected volume of solid radioactive waste generated during routine plant operations is 16,742 cu ft/yr. The volume for Unit 3 does not fall within the single unit value identified in ESP Table D-1. However, the volume for Unit 3 does fall within the overall site value evaluated in the FEIS for two units. Furthermore, the number of waste shipments based on DCD Table 11.4-2 volumes remains well below the one truck shipment per day condition given in 10 CFR 51.52(c), Table S-4.
Plant Characteristics				
Acreage	Approximately 128.5 acres [Both units]	Approximate area on the NAPS site that would be affected on a long-term basis as a result of additional permanent facilities	Approximately 133 acres as shown in Figure 1.1-1	The Unit 3 design characteristic value of approximately 133 acres is the area on the NAPS site that will be affected on a long term basis by the construction of permanent Unit 3 facilities. These areas are shown in Figure 1.1-1. The Unit 3 design characteristic value does not fall within (is greater than) the ESP plant parameter value identified in ESP Table D-1 for two units.
Megawatts Thermal	≤ 4500 MWt	The thermal power generated by one unit (may be the total of several modules)	4500 MWt (Rated)	This Unit 3 design characteristic value of 4500 MWt is the rated reactor thermal power, as described in Section 1.1. The Unit 3 design characteristic value falls within (is equal to) the ESP plant parameter value identified in ESP Table D-1.

Table 3.0-2 Evaluation of ESP Design Parameters

Item	ESP Plant Parameters [From ESP Table D-1] ESP Value	ESP Plant Parameters [From ESP Table D-1] Description and References	Unit 3 Design Characteristic Value	Evaluation
Plant Characteristics (continued)				
Plant Population – Operation	Approximately 720 permanent employees (both units)	Anticipated number of new employees required for operation of the new units	500 permanent employees	The Unit 3 value of 500 is the anticipated number of new employees required for operation of Unit 3. The Unit 3 value falls within the total (two-unit) value identified in the ESP. The Unit 3 value falls within (is less than) the ESP plant parameter value for two units identified in ESP Table D-1.
Plant Population – Refueling/Major Maintenance	Approximately 700 to 1000 temporary workers during planned outages	Anticipated number of additional workers onsite during planned outages of the new units	1000 temporary workers	The Unit 3 value of 1,000 is the anticipated number of additional workers needed on site during Unit 3 planned outages. The Unit 3 value falls within (is equal to) the ESP plant parameter value identified in ESP Table D-1.
Plant Population – Construction	5000 people maximum (simultaneous construction)	Peak workforce of 5000 for construction of both new units	[4100 people	The Unit 3 value of 4100 is the expected peak number of construction workers that are required for the construction of Unit 3. The Unit 3 value falls within (is less than) the ESP plant parameter value for two units identified in ESP Table D-1.
Maximum Fuel Enrichment for Light-Water-Cooled Reactors	5%	Concentration of U-235 in fuel	5%	The Unit 3 design characteristic value is 5% maximum concentration of U-235 in the Unit 3 fuel. The Unit 3 design characteristic value falls within (is equal to) the ESP plant parameter value identified in ESP Table D-1.
Maximum Fuel Burn-up for Light-Water-Cooled Reactors	62,000 MWd/MTU	The value derived by calculating the reactor thermal power multiplied by the time of irradiation divided by fuel mass (expressed as megawatt-days per metric ton of irradiated fuel)	62,000 MWd/MTU	The Unit 3 design characteristic value is 62,000 MWd/MTU maximum fuel burn-up for Unit 3. The Unit 3 design characteristic value falls within (is equal to) the ESP plant parameter value identified in ESP Table D-1.

Table 3.0-2 Evaluation of ESP Design Parameters

Item	ESP Plant Parameters [From ESP Table D-1] ESP Value	Description and References	Unit 3 Design Characteristic Value	Evaluation
Plant Characteristics (continued)				
Maximum Fuel Enrichment for Gas-Cooled Reactors	19.8%	Concentration of U-235 in fuel	Not Applicable	This design parameter is not applicable because it is related to a non-LWR plant.
Maximum Fuel Burn-up for Gas-Cooled Reactors	133,000 MWd/MTU	The value derived by calculating the reactor thermal power multiplied by the time of irradiation divided by fuel mass (expressed as megawatt-days per metric ton of irradiated fuel)	Not Applicable	This design parameter is not applicable because it is related to a non-LWR plant.

a. The staff used a 100 percent capacity factor based on a 365-day rolling average evaporative water use vs. the applicant's 96 percent capacity factor based on long term annual average evaporative water use.

b. FEIS Table I-2 presents no value for the MWC mode evaporation rate. However, it states on page 5-11: "The definition of the PPE instantaneous maximum evaporation rate parameters for the MWC and EC modes was unchanged." This indicates that NRC accepted the 11,532 gpm maximum as the bounding value for MWC mode evaporation rate. In addition, the value of 11,532 gpm was shown in NUREG-1811, Supp 1, (SDEIS).

Unless noted otherwise, the ESP design parameter for one unit is one half of the two-unit value shown, when it is noted that the ESP value is for two units.

Table 3.0-3 Comparison of Unit 3 and ESP Activity Releases for Failure of Small Lines Carrying Primary Coolant Outside Containment Accident

	ESP Activity Release (Ci)			Unit 3 Activity Release (Ci)			Unit 3 Activity Release (MBq)		
Isotope	0–2 hr	2–8 hr	Total	0–2 hr	2–6 hr	Total	0–2 hr	2–6 hr	Total
Co-58	NP	NP	NP	1.2E-03	7.5E-04	2.0E-03	4.5E+01	2.8E+01	7.3E+01
Co-60	NP	NP	NP	2.4E-03	1.5E-03	3.9E-03	8.9E+01	5.6E+01	1.5E+02
Sr-89	NP	NP	NP	5.6E-03	3.5E-03	9.0E-03	2.1E+02	1.3E+02	3.3E+02
Sr-90	NP	NP	NP	3.9E-04	2.4E-04	6.3E-04	1.4E+01	8.9E+00	2.3E+01
Sr-91	NP	NP	NP	2.2E-01	1.4E-01	3.5E-01	8.0E+03	4.9E+03	1.3E+04
Sr-92	NP	NP	NP	4.9E-01	3.0E-01	7.9E-01	1.8E+04	1.1E+04	2.9E+04
Y-90	NP	NP	NP	3.9E-04	2.4E-04	6.3E-04	1.4E+01	8.9E+00	2.3E+01
Y-91	NP	NP	NP	2.3E-03	1.4E-03	3.7E-03	8.4E+01	5.2E+01	1.4E+02
Y-92	NP	NP	NP	2.9E-01	1.8E-01	4.8E-01	1.1E+04	6.8E+03	1.8E+04
Y-93	NP	NP	NP	2.2E-01	1.4E-01	3.5E-01	8.0E+03	4.9E+03	1.3E+04
Zr-95	NP	NP	NP	4.4E-04	2.8E-04	7.2E-04	1.6E+01	1.0E+01	2.7E+01
Nb-95	NP	NP	NP	4.4E-04	2.8E-04	7.2E-04	1.6E+01	1.0E+01	2.7E+01
Mo-99	NP	NP	NP	1.1E-01	6.8E-02	1.8E-01	4.1E+03	2.5E+03	6.6E+03
Tc-99m	NP	NP	NP	1.1E-01	6.8E-02	1.8E-01	4.1E+03	2.5E+03	6.6E+03
Ru-103	NP	NP	NP	1.1E-03	6.9E-04	1.8E-03	4.1E+01	2.6E+01	6.7E+01
Ru-106	NP	NP	NP	1.7E-04	1.1E-04	2.8E-04	6.3E+00	3.9E+00	1.0E+01
Te-129m	NP	NP	NP	2.3E-03	1.4E-03	3.7E-03	8.4E+01	5.2E+01	1.4E+02
Te-131m	NP	NP	NP	5.4E-03	3.4E-03	8.8E-03	2.0E+02	1.3E+02	3.3E+02
Te-132	NP	NP	NP	5.6E-04	3.5E-04	9.0E-04	2.1E+01	1.3E+01	3.3E+01

Table 3.0-3 Comparison of Unit 3 and ESP Activity Releases for Failure of Small Lines Carrying Primary Coolant Outside Containment Accident

	ESP Activity Release (Ci)			Unit 3 Activity Release (Ci)			Unit 3 Activity Release (MBq)		
Isotope	**0–2 hr**	**2–8 hr**	**Total**	**0–2 hr**	**2–6 hr**	**Total**	**0–2 hr**	**2–6 hr**	**Total**
I-131	6.13E+00	1.05E+01	1.66E+01	4.1E+00	2.6E+00	6.7E+00	1.5E+05	9.5E+04	2.5E+05
I-132	8.03E+00	7.35E+00	1.54E+01	2.9E+01	1.8E+01	4.6E+01	1.1E+06	6.6E+05	1.7E+06
I-133	1.51E+01	2.35E+01	3.86E+01	2.7E+01	1.7E+01	4.3E+01	9.9E+05	6.1E+05	1.6E+06
I-134	8.78E+00	4.60E+00	1.34E+01	4.5E+01	2.8E+01	7.2E+01	1.7E+06	1.0E+06	2.7E+06
I-135	1.39E+01	1.85E+01	3.24E+01	3.6E+01	2.2E+01	5.8E+01	1.3E+06	8.2E+05	2.1E+06
Cs-134	NP	NP	NP	1.5E-03	9.2E-04	2.4E-03	5.5E+01	3.4E+01	8.9E+01
Cs-136	NP	NP	NP	1.0E-03	6.2E-04	1.6E-03	3.7E+01	2.3E+01	6.0E+01
Cs-137	NP	NP	NP	4.0E-03	2.5E-03	6.4E-03	1.5E+02	9.1E+01	2.4E+02
Ba-140	NP	NP	NP	2.3E-02	1.4E-02	3.7E-02	8.4E+02	5.2E+02	1.4E+03
La-140	NP	NP	NP	2.3E-02	1.4E-02	3.7E-02	8.4E+02	5.2E+02	1.4E+03
Ce-141	NP	NP	NP	1.7E-03	1.1E-03	2.8E-03	6.3E+01	3.9E+01	1.0E+02
Ce-144	NP	NP	NP	1.7E-04	1.1E-04	2.8E-04	6.3E+00	3.9E+00	1.0E+01
Np-239	NP	NP	NP	4.4E-01	2.8E-01	7.2E-01	1.6E+04	1.0E+04	2.7E+04
Total	5.19E+01	6.45E+01	1.16E+02	1.4E+02	8.8E+01	2.3E+02	5.2E+06	3.3E+06	8.5E+06

Notes:
NP – Not present in the ESP
ESBWR accident release activities from ESP Table D-11
Unit 3-specific accident release activities in the unit of curie (Ci) from DCD Table 15.4-18b
Unit 3-specific accident release activities in the unit of mega-becquerel (MBq) from DCD Table 15.4-18b

Table 3.0-4 Comparison of Unit 3 and ESP Activity Releases for Main Steam Line Break Accident

	ESP Activity Release (Ci)		Unit 3 Activity Release (Ci)		Unit 3 Activity Release (MBq)	
Isotope	Pre-Existing	Equilibrium Activity	Equilibrium Activity	Iodine Spike Activity	Equilibrium Activity	Iodine Spike Activity
Co-58	NP	NP	9.0E-03	9.0E-03	3.03E+02	3.03E+02
Co-60	NP	NP	1.8E-02	1.8E-02	6.6E+02	6.6E+02
Kr-85	6.75E-05	6.75E-05	9.5E-04	9.5E-04	3.5E+01	3.5E+01
Kr-85m	1.72E-02	1.72E-02	2.4E-01	2.4E-01	9.0E+03	9.0E+03
Kr-87	5.74E-02	5.74E-02	7.8E-01	7.8E-01	2.9E+04	2.9E+04
Kr-88	5.74E-02	5.74E-02	7.8E-01	7.8E-01	2.9E+04	2.9E+04
Sr-89	NP	NP	4.1E-02	4.1E-02	1.5E+03	1.5E+03
Sr-90	NP	NP	2.9E-03	2.9E-03	1.1E+02	1.1E+02
Sr-91	NP	NP	1.6E+00	1.6E+00	5.9E+04	5.9E+04
Sr-92	NP	NP	3.6E+00	3.6E+00	1.3E+05	1.3E+05
Y-90	NP	NP	2.9E-03	2.9E-03	1.1E+02	1.1E+02
Y-91	NP	NP	1.7E-02	1.7E-02	6.2E+02	6.2E+02
Y-92	NP	NP	2.2E+00	2.2E+00	8.1E+04	8.1E+04
Y-93	NP	NP	1.6E+00	1.6E+00	5.9E+04	5.9E+04
Zr-95	NP	NP	3.3E-03	3.3E-03	1.2E+02	1.2E+02
Nb-95	NP	NP	3.3E-03	3.3E-03	1.2E+02	1.2E+02
Mo-99	NP	NP	8.1E-01	8.1E-01	3.0E+04	3.0E+04
Tc-99m	NP	NP	8.1E-01	8.1E-01	3.0E+04	3.0E+04
Ru-103	NP	NP	8.2E-03	8.2E-03	3.0E+02	3.0E+02
Ru-106	NP	NP	1.3E-03	1.3E-03	4.7E+01	4.7E+01
Te-129m	NP	NP	1.7E-02	1.7E-02	6.2E+02	6.2E+02
Te-131m	NP	NP	4.0E-02	4.0E-02	1.5E+03	1.5E+03
Te-132	NP	NP	4.1E-03	4.1E-03	1.5E+02	1.5E+02
I-131	1.96E+02	9.79E+00	1.6E+00	3.1E+01	5.7E+04	1.2E+06
I-132	1.86E+03	9.45E+01	1.1E+01	2.2E+02	4.0E+05	8.0E+06

Table 3.0-4 Comparison of Unit 3 and ESP Activity Releases for Main Steam Line Break Accident

	ESP Activity Release (Ci)		Unit 3 Activity Release (Ci)		Unit 3 Activity Release (MBq)	
Isotope	**Pre-Existing**	**Equilibrium Activity**	**Equilibrium Activity**	**Iodine Spike Activity**	**Equilibrium Activity**	**Iodine Spike Activity**
I-133	1.35E+03	6.75E+01	1.0E+01	2.0E+02	3.7E+05	7.5E+06
I-134	3.38E+03	1.72E+02	1.7E+01	3.4E+02	6.2E+05	1.2E+07
I-135	1.92E+03	9.45E+01	1.4E+01	2.7E+02	5.0E+05	1.0E+07
Xe-133	2.46E-02	2.46E-02	3.3E-01	3.3E-01	1.2E+04	1.2E+04
Xe-135	6.75E-02	6.75E-02	9.1E-01	9.1E-01	3.4E+04	3.4E+04
Cs-134	NP	NP	1.1E-02	1.1E-02	4.0E+02	4.0E+02
Cs-136	NP	NP	7.4E-03	7.4E-03	2.7E+02	2.7E+02
Cs-137	NP	NP	2.9E-02	2.9E-02	1.1E+03	1.1E+03
Ba-140	NP	NP	1.7E-01	1.7E-01	6.2E+03	6.2E+03
La-140	NP	NP	1.7E-01	1.7E-01	6.2E+03	6.2E+03
Ce-141	NP	NP	1.3E-02	1.3E-02	4.7E+02	4.7E+02
Ce-144	NP	NP	1.3E-03	1.3E-03	4.7E+01	4.7E+01
Np-239	NP	NP	3.3E+00	3.3E+00	1.2E+05	1.2E+05
Total	8.70E+03	4.39E+02	7.0E+01	1.1E+03	2.6E+06	4.0E+07

Notes:
NP – Not present in the ESP
ESBWR accident release activities from ESP Table D-15
Unit 3-specific accident release activities in the unit of curie (Ci) from DCD Table 15.4-12
Unit 3-specific accident release activities in the unit of mega-becquerel (MBq) from DCD Table 15.4-12

Table 3.0-5 Comparison of Unit 3 and ESP Activity Releases for Loss-of-Coolant Accident

	ESP Activity Release (Ci)						Unit 3 Activity Release (Ci)						Unit 3 Activity Release (MBq)					
Isotope	0–2 hr	2–8 hr	8–24 hr	24–96 hr	96–720 hr	Total	0–2 hr	2–8 hr	8–24 hr	24–96 hr	96–720 hr	Total	0–2 hr	2–8 hr	8–24 hr	24–96 hr	96–720 hr	Total
Co-58	2.28E-03	2.22E-02	3.89E-02	4.18E-02	2.61E-02	1.31E-01	8.0E-03	5.9E-02	1.1E-01	1.5E-01	4.3E-01	7.6E-01	2.9E+02	2.2E+03	4.0E+03	5.5E+03	1.6E+04	2.8E+04
Co-60	2.19E-03	2.16E-02	3.76E-02	4.10E-02	2.89E-02	1.31E-01	1.9E-02	1.4E-01	2.6E-01	3.7E-01	1.2E+00	2.0E+00	7.0E+02	5.1E+03	9.2E+03	1.4E+04	4.4E+04	7.3E+04
Kr-85	6.59E+00	3.23E+02	2.72E+03	2.08E+04	5.31E+04	7.70E+04	1.5E+01	3.5E+02	2.5E+03	2.4E+04	3.2E+05	3.5E+05	5.5E+05	1.2E+07	1.7E+07	9.6E+08	1.2E+10	1.3E+10
Kr-85m	1.14E+02	3.01E+03	5.21E+03	8.50E+02	0.00E+00	9.19E+03	2.3E+02	2.9E+03	4.4E+03	7.0E+02	0.0E+00	8.2E+03	8.5E+06	1.1E+08	1.6E+08	2.0E+07	0.0E+00	3.0E+08
Kr-87	1.17E+02	8.60E+02	1.08E+02	0.00E+00	0.00E+00	1.09E+03	2.4E+02	8.6E+02	1.0E+02	0.0E+00	0.0E+00	1.2E+03	9.0E+06	3.3E+07	3.0E+06	0.0E+00	0.0E+00	4.5E+07
Kr-88	2.68E+02	5.12E+03	4.30E+03	1.63E+02	0.00E+00	9.85E+03	5.4E+02	5.0E+03	3.6E+03	1.0E+02	0.0E+00	9.2E+03	2.0E+07	1.8E+08	1.4E+08	0.0E+00	0.0E+00	3.4E+08
Rb-86	1.38E-01	1.00E+00	1.72E+00	1.79E+00	8.25E-01	5.48E+00	2.8E-01	1.8E+00	3.2E+00	4.4E+00	8.3E+00	1.8E+01	1.0E+04	6.6E+04	1.2E+05	1.6E+05	3.0E+05	6.6E+05
Sr-89	3.53E+00	3.46E+01	6.01E+01	6.43E+01	3.88E+01	2.01E+02	8.9E+00	6.5E+01	1.3E+02	1.7E+02	4.5E+02	8.2E+02	3.3E+05	2.4E+06	4.6E+06	6.7E+06	1.6E+07	3.0E+07
Sr-90	3.48E-01	3.42E+00	5.98E+00	6.51E+00	4.63E+00	2.09E+01	1.0E+00	7.4E+00	1.4E+01	2.0E+01	6.8E+01	1.1E+02	3.7E+04	2.7E+05	5.1E+05	7.8E+05	2.3E+06	3.9E+06
Sr-91	3.95E+00	3.06E+01	2.63E+01	5.00E+00	0.00E+00	6.58E+01	1.0E+01	5.8E+01	5.2E+01	1.0E+01	0.0E+00	1.3E+02	3.7E+05	2.1E+06	2.0E+06	4.0E+05	0.0E+00	4.9E+06
Sr-92	3.18E+00	1.45E+01	2.88E+00	1.25E-01	0.00E+00	2.06E+01	8.3E+00	2.8E+01	5.0E+00	1.0E+00	0.0E+00	4.2E+01	3.1E+05	9.9E+05	2.0E+05	0.0E+00	0.0E+00	1.5E+06
Y-90	6.34E-03	1.70E-01	9.06E-01	2.51E+00	4.25E+00	7.84E+00	1.6E-02	3.6E-01	2.1E+00	8.5E+00	5.9E+01	7.0E+01	6.0E+02	1.3E+04	7.8E+04	3.0E+05	2.2E+06	2.6E+06
Y-91	4.59E-02	4.70E-01	8.96E-01	1.03E+00	6.38E-01	3.08E+00	1.2E-01	8.8E-01	1.8E+00	2.8E+00	7.4E+00	1.3E+01	4.3E+03	3.3E+04	7.3E+04	1.0E+05	2.7E+05	4.8E+05
Y-92	4.89E-01	1.01E+01	8.31E+00	3.75E-01	0.00E+00	1.93E+01	9.7E-01	1.8E+01	1.7E+01	1.0E+00	0.0E+00	3.7E+01	3.6E+04	6.8E+05	5.8E+05	1.0E+05	0.0E+00	1.4E+06
Y-93	4.94E-02	3.87E-01	3.45E-01	7.25E-02	0.00E+00	8.54E-01	1.3E-01	7.4E-01	7.3E-01	1.0E-01	0.0E+00	1.7E+00	4.7E+03	2.7E+04	2.6E+04	6.0E+03	0.0E+00	6.4E+04
Zr-95	6.39E-02	6.26E-01	1.09E+00	1.18E+00	7.25E-01	3.68E+00	1.7E-01	1.2E+00	2.3E+00	3.3E+00	9.0E+00	1.6E+01	6.3E+03	4.6E+04	8.8E+04	1.2E+05	3.3E+05	5.9E+05
Zr-97	6.16E-02	5.28E-01	6.10E-01	2.25E-01	0.00E+00	1.43E+00	1.6E-01	1.0E+00	1.3E+00	6.0E-01	0.0E+00	3.1E+00	6.1E+03	3.9E+04	4.9E+04	1.6E+04	1.0E+04	1.2E+05
Nb-95	6.43E-02	6.30E-01	1.11E+00	1.20E+00	8.25E-01	3.83E+00	1.7E-01	1.2E+00	2.4E+00	3.3E+00	9.9E+00	1.7E+01	6.2E+03	4.6E+04	8.8E+04	1.2E+05	3.9E+05	6.5E+05
Mo-99	8.30E-01	7.86E+00	1.23E+01	9.88E+00	1.00E+00	3.19E+01	2.2E+00	1.6E+01	2.6E+01	2.7E+01	9.0E+00	8.0E+01	8.1E+04	5.8E+05	9.4E+05	1.0E+06	3.0E+05	2.9E+06
Tc-99m	7.46E-01	7.24E+00	1.19E+01	1.01E+01	8.75E-01	3.09E+01	2.0E+00	1.5E+01	2.5E+01	2.8E+01	9.0E+00	7.9E+01	7.5E+04	5.5E+05	9.8E+05	1.0E+06	3.0E+05	2.9E+06
Ru-103	6.66E-01	6.52E+00	1.13E+01	1.21E+01	6.88E+00	3.75E+01	1.8E+00	1.3E+01	2.5E+01	3.5E+01	8.5E+01	1.6E+02	6.7E+04	4.9E+05	9.4E+05	1.3E+06	3.2E+06	6.0E+06
Ru-105	3.48E-01	2.09E+00	8.88E-01	3.75E-02	0.00E+00	3.36E+00	1.0E+00	4.4E+00	2.0E+00	1.0E-01	0.0E+00	7.5E+00	3.7E+04	1.6E+05	7.0E+04	1.0E+04	0.0E+00	2.8E+05
Ru-106	2.33E-01	2.28E+00	3.99E+00	4.34E+00	3.04E+00	1.39E+01	6.9E-01	5.1E+00	9.2E+00	1.4E+01	4.2E+01	7.1E+01	2.5E+04	1.9E+05	3.6E+05	5.3E+05	1.5E+06	2.6E+06
Rh-105	4.05E-01	3.88E+00	5.85E+00	3.74E+00	1.25E-01	1.40E+01	1.1E+00	8.3E+00	1.4E+01	1.0E+01	1.0E+00	3.4E+01	4.2E+04	3.1E+05	4.9E+05	3.6E+05	1.0E+05	1.3E+06
Sb-127	9.09E-01	8.69E+00	1.40E+01	1.23E+01	1.75E+00	3.76E+01	2.5E+00	1.8E+01	3.2E+01	3.5E+01	1.3E+01	1.0E+02	9.3E+04	6.7E+05	1.1E+06	1.3E+06	7.0E+05	3.9E+06
Sb-129	2.18E+00	1.30E+01	5.25E+00	1.25E-01	0.00E+00	2.05E+01	6.0E+00	2.6E+01	1.1E+01	1.0E+00	0.0E+00	4.4E+01	2.2E+05	9.8E+05	4.0E+05	0.0E+00	0.0E+00	1.6E+06
Te-127	9.29E-01	8.96E+00	1.49E+01	1.39E+01	3.13E+00	4.18E+01	2.5E+00	1.9E+01	3.3E+01	3.9E+01	3.7E+01	1.3E+02	9.3E+04	6.8E+05	1.2E+06	1.5E+06	1.3E+06	4.8E+06
Te-127m	1.22E-01	1.20E+00	2.09E+00	2.29E+00	1.54E+00	7.24E+00	3.4E-01	2.5E+00	4.8E+00	6.4E+00	2.1E+01	3.5E+01	1.3E+04	9.7E+04	1.7E+05	2.5E+05	7.7E+05	1.3E+06
Te-129	2.41E+00	1.62E+01	1.15E+01	6.75E+00	3.50E+00	4.04E+01	6.6E+00	3.3E+01	2.3E+01	1.9E+01	4.6E+01	1.3E+02	2.4E+05	1.3E+06	9.0E+05	7.0E+05	1.6E+06	4.7E+06

Table 3.0-5 Comparison of Unit 3 and ESP Activity Releases for Loss-of-Coolant Accident *(continued)*

	ESP Activity Release (Ci)						Unit 3 Activity Release (Ci)						Unit 3 Activity Release (MBq)					
Isotope	0–2 hr	2–8 hr	8–24 hr	24–96 hr	96–720 hr	Total	0–2 hr	2–8 hr	8–24 hr	24–96 hr	96–720 hr	Total	0–2 hr	2–8 hr	8–24 hr	24–96 hr	96–720 hr	Total
Te-129m	4.09E-01	4.02E+00	6.98E+00	7.35E+00	4.13E+00	2.29E+01	1.1E+00	8.2E+00	1.6E+01	2.1E+01	5.1E+01	9.7E+01	4.1E+04	3.0E+05	5.8E+05	7.8E+05	1.9E+06	3.6E+06
Te-131m	1.22E+00	1.11E+01	1.53E+01	8.75E+00	2.50E-01	3.66E+01	3.3E+00	2.3E+01	3.3E+01	2.3E+01	2.0E+00	8.4E+01	1.2E+05	8.3E+05	1.3E+06	8.0E+05	1.0E+05	3.1E+06
Te-132	1.24E+01	1.19E+02	1.88E+02	1.59E+02	1.88E+01	4.96E+02	3.3E+01	2.4E+02	4.0E+02	4.3E+02	2.0E+02	1.3E+03	1.2E+06	8.7E+06	1.5E+07	1.6E+07	7.0E+06	4.8E+07
I-131	6.66E+01	5.13E+02	9.33E+02	1.44E+03	7.00E+02	3.65E+03	1.5E+02	9.5E+02	1.7E+03	2.9E+03	5.3E+03	1.1E+04	5.4E+06	3.5E+07	7.0E+07	1.0E+08	2.1E+08	4.2E+08
I-132	7.88E+01	3.44E+02	2.45E+02	1.89E+02	2.25E+01	8.79E+02	1.9E+02	6.6E+02	5.5E+02	5.0E+02	3.0E+02	2.2E+03	6.9E+06	2.5E+07	1.9E+07	2.0E+07	1.1E+07	8.2E+07
I-133	1.31E+02	9.10E+02	1.22E+03	7.63E+02	1.25E+01	3.04E+03	2.8E+02	1.6E+03	2.3E+03	1.4E+03	1.0E+02	5.7E+03	1.1E+07	6.1E+07	8.8E+07	5.0E+07	0.0E+00	2.1E+08
I-134	4.96E+01	5.10E+01	3.75E-01	0.00E+00	0.00E+00	1.01E+02	1.1E+02	9.0E+01	1.0E+01	0.0E+00	0.0E+00	2.1E+02	4.2E+06	3.4E+06	0.0E+00	0.0E+00	0.0E+00	7.6E+06
I-135	1.11E+02	6.07E+02	4.16E+02	5.38E+01	0.00E+00	1.19E+03	2.4E+02	1.1E+03	8.0E+02	1.0E+02	0.0E+00	2.2E+03	9.0E+06	4.1E+07	2.9E+07	3.0E+06	0.0E+00	8.2E+07
Xe-133	1.08E+03	5.19E+04	4.08E+05	2.51E+06	1.20E+06	4.18E+06	2.2E+03	5.0E+04	3.5E+05	2.5E+06	8.1E+06	1.1E+07	8.1E+07	1.8E+09	1.3E+10	9.5E+10	2.8E+11	3.9E+11
Xe-135	3.68E+02	1.40E+04	5.13E+04	3.80E+04	0.00E+00	1.04E+05	8.2E+02	1.5E+04	4.9E+04	3.5E+04	0.0E+00	1.0E+05	3.1E+07	5.6E+08	1.8E+09	1.4E+09	0.0E+00	3.8E+09
Cs-134	1.16E+01	8.50E+01	1.48E+02	1.63E+02	1.14E+02	5.21E+02	2.7E+01	1.7E+02	3.1E+02	4.5E+02	1.3E+03	2.3E+03	9.9E+05	6.2E+06	1.2E+07	1.6E+07	5.0E+07	8.5E+07
Cs-136	4.03E+00	2.92E+01	5.00E+01	5.05E+01	2.00E+01	1.54E+02	8.7E+00	5.4E+01	9.7E+01	1.3E+02	2.1E+02	5.0E+02	3.2E+05	2.0E+06	3.7E+06	5.0E+06	7.0E+06	1.8E+07
Cs-137	7.54E+00	5.52E+01	9.60E+01	1.05E+02	7.50E+01	3.39E+02	1.7E+01	1.0E+02	2.1E+02	2.8E+02	8.9E+02	1.5E+03	6.3E+05	4.0E+06	7.4E+06	1.0E+07	3.2E+07	5.4E+07
Ba-139	2.96E+00	7.50E+00	3.00E-01	0.00E+00	0.00E+00	1.08E+01	8.2E+00	1.5E+01	0.0E+00	0.0E+00	0.0E+00	2.3E+01	3.0E+05	5.4E+05	2.0E+04	0.0E+00	0.0E+00	8.6E+05
Ba-140	6.26E+00	6.10E+01	1.04E+02	1.06E+02	4.00E+01	3.18E+02	1.6E+01	1.2E+02	2.2E+02	2.9E+02	4.5E+02	1.1E+03	6.1E+05	4.5E+06	7.9E+06	1.1E+07	1.7E+07	4.1E+07
La-140	1.40E-01	4.41E+00	2.37E+01	5.83E+01	4.35E+01	1.30E+02	3.2E-01	8.5E+00	5.0E+01	1.7E+02	5.1E+02	7.4E+02	1.2E+04	3.2E+05	1.9E+06	6.3E+06	2.0E+07	2.8E+07
La-141	4.50E-02	2.56E-01	9.13E-02	2.50E-03	0.00E+00	3.95E-01	1.2E-01	5.0E-01	1.9E-01	1.0E-02	0.0E+00	8.2E-01	4.4E+03	1.9E+04	7.0E+03	0.0E+00	0.0E+00	3.0E+04
La-142	2.84E-02	8.09E-02	4.50E-03	0.00E+00	0.00E+00	1.14E-01	7.8E-02	1.5E-01	1.0E-02	0.0E+00	0.0E+00	2.4E-01	2.9E+03	5.8E+03	3.0E+02	0.0E+00	0.0E+00	9.0E+03
Ce-141	1.49E-01	1.46E+00	2.54E+00	2.69E+00	1.46E+00	8.30E+00	3.9E-01	2.9E+00	5.3E+00	7.4E+00	1.8E+01	3.4E+01	1.4E+04	1.1E+05	2.0E+05	2.8E+05	7.0E+05	1.3E+06
Ce-143	1.35E-01	1.23E+00	1.75E+00	1.05E+00	2.50E-02	4.19E+00	3.5E-01	2.5E+00	3.6E+00	2.7E+00	3.0E-01	9.4E+00	1.3E+04	8.7E+04	1.4E+05	1.0E+05	1.0E+04	3.5E+05
Ce-144	1.21E-01	1.19E+00	2.08E+00	2.26E+00	1.55E+00	7.20E+00	3.2E-01	2.4E+00	4.5E+00	6.8E+00	1.9E+01	3.3E+01	1.2E+04	8.7E+04	1.6E+05	2.4E+05	7.0E+05	1.2E+06
Pr-143	5.46E-02	5.40E-01	9.68E-01	1.06E+00	4.63E-01	3.09E+00	1.4E-01	1.1E+00	2.0E+00	2.9E+00	4.9E+00	1.1E+01	5.2E+03	3.9E+04	7.6E+04	1.1E+05	1.9E+05	4.2E+05
Nd-147	2.38E-02	2.31E-01	3.94E-01	3.95E-01	1.39E-01	1.18E+00	6.3E-02	4.6E-01	8.8E-01	1.0E+00	1.6E+00	4.0E+00	2.3E+03	1.7E+04	3.1E+04	4.1E+04	5.9E+04	1.5E+05
Np-239	1.69E+00	1.59E+01	2.44E+01	1.88E+01	1.38E+00	6.21E+01	4.6E+00	3.2E+01	5.4E+01	4.9E+01	2.0E+01	1.6E+02	1.7E+05	1.2E+06	2.0E+06	1.9E+06	4.0E+05	5.7E+06
Pu-238	2.98E-04	2.93E-03	5.11E-03	5.54E-03	4.00E-03	1.79E-02	9.6E-04	7.0E-03	1.3E-02	1.9E-02	6.0E-02	1.0E-01	3.5E+01	2.7E+02	4.9E+02	7.1E+02	2.2E+03	3.7E+03
Pu-239	3.59E-05	3.53E-04	6.19E-04	6.80E-04	4.75E-04	2.16E-03	1.1E-04	7.8E-04	1.5E-03	2.1E-03	6.5E-03	1.1E-02	3.9E+00	2.9E+01	5.5E+01	8.2E+01	2.5E+02	4.2E+02
Pu-240	4.65E-05	4.56E-04	7.98E-04	8.75E-04	6.13E-04	2.79E-03	1.4E-04	1.1E-03	1.9E-03	2.7E-03	9.2E-03	1.5E-02	5.1E+00	3.8E+01	6.7E+01	1.1E+02	3.2E+02	5.4E+02
Pu-241	1.35E-02	1.33E-01	2.31E-01	2.53E-01	1.78E-01	8.08E-01	4.4E-02	3.3E-01	6.1E-01	9.2E-01	2.7E+00	4.6E+00	1.6E+03	1.2E+04	2.2E+04	3.3E+04	1.0E+05	1.7E+05
Am-241	6.08E-06	5.97E-05	1.06E-04	1.15E-04	9.25E-05	3.79E-04	2.1E-05	1.6E-04	2.9E-04	4.4E-04	1.5E-03	2.4E-03	7.9E-01	5.8E+00	1.1E+01	1.5E+01	5.7E+01	9.0E+01

Table 3.0-5 Comparison of Unit 3 and ESP Activity Releases for Loss-of-Coolant Accident *(continued)*

	ESP Activity Release (Ci)						Unit 3 Activity Release (Ci)						Unit 3 Activity Release (MBq)					
Isotope	0–2 hr	2–8 hr	8–24 hr	24–96 hr	96–720 hr	Total	0–2 hr	2–8 hr	8–24 hr	24–96 hr	96–720 hr	Total	0–2 hr	2–8 hr	8–24 hr	24–96 hr	96–720 hr	Total
Cm-242	1.43E-03	1.40E-02	2.44E-02	2.65E-02	1.76E-02	8.39E-02	5.0E-03	3.7E-02	6.8E-02	1.0E-01	3.0E-01	5.1E-01	1.9E+02	1.4E+03	2.5E+03	3.7E+03	1.1E+04	1.9E+04
Cm-244	6.91E-05	6.77E-04	1.19E-03	1.29E-03	9.13E-04	4.14E-03	2.6E-04	1.9E-03	3.6E-03	5.2E-03	1.7E-02	2.8E-02	9.7E+00	7.1E+01	1.4E+02	1.9E+02	5.9E+02	1.0E+03
Total	2.46E+03	7.82E+04	4.76E+05	2.58E+06	1.25E+06	4.39E+06	5.2E+03	8.0E+04	4.1E+05	2.6E+06	8.4E+06	1.1E+07	1.9E+08	2.9E+09	1.6E+10	9.8E+10	2.9E+11	4.1E+11

Notes:

ESBWR accident release activities from ESP Table D-18

Unit 3-specific accident release activities in the unit of curie (Ci) from DCD Table 15.4-7a

Unit 3-specific accident release activities in the unit of mega-becquerel (MBq) from DCD Table 15.4-7

Table 3.0-6 Activity Releases for ESBWR Cleanup Water Line Break

	ESP Activity Release (Ci)	Unit 3 Activity Release (Ci)		Unit 3 Activity Release (MBq)	
Isotope	0–2 hr	Equilibrium Activity	Pre-Incident Spike	Equilibrium Activity	Pre-Incident Spike
I-131	3.48E+01	4.10E+00	8.21E+01	1.52E+05	3.04E+06
I-132	7.05E+01	2.85E+01	5.71E+02	1.06E+06	2.11E+07
I-133	9.28E+01	2.68E+01	5.35E+02	9.90E+05	1.98E+07
I-134	1.22E+02	4.46E+01	8.92E+02	1.65E+06	3.30E+07
I-135	9.59E+01	3.57E+01	7.14E+02	1.32E+06	2.64E+07
Cs-134	NP	2.95E-02	2.95E-02	1.09E+03	1.09E+03
Cs-136	NP	2.00E-02	2.00E-02	7.39E+02	7.39E+02
Cs-137	NP	7.95E-02	7.95E-02	2.94E+03	2.94E+03
Co-58	NP	2.42E-02	2.42E-02	8.97E+02	8.97E+02
Co-60	NP	4.85E-02	4.85E-02	1.79E+03	1.79E+03
Sr-89	NP	1.11E-01	1.11E-01	4.12E+03	4.12E+03
Sr-90	NP	7.72E-03	7.72E-03	2.86E+02	2.86E+02
Y-90	NP	7.72E-03	7.72E-03	2.86E+02	2.86E+02
Sr-91	NP	4.31E+00	4.31E+00	1.60E+05	1.60E+05
Sr-92	NP	9.76E+00	9.76E+00	3.61E+05	3.61E+05
Y-91	NP	4.54E-02	4.54E-02	1.68E+03	1.68E+03
Y-92	NP	5.90E+00	5.90E+00	2.18E+05	2.18E+05
Y-93	NP	4.31E+00	4.31E+00	1.60E+05	1.60E+05
Zr-95	NP	8.86E-03	8.86E-03	3.28E+02	3.28E+02
Nb-95	NP	8.86E-03	8.86E-03	3.28E+02	3.28E+02
Mo-99	NP	2.20E+00	2.20E+00	8.15E+04	8.15E+04
Tc-99m	NP	2.20E+00	2.20E+00	8.15E+04	8.15E+04
Ru-103	NP	2.23E-02	2.23E-02	8.23E+02	8.23E+02
Ru-106	NP	3.41E-03	3.41E-03	1.26E+02	1.26E+02
Te-129m	NP	4.54E-02	4.54E-02	1.68E+03	1.68E+03
Te-131m	NP	1.09E-01	1.09E-01	4.03E+03	4.03E+03
Te-132	NP	1.11E-02	1.11E-02	4.12E+02	4.12E+02

Table 3.0-6 Activity Releases for ESBWR Cleanup Water Line Break

	ESP Activity Release (Ci)	Unit 3 Activity Release (Ci)		Unit 3 Activity Release (MBq)	
Isotope	0–2 hr	Equilibrium Activity	Pre-Incident Spike	Equilibrium Activity	Pre-Incident Spike
Ba-140	NP	4.54E-01	4.54E-01	1.68E+04	1.68E+04
La-140	NP	4.54E-01	4.54E-01	1.68E+04	1.68E+04
Ce141	NP	3.41E-02	3.41E-02	1.26E+03	1.26E+03
Ce-144	NP	3.41E-03	3.41E-03	1.26E+02	1.26E+02
Np-239	NP	8.86E+00	8.86E+00	3.28E+05	3.28E+05
Total	4.16E+02	1.79E+02	2.83E+03	6.62E+06	1.05E+08

Notes:

NP – Not present in the ESP

ESBWR accident release activities from ESP Table D-22

Unit 3-specific accident release activities in the unit of curie (Ci) from DCD Table 15.4-22

Unit 3-specific accident release activities in the unit of mega-becquerel (MBq) from DCD Table 15.4-22

Table 3.0-6a Activity Releases for ESBWR Feedwater System Pipe Break

	ESP Activity Release (Ci)	Unit 3 Activity Release (Ci)		Unit 3 Activity Release (MBq)	
Isotope	0–2 hr	Equilibrium Activity	Pre-incident Spike	Equilibrium Activity	Pre-incident Spike
I-131	4.39E-03	1.08E+01	2.16E+02	3.99E+05	7.97E+06
I-132	4.05E-02	7.50E+01	1.50E+03	2.77E+06	5.55E+07
I-133	2.94E-02	7.03E+01	1.41E+03	2.60E+06	5.20E+07
I-134	7.43E-02	1.17E+02	2.34E+03	4.33E+06	8.67E+07
I-135	4.05E-02	9.37E+01	1.87E+03	3.47E+06	6.93E+07
Cs-134	NP	7.75E-02	7.75E-02	2.87E+03	2.87E+03
Cs-136	NP	5.25E-02	5.25E-02	1.94E+03	1.94E+03
Cs-137	NP	2.09E-01	2.09E-01	7.72E+03	7.72E+03
Co-58	NP	6.37E-02	6.37E-02	2.36E+03	2.36E+03
Co-60	NP	1.27E-01	1.27E-01	4.71E+03	4.71E+03
Sr-89	NP	2.92E-01	2.92E-01	1.08E+04	1.08E+04
Sr-90	NP	2.03E-02	2.03E-02	7.50E+02	7.50E+02
Y-90	NP	2.03E-02	2.03E-02	7.50E+02	7.50E+02
Sr-91	NP	1.13E+01	1.13E+01	4.19E+05	4.19E+05
Sr-92	NP	2.56E+01	2.56E+01	9.49E+05	9.49E+05
Y-91	NP	1.19E-01	1.19E-01	4.41E+03	4.41E+03
Y-92	NP	1.55E+01	1.55E+01	5.74E+05	5.74E+05
Y-93	NP	1.13E+01	1.13E+01	4.19E+05	4.19E+05
Zr-95	NP	2.33E-02	2.33E-02	8.61E+02	8.61E+02
Nb-95	NP	2.33E-02	2.33E-02	8.61E+02	8.61E+02
Mo-99	NP	5.78E+00	5.78E+00	2.14E+05	2.14E+05
Tc-99m	NP	5.78E+00	5.78E+00	2.14E+05	2.14E+05
Ru-103	NP	5.84E-02	5.84E-02	2.16E+03	2.16E+03
Ru-106	NP	8.94E-03	8.94E-03	3.31E+02	3.31E+02
Te-129m	NP	1.19E-01	1.19E-01	4.41E+03	4.41E+03
Te-131m	NP	2.86E-01	2.86E-01	1.06E+04	1.06E+04
Te-132	NP	2.92E-02	2.92E-02	1.08E+03	1.08E+03

Table 3.0-6a Activity Releases for ESBWR Feedwater System Pipe Break

	ESP Activity Release (Ci)	Unit 3 Activity Release (Ci)		Unit 3 Activity Release (MBq)	
Isotope	0–2 hr	Equilibrium Activity	Pre-incident Spike	Equilibrium Activity	Pre-incident Spike
Ba-140	NP	1.19E+00	1.19E+00	4.41E+04	4.41E+04
La-140	NP	1.19E+00	1.19E+00	4.41E+04	4.41E+04
Ce141	NP	8.94E-02	8.94E-02	3.31E+03	3.31E+03
Ce-144	NP	8.94E-03	8.94E-03	3.31E+02	3.31E+02
Np-239	NP	2.33E+01	2.33E+01	8.61E+05	8.61E+05
Total	1.89E-01	4.69E+02	7.44E+03	1.74E+07	2.75E+08

Notes:
NP – Not present in the ESP
ESBWR accident release activities from ESP Table D-7
Unit 3-specific accident release activities in the unit of curie (Ci) from DCD Table 15.4-15
Unit 3-specific accident release activities in the unit of mega-becquerel (MBq) from DCD Table 15.4-15

Table 3.0-7 Comparison of Unit 3 and ESP Liquid Effluent Release Activities

Isotope	ESP Composite Release Activity (Ci/yr)	North Anna Unit 3 Release Activity (Ci/yr)	North Anna Unit 3 Release Activity (MBq/yr)
H-3	8.5E+02	1.4E+01	5.18E+05
C-14	4.4E-04	NP	NP
Na-24	3.5E-03	4.2E-03	1.55E+02
P-32	6.6E-04	3.5E-04	1.30E+01
Cr-51	2.1E-02	1.1E-02	4.07E+02
Mn-54	2.8E-03	1.3E-04	4.81E+00
Mn-56	4.2E-03	1.0E-03	3.70E+01
Fe-55	6.4E-03	1.9E-03	7.03E+01
Fe-59	2.0E-04	6.0E-05	2.22E+00
Co-56	5.7E-03	NP	NP
Co-57	7.9E-05	NP	NP
Co-58	3.4E-03	3.7E-04	1.37E+01
Co-60	1.0E-02	7.5E-04	2.78E+01
Ni-63	1.5E-04	NP	NP
Cu-64	8.2E-03	1.0E-02	3.70E+02
Zn-65	7.5E-04	3.7E-04	1.37E+01
Zn-69m	6.0E-04	7.5E-04	2.78E+01
Br-83	7.5E-05	1.0E-04	3.70E+00
Br-84	2.0E-05	NP	NP
Rb-88	2.7E-04	NP	NP
Rb-89	4.8E-05	NP	NP
Sr-89	3.6E-04	1.9E-04	7.03E+00
Sr-90	3.8E-05	1.0E-05	3.70E-01
Sr-91	9.8E-04	9.5E-04	3.52E+01
Sr-92	8.8E-04	2.3E-04	8.51E+00
Y-90	3.4E-06	NP	NP

Table 3.0-7 Comparison of Unit 3 and ESP Liquid Effluent Release Activities

Isotope	ESP Composite Release Activity (Ci/yr)	North Anna Unit 3 Release Activity (Ci/yr)	North Anna Unit 3 Release Activity (MBq/yr)
Y-91m	1.0E-05	NP	NP
Y-91	2.4E-04	1.2E-04	4.44E+00
Y-92	6.6E-04	8.7E-04	3.22E+01
Y-93	9.8E-04	1.0E-03	3.70E+01
Zr-95	1.0E-03	1.0E-05	3.70E-01
Nb-95	1.9E-03	1.0E-05	3.70E-01
Mo-99	3.9E-03	2.5E-03	9.25E+01
Tc-99m	5.1E-03	4.6E-03	1.70E+02
Ru-103	4.9E-03	4.0E-05	1.48E+00
Ru-105	1.0E-04	1.3E-04	4.81E+00
Ru-106	7.4E-02	NP	NP
Rh-103m	4.9E-03	NP	NP
Rh-106	7.4E-02	NP	NP
Ag-110m	1.1E-03	NP	NP
Ag-110	1.4E-04	NP	NP
Sb-124	6.8E-04	NP	NP
Te-129m	1.4E-04	7.0E-05	2.59E+00
Te-129	1.5E-04	NP	NP
Te-131m	1.0E-04	8.0E-05	2.96E+00
Te-131	3.0E-05	NP	NP
Te-132	2.4E-04	1.0E-05	3.70E-01
I-131	1.4E-02	6.2E-03	2.29E+02
I-132	2.8E-03	9.3E-04	3.44E+01
I-133	2.4E-02	3.0E-02	1.11E+03
I-134	1.9E-03	4.0E-05	1.48E+00
I-135	8.2E-03	7.1E-03	2.63E+02

Table 3.0-7 Comparison of Unit 3 and ESP Liquid Effluent Release Activities

Isotope	ESP Composite Release Activity (Ci/yr)	North Anna Unit 3 Release Activity (Ci/yr)	North Anna Unit 3 Release Activity (MBq/yr)
Cs-134	9.9E-03	5.7E-04	2.11E+01
Cs-136	1.2E-03	3.5E-04	1.30E+01
Cs-137	1.3E-02	1.5E-03	5.55E+01
Cs-138	2.1E-04	NP	NP
Ba-137m	1.2E-02	NP	NP
Ba-139	2.5E-05	3.0E-05	1.11E+00
Ba-140	5.5E-03	6.9E-04	2.55E+01
La-140	7.4E-03	NP	NP
La-142	2.5E-05	2.0E-05	7.40E+01
Ce-141	1.3E-04	6.0E-05	2.22E+00
Ce-143	1.9E-04	3.0E-05	1.11E+00
Ce-144	3.2E-03	NP	NP
Pr-143	1.4E-04	7.0E-05	2.59E+00
Pr-144	3.2E-03	NP	NP
W-187	2.1E-04	2.0E-04	7.40E+00
Np-239	1.4E-02	9.3E-03	3.44E+02
Total w/o H-3	3.7E-01	9.9E-02	3.66E+03
Total w/ H-3	8.5E+02	1.4E+01	5.22E+05

Notes:

NP – Not present; Note: Isotopes with liquid effluent release activity greater than the ESP activity are represented in bold face

ESBWR accident release activities from ESP Table D-23

Unit 3-specific normal operation liquid effluent release activities in the unit of mega-becquerel (MBq) from FSAR Table 12.2-19bR

Table 3.0-8 Fuel Handling Accident

	ESP Activity Release (Ci)	Unit 3 Activity Release (Ci)
Isotope	**0-2 hr**	**0-2 hr**
Kr-85m	2.68E-03	9.96E+0
Kr-85	1.10E+03	4.98E+02
Kr-87	**NP**	1.07E-02
Kr-88	**NP**	2.85E+01
Xe-131m	5.36E+02	**NP**
Xe-133m	1.29E+03	**NP**
Xe-133	6.94E+04	3.23E+04
Xe-135m	4.37E-01	**NP**
Xe-135	1.32E+02	2.01E+03
I-130	3.52E-02	**NP**
I-131	2.90E+02	1.37E+02
I-132	1.54E+02	7.01E-02
I-133	1.91E+01	8.21E+01
I-134	**NP**	5.24E-07
I-135	1.36E-02	1.28E+01
Total	7.29E+04	3.52E+04

NP = Not present.
ESP accident release activities from ESP Table D-19.
Unit 3-specific accident release activities from DCD Table 15.4-3a.

3.1 External Appearance and Plant Layout

Information regarding external appearance and plant layout is provided in ESP-ER Section 3.1. Supplemental information is provided below.

The design selected for Unit 3 is an ESBWR. A general description of the ESBWR design is provided in FSAR Section 1.1 and FSAR Section 1.2, and the site layout is provided in Figure 1.1-1 and Figure 1.1-2. Table 3.0-2 lists the ESP plant parameter values that were identified in ESP Table D-1 and compares them to the corresponding Unit 3 design characteristics.

In accordance with the commitment in ESP-ER Section 5.8.1.5, a visual impact evaluation has been conducted to assess the aesthetic impact of the external appearance of Unit 3. Section 5.8 describes the results of this evaluation and provides artist renderings of the site with Unit 3.

3.2 Reactor Power Conversion System

The Unit 3 reactor power conversion system consists of an ESBWR, a turbine-generator set, and its auxiliaries. As shown in Table 3.0-2, design characteristics of the Unit 3 reactor power conversion system fall within the ESP plant parameters identified in ESP Table D-1. For further information on the reactor power conversion system, refer to FSAR Chapters 4, 5, 6, and Chapter 10.

3.3 Plant Water Use

Information for this section is provided in ESP-ER Section 3.3 and FEIS Section 3.2.1. Although ESP-ER Section 3.3 described several water treatment systems for the operation of new units, specific chemicals to be used in water treatment were not known. FEIS Section 5.3.3 identified the need to provide the chemical constituents of effluents in waste streams, other than those in cooling tower blowdown. To provide the information requested in FEIS Section 5.3.3, water treatment systems and associated chemical additives for Unit 3 are described in the following subsections.

3.3.1 Water Consumption

The current water consumption associated with proposed Unit 3 is bounded by that reported in the ESP-ER. ESP-ER Table 3.3-1 also provides discharge rates for various systems, including the sanitary waste system. Water release points and quantities are described in Section 3.6 and in ESP-ER Section 3.3.1, respectively. The ESP-ER indicated that the existing sanitary waste system would be modified to accommodate the sanitary waste requirements of the new units. However, it has now been determined that a separate sanitary waste system will be provided for new Unit 3. A description of the Unit 3 sanitary waste system is provided in Section 3.6.2.

3.3.2 Water Treatment

Several water treatment systems will be used in Unit 3 operations. The water treatment systems and associated chemical additives are described in the following sections.

3.3.2.1 **Raw Water**

Make-up water necessary for the Unit 3 cooling towers will be treated for biofouling, scaling, and suspended matter, with acceptable biocides, anti-scalants, and dispersants, respectively.

Each chemical treatment feed system consists of a tank or totes, metering pumps and the necessary associated strainers, pulsation dampeners, piping, valves, instrumentation and controls. Chemical injection points are identified in Table 3.3-1, and the treatment chemicals and their quantities are described below.

The primary biocide to be used for circulating water and plant service water is commercially available 12.5 percent sodium hypochlorite, which will be injected directly into the cooling tower basins and will be equivalent to 120g Cl_2 per liter. A chlorination dosage of 2 ppm chlorine for approximately 30 minutes, three times a day, will maintain a residual of 0.5 ppm Cl_2. This dose is based on the respective system water flow rates.

The anti-scalant to be used for circulating water and plant service water is ChemTreat CL2010 (or equivalent) at a continuous dose rate of 10 ppm neat (i.e., undiluted). The dose is based on the cooling tower blowdown flow rate.

The dispersant to be used for circulating water and plant service water is ChemTreat CL1355 (or equivalent) at a continuous dose rate of 5 ppm neat. The dose is based on the cooling tower blowdown flow rate.

Sodium hypochlorite injection for station water chlorination will be injected into pump discharge piping and is based on a continuous dose of 0.5 ppm Cl_2. The dose is based on plant cooling tower make-up flow and firewater flow, with the dosage adjusted seasonally as required.

Sodium bisulfite will be used for circulating water and plant service water dechlorination. It will be injected at a dose based on neutralizing residual combined chlorine of 0.5 ppm as Cl_2 to at or below the chlorine concentration limits set by the Virginia Pollutant Discharge Elimination System (VPDES) permit. The dose rate will be approximately 120 percent of the stoichiometric rate required to neutralize the residual chlorine in the circulating water and plant service water cooling tower blowdown. This is sufficient to dechlorinate both circulating water and plant service water cooling tower blowdown flows.

Sodium bromide (40% wt) will be used as a secondary biocide, if required. It will be injected at a 6:1 to 10:1 hypochlorite to bromide ratio. Sodium bromide injection will occur simultaneously with sodium hypochlorite injection (approximately 30 minutes, three times a day) as needed.

Provisions are also included to inject, as an option, a non-oxidizing biocide (Nalco's H-130 or equivalent). The proposed dose rate is 15 to 25 ppm neat, based on circulating and plant service water system volume. The injection will be in a 20-to-40-minute period as needed from once per week to once per month.

Raw water from the North Anna Reservoir will be treated by filtration in the station water system and used to provide make-up for demineralized water, fire protection, and miscellaneous station water users. Prior to filtration, the station water system will be treated with hydrogen peroxide, alum as a coagulant and sodium bicarbonate for final pH adjustment, or similar treatment.

3.3.2.2 **Make-up Water**

Make-up water from the North Anna Reservoir for systems other than circulating water and service water will be treated by a process that includes filtration in the station water system followed by processing by one or more treatment methods such as activated carbon filters, reverse osmosis (RO), and mixed bed demineralizers, which will result in highly purified water for use in various plant systems. In addition to the processing described above, the demineralized water system will be treated with an anti-scalant just prior to the RO membranes and with sodium hydroxide between the first and second passes of the RO membranes to improve permeate water quality. Once purified, the make-up water will be directed to various plant systems and services such as condensate and the auxiliary boiler systems.

3.3.2.3 **Condensate System**

Treated condensate water serves as the source of feedwater. Condensate-grade water also serves as the heat transfer media for residual heat removal from primary systems and for the chilled water subsystem. For the existing units, component cooling water is treated by the chemical addition of chromates for corrosion inhibition and pH control. For Unit 3, the component cooling water and chilled water systems will be provided with a chemical feed tank for corrosion inhibitor addition. A specific corrosion inhibitor has not been selected at this time. Water for the chilled water subsystem may need additional treatment depending on the piping materials used.

3.3.2.4 **Domestic Water System**

The domestic water system will provide a safe, state-permitted potable water supply. The Unit 3 domestic water system will be supplied from groundwater wells using hydro-pneumatic tanks and compressors, for pressure maintenance, and a distribution system. Water treatment will be provided through filtration and disinfection, as needed.

Table 3.3-1 Unit 3 Chemical Injection Points

Service	Injection Point
Circulating water sodium hypochlorite feed	Circulating water cooling tower basin
Circulating water anti-scalant feed	Circulating water cooling tower basin or circulating water pump intake bay
Circulating water dispersant feed	Circulating water cooling tower basin or circulating water pump intake bay
Circulating water sodium bromide feed (if required)	Circulating water cooling tower basin
Circulating water non-oxidizing biocide feed (optional)	Circulating water cooling tower basin
Plant service water sodium hypochlorite feed	Plant service water cooling tower basin
Plant service water anti-scalant feed	Plant service water cooling tower basin or essential plant water pump intake bay
Plant service water dispersant feed	Plant service water cooling tower basin or plant service water pump intake bay
Plant service water sodium bromide feed (if required)	Plant service water cooling tower basin
Plant service water non-oxidizing biocide feed (optional)	Plant service water cooling tower basin
Plant intake sodium hypochlorite feed	Common line in Station Water (Plant Cooling Tower Makeup) pump discharge
Firewater sodium hypochlorite injection	Secondary firewater pump discharge
Circulating water cooling tower blowdown sodium bisulfite feed	Circulating water cooling tower blowdown
Reverse Osmosis anti-scalant injection	Upstream of RO membrane
Sodium hydroxide	Between 1st and 2nd passes RO membranes
Hydrogen peroxide, alum (coagulant) & sodium bicarbonate (pH adjustment)	Upstream of station water (pretreated water supply system) filters
Circulating water corrosion inhibitor feed	Circulating water cooling tower basin or circulating water pump intake bay
Plant service water corrosion inhibitor feed	Plant service water cooling tower basin or plant service water pump intake bay
Plant service water cooling tower blowdown sodium bisulfite feed	Plant service water cooling tower blowdown

3.4 Cooling System

The Unit 3 cooling system is a closed-cycle, hybrid cooling system, as described in ESP-ER Section 3.4. Table 3.0-2 compares ESP design parameters against the corresponding design characteristics of the Unit 3 cooling system. Section 5.10.1 provides information addressing the mitigating actions based on the results of the IFIM study.

3.5 Radioactive Waste Management System

Information regarding the radioactive waste management system is provided in ESP-ER Section 3.5 and FEIS Section 3.2.3. Supplemental information is provided below.

Descriptions of the liquid, gaseous, and solid radioactive waste management systems are provided in FSAR Section 11.2, Section 11.3, and Section 11.4, respectively.

Liquid effluent release activities are provided in Table 5.4-1. Liquid pathway doses are evaluated in Section 5.4.2.1.

Gaseous effluent release activities are provided in Table 5.4-3. Gaseous pathway doses are evaluated in Section 5.4.2.2.

The total predicted yearly activity and yearly generated volume of solid radwaste are provided in Table 3.0-2.

3.6 Nonradioactive Waste Systems

Information for this section is provided in ESP-ER Section 3.6 and FEIS Section 3.2.4. At the time of the ESP-ER, the sanitary waste system for Units 1 and 2 was being evaluated for modification to accommodate Unit 3 sanitary waste requirements. It was subsequently determined that a separate sanitary waste system will be designed for Unit 3. A discussion of this separate sanitary waste system is provided in Section 3.6.2.

FEIS Section 5.3.3 states that the applicant would need to provide information regarding chemical effluents at the time of the COL application.

3.6.1 Effluents Containing Chemicals or Biocides

Proper treatment of lake water will be required for use in various plant systems such as: circulating water, plant service water, station water and demineralized water. Waste effluents from these systems would include circulating water and service water system blowdown, station and demineralized water system filter backwashes, demineralized water reverse osmosis reject and nonradioactive drains throughout the station. Unit 3 effluent streams will be directed to the existing discharge canal where it would mix with circulating water from Units 1 and 2, prior to discharge to the WHTF.

Unit 3 effluent streams will contain some low-level chemicals and/or biocides used for water treatment. Section 3.3 identifies systems that use such chemicals, a description of those chemicals and their injection points. None of the chemicals and/or biocides used for water treatment in Unit 3 will contain any of the "126 priority pollutants" listed in 40 CFR 423, Appendix A (Reference 1). Furthermore, their interaction within the plant systems would not create any by-products that would contain any of these pollutants. However, the effluent streams from Unit 3 will include some of the "126 priority pollutants" due to the fact that they are already present in the lake water. Table 2.3-1 provides a list of the constituents that have been measured in lake water. This table also includes the Reported Level of the constituent concentration in the lake, the Virginia Surface Water Quality Criteria (VSWQC) and the Detection Level of various constituents. In addition to the "126 priority pollutants," this table also includes other constituents and characteristics listed on NPDES Form 2C for which sampling is currently performed.

An analysis was performed using Lake Anna water chemistry data to estimate the constituent levels of the projected effluent streams from Unit 3 and to predict if the new effluents would comply with the existing VPDES permit for Units 1 and 2 (Reference 2). As stated above, these effluent streams will contain all of the constituents already present in the lake water. The analysis used the maximum value for each constituent for conservatism. The Unit 3 effluent is primarily composed of cooling water blowdown streams from the circulating water and service water systems. Constituent concentrations will increase in these two effluent streams due to evaporation losses from these cooling systems. Consequently the potential impact of these effluent streams was estimated by increasing measured lake water concentrations, by factors of four and nine (as separate cases), to account for evaporative loss. The combined blowdown discharge was then evaluated to account for the dilution provided by three different circulating water flow conditions for Units 1 and 2 operation (i.e., all eight circulating water pumps running, two pumps running, or only one pump running).

The results of the analysis demonstrate that for all of the case-condition combinations stated above, the constituent concentrations present at the end of the discharge canal will be less than or equal to the existing Virginia Surface Water Quality Criteria for all but two constituents: copper and tributyltin (TBT).

Both of these constituents, on at least one occasion during the sampling period, have been measured in Lake Anna at concentrations equal to or greater than the current Virginia Surface Water Quality Criteria. The table below shows the maximum and average reported lake water concentrations in comparison to the surface water quality criteria. The table also shows that, based on the maximum concentration and an assumed dilution, the projected concentrations are only approximately 6 to 7 percent above that in the lake. Finally, the table shows that if the average readings were used in place of the maximums, the projected concentrations would be below the surface water quality criteria.

The presence of elevated levels of copper is explained by past mining operations that heavily impacted Contrary Creek, which flows into Lake Anna above the North Anna Power Station (see

ESP-ER Section 5.3.2.2.2.b). Furthermore, copper is also a key ingredient in current boat hull paints to prevent/retard biofouling of boat hulls. This copper-based paint is designed to be ablative, thus requiring recoating each year. TBT was also used as a biocide in paint for marine application. Although TBT has been restricted for use in this application and the use of marine paints containing TBT is now regulated under the Organotin Antifouling Paint Control Act of 1988, residual amounts of TBT still remain in water bodies such as Lake Anna. The presence of both of these constituents is unrelated to the operation of Units 1 and 2, and Unit 3 would not contribute further. Additionally the increase in concentrations of these constituents in the discharge to the WHTF attributable to the operation of Unit 3 would be essentially immeasurable using current VDEQ-approved analytical methods.

Nominal amounts of non-priority pollutants may be generated from corrosion and wear of plant piping and equipment, some of which could appear in effluent streams. These include three constituents described in the ESP-ER, i.e., oil and grease, total suspended solids and iron. As indicated in Table 2.3-1, these constituents do not have Virginia Surface Water Quality Criteria. For iron, the only existing numeric criterion is for the protection of public water supplies, and Lake Anna is not a designated public water supply. Although these constituents have no VSWQC, they were included in the waste stream analysis. The results indicate that once mixed with the assumed discharge from Units 1 and 2, oil & grease and iron concentrations are much less than 1 mg/L (ppm) and total suspended solids is approximately 5 mg/L (ppm).

Dominion analyzes station discharge for these constituents and characteristics as required by the VPDES permit for Units 1 and 2. Similar sampling and analyses will be performed in accordance with the VPDES permit for Unit 3. See Section 3.3 for chemicals that would be used in the systems requiring pre-treatment along with the proposed injection points for those chemicals.

The potable water system will be supplied from onsite wells. Currently, water from onsite wells is not treated; however, it can be treated if sampling indicates treatment is necessary.

Table 3.6-1 Copper and Tributyltin Concentrations vs. Water Quality Criteria

Constituent Name (See Note 1)	Virginia Surface Water Quality Criteria (VSWQC)	Reported Level in Lake (Max. Reading)	Projected Concentration in WHTF (Max. Reading) (See Note 2)	Reported Level in Lake (Avg.)	Projected Concentration in WHTF (Avg. Reading) (See Note 2)
Copper	0.0027	0.0030	0.0032	0.0014	0.0015
Tributyltin	0000063	0.000063	0.000067	0.000013	0.000014

Notes:

1. All values are in mg/L (ppm).
2. Based on 4 cycles of concentration with one Unit 1/2 Circulating Water Pump operating considering the reported levels in the lake.

3.6.2 Sanitary System Effluents

A sanitary waste system would be maintained onsite during the construction and operation of Unit 3, with effluents in compliance with acceptable industry design standards, the Clean Water Act (CWA), the state regulatory authority through the VPDES permit and 9 VAC 25-790, Sewage Collection & Treatment Regulations, Commonwealth of Virginia, State Water Control Board. (Reference 3)

The waste treatment system would be permanent, with no wastes handled or processed through a municipal system. Until the permanent sanitary waste treatment facility is functional either during construction or for operation of Unit 3 or as needed during peak construction or outage support activities, additional sewage treatment capacity and approved supplemental means of handling sanitary wastes would be employed. Typically, this supplemental means would be portable sanitary facilities. These facilities could include a centralized restroom and hand-wash trailer(s) in addition to single restroom units located throughout the site as necessary. The wastes collected in these temporary facilities would be pumped out and disposed of by a licensed sanitary waste disposal contractor.

The sanitary waste discharge system for Unit 3 would be designed to collect and transfer sanitary water/waste from the potable water and sanitary waste system to the sewage treatment plant. The sewage treatment plant would be a standard industry design, consisting of two 50 percent-capacity packaged units designed to process the sanitary water/waste to meet local and state regulations for effluent quality in accordance with the VPDES permit. Treated water at a maximum rate of approximately 105 gpm would be routed to the WHTF just south of the Units 1 and 2 circulating water discharge structure. The sludge generated by the treatment facility would be transported to a licensed sanitary waste landfill for disposal.

The sludge would be regularly monitored for radioactivity. In the event that sewage sludge becomes radioactively contaminated, the contents of the sludge tank would be pumped to a drying bed. The sludge would be allowed to dry completely. Once dry, Radiation Protection personnel would survey the bed and collect all contaminated sludge. The sludge would be packaged in an appropriately sized DOT approved shipping container for disposal at a licensed burial facility. Alternatively, the packaged sludge may be shipped to a third party vendor for further processing (e.g., volume reduction by incineration), re-packaging and final disposal.

Approved technology for processing wastes would include laboratory testing of effluents to ensure proper treatment. Monitoring would be implemented to ensure compliance with regulatory limits.

Section 3.6 References

1. U.S. Environmental Protection Agency, "EPA Steam Electric Power Generating Point Source Category, 126 Priority Pollutants," 40 CFR 423, Appendix A.
2. Commonwealth of Virginia, Department of Environmental Quality, "VPDES Permit No. VA0052451, Authorization to Discharge Under the Virginia Pollutant Discharge Elimination System and the Virginia State Water Control Act," October 25, 2007.
3. Commonwealth of Virginia, State Water Control Board, "Sewage Collection & Treatment Regulations," 9 VAC 25-790, January 1, 2008.

3.7 Power Transmission System

ESP-ER Section 3.7 described the anticipated switchyard interfaces and transmission system for new units at NAPS and, based on initial evaluation, stated that existing transmission lines were expected to have sufficient capacity to carry the output of the existing and new units. ESP-ER Section 3.7 stated that detailed system load studies could not be performed until an in-service date for the new units is established.

A system load flow study has now been performed for Unit 3, which determined that a new transmission line and other system reinforcements would be required for grid reliability in association with the interconnection of Unit 3. The sections below provide a description of the final configuration of switchyard interfaces and transmission system connections that would be made for Unit 3.

3.7.1 Switchyard Interfaces

Unit 3 would be connected to the existing 500 kV switchyard by an overhead conductor circuit. The existing switchyard would be extended to the north for construction of additional 230 kV bays. The interface of the extension with the transmission system is through the existing switchyard.

"PJM Generator Interconnection Q65 North Anna 500 kV (1570 MW Capacity/1594 Energy Report) Revised System Impact Study & Facilities Study Report Resulting from Necessary Studies, revised September 2013" (Reference 1), describes the system reinforcements associated with the interconnection of new Unit 3:

- Replacement of existing 500 kV circuit breakers and associated high voltage equipment with ones with higher current and/or short circuit rating.
- Adding a new 500 kV bay to support the new North Anna-to-Ladysmith transmission line.
- Adding a 230 kV bay parallel to the existing 230 kV bay on the North side to support the reserve auxiliary transformer's feed to Unit 3.

New control and relay protection equipment would be installed in a new or expanded control house. Some existing service systems, such as grounding, raceway, lighting, AC/DC station service, and switchyard lightning protection would be expanded or modified.

3.7.2 Transmission System

The PJM System Impact Study determined that an additional 500 kV transmission line from the North Anna Substation to the Ladysmith Switching Substation is required for grid stability associated with the interconnection of Unit 3. The new transmission line would be installed in the NAPS-to-Ladysmith corridor, on new transmission towers located in proximity to the existing towers. This corridor is identified as "Line 575" on ESP-ER Figure 2.2-4 (beginning at NAPS and heading east) and is 84 m (275 ft) wide and approximately 15 miles long.

Transmission tower separation, line installation, and clearances to ground will be consistent with the National Electrical Safety Code (NESC) and transmission line standards. Basic tower structural design parameters, including the number of conductors and other considerations such as height, materials, color, and finish will be consistent with transmission line design standards. Marking for aircraft visibility will be consistent with the existing adjacent tower. The new towers are expected to be about 10 percent taller, but not more than 20 feet taller, than the existing towers. No expansion of the corridor is required. Electrical design parameters, including the electric-field-induced current from transmission lines will not exceed allowable NESC code requirements (Reference 2). In addition, considerations for visibility for aircraft are the same as for the existing, adjacent towers.

Conductors and other line parameters will meet the PJM and transmission line design criteria. The tower grounding system will be verified for safety and adequacy.

The noise levels resulting from new transmission line operations will be consistent with the existing transmission system. Actual decibel noise levels will be minimized by proper sizing of conductors and the use of corona-free hardware. Examples of the measurement of audible noise from overhead transmission lines are given in IEEE Standard 656-1992 (Reference 3).

Section 3.7 References

1. PJM System Planning Division, "PJM Generator Interconnection Q65 North Anna 500 kV (1570 MW Capacity/1594 Energy) Revised System Impact Study & Facilities Study Report Resulting from Necessary Studies," September 2013.
2. National Electrical Safety Code (NESC 2007 - Section 21, Rule 232.C.1.c).
3. IEEE Standard 656-1992, "IEEE Standard for the Measurement of Audible Noise from Overhead Transmission Lines."

3.8 Transportation of Radioactive Materials

The information for this section is provided in ESP-ER Section 3.8 and associated impacts are resolved as SMALL in FEIS Section 6.2.

3.8.1 Transportation of Unirradiated Fuel

No new and significant information has been identified for this section.

3.8.2 Transportation of Spent Fuel

The following commitment was identified in FEIS Section 6.2.2.2 and is addressed below:

> Consequently, the impacts of crud and activation products on spent fuel transportation accident risks will need to be examined at the CP or COL stage.

The highest surface radioactivity of Co-60 in spent fuel crud available for spallation during transportation accidents for the proposed Unit 3 ESBWR is expected to be 579 $\mu Ci/cm^2$. NUREG/CR-6672 (Reference) indicates that the total surface area for a BWR fuel rod is approximately 1600 cm^2. The number of fuel rods for an ESBWR assembly is expected to be about 100. As a result, the total surface area of an ESBWR spent fuel assembly would be 160,000 cm^2. The weight of UO_2 for each ESBWR assembly is estimated to be 0.163 MTU (163 kg U). Thus, the unit-specific inventory of Co-60 in ESBWR spent fuel crud available for spallation during transportation accidents is estimated to be 568 Ci/MTU.

The unit-specific inventory of Co-60 in spent fuel crud used for the FEIS analysis was 2730 Ci/MTU (associated with the ABWR), which also represented the entire inventory of activation products in spent fuel. As such, the available unit-specific inventory of Co-60 in ESBWR spent fuel crud is about a factor of 5 lower than that used in the evaluation for the FEIS.

The FEIS states that activation products will need to be examined at the CP or COL stage. Because FEIS Table 6-8 contains data on activation products for the ESBWR, no additional information is required.

Based on the above discussion, the conclusion presented in the FEIS that the impact is SMALL remains valid.

3.8.3 Transportation of Radioactive Waste

No new and significant information has been identified for this section.

Section 3.8 Reference

U.S. Nuclear Regulatory Commission, "Reexamination of Spent Fuel Shipment Risk Estimates," NUREG/CR-6672, March 2000.

Chapter 4 Environmental Impacts of Construction

4.1 Land-Use Impacts

The information for this section is provided in ESP-ER Section 4.1 and associated impacts are resolved as SMALL in FEIS Sections 4.1 and 4.6. Supplemental information is provided in Sections 4.1.1 through 4.1.4, below.

4.1.1 The Site and Vicinity

In ESP-ER Section 4.1.1.4, it was concluded that all construction activities for new units, including ground-disturbing activities, would occur within the NAPS site boundary. It has now been determined that offsite modifications would be required for Unit 3 to support the transport of the reactor pressure vessel and other large components to the site.

It is expected that the reactor pressure vessel and other large components (e.g., the main generator, large plant modules) would be transported by barge up the Mattaponi River to an offload location near the town of West Point or the town of Walkerton. From West Point or Walkerton, the oversized equipment would be transported to the site either entirely over-the-road or by a combination of over-the-road and rail.

Road improvements (e.g., repairs, widening, and filling-in low areas) would be required for over-the-road transport. Lowering sections of road for clearance under bridges and installation of temporary road bridges may also be needed. Removal of overhead and/or lateral interferences (wires, signs, etc.) would also be required for both transport methods.

Transport operations for the large components, including the road/rail modifications described above, would be coordinated with State and local officials to minimize land use and other impacts. Upon completion of the transports, temporary structures would be removed, interferences would be re-installed, and disturbed areas would be restored back to their original condition or better. Permanent changes are anticipated to be limited in scope and would be coordinated with State and local officials.

For these reasons, land use and other impacts associated with transport of large components to the North Anna site will be SMALL.

4.1.2 Transmission Line Rights-of-Way and Offsite Areas

As described in Section 3.7, the PJM System Impact Study (Reference) determined that an additional 500 kV transmission line from the North Anna Substation to the Ladysmith Switching Substation is required for grid stability associated with the interconnection of Unit 3. The new line would be installed on new transmission towers in the existing NAPS-to-Ladysmith corridor. This corridor is identified as "Line 575" on ESP-ER Figure 2.2-4 (beginning at NAPS and heading east) and is 84 m (275 ft) wide and approximately 15 miles long.

Land-use impacts from constructing the new transmission line would be limited to the existing corridor and access roads and would be minimal. The potential impacts within the corridor and access roads could include:

- Removal of natural landscape (small trees, bushes, vegetation)
- Soil disturbance and erosion
- Siltation of streams
- Tree and brush piles
- Damage to culverts, driveways, and roadways
- Disturbance of archaeological artifacts

Clearing methods for trees, bushes and vegetation would be performed to protect natural resources and control erosion of the landscape and siltation of streams. Trees and brush located within an approximately 100-foot buffer of a stream or ditch with running water would be hand-cleared and material approximately three inches in diameter and above would be removed from the buffer, leaving material less than three inches undisturbed. Appropriate actions (e.g., stop work) would be taken following discovery of potential historic or archaeological resources.

Once the construction of the transmission line has been completed, the transmission corridor and access roads would be restored by means such as:

- Rehabilitation of land including discing, fertilizing, seeding, and installing erosion control devices (e.g., water bars and mulch)
- Removal and proper disposal of debris left or caused by construction
- Restoration of damaged property to its original condition and to the satisfaction of the property owner

Thus, the construction of a new transmission line would result in no additional land use, and land use impacts will be SMALL.

4.1.3 **Historic Properties and Cultural Resources**

A proposed large component transport route was evaluated for potential disruptions to historic properties and cultural resources. The study revealed historic properties and cultural resources may be disrupted in three locations. These locations are described in detail in Section 2.5.3.5, Large Component Transport Route. They include the historic train depot in Beaverdam, a ferry landing, and the North Anna Battlefield.

Temporary modifications to the proposed large component transport route are expected to be minor with little potential to affect cultural resources. Temporary modifications may be required at the historic train depot in Beaverdam, which has been recommended for inclusion in the National Register of Historic Places. Other temporary modifications may be needed at three other locations:

the preferred roll-off location (the ferry landing); the North Anna River crossing at Route 30; and the I-95 crossing. The ferry landing is eligible for inclusion in the National Register. All three proposed modifications have potential to affect cultural resources. The North Anna River crossing is likely to impact a previously recorded archaeological site.

The I-95 crossing and the North Anna River crossing are within the North Anna Battlefield. The North Anna Battlefield is eligible for inclusion in the National Register of Historic Places.

Mitigating measures for these disruptions include avoidance of sensitive areas whenever possible, rehabilitation of land, removal of debris, and restoration of damaged property to its original condition or as close as possible. Impacts resulting from the transport of large components are expected to be SMALL.

The new 500 kV line proposed for the existing NAPS-to-Ladysmith corridor has the potential to impact two newly-identified sites that are eligible for inclusion in the National Register of Historical Places—one archaeological resource and one architectural resource. These sites are described in Section 2.5.3.3. The archaeological resource is located within the right-of-way under the existing lines, but the potential for impact is minimized by the location of the site with respect to the new lines. The site is approximately 70 feet north of the area to be impacted by the new lines and lies across the gravel access road from the area to be impacted by the construction of the new transmission towers. To further avoid any impacts on this archaeological resource, it will be marked and/or flagged prior to and during construction.

The closest architectural resource is about one-quarter mile north of the proposed transmission line. As such, the only expected impact would be visual. This impact is minimized by the presence of the existing transmission lines within the corridor. The new towers are expected to be about 10 percent taller, but not more than 20 feet taller, than the existing towers. If the final tower design has the potential to visually impact the architectural resources, a photo simulation analysis will be performed to assess the impacts. The visual impact upon the historic property will be further minimized by selection of material colors that help the towers blend in to the natural surroundings (See Section 5.6.3.4).

An assessment of historic and cultural resources in the additional property acquired for construction support is provided in Appendix 4A.

4.1.4 **Additional Property**

Dominion owns additional property contiguous with the NAPS site. The additional property will provide alternative space for Unit 3 construction-related activities and facilities such as laydown areas, spoils storage, and access roads, but will not be part of the NAPS site. Further information is provided in Appendix 4A.

Section 4.1 Reference

PJM System Planning Division, "PJM Generator Interconnection Q65 North Anna 500kV (1570 MW Capacity/1594 Energy) Revised System Impact Study & Facilities Study Report Resulting from Necessary Studies," September 2013.

4.2 Water-Related Impacts

The information for this section is provided in ESP-ER Section 4.2 and associated impacts are resolved as SMALL in FEIS Section 4.3. Supplemental information is provided in Sections 4.2.1.1 and 4.2.1.2, below.

4.2.1 Hydrologic Alterations

4.2.1.1 Surface Water

The ESP-ER describes two small ephemeral streams that discharge in the vicinity of the cooling tower area and indicates that these streams would be impacted by construction activities. These streams are designated Stream A and Stream B on ESP-ER Figure 4.2-1. A third ephemeral stream (designated as Stream C) has been identified in the cooling tower area. All three streams are shown on ESP-ER Figure 2.4-5, ESP-ER Figure 2.4-6, and Figure 1.1-1. It has now been determined that Unit 3 construction activities would alter only Streams B and C and that Stream A would not be altered, as it is outside of the construction area. The drainage area of Stream A and Stream C are not substantially different, and the discharge point of both streams is Lake Anna. Once construction is complete, the area would continue to drain to the wetlands, through stream beds, to Lake Anna. Thus, while the particular streams identified as being altered by construction have changed, the impact remains SMALL because the area of concern is not substantially different than what was evaluated in the ESP-ER.

The ESP-ER indicated that no new transmission lines or alterations to existing rights-of-way were expected; however, the PJM System Impact Study (Reference) concludes that an additional transmission line would be required as a system reinforcement associated with the interconnection of Unit 3. The new transmission line would be installed in the NAPS-to-Ladysmith corridor on new transmission towers located in proximity to the existing towers. Construction activities for the new transmission line would be performed in accordance with existing corridor procedures.

Section 2.4 identifies wetlands crossed by the Ladysmith corridor. To the extent practical, the construction of new transmission towers would avoid alterations to wetlands and shorelines. In accordance with existing corridor procedures, impacts from construction of overhead transmission lines adjacent to streams would be minimized through various practices, including:

- Hand-clearing of trees and brush located within approximately 100 feet of a stream or ditch with running water

- Removing material approximately three inches in diameter and above from the buffer and leaving material less than three inches undisturbed
- Limiting the disturbance of soil within an approximate 100-foot buffer zone around streams and ditches
- Crossing creeks and streams at right angles in one location on the corridor using culverts, temporary bridges, or large aggregate stone
- Performing work related to stream crossings in accordance with state standards and specifications
- Removing materials from temporary stream crossings at the completion of the project
- Removing logs, trimmings, or brush from ditches, creeks, and drains

In addition impacts from construction of structure foundations and structure erections would be mitigated through various practices, including:

- Evaluation of the site with respect to earth disturbance and erosion potential
- Stabilization of the work site prior to moving to the next location
- Restoration of areas damaged during foundation construction and structural erection activities to approximate original grade and installation of erosion and sedimentation control measures
- Maintaining temporary erosion and sedimentation controls until permanent stabilization is achieved.

Should wetlands be impacted, the U.S. Army Corps of Engineers and other appropriate agencies would be consulted and permits and approvals obtained as necessary.

For these reasons, no significant hydrologic alterations are anticipated from the installation of the new transmission line and water-related impacts will remain SMALL.

Additional property contiguous with the NAPS site will be utilized for Unit 3 project construction support. An assessment of the construction impacts is provided in Appendix 4A.

4.2.1.2 **Groundwater**

Five domestic water wells are planned for installation inside the EAB. Two are anticipated for batch plant operations with an expected water withdrawal rate of approximately 90 gpm. Three additional domestic water wells with an expected water withdrawal rate of approximately 50 gpm are planned for installation and are anticipated to be part of the permanent potable water system. Two of those three wells are expected to be used during construction activities. The expected average aggregate water withdrawal rate on all construction wells is approximately 130 gpm. Information on groundwater use associated with the additional property acquired for construction support is provided in Appendix 4A.

4.2.2 Water-Use Impacts

No new and significant information has been identified for this section.

4.2.3 Future Growth and Development Impacts

No new and significant information has been identified for this section.

Section 4.2 Reference

PJM System Planning Division, "PJM Generator Interconnection Q65 North Anna 500kV (1570 MW Capacity/1594 Energy) Revised System Impact Study & Facilities Study Report Resulting from Necessary Studies," September 2013.

4.3 Ecological Impacts

The information for this section is provided in ESP-ER Section 4.3 and associated impacts are resolved as SMALL in FEIS Section 4.4. Supplemental information is provided in Sections 4.3.1.1, 4.3.1.3, 4.3.1.4, and 4.3.2.

As discussed in Section 3.7, a new 500 kV transmission line required for Unit 3 would be installed along the existing NAPS-to-Ladysmith corridor. The following sections provide supplemental information regarding the impacts of this construction on terrestrial and aquatic ecological resources.

4.3.1 Terrestrial Ecosystems

4.3.1.1 Transmission Corridors

The new transmission line would be installed on new transmission towers in the existing NAPS-to-Ladysmith corridor. Because the transmission corridor has been maintained at a full 275-foot width, widening to accommodate the additional line would not be required. The NAPS-to-Ladysmith corridor passes through land that is typical of north-central Virginia, such as pastures, row crops, forests and shrub bogs. No areas designated as critical habitat for endangered species by the U.S. Fish and Wildlife Service or VDEQ exist along or adjacent to the transmission line corridor. The corridor does not cross any state or federal parks, wildlife refuges, or wildlife management areas. As described in Section 2.4, potential habitat for the Epling's hedgenettle was identified during a plant-specific habitat survey conducted in November 2009 (Reference 5) for the Blantons Powerline Conservation Site (Conservation Site) (through which the NAPS-to-Ladysmith transmission corridor runs). The Epling's hedgenettle, while neither a federally- nor state-listed species, is considered rare by the Commonwealth of Virginia and the VDCR recommends the avoidance of this species (Reference 6). Follow-up plant-specific identification surveys, conducted during the flowering seasons in 2010 and 2012 (Reference 9) (Reference 10), determined that the

Epling's hedgenettle was present. Survey results were communicated to appropriate regulatory agencies (Reference 11).

Existing access roads would be used to bring the tower components and heavy equipment to the new tower locations, and some clearing of the access roads is anticipated. Land clearing necessary to accommodate the tower foundations would be controlled by existing transmission line procedures, good construction practices, and established best management practices, as well as applicable regulatory requirements. Clearing methods for trees, bushes and vegetation would be performed to protect natural resources and control erosion of the landscape and siltation of streams. Areas disturbed during tower construction would be restored to the original grade, and temporary erosion and sedimentation controls would remain in place until permanent stabilization by means such as re-vegetation is achieved.

Trees and brush located within an approximately 100-foot buffer of a stream or ditch with running water would be hand-cleared and material approximately three inches in diameter and above would be removed from the buffer, leaving material less than three inches undisturbed. Soil disturbances would be avoided or reduced to the extent practicable within an approximately 100-foot buffer of streams and ditches with running water. Erosion and sedimentation control measures and buffer zone maintenance around water bodies would be implemented to reduce runoff and erosion. These measures would be left in place, until stabilization of the area is achieved. Work sites would be stabilized prior to moving to the next area.

Potential impacts to streams and creeks would be mitigated by performing work related to stream crossings in accordance with state standards and specifications. In addition, streams and creeks would be crossed at right angles at one location on the corridor using culverts, temporary bridges, or large aggregate stone. Materials would be removed from the temporary crossing at the completion of the project.

A wetland delineation was conducted along the NAPS-to-Ladysmith corridor in August 2008. (Reference 1) Based upon a field analysis of the vegetation, soils, and hydrology conducted in accordance with the "Corps of Engineers Wetlands Delineation Manual" (1987 Manual) (Reference 2), 39 potential non-tidal wetland areas were flagged.

The current design plan for construction of the transmission line is to place the proposed towers adjacent to existing towers. Out of the 72 potential tower locations identified, one wetland area was located within a proposed tower footprint and one wetland area was located immediately adjacent to a proposed tower. No other wetland areas were identified within the footprints of the remaining towers. The proposed towers will be located in such a manner as to avoid wetland impacts, to the greatest extent practicable, and in accordance with existing regulations, procedures, and/or best management practices.

Wetland boundaries, as defined by regulations, were verified through a site review by the U.S. Army Corps of Engineers (USACE) as indicated in their September 2008 letter (Reference 3), and which contains an approved jurisdictional determination.

Any necessary permits will be obtained prior to work in these areas which is considered structure or fill under current regulations.

Once all the construction of transmission lines has been completed, Dominion would restore disturbed areas by means such as: 1) rehabilitating land by discing, fertilizing, seeding, and installing erosion control devices (e.g., water bars and mulch); 2) properly removing and disposing debris left or caused by construction; and 3) restoring damaged property to its original condition and to the satisfaction of the property owner.

Dust suppression techniques and routine equipment maintenance would be employed to reduce airborne emissions.

The construction activity and associated noise would temporarily disperse nearby wildlife, and a small amount of habitat associated with the tower foundations would be impacted. Although small amphibians and mammals may be displaced, no critical habitats or known protected species would be impacted. Once construction is completed and the corridor is re-vegetated, displaced animals would return to the area.

Thus, impacts from the installation of the transmission line and new transmission towers on terrestrial ecology will be SMALL.

4.3.1.2 **ESP Site**

As described in Section 2.4, potential habitat for the small whorled pogonia was identified during a plant-specific habitat survey conducted in November 2009 (Reference 7) for the ESP Site. Follow-up plant-specific identification surveys, conducted during the flowering season, have determined that the small whorled pogonia was not present in the area of potential effects. (Reference 8)

4.3.1.3 **Additional Property**

Additional property contiguous with the North Anna site will be utilized for Unit 3 project construction support. Additional information is provided in Appendix 4A.

4.3.1.4 **Transportation of Large Components**

Based upon a field analysis in accordance with the "Corps of Engineers Wetlands Delineation Manual" (Reference 2), there were 31 wetlands and 26 waterways scattered along a proposed large component transport route. Dependent upon size of modules and equipment, temporary construction may result at the crossing of I-95. Depending on the final route selected, improvements to the road will impact no more than two potential tidal wetlands, five non-tidal wetland areas, and create a temporary impact on a few waterways. Mitigation measures for these wetlands and waterways would include maintaining temporary erosion and sedimentation controls until permanent stabilization is achieved, removal of all debris, and rehabilitation of disturbed lands as close to their original condition as possible. Wetland impacts from the temporary improvements to the transport route will be SMALL.

4.3.2 **Aquatic Ecosystems**

No new transmission towers would be constructed in Lake Anna (or other water bodies) and, as discussed in Section 4.3.1.1, a buffer zone would be maintained around water bodies, where feasible. Construction within wetlands would be avoided to the extent practical. Should wetlands be impacted, the U.S. Army Corps of Engineers and other appropriate agencies would be consulted and permits and approvals obtained as necessary.

Thus, impacts from construction of the new transmission line and associated transmission towers on aquatic ecosystems will be SMALL.

4.3.2.1 **Additional Property**

Additional property contiguous with the existing North Anna site will be utilized for Unit 3 project construction support. An assessment of the construction impacts is provided in Appendix 4A.

Section 4.3 References

1. EA Engineering, Science, and Technology, Inc., "Dominion North Anna Power Station Wetland Delineation Report for the Proposed Unit 3 500-kV Transmission Line," Sparks, Maryland, September 2008.

2. Environmental Laboratory, "Corps of Engineers Wetlands Delineation Manual," Technical Report Y-87-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, January 1987.

3. Department of the Army, Northern Virginia Regulatory Section, NAO 2008-02731 (Lake Anna), September 24, 2008.

4. EA Engineering, Science, and Technology, Inc., "Dominion North Anna Power Station Wetland Delineation Report for the Proposed Unit 3 Heavy Haul Route," June 2009.

5. Williamsburg Environmental Group Inc., "Habitat Survey for the Epling's Hedge-nettle (*Stachys eplingii*) and Small Whorled Pogonia (*Isotria medeoloides*) Blantons Powerline Conservation Site, Caroline County, Virginia," November 2009.

6. Virginia Department of Conservation and Recreation, letter from Rene Hypes to Michael Sackschewky, Pacific Northwest National Laboratory, dated September 29, 2009.

7. Williamsburg Environmental Group Inc., "Habitat Survey for the Small Whorled Pogonia (*Isotria medeoloides*) North Anna Power Station, Louisa County, Virginia," November 2009.

8. Williamsburg Environmental Group Inc., "Detailed Survey for the Small Whorled Pogonia (*Isotria medeoloides*) North Anna Power Station, Louisa County, Virginia," August 2012.

9. Williamsburg Environmental Group Inc., "Detailed Survey for the Epling's Hedge-nettle (Stachys eplingii) Blantons Powerline Conservation Site, Caroline County, Virginia," July 2010.

10. Williamsburg Environmental Group Inc., "Detailed Survey for the Epling's Hedge-nettle (Stachys eplingii) Blantons Powerline Conservation Site, Caroline County, Virginia," July 2012.

11. Dominion Resources Services, Inc., "Transmittal of Epling's Hedgenettle Survey Report Virginia Electric and Power Company (Dominion) North Anna Power Station - Proposed Unit 3 Louisa County, Virginia," March 7, 2011.

4.4 Socioeconomic Impacts

The information for this section is provided in ESP-ER Section 4.4 and associated impacts are resolved in FEIS Sections 4.2, 4.5, 4.7, and 4.8. These FEIS sections resolved that adverse impacts range from SMALL to MODERATE and beneficial impacts range from SMALL to MODERATE. Supplemental information is provided below.

As discussed in Section 3.7, the new 500 kV transmission line required in connection with Unit 3 would be installed in the existing NAPS-to-Ladysmith corridor. As discussed in Section 2.4, a portion of this new transmission line would cross Lake Anna, as well as other waterways and wetlands. As a precaution, during installation of the new transmission line across Lake Anna and the other waterways, access to the subject areas would be temporarily restricted from recreational use. Although this would limit the areas that are accessible to the public for recreational use, the limitation would be temporary in nature, and full use would be restored once the installation has been completed. A communications plan would be developed to notify local citizens concerning the impacts of this activity. Notification would include a description of the construction schedule with expected durations of activities. Typically, interruptions affecting recreation in waterways are expected to be of short duration. Implementation of the communications plan would include advanced coordination with appropriate agencies and organizations, public notices, use of actual "day-of" postings, and notification to marine vessels via citizen band radio. The impacts of construction of the transmission line on the recreational use of Lake Anna and the other waterways will be SMALL, and further mitigation is not warranted.

4.5 Radiation Exposure to Construction Workers

The information for this section is provided in ESP-ER Section 4.5 and associated impacts are resolved as SMALL in FEIS Section 4.9.

Supplemental information is provided below.

4.5.1 Site Layout

No new and significant information has been identified for this section.

4.5.2 Radiation Sources

No new and significant information has been identified for this section.

4.5.2.1 Direct Radiation

No new and significant information has been identified for this section.

4.5.2.2 Gaseous Effluents

Sources of gaseous releases at Units 1 and 2 include the waste decay tanks, boron recovery and high-level waste tanks, containment purge system, auxiliary building vent, main condenser air ejector vents, auxiliary steam drain receiver, Turbine Building ventilation exhaust, and gland seal ejector vent. The annual radioactive effluent release reports for the years 2001 to 2011 indicate average annual gaseous releases of 48 Ci of fission and activation gases and 55 Ci of tritium (References 1 through 11).

4.5.2.3 Liquid Effluents

Effluents from the liquid waste disposal system of Units 1 and 2 produce small amounts of radioactivity in the North Anna Reservoir and the WHTF. The annual effluent reports for the years 2001 to 2011 indicate average annual liquid releases of 0.2 Ci of fission and activation products and 966 Ci of tritium (References 1 through 11).

4.5.3 Measured and Calculated Dose Rates

No new and significant information has been identified for this section.

4.5.3.1 Direct Radiation

Thermo-luminescent dosimeter (TLD) measurements at the west protected area fence of Units 1 and 2 from 2001 to 2011 indicate an average annual dose of 72 mrem, which equates to a continuous dose rate of 8.22E-3 mrem/hr. This location is along the eastern edge of the Unit 3 construction area.

TLD readings taken along the ISFSI perimeter fence for the two-year period third quarter 2010 to third quarter 2012 indicate a maximum quarterly dose of 192 mrem during the fourth quarter of

2011, when there were 27 casks on Pad One and 13 on Pad Two for a total of 40 casks. The plan for the ISFSI is to load 28 casks on Pad One and 40 on Pad Two for a total of 68 casks. The maximum TLD reading of 192 mrem may be multiplied by 68/40 to estimate the dose from a fully loaded ISFSI. For conservatism, however, a growth factor of two is applied. Based on 91 days per quarter and 24 hours per day, 192 mrem/quarter is equivalent to a dose rate of 8.79E-2 mrem/hr. Multiplying by the growth factor of two yields a dose rate of 0.176 mrem/hr at the ISFSI fence from a fully loaded ISFSI.

The dose rate at the construction area boundary near the ISFSI may be estimated by dividing the ISFSI fence dose rate by a distance reduction factor. The distance from the ISFSI to the ISFSI fence is 203 ft (Reference 12). The distance from the ISFSI to the nearest point of the construction area is approximately 500 ft (Figure 1.1-1). A Monte Carlo calculation was performed to assess the dose rate as a function of distance from the ISFSI when loaded with 84 casks, which bounds the planned 68 casks. This calculation shows dose rates of 1.39 mrem/hr at 203 ft and 0.24 mrem/hr at 500 ft, yielding a reduction factor of 5.8. Dividing the ISFSI fence dose rate of 0.176 mrem/hr by 5.8 yields a dose rate of 3.04E-2 mrem/hr at the construction area boundary nearest the ISFSI.

The same method is used to estimate the ISFSI dose rate in the center of the construction area. The distance from the ISFSI to the center of the construction area is approximately 1600 ft (Figure 1.1-1). The distance reduction factor for this distance is 294. Dividing the ISFSI fence dose rate of 0.176 mrem/hr by 294 yields a dose rate of 5.98E-4 mrem/hr at the center of the construction area.

4.5.3.2 Gaseous Effluents

The annual radioactive effluent release reports for 2001 to 2011 indicate average dose rates of 1.01E-2 mrem/yr for the whole body and 0.129 mrem/yr for the critical organ of the maximally exposed member of the public due to the release of gaseous effluents from Units 1 and 2, calculated in accordance with the Offsite Dose Calculation Manual (ODCM) for Units 1 and 2.

According to the ODCM, gaseous effluent doses to the members of the public are calculated at or beyond the site boundary (Reference 13). The construction area is closer to the effluent release point than is the site boundary. A review of the atmospheric dispersion factors (χ/Q values) for Units 1 and 2 indicates that the ratio of χ/Q a few hundred feet from these units to that at the site boundary is no more than a factor of ten (Reference 14). Hence, the dose rates for the maximally exposed member of the public are multiplied by ten, yielding 0.101 mrem/yr for the whole body and 1.29 mrem/yr for the critical organ of the construction worker.

4.5.3.3 Liquid Effluents

The annual radioactive effluent release reports for 2001 to 2011 (References 1 through 11) indicate average dose rates of 0.357 mrem/yr for the whole body and 0.435 mrem/yr for the critical organ of the maximally exposed member of the public due to the release of liquid effluents from Units 1 and 2, calculated in accordance with the ODCM for Units 1 and 2.

4.5.4 Construction Worker Doses

Construction worker doses are conservatively estimated using the following information:

- The estimated maximum dose rate for each exposure pathway
- An exposure time of 2500 hours per year per worker
- A peak loading of 4088 construction workers per year

Using the above worker occupancy time and workforce size, annual doses to the maximally exposed worker as well as the peak workforce are calculated due to direct radiation and gaseous and liquid effluents.

4.5.4.1 Direct Radiation Doses

The TLD at the west protected area fence of Units 1 and 2 is along the eastern edge of the construction area while the maximum dose from the ISFSI occurs along the southern edge of the construction area. Although these two locations are separated by more than 1000 ft (Figure 1.1-1), the direct radiation dose rates at the two locations are conservatively added, yielding a total dose rate of 3.86E-2 mrem/hr. Multiplying by the worker exposure time of 2500 hr yields a maximum annual dose of 96.4 mrem due to direct radiation.

While the maximum dose occurs at the southern edge of the construction area, the center of the construction area is representative of the location of the average member of the construction workforce over the course of a year. Adding the west protected area fence dose rate to the ISFSI dose rate at the center of the construction area yields a total dose rate of 8.82E-3 mrem/hr. Multiplying by the worker exposure time of 2500 hr yields an annual worker dose of 22.0 mrem at this location.

4.5.4.2 Gaseous Effluents

The gaseous effluent dose rates in Section 4.5.3.2 are multiplied by the ratio of expected hours worked per year per worker by the number of hours in a year (2500/8760) to account for the fraction of the year that workers are exposed, resulting in doses of 2.89E-2 mrem to the whole body and 0.368 mrem to the critical organ. These doses are converted into total effective dose equivalent (TEDE) by applying a weighting factor of 0.3 to the critical organ dose (Reference 15) and adding the product to the whole body dose, yielding an annual dose of 0.139 mrem TEDE.

4.5.4.3 Liquid Effluents

Although construction workers are not expected to be exposed to liquid effluents from Units 1 and 2, it is assumed that they receive the same dose rates as the maximally exposed member of the public. The liquid effluent dose rates in Section 4.5.3.3 are multiplied by 2500/8760 to account for the fraction of the year that workers are exposed, resulting in doses of 0.102 mrem to the whole body and 0.124 mrem to the critical organ. Applying a weighting factor of 0.3 to the organ dose and adding the product to the whole body dose, an annual dose of 0.139 mrem TEDE is estimated.

4.5.4.4 **Total Doses**

Adding the doses from the preceding subsections of 96.4 mrem TEDE due to direct radiation, 0.14 mrem TEDE due to gaseous effluents, and 0.14 mrem TEDE due to liquid effluents, the total annual dose to the maximally exposed construction worker is estimated as 97 mrem TEDE. As indicated in Section 4.5.4.1, the maximum dose rate in the construction area is less than 0.04 mrem/hr. These doses are within the regulatory limits of 10 CFR 20.1301. Since the calculated doses meet the public dose criteria of 10 CFR 20 1301, the workers would not need to be classified as radiation workers.

Adding the doses from the preceding subsections of 22.0 mrem TEDE due to direct radiation, 0.14 mrem TEDE due to gaseous effluents, and 0.14 mrem TEDE due to liquid effluents, the total annual dose to the average member of the construction workforce is estimated as 22 mrem TEDE. Multiplying by 4088 workers yields a collective dose of 91 person-rem.

The calculated doses are based on available dose rate measurements for the site. It is possible that these dose rates would increase in the future as site conditions change. However, the construction area would be continually monitored during the construction period and appropriate actions would be taken as necessary to ensure that doses to the construction workers are as low as reasonably achievable (ALARA).

Section 4.5 References

1. Annual Radioactive Effluent Release Report, North Anna Power Station (January 01, 2001 to December 31, 2001).

2. Annual Radioactive Effluent Release Report, North Anna Power Station (January 01, 2002 to December 31, 2002).

3. Annual Radioactive Effluent Release Report, North Anna Power Station (January 01, 2003 to December 31, 2003).

4. Annual Radioactive Effluent Release Report, North Anna Power Station (January 01, 2004 to December 31, 2004).

5. Annual Radioactive Effluent Release Report, North Anna Power Station (January 01, 2005 to December 31, 2005).

6. Annual Radioactive Effluent Release Report, North Anna Power Station (January 01, 2006 to December 31, 2006).

7. Annual Radioactive Effluent Release Report, North Anna Power Station (January 01, 2007 to December 31, 2007).

8. Annual Radioactive Effluent Release Report, North Anna Power Station (January 01, 2008 to December 31, 2008).

9. Annual Radioactive Effluent Release Report, North Anna Power Station (January 01, 2009 to December 31, 2009).

10. Annual Radioactive Effluent Release Report, North Anna Power Station (January 01, 2010 to December 31, 2010).

11. Annual Radioactive Effluent Release Report, North Anna Power Station (January 01, 2011 to December 31, 2011).

12. North Anna Independent Spent Fuel Storage Installation Safety Analysis Report, Revision 6.

13. Offsite Dose Calculation Manual (North Anna), Procedure Number VPAP-2103N, Revision 16.

14. North Anna Power Station Updated Final Safety Analysis Report, Revision 45.

15. Limits for Intake of Radionuclides by Workers, ICRP Publication 30, Part 1, International Commission on Radiological Protection, Pergamon Press, 1979.

4.6 Measures and Controls to Limit Adverse Impacts During Construction

Measures and controls to limit adverse impacts during construction were addressed in ESP-ER Section 4.6 and in FEIS Section 4.10. Those measures and controls remain applicable to Unit 3, along with the following new mitigation measures and controls:

- Upon completion of the transports, temporary structures would be removed, interferences would be reinstalled, and disturbed areas would be restored. (Section 4.1.1).
- The new transmission line would be located in an existing corridor and constructed under practices and procedures applicable to the existing transmission lines. (Sections 4.1.2, 4.2.1.1 and 4.3.1.1).
- Land clearing necessary to accommodate the new transmission tower foundations would be controlled by existing transmission line procedures, good construction practices, and established best management practices (Section 4.3.1.1), as well as all applicable regulations.

- Clearing methods for small trees, bushes, and vegetation would be performed to protect natural resources and control erosion of the landscape and siltation of streams. Trees and brush located within an approximately 100-foot buffer of a stream or ditch with running water would be hand-cleared and material approximately 3 inches in diameter and above would be removed from the buffer, leaving material less than 3 inches undisturbed (Sections 4.1.2, 4.2.1.1, and 4.3.1.1).
- Once all the construction of transmission lines has been completed, Dominion would restore disturbed areas by means such as: 1) rehabilitating land by discing, fertilizing, seeding, and installing erosion control devices (e.g., water bars and mulch), 2) properly removing and disposing debris left or caused by construction, and 3) restoring damaged property (Sections 4.1.2 and 4.3.1.1).
- Appropriate actions (e.g., stop work) would be taken following discovery of potential historic or archaeological resources (Sections 4.1.2 and 4.1.3).
- While the goal is zero impacts to historic properties and cultural resources located adjacent to the proposed large component transport route, appropriate actions for potential impacts include rehabilitation of land, removal of debris, and restoration of damaged property (Section 4.1.3).
- Potential impacts to streams and creeks would be mitigated by performing work related to stream crossings in accordance with state standards and specifications. In addition, streams and creeks would be crossed at right angles at one location on the corridor using culverts, temporary bridges, or large aggregate stone. Materials would be removed from the temporary crossing at the completion of the project (Sections 4.2.1.1 and 4.3.1.1).
- Soil disturbances would be avoided or reduced to the extent practicable within an approximately 100-foot buffer of streams and ditches with running water. Erosion and sedimentation control measures and buffer zone maintenance around water bodies would be implemented to reduce runoff and erosion. These measures would be left in place, until stabilization of the area is achieved. Work sites would be stabilized prior to moving to the next area (Sections 4.2.1.1, 4.3.1.1, and 4.3.1.4).
- To the extent practicable, construction would avoid alterations to shorelines and wetland areas. Should wetlands be impacted, the U.S. Army Corps of Engineers (and other appropriate agencies) would be consulted, and permits and approvals would be obtained as necessary. (Sections 4.2.1.1 and 4.3.2).
- Dust suppression techniques would be utilized and equipment maintenance employed to reduce airborne emissions (Section 4.3.1.1).
- Potential impacts to wetlands along the proposed large component transport route would be addressed by maintaining temporary erosion and sedimentation controls until permanent stabilization is achieved, removing debris, and rehabilitating disturbed lands as practicable (Section 4.3.1.4).

- As a safety precaution, during installation of the transmission lines, access to the area would be temporarily restricted from recreational use (Section 4.4).
- To help avoid impacts to the archaeological resource along the transmission corridor, the identified archaeological site will be marked and/or flagged prior to and during construction of the new transmission line (Section 4.1.3).
- Impacts to wetlands within the additional property would be addressed through preservation of other onsite streams or through purchasing offset credits from an approved mitigation bank (Appendix 4A).
- The additional property area will be stabilized and facilities will be removed upon completion of the construction of Unit 3 (Appendix 4A).

4.7 [Deleted]

Appendix 4A Environmental Information Concerning Additional Property

4A.1 Status of Activities Related to Additional Property

Dominion owns additional property contiguous with the existing NAPS site. The additional property will provide supplemental space for Unit 3 construction activities such as laydown areas, spoils storage, and access roads, but will not be part of the NAPS site. It has been determined through GIS data that the area of the additional property is approximately 111 acres, as shown in Figure 1.1-1.

4A.2 Habitat Assessment

A habitat assessment for selected rare, threatened and endangered species was conducted for the additional property in May 2008. (Reference 3) Four bird species of concern listed by the Virginia Natural Heritage Program as threatened or in decline were identified for this area, and the evaluation considered habitat availability for these birds on the additional property. The report concludes that suitable habitat for each of these four species was not present. USACE letter dated August 27, 2008 confirms that no known populations of federally-listed threatened or endangered species are located on the additional property. (Reference 2) However, the Commonwealth of Virginia Department of Conservation and Recreation requested that Dominion conduct a plant-specific habitat survey to determine if the additional property contains habitat suitable for the small whorled pogonia. (Reference 6) The plant-specific habitat survey identified three small areas in the additional property, comprising a total area of 4.5 acres that are potentially suitable habitat for the small whorled pogonia. (Reference 7) Follow-up plant-specific identification surveys, conducted during the flowering season, determined that the small whorled pogonia was not present within these habitat areas. (Reference 8)

A habitat map of the additional property is provided as Figure 4A-2. The background habitat mosaic of Figure 4A-2 was created from the 2001 National Land Cover Dataset (NLCD). NLCD 2001 land cover data is the most current database available. The NLCD codes were used for mapping habitat types and to develop Figure 4A-2.

NLCD Code	NLCD Code Description	Acres	Percent of Total Acreage
21	Developed Open Space	0.3	0.3
22	Developed Low Intensity	0.1	0.1
31	Barren Land (rock/sand/clay)	6.3	6.6
41	Deciduous Forest	51.0	53.4
42	Evergreen Forest	36.9	38.6
81	Pasture/Hay	0.9	1.0
82	Cultivated Crops	0.0	0.0
	Total	95.5	100.0

NLCD = National Land Cover Data developed by a consortium of federal agencies: U.S. Geological Survey, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, U.S. Forest Service, NASA, Bureau of Land Management, LANDFIRE, Natural Resources Conservation Service, National Park Service, U.S. Fish and Wildlife Service, Office of Surface Mining.

2001 NLCD Code Definitions (2001 Data are the most recent data available)

21. Developed, Open Space - Includes areas with a mixture of constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

22. Developed, Low Intensity - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of total cover. These areas most commonly include single-family housing units.

31. Barren Land (Rock/Sand/Clay) - Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15 percent of total cover.

41. Deciduous Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.

42. Evergreen Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.

81. Pasture/Hay - Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.

82. Cultivated Crops - Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.

The habitat map provided from the 2001 NLCD data does not provide the most current account of the habitat cover types on the additional property but uses the most current official data available from NLCD. Since the 2001 timeframe, habitat cover on the additional property has changed due to clearing of forested areas by the former owner. The following four habitat cover types were found on the additional property during the May 2008 habitat assessment.

1. **Recent Mixed Hardwood/Pine Cut-over:** Approximately 62 acres or 66 percent of the northeast part of the additional property has been timbered within the last one-to-three years.
2. **Deciduous Hardwood Forest:** Approximately three-to-five acres or 3 percent of the northwest boundary of the additional property is covered with mixed deciduous hardwood forest area and lies between two wetland drainages.
3. **Young Mixed Pine/Hardwood:** Approximately 22 to 24 acres or 23.5 percent of the additional property consist of a young mixed pine/hardwood cover type.
4. **Grassy Field:** Approximately 7 acres or 7.5 percent of the additional property consists of grassy fields and is located immediately north of the intersection of Kentucky Springs Road and Haley Drive.

The habitat map shown on Figure 4A-2 also shows the small whorled pogonia survey area inside the additional property as well as the areas that were identified as potentially suitable habitat.

4A.3 Cultural Resources Identified on NAPS Properties

Currently, there are no known historic architectural resources within the Area of Potential Effects for the NAPS site or additional property that are eligible for inclusion in or currently listed on the National Register of Historic Places. During the archaeological survey conducted in April 2008, one potentially historic site was identified which consisted of a partially collapsed log cabin. It has not yet been determined if the site is eligible for inclusion in the National Register of Historic Places. The absence of known historic properties on the additional property precludes the need for a view shed analysis.

4A.4 Cultural Resource Protection on NAPS Properties

Dominion has stated in both the ESP Application (ESP-ER Section 4.1.3) and COL Application (ER Table 1.2-1) that administrative and physical controls will be maintained to report assessments and avoid cultural resources. Dominion has continued consultation with the VDHR throughout several cultural resources assessments, and intends to preserve such cultural resources and avoid sites during ground-disturbing activities to the extent practicable. (Reference 4) These statements, along with the administrative controls, serve as Dominion's corporate commitment to protect identified historical resources and any future discovery of cultural resources.

An archaeological survey of the additional property was completed in April 2008 and one potentially historic site was identified consisting of a partially collapsed log cabin. (Reference 5) The eligibility of this historic site for the National Register of Historic Places has not yet been determined. The final archaeological survey was sent to VDHR in September 2009. In a November 2009 letter to

Dominion, VDHR concurred that the cabin is potentially eligible for inclusion in the National Register, and also that the site be avoided and preserved in place, if feasible. VDHR's expectation is for Dominion to reinitiate consultation if avoidance is deemed impractical.

4A.5 Wetlands and Surface Water

A wetlands and streams delineation survey, map, and detailed report for the additional property has been prepared and identifies nine additional non-tidal wetlands and streams within the land area southwest of NAPS. The nine wetlands and streams boundaries were identified and flagged during the wetland delineation conducted in March 2008. (Reference 1) The wetland boundaries were verified through a site review conducted by the USACE. USACE letter dated August 27, 2008 documents acceptance of the wetland boundaries on the additional property. (Reference 2)

The wetland delineation, construction use, and earth work are depicted on Figure 1.1-1. Based upon the construction utilization predicted in Figure 1.1-1, all identified wetlands will be impacted during NAPS construction. While the current construction and utilization plan has not been finalized, it appears that approximately 133,700 square feet of wetlands within the additional property will be affected. The majority of wetlands will be impacted by the spoils storage and material lay down area. The remaining impacts will be by aggregate storage area with material lay down and storage areas. This is expected to have a MODERATE impact to the wetlands in the additional property area. The survey also found the majority of wetland areas were located in valleys with intermittent or perennial streams totaling approximately 3700 linear feet that generally flowed north toward Harris Creek. Impacts to the streams are expected to be SMALL.

As a result of the construction of Unit 3, direct impacts to wetlands and streams in the area will occur. It is Dominion's practice to avoid these areas during construction where practical and minimize potential impacts when no alternative exists. As such, a mitigation plan will be developed to offset the disruption of these identified wetlands. The wetland areas to be impacted include both forested and emergent wetlands. Mitigation measures being considered to compensate for stream and wetland losses may include preservation of other onsite streams or purchasing credits from an approved mitigation bank.

Structures planned for the additional property outside of the NAPS site during the construction of Unit 3 are not expected to be permanent following the completion of construction. Structures are planned to be removed and the area would be stabilized.

4A.6 Groundwater Aquifers

Approximately two to three domestic wells will be installed on the additional property to provide water to support construction activities. The wells are expected to have a water withdrawal rate of approximately 2 gpm each.

4A.7 Conclusion

Construction impacts to the additional property area will range from SMALL to MODERATE with only roads remaining and structures expected to be removed.

4A.8 References

1. EA Engineering, Science, and Technology, Inc., "Dominion North Anna Power Station Wetland Delineation on Route 700 Parcels Adjacent to Haley Drive and Kentucky Springs Road," June 2008.

2. Department of the Army, Norfolk District Corps of Engineers, "Confirmation of Wetland Delineation (Harris Creek)," NAO-2008-002533, Northern Virginia Regulatory Section, August 27, 2008.

3. Davis Environmental Consultants, Inc., "Habitat Assessment for Selected Rare, Threatened and Endangered Species Near the Dominion North Anna Power Station Louisa County, Virginia," July 22, 2008.

4. Dominion, "Dominion Combined License Project, North Anna Power Station, Project Update and Archaeological Survey (2008) VDHR File No.: 2000-1210," letter to Kathleen Kilpatrick, Director, Virginia Department of Historic Resources from Eugene S. Grecheck, Vice President, Dominion, November 4, 2008.

5. The Louis Berger Group, Inc., "Archaeological Survey Dominion Combined License Project North Anna Power Station Louisa County, Virginia," June 2009.

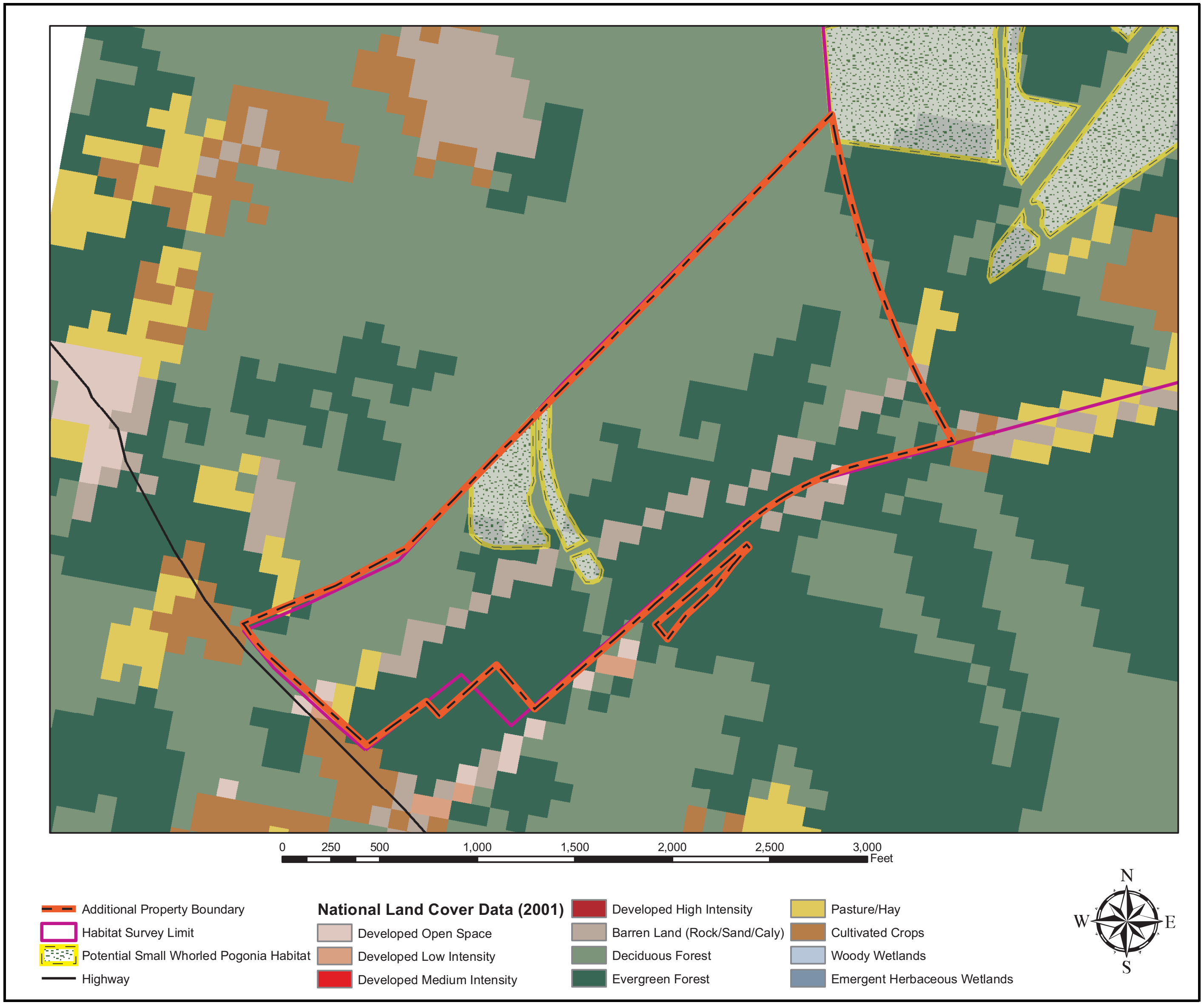
6. Commonwealth of Virginia, Department of Conservation and Recreation, Correspondence to Michael Sackschewky of Pacific Northwest National Laboratory, "Re: North Anna Power Station Unit 3-North Anna Project Site, Construction Staging Area and North Anna Ladysmith Transmission Line Corridor," September 2009.

7. Williamsburg Environmental Group, Inc., Habitat Survey for the Small Whorled Pogonia (Isotria medeoloides), North Anna Power Station, Louisa County, Virginia, November 2009.

8. Williamsburg Environmental Group Inc., "Detailed Survey for the Small Whorled Pogonia (*Isotria medeoloides*) North Anna Power Station, Louisa County, Virginia," August 2012.

Figure 4A-1 Deleted

Figure 4A-2 Habitat Map for Additional Property



Appendix 4B Site Separation Activities

4B.1 Summary of Planned Site Separation Activities

Dominion is making certain changes to facilities for the existing units on the NAPS site so that the operation of Units 1 and 2 will not be affected by Unit 3 construction. These activities are referred to as site separation.

Although these activities are not construction of Unit 3, environmental impacts of site separation activities (SSAs) are evaluated to determine if they could contribute to adverse cumulative impacts related to the NAPS Unit 3 project.

The following activities define the scope of required SSAs:

- Construct communication tower, telephone switch, and fiber-optic network
- Construct new fabrication shop and office facilities, and underground support utilities, i.e., electrical, mechanical
- Install sewage system modifications
- Construct fire protection and domestic water supplies to avoid Unit 3 facilities
- Modify onsite haul route
- Construct southeast security building and sally port
- Conduct general earthwork for new facilities
- Implement stormwater runoff plan alterations (near west end Unit 2 Turbine Building)
- Build new parking areas

Figure 4B-1 shows the areas on the NAPS site impacted by SSAs. This appendix addresses the impacts of these activities upon wetlands, surface water, cemeteries, archaeological sites and terrestrial and aquatic habitats as well as mitigation strategies for those areas potentially impacted by the SSAs.

4B.2 Discussion of Impacts

The primary receptors of concern for the SSAs are wetlands and surface water quality. There are three potential non-tidal wetland areas within the lands proposed for the SSAs with a total observed area of 43,952 square feet (1.01 acres) (Reference 1). As discussed below, the impacts to wetlands would be similar to those in ESP-ER Section 4.3.1.2 and the impacts to surface waters would be similar to those in ESP-ER Section 4.2.1.1.

4B.2.1 Wetlands

A new paint shop supporting the existing units will impact a small emergent wetland system.

New parking areas will be built for SSA construction and personnel supporting the existing units. Two of three identified wetland areas are adjacent to and would be impacted by these activities.

Onsite haul route modifications – The proposed haul route modifications will impact one small emergent wetland area.

The guidelines presented in ESP-ER Section 4.3.1.2 (e.g., avoidance where possible and permit attainment and compliance) will be applied to SSAs in those areas which will or may impact wetlands. As a result of avoidance, protection, and permit compliance impacts to wetlands from conducting SSAs will be SMALL.

4B.2.2 Surface Water

New support facilities – New facilities will be built in the southeast corner of the site and will require grading work adjacent to a sloping terrain above the WHTF. This work has the potential to cause impacts to surface water quality from sediment laden runoff during construction.

Onsite haul route modifications – Because of its proximity to the discharge canal this activity may allow sedimentation from construction activities to enter the WHTF via the discharge canal.

General earthwork for SSAs – The earthwork required to build the new SSAs has the potential to impact the WHTF with sediment laden runoff during construction activities.

ESP-ER Section 4.2.1.1 states "During construction of the new units, the potential would exist for sediment from the construction site to be eroded and conveyed to Lake Anna by stormwater runoff until the ESP site drainage system is installed and construction is completed. Best management practices (BMPs) described in the Virginia Erosion and Sediment Control Handbook (ESP-ER Section 4.2) would be used to control erosion and minimize the sediment load to Lake Anna in accordance with an approved erosion and sediment control plan. Best management practices may include sediment basins, sediment barriers, vegetative stabilization and filter strips, rip rap, rock filter berms, mulching, etc." These measures will be adopted during the construction-related SSAs.

4B.2.3 Aquatic Habitat

Because the SSAs are constrained to terrestrial areas of the existing site, their impacts would be bounded by those described in ESP-ER Section 4.3.2.

Because no other impacts are anticipated, mitigation measures for SSAs will include applicable mitigation described in ESP-ER Section 4.3.2.

4B.2.4 Terrestrial Habitat

Because the SSAs are constrained to the existing site, their impacts would be bounded by those described in ESP-ER Section 4.3.1.2.

However, a November 2009 plant-specific habitat survey (Reference 2) identified a potential small whorled pogonia habitat on the site. This potential habitat includes the construction backfill borrow area and the stormwater management pond (as shown in the northwest corner of Figure 4B-1) required for the general earthworks SSA. Follow-up plant-specific identification surveys, conducted during the flowering season, determined that the small whorled pogonia was not present within these habitat areas. (Reference 3) Mitigation measures for SSAs will include applicable mitigation described in ESP-ER Section 4.3.1.2.

4B.2.5 Cemeteries

Three cemeteries are identified on the NAPS site in ESP-ER Figure 2.5-18. The SSAs are constrained to areas of the site where there are no known cemeteries.

Because no impacts are anticipated, no mitigation is required.

4B.2.6 Archaeological Sites

ESP-ER Figure 2.5-17 shows the locations of areas with potential for yielding archaeological resources within the NAPS study area. The only known archaeological site within the EAB is on the western edge of the site, outside the area to be impacted by the SSAs. Dominion will maintain communications with the Virginia Department of Historic Resources (VDHR) regarding the management of the NAPS site and the potential ground-disturbing activities in areas that have the potential for containing historic and/or archaeological artifacts.

Because no other impacts are anticipated that differ from those in the ESP-ER, mitigation measures for SSAs will include applicable mitigation described in ESP-ER Section 4.1.3 and ESP-ER Table 4.6-1.

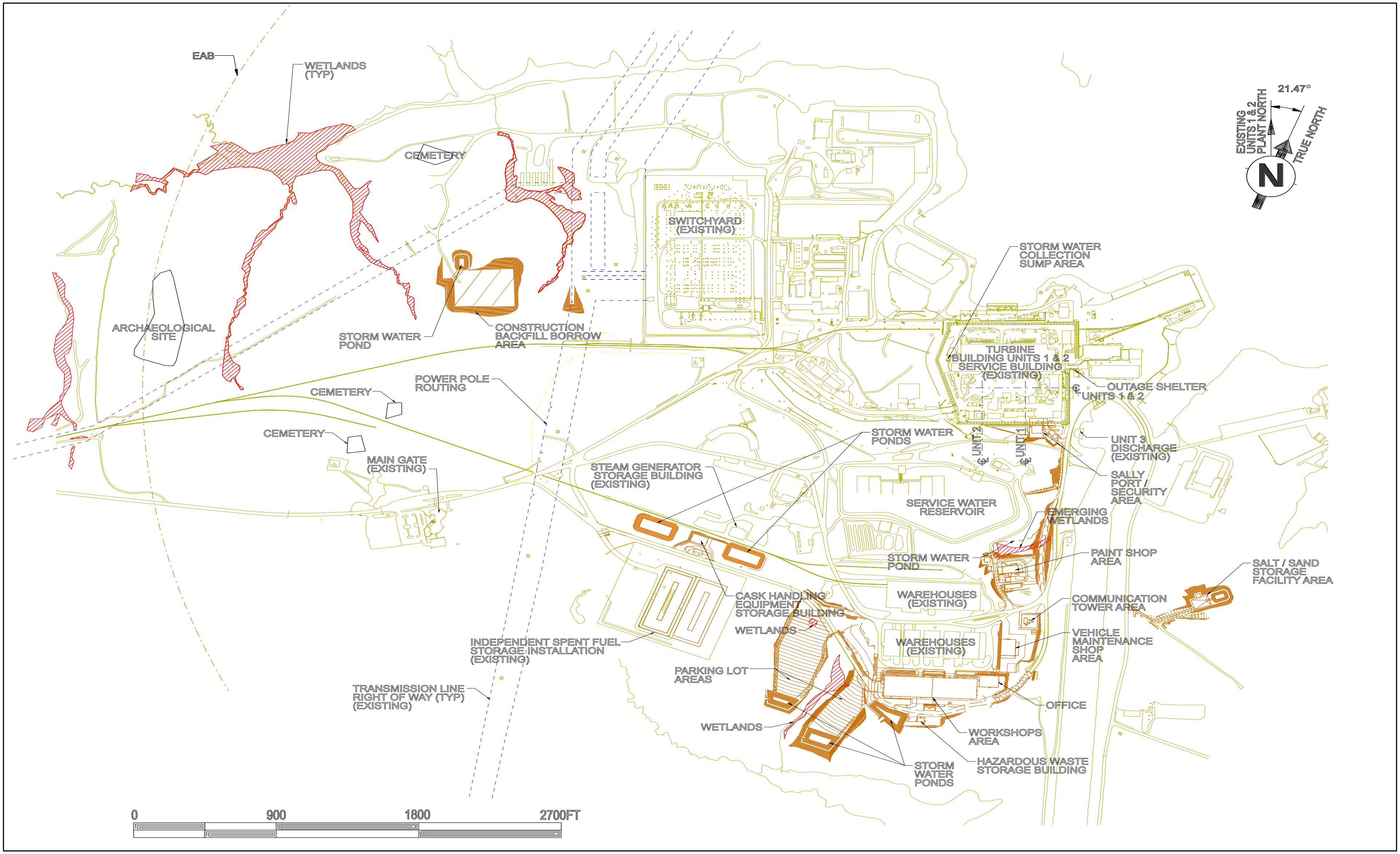
4B.2.7 Socioeconomic Impacts

The size of the workforce that will be required to conduct SSAs will be much smaller than the workforce that will be required to construct NAPS Unit 3. In addition, SSA construction will occur prior to the peak of Unit 3 construction. Because of this, the socioeconomic impacts associated with the SSAs will be proportionately smaller than the socioeconomic impacts for construction of Unit 3.

Section 4B.4 References

1. EA Engineering, Science, and Technology, Inc., "Dominion North Anna Power Station Wetland Delineation for Site Separation Projects," June 2008.
2. Williamsburg Environmental Group, Inc, "Habitat Survey for the Small Whorled Pogonia (Isotria medeoloides), North Anna Power Station, Louisa County, Virginia," November 2009.
3. Williamsburg Environmental Group Inc., "Detailed Survey for the Small Whorled Pogonia (*Isotria medeoloides*) North Anna Power Station, Louisa County, Virginia," August 2012.

Figure 4B-1 Site Separation Activities



Chapter 5 Environmental Impacts of Station Operation

5.1 Land-Use Impacts (Operations)

The information for this section is provided in ESP-ER Section 5.1 and associated impacts are resolved as SMALL in FEIS Section 5.1. Supplemental information is provided in Section 5.1.2 below.

5.1.1 The Site and Vicinity

No new and significant information has been identified for this section.

5.1.2 Transmission Corridors and Offsite Areas

As discussed in Section 3.7, the new 500 kV transmission line required in connection with Unit 3 will be installed along the existing NAPS-to-Ladysmith corridor. As discussed in Section 5.6, the impacts of maintenance practices, visual impacts, shock, noise, or electro-magnetic fields would not change. Existing corridor access routes would be used. Therefore, no changes in or new restrictions to land use would result, and offsite land-use impacts will remain SMALL. No new mitigation measures or controls are warranted.

5.1.3 Historic Properties

No new and significant information has been identified for this section.

5.2 Water-Related Impacts

The information for this section is provided in ESP-ER Section 5.2 and associated impacts, with the exception of water quality impacts, are resolved in FEIS Sections 5.3 and 7.3 as SMALL during normal water years and temporarily MODERATE during severe droughts. Supplemental information regarding water quality impacts is provided in Section 5.2.2 below. In addition, supplemental information on the hydrologic alterations, plant water supply and water-use impacts is provided in Section 5.10.1 that addresses specifically the mitigating actions based on the results of the IFIM study.

5.2.1 Hydrologic Alterations and Plant Water Supply

Supplemental information on hydrologic alterations and plant water supply is provided in Section 5.10.1.3 that addresses specifically the lake mitigating actions based on the results of the IFIM study.

5.2.2 Water-Use Impacts

Section 3.3 describes water treatment and Section 3.6 describes nonradioactive effluents, including sanitary waste and cooling tower blowdown. Section 3.6 identifies the expected constituents that would be contained in the effluents discharged to the WHTF (from Units 1 and 2, as well as Unit 3) and compares them to Virginia Surface Water Quality Criteria (Reference), as applicable.

The effluent from Unit 3 would include circulating water and service water system blowdown (which have been concentrated due to evaporation from the systems) and other system backwashes, rejects and drains (which have the same concentrations as the lake water). Concentrations of various constituents in the Unit 3 effluent would be diluted with a much larger volume of water in the WHTF. Operation of a dechlorination system would neutralize chlorine in the circulating water and plant service water cooling tower blowdown before discharge to the WHTF and eventually to the North Anna Reservoir.

As described in Section 3.6, the results of the effluent analysis demonstrate that for all postulated case/condition combinations, the constituent concentrations that are discharged to the lake would remain within the existing VPDES permit water quality criteria with the exception of two constituents: copper and tributyltin.

Both of these constituents are already present in the lake water at concentrations equal to or greater than the current VPDES water quality criteria. The presence of both of these constituents is unrelated to the operation of the existing Units 1 and 2, and Unit 3 would not contribute to the amounts already existing in the lake. Additionally the increase in concentrations of these constituents in the discharge to the WHTF attributable to the operation of Unit 3 would be essentially immeasurable using current VDEQ-approved analytical methods.

Dominion analyzes station discharge for these constituents and characteristics as required by the VPDES permit for Units 1 and 2. Similar sampling and analyses would be performed in accordance with the VPDES permit for Unit 3.

Supplemental information on water-use impacts is provided in Section 5.10.1.3 that addresses specifically the lake mitigating actions based on the results of the IFIM study.

Section 5.2 Reference

Commonwealth of Virginia, State Water Control Board, "Virginia Water Quality Standards," 9 VAC 25-260 (et seq.), August 14, 2007.

5.3 Cooling System Impacts

The information for this section is provided in ESP-ER Section 5.3, and associated cooling system impacts are resolved as SMALL in FEIS Sections 5.4 and 5.8.

For the ESP-ER, an analysis was performed for the wet cooling towers to describe the plume impacts including: fogging, icing, salt deposition and visible plumes from traditional (e.g., non plume abated) wet cooling towers. The results of that analysis are documented in ESP-ER Section 5.3. In ESP-ER Section 5.3.3.1, a commitment was made to conduct a confirmatory evaluation of the fogging, icing, and salt deposition to show that the values in the ESP-ER remain bounding, when specific cooling tower and plant designs had been selected. To satisfy this commitment, a confirmatory analysis of the plume impacts associated with the closed-cycle, combination dry and wet towers has been performed, using manufacturer's data representative of the Unit 3 cooling towers' design. The methodology used is the same as that used in the ESP-ER analysis. The confirmatory analysis concluded that the plume impacts reported in the ESP-ER, associated with the main cooling towers, remain bounding for fogging, icing and salt deposition.

Supplemental information is provided in Section 5.10.1 that addresses specifically the mitigating actions resulting from the IFIM study.

5.4 Radiological Impacts of Normal Operation

The information for this section is provided in the ESP-ER Section 5.4, and associated impacts are resolved as SMALL in FEIS Section 5.9. However, ESP-ER Section 5.4 includes a commitment to verify the maximum occupational dose at the time of selection of the reactor design. The commitment is addressed in Section 5.4.2.

5.4.1 Exposure Pathways

No new and significant information has been identified for this section.

5.4.2 Radiation Doses to Members of the Public

In the ESP-ER, the maximum annual occupational dose to the workers from normal operation of proposed Unit 3 was estimated to be 150 person-rem. Using ESBWR-specific data, the annual occupational dose has been calculated as shown in DCD Table 12.4-1 to be 84.5 person-rem. The ESP-ER value for occupational dose bounds the dose calculated for the ESBWR, and thus the impact due to occupation worker dose remains SMALL and no new mitigation measures or controls are warranted.

5.4.2.1 Liquid Pathway Doses

ESP-ER Table 5.4-6 presented the composite release activities of liquid effluents for a single new unit. These composite activities were obtained by taking the maximum activity for each isotope from multiple reactor designs. ESBWR-specific liquid effluent release activities are presented in

Table 5.4-1 and compared to the ESP-ER composite release activities. Activities in bold print indicate isotopes for which the estimated ESBWR release activity is greater than the corresponding ESP-ER composite release activity. "NP" denotes isotopes which are not present in ESBWR liquid effluents.

There are increases in liquid effluent release activities for some radioisotopes associated with normal operation of Unit 3 as compared to the composite release activities presented in the ESP-ER. However, the total liquid effluent release activity of Unit 3 is less than the total ESP-ER composite release activity.

ESP-ER Table 5.4-10 provided the total body and organ doses to the maximally exposed individual (MEI) resulting from liquid and gaseous effluent releases of a single new unit. These calculated doses were determined to be within the design objectives of 10 CFR 50, Appendix I. Using design-specific release activities of liquid effluents from Unit 3, the total annual doses to the MEI from liquid effluents are calculated and presented in Table 5.4-2. The total annual doses from liquid effluents were calculated using the same methodologies and parameters (with the exception of release activity) as those used in ESP-ER annual MEI dose calculations.

As shown in Table 5.4-2, the annual doses to the MEI from some liquid effluent pathways are consistently lower than those calculated and presented in the ESP-ER. Therefore, the dose impacts to the MEI remain SMALL, and no new mitigation measures or controls are warranted.

5.4.2.2 **Gaseous Pathway Doses**

ESP-ER Table 5.4-7 presented the composite release activities of gaseous effluents for a single new unit. These composite activities were obtained by taking the maximum activity for each isotope from multiple reactor designs. ESBWR-specific gaseous effluent release activities are presented in Table 5.4-3 and are compared to ESP-ER composite release activities. Activities in bold print indicate isotopes for which the estimated ESBWR release activity is greater than the corresponding ESP-ER composite release activity. "NP" denotes isotopes which are not present in ESBWR gaseous effluents.

The total annual doses to the MEI from gaseous effluents have been re-calculated using the ESBWR-specific gaseous release activities and the same methodologies and parameters as those used in ESP-ER calculations, with the exception of MEI locations. As discussed in Section 2.7, the MEI locations for the vegetable garden, residential, and meat animal receptors have changed. A single, bounding location, has been selected for these receptors and the doses from the garden, residential, and meat animal pathways are summed to arrive at the total dose at this location. For Reactor Building releases, the χ/Q values are at 0.74 mile NNE from the facility boundary and the D/Q values are at the same distance in the NNE direction. For Reactor Building releases, the maximum χ/Q site boundary MEI location (0.88 mile NNE of the plant boundary) and maximum D/Q site boundary location (0.62 mile in the south direction) are the same as were used in the ESP-ER. Table 2.7-2 summarizes the distances and directions from the Reactor Building, Turbine Building, Radwaste Building, and the circulating water cooling tower to receptors of interest, as well as the associated χ/Q and D/Q values. The results of the total annual dose calculations are provided in Table 5.4-4.

Table 5.4-5 shows that the annual total body, maximum organ, and skin doses to the MEI are lower than those calculated and presented in the ESP-ER. Therefore, the impact of gaseous pathway doses remains SMALL, and no mitigation measures or controls are warranted.

5.4.2.3 **Direct Radiation from Station Operation**

As indicated in ESP-ER Section 5.4.1.3, the offsite dose due to direct radiation from the new and existing units will be negligible. However, an assumed value of 1 mrem/yr is included in Table 5.4-6 to account for the dose to the MEI at the nearest residence from operation of Units 1 and 2. Another source of direct radiation is the NAPS ISFSI, which is located south of the proposed Unit 3 site. The distance from the ISFSI to the site boundary is 2500 ft. The annual direct radiation contribution at the site boundary from the ISFSI is no more than 3.6 mrem/yr. The distance from the ISFSI to the nearest residence is 2860 ft. Since this is farther away than the site boundary, the direct radiation dose to the MEI at the nearest residence would be less than 3.6 mrem/yr.

5.4.3 **Impacts to Members of the Public**

ESP-ER Table 5.4-11 demonstrated that the total site liquid and gaseous effluent doses resulting from the normal operation of the two existing North Anna units and two proposed new units would be well within the regulatory limits of 40 CFR 190. ESP-ER Table 5.4-12 presented the collective doses attributable to two new units for the population within 50 miles of the proposed ESP site. Accounting for changes in the liquid and gaseous effluent release activities, identified in Table 5.4-1 and Table 5.4-3, the total annual doses to the MEI and the total population doses resulting from the proposed Unit 3 liquid and gaseous effluents are calculated and presented in Table 5.4-6 and Table 5.4-7, respectively. These total annual doses to the MEI and to the population were calculated using the same methodologies and parameters (with the exception of the release activities) as those used in ESP-ER.

As shown in Table 5.4-4 some of the annual doses to the MEI resulting from Unit 3 gaseous effluents are higher than those in the ESP-ER. However, as shown in Table 5.4-6, even when direct radiation doses from operation of the ISFSI and Units 1 and 2 are included with the gaseous effluent doses to the MEI, the total site doses are below regulatory limits, the impact to members of the public remains SMALL, and no mitigation measures or controls are warranted.

As shown in Table 5.4-7, the annual dose to the population within 50 miles resulting from Unit 3 liquid and gaseous effluents are lower than those calculated for a single unit and presented in the ESP-ER. Therefore, the liquid and gaseous effluent doses to the population provided in the ESP-ER are bounding, the impact to members of the public remains SMALL, and no mitigation measures or controls are warranted.

5.4.4 Impacts to Biota Other Than Members of the Public

ESP-ER Table 5.4-16 presented the maximum calculated doses to biota from liquid and gaseous effluents. In FEIS Section 5.9.5.3, the NRC staff concluded that, based on Dominion calculations, the impacts to the biota would be SMALL, and mitigation is not warranted. The maximum doses to biota resulting from proposed Unit 3 liquid and gaseous effluents have been calculated using the same methodologies in the ESP-ER, accounting for the changes in liquid and gaseous effluent release activities. These doses are provided in Table 5.4-8.

As shown in Table 5.4-8, the annual doses to the biota from liquid and gaseous effluent releases are lower than those calculated and presented in ESP-ER. Therefore, the liquid and gaseous effluent biota doses in the ESP-ER are still bounding, and impact from doses on biota other than members of the public remains SMALL, and no mitigation measures and controls are warranted.

5.4.5 Conclusion

As discussed previously, the impacts of radiological exposure to the MEI, the population, occupational workers, and biota resulting from normal operation of Unit 3 will be SMALL, and mitigation measures and controls are not warranted.

Table 5.4-1 Release Activities (Ci/yr) in Liquid Effluent

Isotope	ESP-ER Composite Release Activity (Ci/yr)	Unit 3 Release Activity
H-3	8.5E+02	**1.4E+01**
C-14	4.4E-04	NP
Na-24	3.5E-03	**4.2E-03**
P-32	6.6E-04	3.5E-04
Cr-51	2.1E-02	1.1E-02
Mn-54	2.8E-03	1.3E-04
Mn-56	4.2E-03	1.0E-03
Fe-55	6.4E-03	1.9E-03
Fe-59	2.0E-04	6.0E-05
Co-56	5.7E-03	NP
Co-57	7.9E-05	NP
Co-58	3.4E-03	3.7E-04
Co-60	1.0E-02	7.5E-04
Ni-63	1.5E-04	NP
Cu-64	8.2E-03	**1.0E-02**
Zn-65	7.5E-04	3.7E-04
Zn-69m	6.0E-04	**7.5E-04**
Br-83	7.5E-05	**1.0E-04**
Br-84	2.0E-05	NP
Rb-88	2.7E-04	NP
Rb-89	4.8E-05	NP
Sr-89	3.6E-04	1.9E-04
Sr-90	3.8E-05	1.0E-05
Sr-91	9.8E-04	9.5E-04
Sr-92	8.8E-04	2.3E-04
Y-90	3.4E-06	NP
Y-91m	1.0E-05	NP
Y-91	2.4E-04	1.2E-04
Y-92	6.6E-04	**8.7E-04**

Table 5.4-1 Release Activities (Ci/yr) in Liquid Effluent

Isotope	ESP-ER Composite Release Activity (Ci/yr)	Unit 3 Release Activity
Y-93	9.8E-04	**1.0E-03**
Zr-95	1.0E-03	1.0E-05
Nb-95	1.9E-03	1.0E-05
Mo-99	3.9E-03	2.5E-03
Tc-99m	5.1E-03	4.6E-03
Ru-103	4.9E-03	4.0E-05
Ru-105	1.0E-04	**1.3E-04**
Ru-106	7.4E-02	NP
Rh-103m	4.9E-03	NP
Rh-106	7.4E-02	NP
Ag-110m	1.1E-03	NP
Ag-110	1.4E-04	NP
Sb-124	6.8E-04	NP
Te-129m	1.4E-04	7.0E-05
Te-129	1.5E-04	NP
Te-131m	1.0E-04	8.0E-05
Te-131	3.0E-05	NP
Te-132	2.4E-04	1.0E-05
I-131	1.4E-02	6.2E-03
I-132	2.8E-03	9.3E-04
I-133	2.4E-02	**3.0E-02**
I-134	1.9E-03	4.0E-05
I-135	8.2E-03	7.1E-03
Cs-134	9.9E-03	5.7E-04
Cs-136	1.2E-03	3.5E-04
Cs-137	1.3E-02	1.5E-03
Cs-138	2.1E-04	NP
Ba-137m	1.2E-02	NP
Ba-139	2.5E-05	**3.0E-05**

Table 5.4-1 Release Activities (Ci/yr) in Liquid Effluent

Isotope	ESP-ER Composite Release Activity (Ci/yr)	Unit 3 Release Activity
Ba-140	5.5E-03	6.9E-04
La-140	7.4E-03	NP
La-142	2.5E-05	2.0E-05
Ce-141	1.3E-04	6.0E-05
Ce-143	1.9E-04	3.0E-05
Ce-144	3.2E-03	NP
Pr-143	1.4E-04	7.0E-05
Pr-144	3.2E-03	NP
W-187	2.1E-04	2.0E-04
Np-239	1.4E-02	9.3E-03
Total w/o H-3	3.7E-01	9.9E-02
Total w/ H-3	8.5E+02	1.4E+01

Note 1: Activities in bold print indicate isotopes for which the estimated ESBWR release activity is greater than the corresponding ESP-ER composite release activity.
Note 2: "NP" denotes isotopes which are "not present" in ESBWR liquid effluents.

Table 5.4-2 Comparison of Annual Doses to MEI from Unit 3 Liquid Effluent at Lake Anna

	ESP Dose (mrem/yr)			Unit 3 Dose (mrem/yr)		
Pathway	**Total Body**	**Thyroid**	**Bone**	**Total Body**	**Thyroid**	**Bone**
Fish	5.1E-01	N/A	2.3E+00	6.5E-02	N/A	1.0E+00
Invertebrate	6.6E-02	N/A	1.5E-01	6.9E-03	N/A	5.4E-02
Drinking	2.0E-01	6.5E-01	2.7E-02	4.0E-03	2.5E-01	4.5E-03
Shoreline	3.0E-02	3.0E-02	3.0E-02	2.5E-03	2.5E-03	2.5E-03
Swimming	3.2E-04	3.2E-04	3.2E-04	1.2E-04	1.2E-04	1.2E-04
Boating	4.0E-04	4.0E-04	4.0E-04	1.5E-04	1.5E-04	1.5E-04
Total	8.1E-01	6.8E-01	2.5E+00	7.9E-02	2.6E-01	1.1E+00
Age group receiving maximum dose	Adult	Infant	Child	Adult	Infant	Child

Note 1: The organ receiving the maximum dose is the child’s bone.

Note 2: There are no infant doses for the vegetable and meat pathways because infants do not consume these foods. “N/A” denotes “not applicable.”

Table 5.4-3 Release Activities (Ci/yr) in Gaseous Effluent

Isotope	ESP-ER Composite Release Activity (Ci/yr)	Unit 3 Release Activity
H-3	3.5E+03	2.5E+02
C-14	1.2E+01	**1.4E+01**
Na-24	4.4E-03	1.6E-04
P-32	1.0E-03	4.1E-05
Ar-41	3.0E+02	**3.8E-02**
Cr-51	3.8E-02	7.2E-03
Mn-54	5.9E-03	**8.2E-03**
Mn-56	3.8E-03	3.2E-04
Fe-55	7.1E-03	1.4E-03
Fe-59	8.9E-04	**1.1E-03**
Co-57	8.2E-06	NP
Co-58	2.3E-02	2.2E-03
Co-60	1.4E-02	**1.8E-02**
Ni-63	7.1E-06	1.4E-06
Cu-64	1.1E-02	2.0E-04
Zn-65	1.2E-02	**1.7E-02**
Kr-83m	1.3E-03	**2.3E-03**
Kr-85m	3.6E+01	1.8E+01
Kr-85	4.1E+03	1.4E+02
Kr-87	4.9E+01	3.9E+01
Kr-88	7.4E+01	5.7E+01
Kr-89	4.7E+02	3.7E+02
Kr-90	4.2E-04	NP
Rb-89	4.7E-05	5.4E-06
Sr-89	6.2E-03	**8.3E-03**
Sr-90	1.2E-03	5.0E-05
Sr-91	1.1E-03	2.0E-04
Sr-92	8.6E-04	1.3E-04

Table 5.4-3 Release Activities (Ci/yr) in Gaseous Effluent

Isotope	ESP-ER Composite Release Activity (Ci/yr)	Unit 3 Release Activity
Y-90	5.0E-05	2.4E-06
Y-91	2.6E-04	5.1E-05
Y-92	6.8E-04	1.0E-04
Y-93	1.2E-03	2.2E-04
Zr-95	1.7E-03	**2.5E-03**
Nb-95	9.2E-03	**1.4E-02**
Mo-99	6.5E-02	**9.3E-02**
Tc-99m	3.3E-04	6.5E-05
Ru-103	3.8E-03	**5.8E-03**
Ru-106	7.8E-05	4.3E-06
Rh-103m	1.2E-04	1.0E-07
Rh-106	2.1E-05	1.4E-10
Ag-110m	2.2E-06	**4.6E-06**
Sb-124	2.0E-04	**3.0E-04**
Sb-125	6.1E-05	NP
Te-129m	2.4E-04	4.9E-05
Te-131m	8.3E-05	1.6E-05
Te-132	2.1E-05	4.1E-06
I-131	5.1E-01	5.0E-01
I-132	2.4E+00	**2.5E+00**
I-133	1.9E+00	**2.4E+00**
I-134	4.1E+00	4.0E+00
I-135	2.6E+00	**3.2E+00**
Xe-131m	1.8E+03	4.1E+00
Xe-133m	8.7E+01	5.2E-03
Xe-133	4.6E+03	1.1E+03
Xe-135m	7.7E+02	6.1E+02
Xe-135	8.2E+02	7.5E+02

Table 5.4-3 Release Activities (Ci/yr) in Gaseous Effluent

Isotope	ESP-ER Composite Release Activity (Ci/yr)	Unit 3 Release Activity
Xe-137	9.8E+02	7.8E+02
Xe-138	7.8E+02	6.3E+02
Xe-139	5.3E-04	NP
Cs-134	6.8E-03	**1.0E-02**
Cs-136	6.5E-04	**8.3E-04**
Cs-137	1.0E-02	**1.5E-02**
Cs-138	1.9E-04	2.3E-05
Ba-140	3.0E-02	**4.4E-02**
La-140	2.0E-03	3.8E-04
Ce-141	1.0E-02	**1.5E-02**
Ce-144	2.1E-05	4.3E-06
Pr-144	2.1E-05	4.9E-09
W-187	2.1E-04	3.8E-05
Np-239	1.3E-02	2.4E-03
Total w/o H-3	1.5E+04	4.5E+03
Total w/ H-3	1.8E+04	4.8E+03

Note: "NP" denotes isotopes which are "not present." Activities in bold print indicate isotopes for which the estimated ESBWR release activity is greater than the corresponding ESP-ER composite release activity. Unit 3 H-3 activity includes the contribution from cooling tower evaporation. Since Lake Anna serves as the source of makeup water for the Unit 3 cooling tower, it is assumed that the tritium in Lake Anna is released to the environment as gaseous effluent via cooling tower evaporation. The maximum tritium concentration in Lake Anna from the operation of Units 1, 2, and 3 is 5.6E-06 μCi/ml. Multiplying this concentration by the maximum circulating water cooling tower evaporation rate (and associated drift rate) of 16,135 gpm or 3.21E+13 ml/yr yields a release of 1.8E+02 Ci/yr. Adding this value to the normal ESBWR release of 7.2E+01 Ci/yr (DCD Table 12.2-16) results in a total tritium release of 2.5E+02 Ci/yr.

Table 5.4-4 Gaseous Pathway Doses (mrem/yr) to the MEI

		ESP-ER			Unit 3		
Location	**Pathway**	**Total Body**	**Thyroid**	**Skin**	**Total Body**	**Thyroid**	**Skin**
Site Boundary (0.88 mi ESE for ESP-ER; 0.88 mi NNE/ESE, 0.34 mi W for this ER)	Plume	2.1E+00	N/A	6.2E+00	2.8E-01	**2.8E-01**	5.0E-01
	Inhalation						
	Adult	3.0E-01	1.6E+00	N/A	2.7E-02	1.0E-01	N/A
	Teen	3.1E-01	2.0E+00	N/A	2.7E-02	1.3E-01	N/A
	Child	2.7E-01	2.3E+00	N/A	2.4E-02	1.5E-01	N/A
	Infant	1.6E-01	2.0E+00	N/A	1.4E-02	1.3E-01	N/A
Nearest Garden (0.94 mi NE for ESP-ER; 0.74 mi NNE/ESE for this ER)	Vegetable						
	Adult	4.4E-01	4.9E+00	N/A	8.0E-02	1.6E+00	N/A
	Teen	5.7E-01	6.6E+00	N/A	8.9E-02	2.2E+00	N/A
	Child	1.1E-00	1.3E+01	N/A	1.3E-01	4.2E+00	N/A
Nearest Residence (0.96 mi NNE for ESP-ER; 0.74 mi NNE/ESE for this ER)	Plume	1.4E+00	N/A	4.0E+00	3.2E-01	**3.2E-01**	5.9E-01
	Inhalation						
	Adult	2.0E-01	1.0E+00	N/A	2.7E-02	1.2E-01	N/A
	Teen	2.0E-01	1.3E+00	N/A	2.7E-02	1.5E-01	N/A
	Child	1.8E-01	1.5E+00	N/A	2.4E-02	1.8E-01	N/A
	Infant	1.0E-01	1.3E+00	N/A	1.4E-02	1.5E-01	N/A
Nearest Meat Animal (1.37 mi SE for ESP-ER; 0.74 mi NNE/ESE for this ER)	Meat						
	Adult	6.7E-02	1.5E-01	N/A	1.2E-02	6.5E-02	N/A
	Teen	4.9E-02	1.1E-01	N/A	7.2E-03	4.6E-02	N/A
	Child	7.9E-02	1.7E-01	N/A	9.2E-03	6.9E-02	N/A
Nearest Garden/ Residence/ Meat Animal (Varies for ESP-ER; 0.74 mi NNE/ESE for this ER)	All						
	Adult	1.6E+00	4.9E+00	4.0E+00	4.3E-01	2.1E+00	5.9E-01
	Teen	1.6E+00	6.6E+00	4.0E+00	4.4E-01	2.7E+00	5.9E-01
	Child	1.6E+00	1.3E+01	4.0E+00	4.8E-01	4.7E+00	5.9E-01
	Infant	1.5E+00	1.3E+00	4.0E+00	3.3E-01	4.7E-01	5.9E-01

Table 5.4-4 Gaseous Pathway Doses (mrem/yr) to the MEI

Notes:

1. There are no infant doses for the vegetable and meat pathways because infants do not consume these foods.
2. “N/A” denotes “not applicable.”
3. For Unit 3, the doses shown for “nearest garden/residence/meat animal” location are the sum of garden, residence, and meat animal doses at 0.74 mi NNE for releases from Reactor and Turbine Buildings and 0.74 mi ESE for releases from Radwaste Building and circulating water hybrid cooling tower. For ESP-ER, these doses are the maximum of garden, residence, and meat animal doses at 0.94 mi NE, 0.96 mi NNE, and 1.37 mi SE, respectively. The site boundary and residence plume doses include ground shine contribution. For Unit 3, the site boundary doses are the sum of the maximum from each release point regardless of distance and direction (0.88 mi NNE for Reactor and Turbine Buildings, 0.88 mi ESE for Radwaste Building, 0.34 mi W for cooling tower).
4. The maximum (child) bone dose for Unit 3 from all gaseous effluent pathways is shown in Table 5.4-6.

Table 5.4-5 Comparison of Annual Doses to the MEI from Gaseous Effluents

Type of Dose	ESP-ER 1 New Unit (MEI Location)	Unit 3 (MEI Location)	10 CFR 50 Appendix I Limit
Gamma Air (mrad/yr)	3.2 (Site Boundary)	2.7E-01 (Residence)	10
Beta Air (mrad/yr)	4.8 (Site Boundary)	2.5E-01 (Residence)	20
Total Body (mrem/yr)	2.4 (Site Boundary)	3.2E-01 (Residence)	5
Skin (mrem/yr)	6.2 (Site Boundary)	5.9E-01 (Residence)	15
Iodine and Particulates – Maximum Organ (mrem/yr)	12 (Garden)	4.4E+00 (Residence/ Garden/ Meat Animal)	15

Table 5.4-6 Comparison of Site Doses (mrem/yr) to the MEI

Type of Dose	ESP Site Total (1)(4)	Unit 3			Existing Units (2)(4)	Site Total (3)	40 CFR 190 Limit
		Liquid	Gaseous	Total			
Total Body (mrem/yr)	6.8	7.9E-02	4.8E-01	5.6E-01	5.0E+00	5.5E+00	25
Thyroid (mrem/yr)	27	2.6E-01	4.7E+00	5.0E+00	5.1E+00	1.0E+01	75
Bone (mrem/yr)	12	1.1E+00	5.5E-01	1.6E+00	5.1E+00	6.8E+00	25

Notes:

1. The ESP site total doses are for two new units and the two existing units, and do not include a dose contribution from the ISFSI.
2. The doses from existing units include contributions from liquid and gaseous effluents (0.37 mrem), ISFSI (3.6 mrem), and an assumed dose of 1 mrem/yr due to direct radiation from the existing units.
3. This site total dose includes the Unit 3 total dose and the dose from the existing units.
4. The effluent dose from ESP-ER Section 5.4, Reference 11, is a critical organ dose that is applied as the thyroid and bone dose.

Table 5.4-7 Collective Total Body (Population) Doses (person-rem/yr) Within 50 Miles

	ESP-ER 1 New Unit	Unit 3
Liquid	8.6E+00	8.4E-01
Noble Gases (Gaseous)	3.5E+00	5.7E-01
Iodines and Particulates (Gaseous)	1.4E+00	1.2E+00
H-3 and C-14 (Gaseous)	1.4E+01	2.7E+00
Total	2.8E+01	5.3E+00
Natural Background	9.2E+05	9.2E+05

Notes:
1. ESP doses are based on data from ESP-ER Tables 2.5-8, 5.4-1, and 5.4-3.
2. The corresponding collective thyroid doses for Unit 3 are 9.9E-01 person-rem/year from liquid effluents and 25 person-rem/year from gaseous effluents.
3. The long-term χ/Q and D/Q values used in deriving Unit 3 collective doses from routine gaseous effluent releases within 50 miles of the plant are shown in Tables 2.7-5 to 2.7-12.

Table 5.4-8 Comparison of Annual Doses (mrad/yr) to Biota from Liquid and Gaseous Effluent

Biota Effluents	ESP-ER		Unit 3	
	Liquid	**Gaseous**	**Liquid**	**Gaseous**
Fish	9.7E+00	N/A	2.8E+00	N/A
Invertebrates	4.6E+01	N/A	9.3E+00	N/A
Algae	5.4E+01	N/A	1.4E+01	N/A
Muskrat	4.3E+01	3.4E+01	1.8E+01	3.4E+00
Raccoon	4.9E+00	3.4E+01	5.2E-01	3.4E+00
Heron	5.4E+01	3.4E+01	8.3E+00	3.4E+00
Duck	4.3E+01	3.4E+01	1.8E+01	3.4E+00

5.5 Environmental Impact of Waste

The information for this section is provided in ESP-ER Section 5.5. Supplemental information is provided in Section 5.5.1 below.

5.5.1 Nonradioactive-Waste-System Impacts

No new and significant information has been identified for this section, with the exception of the sanitary waste system, as discussed below.

The ESP-ER described that sewage from new units would be combined with the sanitary sewage from Units 1 & 2 for treatment. As discussed in Section 3.6, it has since been determined that sanitary sewage from Unit 3 would be treated in a new dedicated sanitary sewage waste treatment system. This new system would be similar to sanitary sewage treatment plants typically used for industrial applications. These sanitary waste plants have proven performance and substantial operational history.

Sanitary wastes from this new system would be managed on site and disposed of off site in compliance with applicable laws, regulations, and permit conditions imposed by federal, Virginia, and local agencies.

Impacts associated with treatment of sanitary waste from operation of Unit 3 will be SMALL and no mitigation is warranted.

5.5.2 Mixed Waste Impacts

No new and significant information has been identified for this section.

5.5.3 Conclusions

Impacts associated with treatment of sanitary waste from operation of Unit 3 will be SMALL and no mitigation is warranted.

5.6 Transmission System Impacts

The information for this section is provided in ESP-ER Section 5.6 and associated impacts, other than the effects of electro-magnetic fields (EMFs) are resolved as SMALL in FEIS Sections 5.1.2 and 5.4.1.5. Supplemental information is provided below to address the impacts of the new transmission line for Unit 3 and the unresolved FEIS issue on EMF exposure from transmission system operations.

5.6.1 Terrestrial Ecosystems

Maintenance practices for the existing NAPS transmission corridors are described in ESP-ER Sections 5.6.1.1 and 5.6.1.2. The new transmission line would be installed in the existing NAPS-to-Ladysmith corridor and would not result in changes to these practices. Therefore, impacts on terrestrial ecosystems from operation of the new transmission line will be SMALL. No mitigation measures or controls are warranted.

5.6.2 Aquatic Ecosystems

Maintenance practices for the existing NAPS transmission corridors are described in ESP-ER Sections 5.6.2.1 and 5.6.2.2. The effect of these procedures is described in ESP-ER Section 5.6.2. The new transmission line would not result in changes to these practices. Therefore, impacts on aquatic ecosystems from operation of the new transmission line will be SMALL. No mitigation measures or controls are warranted.

5.6.3 Impacts to Members of the Public

This section discusses the potential impacts on members of the public from electrical shock, EMF exposure, noise, and aesthetics associated with transmission system operations.

5.6.3.1 Electrical Shock

The new transmission line would be designed to ensure that steady-state short-circuit discharge currents from both the existing lines and additional line are no greater than 5 milliamperes, for the limiting case, per the NESC. Thus, potential electrical shock impacts to members of the public from the transmission lines would be SMALL.

5.6.3.2 Electromagnetic Field Exposure

FEIS Sections 5.8.5 and 7.7 state that the NRC staff does not consider potential impact of chronic effects of electromagnetic fields as significant. However, because available evidence was inconclusive, this issue was not resolved. As discussed below, the evidence remains inconclusive but continues to suggest that the impact is insignificant.

In 1996, after 17 years of research that examined more than 500 studies, the National Research Council released the results of a study that stated, "the conclusion of the committee is that the current body of evidence does not show that exposure to these fields presents a human-health hazard." Furthermore the report added there is no conclusive evidence that EMF plays a role in the development of cancer, or reproductive or other abnormalities in humans. (Reference 1)

As part of The World Health Organization (WHO) International EMF Project, in 1997 a working group of 45 scientists from around the world surveyed the evidence for adverse EMF health effects. Regarding health effects other than cancer, the WHO scientists reported that the epidemiological studies "do not provide sufficient evidence to support an association between extremely-low-frequency magnetic-field exposure and adult cancers, pregnancy outcome, or neurobehavioural disorders." (Reference 2)

The American Physical Society (APS) represents thousands of U.S. physicists. In response to the National Institute of Environmental Health Sciences (NIEHS) Working Group's conclusion that EMF is a possible human carcinogen, the APS executive board voted in 1998 to reaffirm its 1995 opinion that there is "no consistent, significant link between cancer and power line fields."

A 1999 NIEHS report (Reference 3) 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.

Although studies continue to be conducted and additional information is published regarding the effects of exposure to EMF (References 4 and 5), there continues to be no conclusive evidence of a link between EMF and the development of cancer, or reproductive or other abnormalities in humans. Thus, impacts to members of the public attributable to EMF exposure from transmission system operations will be SMALL. No mitigation measures or controls are warranted.

5.6.3.3 **Noise**

The noise levels resulting from transmission system operations would be in accordance with the state and local code requirements. Actual decibel noise levels would be minimized by proper sizing of conductors and the use of corona-free hardware. Thus, the impacts to the public attributable to noise from the transmission system operations will be SMALL, and no mitigation measures or controls are warranted.

5.6.3.4 **Visual Impacts**

As stated in Section 3.7, the new towers are expected to be about 10 percent taller, but not more than 20 feet taller than the existing towers, and thus would not have a significantly greater visual impact. Further, the visual impacts of the new line would be mitigated by techniques such as selecting material colors that would blend into the surroundings, aligning the new towers with the existing towers, and maintaining a screen of natural vegetation in the corridor on each side of major highways and rivers. Based on the design and vegetation control practices, the visual impacts to members of the public from the NAPS transmission lines will be SMALL.

5.6.3.5 **Conclusions**

Potential impacts from electric shock, EMF exposure, noise, or visual impacts from transmission system operations will be SMALL, and no mitigation measures or controls are warranted.

Section 5.6 References

1. National Research Council, "Possible Health Effects of Exposure to Residential Electric and Magnetic Fields," October 1996.

2. National Institute of Environmental Health Sciences/National Institutes of Health, "EMF, Electric and Magnetic Fields Associated with the Use of Electric Power, Questions and Answers," June 2002.

3. NIEHS report to U.S. Congress, "Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields," June 1999.

4. National Institute of Environmental Health Sciences/National Institutes of Health, "NIEHS Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields," May 1999.

5. World Health Organization, "Electromagnetic Fields and Public Health - Electromagnetic Hypersensitivity - Fact Sheet No. 296," December 2005.

5.7 Uranium Fuel Cycle Impacts

The information for this section is provided in ESP-ER Section 5.7, and associated impacts for light-water reactors are resolved as SMALL in FEIS Section 6.1.

No new and significant information has been identified for this section.

5.8 Socioeconomic Impacts

The information for this section is provided in ESP-ER Section 5.8 and associated impacts are resolved in FEIS Sections 5.4, 5.5, and 5.7. These FEIS sections resolved that adverse impacts range from SMALL to MODERATE and beneficial impacts range from SMALL to LARGE. Supplemental information is provided below.

In addition, supplemental information on recreational impacts is provided in Section 5.10.1.6 that addresses specifically the lake mitigating actions resulting from the IFIM study.

In ESP-ER Section 5.8, commitments were made to perform a confirmatory noise evaluation and a visual impact study.

Cooling Tower Noise Study

For the ESP-ER, a noise study was performed for the main cooling tower and the service water cooling tower, and the results are documented in ESP-ER Section 5.8. To satisfy the commitment made in the ESP-ER, a confirmatory analysis of the noise level associated with the cooling towers was performed, using the location of the towers, the topography of the area surrounding the towers, and manufacturer's data typical of the towers selected for Unit 3. The methodology used was the same as that used in the ESP-ER analysis. The confirmatory analysis concluded that the noise level reported in the ESP-ER, associated with the cooling towers, was bounding.

The noise level will be ≤ 65 dBA at the EAB.

Visual Impact Study

The visual impact study has been performed. Figures 5.8-1, 5.8-2, and 5.8-3 provide artist renderings of Unit 3, including the main building group (Reactor Building, Turbine Building, etc.) and the cooling towers, as they would appear upon their completion. These renderings have been superimposed on photographs taken of existing Unit 1 and 2 facilities from various locations.

Figures 5.8-1 and 5.8-2 depict the approach to the main gate along the plant access road, in views progressively closer to the gate. The principal Unit 3 structures encountered along this approach are the hybrid and dry cooling towers, which emerge in profile off the road to the north. The low profile of the towers results in their view being mostly obscured behind a line of trees adjacent to the access road.

Figure 5.8-3 depicts the facility looking southwest from the Unit 1 and 2 intake area. From this perspective, the Unit 3 facilities are seen to blend in with the existing Units 1 and 2 buildings. The Unit 3 profile is of a similar shape and size as that of Units 1 and 2. The overall shape and configuration of the Unit 3 setting, which consists of a main building group with several adjacent smaller buildings, is similar to that of the existing units.

These figures portray the completed facility. During construction of Unit 3, there would be additional temporary visual impacts. Equipment and material storage areas, parking areas, and elevated cranes and other construction equipment would be visible at least in part as construction progresses. However, these impacts would be temporary and would not be unexpected by members of the public during construction of new Unit 3.

In summary, the visual impact to the public from Unit 3 will be similar to the visual impact from the existing units, and thus the aesthetic impact will continue to be SMALL. No mitigation measures or controls are warranted.

Figure 5.8-1 Looking Northeast Along the Plant Access Road

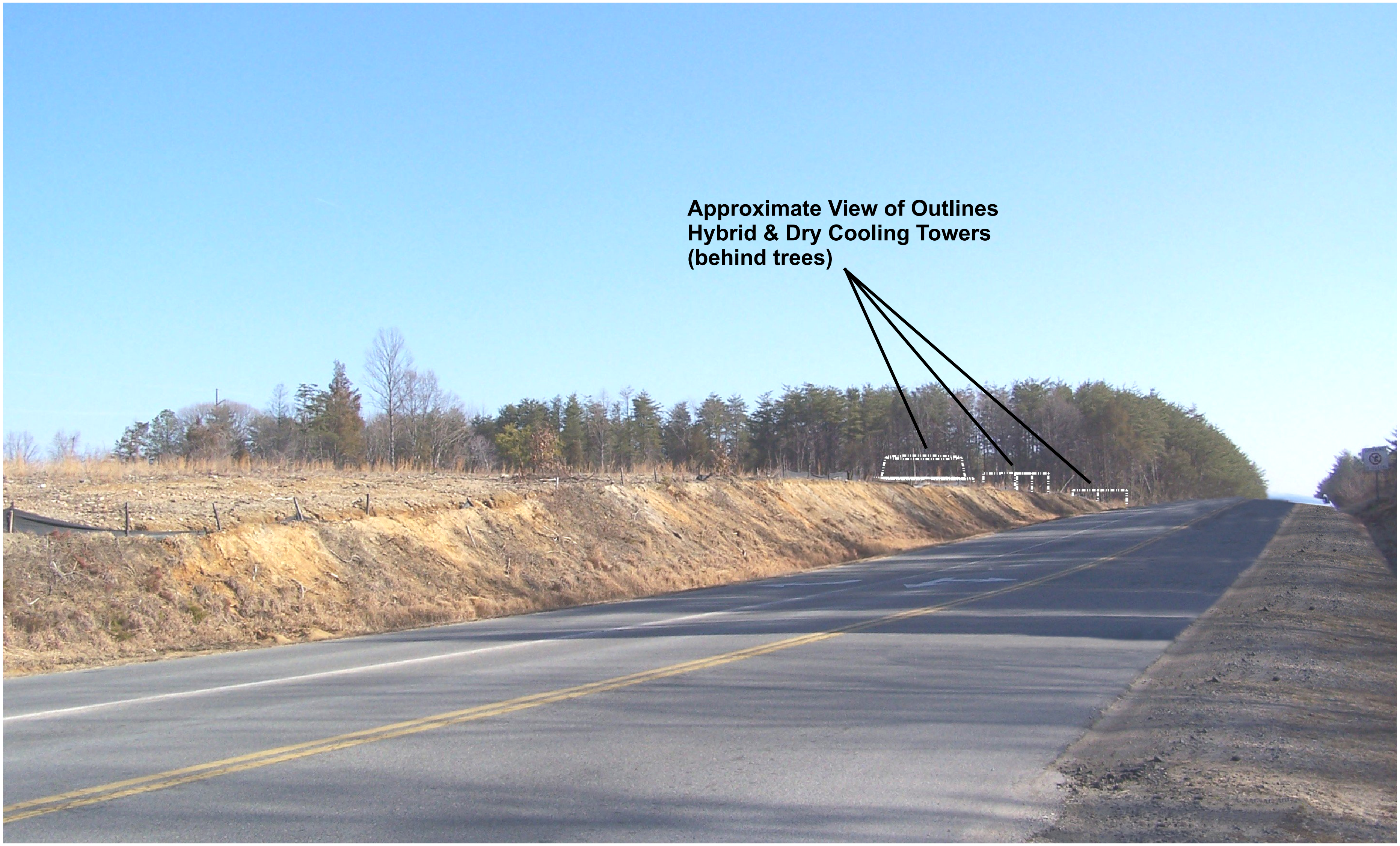


Figure 5.8-2 Looking Northward from Final Approach after Main Gate. Unit 3 Is Shown in the Distance.

Figure 5.8-3 Looking Southwest from Unit 1 and 2 Intake Area

5.9 Decommissioning

FEIS Sections 6.3 and 7.9 identified that impacts from decommissioning were not addressed at the ESP-ER stage and would be required to be addressed at the COL stage. The following information is provided to address the impacts from decommissioning.

5.9.1 Financial Assurance

Information on decommissioning funding, including the funding amount required by 10 CFR 50.75(c), method of funding, and certification, is provided in the Decommissioning Funding Assurance Report provided in COLA Part 1.

5.9.2 Environmental Impacts

According to NUREG-1555, Section 5.9 (Reference 1, p. 5.9-7), studies of social and environmental effects of decommissioning large commercial power generating units have not identified any significant impacts beyond those considered in the Final Generic Environmental Impact Statement (GEIS) on decommissioning (Reference 2). The GEIS evaluates the environmental impact of the following three decommissioning methods:

- DECON - The equipment, structures, and portions of the facility and site that contain radioactive contaminants are removed or decontaminated to a level that permits termination of the license shortly after cessation of operations.
- SAFSTOR - The facility is placed in a safe stable condition and maintained in that state until it is subsequently decontaminated and dismantled to levels that permit license termination. During SAFSTOR, a facility is left intact, but the fuel has been removed from the reactor vessel and radioactive liquids have been drained from systems and components and then processed. Radioactive decay occurs during the SAFSTOR period, thus reducing the quantity of contaminated and radioactive material that must be disposed of during the decontamination and dismantlement.
- ENTOMB - This alternative involves encasing radioactive structures, systems, and components in a structurally long-lived substance, such as concrete. The entombed structure is appropriately maintained, and continued surveillance is carried out until the radioactivity decays to a level that permits termination of the license.

NRC regulations do not require a COL applicant to select one of these decommissioning alternatives or to prepare definite plans for decommissioning at the time of the COL (Reference 1, p. 5.9-6). Pursuant to 10 CFR 50.82, planned decommissioning activities would be described after a decision has been made by the licensee to cease operations. Further, the choice of decommissioning methods, the identification of disposal sites for waste, and other pertinent information required to develop definitive plans would be determined by the conditions at the time.

Therefore, at this stage, a general assessment of decommissioning environmental impacts is provided.

Decommissioning of a nuclear facility that has reached the end of its useful life is in essence an environmental remediation and therefore has an overall positive environmental impact (Reference 1, p. 5.9-7). The main adverse environmental impact, regardless of the specific decommissioning option selected, is the commitment of relatively small amounts of land for waste burial in exchange for the potential re-use of the land where the facility is located (Reference 2).

NUREG-0586 (Reference 2) indicates that the NRC has evaluated environmental impacts from decommissioning. NRC-evaluated impacts presented in this report include: 1) occupational and population doses; 2) impacts of waste management; 3) impacts to air and water quality; and 4) ecological, economic, and socioeconomic impacts. NRC also indicated (Reference 3, p. 4-15) that the environmental effects of greatest concern (i.e., radiation dose and releases to the environment) are substantially less than the same effects resulting from reactor operations. As such, Dominion adopts by reference the NRC conclusions regarding environmental impacts of decommissioning presented in NUREG-0586.

In addition, a DOE study (Reference 4, p. 17) indicated that projected physical plant inventories associated with the ESBWR design would generally be less than those for currently operating power reactors. This is due to the advances in technology and the use of passive support systems that have significantly simplified and reduced inventories of electrical cabling, piping, pumps, motors, instrumentation and controls wiring, building size and concrete volume typically used in contemporary power plants. This ultimately reduces the overall quantity of contaminated and non-contaminated waste required for disposal, along with transportation to and from disposal sites. Additionally, the ESBWR is designed to reduce accumulation of radioactivity in plant components (DCD Section 12.1.2). An ESBWR has only one significant source of radiation in the containment post operation—the reactor core (DCD Section 12.2.1.1). It also includes a number of design features as described in DCD Section 12.1.2 to maintain low occupational doses during decommissioning. Further, the new facility is situated on the existing NAPS site and is contained within the original site boundaries, not requiring encroachment onto additional property that is not already designated for use in power production. Therefore, the estimated environmental impacts of decommissioning presented in NUREG-0586 are reasonably expected to bound the impacts of decommissioning an ESBWR at North Anna.

Regardless of the option chosen in the future, decommissioning must be completed within 60 years of permanent cessation of plant operations per 10 CFR 50.82(a)(3). Unit 3 would be operated until the approved combined license expires and then decommissioning activities would be initiated in accordance with NRC requirements. In accordance with 10 CFR 50.82, these decommissioning activities would include the following submissions:

1. Written certification to the NRC within 30 days of the decision to permanently cease operations per 10 CFR 50.4(b)(8);
2. Written certification to the NRC once the fuel has been permanently removed from the reactor vessel per 10 CFR 50.4(b)(9);
3. A post-shutdown decommissioning activities report (PSDAR) to the NRC within two years after permanent cessation of operations per 10 CFR 50.82(a)(4), detailing planned decommissioning activities, schedule for the accomplishment of significant milestones, estimated decommissioning costs, and documentation showing that the environmental impacts associated with the site-specific decommissioning activities are bounded by appropriate previously issued environmental impact statements and;
4. A license termination plan at least two years before termination of the license date, per 10 CFR 50.82(a)(9), which includes: site characterization, identification of remaining dismantlement activities, plans for site remediation, detailed plans for the final radiation survey, a description of the end use of the site (if restricted), an updated site-specific estimate of remaining decommissioning costs and a supplement to the environmental report describing any new information or significant environmental change associated with the proposed termination activities.

During decommissioning of Unit 3 facilities, radiological doses would be controlled with appropriate work procedures, shielding, and other control measures similar to those used during plant operations. Experience with decommissioned power plants has shown that the occupational exposures during the decommissioning period are comparable to those associated with refueling and plant maintenance of an operational unit (Reference 2). Each decommissioning alternative has radiological impacts resulting from the transport of materials to disposal sites. The expected impact from this transportation activity would not be significantly different from that associated with normal operations (Reference 1, Section 5.9).

Based on the factors described above, it can be reasonably concluded that the environmental impacts resulting from decommissioning proposed Unit 3, after it ceases operations, are bounded by those presented in NUREG-0586. Pursuant to 10 CFR 50.82(a)(4), a further analysis would be provided at the time of decommissioning, when the activities and schedule are known, to demonstrate that the previously estimated impacts are still bounding.

Section 5.9 References

1. U.S. Nuclear Regulatory Commission, "Environmental Standard Review Plan," NUREG-1555, October 1999.
2. U.S. Nuclear Regulatory Commission, "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," NUREG-0586, Supplement 1, November 2002.
3. U.S. Nuclear Regulatory Commission, "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," NUREG-0586, August 1988.
4. U.S. Department of Energy, "Study of Construction Technologies and Schedules, O&M Staffing and Cost, Decommissioning Costs and Funding Requirements for Advanced Reactor Designs," Volume 1, May 27, 2004.

5.10 Measures and Controls to Limit Adverse Impacts During Operation

Measures and controls to limit adverse impacts during operation were addressed in ESP-ER Section 5.10 and in FEIS Section 5.11. Those measures and controls remain applicable to Unit 3, along with the following new mitigation measures and controls:

- Nonradioactive effluents, including sanitary waste and blowdown from the Unit 3 cooling towers, would be controlled by the limits established in VPDES permit (Sections 5.2.2 and 5.5.1).
- The new and separate Unit 3 sanitary waste treatment systems would be governed by applicable regulations and permits (Section 5.5.1).
- Operation of a dechlorination system would neutralize chlorine in the circulating water and plant service water cooling system blowdown before discharge to the WHTF and eventually to the North Anna Reservoir (Section 5.2.2).
- Increase the normal pool level of Lake Anna (North Anna Reservoir) by 3 inches from Elevation 250.0 ft msl to 250.25 ft msl to reduce the potential frequency of occurrence and duration of low flow conditions, and to reduce impacts on the ecology, wetlands, and recreation in Lake Anna and downstream (Section 5.10.1).
- Continue collaboration with Virginia resource agencies to address long-term enhancements within the watershed (Section 5.10.1).

5.10.1 Mitigating Actions Based on the Results of the IFIM Study

5.10.1.1 IFIM Study

The final IFIM study report was submitted to VDEQ in October 2009. The scope of the IFIM study was developed in consultation with the VDEQ, VDGIF, and VDCR. The agency-approved "North Anna IFIM Study Plan" (March 28, 2007) included components that evaluated how the addition of a third unit could impact habitat for fish, other organisms, and recreation on the North Anna River and Pamunkey River. Wetlands, boat docks, and ramps on Lake Anna were also studied to assess a potential rise in lake level. Completion of the IFIM study satisfies the special condition in the Coastal Zone Consistency determination for North Anna Power Station Unit 3 and ESP Permit Condition 3.I.(2) (issued November 27, 2007). Dominion will continue collaboration with Virginia resource agencies to address other longer-term enhancements within the watershed.

Two primary concerns to natural resource agencies and other stakeholders were the potential for a higher frequency of reduced flows to the North Anna River and lake level changes. Specific objectives included avoiding significant increases in the frequency of low flow conditions, and avoiding impacts to downstream habitats for fish and other organisms. The frequency of 20 cubic feet per second (cfs) flow from the dam, which represents the required minimum flow from the dam under drought conditions (lake elevation <248.0 ft msl), was of interest because of potential impacts to aquatic habitats and downstream users of the rivers. Based on iterative interactions with the natural resources agencies, emphasis was placed on evaluating the frequency of various flows under three station operating scenarios:

- Existing Conditions – the current operation of Units 1 and 2, and associated lake management operations
- Lake Anna at 250.0 ft msl with Unit 3 Scenario – Dominion's proposed operations with three units and a year-round normal pool elevation of 250.0 ft msl. The cooling system would be operated in MWC mode below a lake elevation of 250.0 ft msl.
- Lake Anna at 250.25 ft msl with Unit 3 Scenario – An alternative operating scenario with three units and a year-round normal pool elevation of 250.25 ft msl. The cooling system would be operated in MWC mode below a lake elevation of 250.0 ft msl.

The study area comprised approximately 70 miles of stream between the North Anna Dam and the head of tide in the Pamunkey River at the U.S. Route 360 bridge. Fifteen individual and groups of fish and invertebrates were identified for evaluation. Each of these has specific habitat requirements for living and reproducing (e.g., water velocity, water depth, bottom material). The study also examined how changes in flow from the North Anna Dam could affect recreation.

In summary, based on the results of the IFIM study, Dominion plans to: 1) increase the normal pool level of Lake Anna by 3 inches to Elevation 250.25 ft msl year-round, once Unit 3 is operational; 2) provide recreational flows to North Anna River each Saturday during June and July, when lake elevations exceed 250.0 ft msl, once Unit 3 is operational; and 3) develop a memorandum of agreement with VDGIF to provide additional enhancement to watershed aquatic habitat.

5.10.1.2 **Lake Operation Changes with 250.25 ft msl Normal Pool Level**

As a result of conducting the IFIM study, and once Unit 3 begins operation, the normal pool level will be raised to Elevation 250.25 ft msl in Lake Anna (North Anna Reservoir) year-round (i.e., a

3-inch rise above the existing normal pool level). Minimum flow releases from the North Anna Dam are regulated by the Commonwealth of Virginia under the VPDES Permit. The Lake Level Contingency Plan as stipulated in the current VPDES permit for NAPS (Reference) requires a minimum instantaneous discharge of 40 cfs from the Lake Anna impoundment, except under drought conditions. During droughts when lake level falls below Elevation 248 ft msl, releases can be incrementally reduced to a 20 cfs minimum. These minimum release rules of 40 cfs and 20 cfs are expected to remain the same when the normal pool level of Elevation 250.25 ft msl becomes effective.

5.10.1.3 Hydrologic Alterations and Water-Use Impacts with 250.25 ft msl Normal Pool Level

5.10.1.3.1 Hydrologic Alterations

Under this mitigating action, even though the normal pool level of the reservoir would be raised 3 inches, the operating schedule of Unit 3 circulating water (CIRC) system cooling towers in EC mode versus MWC mode relative to lake levels would be the same as described in ESP-ER Section 3.4. Table 5.10-1 summarizes specifically how Dominion plans to operate the CIRC cooling tower system and manage the dam releases at different lake levels.

The design of the Unit 3 station water intake system and blowdown discharge system would accommodate a 3-inch rise in the normal pool level. The water level in the WHTF is designed to operate with a differential head of 1 to 1.5 feet normally above the water level in the reservoir. At the normal pool level of Elevation 250.25 ft msl, the normal water level in the discharge canal would be about Elevation 251.75 ft msl.] The schematic section views of the intake structure and the discharge system at the normal pool level of Elevation 250.25 ft msl are shown on Figures 5.10-1 to 5.10-3. There would be no change to the minimum operating water level of Elevation 242 ft msl for the existing units and Unit 3 with this lake mitigating action.

The new normal pool level of Elevation 250.25 ft msl will introduce small changes to the physical attributes and hydrologic characteristics of the lake as described below. In terms of hydrologic impacts as a result of the operation of Unit 3, the change would also be SMALL.

The surface area of the lake increases with higher water levels, but the impacts with the increase due to a 3-inch rise in the pool level will be SMALL. For the purposes of hydrologic alteration and water-use impacts evaluations, the nominal surface area of the lake is considered to remain on the same order of 13,000 acres; with 9600 acres in the North Anna Reservoir, and 3400 acres in the WHTF.

At the Elevation 250.25 ft msl normal pool level, the lake storage will increase to 308,300 acre-ft, an increase of 3 inches or about 3300 acre-ft, which is approximately one percent additional volume over the 305,000 acre-ft storage at 250 ft msl pool level. The 3300 acre-ft increase in storage volume will be part of the conservation and active storage, and will be accompanied by a corresponding reduction of 3 inches in the flood control storage, which will be lowered from the current 15 feet to 14.75 feet above normal pool level, as shown in Table 5.10-2.

In addition to the surface area of the lake, other nominal attributes, such as the length of the lake, the shoreline length, and the maximum water depths in the North Anna Reservoir and the WHTF, are also expected to increase only marginally, and therefore are considered to remain essentially the same as in the existing lake operation with the pool level at Elevation 250 ft msl. The changes in the major physical attributes of the North Anna Reservoir and WHTF with the 3-inch rise in normal pool level are further summarized in Table 5.10-3.

The 3-inch change in the normal pool level and the corresponding change in the storage volume as a result of this mitigating action are relatively small, on the order of one percent. The physical hydrologic and hydrodynamic properties of the lake, including the lake current circulation patterns and magnitudes, scouring and erosion potentials, turbidity levels, sediment transport and siltation behavior, stratification patterns, and the associated impacts from the operation of Unit 3 are expected to be essentially the same as described in ESP-ER Section 5.3.1.1. Consequently, this mitigation would not change the FEIS conclusions that the stratification pattern in Lake Anna would not change with the operation of Unit 3 (FEIS Sections 5.4.2.4 and 5.4.2.5), and that because low-flow velocities in Lake Anna predominate, increased shoreline erosion, lake-bed scouring and increased turbidity levels caused by the operation of Unit 3 would not be detectable or destabilizing to aquatic resources of Lake Anna (FEIS Section 5.4.2.7). Although the flood control volume will be lowered by about one percent, an analysis of extreme floods, such as the probable maximum flood event, indicates that there would be no measurable increase in the flood level at Lake Anna. Hydrologic impacts related to plant water use, flow releases from the dam and frequency of low flow conditions in the lake and the North Anna River are described in Section 5.10.1.3.2.

5.10.1.3.2 **Water Use Impacts**

As part of the IFIM study, the impacts of plant water use on lake levels and on flow releases from the North Anna Dam, especially during drought conditions, were evaluated with a water budget model that incorporated a normal pool level of Elevation 250.25 ft msl when Unit 3 commences operation. The model approach and formulation are the same as the Lake Anna water budget model described in ESP-ER Section 5.2.2, with the following exceptions:

- The lake operation rule curve implemented the normal pool level of Elevation 250.25 ft msl such that when lake level is less than or equal to Elevation 250.25 ft msl, a minimum instantaneous flow of 40 cfs would be released from the dam. When lake level drops to or below Elevation 248 ft msl, releases would be reduced to 20 cfs minimum. For lake level greater than or equal to Elevation 250.35 ft msl (0.1 ft was added to the normal pool level in the model to approximate the potential head buildup behind the dam), any inflow in excess of the evaporative losses would be released, provided that the minimum release requirements are met.
- At the recommendation of the state agencies, the model simulation was extended four and one half years for the time period from October 1978 through October 2007 to capture the influence of climatic conditions of recent years.
- The evaporation losses from the CIRC cooling towers of Unit 3 were estimated based on revised performance characteristics from technology inputs.
- The Unit 3 CIRC cooling towers would operate in the same manner as described in ESP-ER Section 5.2.2, except that the dry tower implemented in the model could dissipate the entire heat load when the dry bulb temperature is equal to or less than 40°F, lower than the 67°F used in the ESP model.

The remaining model input data including total heat loads and station capacity factors (or availability factors) of the existing units and Unit 3, the circulating water flow rates of the existing units, the elevation-storage relationship of Lake Anna, and the EC mode versus MWC mode operation rule of Unit 3 in response to water levels are the same as those used in the ESP model. Simulations were conducted on a weekly basis to predict lake levels and flow releases at the North Anna Dam for the 29-year period extending from October 1978 through October 2007, a total of 1517 weeks. Table 5.10-4 summarizes the results of the predicted downstream flow releases. For comparison purposes, water budget simulations were also performed for two additional scenarios:

- The existing condition with Lake Anna at Elevation 250 ft msl pool level and only Units 1 and 2 in operation.
- Lake Anna at Elevation 250 ft msl pool level with both the existing units and Unit 3 in operation.

Table 5.10-4 indicates that, for existing conditions over many years, water would be released from the dam at a rate of 20 cfs 4.7 percent of the time. If the pool level remained at Elevation 250.0 ft msl, this frequency would increase to 6.5 percent of the time due to increased plant water needs associated with Unit 3 operation. At the new normal pool level of Elevation 250.25 ft msl, the frequency of releases at 20 cfs with Unit 3 in operation would be 5.7 percent of the time, closer to the existing condition. Thus, raising the pool level in Lake Anna by 3 inches would meet the objective of this mitigating action by minimizing the disruption to flows in the North Anna River during drought conditions.

Table 5.10-5 provides the water level frequency for the low water levels of interest to Lake Anna users and the minimum water level for the 29-year simulation period. With the pool level raised by 3 inches to Elevation 250.25 ft msl, and Unit 3 operating, the percent of time the lake level would lower to Elevation 248 ft msl or less is 5.5 percent, versus 6.3 percent if the pool level remained at Elevation 250.0 ft msl. The flow discharges reported in Table 5.10-4 were determined by the computed lake level at the beginning of each model time step. The lake levels shown in Table 5.10-5 correspond to the levels at the end of each time step. Even with this slight model difference, results are similar.

Figure 5.10-4 shows the variation in the lake levels as a function of time as predicted by the water budget model for the existing condition and for the Elevation 250.25 ft msl raised pool level mitigating action scenario for Unit 3. It is evident from both Table 5.10-5 and Figure 5.10-4 that the proposed lake mitigating action of raising the pool level to Elevation 250.25 ft msl will help reduce the impact of additional plant water needs for Unit 3, both in maintaining a slightly higher minimum lake water level and in reducing the frequency of low lake levels. Based on these low outflow and low lake level frequencies, it is concluded that the impacts associated with Unit 3 operation on the downstream flow and lake level is SMALL, less than 2 percent when compared with existing conditions. Impacts would be further reduced to about 1 percent or less with implementation of the IFIM lake mitigating action of raising the normal pool level by 3 inches.

Table 5.10-6 compares the available water supplies to the plant water needs for the existing units and Unit 3 on a long-term time-averaged basis, with and without the mitigating action of raising the normal pool level of the lake by 3 inches, as estimated using the extended water budget model. It demonstrates that the net inflow to Lake Anna exceeds the water use expected from the operation of the existing units and Unit 3 for both scenarios. The long-term average outflow from Lake Anna to the North Anna River downstream was estimated to be about 278 cfs for the existing conditions with only Units 1 and 2 in operation.

The long-term average evaporation loss associated with Unit 3 operation is estimated to be about 20 cfs with the normal pool level maintained at Elevation 250 ft msl, and about 22 cfs with the pool level raised to Elevation 250.25 ft msl.

The long-term average outflow is reduced by the Unit 3 evaporation loss rates of 20 cfs to about 258 cfs, at the normal pool level of 250 ft msl. At the new normal pool level of 250.25 ft msl, the long-term average outflow is reduced by the Unit 3 evaporation loss of 22 cfs to about 256 cfs.

This lake mitigation action does not affect the EC mode and MWC mode maximum evaporation rates, maximum blowdown rates and maximum make-up water rates for Unit 3 cooling towers as shown in Table 3.0-2.

5.10.1.4 **Aquatic Ecology Impact with Elevation 250.25 ft msl Normal Pool Level**

The impact of the 3-inch lake level increase on the aquatic ecology in Lake Anna is expected to be SMALL. The frequency of drought releases of 20 cfs will be reduced, which reduces impact to aquatic habitat.

5.10.1.5 **Wetland Impacts with Elevation 250.25 ft msl Normal Pool Level**

The primary purpose of the lake studies (field and desktop) was to evaluate the relationship between Lake Anna water levels and wetland areas. Field studies were conducted within five coves on Lake Anna in September 2007. The selected coves were associated with the confluence of tributaries entering Lake Anna, and were located at the interface between tributary streams and the existing Elevation 250.0 ft msl normal pool level.

To define the evaluation areas the study utilized existing aerial photography from the Virginia Geographic Information Network, national wetlands inventory (NWI) maps, topographic data and Light Detection and Ranging (LIDAR) information collected in 2006. The GIS desktop analysis of wetlands around Lake Anna and its associated environs was conducted in 2008.

Forested wetlands, primarily located at higher elevations and away from the lake/tributaries, are not likely to experience any change from the 3-inch increase in normal pool level. Emergent wetlands located near the elevation of the current pool level should not change substantially in existing distribution and areal coverage relative to existing conditions. Any wetland losses due to more frequent inundation resulting from the 3-inch level increase are expected to be SMALL, and would likely be offset by new emergent wetlands which will grow over time at a slightly higher elevation.

In addition, Lake Anna and WHTF wetland impacts associated with the 3-inch increase in normal pool level have been discussed with USACE and VDEQ representatives. A USACE jurisdictional determination has been received, and future potential wetland impacts will be addressed through an individual state water protection permit.

5.10.1.6 **Recreational Impacts with 250.25 ft msl Normal Pool Level**

The proposed increase of the normal pool level of Lake Anna would have multiple positive recreational implications. Canoeists would have enhanced conditions in both the Fall and Piedmont zones of the North Anna River caused by potential increases in recreational water releases. In June and/or July additional releases would occur one day each weekend when the water elevation in Lake Anna exceeds 250.0 ft msl.

As part of the IFIM study, fifteen boat docks and six marinas in Lake Anna were evaluated for the ability of recreational boaters to get into and out of their boats safely with a 3-inch increase in normal pool level. Lake Anna would experience a slight increase in lake elevation under the 250.25 ft scenario approximately 75 percent of the time. This benefit would be particularly noticeable during drought conditions when the pool level may be only 1.7 inches lower than existing conditions compared to an estimated 4.2 inches below existing conditions for three units operating at the 250.0 ft msl normal lake level. Therefore, the operation of Unit 3 with the 3-inch increase in normal pool level would not adversely affect access to boats from public docks on Lake Anna.

Section 5.10 Reference

Commonwealth of Virginia, Department of Environmental Quality, "VPDES Permit No. VA0052451, Authorization to Discharge under the Virginia Pollutant Discharge Elimination System and the Virginia State Water Control Act," October 25, 2007.

Table 5.10-1 Dam Releases and Modes of Operation of Unit 3 CIRC Cooling Towers Relative to Lake Levels

Lake Level (ft msl)	Dam Release Flow	EC/MWC Mode
≥250.25	≥40 cfs[a]	EC
≥250.0 to <250.25	40 cfs[a]	EC
>248.0 to <250.0	40 cfs	MWC[b,c]
≤ 248.0	20 cfs	MWC[c]

a. Provide weekend recreational flows during June and July when lake level is >250.0 ft msl.
b. Allow up to seven consecutive days when the lake level is <250.0 ft msl each time the dry tower is placed in service.
c. Annual allowance when lake level is <250.0 ft msl to operate in EC mode only (dry tower fans off) for up to 100 hours/year to meet high electricity demand.

Table 5.10-2 Lake Anna Storage Allocation Based on the 250.25 ft msl Normal Pool Level

Purpose	Volume (acre-feet)
Minimum recreational pool and inactive storage below 246 ft msl	255,000
Conservation and active storage, 246 to 250.25 ft msl	53,300
Flood control storage, 250.25 to 265 ft msl	241,700
Total Storage	550,000

Table 5.10-3 Physical Attributes of Lake Anna

North Anna Reservoir		
Normal Pool Level	250 ft msl	250.25 ft msl
Surface Area	9600 acres	9600 acres
Downstream from NAPS[a]	4998 acres	4998 acres
Upstream from NAPS	4602 acres	4602 acres
Volume	10.6×10^9 ft^3	10.7×10^9 ft^3 [b]
Mean Depth	25.35 ft [c]	25.6 ft
Downstream from NAPS	36 ft	36.25 ft
Upstream from NAPS	13 ft	13.25 ft
Maximum Depth	80 ft	80 ft
Length	17 miles	17 miles
Shoreline Length	272 miles	272 miles
Waste Heat Treatment Facility		
Normal Water Level	251.5 ft msl	251.75 ft msl
Surface Area	3400 acres	3400 acres
Volume	2.66×10^9 ft^3	2.7×10^9 ft^3 [b]
Mean Depth	18 ft [c]	18.25 ft
Maximum Depth	50 ft	50 ft
Side-Arm Area	1530 acres	1530 acres

a. From NAPS to the North Anna Dam.
b. Storage Volume at Elevation 250.25 ft msl is estimated based on "Mean Depth" x "Surface Area."
c. Mean Depth at Elevation 250 ft msl is defined as "Volume" divided by "Surface Area."

Table 5.10-4 Lake Anna Low Outflow Frequency

	Percent of Time Outflow is Less Than or Equal to Indicated Values		
Outflow (ft^3/s)	Existing Units (250 ft msl Pool Level)	Existing Units plus Unit 3 (250 ft msl Pool Level)	Existing Units plus Unit 3 (250.25 ft msl Pool Level)
100	48.6%	54.1%	54.6%
80	46.1%	51.6%	52.1%
60	44.2%	49.0%	49.8%
40	42.2%	47.6%	48.5%
20	4.7%	6.5%	5.7%

Table 5.10-5 Lake Anna Low Water Level Frequency

	Percent of Time Lake Level is Less Than or Equal to Indicated Values		
Elevation (ft msl)	Existing Units (250 ft msl Pool Level)	Existing Units plus Unit 3 (250 ft msl Pool Level)	Existing Units plus Unit 3 (250.25 ft msl Pool Level)
248	4.7%	6.3%	5.5%
246	0.9%	1.2%	1.1%
244	0%	0%	0%
242	0%	0%	0%
Minimum Lake Water Level	245.1 ft msl	244.2 ft msl	244.4 ft msl

Table 5.10-6 Available Water Supply Versus Plant Water Needs With and Without Lake Mitigating Actions

	Flow Rate (ft^3/s)	
Quantity	**Existing Units plus Unit 3 (El. 250 ft msl Pool Level)**	**Existing Units plus Unit 3 (El. 250.25 ft msl Pool Level)**
Net Inflow[a]	369	369
Pre-Operational Evaporation[b]	92	92
Minimum Release[c]	40	40
Available Water Supply[d]	237	237
Plant Water Needs[e]	20	22[f]

a. Average net inflow estimated from the extended water budget model.

b. Natural evaporation from the lake plus forced evaporation from the existing units on a time-averaged basis and based on a 93% plant capacity factor.

c. Minimum release for Lake Anna water levels in excess of Elevation 248 ft msl.

d. Available water supply is defined as (Net Inflow – Pre-operational Evaporation – Minimum Release).

e. Average evaporation associated with Unit 3 wet cooling towers based on a 96% plant capacity factor, predicted by the extended water budget model.

f. The value of 22 cfs was rounded from 21.6 cfs.

Figure 5.10-1   Schematic View of Station Water Intake

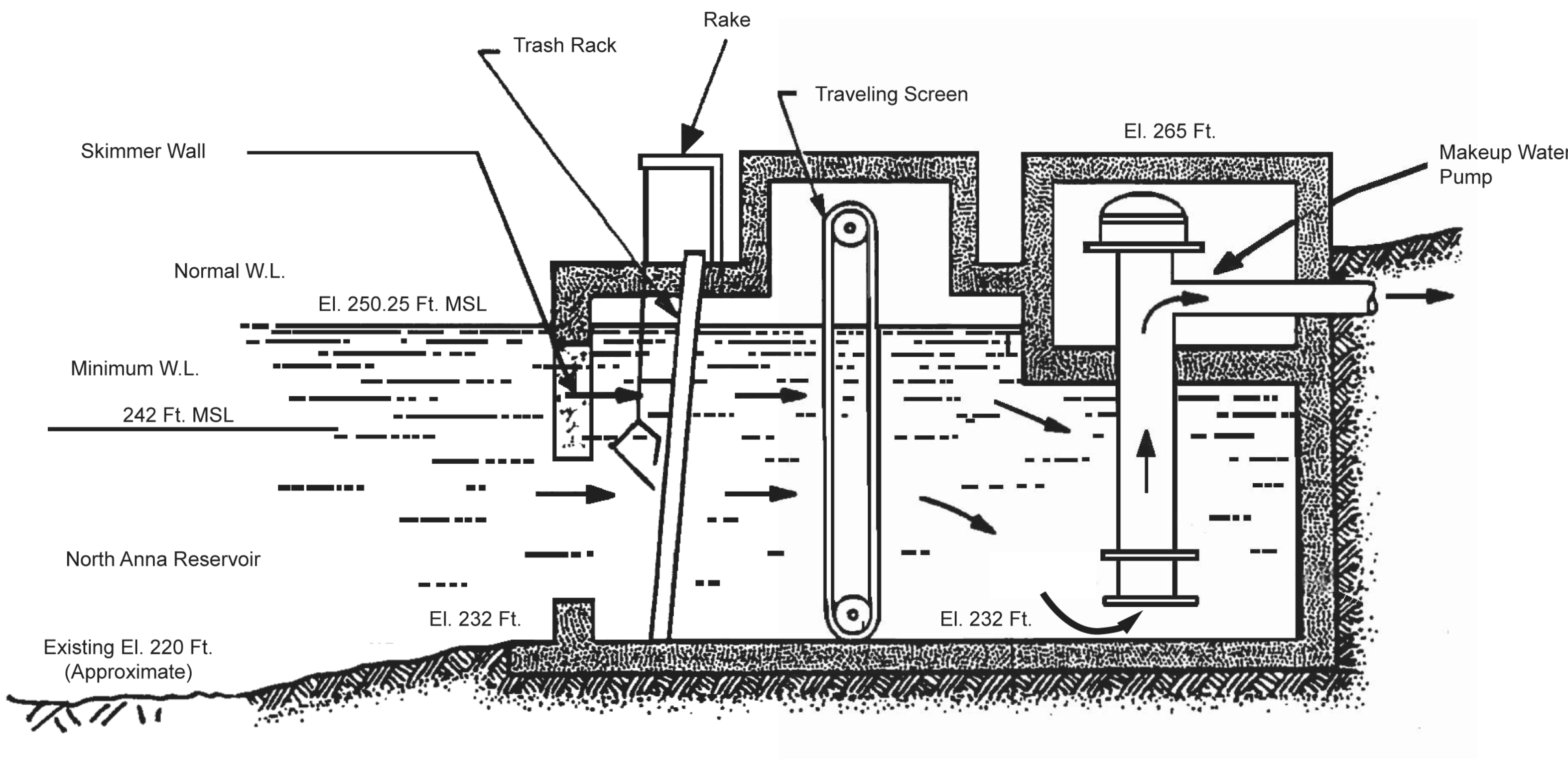
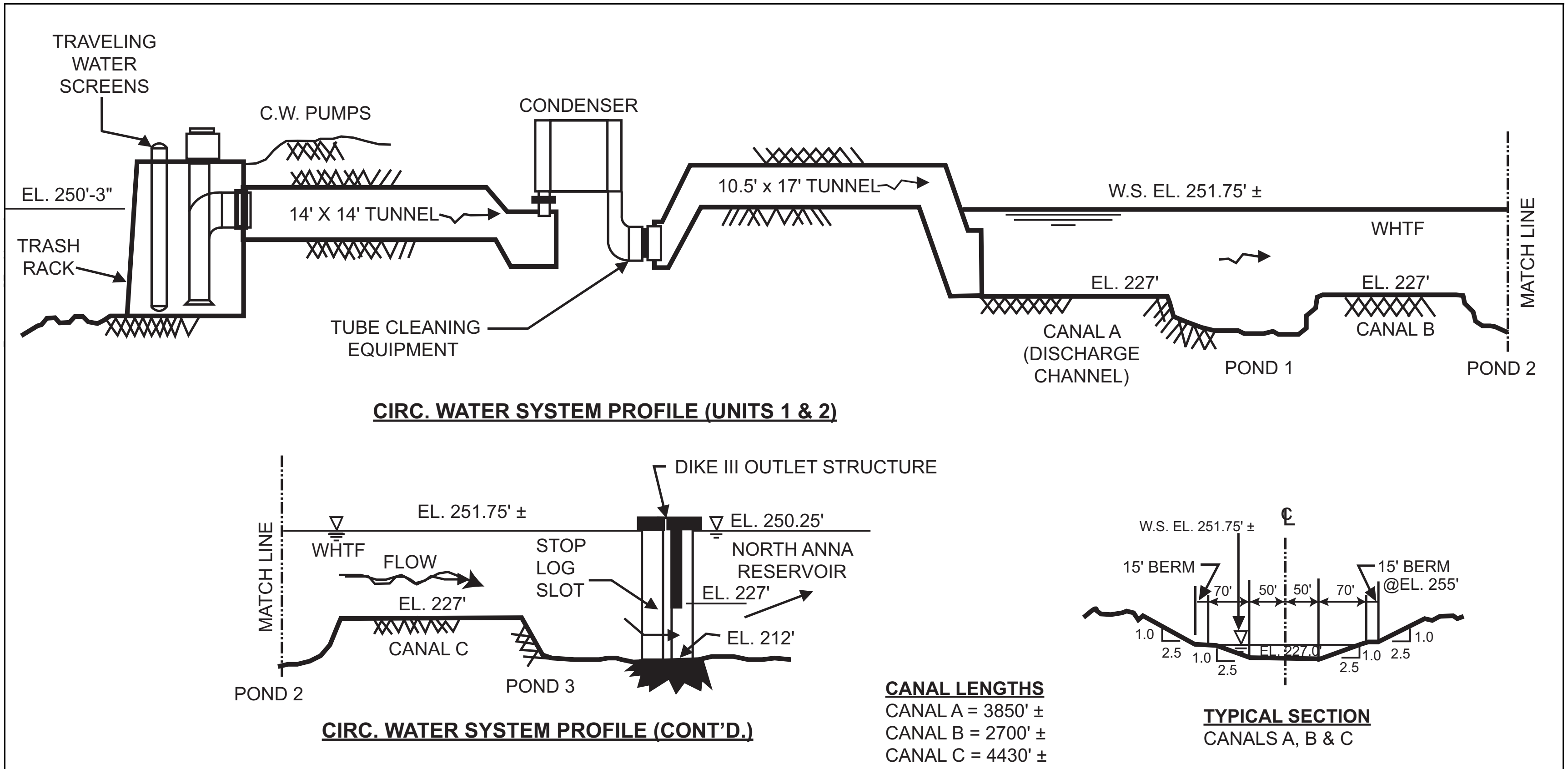


Figure 5.10-2 Discharge Channel and Dike 3 Outlet Structure



CANAL LENGTHS
CANAL A = 3850' ±
CANAL B = 2700' ±
CANAL C = 4430' ±

DISCHARGE TUNNEL LENGTHS
UNIT 1 = 720' ±
UNIT 2 = 970' ±

Figure 5.10-3 Schematic Diagram of the Discharge System

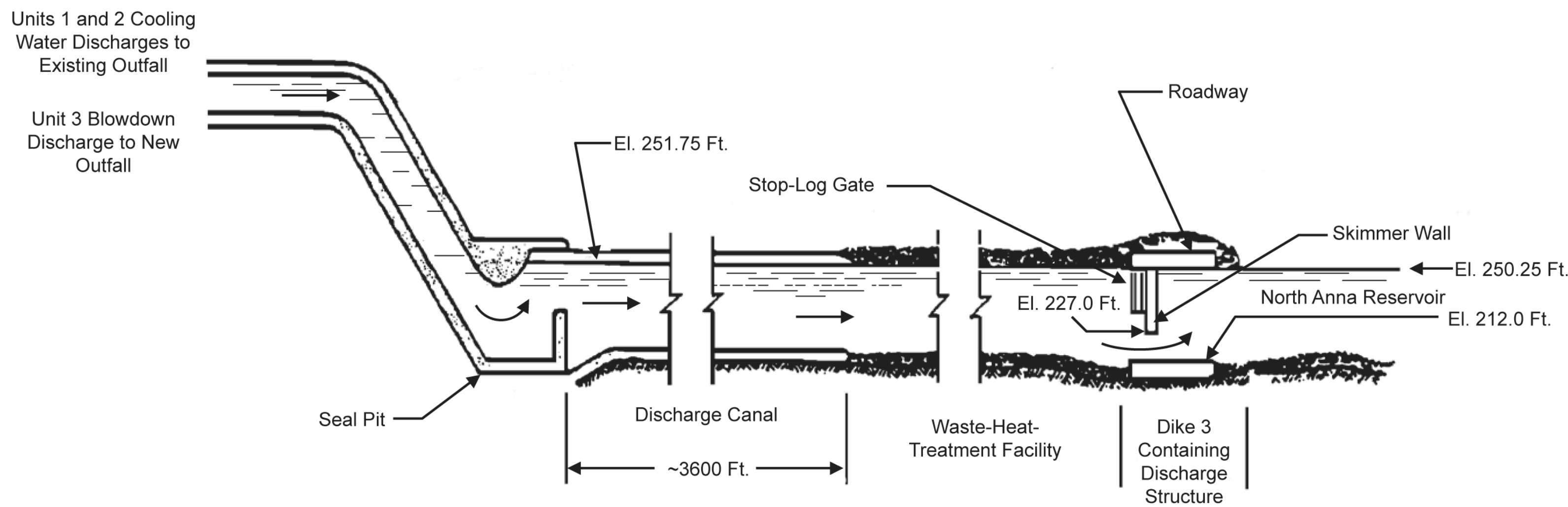
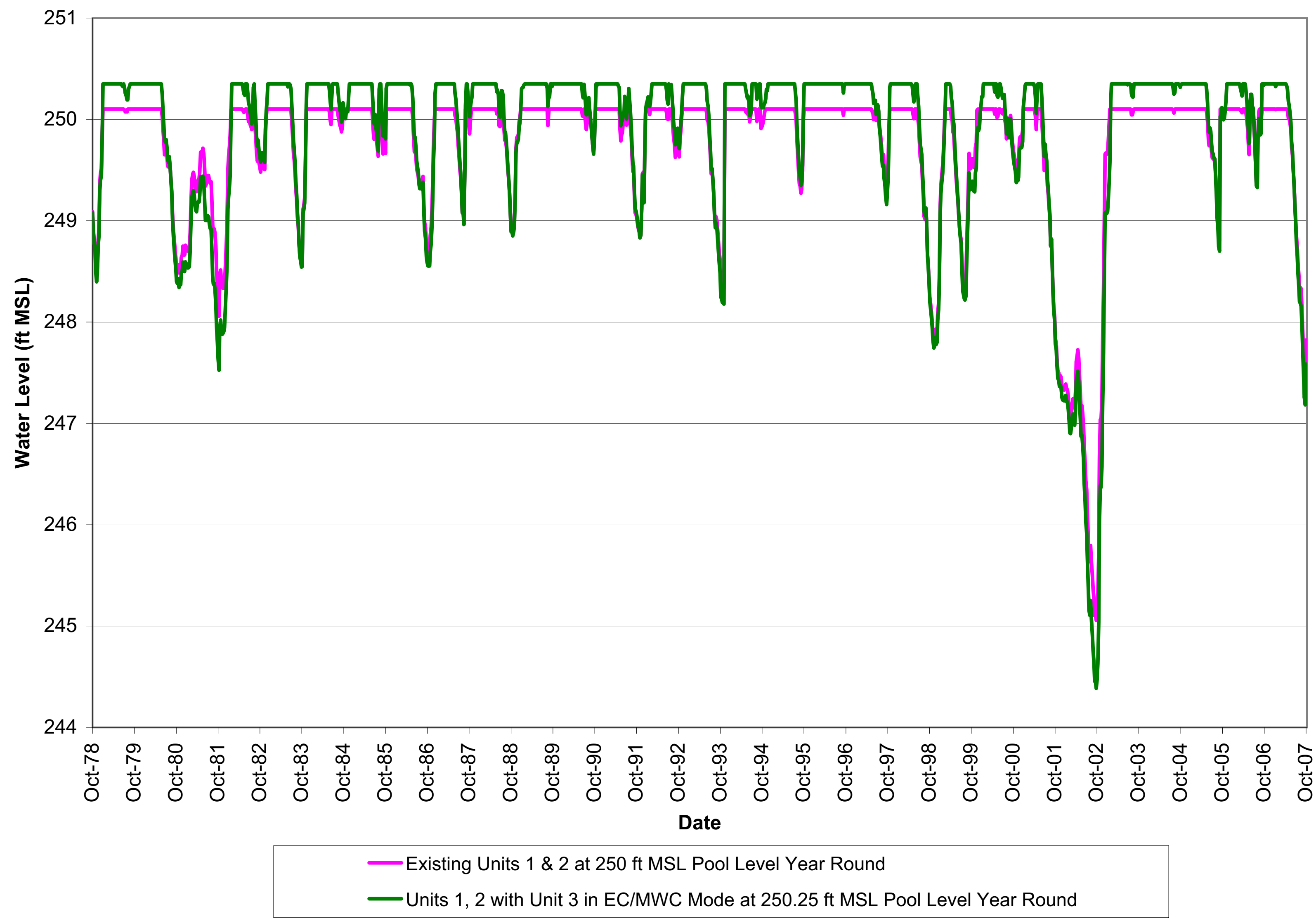


Figure 5.10-4 Lake Anna Water Level Hydrographs (October 1978 to October 2007)



Chapter 6 Environmental Measurements and Monitoring Programs

6.1 Thermal Monitoring

The information for this section is provided in ESP-ER Section 6.1 and resolved in FEIS Section 2.6.3.3.

No new and significant information has been identified for this section.

6.2 Radiological Monitoring

The information for this section is provided in ESP-ER Section 6.2 and resolved in FEIS Section 5.9.6.

No new and significant information has been identified for this section.

6.3 Hydrological Monitoring

The information for this section is provided in ESP-ER Section 6.3 and resolved in FEIS Section 2.6.1.3.

No new and significant information has been identified for this section.

6.4 Meteorological Monitoring

The information for this section is provided in ESP-ER Section 6.4 and resolved in FEIS Section 2.3.1.6. Dominion will use the existing Unit 1 and 2 data recording systems for Unit 3. These systems will be linked to the Unit 3 control room for meteorological monitoring.

No new and significant information has been identified for this section.

6.5 Ecological Monitoring

The information for this section is provided in ESP-ER Section 6.5 and resolved in FEIS Section 2.7.

No new and significant information has been identified for this section.

6.6 Chemical Monitoring

The information for this section is provided in ESP-ER Section 6.6 and resolved in FEIS Section 2.6.3.4.

No new and significant information has been identified for this section.

6.7 Summary of Monitoring Programs

The information for this section is provided in ESP-ER Section 6.7. No new and significant information has been identified for this section.

Chapter 7 Environmental Impacts of Postulated Accidents Involving Radioactive Materials

7.1 Design Basis Accidents

The information for this section is provided in ESP-ER Section 7.1 and associated impacts are resolved as SMALL in FEIS Section 5.10, for light-water reactors. Supplemental information, regarding Unit 3 specific source terms and doses, is provided in the following sections.

7.1.1 Selection of Accidents

No new and significant information has been identified for this section. The same ESBWR accidents are considered as in ESP-ER Section 7.1. These encompass all of the Design Basis Accidents (DBAs) evaluated for radiological consequences in DCD Chapter 15.

7.1.2 Evaluation Methodology

No new and significant information has been identified for this section.

7.1.3 Source Terms

The activity releases and doses for Unit 3 are based on a power level of 4590 MWt, which represents a core thermal power of 4500 MWt multiplied by an uncertainty factor of 1.02. Unit 3 DBA source terms have been updated and are presented as isotopic activity releases to the environment in the unit of megabecquerel (MBq) in DCD Section 15.4, Tables 15.4-3a, 15.4-7, 15.4-12, 15.4-15, 15.4-18a, 15.4-18b, and 15.4-22. These tables reflect updated activity releases from those presented in the ESP-ER. The DCD updated activity releases do not include the 25 percent margin of uncertainty previously assumed in the ESP-ER analysis.

7.1.4 Radiological Consequences

In the ESP-ER, design basis accident doses for the ESBWR were calculated based on activity releases, χ/Q values, breathing rates, and dose conversion factors. In this ER, Unit 3-specific doses are calculated based on the DCD doses for the ESBWR. For each of the design basis accidents, the Unit 3-specific dose is calculated by multiplying the ESBWR dose (provided in DCD Section 15.4) by the ratio of the Unit 3 site-specific χ/Q value to the DCD χ/Q value (provided in DCD Section 15.4). The Unit 3 site-specific χ/Q values are the time-dependent χ/Q values from FEIS Table I-1. The resulting χ/Q ratios are shown in Table 7.1-1. Because the DCD does not provide time-dependent LPZ doses, the site LPZ dose is determined by multiplying the total DCD dose by the maximum χ/Q dose.

Because the Unit 3 site-specific χ/Q values are bounded by the DCD χ/Q values, the Unit 3-specific doses are within those calculated in DCD Section 15.4. The DBA doses summarized in Table 7.1-2 are based on individual accident doses presented in Table 7.1-3 through Table 7.1-10. These tables replace those showing ESBWR doses in the ESP-ER. For each accident, the EAB dose shown is for the two-hour period that yields the maximum dose, in accordance with RG 1.183 (Reference 1). The Unit 3-specific doses summarized in Table 7.1-2 are lower than and thus remain bounded by the surrogate ESBWR DBA doses calculated for the ESP-ER for all accidents except for Feedwater System Pipe Break with Equilibrium Iodine Activity (Table 7.1-3a, ESP-ER Table 7.1-6d), Failure of Small Line Carrying Primary Coolant Outside Containment with Equilibrium Iodine Activity (Table 7.1-4a, ESP-ER Table 7.1-13b), Main Steam Line Break with Equilibrium Iodine Activity (Table 7.1-6, ESP-ER Table 7.1-20c), and LOCA (Table 7.1-7, ESP-ER Table 7.1-24b). Furthermore, Feedwater System Pipe Break with Pre-Existing Iodine Spike (Table 7.1-3), Failure of Small Line Carrying Primary Coolant Outside Containment with Pre-Existing Iodine Spike (Table 7.1-4), and Reactor Water Cleanup/Shutdown Cooling (RWCU/SDC) System Line Failure (with Pre-Existing Iodine Spike) (Table 7.1-9) were not considered in the ESP-ER. However, the Unit 3-specific doses for these accidents remain a small fraction of the regulatory limit. All doses are within the acceptance criteria of RG 1.183 and NUREG-0800 (Reference 2). Thus, the potential environmental impacts of DBAs will remain SMALL.

Section 7.1 References

1. U.S. Nuclear Regulatory Commission, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," Regulatory Guide 1.183, July 2000.
2. U.S. Nuclear Regulatory Commission, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," NUREG-0800, March 2007.

Table 7.1-1 DCD and Unit 3 Site-Specific χ/Qs, and Unit 3/DCD χ/Q Ratios

Accident	Location		χ/Q (sec/m^3) DCD	χ/Q (sec/m^3) Unit 3	Ratio (Unit 3/DCD)
Loss-of-Coolant Accident, Failure of Small Line Carrying Primary Coolant Outside Containment	EAB		2.00E-03	3.34E-05	1.67E-02
	LPZ	0–8 hr	1.90E-04	2.17E-06	1.14E-02
		8–24 hr	1.40E-04	1.50E-06	1.07E-02
		24–96 hr	7.50E-05	1.20E-06	1.60E-02
		96–720 hr	3.00E-05	9.00E-07	3.00E-02
All Others	EAB		2.00E-03	3.34E-05	1.67E-02
	LPZ		1.90E-04	2.17E-06	1.14E-02

Table 7.1-2 Summary of Design Basis Accident Doses

SRP Section	Accident	Unit 3 TEDE (Rem)		
		EAB	LPZ	Limit
15.2.8	Feedwater Line Break			
	Pre-Existing Iodine Spike	3.0E-01	1.9E-02	25
	Equilibrium Iodine Activity	1.8E-02	1.1E-03	2.5
15.3.3	Locked Rotor Accident	Not applicable to the ESBWR		
15.3.4	Reactor Coolant Pump Shaft Break	Not applicable to the ESBWR		
15.4.9	BWR Control Rod Drop Accident	Evaluation of radiological consequences not required		
15.6.2	Failure of Small Line Carrying Primary Coolant Outside Containment			
	Pre-Existing Iodine Spike	5.7E-03	1.1E-03	25
	Equilibrium Iodine Activity	1.7E-03	1.1E-03	2.5
15.6.4	Main Steam Line Break Accident			
	Pre-Existing Iodine Spike	4.3E-02	2.3E-03	25
	Equilibrium Iodine Activity	3.3E-03	1.1E-03	2.5
15.6.5	Loss-of-Coolant Accident	3.7E-01	6.2E-01	25
15.7.4	Fuel Handling Accident	6.9E-02	4.6E-03	6.3
	RWCU/SDC System Line Failure			
	Pre-Existing Iodine Spike	1.2E-01	8.0E-03	25
	Equilibrium Iodine Activity	6.7E-03	1.1E-03	2.5
15.7.5	Spent Fuel Cask Drop Accident	Evaluation of radiological consequences not required		

Table 7.1-3 Doses for ESBWR Feedwater Line Break, Pre-Existing Iodine Spike

	DCD TEDE (Rem)	χ/Q Ratio (Unit 3/DCD)	Unit 3 TEDE (Rem)
EAB	1.81E+01	1.67E-02	3.02E-01
LPZ	1.70E+00	1.14E-02	1.94E-02
Limit			25

Table 7.1-3a Doses for ESBWR Feedwater Line Break, Equilibrium Iodine Activity

	DCD TEDE (Rem)	χ/Q Ratio (Unit 3/DCD)	Unit 3 TEDE (Rem)
EAB	1.10E+00	1.67E-02	1.84E-02
LPZ	1.00E-01	1.14E-02	1.14E-03
Limit			2.5

Table 7.1-4 Doses for ESBWR Failure of Small Line Carrying Primary Coolant Outside Containment, Pre-Existing Iodine Spike

	DCD TEDE (Rem)	χ/Q Ratio (Unit 3/DCD)	Unit 3 TEDE (Rem)
EAB	3.40E-01	1.67E-02	5.68E-03
LPZ	1.00E-01	1.14E-02	1.14E-03
Limit			25

Table 7.1-4a Doses for ESBWR Failure of Small Line Carrying Primary Coolant Outside Containment, Equilibrium Iodine Activity

	DCD TEDE (Rem)	χ/Q Ratio (Unit 3/DCD)	Unit 3 TEDE (Rem)
EAB	1.00E-01	1.67E-02	1.67E-03
LPZ	1.00E-01	1.14E-02	1.14E-03
Limit			2.5

Table 7.1-5 Doses for ESBWR Main Steam Line Break, Pre-Existing Iodine Spike

	DCD TEDE (Rem)	χ/Q Ratio (Unit 3/DCD)	Unit 3 TEDE (Rem)
EAB	2.60E+00	1.67E-02	4.34E-02
LPZ	2.00E-01	1.14E-02	2.28E-03
Limit			25

Table 7.1-6 Doses for ESBWR Main Steam Line Break, Equilibrium Iodine Activity

	DCD TEDE (Rem)	χ/Q Ratio (Unit 3/DCD)	Unit 3 TEDE (Rem)
EAB	2.00E-01	1.67E-02	3.34E-03
LPZ	1.00E-01	1.14E-02	1.14E-03
Limit			2.5

Table 7.1-7 Doses for ESBWR Loss-of-Coolant Accident

	DCD TEDE (Rem)	χ/Q Ratio (Unit 3/DCD)	Unit 3 TEDE (Rem)
EAB	2.24E+01	1.67E-02	3.74E-01
LPZ	2.07E+01	3.00E-02	6.21E-01
Limit			25

Table 7.1-8 Doses for ESBWR Fuel Handling Accident

	DCD TEDE (Rem)	χ/Q Ratio (Unit 3/DCD)	Unit 3 TEDE (Rem)
EAB	4.10E+00	1.67E-02	6.85E-02
LPZ	4.00E-01	1.14E-02	4.57E-03
Limit			6.3

Table 7.1-9 Doses for ESBWR RWCU/SDC System Line Failure, Pre-Existing Iodine Spike

	DCD TEDE (Rem)	χ/Q Ratio (Unit 3/DCD)	Unit 3 TEDE (Rem)
EAB	6.90E+00	1.67E-02	1.15E-01
LPZ	7.00E-01	1.14E-02	7.99E-03
Limit			25

Table 7.1-10 Doses for ESBWR RWCU/SDC System Line Failure, Equilibrium Iodine Activity

	DCD TEDE (Rem)	χ/Q Ratio (Unit 3/DCD)	Unit 3 TEDE (Rem)
EAB	4.00E-01	1.67E-02	6.68E-03
LPZ	1.00E-01	1.14E-02	1.14E-03
Limit			2.5

7.2 Severe Accidents

The information for this section is provided in ESP-ER Section 7.2 and associated impacts are resolved as SMALL in FEIS Section 5.10.2 for light water reactors.

No new and significant information has been identified for this section.

7.3 Severe Accident Mitigation Alternatives

This section addresses severe accident mitigation alternatives (SAMAs), based on GEH's evaluation of severe accident mitigation design alternatives (SAMDAs) for the ESBWR (NEDO-33306, Reference 1), which is incorporated herein by reference, and North Anna site and regional data. This section demonstrates that the severe accident mitigation design alternatives screened out by GEH are also screened out when North Anna site-specific characteristics are considered.

In the GEH analysis, potential design improvements are identified, in a systematic method, and evaluated on a cost-benefit basis. The evaluation determined that there are no practical and cost-beneficial design enhancements that should be considered. Therefore, appropriate mitigating measures are already incorporated into the plant design.

This section determines that the conclusions in the GEH analysis remain valid for Unit 3. The analysis in this section indicates that there are no cost-beneficial design alternatives that would need to be implemented for Unit 3 to further mitigate severe accident risk.

7.3.1 The SAMA Analysis Process

Measures that could mitigate the consequences of a severe accident are known as SAMAs. The evaluation process for identifying potential SAMAs includes four steps:

1. Define the base case – The base case is the dose-risk and cost-risk of severe accident before implementation of any SAMAs. A plant's probabilistic risk assessment is a primary source of data in calculating the base case. The base case risks are converted to a monetary value to use for screening SAMAs.

2. Identify and screen potential SAMAs – Potential SAMAs can be identified from the plant's probabilistic risk assessment and the results of other plants' SAMA analyses. This list of potential SAMAs is assigned a conservatively low implementation cost based on historical costs, similar design changes and/or engineering judgment, then compared to the base case screening value. SAMAs with higher implementation cost than the base case are not evaluated further.

3. Determine the cost and net value of each SAMA – Each SAMA remaining after Step 2, has a detailed engineering cost evaluation developed using current plant engineering processes. If the SAMA continues to pass the screening value Step 4 is performed.

4. Determine the benefit associated with each screened SAMA – Each SAMA that passes the screening in Step 3, is evaluated using the probabilistic risk assessment model to determine the reduction in risk associated with implementation of the proposed SAMA. The reduction in risk benefit is then monetized and compared to the detailed cost estimate. Those SAMAs with reasonable cost-benefit ratios are considered for implementation.

The SAMA analysis for Unit 3 focuses on demonstrating that the North Anna site is bounded by the GEH DCD analysis and determining what magnitude of plant-specific design or procedural modifications would be cost-effective. The base case benefit value is calculated by assuming the current dose risk of the unit could be reduced to zero and assigning a defined dollar value for this change in risk. Any design or procedural change cost that exceeded the benefit value would not be considered cost-effective. The dose-risk and cost-risk results are monetized in accordance with methods established in NUREG/BR-0184, Regulatory Analysis Technical Evaluation Handbook, 1997. NUREG/BR-0184 presents methods for determination of the value of decreases in risk, using four types of attributes: public health, occupational health, offsite property, and onsite property. Any SAMAs in which the conservatively low implementation cost exceeds the base case monetization are screened out. If the analysis produces a value that is below that expected for implementation of any reasonable SAMA, no matter how inexpensive, then the remaining steps of the SAMA analysis are not necessary.

7.3.2 **The GEH ESBWR SAMDA Analysis**

NEDO-33306 compiles a list of potential SAMDAs based on a generic list from license renewal actions and the Advanced Boiling Water Reactor (ABWR) SAMA study. Most SAMDAs were then screened out based on their inapplicability to the ESBWR here or the fact that they were already included in the ESBWR design or accomplished by alternative features in the design. SAMDAs with rough implementation costs that far exceeded any reasonable benefit were also excluded. The maximum averted risk benefit presented in NEDO-33306 is $397,863. None of the SAMDAs passed the screening process.

GEH concluded that due to the low absolute value of core damage and offsite release risk, there are no design improvements that could yield a significant severe accident mitigation benefit, and it is unlikely that any future design changes could be justifiable.

7.3.3 **Unit 3 ESBWR SAMA Analysis**

Unit 3 specific design features (e.g., cooling towers, lake location, proximity to Units 1 and 2, weather, seismology) were all considered for potential impact on the generic GEH ESBWR SAMDA analysis, and none were determined to potentially impact it. To demonstrate the applicability of the GEH ESBWR SAMDA analysis to Unit 3, the MACCS2 Code was used to re-calculate offsite consequences for a severe accident of an ESBWR at the North Anna site. MACCS2 analysis used the source terms, release fractions, and core damage frequencies from the GEH ESBWR PRA with current site information (population, economic, and meteorological data). The offsite consequence results were then used to calculate the maximum averted risk benefit for Unit 3. The maximum averted risk benefit for Unit 3 is calculated to be $96,827 with a 7% discount rate applied, and $169,560 with a 3% discount rate applied. These maximum benefits are bounded by the generic value calculated in the GEH ESBWR SAMDA analysis.

New information pertinent to SAMDAs was addressed. The August 23, 2011 Mineral, Virginia earthquake was included in the analysis of probabilistic seismic hazard (FSAR 2.5). Also, seismic margins analysis of the ESBWR NEDO-33201 (Reference 2) concludes that the risks of beyond design basis earthquakes are sufficiently low. Seismic risk does not alter the SAMDA analysis as most SAMDAs have already been addressed in design, and implementation costs of others far exceed the averted risk benefit, therefore, no additional SAMDAs have been identified for this section.

A review was performed of the compilation of SAMAs in NEDO-33306 to identify procedural and administrative measures that were not considered design alternatives. Most of these items related to PWRs and have no relevance to the ESBWR. Those administrative and procedural measures applicable to the ESBWR will be considered for implementation when procedures are developed prior to fuel load.

Accordingly, no cost-beneficial SAMDAs have been identified. Further, pursuant to 10 CFR 51.30(d), the NRC will, as part of its design certification rulemaking, prepare an environmental assessment evaluating the costs and benefits of SAMDAs for the ESBWR. Pursuant to 10 CFR 51.50(c)(2) and 51.75(c)(2), this environmental assessment may be incorporated by reference into the ER and EIS upon completion.

Section 7.3 References

1. GEH Nuclear Energy, "ESBWR Severe Accident Mitigation Design Alternatives," Revision 4, NEDO-33306, October 2010.

2. GEH Nuclear Energy, "ESBWR Certification Probabilistic Risk Assessment," Revision 6, NEDO-33201, October 2010.

7.4 Transportation Accidents

The information for this section is provided in ESP-ER Section 3.8, and the associated impacts, with the exception of crud and activation products on spent fuel transportation accidents, are resolved as SMALL for light-water reactors in FEIS Section 6.2.

The evaluation of the impact of crud and activation products on spent fuel transportation accidents is provided in Section 3.8.

Chapter 8 Need for Power

This chapter demonstrates the need for the power to be generated by the proposed facility and related benefits. This demonstration is supported by an analysis, which is organized into five sections:

- A discussion of benefits in Section 8.0.1,
- A power system description in Section 8.1,
- An analysis of demand for capacity and energy in Section 8.2,
- An analysis of supply resources in Section 8.3, and
- An assessment of need in Section 8.4.

8.0.1 Benefits

This section describes the benefits associated with construction and operation of the proposed NAPS Unit 3. Non-monetary benefits of constructing and operating the proposed Unit 3 include benefits related to: net electrical generating benefits; fuel diversity; mitigated price volatility; enhanced reliability; emissions avoidance; waste reduction; and reduction in dependence on imported power. Monetary benefits of constructing and operating Unit 3 include benefits related to tax revenues and to the local and state economy.

8.0.1.1 Net Electrical Generating Benefits

As demonstrated in Section 8.4, the Dominion Zone, the region of interest (as defined in Section 8.1.1), has a specific need for new baseload capacity and this need is projected to increase. The baseload capacity supply portfolio in the Dominion Zone is currently out of balance with baseload requirements, because development of new baseload capacity has not kept pace with recent growth in capacity requirements. Instead, the growth in energy consumption has been met predominantly by the recent development of gas-fired units, which over the long term are more suitable as cycling or mid-range resources.

As shown in Section 8.4, there is a current need for baseload capacity in the Dominion Zone, and additional baseload capacity requirements in the Dominion Zone are projected to be approximately 2,100 MW and 2,800 MW by 2024 and 2028, respectively.[1] To meet its baseload requirements in 2012, DVP constructed the Virginia City Hybrid Energy Center (VCHEC), which is a 585 MW coal facility located in Virginia City, Virginia. DVP also completed uprates, from 2010 to 2013, totaling 126 MW to the existing North Anna and Surry power plants, 31 MW of uprates at Mt. Storm, and 16 MW at Chesterfield Power Station, but considerable additional baseload capacity will be needed. Currently, the VCHEC and Mt. Storm units have been providing needed baseload capacity and

1. If measured by the need to maintain peak summer margin, about 4,000 MW of capacity would be required by 2023, as discussed in Section 8.2.2.1.

energy to the Company's service territory, therefore they are considered part of the Dominion Zone supply portfolio.

The primary benefit of the proposed Unit 3 is the consistent provision of baseload capacity necessary to meet the needs of customers, and to maintain a reliable, stable supply of electricity within the Dominion Zone. The proposed Unit 3 will provide approximately 1,500 MW of average net summer capacity. Conservatively assuming an average capacity factor of 90 percent, the plant average annual electrical-energy generation is approximately 12,000,000 megawatt hours.[1] Unit 3 would provide a benefit to DVP's service territory by maintaining DVP's baseload capacity portfolio and helping to meet the growing baseload needs in the Dominion Zone. It is important for DVP to continue to maintain its diverse generation asset portfolio, both in terms of fuel diversity and operational diversity (baseload, intermediate and peaking) in order to protect against the risks of natural gas and oil price volatility, potential supply constraints, and potential future environmental regulations.

8.0.1.2 Fuel Diversity Mitigated Price Volatility and Enhanced Reliability

Energy diversity is a key to providing a reliable and affordable electrical power supply system. Achieving a balanced portfolio of fuels and technologies best manages a variety of risks, including commodity price volatility, fuel supply disruptions, and changes in regulatory practices. (Reference 3) Consequently, Virginia law governing electric utility resource planning calls for the integrated resource plan (IRP) that DVP has, and that it must continue to "reflect a diversity of electric generation and supply and cost-effective demand reduction contracts and services so as to reduce the risks associated with an over-reliance on any particular fuel or type of generation demand and supply resources…." (Va. Code § 56-598(3)). The Energy Policy Act of 2005 also includes provisions for utilities to develop plans to minimize their dependence on one fuel source by requiring them to use a diverse range of fuels and technologies in meeting their customer energy requirements. (Energy Policy Act of 2005 (Pub. L. 109-58) (Aug. 8, 2005)). In fact, a balanced energy portfolio has been the key to providing the U.S. with a growing supply of affordable electricity for the past 30 years. (Reference 4)

Fuel diversity is using a balance of fuel mixes. Each potential generation fuel has merits and risks related to price volatility, transportation, and supply disruptions that need to be considered in long-term planning. In 2005 and 2008, natural gas prices were at all-time highs; however, due to fundamental changes in technology used to extract natural gas from shale formations, combined with mild winter weather, prices reached historic lows in 2012. Coal prices, while not as volatile as natural gas, have also experienced price swings related to various domestic and international issues, such as global supply disruptions, new environmental regulations, increasing extraction cost, and, at least for some eastern coals, a general decline in the minable resource base. The

1. As stated in Appendix 3D of the 2012 IRP, Dominion's nuclear units in Virginia operated with an average capacity factor of 90% from 2009 to 2011. (Reference 2)

price swings experienced in the natural gas and coal markets during the last 10 years illustrate the need for consideration of fuel diversity in long-term planning of the generation fleet.

Utilities require a mix of generation technical capabilities to meet the complexity of the load-following requirements to keep on their customers' lights. (Reference 5) Generation units' capabilities vary, as some units, such as natural gas-fired combustion turbines, are designed to start and ramp-up to full capacity in a short period of time, while running at relatively low capacity factors to meet system peak loads. Baseload generation, such as nuclear units, run reliably for long periods of time at a consistent level of output. Utilities must have a mix of generation, not only for fuel diversity, but simply to have the right combination of technologies to meet their customers' loads reliably. (Reference 5)

Generation planning horizons are long-term outlooks with diverse generation assets and types (fuel) providing a hedge against risks that are too long-lived to be covered by short-term outlooks for fuel prices or forward commodity markets. A diverse generation fleet is useful to mitigate uncertainties when traditional risk management tools are not available. For example, there is no negatively correlated asset to materially hedge potential risk such as CO_2 regulation, and there is not yet a clear timeframe for exactly when and to what extent such hedges may be needed. A diverse fleet of generation options including nuclear and renewable sources will most reasonably address this type of uncertainty.

Diversity can also provide risk mitigation related to unforeseen changes in policy directions. For example, EPA's proposed New Source Performance Standard for carbon dioxide (CO_2) requires new fossil fuel electric generators to meet an output-based standard for CO_2 emissions that is roughly equivalent to the emissions level of a gas-fired combined cycle plant. Because Carbon Capture and Sequestration (CCS) would be required for a new coal plant to meet this standard, this rule essentially eliminates new coal plants as a fuel diversity option until CCS technology is proven and economic. This limits the generation diversity options to natural gas, nuclear, and renewable technologies and cost effective load growth reduction programs. Until CCS technology is proven and economic, nuclear generation is one of a few remaining dispatchable baseload generation options available to mitigate long-term risk associated with unforeseen changes in fuel prices and policy.

The existing coal generation fleet in the eastern U.S. is currently undergoing a significant transformation driven by low gas prices, an aging fleet, and effective and anticipated environmental regulations. As a result, 16 GW of coal units have retired since 2008, and 19 GW of additional coal plants have announced plans to retire over the next 3 to 5 years. The Company is no different and plans to retire 856 MW of coal-fired generation by 2015. Longer term, the eastern U.S. coal fleet faces another challenge, with approximately 60 percent of the remaining coal units being in operation for over 50 years by 2025. Since 2008, only 9 GW of new coal generation has been built or is currently under construction. Replacing the retiring capacity will require new baseload generation. Considering the restrictions on new coal plant construction and these noted retirements, nuclear generation is needed to sustain a diverse and reliable baseload generation option. See Figure 8.0-1 regarding coal generation.

The operating licenses for the existing fleet of U.S. nuclear power generation begin to expire en masse in the 2030s with 37 percent of the licenses expiring by the end of 2030 and 64 percent expiring by the end of 2035. Dominion's nuclear plants' operating licenses for North Anna (Units 1 and 2) and Surry (Units 1 and 2) will also expire in the 2030s. While some additional license renewals are possible, replacing any significant portion of this U.S. fleet will require careful consideration of long-term plans to assure the generation fleet remains diverse in fuel type and technology. See Figure 8.0-2 regarding nuclear generation.

As noted earlier, the price for natural gas has recently been at historically low levels. This has prompted an interest in developing new generation plants fired by natural gas. Gas generation development, since 2008, has represented the majority of new generation constructed in the eastern U.S., with 25 GW of new gas-fired generation put into service since 2008 and an additional 5 GW under construction. Review of recent Integrated Resource Plans for utilities in the eastern U.S. indicate another 13 GW of gas-fired generation are included in their long-term plans. Additionally, 7 GW of coal units are converting to gas as the primary fuel. Low prices allow for the build-out of natural gas generation as the most attractive option over the short-term. DVP remains positive on natural gas and believes in its supply, reliability, environmental benefits, and transportation systems to support the electric generation fleet. However, when considering the longer-term perspective, it is not prudent to expect natural gas to overcome the decrease in fuel and operational diversity created by coal and nuclear retirements, as well as increasing electricity demand. New nuclear must remain an option to provide reliable electricity within Virginia. Long-term perspectives require nuclear project development to be underway to assure the nuclear option remains available to continue a diverse fleet of generation units. See Figure 8.0-3 regarding gas generation.

8.0.1.3 Emissions Avoidance

Fossil fuel-fired electrical generation plants produce more air emissions (e.g., nitrogen oxides, sulfur dioxide, and carbon dioxide) associated with air quality, climate change, aesthetic and health concerns than nuclear energy. As shown in Figure 8.0-4, electricity generated by nuclear power provided approximately 20 percent of the total electricity generated in the U.S. in 2010 without any appreciable air emissions.

Beyond steam and water vapor, modern nuclear reactors produce virtually no air emissions. Nuclear power generation, therefore, leads to significant local, national, and global air quality benefits. (Reference 7) Section 9.2 and NUREG-1437 Supplement 7, Section 8.2 compare the emissions from coal- and gas-fired alternatives. (Reference 8)

8.0.1.4 **Carbon Dioxide Emissions**

The 2007 Virginia Energy Plan (Reference 11) established the goal to reduce carbon dioxide emissions by 30 percent by 2025, bringing emissions back to 2000 levels. Currently, nuclear power is the only available and proven technology that provides a viable alternative to fossil-fired plants for baseload electrical generation. Unit 3 will significantly contribute to the achievement of Virginia's goal to reduce carbon dioxide emissions.

8.0.1.5 **Tax Revenues**

Taxes are transfer payments that would share and distribute the economic benefit of Unit 3 with state and local governments. While tax revenues are not independent benefits, they are described below to properly describe the allocation of benefits.

The proposed NAPS Unit 3 would make tax payments to the Commonwealth of Virginia and counties for the 40 operating years of the license. Additionally, in 2006, Virginia Economic Development Partnership (VEDP) used IMPLAN, a commercially available input-output modeling program, to estimate the economic impact of the jobs created by the addition of a new nuclear generating unit at the NAPS. (Reference 1) Dominion provided the following key parameters for this analysis: 750 new direct jobs during the plant operation period with an average annual salary of $67,000 and 2,000 direct jobs during the construction period.

During the plant construction period, VEDP estimates that the direct and additional jobs created due to construction of a new unit at NAPS should generate annually $4.8 million in state tax revenue and $3.5 million in tax revenue for the local counties. Tax revenue for the local counties consists of $3.1 million in property taxes and $400,000 in sales and use taxes annually. At the above rate, the direct and additional jobs due to the proposed Unit 3 should result in $24.9 million in total tax revenues to the Commonwealth of Virginia and local counties over the projected 3-year construction period. This amount consists of $14.4 million in total state taxes to Virginia, $9.3 million in total property tax and $1.2 million in total sales and use tax revenues allocated to the local counties.

During the plant operation period, VEDP estimates that the direct and additional jobs created due to a new unit at NAPS should generate annually $14.8 million in state tax revenue and $27.7 million in tax revenue for the local counties. Tax revenue for the local counties consists of $3.5 million in property taxes and $24.2 million in sales and use taxes annually. At the above rate, the direct and additional jobs due to the proposed Unit 3 should result in $1.7 billion in taxes to the Commonwealth of Virginia and the local counties over the 40-year operating license. This amount consists of $592 million in total state taxes to Virginia, $140 million in total property tax and $968 million in total sales and use tax revenues to the local counties.

The additional tax revenues generated from construction and operation of Unit 3 should benefit the state and local county government agencies because the revenues would support the development of infrastructure and services that support the community and promote further economic development.

8.0.1.6 Local and State Economy

The construction of NAPS Unit 3 would require a workforce of about 2000 people (conservatively estimated) and would generate additional income for the Commonwealth of Virginia and local economy for a period of three years. The subsequent operation of the proposed Unit 3 would require an operational workforce of about 750 people and would generate additional income and value for the Commonwealth of Virginia and local economy for a period of at least 40 years.

Based on the VEDP estimates, (Reference 1) the construction and operation of the proposed Unit 3 would increase the Commonwealth of Virginia's economic output by $42.5 million annually. If the direct value of the new unit output is included, state and county output attributable to the operation of Unit 3 would be significantly higher.

VEDP estimates (Reference 1) that the construction of the proposed Unit 3 would require the hiring of 2000 workers during three years of construction, some of which are expected to come from outside the local area. These construction workers and their employers would pay income taxes and support additional employment in the local areas through their spending. VEDP estimates that 1236 additional indirect jobs would be created as a result of the construction. Temporary construction workers and their families increase rental and property demand, spending on goods and services, and sales taxes that benefit the local economy.

In addition, VEDP estimates (Reference 1) that the operation of Unit 3 would create 750 direct jobs for Louisa County for 40 years. These permanent operational workers would pay income taxes and support additional employment in the local areas through their spending. VEDP also estimates that 1553 additional indirect jobs would be created as a result of operation of Unit 3. The communities potentially impacted socio-economically by construction and operation of Unit 3 are Louisa, Orange, and Spotsylvania Counties, all in central Virginia. Louisa County, where NAPS is located, would see the greatest impact. All these counties have experienced steady growth in population and economic activity during the last decade. Moreover, an additional nuclear unit will increase career opportunities within Dominion's nuclear organization, allowing for new opportunities in the nuclear operations for entry-level employees, as well as additional opportunities for promotion and retention of the exceptionally qualified staff.

8.0.1.7 Other Benefits

Section 10.3 (also ESP-ER Section 10.3) describes the relationship between short-term uses and long-term productivity of the human environment. These benefits are summarized in Table 8.0-1.

Section 8.0 References

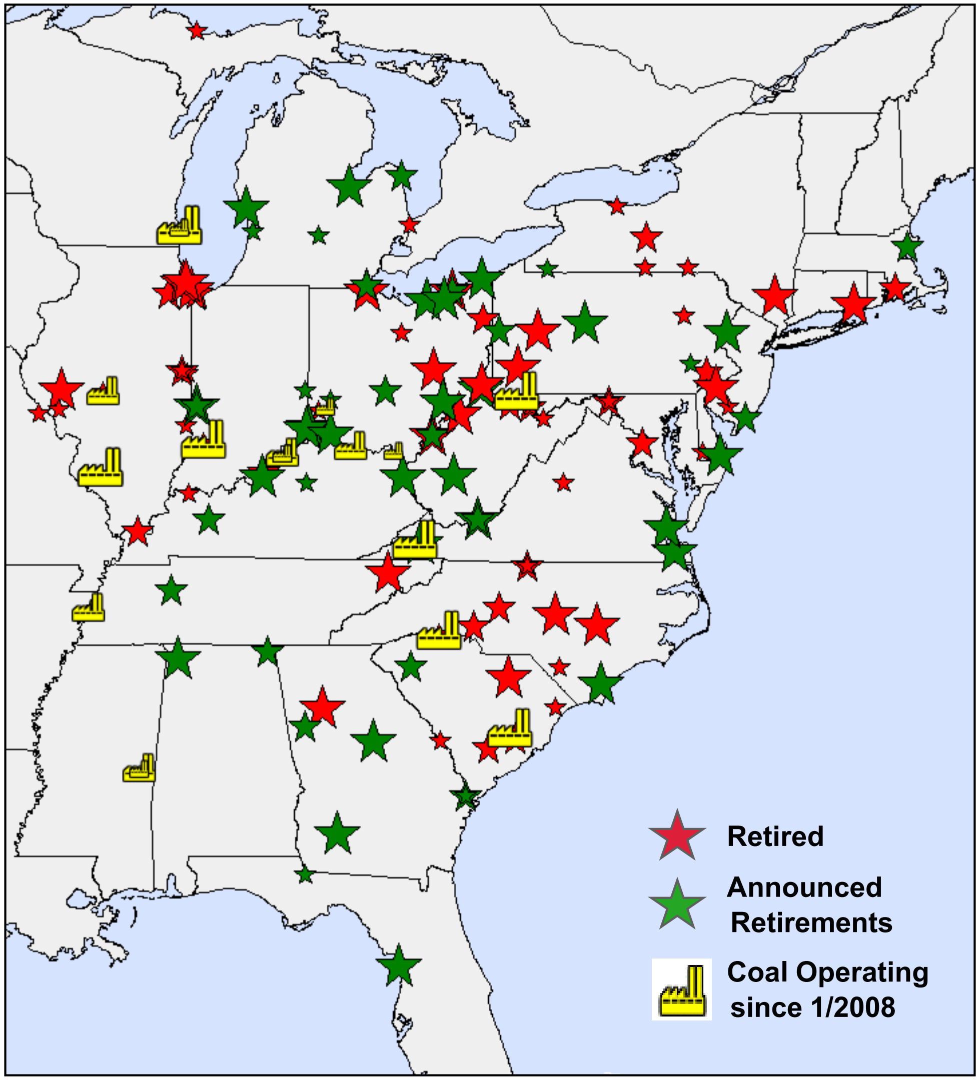
1. Virginia Economic Development Partnership, “The Estimated Economic Impact of an Expansion of the North Anna Power Station on Virginia,” November 14, 2006.
2. DVP, “Dominion North Carolina Power and Dominion Virginia Power's Integrated Resource Plan: Chapter 3.2”, August 31, 2012.
3. Edison Electric Institute (EEI) website, “Fuel Diversity,” 2006.
4. Center for Energy and Economic Development (CEED) website, “Fuel Diversity,” 2006.
5. Edison Electric Institute (EEI), “Utility Supply Portfolio Diversity Requirements,” May 2007.
6. [Deleted]
7. Massachusetts Institute of Technology (MIT), “The Future of Nuclear Power, An Interdisciplinary MIT Study,” report, 2003.
8. U.S. Nuclear Regulatory Commission, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 7, Regarding North Anna Power Station, Units 1 and 2,” Final Report, NUREG-1437, November 2002.
9. [Deleted]
10. [Deleted]
11. Commonwealth of Virginia, Department of Mines, Minerals and Energy, “The Virginia Energy Plan,” September 12, 2007.

Table 8.0-1 Monetary and Non-Monetary Benefits of NAPS Unit 3

Category of Benefit	Description of Benefit
Net Electrical Generating Benefits	
Net Generating Capacity	~1,500 MWe
Electricity Generated (operating at 90% cap.)	~12,000,000 MW-hrs
Taxes and Revenue During Plant Operation Period (Transfer Payments - Not Independent Benefits)	
Annual State Taxes	NAPS Unit 3 pays $14.8 million.
Annual Property Taxes	NAPS Unit 3 pays $3.5 million.
Annual Sales Taxes	NAPS Unit 3 pays $24.2 million.
Effects on Regional Productivity	
Construction Workers	Approximately 2,000 workers create an incremental increase of 1,236 indirect jobs, within the region.
Operational Workers	750 new workers create an incremental increase in 1,553 indirect permanent jobs within the region for at least 40 operating years.
Socioeconomics	Increased tax revenue supports improvements to public infrastructure and social services. The increased revenue spurs future growth and development.
Technical and Other Non-Monetary Benefits	
Fuel Diversity	Reduces exposure to supply and price risk associated with reliance on any single fuel source.
Price Volatility	Dampens potential for fuel price volatility.
Fossil Fuel Supplies	Offsets usage of finite fossil fuel supplies.
Electrical Reliability	Enhances electrical reliability.
Emissions Reduction	Significant beneficial impact in terms of avoidance of air emissions.
Carbon Dioxide Emissions	Baseload generation with virtually no carbon dioxide emissions.
Wastes	Compared with fossil-fueled plants, nuclear plants produce less nonradioactive waste products.

Table 8.0-2 Deleted

Figure 8.0-1 Eastern U.S.* Coal Generation Developments 2008 through March 2013



Coal Retirements – 35 GW

- 16 GW retired since 2008
- 19 GW of additional retirements announced

New Coal – 9 GW

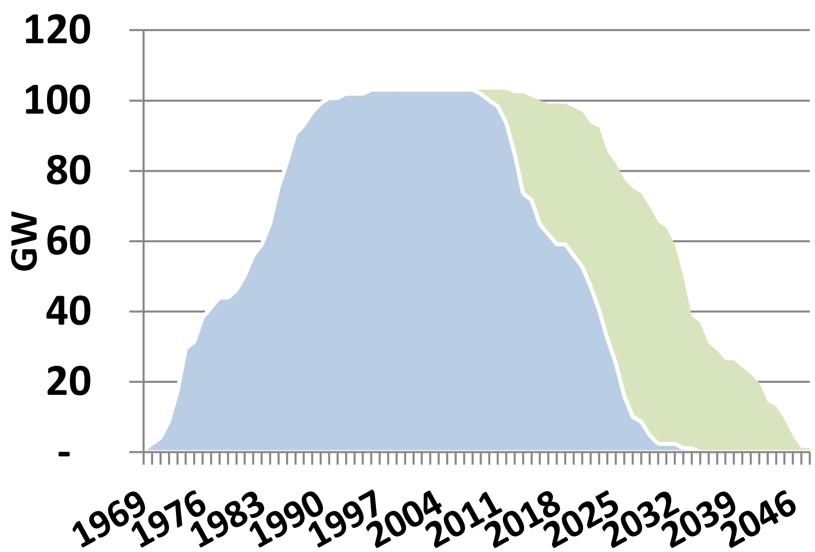
- 8 GW new coal online Since 2008
- 1.2 GW currently under construction
  - Both IGCC Units

Future coal development unlikely given the GHG NSPS Ruling

- Limits GHG emission rates on new units to gas fired combined cycle equivalent
- Requires development of Carbon Capture and Storage technology

* Eastern U.S. includes NERC Regions RFC, NPCC, SERC and FRCC
Source: Energy Velocity and internal Dominion research

Figure 8.0-2 Fuel Diversity: U.S. Commercial Nuclear Power Reactor Generation Capacity/Gas Supplementation



Combination of Coal Retirements, Nuclear Retirements, and Demand Growth Will Challenge Any Single Source Fuel Option

<u>2012 Stats</u>

24 TCF - Annual U. S. Natural Gas Production

9.1 TCF – Gas Consumption by Electric Generation

- 38% of U.S. Production

<u>Nuclear Replacement Scenario</u>

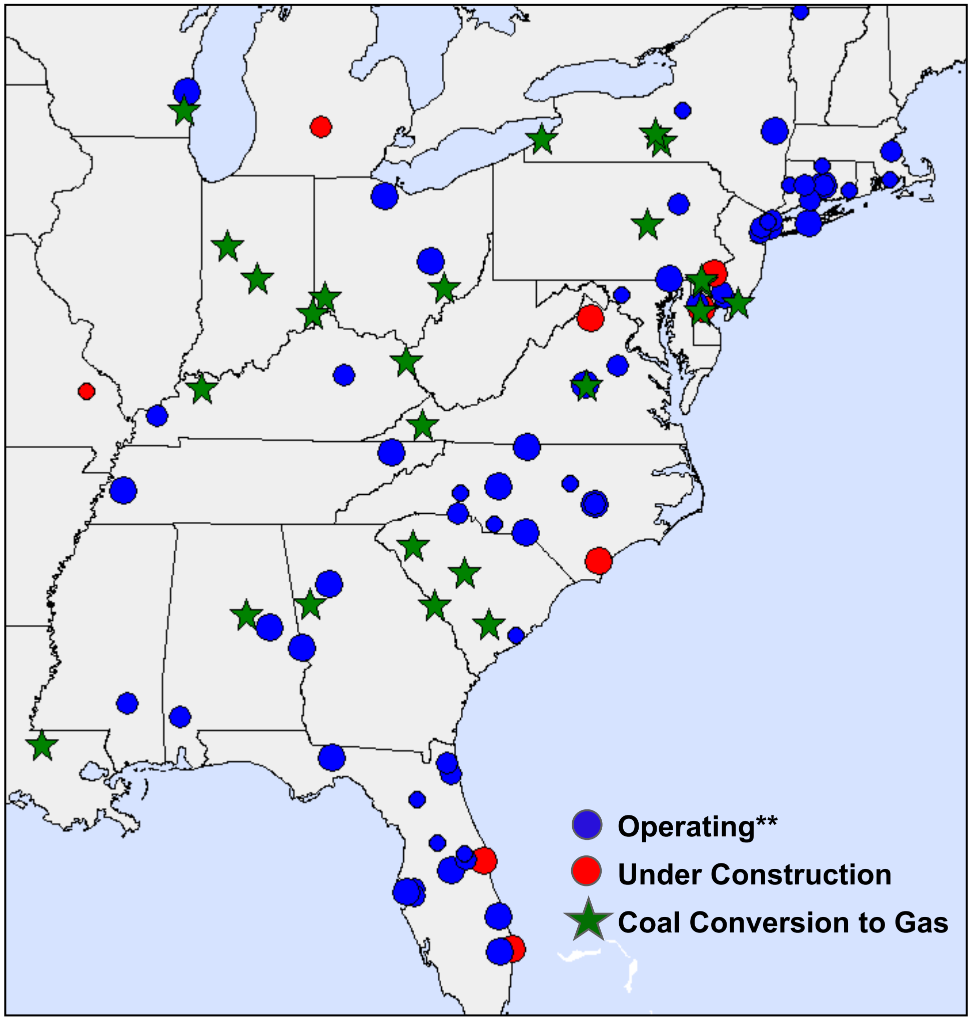
5.5 TCF – Natural Gas Required to Replace Nuclear

- 23% of U.S. Production

14.6 TCF - Combined 2012 Electric Sector Gas Consumption and Nuclear Replacement

- 60% of U.S. Production

Figure 8.0-3 Eastern U.S.* Gas Generation Development 2008 Through March 2013



32 GW - New Gas

- 25 GW in service since 2008
- 5 GW under construction
- 2 GW cleared PJM BRA, but not under construction

7 GW -Coal to Gas Conversions

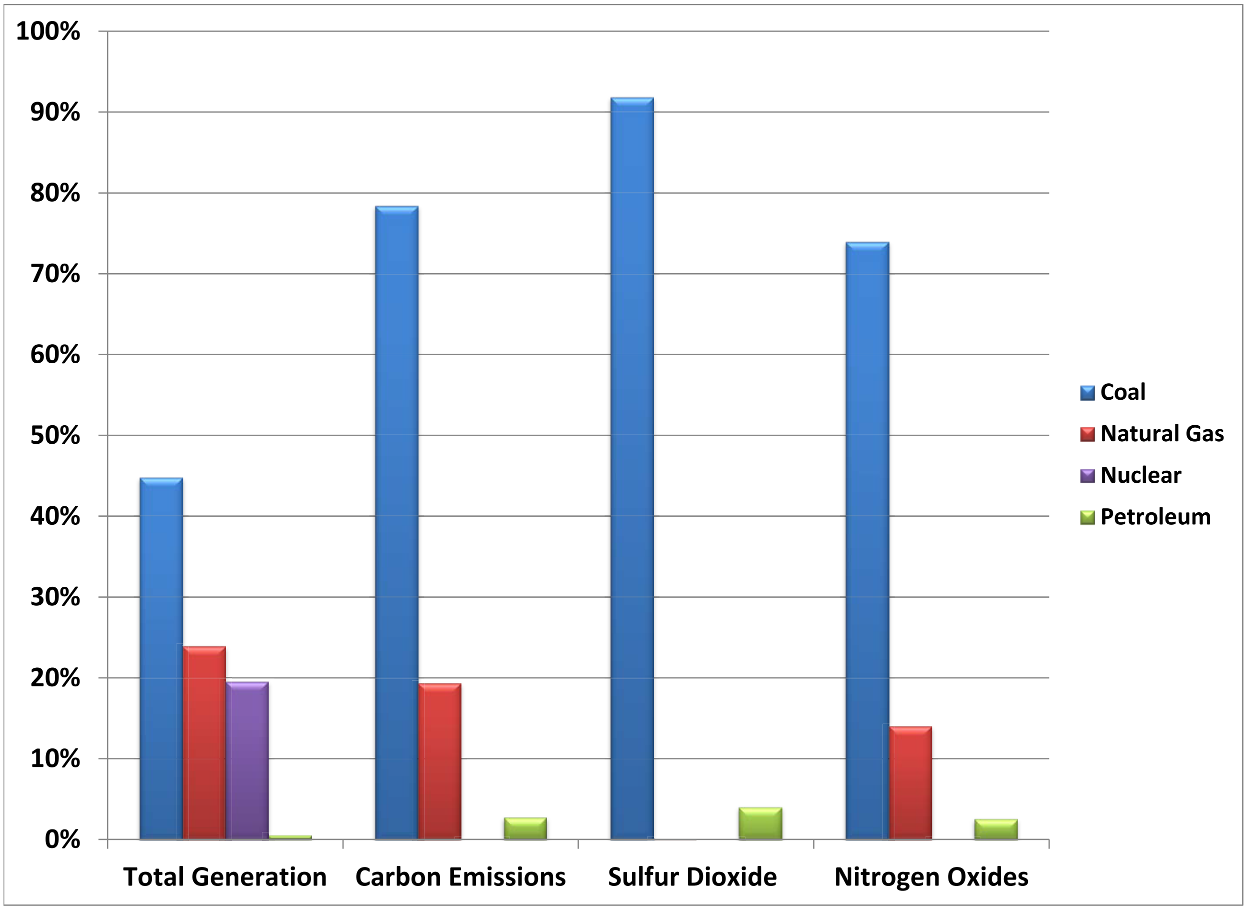
- Coal units with announced plans to convert to gas

~13 GW - Gas generation included in long term plans of regulated utilities

- Included in IRPs
- Not shown on map

* Eastern U.S. includes NERC regions RFC, NPCC, SERC and FRCC
** Gas unit in service after Jan 1, 2008
Source: Energy Velocity and internal Dominion research

Figure 8.0-4 Total U. S. Generation and Air Emissions from Electricity Generation 2010



Source: Graph generated with EIA data, including Form EIA-923, Power Plant Operations Report, Form EIA-906, Power Plant Report, Form EIA 920, Continued Heat and Power Plant Report and predecessor forms.

8.1 Power System

This section describes and assesses the regional power system in which the proposed facility would operate. This section describes: i) DVP's transmission zone (also referred to as either Dominion Zone or PJM South Region (Figure 8.1-1)); ii) DVP's electric distribution service territory; iii) the PJM market, in which DVP operates and of which DVP's transmission zone is a part; and iv) the Regional Reliability Organization—SERC Reliability Corporation (SERC)—to which DVP belongs. This section also defines the appropriate region of interest for assessing the need for power. As discussed further below, legislation was passed in Virginia that redefined investor-owned electric utilities' native load obligations.

8.1.1 Region of Interest – Dominion Zone

In May 2005, DVP joined PJM and transferred control of the transmission facilities that it owns and operates in its control area to PJM. With its integration into PJM, DVP separated its electric generation and traditional customer delivery businesses into two distinct operations within PJM's system. The region of interest (ROI) for the purposes of this COL Application is the Dominion Zone which also includes the electric distribution service territories comprised of DVP, ODEC, North Carolina Electric Cooperatives (NCEMCS) and other municipals. DVP operates as the principal load serving entity or LSE in the Dominion Zone.

DVP serves approximately 90 percent of the electric load in the Dominion Zone including both peak demand and total energy requirements.[1] The need for power analysis presented in Section 8.4 relies upon baseload growth projections based on historical growth observed by DVP in the Dominion Zone.

8.1.2 Deleted

8.1.3 DVP's Electric Service Territory

DVP's electric service territory encompasses most of the population of the Commonwealth of Virginia as well as sections of North Carolina (see the shaded area in Figure 8.1-3). DVP's service territory in Virginia comprises about 65 percent of the state's total land area, but accounts for over 80 percent of its total load and includes one of the fastest growing counties in Virginia. (Reference 3) In North Carolina, DVP serves the northeastern corner of the state excluding several municipalities. As discussed in Section 8.1.3.1, DVP has native load obligations throughout its service territory in Virginia and North Carolina.

DVP serves the fast-growing Northern Virginia area. This area comprises the counties of suburban Washington DC, one of which, Loudoun, was named one of 100 fastest-growing counties in the

1. This assessment is based on analysis of DVP's 2012 actual peak demand and annual energy compared to 2012 historical PJM integrated hourly loads for the Dominion Zone (Reference 9).

nation according to the U.S. Census Bureau. (Reference 10) In addition, DVP's service territory includes the cities of Richmond, Norfolk, Williamsburg, Fredericksburg, Virginia Beach, and Charlottesville.

The estimated population for the Commonwealth of Virginia as of July 2012 was 8,185,867 as published by the U.S. Census Bureau (Reference 11) and is on pace for approximately 0.98 percent - 1.8 percent per annum growth based on the growth experienced from 2007 to 2012. DVP estimates that its Virginia service territory population has grown at about 1.1 percent - 1.9 percent per annum since 2007, leading to its 2012 population estimate of 6,853,425.[1]

The population growth for the state of North Carolina has ranged from about 0.96 percent–2.0 percent per annum since 2007, to the Census Bureau's July 2012 estimate of 9,752,073. (Reference 12) Population growth in the counties in which DVP's service territory is located in North Carolina has ranged from about 0.1 percent - 4.0 percent per annum since 2007, to the 2012 estimate of 592,969.

The estimated population growth rates for counties in which DVP has service territory are outlined in Table 8.1-1, and the counties and cities in which DVP's service territory is located are listed in Table 8.1-2. DVP expects significant growth in baseload requirements through new customer additions, which DVP estimates at approximately 35,000–40,000 new customer connections each year, and data center growth of 455 MW from 2013 to 2017. (Reference 4)

The breakdown of residential, commercial and industrial customers served by DVP as reported by the EIA in its EIA-861 database is provided in Table 8.1-3. Roughly 40 percent of the total load reported was residential, 50 percent was commercial (public authority) and the remaining 10 percent industrial.

Electric sales by class have been impacted by the recent recession and abnormal weather patterns over the past several years as shown in Table 8.1-3. However, both PJM and DVP project an increase in weather normalized total electric sales (output) over the next 15 years. The economic fundamentals in the Commonwealth of Virginia remain strong which are primary drivers of electric consumption. The majority of the growth is expected to come from the residential and commercial classes. The increase in residential class electric sales is expected to reflect increases in disposable income, lowered unemployment and increased housing starts, while the commercial sector is expected to be driven largely by data centers. Data centers, located in the Commonwealth, have contributed to the share of commercial class sales and are expected to continue that trend. Data centers are large commercial, high load-factor customers that contribute to baseload need requirements. Data center electricity usage is projected to grow rapidly over the next decade as information storage and availability requirements expand.

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1. This estimate was developed by cross referencing the population estimates published by the U.S. Census Bureau and resulting growth rates with information published in the EIA-861 database regarding the counties where DVP distributes electricity.

8.1.3.1 Status of Electricity Market Reforms in DVP's Service Territory

In 2007, the Virginia General Assembly passed House Bill 3068 and Senate Bill 1416 (the Legislation), which were signed into law by Virginia's governor. A primary objective of the Legislation, also know as the Virginia Electric Utility Regulation Act (the Regulation Act), is to ensure a reliable and adequate supply of electricity by investor-owned electric utilities for their native load obligations[1] and to return Virginia's electric system to an incentive form of "cost-of-service" regulation beginning July 1, 2007. One of the goals of the Regulation Act is to encourage the construction of new baseload generation, including nuclear generation, to serve in-state system requirements by providing higher rates of return on common equity for these facilities. North Anna Unit 3 is being developed to meet native load obligations pursuant to the Regulation Act. This Legislation also requires that 75 percent[2] of the total annual margins from off-system sales be applied to the utility's fuel expenses, reinforcing that these facilities are primarily intended to serve native load customer requirements.

The 2013 Virginia General Assembly passed House Bill 2261 amending the Regulation Act. The amendments became effective upon the governor's signature in February 2013. House Bill 2261 preserved the central elements of the Regulation Act. House Bill 2261 retains enhanced rates of return for nuclear and offshore wind generation projects, consistent with the General Assembly's strong interest in promoting these forms of generation, including new nuclear units.

DVP and other electric utilities in North Carolina have continued to be responsible for supplying their native load obligations. (Reference 13)

8.1.4 Dominion Zone Oversight

The Dominion Zone is subject to oversight from four separate entities with respect to reserve margin standards, system reliability, and planning. A summary of each entity's oversight function is provided below.

8.1.4.1 Deleted

8.1.4.2 PJM

PJM is an independent regional transmission organization (RTO) responsible for operating the wholesale energy market in the largest centrally dispatched control area in North America

1. There are approximately 111 Virginia jurisdictional customers with loads greater than 5 MW representing a total coincident peak load of approximately 980 MW and these customers may, if they choose, purchase power from other providers. In addition, the Legislation allows non-residential customers to aggregate their loads to greater than 5 MW and be served by a competitive supplier.
2. The Virginia State Corporation Commission may require less than 75 percent of such margins to be so credited if it finds by clear and convincing evidence that such a requirement is in the public interest.

encompassing all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and the District of Columbia (see Figure 8.1-4). PJM also has primary responsibility for administering a long-term PJM Regional Transmission Expansion Planning (RTEP) and the Reliability Pricing Model (RPM) which provides a long-term price signal for existing and new generating capacity resources to ensure reliability for the PJM control area. As a PJM member, DVP, as a LSE, is a signatory to PJM's Reliability Assurance Agreement among Load Serving Entities in the PJM Region (RAA),[1] which obligates DVP to own or procure an amount of capacity in order to maintain overall system reliability. (Reference 7) The process and framework established by PJM's RAA is a comprehensive and rigorous method for ensuring the reliability of resources in the Dominion Zone. PJM performs a technical analysis on an annual basis that calculates the appropriate generating capacity including reserve margin required to meet the RAA-defined reliability criteria.[2] This technical analysis is based on a loss of load expectation (LOLE) of one day in ten years, which is also the standard adopted by SERC and the Reliability First Corporation (RFC), which is the regional reliability organization which covers much of the PJM market. The Installed Reserve Margin (IRM) is determined annually and is vetted at various stakeholder forums including the Resource Adequacy Analysis Subcommittee, Planning Committee, Markets and Reliability Committee and the Members Committee. If approved by the stakeholders, it is then forwarded to the PJM Board for final approval. The IRM for future years (as shown in 2012 PJM Reserve Requirement Study (Reference 8)) averages 15.6%. This region-wide IRM target is used for RPM and is the basis for allocating a capacity obligation to each LSE within PJM based on that LSE's share of the PJM summer peak load.

Each LSE is responsible for installing or purchasing capacity, on a daily basis, to meet its obligation. The rationale for imposing capacity obligations on PJM LSEs is that installation of generating capacity requires time, coordination of electric system resources, and financial backing and, therefore, must be planned for in advance of need. To meet its capacity, long-term reliability obligations and customer energy requirements within PJM in a cost-effective manner, DVP is developing North Anna Unit 3 and proposing to build the Brunswick facility, as well as Warren County Power Station, which is under construction.

In order to balance the requirements of buyers and loads with offers of suppliers and by so doing manage the reliability of the system, PJM administers an hourly market (both day ahead and real time) for energy and the RPM annual market for capacity. While the energy market is designed to balance day-to-day (and hour-to-hour) supply and demand within PJM, the RPM capacity market is

1. Parties previously have entered into similar commitments related to sub-regions of the PJM Region through the East RAA, the West RAA, and the South RAA. In June 2007, these agreements were replaced with a single reliability assurance agreement among all Load-Serving Entities in the PJM Region. (Reference 7)
2. PJM outlines the process for establishing a reserve margin target and allocating responsibility for meeting this target among members in its Manual 20.

designed to provide a price signal to ensure that the long-term peak requirements of the PJM system can be met by available capacity resources. PJM defines the purpose of the RPM market as "to develop a long term pricing signal for capacity resources and LSE obligations that is consistent with the RTEP." (Reference 14)

The Dominion Zone is one of the 26 Locational Deliverability Areas (LDA) in PJM. These 26 LDAs, most of which reflect service territory boundaries of PJM member electric utilities, were identified by PJM's load deliverability analyses conducted pursuant to the RTEP protocol and the PJM Manuals as "constrained areas that have a limited ability to import capacity due to physical limitations of the transmission system, voltage limitations or stability limitations." (Reference 7) Each of the 26 LDAs are modeled in the RPM Base Residual Auction. Capacity to serve LSEs in constrained areas must be located within the constrained area or the LSE must enter into a bilateral transaction for capacity into the constrained area with another entity through Capacity Transfer Rights (CTRs). A discussion of the capacity resources located in the Dominion Zone is presented in Section 8.3.

8.1.4.3 Virginia SCC

As discussed in Section 8.1.3.1, in 2007 the Virginia General Assembly significantly amended the Virginia Utility Electric Restructuring Act, Code of Virginia (Title 56, Chapter 23), in large part to accommodate amendments designed to ensure reliable and adequate supply of electricity. The amended statute known as the Virginia Electric Utility Regulation Act, or the Regulation Act, "was further amended by the Virginia General Assembly in 2008, with the addition of language (Va. Code §§ 56-597 through 56-599) requiring each electric utility to file every two years an Integrated Resource Plan (IRP) with the Virginia SCC.[1] The Plan shall present the utility's forecast of demand for its electric supply obligations over the ensuing 15 years and its plan to meet these obligations "by supply side and demand side resources" in a manner that promotes "reasonable prices, reliable service, energy independence, and environmental responsibility." (Va. Code § 56-597).

Among other requirements, the utility's Plan must "[i]dentify a portfolio of electric generation supply resources, including purchased and self-generated electric power…." (Va. Code § 56-598). Additionally, the portfolio must "[r]eflect a diversity of electric generation supply and cost-effective demand reduction contracts and services so as to reduce the risks associated with an over-reliance on any particular fuel or type of generation demand and supply resources…." (Id.). The Virginia SCC must consider and rule on the application for the CPCN that DVP must file for Unit 3. Under Va. Code §56-580.D, a utility must demonstrate to the Virginia SCC that a proposed facility: i) will have no material adverse effect upon reliability of electrical service provided by any regulated public utility, ii) is required by the public convenience and necessity, and iii) is not otherwise contrary to the public interest.

1. Dominion North Carolina Power's and Dominion Virginia Power's Report of Its Integrated Resource Plan filed on August 31, 2012 (2012 IRP) is available at: www.dom.com/about/pdf/irp/irp-083112.pdf

As prescribed by the Virginia General Assembly, the Virginia SCC also has the responsibility to fix, for each Virginia public utility, just and reasonable rates that it may charge for its services to its customers. The Virginia SCC also has authority over the manner in which the utility companies provide service to their customers and requires public utilities to provide reasonable and reliable service and to adopt safety rules and regulations for the protection of the public.

8.1.4.4 **North Carolina Utilities Commission (NCUC)**

The NCUC requires all public utilities to first obtain a certificate of public convenience and necessity from the NCUC before beginning the construction or operation of any utility plant or system in North Carolina or acquiring ownership or control thereof. In August 2007 the Governor of North Carolina signed into law Senate Bill 3 (Session Law 2007-397) for generation facilities constructed outside of North Carolina. The law provides for utilities to petition the NCUC for approval of the estimated construction schedule and costs if an out-of-state plant is needed and intended to serve North Carolina customers. The law also contains provisions regarding review of the development costs for nuclear generation.

As a general rule, the NCUC has the responsibility under the law to fix, for each North Carolina public utility, the rates that it may charge for its services to its customers. These rates are required to be just and reasonable and fair both to the public utility and to its customers. In addition, the NCUC has authority over the manner in which the utility companies provide service to their customers and requires public utilities to provide reasonable and reliable service and to adopt safety rules and regulations for the protection of the public. (Reference 16)

8.1.4.5 **SERC**

DVP's service territory is located in the Virginia-Carolinas (VACAR) sub-region of SERC (Figure 8.1-6). (Figure 8.1-5 identifies the area covered by SERC.) SERC is responsible for proposing and enforcing reliability standards within the SERC region based on authority delegated to it from the North American Electric Reliability Corporation. SERC is also responsible for promoting and improving the reliability, adequacy, and critical infrastructure of the bulk power supply systems in the SERC region. SERC promotes the development of reliability and adequacy arrangements among the power supply systems; administers a regional compliance and enforcement program to achieve the reliability benefits of coordinated planning and operations; and provides a mechanism to resolve disputes on reliability issues. (Reference 6)

Section 8.1 References

1. [Deleted]
2. [Deleted]
3. Dominion website, "Dominion Virginia Power," May 14, 2013.
4. DVP, "Investor and analyst Meeting," March 4, 2013.
5. [Deleted]
6. SERC Reliability Corporation, "The Region," May 7, 2013.
7. PJM Interconnection, LLC, "Reliability Assurance Agreement Among Load Serving Entities in the PJM Region," report, January 4, 2013.
8. PJM Interconnection, LLC, "2012 PJM Reserve Requirement Study," October 5, 2012.
9. PJM Interconnection, LLC, "Hourly Load Data, 2012," from a website database.
10. U.S. Census Bureau, Population Division, "Table 4: Housing Unit Estimates for the 100 Fastest Growing U.S. Counties with 5,000 or more housing units in 2010: April 1, 2010 to July 1, 2011," HU-EST2011-04, May 7, 2013.
11. U.S. Census Bureau, Population Division, "Table 1: Annual Estimates of the Population for Counties of Virginia: April 1, 2010 to July 1, 2012," May 7, 2013.
12. U.S. Census Bureau, Population Division, "Annual Estimates of the Resident Population of North Carolina: April 1, 2010 to July 1, 2012," May 7, 2013.
13. North Carolina Utilities Commission website, "Electric Industry Restructuring," May 8, 2013.
14. PJM Interconnection, LLC, "Reliability Pricing Model (RPM) Business Rules," report, May 14, 2013.
15. [Deleted]
16. North Carolina Utilities Commission website, "Industries Regulated by the Commission," May 8, 2013.
17. [Deleted]

Table 8.1-1 Population Statistics

Virginia Statistics

	Entire State	Growth	Counties Listed in Table 8.1-2	Growth
7/1/2007	7,719,749	—	6,423,517	—
7/1/2008	7,795,424	.98%	6,492,971	1.1%
7/1/2009	7,882,590	1.1%	6,574,634	1.3%
7/1/2010	8,025,105	1.8%	6,697,245	1.9%
7/1/2011	8,104,384	.99%	6,775,652	1.2%
7/1/2012	8,185,867	1.0%	6,853,425	1.2%

North Carolina Statistics

	Entire State	Growth	Counties Listed in Table 8.1-2	Growth
7/1/2007	9,064,074	—	561,868	—
7/1/2008	9,247,134	2.0%	567,355	0.98%
7/1/2009	9,380,884	1.5%	569,253	0.33%
7/1/2010	9,559,048	1.9%	592,124	4.0%
7/1/2011	9,651,103	.96%	592,703	0.10%
7/1/2012	9,752,073	1.1%	592,969	0.04%

Source: U.S. Census Bureau

Table 8.1-2 List of Counties and Cities Included in Service Territory Estimates

Virginia Counties/Cities	Virginia Counties/Cities (cont'd.)	North Carolina Counties/Cities
Albemarle County	Northumberland County	Beaufort County
Alleghany County	Nottoway County	Bertie County
Amelia County	Orange County	Camden County
Amherst County	Page County	Chowan County
Appomattox County	Pittsylvania County	Currituck County
Arlington County	Powhatan County	Dare County
Augusta County	Prince Edward County	Edgecombe County
Bath County	Prince George County	Gates County
Bedford County	Prince William County	Halifax County
Botetourt County	Richmond County	Hertford County
Brunswick County	Rockbridge County	Hyde County
Buckingham County	Rockingham County	Martin County
Campbell County	Shenandoah County	Northampton County
Caroline County	Southampton County	Pasquotank County
Charles City County	Spotsylvania County	Perquimans County
Charlotte County	Stafford County	Pitt County
Chesterfield County	Surry County	Tyrrell County
Clarke County	Sussex County	Washington County
Culpeper County	Westmoreland County	
Cumberland County	York County	
Dinwiddie County	Alexandria city	
Essex County	Buena Vista city	
Fairfax County	Charlottesville city	
Fauquier County	Chesapeake city	
Fluvanna County	Clifton Forge city	
Gloucester County	Colonial Heights city	
Goochland County	Covington city	
Greene County	Emporia city	

Table 8.1-2 List of Counties and Cities Included in Service Territory Estimates

Virginia Counties/Cities	Virginia Counties/Cities (cont'd.)	North Carolina Counties/Cities
Greensville County	Fairfax city	
Halifax County	Falls Church city	
Hanover County	Franklin city	
Henrico County	Fredericksburg city	
Isle of Wight County	Hampton city	
James City County	Hopewell city	
King And Queen County	Lexington city	
King George County	Manassas city	
King William County	Newport News city	
Lancaster County	Norfolk city	
Loudoun County	Petersburg city	
Louisa County	Poquoson city	
Lunenburg County	Portsmouth city	
Madison County	Richmond city	
Mathews County	South Boston city	
Mecklenburg County	Staunton city	
Middlesex County	Suffolk city	
Nelson County	Virginia Beach city	
New Kent County	Waynesboro city	
	Williamsburg city	

Table 8.1-3 Sales Information by Rate Class

Sales by Rate Class (MW-hr)

	State of VA				State of NC				Total Service Territory			
	Res	Com	Ind	Total	Res	Com	Ind	Total	Res	Com	Ind	Total
2007	28,890,195	38,215,503	8,349,791	75,455,489	1,578,818	958,645	1,723,634	4,261,097	30,469,013	39,174,148	10,073,425	79,716,586
2008	28,096,943	38,113,267	8,064,086	74,274,296	1,546,418	949,812	1,715,159	4,211,389	29,643,361	39,063,079	9,779,245	78,485,685
2009	28,341,098	38,043,912	7,147,238	73,532,248	1,578,817	953,346	1,496,614	4,028,777	29,919,915	38,997,258	8,643,852	77,561,025
2010	30,821,549	39,012,738	6,872,415	76,706,702	1,716,948	973,584	1,639,786	4,330,318	32,538,497	39,986,322	8,512,201	81,037,020
2011	29,143,896	38,649,800	6,342,210	74,135,906	1,624,886	934,318	1,617,630	4,176,834	30,768,782	39,584,118	7,959,840	78,312,740

Customer Count by Rate Class (#)

	State of VA				State of NC				Total Service Territory			
	Res	Com	Ind	Total	Res	Com	Ind	Total	Res	Com	Ind	Total
2007	2,004,160	241,253	554	2,245,967	99,867	17,709	66	117,642	2,104,027	258,962	620	2,363,609
2008	2,024,733	244,486	538	2,269,757	100,497	17,766	60	118,323	2,125,230	262,252	598	2,388,080
2009	2,038,871	246,160	522	2,285,553	100,761	17,750	59	118,570	2,139,632	263,910	581	2,404,123
2010	2,056,576	247,036	504	2,304,116	101,005	17,658	56	118,719	2,157,581	264,694	560	2,422,835
2011	2,070,786	248,232	482	2,319,500	101,009	17,662	53	118,724	2,171,795	265,894	535	2,438,224

Table 8.1-3 Sales Information by Rate Class

Average Sales per Customer (MW-hr)

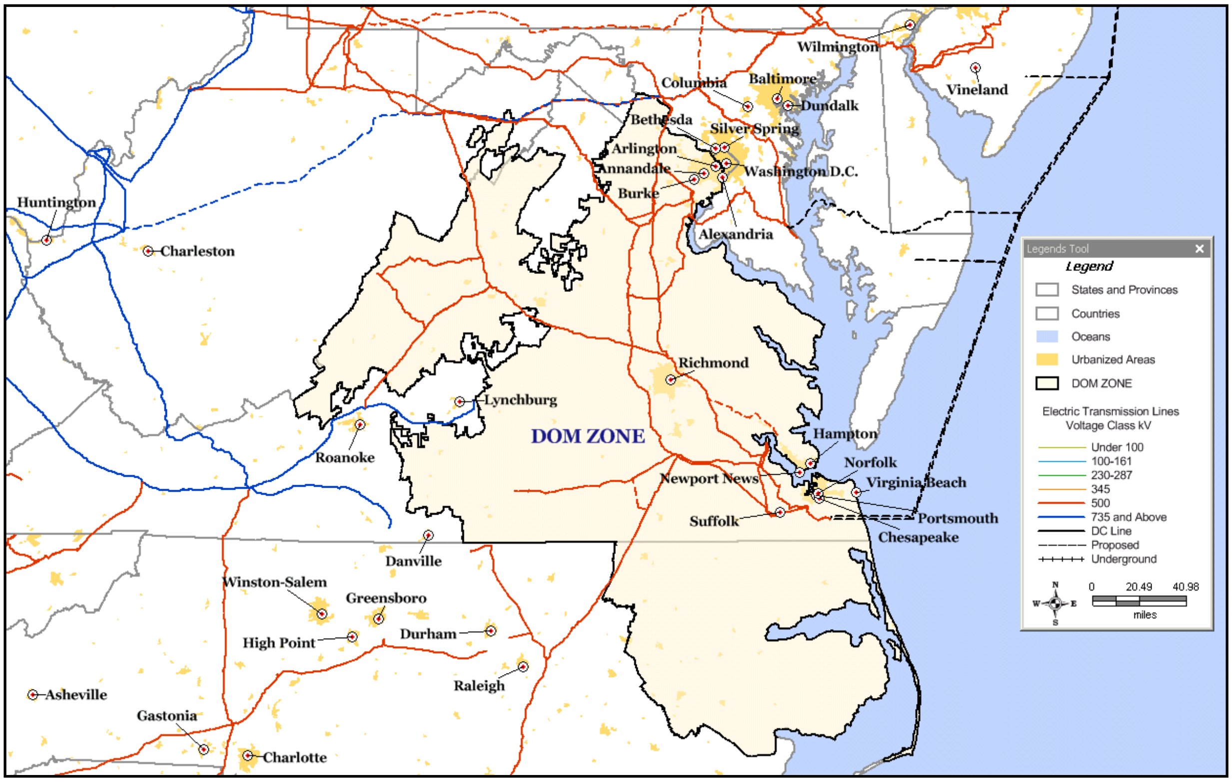
	State of VA				State of NC				Total Service Territory			
	Res	**Com**	**Ind**	**Total**	**Res**	**Com**	**Ind**	**Total**	**Res**	**Com**	**Ind**	**Total**
2007	14	158	15,072	34	16	54	26,116	36	14	151	16,247	34
2008	14	156	14,989	33	15	53	28,586	36	14	149	16,353	33
2009	14	155	13,692	32	16	54	25,366	34	14	148	14,878	32
2010	15	158	13,636	33	17	55	29,282	36	15	151	15,200	33
2011	14	156	13,158	32	16	53	30,521	35	14	149	14,878	32

% of Total MW-hr by Rate Class

	State of VA				State of NC				Total Service Territory			
	Res	**Com**	**Ind**	**Total**	**Res**	**Com**	**Ind**	**Total**	**Res**	**Com**	**Ind**	**Total**
2007	38%	51%	11%	100%	37%	22%	40%	100%	38%	49%	13%	100%
2008	38%	51%	11%	100%	37%	23%	41%	100%	38%	50%	12%	100%
2009	39%	52%	10%	100%	39%	24%	37%	100%	39%	50%	11%	100%
2010	40%	51%	9%	100%	40%	22%	38%	100%	40%	49%	11%	100%
2011	39%	52%	9%	100%	39%	22%	39%	100%	39%	51%	10%	100%

(Source: EIA-861 Database)

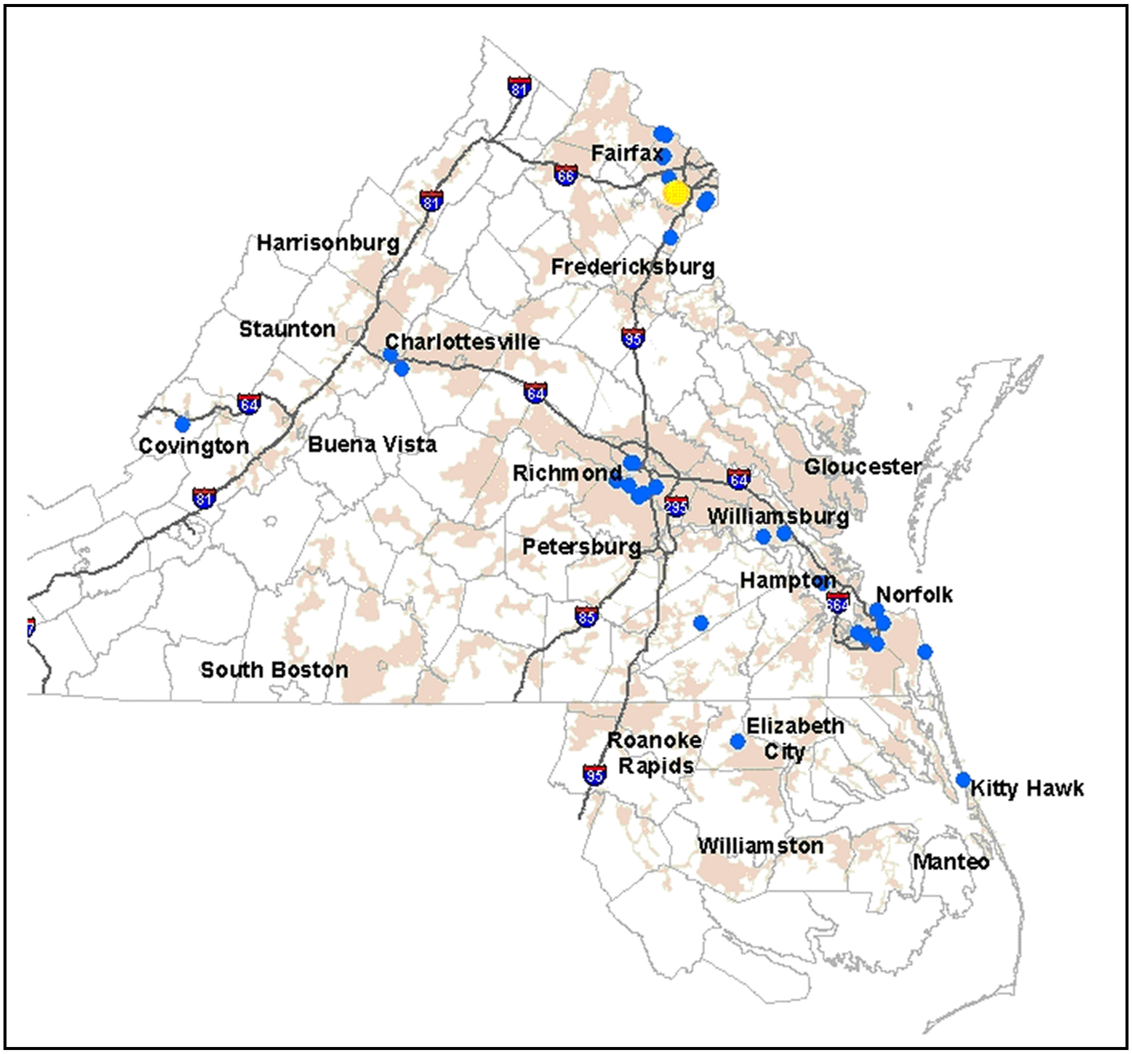
Figure 8.1-1 Map of Major Transmission Lines into Dominion Zone



Source: Energy Velocity

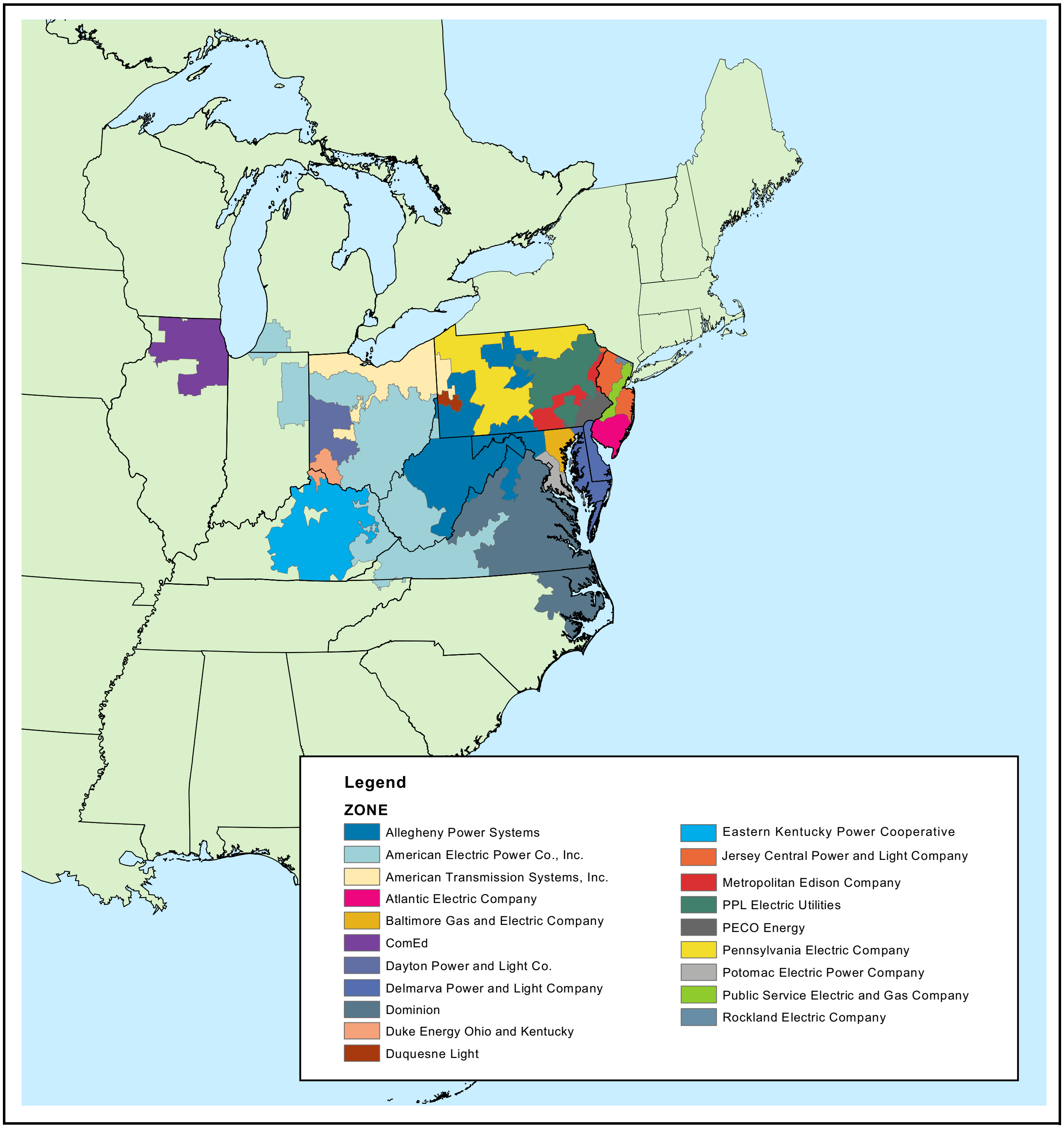
Figure 8.1-2 Deleted

Figure 8.1-3 Map of DVP's Electric Service Territory



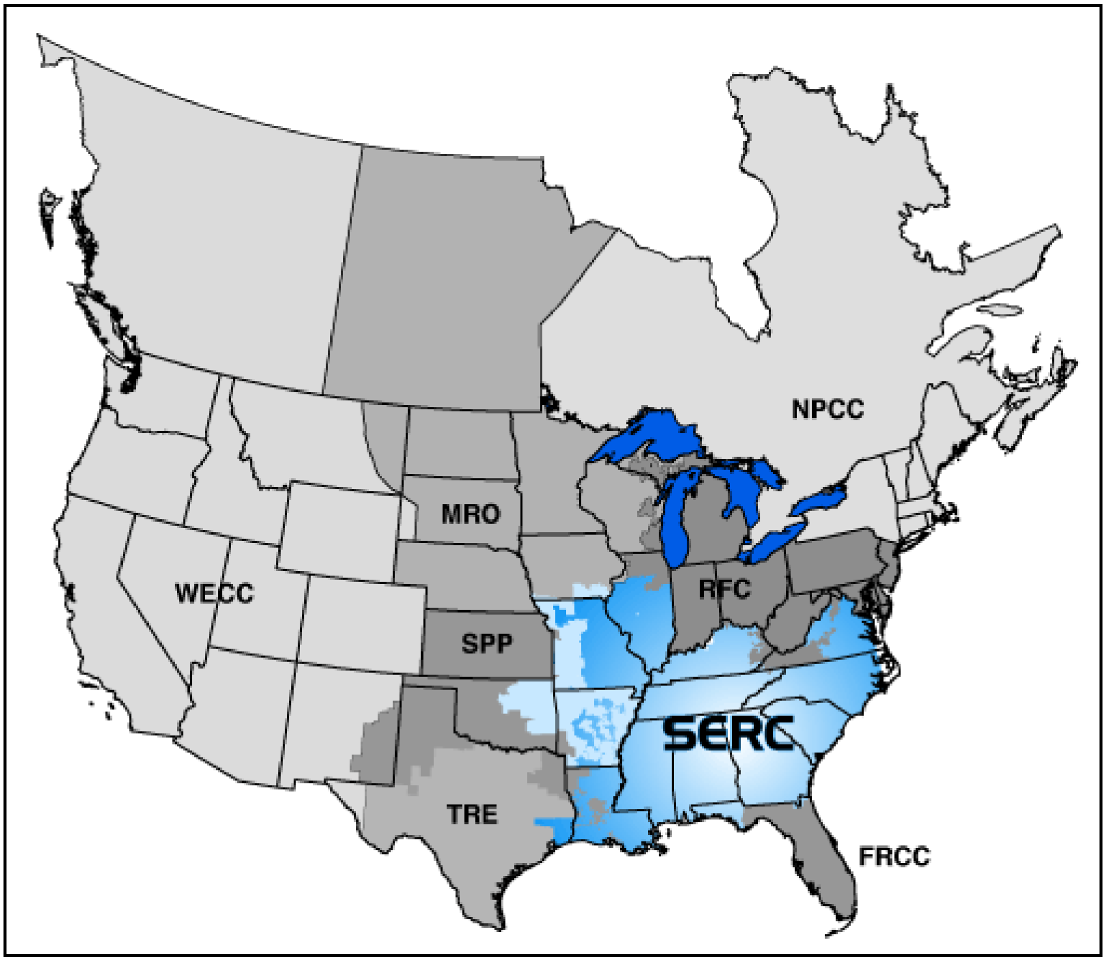
Source: www.dom.com

Figure 8.1-4 PJM RTO Map



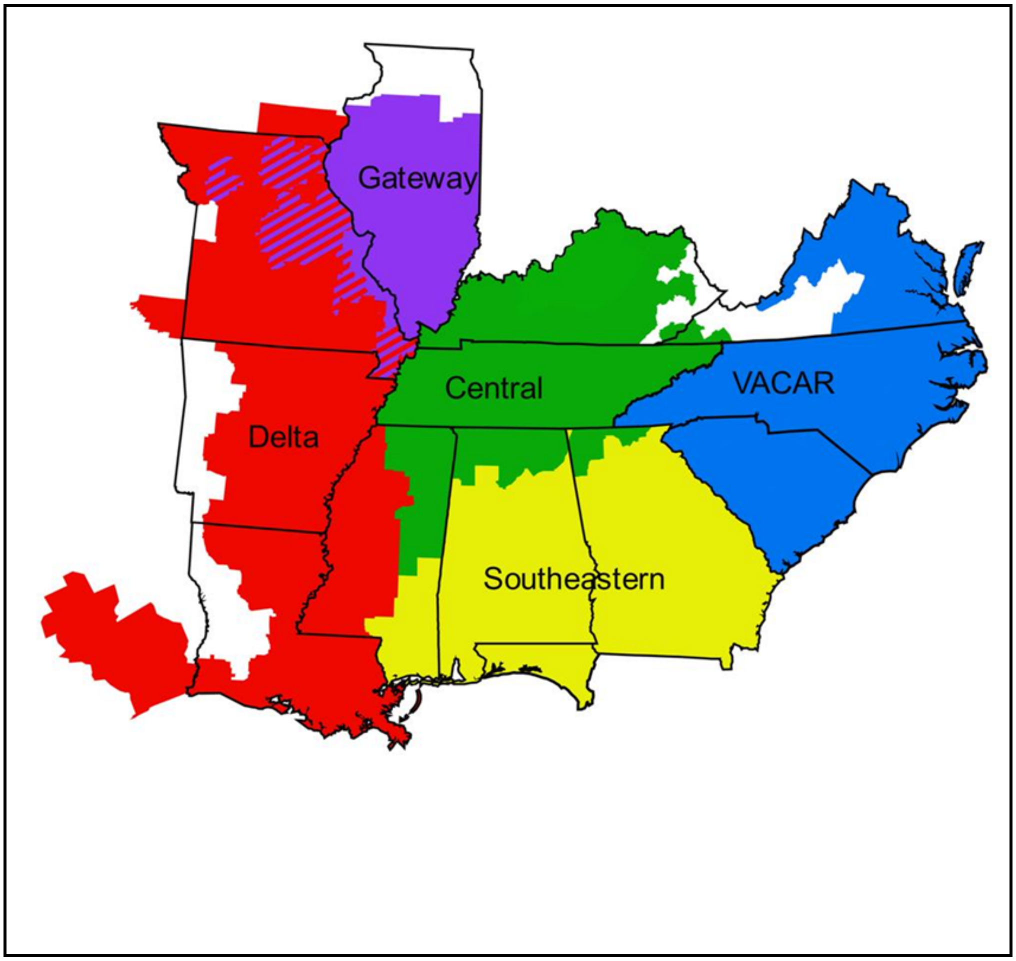
Source: www.pjm.com

Figure 8.1-5 SERC Region



Source: www.serc1.org/Images/USCanMap500x500.gif

Figure 8.1-6 VACAR Sub-Region



Source: http://www.serc1.org

8.2 Power Demand

8.2.1 Power and Energy Requirements

8.2.1.1 Load Forecast

Under the PJM RAA approved by FERC (Reference 1), PJM is responsible for producing a load forecast that is the basis for determining "capacity obligations" for each LSE.[1] Each LSE is required to procure enough capacity, or generation capability, to satisfy its load obligation (with reserve margin). As described below, the PJM load forecast process is systematic, comprehensive, subject to confirmation, and responsive to forecasting uncertainty. Thus, as allowed by NRC's Environmental Standard Review Plan (ESRP), PJM's load forecast is used as the "demand" component of the need for power evaluation.

PJM produces a systematic load forecast every year for a 15-year planning horizon. The 2013 PJM Load Forecast for the Dominion Zone is presented in Table 8.2-1. The forecast represents summer peak load estimates under normal peak weather conditions in the absence of any load reductions due to active load management, voltage reductions or voluntary curtailments. Traditionally, the Dominion Zone is "summer-peaking", i.e., the absolute peak load for the entire year occurs during the summer months. Capacity obligations of each LSE in PJM are determined for the RPM capacity market based on summer peak load. Thus, for reliability planning purposes, the summer peak load forecast is used to evaluate the region's generation adequacy.

According to PJM's 2013 Load Forecast Report (Reference 3), summer peak load growth for the PJM RTO is projected to average 1.3 percent per year over the next 10 years, and 1.2 percent over the next 15 years. Annualized 10-year growth rates for individual zones range from 0.6 percent to 1.9 percent. For the Dominion Zone peak load will increase from 19,619 MW in 2013 to 25,107 MW in 2028, an increase of 5488 MW at a compound average annual growth rate of 1.7 percent. PJM predicts that demand growth in the Dominion Zone will exceed growth rates in all PJM geographic zones except the Pennsylvania Electric Company (PENELEC) zone. For the Dominion Zone, the energy requirement will increase from 97,454 GWh in 2013 to 126,950 GWh in 2028, an increase of 29,496 GWh at a compound average annual growth rate of 1.8 percent. PJM predicts that demand in the Dominion Zone will grow at the second fastest rate in all of the PJM zones.

8.2.1.2 PJM Load Forecast

The PJM demand forecast satisfies the NRC's evaluation criteria of being: 1) systematic; 2) comprehensive; 3) subject to confirmation; 4) and responsive to forecast uncertainty. The basis of this assessment is presented below.

1. Under this RAA, PJM is authorized to guide the reliability planning process in accordance with the reliability principles and standards of other organizations such as the NERC.

8.2.1.2.1 Systematic Process

PJM has a systematic process for load forecasting. The forecast was developed using accepted techniques and employs a wide range of explanatory variables. The PJM load forecasts are based on a multiple variable Ordinary Least Squares regression using economic and calendar variables for each of the 26 LDAs in PJM. Manual 19 provides an overview of the load forecasting process (Reference 2):

> The PJM Load Forecast Model produces 15-year monthly forecasts of unrestricted peaks assuming a range of weather conditions for each PJM zone, load deliverability area and the RTO. The model uses anticipated economic growth and historical weather patterns to estimate growth in peak load and energy use. It is used to set the peak loads for capacity obligations, for reliability studies, and to support the Regional Transmission Expansion Plan. Net energy forecasts are used in reporting requirements of FERC and NERC, and for market efficiency studies.

The regressions are specified using zonal metered load data which are adjusted to account for estimated load reductions for recognized demand management efforts. The actual loads used in the regressions are the maximum value for each day, adjusted to reflect unrestricted (before the impact of load management) loads. Calendar effects are then captured by specifying the days of the week, month of the year, holidays, hours of daylight and Daylight Savings Time. Holiday seasonal lighting load is reflected using a trend variable. Weather is reflected in the models as Temperature-Humidity Index and heating and cooling degree-days.[1] Measures of economic and demographic activity are included in the forecast model, representing total U.S., state, or metropolitan areas, depending upon their predictive value. The original economic model specification was based on the U.S. Gross Domestic Product. This specification was updated to reflect Gross State Product and Gross Metropolitan Area Product (Richmond, Virginia Beach and Roanoke for the Dominion Zone model) for Metropolitan Statistical Areas. PJM's Manual 19 provides a detailed description of the load forecasting methodology.

To reflect the variability of weather conditions, for each PJM zone, a distribution of non-coincident peak (NCP) forecasts is produced using a Monte Carlo simulation process. The weather distributions are developed using observed historical weather data. The simulation process produces a distribution of monthly forecast results by selecting the 12 monthly peak values per forecast year for each weather scenario. For each year, by weather scenario, the maximum daily

1. THI = DB - 0.55 * (1 – HUM) * (DB – 58)
   Where: THI = Temperature humidity index;
   DB = Dry bulb temperature (°F);
   HUM = Relative Humidity (where 100% = 1).
   THI readings are divided into separate morning, afternoon, evening, and night effects, as well as weekends.

NCP load for a zone over each season is found. For each zone and year, a distribution of zonal NCP by weather scenario is developed. The median values are used as the base (50/50) forecast.

8.2.1.2.2 **Comprehensive**

PJM evaluated a comprehensive set of model parameters and model specifications. The PJM NCP model specification consists of over 50 independent variables which were reviewed above. In PJM's forecasting approach, while the parameter estimates do not vary by month, they do vary across the 20 electric distribution company zones.

A range of different model specifications were evaluated and the preferred specification selected based on its superior performance according to accepted statistical techniques. Specifically, the preferred model specification was chosen based on model backcasting performance after reviewing several alternative specifications. The PJM Load/Energy Forecasting Model White Paper (White Paper) serves as documentation of the implemented peak and energy forecast models as well as other methods and specifications that were tested, but not adopted.

8.2.1.2.3 **Subject to Confirmation**

The PJM load forecast and the forecast results are subject to confirmation by multiple parties. The load forecast is a critical element of the process that is used to establish the capacity obligations of each LSE, which represent significant financial obligations. Thus, the load forecast receives considerable scrutiny from PJM members to ensure that it represents a reliable estimate of future peak loads and basis upon which to evaluate future capacity requirements. The load forecast must meet the forecasting standards of the Reliability Assurance Agreement and PJM Manual 19: Load Data Systems. The Load Analysis Subcommittee (LAS) is organized as a member oversight group that monitors each load forecast produced by PJM.

Under PJM Manual 19, the PJM Load Forecast is reviewed by the LAS, and presented to the Planning Committee for endorsement. Final approval is received from the PJM Board of Managers. A member of the Planning Committee may submit an appeal (detailing the issue and outlining a solution) for a review of part of or all the forecast, which will be forwarded by the Chair of the Planning Committee to PJM, upon a vote of the Committee. The LAS is comprised of representatives from electrical distribution companies that are members of PJM.

In 2006, PJM load forecast was independently confirmed by the Brattle Group, who were engaged by PJM to provide an independent assessment of PJM's load forecast. (Reference 3) PJM was prompted to conduct this independent evaluation of the model because, among other issues, the 2006 peak load forecast understated the actual peak by 9.36 percent. Weather conditions for the summer 2006 peak were extreme and when the PJM load forecast was re-simulated using those actual weather and economic conditions, the forecast error was only 0.7 percent. The Brattle Group concluded that "the model is doing a good job of forecasting peak demand and the main source of error is weather." (Reference 4)

Additionally, Itron was retained by PJM in 2011 to enhance the accuracy of the existing model by including an index variable. The index variable was developed to remove forecast swings associated with variability in a single economic variable (previously GMP). The index includes other demographic variables that are more stationary and also weights class level sales. The result is expected to be a more consistent forecast from year to year.

8.2.1.2.4 **Responsive to Forecast Uncertainty**

The predictive capability of the PJM load forecast for the Dominion Zone is indicated by its adjusted R-Squared of 0.961, indicating the over 96 percent of the dependent variable's (i.e., load) variance from the mean is explained by the regression's independent variables and specified parameter estimates. (Reference 3)

The Brattle Group review of the peak demand forecast methodology indicates that the primary source of forecast error and uncertainty are weather conditions. PJM addressed the forecast uncertainty associated with weather through the use of a Monte Carlo simulation based on actual weather conditions. As such the forecast methodology and forecast results adequately account for forecast uncertainty.

8.2.2 **Factors Affecting Growth of Demand**

This section reviews the factors that affect growth in power demand in the Dominion Zone, including a discussion of the potential impacts of demand side management (DSM) programs on load growth in the Dominion Zone.

8.2.2.1 **Economic and Demographic Trends**

Section 8.2.1.2 discusses inputs to PJM's load forecast model, which include factors that affect load growth. Specifically, in the PJM load forecast model, calendar effects are captured by specifying the days of the week, month of the year, holidays, hours of daylight and Daylight Savings Time. Holiday seasonal lighting load is reflected using a trend variable. Weather is reflected in the models as Temperature-Humidity Index and heating and cooling degree-days. PJM's Manual 19 provides a detailed description of load forecasting methodology. Measures of economic and demographic activity are included in the forecast model, representing total U.S., state, or metropolitan areas, depending upon their predictive value. The original economic model specification was based on the U.S. Gross Domestic Product. This specification was updated to reflect Gross State Product and Gross Metropolitan Area Product (Richmond, Virginia Beach and Roanoke for the Dominion Zone model) for Metropolitan Statistical Areas. See Figure 8.2-1. (Reference 6)

According to PJM's 2013 Load Forecast Report, the summer peak load for the Dominion Zone will increase from 19,619 MW in 2013 to 23,558 MW in 2023, an increase of 3,939 MW at a compound annual growth rate of 1.8 percent. (Reference 3)

PJM has also recognized the significant economic growth potential in Virginia, stating in their Load Forecast Report from January 2013 (Reference 3):

> The southernmost metro areas are expected to be among the fastest growing in the PJM service territory…Virginia metro areas, including Lynchburg and Richmond, as well as Wilmington DE and Bowling Green, KY, are expected to lead with average annual GDP growth of 2.4 percent or more. Aside from favorable demographics, these metro areas will be driven by highly educated labor forces, productivity growth, and relatively low costs.

As discussed previously in Section 8.1.3, DVP estimates the population growth in the counties in its Virginia and North Carolina service territories since 2007 at about 1.2 percent–1.9 percent per annum and 0.1 percent–4.0 percent per annum, respectively. DVP expects significant growth in baseload requirements through new customer additions, which DVP estimates at approximately 35,000 to 40,000 new customer connections each year and data center growth of 455 MWs from 2013 to 2017. (Reference 5)

8.2.2.2 Energy Efficiency, Conservation and DSM

Electricity demand can also be influenced by DSM programs which are essentially interventions in the market to promote the adoption of more efficient end-uses and to change consumer behavior. This section evaluates the potential impact of such programs on demand growth. Because this analysis is for Unit 3, which would provide baseload power, the focus of the impact of DSM programs is on the impact of such DSM programs on energy requirements, rather than peak demand. In the context of DSM program design, the analysis of the effects is on conservation and energy efficiency programs that are targeted at reducing overall energy requirements rather than demand management programs that are focused on reducing peak demand.

8.2.2.2.1 Current DSM Programs in PJM

PJM has several programs that offer incentives to customers to reduce consumption during peak demand. For example, PJM's Emergency Load Response Program (Reference 8) is designed to encourage customers to reduce load during an emergency event in exchange for compensation from PJM. In addition, the Economic Load Response Program is designed to encourage customers to reduce load when Locational Marginal Prices are high, in exchange for compensation from PJM. These programs are established programs that have been in place since 2002. According to PJM, more than 6000 commercial and industrial facilities (with demand greater than 100 kW) and 45,000 small commercial and residential customers participate in demand response programs offered by PJM. (Reference 7) These programs focus on reducing peak demand and will have virtually no impact on baseload requirements.

8.2.2.2.2 Current DSM Programs in DVP's Service Territory

DVP offers several tariff-based DSM options for both residential and non-residential customers. DVP offers new residences in North Carolina that meet the Energy Star Home (ESH) Plus

Standards for energy efficiency a 5 percent conservation rate discount through its ESH Plus program. DVP also offers Time-of-Usage rate schedules to North Carolina residential customers through Schedule 1P and Schedule 1T and to Virginia residential customers through Schedule 1S and Schedule 1T. (Reference 12, Chapter 3.2) Examples of non-residential tariff-based DSM programs include the Schedule 10 – Large General Service, (Reference 10) which is designed to promote energy conservation on peak days through pricing. This schedule is applicable to customers in both Virginia and North Carolina service territories electing to receive 500 kW or more of Electricity Supply Service and Electric Delivery Service from the Company. For larger customers in North Carolina, with annual average demand of 5000 kW or more, DVP offers the Schedule 6VP - Large General Service, by which a customer's loads are categorized as baseload and peak load, with the prices applicable to peak loads varying by day according to day type. (Reference 12, Chapter 3.2) In addition, for up to 150 hours per year, a Capacity Surcharge rate is applicable to both the base and peak loads. Dominion Virginia Power notifies customers taking service under this schedule to curtail consumption during hours when peak loads are expected to be high, most often during the summer months. During the past two years, customer curtailments reduced load by an estimated 20–22 MW.

In addition to the tariff-based DSM options mentioned above, DVP also offers DSM education programs, which are designed to educate customers and promote energy efficiency and/or conservation. With the exception of education programs, which are focused on capital improvements, the typical DSM programs are designed to reduce consumption during times of peak demand and focus on reliability.

8.2.2.2.3 **Virginia DSM Programs**

As discussed in Section 8.1.3.1, Legislation was recently passed in Virginia that provides for investor-owned electric utilities to meet native load obligations. This Legislation also establishes a goal for the year 2022 of "reducing the consumption of electric energy by retail customers" in Virginia by ten percent of the electric energy consumed by retail customers in 2006. Furthermore, it directed the Virginia SCC to conduct a proceeding to:

> (i) determine whether the ten percent electric energy consumption reduction goal can be achieved cost-effectively through the operation of such programs, and if not, determine the appropriate goal for the year 2022 relative to base year of 2006; (ii) identify the mix of programs that should be implemented in the Commonwealth to cost-effectively achieve the defined electric energy consumption reduction goal by 2022, including but not limited to demand side management, conservation, energy efficiency, real time pricing and consumer education; (iii) develop a plan for the development and implementation of recommended programs, with incentives and alternative means of compliance to achieve such goals, (iv) determine the entity or entities that could most efficiently deploy and administer various

elements of the plan, and (v) estimate the cost of attaining the energy consumption reduction goal. (Reference 9)

The Legislation indicated that these programs may include activities by electric utilities, public or private organizations, or both electric utilities and public or private organizations. The Virginia SCC submitted its findings and recommendations to the Governor and General Assembly in December 2007. In response to this directive by the General Assembly, the Virginia SCC staff and interested parties (including DVP) worked to develop a long-term energy conservation plan (Reference 11) for Virginia.[1]

In July 2007, DVP announced that it had formed a conservation group "to encourage a renewed customer interest in energy efficiency." (Reference 14) The conservation "group will explore new technologies and techniques for residential and business customers to reduce their impact on the environment and help them reduce their demand for electricity."[2] DVP also has identified pilot programs, which are summarized below, to gauge customer interest in and response to certain conservation, energy efficiency, education, demand response, and load management initiatives in Virginia.

Currently, in the Company's Virginia service territory, there are three active Residential DSM Programs approved by the Virginia State Corporation Commission (SCC). These include the Air Conditioner Cycling, Low Income, and Residential Bundle Programs, which is comprised of four programs: Home Energy Check-Up, Duct Testing & Sealing, Heat Pump Tune-Up and Heat Pump Upgrade Programs. In addition, there are three active SCC approved DSM Commercial Programs in Virginia. These include the Commercial Energy Audit, Distributed Generation, and Commercial Duct Testing & Sealing Programs. (Reference 12)

8.2.2.2.4 DVP's Pilot DSM Programs

On September 18, 2007, the Company filed with the SCC for approval of nine conservation, energy efficiency, education, demand response, and load management Pilots. The SCC issued a Final Order on January 17, 2008, that approved the Pilots finding that they were necessary to gather information to help the Commonwealth determine methods to achieve the legislative goal affirmed by the Virginia Energy Plan of reducing energy demand by 10 percent (using 2006 as the base year) by 2022, an approximate 6,170 gigawatt-hour (GWh) reduction. The Pilots were designed not only to reduce sales and peak demand, but to gain valuable operational information and data on customer usage and customer acceptance of DSM programs. The nine approved Pilots included:

1. Direct Load Control - Outdoor Air-Conditioning Control Device Pilot

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1. This long-term energy conservation plan is a separate procedure from the development of the Virginia Energy Plan discussed earlier, which was released September 12, 2007, through the Commonwealth of Virginia Department of Mines, Minerals and Energy (see Section 8.2.2.2.5).
2. Ibid.

2. Programmable Thermostats - Indoor Air-Conditioning Control Device Pilot
3. Programmable Thermostats with Advanced Metering Infrastructure and Critical Peak Pricing Pilot
4. Standard Residential In-Home Energy Audits Pilot
5. ENERGY STAR® Qualified Homes Energy Audits Pilot
6. Energy Efficiency Welcome Kits Pilot
7. PowerCost™ Monitor Pilot
8. Small Commercial On-Site Energy Audits Pilot
9. Distributed Generation ("DG") Pilot Program

In March 2009, the Company filed with the SCC its Final Quarterly Report on the status of the Pilots (Case No. PUE-2007-00089). Since that SCC filing, the Company has filed four follow-up or quarterly reports regarding the status of its Pilots. The Company ended its DG Pilot since its request for approval of the Commercial DG Program was approved by the SCC in Case No. PUE-2011-00093.

The Company is also implementing an Advanced Metering Infrastructure Demonstration.

8.2.2.2.5 **Virginia Target DSM Goals**

As previously noted, the Legislation set the goal to reduce 2022 electric use by 10 percent of 2006 retail consumption through a mix of conservation, energy efficiency, load management, and DSM programs. This same goal was considered by the ten-year comprehensive Virginia Energy Plan (Virginia Energy Plan),[1] issued by the Commonwealth of Virginia Department of Mines, Minerals and Energy on September 12, 2007. The Virginia Energy Plan refers to calculations based on studies in other states that show that Virginia, with a concerted investment in energy efficiency and conservation activities, has an achievable cost-effective electric energy reduction potential of 14 percent over the next ten years. The achievable cost-effective potential is defined as "the potential for a realistic penetration of energy-efficient measures based on a cost-effectiveness evaluation. High levels of support are required, but measured results should exceed associated program costs."[2] The Virginia Energy Plan acknowledges that meeting the achievable cost-effective potential of 14 percent would require a combination of government, utility, non-profit, industry, and business efforts. The plan ultimately calls for a 10 percent reduction goal, which is consistent with the Legislation target, to provide a measure of conservatism. The Virginia Energy Plan acknowledges that Virginia has no established funding source for energy-efficiency and

1. Senate Bill 262 (2006), Virginia Energy Plan Va. Code sec. 67-100 et. seq. (Reference 14).
2. Ibid at 63.

conservation programs and that most states with a successful history of efficiency programs provide significant funding resources. The plan also acknowledges "substantial up-front investment" would be required to achieve the 10 percent reduction goal and estimates "that utilities and consumers together would have to invest an average of approximately $300 million per year over the fifteen-year life of the program ($100 to $120 million by electric utilities, matched by $180 to $200 million by consumers)."[1]

8.2.2.2.6 Challenges to Adoption of Energy Conservation Measures

Experience reveals that while a DSM measure may offer lower life cycle costs, capital improvements are generally not implemented by residential, commercial, and industrial consumers, because of long payback periods. Large government complexes are the exception, because they are more willing to accept payback periods of up to 20 years or longer; however, the majority of those opportunities have been explored and implemented, where they meet the requirements of the government programs. As such, there is little opportunity to increase participation in capital intensive DSM programs until the cost of power increases significantly to shorten expected payback periods. An analyst presentation on DSM portfolio development for the City of Tallahassee estimated DSM market penetration for various payback periods. (Reference 13) As shown in Figure 8.2-2, payback periods accepted by customers typically range from 1 to 3 years. This period could be significantly shorter for large industrial customers. The Company utilizes ICF International, Inc. (ICF) to assist in developing its DSM Portfolio and uses a similar payback acceptance curve in its development of DSM Programs.

In addition to long payback periods, many consumers do not implement higher efficiency measures because of:

1. a higher first cost (i.e., initial capital cost);
2. limited capital availability for such higher efficiency measures (e.g., for institutional customers such as governments, budgeting processes make it difficult to purchase replacement equipment even when the electricity cost savings can justify the investment given capital budget limits;[2]
3. concerns about its performance (i.e., service quality as well as the consumer's ability to realize the promised level of savings);
4. lack of credible or reliable information regarding the new product or service which makes it harder to assess the tradeoff between higher first cost and lower operating costs;[3]

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1. Ibid at 66.
2. Energy users appear to discount future savings at rates well in excess of market rates for borrowing or saving (see Reference 15).

5. the cost and level of effort required to become informed regarding the performance characteristics of the new appliance or service (i.e., high "transaction costs");

6. lack of required support infrastructure (e.g., trade allies) to install and service the more efficient device;

7. split incentives where the party making the efficiency decision based on the initial capital outlay is different than the party that is responsible for paying for its operating costs over the life of the investment;[1] and

8. limited attention paid to decisions to implement (purchase or replace) such a measure given the small role energy plays in the total budget.

Based on the above, there is a risk that the Legislation's 10 percent target for potential energy savings does not adequately reflect the impact of the challenges to the adoption of more efficient appliances or end-use equipment by customers or the need for other initiatives such as potential changes to building codes. Thus, the 10 percent reduction supported by the Legislation and the 14 percent potential savings noted in the Virginia Energy Plan are targets that remain uncertain. Moreover, given that many energy conservation and DSM measures affect peak load demand, these reductions likely would have little, if any, impact on DVP's ever-growing need for additional baseload resources. Even if these conservation and DSM measures are assumed to reduce baseload demand, as shown in Section 8.4.1, Unit 3 is still necessary to meet the growth in baseload demand.

Section 8.2 References

1. PJM Interconnection, LLC, "Reliability Assurance Agreement Among Load Serving Entities in the PJM Region," report, January 4, 2013.

2. PJM Interconnection, LLC, "PJM Manual 19: Load Data Systems," Revision 22, report February 28, 2013.

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3. This is characterized by economists as "imperfect information". Another example of imperfect information would be future electricity prices which will determine the value of the energy savings. Behavioral research indicates that when consumers are faced with imperfect information and uncertainty consumers are more reluctant to make decisions. This is critical because many of the DSM measures that produce this savings estimate require consumers to make investment decisions to replace existing appliances with new, more efficient appliances or to purchase a new type of appliance with which they have no experience (e.g., ground source heat pump).
1. This is typical in many real estate transactions where residential builders or commercial real estate developers are most concerned with the construction costs of the facility and where the eventual occupant pays the operating costs. Given that the anticipated electricity bills for the property are typically a minor consideration in the purchase or rental decision, buyers and renters give limited consideration to the relative electricity costs.

3. PJM Interconnection, LLC, "PJM Load Forecast Report," report, January, 2013.

4. The Brattle Group, "An Evaluation of PJM's Peak Demand Forecasting Process," December 5, 2006.

5. Dominion, "Investor and Analyst Meeting Presentation," March 4, 2013.

6. U.S. Department of Commerce, Bureau of Economic Analysis website, June 2013.

7. PJM Interconnection (PJM) website, "2012 State of the Market Report for PJM," Section 5: Demand Response, March 14, 2013.

8. PJM Interconnection (PJM), "PJM Emergency Load Response Program" report, October 20, 2011.

9. Virginia Legislature, House Bill 3068, Senate Bill 1416, Acts of Assembly Chapters 888 and 933, 2007.

10. Virginia Electric and Power Company, "Schedule 10, Large General Service," report, November 2, 2012.

11. Commonwealth of Virginia, Department of Mines, Minerals and Energy website, "2010 The Virginia Energy Plan," July 1, 2010.

12. Dominion, "Dominion North Carolina Power's and Dominion Virginia Power's Report of Its Integrated Resource Plan", August 31, 2012.

13. Gary Brinkworth and Steve Hastie, Presentation to FEC Advisory Group, DSM Portfolio Development, City of Tallahassee Integrated Resource Planning Study, July 27, 2007.

14. Dominion Electric News Release, "Dominion Virginia Power Announces Energy Conservation Efforts," July 13, 2007.

15. Marbek Resource Consultants Ltd. and M.K. Jaccard and Associates, Inc., "Demand Side Management Potential In Canada: Energy Efficiency Study", May 2006.

Table 8.2-1 Dominion Zone - Summer Peak Loads (MW) and Growth Rates

	MW	Growth %
2013	19,619	1.5
2014	20,154	2.7
2015	20,747	2.9
2016	21,228	2.3
2017	21,604	1.8
2018	21,919	1.5
2019	22,262	1.6
2020	22,614	1.6
2021	22,931	1.4
2022	23,232	1.3
2023	23,558	1.4
2024	23,856	1.3
2025	24,201	1.4
2026	24,518	1.3
2027	24,781	1.1
2028	25,107	1.3
Average Annual Growth Rate (10-Year)		1.8
Average Annual Growth Rate (15-Year)		1.7

Figure 8.2-1 Industrial Structure of the Gross State Product, 2011

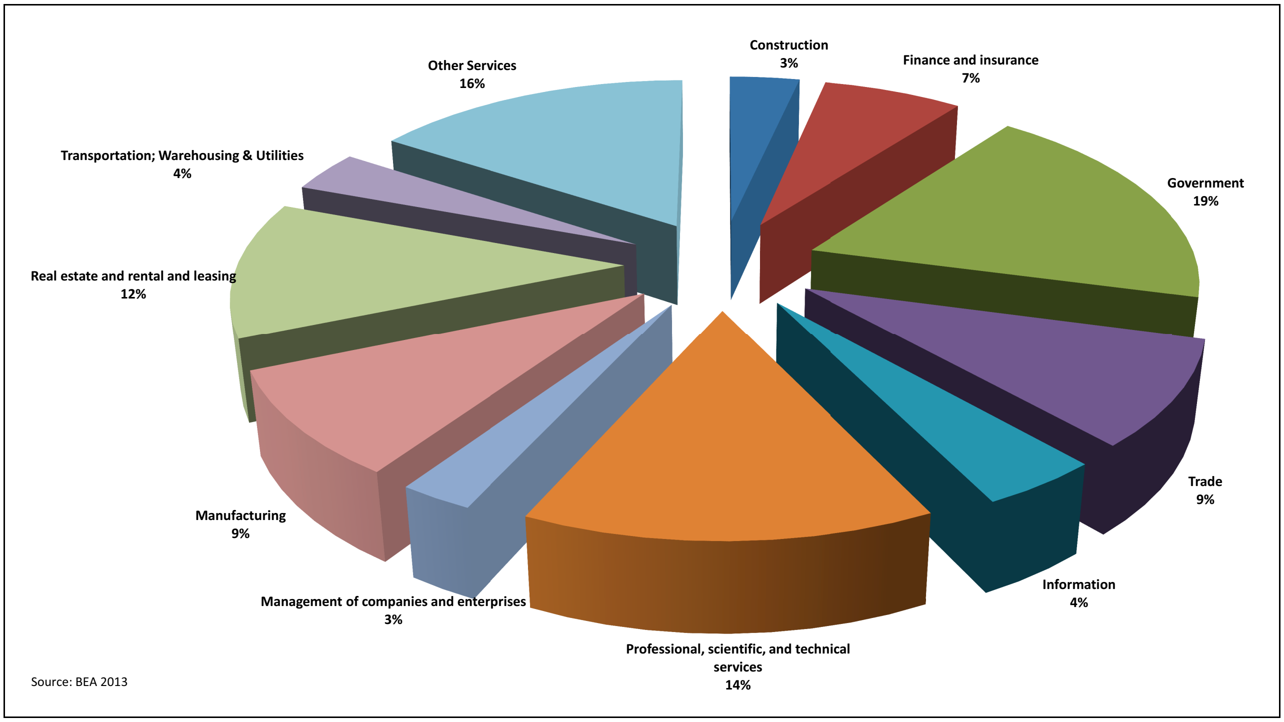
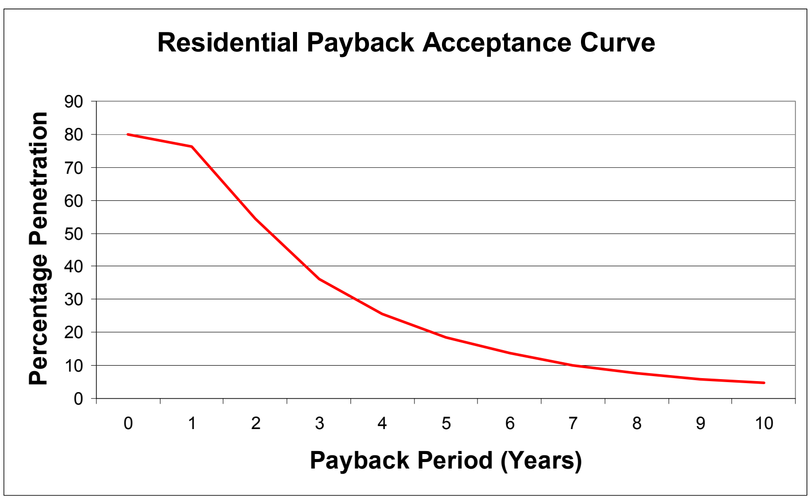


Figure 8.2-2 Residential Payback Acceptance Curve



Source: Gary Brinkworth and Steve Hastie, Presentation to FEC Advisory Group, DSM Portfolio Development, City of Tallahassee Integrated Resource Planning Study, July 27, 2007

8.3 Power Supply

This section reviews the present and planned generating capability within the Dominion Zone and the present and planned purchases and sales of power and energy.

8.3.1 Existing and Planned Generating Capacity in PJM Dominion Zone

8.3.1.1 Existing Generating Capacity

PJM periodically publishes information regarding generating unit ratings most recently in its "2010 PJM EIA-411 Report." (Reference 8) These reports contain PJM's published assessment of each utility system's installed capacity. PJM uses the term "rating" synonymously with installed capacity, and these values are the basis for the following regional capability analysis.

The generating units located within the Dominion Zone currently total summer and winter capacity of 23,993 MW and 24,819 MW, respectively. (Reference 8) As shown in Figure 8.3-1, oil and/or gas-fired units make up approximately 41 percent, while coal-fired and nuclear units account for approximately 28 percent and 15 percent of summer capacity, respectively.

8.3.1.1.1 Baseload, Intermediate, and Peaking Capacity

Each of the different technology types listed in Figure 8.3-1 has different performance characteristics, capital costs, and operation and maintenance costs. The generating units with the least expensive variable costs (e.g., nuclear and coal units), operate almost continuously to meet the minimum level of electricity that is demanded by a system, (i.e., the baseload). While hydro and wind are also used to meet demand, these technology types are considered intermittent capacity resources as their operation capability depends on such factors as water flow and wind speeds, respectively.

For purposes of this analysis, baseload capacity is defined to include units with a capacity factor of 65 percent or greater. This baseload capacity factor assumption is consistent with the baseload definitions assumed by the Edison Electric Institute (EEI) and California Senate Bill 1368. (Reference 2) Baseload capacity includes nuclear, coal, biomass, and hydro units.

During peak demand periods when consumers demand more electricity, the generating units with higher variable fuel costs (typically oil or natural gas) and the operational capability to quickly start are called upon by the PJM RTO to meet the peak load. "Peaking capacity," while expensive to operate, is relatively less expensive to construct. For purposes of this analysis, peak capacity is defined to include units with a capacity factor of 30 percent or less; this definition of a peaking resource is consistent with methods utilized by market participants (e.g., Calpine), and power pool market administrators (e.g., Ontario Independent Electricity System Operator). (Reference 1 and Reference 6) Given the assumed capacity factor ranges for baseload and peaking capacity, it follows that intermediate capacity includes units with a capacity factor that falls within a range of 30 percent to 65 percent. Based on the 2012 IRP, DVP's current and future Combined Cycle units, on average, which have been operating at considerably higher capacity factors than in the past, are projected to operate at capacity factors below 65 percent, thus they should not be considered baseload units.

Figure 8.3-2 is an illustrative representation of the Dominion Zone's 2012 historical load duration curve and its fit against the current installed capacity in the Dominion Zone. While the 65th percentile hour load is not exactly equal to the amount of required installed baseload capacity, it is a reasonable proxy for baseload capacity requirements after reducing capacity supply by assumed availability rates. Figure 8.3-2 includes the installed capacity listed in Figure 8.3-1 adjusted for assumed unit availability rates presented in Table 8.3-1.

As shown in Figure 8.3-2, baseload capacity in the Dominion Zone is composed predominately of nuclear and coal-fired units. Intermediate capacity is composed of gas-fired combined cycle units, while peaking capacity is composed predominantly of pumped storage, oil and gas-fired units.

To estimate the unit availability rates shown above for hydroelectric and nuclear sources, historical state level generation and capacity data published by the EIA were reviewed. As previously noted, nuclear units in Virginia on average operated with a 90 percent capacity factor over the three year period from 2009 to 2011, while hydroelectric units operated with a 20 percent average capacity factor in this timeframe.

Availability rates for all technology types shown in Table 8.3-1 were assumed to be equal to 1 minus the five-year average Equivalent Forced Outage Rate (EFORd) minus Planned Outage Rate as published by NERC in its "2006-2010 Generating Unit Statistical Brochure." (Reference 10)

8.3.1.1.2 **Recently Constructed Generating Capacity**

In 2012, DVP completed VCHEC, which is a 585 MW coal facility located in Virginia City, Virginia. DVP also completed uprates totaling 126 MW to the existing North Anna and Surry power plants, and 31 MW of uprates to Mt. Storm, and 16 MW at Chesterfield Power Station, in addition to combined cycles and combustion turbines that have been added since 2003, which are generally more suitable in the long term as cycling or mid-range resources. As shown in Section 8.4, additional baseload capacity is needed to meet growing baseload requirements in the Dominion Zone.

As shown in Table 8.3-3, 20 generating units have been built and placed into commercial operation within the Dominion Zone since 2003, totaling 3564 MW of summer capacity. These recent capacity additions have been predominantly gas-fired. Specifically, over 99 percent of these recent capacity additions are from gas-fired units of which 40 percent are peaking simple-cycle combustion turbines and 58 percent are combined-cycles.

This recent trend of predominantly gas-fired capacity additions in the Dominion Zone is expected to continue based on analysis of the PJM Generation Interconnection Queue.

8.3.1.2 **Planned Generating Capacity**

One of PJM's primary roles is the oversight of the reliability planning process. (Reference 9) PJM manages incremental generation capacity development through the Generation Interconnection Queue, which is part of a larger RTEP. Developers wishing to provide new incremental generation capacity must file an interconnection request and enter into PJM's queue-based, 3-study interconnection process, which offers developers the flexibility to consider and explore their respective generation interconnection business opportunities. While a developer can withdraw a project from the Generation Interconnection Queue at any point, the process is structured such that each step imposes its own increasing financial obligations on the developer. (Reference 14) While not all projects in the Generation Interconnection Queue are expected to be built, the Generation Interconnection Queue does provide an authoritative source for future generation investment trends in the PJM RTO.

Table 8.3-4 lists the individual generation interconnection requests for projects located in the Dominion Zone that are currently active in the PJM Generation Interconnection Queues as of May 2013.

Analysis of the individual generation interconnection requests listed in Table 8.3-4 reveals 27 active generating interconnection requests in the Dominion Zone totaling 5,896 MW from primarily natural gas fuel sources. Again, not all of these projects currently under-study are expected to be built. According to the 2012 PJM Reserve Requirement Study, the commercial probability of a unit coming into service is between 12 and 66 percent. (Reference 17)

Excluding the proposed Unit 3, there are currently only 161 MW of other baseload capacity projects listed in the interconnection queue. Unit 3 is the only baseload capacity project currently listed in the Generation Interconnection Queue for the Dominion Zone that is over 100 MW.

The pumped storage and conventional hydro projects listed in the interconnection queue primarily represent improvements to existing generating facilities, rather than new facilities. (Reference 14)

Figure 8.3-3 shows Wind-Powered Generation in PJM as of 2012. Wind-powered generation projects require geographic areas with favorable wind characteristics such as speed, duration, and frequency of occurrence. See Section 9.2.2.1.1 for a discussion of the feasibility of wind-powered generation projects in the Dominion Zone.

8.3.1.3 **Renewable Portfolio Standards**

Both Virginia and North Carolina have adopted Renewable Portfolio Standards (RPS), but with different goals or requirements and RPS targets as described in more detail below. Based on EIA state-wide generation by fuel source data and EIA's own definition of renewable resources, which may or may not agree with Virginia and North Carolina's RPS definitions for qualifying renewable resources, excluding hydroelectric projects, currently supply about 3.2 percent and 1.4 percent of the net generation produced state-wide in Virginia and North Carolina, respectively. (Reference 5)

While the development of new renewable sources may increase, most new renewable sources alone are unlikely to replace the need for additional baseload generation, because most renewable projects fit into one of the following categories: 1) utility-scale facilities (over 100 MW) such as wind, solar, or hydro that have capacity factors of between 20 percent and 40 percent and are recognized by PJM as being intermittent generation resources, or 2) smaller facilities (<10 MW) with capacity factors greater than 65 percent but are limited by available viable sites and therefore cannot, on their own, meet the projected growth rate for baseload electricity demand in the Dominion Zone. As discussed in Section 9.2.2.1, while DVP plans to undertake all commercially reasonable efforts to meet renewable portfolio standards and emerging state initiatives, renewable resources are not of the scale or type needed to provide power to meet the baseload needs of the Dominion Zone.

Virginia enacted a voluntary renewable energy portfolio goal as part of the 2007 Legislation. Under the RPS goal, investor-owned utilities are encouraged to produce or procure, by 2022, 12 percent of the amount of electricity sold in 2007 (the "base year") from eligible renewable sources, and the Legislation provides for recovery of certain incremental costs by a utility participating in such a program. The following schedule of intermediate RPS goals was adopted. (Reference 3)

- RPS Goal I: 4 percent of base year sales in 2010
- RPS Goal II: Average of 4 percent of base year sales in 2011 through 2015, and 7 percent of base year sales in 2016
- RPS Goal III: Average of 7 percent of base year sales in 2017 through 2021, and 12 percent of base year sales in 2022[1]

North Carolina enacted a Renewable Energy and Energy Efficiency Portfolio Standard (REPS) in August 2007 requiring all investor-owned utilities in the state to supply 12.5 percent of 2020 retail electricity sales in the state from eligible renewable energy resources by 2021. The overall target for renewable energy includes technology-specific targets of 0.2 percent solar by 2018, 0.2 percent energy recovery from swine waste by 2018, and 900,000 megawatt-hours (MW-hrs) of electricity derived from poultry waste by 2014. Large hydroelectric units over 10 MW are not considered eligible energy resources in North Carolina. The North Carolina REPS compliance schedule is listed below with each year's percentage requirement referring to the previous year's electricity sales.

- 2010: 0.02 percent solar
- 2012: 3 percent (including 0.07% solar + 0.07 percent swine waste + 170,000 MW-hrs poultry waste)

1. According to Va. Code §56-585.2(A), base year sales are calculated as "Total electric energy sold to Virginia jurisdictional retail customers by a participating utility in calendar year 2007, excluding an amount equivalent to the average of the annual percentages of the electric energy that was supplied to such customers from nuclear generating plants for the calendar years 2004 through 2006.

- 2013: 3 percent (including 0.07% solar + 0.07% swine waste + 700,000 MW-hrs poultry waste)
- 2014: 3 percent (including 0.07% solar + 0.07% swine waste + 900,000 MW-hrs poultry waste)
- 2015: 6 percent (including 0.14% solar + 0.14% swine waste + 900,000 MW-hrs poultry waste)
- 2018: 10 percent (including 0.20% solar + 0.20% swine waste + 900,000 MW-hrs poultry waste)
- 2021: 12.5 percent (including 0.20% solar + 0.20% swine waste + 900,000 MW-hrs poultry waste)

Up until 2021, 25 percent of the REPS requirements may be met through savings due to the implementation of energy efficiency measures. Beginning in calendar year 2021 and each year after, 40 percent of the REPS requirements may be met through savings due to the implementation of energy efficiency measures.

Senate Bill 3 allows electric power suppliers to recover the incremental costs incurred to comply with the REPS requirements and fund research through an annual rider, which is not to exceed the following per-account annual charges:

8.3.2 **Purchases and Sales**

Based on U.S. EIA data, in 2010, the Commonwealth of Virginia was the second largest importer of electricity in the United States on a total MW-hr basis. Based on the same data, the Commonwealth of Virginia imported the third largest percentage of consumed power of PJM states, with imports meeting approximately 36 percent of Virginia's total state-wide electric consumption. (Reference 4) The District of Columbia, Delaware, Maryland, and New Jersey also rely heavily on imported power and compete with Virginia for available power supplies from West Virginia, Pennsylvania and Illinois. North Carolina is less reliant on imports, but does import approximately 6 percent of its annual energy consumption. (Reference 4)

8.3.2.1 **Existing Purchase Agreements**

As shown in Table 8.3-7, DVP currently contracts for 1,867 MW of capacity through existing Power Purchase Agreements (PPAs). All 1,867 MW of this capacity comes from generation located within the Dominion Zone, of which 44 percent is from coal-fired baseload capacity. In addition, all 1,867 MW (822 MW is baseload) of this contracted capacity is scheduled to expire by end of 2024.

Relying on the future availability of long-term PPAs from developers of new baseload resources in other regions outside Virginia introduces uncertainty as to capacity and energy supply for DVP. Under the terms of Virginia's recent Legislation, DVP has an obligation to meet the demands of its native-load customers and the Virginia General Assembly has made the policy determination to promote the construction of baseload generation for this purpose. Power project developers may not have energy and capacity available to provide to DVP in the future. There may also be competition for the available long-term baseload PPAs among the other load centers surrounding the Dominion Zone.

In 2012, DVP executed 22,633,479 MW-hrs of power purchases, over 25 percent of its total energy requirements, of which 8,428,351 MW-hrs was contracted through PPAs and the remaining 14,205,128 MW-hrs were purchases from the PJM spot energy market. (Reference 7)

8.3.2.2 Power Sales

As shown in Table 8.3-9, DVP sold 4,217,681 MW-hrs for resale in 2012. The majority of these sales for resale was within the Dominion Zone and was sold specifically to VMEA, NCEMC, and ODEC under purchase agreements with a set pricing schedule, but load-based requirements. These sales were usually met with intermediate and peaking units.

DVP currently has one long-term power sales contract with NCEMC for 150 MW through a combined cycle call option agreement that is due to expire at the end of 2014.

8.3.2.3 Transmission and Additional Constraints on Power Purchases

In addition to concerns of long-term supply assurance, reliance on power imported from other states increases demand on west-to-east transmission capabilities, resulting in heightened vulnerability to transmission-related interruptions.

The Virginia SCC has also expressed concerns regarding congestion in northern Virginia and the Dominion Zone in particular. (Reference 15) The impact of congestion on the Dominion Zone's cost of power is illustrated in Figure 8.3-5, which shows the simple average Day-Ahead Locational Marginal Price (LMP) by PJM zone for the twelve month period ended December 31, 2012.

A review of the 2012 simple average day-ahead zonal LMPs reveals that the Dominion Zone, along with Potomac Electric Power Company (PEPCO), Baltimore Gas and Electric (BGE), and Delmarva Power and Light Company (DPL) zones were the most expensive PJM zones. On average, the Dominion Zone LMP was 4.6 percent higher than the average PJM LMP. Zones to the west (i.e., American Electric Power Co. (AEP), Allegheny Power (APS) and Duquesne Light Company (DUQ)) were less expensive zones compared to the Dominion Zone. The zonal average LMP differentials shown in Figure 8.3-5 are conservative, as these 2012 average LMPs are not load-weighted annual averages.[1]

8.3.3 Potential Retirements

Between September 2002 and April 2013, 15,205 MWs of generator retirements (deactivations) have taken place within PJM, of which 241 MWs were in the Dominion Zone (Reference 17). For the May 2013 through December 2015 period, there have been announced retirements of an additional 11,416 MWs, of which 902 MWs are in the Dominion Zone (Reference 16).

1. The load weighted LMP price is a better indicator of market prices in that the actual costs incurred to serve load will vary with the respective load and price for the varying time intervals. LMPs paid by loads vary hourly (Reference 15).

Section 8.3 References

1. Calpine, "Contractual Portfolio," November 3, 2005.
2. California Senate Bill No. 1368, Chapter 598, Approved by Governor, December 2009.
3. Database of State Incentives for Renewables & Efficiency (DSIRE), website, March 28, 2013.
4. Energy Information Administration website, "State Electricity Profiles 2010", January 27, 2012.
5. Energy Information Administration, "2011 State Energy Profile," February 14, 2013.
6. Independent Electricity Market Operator, "Market Evolution Program (MEP) Breakout Feedback Sessions," report, February 18, 2003.
7. Virginia Electric and Power Company, "FERC Form 1," 2012.
8. PJM Interconnection, LLC, "2010 PJM Load Capacity and Transmission Report," EIA-411 Report, December 28, 2011.
9. PJM Interconnection, LLC website, "About PJM," 2013.
10. NERC website, "2006-2010 Generating Unit Statistical Brochure - Units Reporting Events," November 16, 2011.
11. PJM Interconnection, LLC website, "Hourly Load Data, 2005-2007," from a website database.
12. PJM Interconnection, LLC website, "Future Deactivations (as of 6/5/2013)," from a website database.
13. PJM Interconnection, LLC website, "Generation Interconnection Queue (as of 5/4/2013)," from a website database.
14. PJM Interconnection, LLC, "PJM 2012 Regional Transmission Expansion Plan," February 28, 2013.
15. Virginia State Corporation Commission, "Status Report: Implementation of the Virginia Electric Utility Regulation," September 1, 2012.
16. PJM Interconnection, LLC website, "Generator Deactivations (as of 5/12/2013)," from PJM's website.
17. PJM Interconnection, LLC, "2012 PJM Reserve Requirement Study," October 5, 2012.

Table 8.3-1 Unit Availability Rates by Technology Type

Unit Availability Rates By Technology Type	(EFORd) Forced Outage Rate	Planned Outage Rate	Availability Rate
Hydroelectric	5.39%		95%
Nuclear	2.99%	7.34%	90%
Biomass	7.61%	8.94%	83%
Coal	7.40%	8.73%	84%
Gas Combined Cycle	5.01%	-	95%
Gas/Oil Steam	9.44%	-	91%
Pumped Storage	3.24%	-	97%
Combustion Turbine	9.62%	-	90%
Internal Combustion	15.79%	-	84%

Table 8.3-2 Deleted

Table 8.3-3 New Generating Capacity Additions in the Dominion Zone Since 2010

	Company	Plant Name	Unit	Fuel Type	Type	Net Capability (MW)	On Line Year
1	Old Dominion Electric Coop	Louisa	G12	NG	GT	154	2003
2	Old Dominion Electric Coop	Louisa	G34	NG	GT	154	2003
3	Old Dominion Electric Coop	Louisa	G5	NG	GT	158	2003
4	Virginia Electric & Power Co	Possum Point	G6S	NG	CC	559	2003
5	Industrial Power Generating Company LLC	Chesterfield Landfill	1-48	Landfill gas	IC	14	2004
6	Tenaska Virginia Partners LP	Fluvanna	GS12	NG	CC	920	2004
7	Old Dominion Electric Coop	Marsh Run	CT1	NG	GT	160	2004
8	Old Dominion Electric Coop	Marsh Run	CT2	NG	GT	159	2004
9	Old Dominion Electric Coop	Marsh Run	CT3	NG	GT	162	2004
10	INGENCO Wholesale Power LLC	BRUNSWICK CTY LF	IC	Landfill gas	IC	11	2007
11	WM Renewable Energy LLC	Bethel	IC	Landfill gas	IC	5	2007
12	Virginia Electric & Power Co	Ladysmith	GT3	NG	GT	161	2008
13	INGENCO Wholesale Power LLC	King & Queen County Landfill	IC	Landfill gas	IC	14	2008
14	Ameresco Stafford LLC	Stafford 1	IC	Landfill gas	IC	2	2008
15	Virginia Electric & Power Co	Ladysmith	GT4	NG	GT	160	2009
16	Virginia Electric & Power Co	Ladysmith	GT5	NG	GT	160	2009
17	WM Renewable Energy LLC	Middle Peninsula Landfill	IC	Landfill gas	IC	6	2009
18	WM Renewable Energy LLC	King George Landfill	GT	Landfill gas	GT	12	2010
19	INGENCO Wholesale Power LLC	Henrico County Landfill	IC	Landfill gas	IC	4	2010
20	Virginia Electric & Power Co	Bear Garden	CC	NG	CC	590	2012
					Total	3,564	

Table 8.3-4 Generator Interconnection Requests in the Dominion Zone, 2013

Queue	PJM Substation	MW	MWC	Year	Type	Fuel
T-167	Four Rivers 230kV	287	120	2017	Intermediate/ Peaking	Natural Gas
V2-030	Front Royal 500kV	950	875	2015	Intermediate/ Peaking	Natural Gas
V4-018	Front Royal 500kV	1,425	415	2015	Intermediate/ Peaking	Natural Gas
W1-029	Winfall 230kV	300	39	2015	Intermittent	Wind
W2-022	Pantego 115kV	74	10	2015	Intermittent	Wind
W2-049	Reedy Creek 115kV	47	47	2013	Baseload	Biomass
W3-047	Front Royal 500kV	1,464	60	2015	Intermediate/ Peaking	Natural Gas
W3-066	Shawboro 230kV	300	40	2015	Intermittent	Wind
X1-080	Poe-Suffolk 115kV	135	135	2013	Intermediate/ Peaking	Natural Gas
X1-084	Altavista 115kV	60	60	2013	Baseload	Biomass
X2-060	East Mill 138kV	30	-	2014	Baseload	Biomass
X2-076	Carson-Wake 500kV	1,551	1,376	2016	Intermediate/ Peaking	Natural Gas
X3-032	Poe-Suffolk 115kV	155	20	2013	Intermediate/ Peaking	Natural Gas
X3-076	Loudoun-Meadowbrook 500kV	1,270	412	2015	Intermediate/ Peaking	Natural Gas
X4-039	Pleasant View-Brambleton 230kV	800	750	2015	Intermediate/ Peaking	Natural Gas
Y1-048	Four Rivers 115kV	372	20	2016	Intermediate/ Peaking	Natural Gas
Y1-066	Four Rivers 115kV	182	13	2016	Intermediate/ Peaking	Natural Gas
Y1-068	East Mill 138kV	50	-	2014	Baseload	Biomass
Y1-086	Morgans Corner	20	8	2016	Intermittent	Solar
Y2-001	Gosport	50	40	2013	Baseload	Biomass
Y2-066	Suffolk 34.5kV	9	9	2013	Intermediate/ Peaking	Methane
Y2-074	Hopewell 230kV	401	8	2013	Intermediate/ Peaking	Natural Gas
Y2-076	Clover 230kV	445	14	2014	Baseload	Coal
Y2-077	Hopewell 230kV	401	30	2013	Intermediate/ Peaking	Natural Gas
Y2-097	Brunswick 500kV	1,551	1,376	2018	Intermediate/ Peaking	Natural Gas
Y2-099	Warrenton 34.5kV	2	2	2016	Intermediate/ Peaking	Methane
Y3-031	Riders Creek 115kV	131	17	2016	Intermittent	Wind
Total			5,896			

MWC = capacity component of total energy output of facility MW = total energy output of facility
Source: Analysis of PJM Generation Interconnection Queue as of May 15, 2013.

Table 8.3-5 Summary of Active Generator Interconnection Requests in the Dominion Zone

Fuel Type	MWC	Percent
Natural Gas	5,610	95%
Wind	106	2%
Biomass	147	3%
Methane	11	0.20%
Solar	8	0.10%
Coal	14	0.20%
Oil	0	0.00%
Total	5,896	100%

Table 8.3-6 North Carolina Annual Rider Caps

Customer Class	2008-2011	2012-2014	2015 and thereafter
Residential per account	$10.00	$12.00	$34.00
Commercial per account	$50.00	$150.00	$150.00
Industrial per account	$500.00	$1,000.00	$1,000.00

Table 8.3-7 Summary of DVP's Power Purchase Agreements

PPAs currently held by DVP as of April 2013 but all are scheduled to expire prior to end of 2024

Capacity Type	Summer Capacity (MW)	Percent of Total
Coal	743	40
Coal/Wood	79	4
Baseload Capacity Subtotal	822	44
Gas/Oil	942	50
Hydro	5	0
Solar	5	0
Landfill Gas	9	1
Solid Waste	84	5
Intermittent/Intermediate Capacity Subtotal	1,045	56
Total Capacity	1,867	100

Table 8.3-8 Deleted

Table 8.3-9 Summary of DVP Sales for Resale, 2012

Name of Company or Public Authority	Statistical Classification	Average Monthly Billing Demand (MW)	Average Monthly NCP Demand	Average Monthly CP Demand	MW-hr Sold
Old Dominion Electric Cooperative	Requirements				—
Craig-Botetourt Electric Coop.	Requirements	3	6	5	26,168
Town of Windsor	Requirements	9	9	7	50,055
Virginia Municipal Electric Assoc.	Requirements	292	294	291	1,871,079
Virginia Municipal Electric Assoc.	Requirements				
North Carolina Electric (NCEMC)	Requirements				1,051,101
Pennsylvania-New Jersey-Maryland	Other Service				188,675
Potomic Electric & Power	Other Service				
Old Dominion Electric Cooperative	Long Term				1,030,612
Allegheny	Short Term				
Edison Mission	Short Term				
Energy Connect	Short Term				
Tenaska	Short Term				
Nextera	Short Term				
NRG	Short Term				
PSEG	Short Term				
RRI	Short Term				
Duquesne	Short Term				
First Energy (ATSI)	Short Term				
PPL Energy Plus	Short Term				
Duke Energy Ohio	Short Term				
First Energy Solutions	Short Term				
Subtotal RQ		304	308	303	2,998,403
Subtotal Non-RQ		—	—	—	1,219,288
Total		304	303	303	4,217,691

Notes:

(1) Requirements Service is service which the supplier plans to provide on an ongoing basis (i.e., the supplier includes projected load for this service in its system resource planning). In addition, the reliability of requirements service must be the same as or second only to the supplier's service to its own ultimate customers.

Table 8.3-9 Summary of DVP Sales for Resale, 2012

(2) Long-Term Service means five years or longer.

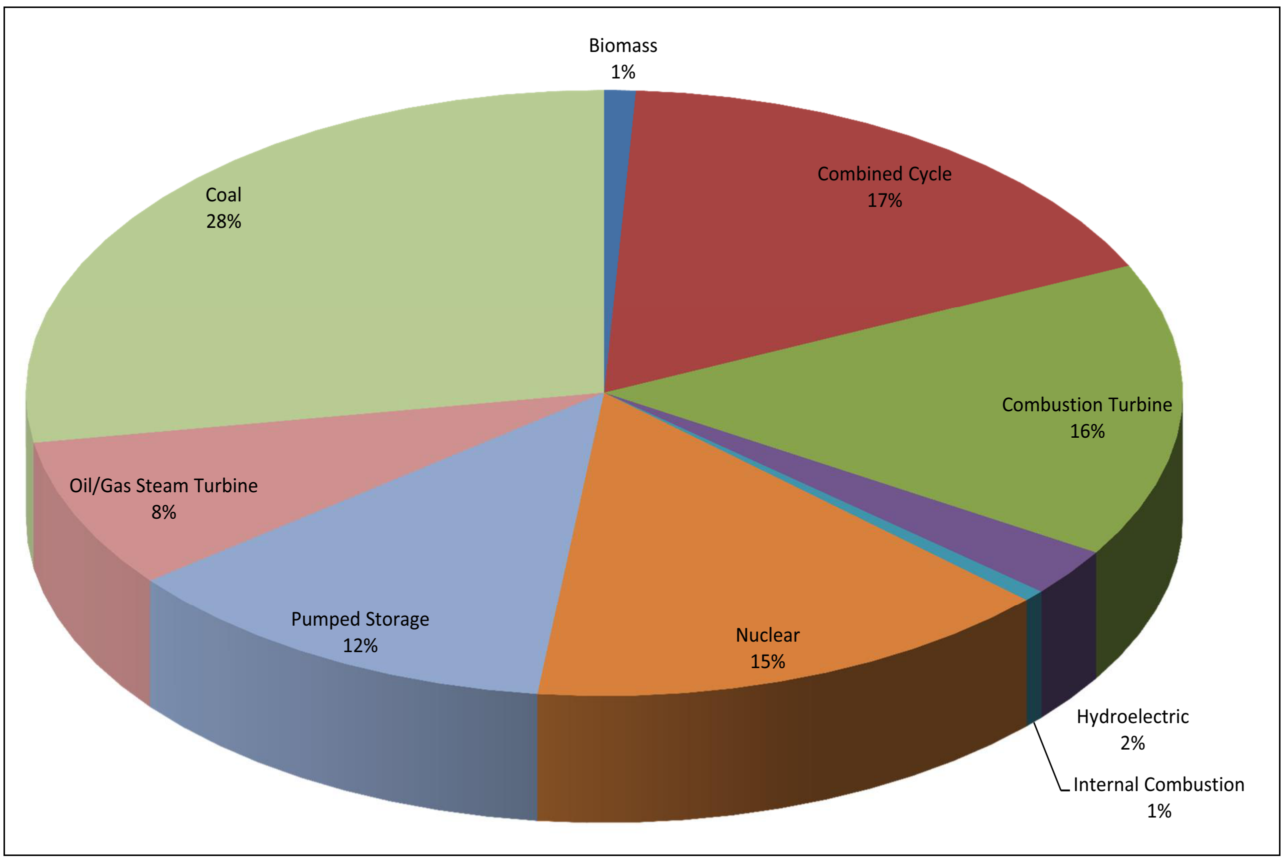
(3) Monthly NCP demand is the maximum metered hourly (60-minute integration) demand in a month.

(4) Monthly CP demand is the metered demand during the hour (60-minute integration) in which the supplier's system reaches its monthly peak.

Source: Virginia Electric and Power Company FERC Form 1, 2012

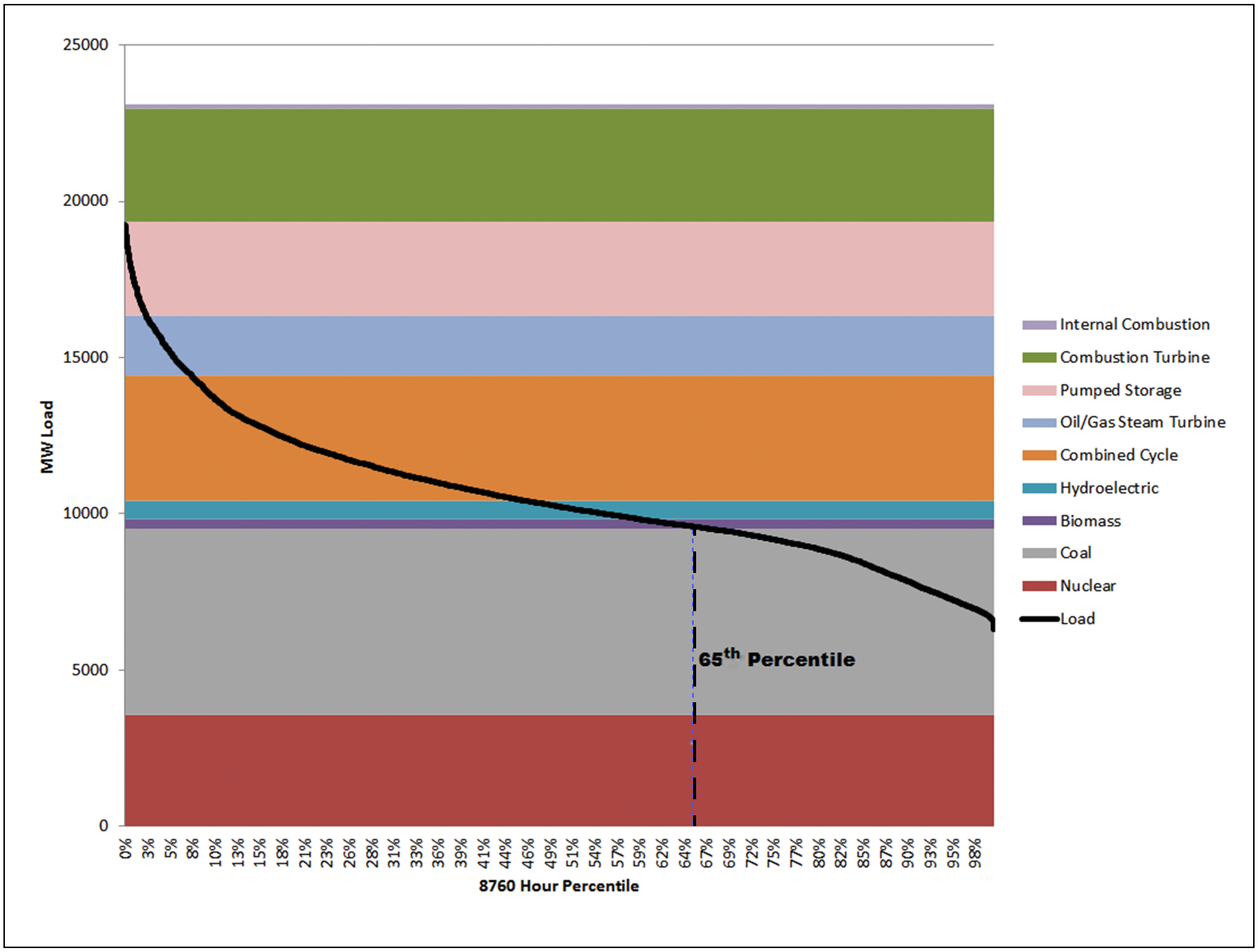
Figure 8.3-1 Dominion Zone – Total Installed Capacity by Technology Type, 2012

Technology Type	Summer Capacity (MW)
Biomass	210
Combined Cycle	4,129
Combustion Turbine	3,780
Hydroelectric	612
Internal Combustion	144
Nuclear	3,563
Pumped Storage	3,003
Oil/Gas Steam Turbine	1,920
Coal	6,633
Total	23,993



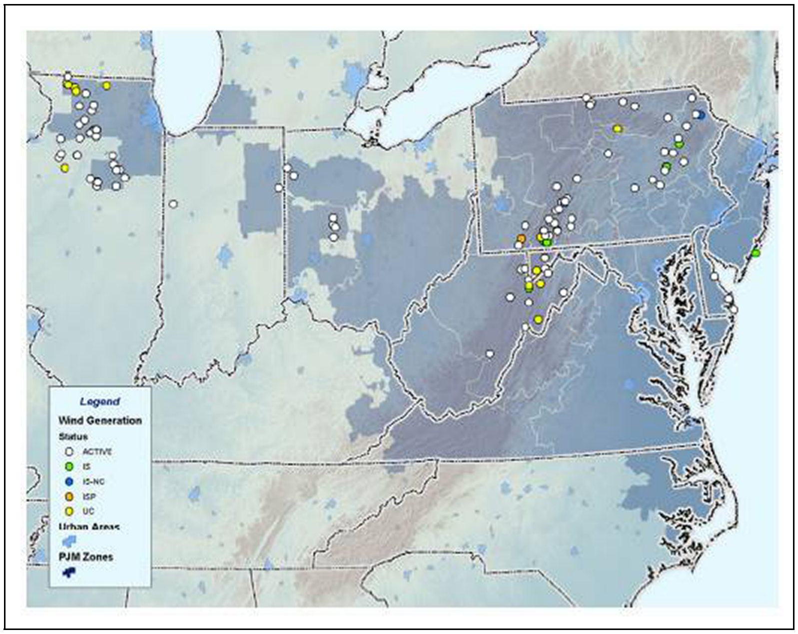
Source: 2012 IRP, EEI, Internal Dominion Analysis

Figure 8.3-2 PJM Dominion Zone 2012 Load Duration Curve



Source: 2012 IRP

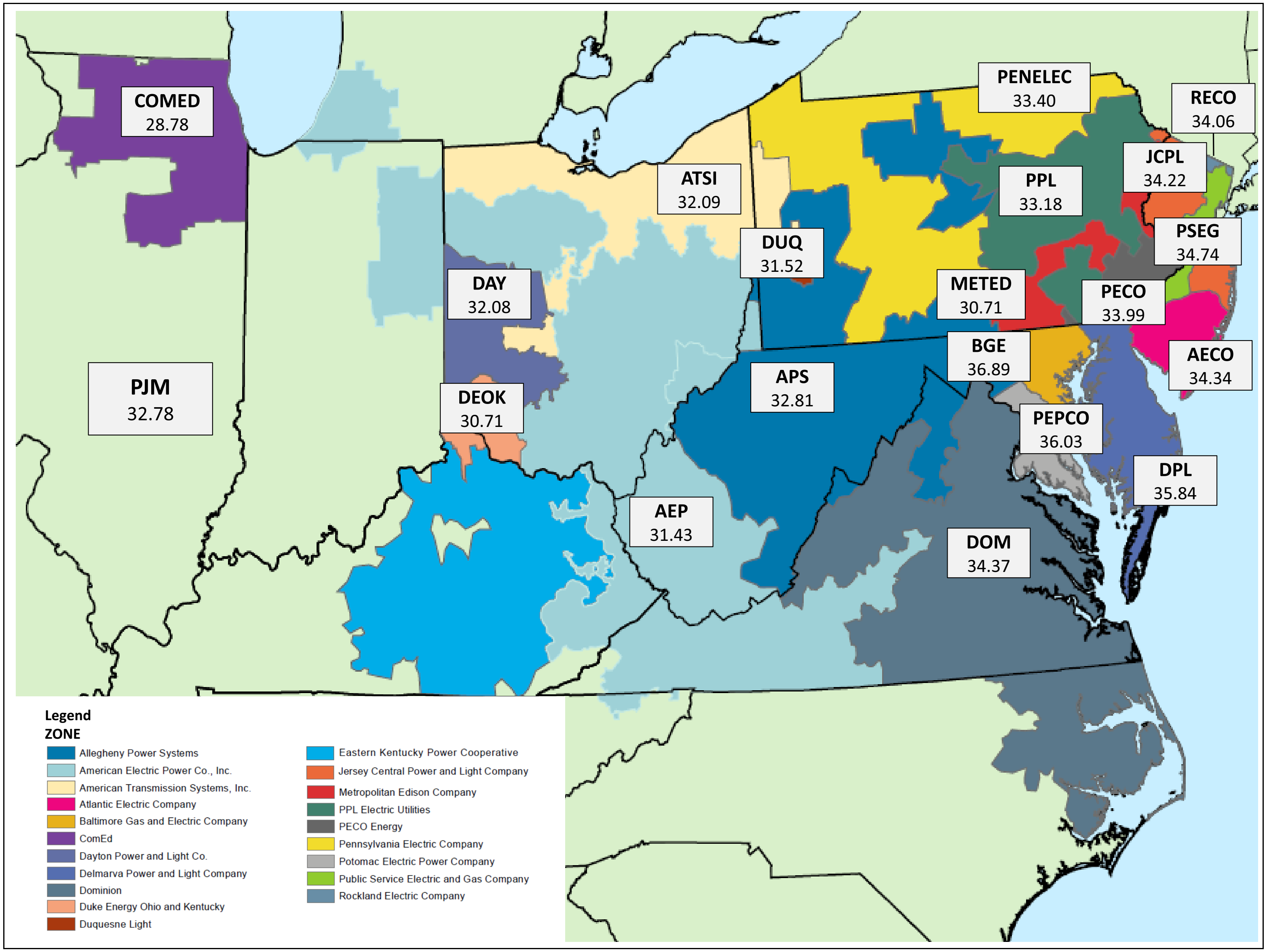
Figure 8.3-3 Clustered Location of Wind-Powered Generation Projects in PJM



Source: PJM 2012 RTEP

Figure 8.3-4 Deleted

Figure 8.3-5 PJM 2012 Zonal Day Ahead LMP



8.4 Assessment of Need for Power

This Section 8.4 identifies the need for power within the Dominion Zone. The Dominion Zone summer peak demand and baseload demand forecasts used in this assessment are discussed in more detail in Section 8.2. Current installed capacity and planned new capacity additions are discussed in Section 8.3.

8.4.1 Need for Baseload Capacity

This section assesses the need for baseload capacity within the Dominion Zone. Unit 3 is proposed and will operate as a baseload facility to help meet this need.

The current baseload demand in the Dominion Zone has been estimated by reviewing 2012 historical PJM integrated hourly loads for the Dominion Zone, sorting the 8760 hourly loads (i.e., 24 hours $\times$ 365 days) in declining order to create the load duration curve shown in Figure 8.3-2, and selecting the 65th percentile hour load equal to 9601 MW as the proxy for 2012 baseload demand. It is assumed that this baseload demand would continue to grow at a compound annual growth rate of 1.8 percent, consistent with PJM's forecasted energy growth rate for the Dominion Zone.

While the 65th percentile hour load is not exactly equal to the amount of required installed baseload capacity, it is a reasonable proxy for baseload capacity requirements after reducing capacity supply by assumed availability rates. For purposes of this analysis, baseload capacity includes capacity from currently operating and planned coal, nuclear, and biomass facilities.[1] These capacity values are reduced by the assumed unit availability rates presented earlier in Table 8.3-1. The derivation of these unit availability rates is discussed in Section 8.3.1. The impact of any potential baseload capacity retirements both in and out of the Dominion Zone is conservatively excluded from the need for baseload capacity analysis.

For the purpose of this analysis, it is assumed that the DSM targets established in the Regulation Act and Virginia Energy Plan will be met in full and it is further assumed that baseload demand will be reduced by those target levels. These conservative assumptions overstate the impact to baseload demand because typical DSM programs serve to reduce peak load demand. The analysis is based on the DSM reduction projected in 2012 IRP. These assumptions are made for both DVP's Virginia and North Carolina service territories in the Dominion Zone.

As shown in Table 8.4-1, the results of the need for baseload capacity analysis indicate that there is currently a need for additional baseload capacity within the Dominion Zone. Unit 3 is not anticipated to be in-service until 2024, by which time the baseload capacity deficiency is projected to be over 2,100 MW, even with the addition of DVP's recently completed VCHEC, and assuming that DSM

1. In the assessment of need for baseload capacity, currently operating and planned combined-cycle units are not considered baseload capacity because they are more generally suitable as cycling or mid-range resources in the long term, particularly during periods of high natural gas prices and price volatility.

levels projected by the 2012 IRP will reduce baseload demand. This additional need for baseload capacity is greater than the potential capacity that would be available from the proposed Unit 3.

8.4.2 Installed Reserve Margins - Peak Demand Supply/Demand Analysis

Projected installed reserve margins for the Dominion Zone are presented in this section, including the proposed projects listed in the PJM Generation Interconnection Queue listed in Table 8.3-4.

Similar to the Need for Baseload Capacity analysis presented above, the impact of any potential retirements both in and out of the Dominion Zone is conservatively excluded from the calculation of installed reserve margins.

The reserve margin calculation (expressed as percentage) is defined as follows:

$$\frac{\text{Estimated Generating Capability + Import Capability – Estimated Peakload Responsibility}}{\text{Estimated Peakload Responsibility}}$$

Table 8.4-2 shows that the projected installed reserve margin, excluding import capacity, falls to 14 percent by 2027, which is below the 15.6 percent installed reserve margin (IRM) planning standard currently approved by PJM.

8.4.3 Summary of Need for Power

As identified in Table 8.4-1, the Dominion Zone has a specific need for new baseload capacity and this need is projected to increase. The baseload capacity supply portfolio in the Dominion Zone is currently out of balance with the need for generation. Development of new baseload capacity has not kept pace with recent growth in energy consumption. Instead, the growth in energy consumption has been met predominantly by the recent development of gas-fired units, which are generally more suitable as cycling or mid-range resources during periods of high gas prices and price volatility, and imported power. In fact, only one new baseload facility has been built in the Dominion Zone since 1996, which is the VCHEC (585 MW), in addition to the completed uprates totaling 126 MW to the existing North Anna and Surry power plants, 31 MW of uprates to Mt Storm, and 16 MW at Chesterfield Power Station. The proposed Unit 3 is the only major facility over 100 MW that does not rely on gas fuel within the Dominion Zone currently under study in the PJM Generation Interconnection Queue. (Reference 5)

Without the additional capacity from the proposed Unit 3 project in 2024, the Dominion Zone will continue to rely heavily on imported power and natural gas for reliability. Reliance on power imported from other states increases demand on west-to-east transmission capabilities, resulting in heightened vulnerability to transmission-related interruptions.

The predominance of new gas-fired generation, planned retirements of aging coal units, and lack of new baseload capacity will decrease fuel diversity, leaving customers more vulnerable to volatility in oil and natural gas prices. According to the PJM market monitor's State of the Market Report, during 2012, coal units provided 42.1 percent, nuclear units 34.6 percent and gas units 18.8 percent of total generation. (Reference 6) Compared to 2011, generation from coal units decreased 7.4 percent, generation from nuclear units increased 4.0 percent, and generation from gas units increased 39.0 percent. Expanding nuclear power within DVP's generation portfolio affords DVP the ability to provide much needed additional fuel diversity and a reliable baseload generation resource with stable operating and fuel cost for its retail customers.

The proposed Unit 3 (approximately 1500 MW) would help alleviate the projected supply imbalance, lessen the region's vulnerability to gas transmission-related interruptions, and manage risks associated with volatility in oil and natural gas prices. Upon commercial operation, Unit 3 will increase the nuclear capacity within the Dominion Zone. When coupled with the recently completed VCHEC, Unit 3 will not only increase diversity of generation technologies for the baseload generation resources in the Dominion Zone, but also enhance the fuel supply diversity of the baseload generation resources.

Section 8.4 References

1. [Deleted]
2. [Deleted]
3. [Deleted]
4. [Deleted]
5. PJM Interconnection, LLC website, "Generation Interconnection Queue (as of 5/15/2013)," from a website database.
6. PJM Interconnection, LLC, "State of Market Report for PJM," March 14, 2013.

Capacity

noted	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	CAGR 2013–2028
lour	9,852	10,129	10,439	10,750	10,929	11,099	11,261	11,471	11,630	11,810	11,981	12,176	12,306	12, 467	12,627	12,834	1.8%
	0.6%	0.9%	1.4%	1.9%	2.6%	3.0%	3.4%	3.9%	3.9%	3.8%	3.8%	3.7%	3.7%	3.6%	3.5%	3.6%	
	57	87	141	199	288	337	381	442	448	453	458	450	456	450	445	457	
	9,795	10,042	10,298	10,550	10,641	10,762	10,880	11,028	11,182	11,357	11,523	11,727	11,850	12,018	12,182	12,377	
ility Adjusted	10,415	10,415	10,415	10,415	10,415	10,415	10,415	10,415	10,415	10,415	10,415	10,415	10,415	10,415	10,415	10,415	
bility Adjusted																	
	0	0	-856	-856	-856	-856	-856	-856	-856	-856	-856	-856	-856	-856	-856	-856	
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	
	46	46	-810	-810	-810	-810	-810	-810	-810	-810	-810	-810	-810	-810	-810	-810	
	10,461	10,461	9,605	9,605	9,605	9,605	9,605	9,605	9,605	9,605	9,605	9,605	9,605	9,605	9,605	9,605	
	666	419	-693	-945	-1,036	-1,157	-1,275	-1,423	-1,577	-1,752	-1,918	-2,122	-2,245	-2,413	-2,577	-2,772	

2012 historical actual hourly load data. Assumes baseload demand will increase at same annual energy growth rate as projected in PJM's 2013 Load Forecast Report for Dominio

RP

nstalled Reserve Margin

noted.	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
[1]	19,619	20,154	20,747	21,228	21,604	21,919	22,262	22,614	22,931	23,232	23,558	23,856	24,201	24,518	24,781	25,107
[2]	24,047	24,047	24,047	24,047	24,047	24,047	24,047	24,047	24,047	24,047	24,047	24,047	24,047	24,047	24,047	24,047
	0	-72	-1,049	-1,096	-1,096	-1,175	-1,175	-1,175	-1,175	-1,175	-1,175	-1,175	-1,175	-1,175	-1,175	-1,175
[3]	163	166	1,775	3,191	3,270	3,270	4,645	4,649	5,049	5,465	4,375	5,482	5,482	5,482	5,482	5,482
[4]	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100
	27,310	27,241	27,873	29,242	29,322	29,243	30,618	30,621	31,021	31,437	31,447	31,454	31,454	31,454	31,454	31,454
orts)	39%	35%	34%	38%	36%	33%	38%	35%	35%	35%	33%	32%	30%	28%	27%	25%
mports)	23%	20%	19%	23%	21%	19%	24%	22%	22%	22%	20%	19%	17%	16%	14%	13%

ity as of 2013; Source: PJM 2010 EIA-411 Data

eue as of 5/15/2013

rgency transfer limit (CETL). Order on Rehearing and Clarification and Accepting Compliance Filing, Federal Energy Regulatory Commission, Docket No ER05-1410-002 et al., Jun
sed in megawatts, of the Locational Deliverability Area (here, the Dominion Zone).

Chapter 9 Alternatives to the Proposed Action

This chapter assesses the feasibility and potential impact of various alternatives to developing the proposed Unit 3 project while still providing the necessary power to meet projected baseload demand. The alternatives considered and addressed include taking no-action and energy resource alternatives both with and without the development of new generating capacity. This assessment demonstrates that there are few alternatives reasonably capable of meeting DVP's baseload need, and those few alternatives are not environmentally preferable to Unit 3.

While reasonably feasible alternatives are not environmentally preferable to Unit 3, DVP believes that such alternatives are important generation resources that are properly included in a balanced generation portfolio. While DVP believes Unit 3 offers many advantages as part of a baseload generation portfolio, DVP believes that additional, alternative sources will also be required to provide a balanced, fuel-diverse supply to meet DVP's large projected baseload supply obligations.

Section 9.1 provides a discussion of the no-action alternative and its implications on system reliability, fuel diversity and the future price of electricity to consumers. Energy resource alternatives are discussed in Section 9.2.

9.1 No-Action Alternative

The no-action alternative is a scenario under which the NRC denies the application and the proposed Unit 3 is not constructed. Under this scenario, the environmental impacts of constructing and operating Unit 3 would be avoided, but the primary benefit of the project—the needed baseload power—would either remain unfulfilled or have to be provided by an alternative energy resource. The viability and environmental impacts of energy alternatives are addressed in Section 9.2.

Leaving the need unfulfilled is neither desirable nor consistent with DVP's public service obligations. Without the additional capacity from the proposed Unit 3 project or an energy alternative, the Dominion Zone will continue to rely heavily on imported power or as yet unplanned alternative generation, in order to meet its baseload service and reliability obligations. Too great a dependence on power imported from other states is undesirable for Virginia because of the increased demand that it places on west-to-east transmission capabilities, and associated increased vulnerability to transmission-related interruptions. Moreover, imported power may not be a viable alternative for meeting baseload obligations due to competition for baseload capacity resources from surrounding areas (see Section 8.3.2).

As demonstrated in Section 8.4.2, by 2024, projected planned capacity additions will not be sufficient to maintain the 15.6 percent installed reserve margin (IRM) planning standard.[1] Reliability of service to DVP customers could be at risk even sooner than 2024, given the uncertainty

1. Excluding imports.

surrounding whether planned projects will actually be developed and current power supply vulnerability to equipment failure and unplanned shut-downs for maintenance.

As discussed in Section 8.4, there is a current need for additional baseload capacity. Without the development of new baseload capacity, such as Unit 3, the supply portfolio in the Dominion Zone will become increasingly reliant on gas and oil-fired units and will need those resources to operate at higher capacity factors than typical cycling or mid-range resources in order to meet increasing growth in baseload demand. Gas and oil-fired units generally have higher variable operating costs than baseload generation resources. The benefit of adding the nuclear Unit 3 as this low variable cost option to meet baseload demand cannot be attained without NRC action. The mismatch of generation technology type to operational requirement will cause system inefficiencies resulting in increased electricity prices. Moreover, customers will be more vulnerable to oil and natural gas price volatility. While the risk of oil and natural gas price volatility can be hedged in part through long-term contracts, this risk can be further managed by increasing fuel diversity through the development of new nuclear and clean coal capacity. Hence, the development of Unit 3 will help manage risks associated with oil and natural gas price volatility and enable DVP to retain its supply portfolio balance.

9.2 Energy Alternatives

This section describes the environmental impact and viability of various energy sources to serve as alternatives to the baseload generation that would be provided by Unit 3. The alternatives considered and addressed include: power purchases from other generators or the market, reliance on improvement in energy efficiency or demand side management, and other new generating resources from both renewable resources as well as fossil fuels.

Alternatives that do *not* require new generating capacity are assessed in Section 9.2.1. Alternatives that do require new generating capacity are assessed in Section 9.2.2. Certain alternatives reviewed in Section 9.2.2 are eliminated on the basis of being unavailable in the relevant region (i.e., the Dominion Zone) or not commercially feasible; those which may be viable are discussed in Section 9.2.3, which includes an assessment of environmental impact, reliability and general economic competitiveness of each technology.

Consistent with NUREG-1555, (Reference 1) this analysis considers the impact of the integrated PJM market, projected reserve margins, peak loads and load duration curves, transmission inter-tie capability, as well as plant retirements, expected new generation, plant availability and the effect of conservation and load management. Each of these elements, and its impact on the need for power, is addressed in Sections 8.2 and 8.3. Accordingly, Section 9.2 does not repeat those factors but focuses on the ability of alternative sources to meet the baseload need that is projected for the 2024 timeframe, inclusive of the impact of the above-mentioned factors.

9.2.1 Alternatives Not Requiring New Generating Capacity

This section discusses possible methods of supplying the projected demand for baseload energy *without* constructing new generating capacity. The specific options considered include: the viability of purchasing power from other resources, plant reactivation and extended service life, and obviating the need for generation through energy conservation and demand side management measures.

9.2.1.1 Power Purchases

The option of supplying DVP's increasing power requirements to serve native load with power purchases is theoretically possible through purchases from the wholesale market, a specific generating asset or a neighboring utility. However, as discussed in Section 8.1.4, the Dominion Zone is one of 26 Locational Deliverability Areas (LDA) identified by PJM as "constrained areas that have a limited ability to import capacity due to physical limitations of the transmission system, voltage limitations or stability limitations." (Reference 2, Schedule 10) In constrained areas, such as the Dominion Zone, baseload capacity for load serving entities (LSEs) must be located within the constrained area or the LSE must enter into a bilateral transaction for capacity into that constrained area.

The option of purchasing energy and capacity from neighboring utilities or resources outside of the Dominion Zone is limited by both transmission import capability as well as other demand centers competing for the same energy and capacity purchases. Significant incremental imports on a firm baseload basis would require major transmission system upgrades or reliance on an already strained transmission system, as discussed in Section 8.3.2. Even with the recently completed Meadow Brook - Loudoun 500 kV line sponsored by DVP and other baseline transmission upgrades included in the PJM RTEP, PJM believes that additional transmission system expansion and new generating sources will still be required to meet expected peak load supply requirements in the Dominion Zone beyond 2015. (Reference 3) Mt Storm-Doubs 500 kV line uprate under construction and proposed Surry-Skiffes Creek 500 kV line, projected to be online by 2015 and 2016, respectively, will enable reliable service in the Dominion Zone. Further, any upgrades to enable a power import comparable to Unit 3 would need to cross multiple utility service territories and may prove cost prohibitive.

DVP has an obligation to meet the demands of its native-load customers, but power project developers may not have energy and capacity available to provide to DVP in the future. (Reference 4) In addition to transmission limits, the availability of energy and capacity from resources outside of Virginia will be reduced by competition from other load centers surrounding the Dominion Zone. Specifically, the District of Columbia, Delaware, Maryland, and New Jersey are also experiencing significant growth and already rely heavily on imports from adjoining regions. Based on EIA generation and consumption data, the District of Columbia imports approximately

98 percent of its annual energy consumption; while Delaware and Maryland import approximately 52 percent and 33 percent, respectively, of their annual energy consumption.

Virginia currently imports approximately 36 percent of its annual energy consumption; North Carolina is less reliant on imports, but does import approximately 6 percent of its annual energy consumption. (Reference 5) The Public Service Commission of Maryland in its "Electric Supply Adequacy Report of 2007," has expressed concerns regarding the uncertainty of electric reliability in Maryland, citing expected demand growth between 1 percent and 2 percent per year, development of little new in-state electric generation, potential de-rates or retirements of fossil-fired generating capacity, and limited transmission capability during peak demand periods. (Reference 6) The projected growth of utilities' energy requirements in the region, combined with the retirements of 1821 MW of capacity in PJM between September 2008 and May 2012, rendered long-term baseload purchases from neighboring utilities unlikely. (Reference 7) By 2011, PJM was projecting that reserve margins in the central portion of Maryland and other eastern regions of PJM would be barely adequate to ensure reliability. (Reference 6) Thus, power purchases cannot be reasonably expected to provide power for a term that would be equivalent to the life of Unit 3.

Based on analysis of the PJM Generation Interconnection Queue as of May 2013, there are currently 5,418 MW (summer rated capacity) under study[1] for the surrounding regions outside the Dominion Zone including in all or parts of VA, NC, WV, PA, OH, NJ, DC and IN.[2] Gas comprises the largest portion with 5,080 MW.

In conclusion, with regard to power purchases as an alternative not requiring new generation, DVP considers the likelihood of resource availability to be low, the potential for additional import delivery through the transmission system to be potentially constrained, and the potential term of such a purchase to be inferior to the Unit 3 option. Accordingly, this alternative is not deemed reasonable or feasible.

9.2.1.2 **Plant Reactivation or Extended Service Life**

DVP has no opportunities to meet its incremental baseload needs through extending the service life of existing plants. There are currently planned plant retirements for Yorktown 1 and 2 and Chesapeake 1,2,3 and 4, totaling 918 MW in the Dominion Zone by 2015

Similarly, there are no viable opportunities for DVP to meet its baseload and reliability needs through re-activating plants. DVP has no plants that are viable candidates for reactivation. Any plant re-activation within the Dominion Zone would require returning to service units that are already retired or mothballed and are likely to need significant uneconomic and capital intensive upgrades to meet current and expected future environmental requirements.

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1. Includes projects listed as Active, Under Construction, or Partially In-Service with planned in-service dates after 1/1/2013.
2. As shown in Figure 8.3-5, the average cost of power in these regions is typically lower than in the Dominion Zone.

Even if there were plants with the potential for re-activation or extended service, the plant must first resolve the initial reasons the plant was, or is planned to be, shut down. These reasons typically include failure to be economic in the market or an inability to meet environmental standards; otherwise the plant would not have been retired. Moreover, the plants that have been shutdown, and those that are planned to be retired in the SERC reliability region are, for the most part, fossil fuel stations. Section 9.2.3 examines the environmental impact and feasibility of these technologies and concludes that none of these generating sources are environmentally superior to Unit 3. These technologies also would not provide many of the benefits of Unit 3 discussed in Chapter 8.

9.2.1.3 Conservation (Energy Efficiency)

Section 8.2.2.2 details the PJM efforts and the efforts in both Virginia and North Carolina to encourage conservation and energy efficiency. As noted in that section, conservation efforts are not expected to have a significant impact on baseload power needs but rather on peak requirements. In addition, Section 8.4 demonstrates that the growth in baseload need is projected to be over and above the potential effects of the conservation and efficiency targets established by both states and the existing PJM programs. Even if the state targets are met and the PJM programs continue, they will not alter the need for baseload power from Unit 3. Conservation programs have DSM components which are primarily aimed at managing the efficiency gains from peak load, not baseload. If the conservation programs met with extraordinary success, the impact of these programs, at best, could only moderate load growth and slightly defer the need for additional baseload power, but not the need for Unit 3 as shown in Section 8.4. DVP does not consider conservation alone to be a feasible alternative to the proposed Unit 3.

9.2.2 Alternatives Requiring New Generating Capacity

This section analyzes possible alternative sources of energy and whether they could reasonably be expected to provide additional generating capacity to commercially serve DVP's baseload power and reliability obligations in a manner that is environmentally preferable to the proposed alternative. Each potential resource is assessed in terms of its potential to provide the required baseload power offered by Unit 3. If a generating source is determined to be viable pursuant to the review in this Section 9.2.2, it is then compared with the proposed project, Unit 3, in Section 9.2.3. This section includes an assessment of currently available technologies as well as those that are projected to be available within the relevant timeframe. Technologies reviewed include fossil fuels, taking into account national policy regarding the use of such fuels, as well as alternative/renewable resources available within the region. Specifically this section covers:

Renewable Fuels:

- Wind
- Geothermal
- Hydropower

- Municipal solid waste and landfill gas
- Biomass/wood waste
- Agriculture-derived biomass (e.g. energy crops)
- Photovoltaic cells and solar thermal

Other Alternatives:

- Integrated gas-fired combined cycle (IGCC)
- Other advanced systems (e.g. fuel cells, synthetic fuels, etc.)

Non Renewable Fuels:

- Petroleum liquids
- Natural gas
- Coal

For the purposes of this Section 9.2.2, DVP assesses renewable resources capable of running exclusively on a renewable fuel. Alternatives involving combinations of facilities are addressed in Section 9.2.2.4.

In performing this evaluation, DVP has used the NRC's Generic Environmental Impact Statement (GEIS) (References 14 and 12) to inform its analysis. The GEIS is useful for the analysis of alternative sources because for License Renewal plants the NRC has determined that evaluation of these alternatives enables the agency to consider the relative environmental consequences of each alternative. To generate the reasonable set of alternatives used in the GEIS, the NRC included commonly known or anticipated generation technologies.

9.2.2.1 **Renewable Fuels**

Generally, renewable resources are not of the scale or type to provide baseload power comparable to the output of Unit 3. Table 9.2-1 depicts the average capacity factors achieved by various renewable resource types nation-wide using data from EIA.

These data indicate that even where viable, most renewable resources are not generally able to provide baseload power or higher capacity outputs equivalent to Unit 3. The non-baseload nature of these resources may be overcome in the future with the development of nano-supercapacitors, energy storage devices such as compressed air systems or large-scale battery systems, and deployment of significant transmission system enhancements. EPRI forecasts that by the mid-2020's nano-capacitor technology may become available for deployment. Large-scale energy storage devices also have not been advanced to the point of economic feasibility. Until these technologies are advanced, non-baseload resources such as solar and wind cannot provide baseload power.[1]

1. Reference 11, pp3–6.

Any comparison of economic or environmental viability between non-baseload or mid-range capacity and baseload capacity would need to account for the diminished average available capacity by proportionately reducing the non-baseload or mid-range capacity ratings by an assumed technology-specific availability rating. However, DVP notes that the resulting average available capacity is not equivalent to the reliability of a baseload unit.

9.2.2.1.1 **Wind**

GEIS Supplement 7 concludes that Virginia is a Class 1 Wind Power region.[1] Figure 9.2-1 shows the annual average wind power in the United States.

Given that wind power is an intermittent resource, in order to compare a wind resource with Unit 3, in terms of average available capacity, one must adjust for the expected capacity factor of that resource. As noted above, EIA data indicate that wind power in the United States has achieved average capacity factors of approximately 23 percent in the 2001–2005 timeframe. The GEIS projects that the average annual capacity factor for wind power will be 29 percent in 2010. (Reference 14) Further, there is poor correlation between wind output and peak demand; in particular, wind tends to be unavailable on a hot summer day when both baseload and peaking resources are most needed. On average, wind resources would require 3.5 times as many MW of installed capacity to provide an average available capacity level equivalent to that from baseload nuclear resources with a capacity factor of 90 percent. However, even after adjusting for average available capacity, this capacity is not equivalent to that of a reliable baseload resource, given that in any point in time, generation can range from zero MW to full capacity.

The GEIS and other public data indicate that wind power requires from 60,000 to 150,000 acres per 1000 MW of capacity depending on location and other siting parameters. (References 14 and 15) In sum, wind power is not a reasonable alternative to provide for the baseload need that would be served by Unit 3 because of wind power's lower capacity factor and land requirements.

9.2.2.1.2 **Geothermal**

GEIS Supplement 7 (References 14 and 15) determined that the average annual capacity factor for geothermal power was 90 percent, making it suitable as a source of baseload generation. The EIA data provided in Table 9.2-1 shows that on average, geothermal resources in the United States achieved capacity factors of approximately 75 percent, in the 2001–2005 timeframe.

While industrial-scale geothermal power generally is available as a baseload resource, it is only available in Virginia or North Carolina for use with ground coupled heat pumps. Figure 8.4 of the GEIS shows that areas with potential for geothermal project development are found in the western United States. Based on 2005 data, the EIA found that there is no industrial-scale geothermal potential in the Dominion Zone. Further, DOE reports that North Carolina and Virginia have only low

1. Reference 12, Section 8.2.5.2.

to moderate temperature resources, and electricity generation from these is not possible. (Reference 16)

Because there is no industrial-scale geothermal potential in the Dominion Zone or even nearby, it is not a reasonable alternative to Unit 3.

9.2.2.1.3 Hydropower

GEIS Supplement 7 [1] found that Virginia had 617 MW of undeveloped hydropower resources, which is not enough to equal the output of the proposed project. The GEIS[2] estimates that a 1000 MW hydropower project would require about 1 million acres of land. Based on the project size of Unit 3, approximately 1.5 million acres would have to be flooded in order to be equivalent in capacity. This would create a land use impact of over 2300 square miles.

Hydropower is not a reasonable alternative to the proposed Unit 3 due to the limited availability of identified sites within the Dominion Zone and the amount of land needed.

9.2.2.1.4 Municipal Solid Waste and Landfill Gas-Fired Facilities

The GEIS[3] found that municipal solid waste (MSW) projects could achieve a capacity factor of approximately 85–90 percent, making it a potential source of baseload generation. However, the EIA data provided in Table 9.2-1 shows that on average, landfill gas and MSW resources in the United States achieved more modest capacity factors of approximately 65 percent in the 2001–2005 timeframe.

According to the EIA, in 2005, there were 3055 MW of installed MSW projects throughout the U.S., representing a 7 percent reduction from the 3292 MW installed nationwide in 2001. (Reference 10) Currently there are three MSW facilities, including industrial cogeneration, in the Dominion Zone totaling 207 MW of summer capacity. (References 17 and 18) Site development of MSW projects is limited to landfill sites and is driven by waste management considerations, such as limited availability of sites for landfills due to permitting requirements and zoning restrictions. EPA data indicate that MSW facilities require, on average, 15,000 tons of waste material per year for each MW of capacity. (Reference 19) Accordingly, to provide even 20 percent of the capacity of Unit 3 would mean incinerating an incremental 4.5 million tons of MSW per year, which is over two times the amount of MSW incinerated in Virginia in 2006.[4]

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1. Reference 12, Section 8.2.5.4.
2. Reference 14, Section 8.3.4.
3. Reference 14, Section 8.3.7.
4. In 2006, 16.8 million tons of MSW were received in the state of Virginia, including 7.3 million tons of MSW imported from other states. Of this total, 2.1 million tons of MSW was incinerated (Reference 35).

An MSW facility has a footprint similar in size to that of a fossil fuel-fired generator, but also requires landfill space to deposit non-hazardous ash residue. Net landfill space is reduced overall as a result of the combustion process.

The mandatory Renewable Portfolio Standard recently enacted in North Carolina considers landfill gas-fired facilities to be a renewable technology. The Chicago Climate Exchange considers certain landfill gas-fired generation facilities to qualify as emission offset projects.

A report by the National Renewable Energy Laboratory (NREL) presents the current availability of methane from landfills by state. The annual potential amount of this resource is 275,000 tons in Virginia. (Reference 22) Given the dispersed nature of this energy source and the relatively small amount, landfill gas generating facilities could only serve a small portion of an overall energy portfolio.

Due to low generation outputs, MSW and landfill gas are not reasonable alternatives to Unit 3 as potential baseload resources.

9.2.2.1.5 **Biomass (Wood), Wood Waste**

Wood-burning projects can have capacity factors competitive with traditional baseload sources of generation, although the EIA data provided in Table 9.2-1 shows that on average wood waste resources in the United States achieved capacity factors below 20 percent, in the 2001 – 2005 timeframe, with other biomass resources averaging 36 percent capacity factor.

Presently, wood waste burning projects are effectively limited to small-scale facilities because large-scale facilities are not economical. These developments are opportunistic and located near pulp, paper and paperboard industrial locations from which waste is available. EIA data indicate that in all of Virginia and North Carolina there are only 15 generating stations that are capable of burning wood waste, including industrial cogeneration, with a combined total summer capacity of 835 MW. However, many of these plants burn multiple fuels. Pro-rating the capacity of the amount of energy generated using wood-waste as a fuel yields 287 MW. (References 17 and 18) The counties and cities listed in Table 8.1-2 have 8 units totaling 579 MW capable of burning wood waste, which on a prorated basis yields 162 MW of wood waste potential.[1]

Additional development of wood waste generation is limited by the location and availability of additional wood waste resources. A report recently issued by DOE and USDA found that the amount of forestland-derived biomass that could be sustainably consumed nationally is approximately 368 million dry tons annually, which is more than 2.5 times the current national level. (Reference 24) However, the report cites accessibility of terrain, transportation costs, labor availability, and needed equipment improvements as major limiting factors in the expansion of biomass production. Section 8.3.6 of the GEIS found that the construction impacts per MW of

1. Ibid. (References 17 and 18).

installed capacity of a wood-burning project were similar to a coal project. These impacts are examined further in Section 9.2.3.

A report by NREL presents the current availability of biomass resources by state. (Reference 22) Table 9.2-2 shows the annual wood-derived biomass resource potential in Virginia.

In order to provide a similar capacity to Unit 3, approximately 8.6 million tons per year of biomass fuel would be needed. The Virginia RPS, described in Section 8.3.1.3 also provides state-wide, cumulative limitations on the use of certain types of biomass at 1.5 million tons for utilities that have received Virginia SCC approval to participate in a renewable energy portfolio standard program and who seek to meet statutorily-defined RPS goals.[1]

Wood waste material being used exclusively in a utility boiler has the characteristic of having a maximum installed capacity of approximately 65 to 100 MW. Additionally, saturation of this technology option in the DVP service territory could lead to fuel price volatility for DVP rate payers as the market dealing with woody biomass as a fuel for utility scale operations is not considered fluid, indeed the Legislation's 1.5 million ton statewide cap on certain types of biomass has the effect of limiting the potential of fuel volatility. While smaller installations of biomass power plants are considered viable options that support the Virginia RPS targets, the volumes needed to equal that of Unit 3 are considered to be unattainable; therefore, wood waste power is not a reasonable baseload alternative when compared to Unit 3.

9.2.2.1.6 Agriculture-Derived Biomass

A report recently issued by DOE and the U.S. Department of Agriculture found that biomass resources made available from agriculture could sustainably increase by a factor of five over the next 35 to 40 years. Currently 194 million dry tons of biomass, including manure and corn stover, is made available annually in the U.S. from agriculture, though only a small fraction of this total amount is converted into biofuel or bioenergy. (Reference 24) Technological processes for converting forms of biomass such as corn stovers and manure into energy are still in the developmental phase.

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1. *See* Va. Code § 56-585.2(F), which states that utilities participating in RPS programs shall collectively "use or cause to be used no more than a total of 1.5 million tons per year of green wood chips, bark, sawdust, a tree or any portion of a tree which is used or can be used for lumber and pulp manufacturing by facilities located in Virginia towards meeting RPS goals." The 1.5 million tons is apportioned among the utilities based on each utility's share of "total electric energy sold to Virginia jurisdictional retail customers" during 2007 "excluding an amount equivalent to the average of the annual percentages of the electric energy that was supplied to such customers from nuclear generating plants for the calendar years 2004 through 2006." Note that, even if Dominion Virginia Power were allotted full use of the 1.5 million tons in accordance with the RPS program, that would allow DVP to produce only 190 to 200 MW of electricity. The statute also allows other biomass fuels to be used without limitation, including slash, logging and construction debris, yard waste, non-merchantable waste paper, and agricultural and vineyard materials.

Some states have an abundance of agriculture-derived biomass in the form of animal waste products. These states want to use this resource as a multi-tiered solution that addresses RPS goals as well as provide economic relief for a sector of their supporting economy. Section 8.3.1.3 found that North Carolina has established targets to recover energy from swine waste and from poultry waste beginning in 2012. Such generating facilities are limited in capacity, availability and are not a viable alternative to Unit 3.

A report by NREL presents the current availability of biomass resources by state. (Reference 22) Table 9.2-3 shows the annual agriculture-derived biomass resource potential in Virginia is only 822,000 tons. Based on the foregoing, agriculture-derived biomass power is not a reasonable baseload alternative when compared to Unit 3.

Energy Crops

Currently, the use of energy crops in the U.S. is largely focused on producing ethanol for use in the transportation sector. Energy crops as feedstock for large-scale generation have not enjoyed the same attention or level of development. Section 8.3.8 of the GEIS states that energy crop technology is uneconomical when compared with traditional sources of baseload generation. According to the U.S. Climate Change Technology Program (Section 2.3.8), (Reference 25) energy crop technology for generation is not expected to approach goal levels until 2020, mainly due to cost inefficiencies and a lack of commercial demonstration. Factors that may hinder growth in biomass resource include urbanization of farm lands, increased demand in the international meat and food grain markets, and soil erosion caused by harvesting of biomass residues.

Because of the lower efficiency of these plants (approximately 30 percent), the land use requirements are many thousands of times greater than the land required to support nuclear. On an energy equivalent basis, the acreage required to support 1000 MW of baseload generation is approximately 600,000 acres. (Reference 26) Section 8.3.8 of the GEIS indicates that a crop-fired plant would have similar construction impacts and operational impacts as a wood-fired plant.

Switchgrass is an energy crop that has been tested at two coal plants owned by Southern Company. During a three-year demonstration period at the Gadsden Plant in Alabama between 2002 and 2004, switchgrass contributed between 7 percent and 10 percent of the energy produced. (Reference 27) One acre of a switchgrass plot can grow the energy equivalent of about 2–6 tons of coal per year. (Reference 27) On an energy equivalent basis, the acreage required to produce 1000 MW of baseload generation entirely from switchgrass is between 0.5 and 1.5 million acres. (Reference 28) The land area to produce switchgrass is not significantly different from that required for other energy crops. Additionally, this crop has only been used in relatively small proportion to fossil fuels in co-firing tests. It is not yet commercially viable to use switchgrass as either a secondary, much less primary, fuel source.

Due to their limited commercial potential and large land use requirements, energy crops are not a reasonable alternative to Unit 3.

9.2.2.1.7 **Photovoltaic Cells, Solar Thermal Power**

Consideration of solar technologies as an alternative to Unit 3 must first focus on whether they can be built as baseload capacity. Due to their intermittent nature during the day and lack of economic thermal storage devices for use at night, solar is not considered a baseload replacement option compared to Unit 3. Concentrated solar power and photovoltaic distributed generation generally are installed at the end-user location. According to GEIS Supplement 7, (Reference 12) photovoltaic cells have an average annual capacity factor of 25 percent. These estimates are high compared to EIA data in Table 9.2-1, which indicate that only 16 percent average annual capacity factors have been achieved across all solar technologies. Storage capability is not commercially available to serve as baseload generation. As noted by EPRI, improved technology for energy storage is necessary to enable deployment of solar as a baseload resource, but those advances are not projected to be achieved in time to meet the baseload need for the Dominion Zone.

GEIS Supplement 7 (Section 8.2.5.3) established that the areas surrounding the proposed project site for Unit 3 had a daily average generation potential of 4 kW-hrs per square meter compared with 7 to 8 kW-hrs per square meter achievable in certain parts of the western United States. It estimates land requirements of about 35,000 acres per 1000 MWe for photovoltaic and about 14,000 acres per 1000 MW for solar systems.

The use of solar energy for baseload, large-scale installations is not a reasonable alternative to Unit 3 due to its intermittent nature, and moderate solar insolation within the region of interest.

9.2.2.2 **Other Alternatives**

9.2.2.2.1 **Coal-fired IGCC**

An alternative coal-based technology is integrated gas-fired combined cycle technology (IGCC). This technology converts coal or petroleum coke or other products into synthetic gas (syngas) which is then used in a traditional gas-fired combined cycle plant. IGCC also offers the possibility, in the future, of capturing CO_2 before combustion. To date, carbon capture and sequestration (CCS) has not been proven on a commercial scale.

The NRC has recently observed that IGCC is not a reasonable alternative to a large nuclear power generation facility because: 1) existing IGCC plants have considerably smaller capacity, 2) system reliability of existing IGCC plants has been lower than pulverized coal plants, 3) existing IGCC plants have had extended shakedown periods, and 4) lack of overall plant performance warranties for IGCC plants have hindered commercial financing.[1] DVP also notes that existing U.S. plants received governmental subsidies and proposed new IGCC plants are being located in states offering tax incentives in support of the technology, a step that the Commonwealth of Virginia has not taken.

1. Reference 34, Volume 1 at 9-6.

Accordingly, IGCC with or without CCS, as a form of coal-fired technology, is not considered as a reasonable alternative to Unit 3.

9.2.2.2.2 **Fuel Cells**

According to the EIA's Annual Energy Outlook for 2007,[1] fuel cells are not projected to provide any measurable source of electric generation through 2030. On a per-kW basis, the installed costs (EIA assumes that the installed cost of a 10 MW fuel cell unit in 2006 is $4,520/kW (Reference 31)), plus variable operating plus maintenance costs for a fuel cell facility greatly exceed those of any other commercial-scale generating technology. The capital cost of advanced fuel cells is projected to remain uncompetitive with traditional sources of generation and the U.S. does not have an established hydrogen fuel supply structure. Hydrogen fuel is expensive and, like natural gas from which it is derived, it has a volatile price history. Because of its high marginal cost, a fuel cell would most likely be used in periods of peak electricity demand. Moreover, because fuel cell technology has a short operating history, the lifespan of a fuel cell unit is uncertain.

Dominion recently invested in the Raleigh, N.C.-based Microcell Corp. in order to accelerate the development of new fuel cell technology. (Reference 32) Microcell is a leader in proton exchange membrane microfiber fuel cells that operate on a cylindrical platform for applications ranging from back-up power to automotive.

Although DVP strongly supports the development of fuel cell technology, at this time, fuel cells are not a reasonable alternative to Unit 3.

9.2.2.3 **Non Renewable Fuels**

9.2.2.3.1 **Petroleum Liquids**

DVP currently operates 29 primarily oil-fired combustion turbines and two oil-fired steam turbines at eight different sites within the Dominion Zone, with a total maximum deliverable capacity (MDC) of 2246 MW. This equates to approximately 12 percent of installed capacity of DVP's Virginia and North Carolina power fleet.(Reference 23) A petroleum liquids alternative to the proposed unit would result in an approximate doubling of DVP's exposure to petroleum price volatility. From an environmental perspective, Section 8.3.11 of the GEIS finds that oil units have comparable air emissions to coal units.[2] In addition, the marginal cost of producing electricity with oil-fired generation is much higher than the marginal cost of energy produced by a nuclear unit, and as a result oil-fired generation is less desirable as a baseload generation source. At a time when oil commodity price levels remain high when compared with the commodity cost of coal or nuclear fuel, this is not an economically competitive option.

1. Reference 30, Tables A8 and A9.
2. Coal emissions are discussed in Section 9.2.3.

Petroleum liquid generation is not a reasonable baseload alternative to Unit 3 on either an environmental or economic basis.

9.2.2.3.2 Natural Gas-Fired Generation

DVP chose to evaluate gas-fired generation, using combined-cycle technology because the technology is mature, economical and feasible; and DVP has experience operating several combined-cycle gas units. One of DVP's most recently commissioned combined-cycle plants, Possum Point Unit 6, became commercially operable in July 2003. Possum Point 6 has a capacity of approximately 540 MW. For the purposes of this analysis, DVP assumed a new combined-cycle plant would have a capacity of approximately 550 MW; thus, DVP evaluated three units, in order to be compatible with the project, for a total capacity of 1650 MW. Combined-cycle technology is considered a competitive alternative and is evaluated further in Section 9.2.3.

9.2.2.3.3 Coal-Fired Generation

In 2004, the General Assembly amended the Virginia Electric Utility Restructuring Act to add a new subsection §56-585.G to encourage the construction of a coal-fired generation facility in the coalfield region of Virginia that would use coal from that region. Consistent with the 2004 Virginia legislation, DVP supports the development of coal technologies. Accordingly, coal is considered a potential alternative, and thus discussed further in Section 9.2.3.

9.2.2.4 Evaluation of Combinations of Alternatives

This section examines whether combinations of alternatives could generate baseload power in an amount equivalent to the proposed Unit 3. There are numerous possible combinations of power sources and the amount of output of each source. For the renewal of licenses pursuant to 10 CFR 54, the NRC has already determined that expansive consideration of combinations would be too unwieldy given the purposes of the alternatives analysis. (Reference 14)

The following analysis provides the basis for evaluating whether a combination of alternative energy sources is a viable option and, if so, whether it provides any difference in environmental impacts with respect to evaluating possible alternatives to Unit 3. Section 9.2.2.4.1 evaluates whether any combination of renewables with non-renewable fuels is a viable and reasonable means of providing baseload power in the Dominion Zone. Section 9.2.2.4.2 evaluates whether any combination of non-renewable fuels provides a different set of environmental impacts than individual non-renewable fuel facilities such that a separate analysis of the environmental impacts of the combination is necessary.

9.2.2.4.1 Combinations of Alternatives Involving Renewable Fuels

As discussed in Section 9.2.2.1, renewable resources are not of the scale or type to provide baseload power. Wind and solar are not feasible on their own to generate the equivalent baseload capacity or output of Unit 3 because of the intermittent nature of the resources, as discussed in

Section 9.2.2.1.1 and Section 9.2.2.1.7. As discussed below, no combination of a renewable fuel facility and a non-renewable fuel facility is a viable alternative to provide baseload generation in the Dominion Zone at the equivalent capacity of Unit 3.

Wind and Non-Renewable Fuels

As discussed above, wind power is considered by the industry as an intermittent, non-baseload generation resource. Accordingly, any combination of wind power with a non-renewable fuel facility would require not only that two facilities would be built—the wind facility and the non-renewable fuel facility—with the concomitant construction impacts of each, but that based on wind power's lower capacity factor the reduction in emissions would conservatively be only approximately 23 percent. Accordingly, a combination of a wind power with non-renewable fuel facility is not a viable or reasonable alternative to Unit 3.

Photovoltaic Cells, Solar Thermal Power and Non-Renewable Fuels

A combination of photovoltaic cells, solar thermal power, and non-renewable fuel alternatives would require, and have the impacts of, construction of two separate facilities. Also like wind power, a conservative assumption for the effect of such a facility on the air emissions and solid waste associated with a non-renewable fuel facility would be an approximate reduction of 16 percent to 25 percent. Due to the low capacity factor of a solar resource, although the combination of solar and non-renewable fuels may be viable on a small-scale, it is not a reasonable alternative to Unit 3.

Biomass, Wood Waste, Fuel Crops and Non-Renewable Fuels

As described above, there are not large-scale installations for the use of various types of biomass facilities in the Dominion Zone. Many of these opportunities would result in only small-sized facilities with lower capacity output compared to Unit 3. A combination of such a facility with a non-renewable fuel facility also has land impacts in the case of fuel crops. In addition, the combination of biomass, wood waste, or fuel crops and a non-renewable fuel facility is not a viable or reasonable alternative to Unit 3.

MSW and Non-Renewable Fuels

As described in Section 9.2.2.1.4, MSW projects could achieve capacity factors of 85–90 percent. However, site development of MSW projects is limited to landfill sites and is driven by waste management considerations. There are limited identified opportunities for such facilities in the Dominion Zone and a comparable-sized facility to Unit 3 would require 4.5 million tons of MSW. Pairing a smaller facility with a non-renewable fuels facility would only proportionally reduce the amount of MSW needed for such a facility. Thus, a combination MSW and non-renewable fuel alternative is not a viable or reasonable alternative to Unit 3.

9.2.2.4.2 **Combinations of Alternatives Involving Non-Renewable Fuels**

Any combination of coal- and natural gas-fired facilities would have the characteristics set forth in Section 9.2.3. In the analysis presented in Section 9.2.3, neither coal- nor natural gas-fired generation is environmentally preferable to Unit 3. Thus, no combination of coal- and natural gas-fired generation will be environmentally preferable to Unit 3. Likewise, as discussed in Section 9.2.2.3.1, oil-fired generation is not a reasonable alternative to Unit 3 on an environmental or economic basis. Further because oil-fired generation has comparable emissions to a coal-fired plant, no combination of oil-, coal- or natural gas-fired facilities is environmentally preferable to Unit 3. Accordingly, combinations of non-renewable fuels are not environmentally superior to Unit 3, are already bounded by the analysis in Section 9.2.3, and therefore do not need to be assessed separately from the analysis in Section 9.2.3.

9.2.3 Assessment of Alternative Energy Sources and Systems

This section analyzes the possible alternative energy sources and systems, and evaluates their ability to have an appreciable reduction in overall environmental impact. The alternative energy sources evaluated in this section are coal and natural gas.

9.2.3.1 Coal-Fired Generation

For purposes of assessing the alternatives to Unit 3, a generic pulverized coal facility with supercritical boiler is analyzed. Specifically, the coal-fired alternative assumes three approximately 507 MW net output, pulverized coal-fired units with a wet scrubber for flue gas desulfurization (FGD) with approximately 95 percent SO_x removal efficiency, as well as low NO_x burners, overfire air, and SCR with approximately 80 percent NO_x removal efficiency. Particulate matter (PM-10) is reduced in a dry electrostatic precipitator (ESP).

The following emissions data represent pro-rated emissions assuming proxy state-of-the-art coal plants were sized similarly to Unit 3 (approximately 1500 MW) and operated at a 90 percent capacity factor burning 2.65 percent sulfur Eastern bituminous coal.

9.2.3.1.1 Air Quality Impacts

Dust emissions from construction activities for a coal-fired generation plant would be similar to those from any similar construction project. Such emissions would be temporary, mitigated using best management practices, and therefore small.

During its operating life, the emissions profile regarding air quality from coal-fired generation will vary significantly from that of nuclear power generation because of emissions of sulfur oxides (SO_x), nitrogen oxides (NO_x), carbon monoxide (CO), particulates, and other constituents. DVP has assumed generically that a plant design that would be selected and managed to minimize air emissions through a combination of boiler technology and post-combustion pollutant removal. The estimated coal-fired alternative emissions for SO_x, NO_x, CO, and particulate matter (PM), are provided in Table 9.2-4.

Table 9.2-4 provides DVP's emissions calculation formula and estimates for three typical plant configurations, normalized to 1500 MW, which are then used to present the range of emissions for the generic plant described in Section 9.2.3.1.

The US Environmental Protection agency has indicated that the average CO_2 emissions rate for a coal-fired plant is 2249 lb/MW-hrs. Thus, an approximately 1500 MW coal-fired plant would emit approximately 13.5 million tons of CO_2 annually. The supporting calculations are provided in Table 9.2-5.

9.2.3.1.2 **Water Quality and Use**

DVP expects that a coal-fired alternative would use conventional mechanical draft cooling towers. DVP forecasts that plants may have a range of water consumption, and three examples of water consumption are provided in Table 9.2-6.

Blowdown from the cooling towers and other plant discharges would meet limits established in a VPDES permit. Accordingly, the impact of such discharges on water quality and aquatic life would be small.

Impacts to aquatic resources and water quality would be minimized through the use of mechanical draft towers. Consumptive use of water could be considered small to moderate depending on plant location and application of further mitigation measures. Consumptive water use would not differ significantly from a similarly sized nuclear unit with the same cooling water system.

9.2.3.1.3 **Coal Combustion Byproduct (CCB) Management**

DVP concurs with the GEIS assessment that the coal-fired alternative would generate substantial solid waste.[1] DVP's calculations regarding the range of CCB produced are set forth in Table 9.2-7.

Based on the calculations in Table 9.2-6, DVP believes that CCB disposal for the coal-fired alternative would have moderate impacts; the impacts would be clearly noticeable, but would not destabilize resources, and that further mitigation would be unwarranted.

9.2.3.1.4 **Socioeconomic Impact**

A coal-fired alternative would offer a number of local and regional economic benefits including: construction jobs, permanent jobs, property taxes to its host community for the life of the facility, consumption of a large quantity of coal produced by Virginia mines, and the additional economic multiplier effect of such a project on the regional economy. Construction of a similarly-sized facility, using clean-coal technology, would have an overnight cost in the range of $2,500 to $3,000 (depending on technology and location) per kW. The construction of a generic 1500 MW coal-fired plant would offer similar incremental employment opportunities when compared to Unit 3. The GEIS estimated that a 1000 MW coal-plant would require a peak load workforce of 1200 to 2500 workers

1. Reference 36, Section 8.3.9.

during construction.[1] Given that the alternative described in this section is larger than 1000 MW, DVP expects that the construction workforce would be modestly larger than that identified by the NRC. Further operation of the plant would require permanent employment of approximately 200 plant operators. A coal project would further enhance the Virginia economy through local property tax contributions and consumption of large amounts of regional coal and limestone every year, creating approximately 360 mining jobs. In addition, like the proposed Unit 3, a coal-fired station is expected to provide significant tax revenue for the local economy. Overall, similar to Unit 3, the socioeconomic impact of a coal-fired plant would be small to moderately beneficial.

9.2.3.1.5 **Other Impacts**

Other impacts from a coal-fired alternative include impact on terrestrial habitat on approximately 300 acres for the construction of the power block and coal storage area. As with any large construction project, some erosion, sedimentation, and fugitive dust emissions could be anticipated, but would be minimized by using best management practices. It is assumed that construction debris from clearing and grubbing could be disposed of onsite and municipal waste disposal capacity would be available.

The GEIS indicates that a 1000 MW coal-fired facility would require approximately 1700 acres which is comparable to the total NAPS site area.[2] Moreover, even if sited elsewhere, beneficial reuse of land formerly used for surface coal mining or other mine related activities may be possible, minimizing land use and impacts on terrestrial habitat and other ecological resources.

Air emissions would be required to meet standards established under the Clean Air Act. These standards are established at levels deemed protective of the public health. Accordingly, health impacts would be small. The potential for accidents affecting public health or the environment is also small.

The plant structures would be an incremental visual impact. Plant operations and routine noise would also contribute to an impact on aesthetics. Such impact could range from small to moderate depending on plant location and mitigation measures.

Impacts on cultural resources would not be markedly different from impacts associated with other alternative generating facilities of similar size. With proper consideration of cultural resources during siting, and appropriate survey and recovery techniques during construction, such impacts would be small.

9.2.3.1.6 **Conclusion**

Current supercritical coal plant designs, utilizing FGD, SCR and ESP equipment, provide a substantial reduction in airborne emissions when compared to a traditional pulverized coal unit

1. Reference 36, Section 8.3.9 and Reference 44, Section 8.2.1.
2. Reference 36, Section 8.3.9 and Reference 44, Section 8.2.1.

without such emission reduction technologies. However, even with the advanced design for emission reduction systems, a coal plant would not appreciably reduce the environmental impacts relative to proposed Unit 3. As a result, DVP concludes that a supercritical pulverized coal plant is not environmentally preferable to the proposed project.

9.2.3.2 **Natural Gas**

For purposes of assessing the generic alternatives to Unit 3, and in part based on equipment availability, a standard gas-fired facility is used as a proxy. Specifically, DVP has based this analysis on a three unit natural-gas-fired, combined-cycle plant, with each unit generating approximately 500 MW of net capacity. Each unit consists of two 165 MW gas turbines (e.g., General Electric Frame 7FA), and two heat-recovery steam generators followed by a nominal 170 MW capacity Steam Turbine Generator were considered for a total of approximately 1500 MW net. DVP based its emission control technology and emission control assumptions on alternatives that the EPA has identified as being available for minimizing emissions. The facility is assumed to include SCR with steam/water injection with 80 percent removal efficiency.

DVP has assumed that there would be sufficient natural gas available although no studies have been undertaken to confirm that sufficient baseload gas supplies could be economically delivered.

While combined-cycle technology is a potential source of baseload generation due to its mature technology and efficient operating characteristics, the costs of natural gas have become very volatile in recent years making it a less attractive source of baseload power than the proposed Unit 3. Moreover, as noted in Section 8.0.1.2, natural gas plants have accounted for more than 90 percent of all new electric generating capacity added in the U.S. over the past five years. Natural gas has many desirable characteristics and should be part of, but not dominate, the fuel mix because "over-reliance on any one fuel source leaves consumers vulnerable to price increases, volatility and supply disruptions." (Reference 41)

9.2.3.2.1 **Air Quality Impacts**

Natural gas is a relatively clean combusting fossil fuel. High efficiency is achieved in a combined cycle operation through the utilization of a heat recovery steam generator. With little or no firing of natural gas into the heat recovery steam generator, the combined cycle alternative would have similar types of emissions to those of the coal-fired alternative.

Table 9.2-8 and Table 9.2-9 summarize the emissions estimates for the combined-cycle gas alternative, assuming a capacity factor of 90 percent.

Clean Air Act requirements and the Virginia Department of Environmental Quality's regulations are also applicable to the gas-fired generation alternative. Air quality impacts would therefore be moderate, but any emission from a natural gas-fired combined cycle unit would be in excess of those from nuclear generation.

The US Environmental Protection Agency has indicated that the average CO_2 emissions rate for a gas-fired plant is 1135 lb/MW-hrs. Thus, an approximately 1500 MW gas-fired unit would emit approximately 6.7 million tons annually. The supporting calculations are provided in Table 9.2-10.

Like a coal or nuclear plant, construction of a gas-fired unit would result in some fugitive dust emissions typical of any construction project of similar size. Such impacts would be temporary, controlled by best management practices, and therefore small.

9.2.3.2.2 Water Quality and Use

DVP expects that a gas-fired combined cycle alternative would use conventional mechanical draft cooling towers. A gas-fired combined-cycle plant may have a range of water consumption, three examples of which are provided in Table 9.2-11. The consumptive use of water could be considered small to moderate depending on plant location and application of further mitigation measures.

Blowdown from the cooling towers and other plant discharges would meet limits established in a VPDES permit. Accordingly, the impact of such discharges on water quality and aquatic life would be small.

9.2.3.2.3 Waste Management

Gas-fired generation generates almost no waste, with the exception of the spent catalyst used for NO_x control. DVP concludes that gas-fired generation waste management impacts would be minimal.

9.2.3.2.4 Socioeconomic Impact

The GEIS concluded that the construction workforce and local and state tax revenue would be smaller than a coal unit's.[1] Additionally, the construction period would be shorter than either coal or nuclear. The GEIS estimated that the full-time workforce of an approximately 1500 MW(e) plant would be 150, the lowest of any technology.[2] Based on experience DVP anticipates this number to be lower and estimates approximately 30 to 50 workers for a plant this size. However, socioeconomic impacts would result from the workforce needed to operate the gas-fired facility, as well as local tax revenues from the facility.

9.2.3.2.5 Other Impacts

The GEIS estimated that 110 acres would be needed for a plant site.[3] In addition to site specific impact, the terrain near the site may be affected by the underground construction of a natural gas pipeline. To the extent practicable, the pipeline route would utilize previously disturbed rights-of-way to minimize impacts. The pipeline construction management practices would be expected to minimize soil loss and restore vegetation immediately after the excavation is backfilled. There

1. Reference 44, Section 8.2.2
2. Reference 36, Section 8.3.10; Reference 44, Section 8.2.2
3. Reference 36, Section 8.3.10; Reference 44, Section 8.2.2

would be some disturbance of wildlife and habitat during pipeline construction. DVP expects these impacts would be minimized and that they would not result in a long-term reduction in the local or regional diversity of plants and animals.

Air emissions would be required to meet standards established under the Clean Air Act. These standards are established at levels deemed protective of the public health. Accordingly, health impacts would be small. The potential for accidents affecting public health or the environment is also small.

The plant structures would be an incremental visual impact. Plant operations and routine plant noise would contribute to a small aesthetic impact.

Impacts on cultural resources would not be markedly different from impacts associated with other alternative generating facilities of similar size. With proper consideration of cultural resources during siting, and appropriate survey and recovery techniques during construction, such impacts would be small.

9.2.3.2.6 **Conclusion**

Current combined cycle plant designs, utilizing low NO_x burners and SCR equipment, provide for minimal airborne emissions. However, even with heat recovery steam generators, the advanced design for power generation realized in a combined cycle plant would not appreciably reduce the environmental impacts relative to proposed Unit 3. As a result, DVP concludes that a gas-fired combined cycle plant is not environmentally preferable to the proposed Unit 3 project.

9.2.4 **Conclusion**

As analyzed in this Chapter 9, based on environmental impacts, DVP has concluded that neither a coal-fired nor a gas-fired plant would provide an appreciable reduction in overall environmental impact relative to a nuclear plant and neither is environmentally preferable to the proposed Unit 3.

Section 9.2 References

1. U.S. Nuclear Regulatory Commission, “Environmental Standard Review Plan,” NUREG-1555, Office of Nuclear Reactor Regulation, October 1999.
2. PJM Interconnection, LLC website, “Reliability Assurance Agreement Among Load Serving Entities in the PJM Region,” January 4, 2013.
3. PJM Interconnection, LLC, “PJM 2012 Regional Transmission Expansion Plan,” February 28, 2013.
4. Virginia State Legislature, House Bill 3068, Senate Bill 1416, Acts of Assembly Chapters 888 and 933, 2007.

5. U.S. Energy Information Administration website, "Electric Power Annual 2005 State Data Tables," from a website database.
6. Public Service Commission of Maryland, "Electric Supply Adequacy Report of 2007," January 2007.
7. PJM Interconnection, LLC website, "Future Deactivations (as of 10/2/2007)," from a website database.
8. US DOE-EIA, "Table A1. Selected Electric Industry Summary Statistics by State, 2005," State Electricity Profiles, 2005.
9. US DOE-EIA website, Renewable Energy Annual, 2005 Edition, "Table 11. Electricity Net Generation From Renewable Energy by Energy Use Sector and Energy Source, 2001-2005," Form EIA-906 and Form EIA-920, from a website database.
10. U.S. Energy Information Administration (EIA), "Table 12: U.S. Electric Net Summer Capacity, 2001-2005."
11. Electric Power Research Institute, "The Power to Reduce CO2 Emissions," Summer 2007.
12. U.S. Nuclear Regulatory Commission (NRC), "Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Supplement 7 Regarding North Anna Power Station, Units 1 and 2," NUREG-1437, Volumes 1 and 2, 2002.
13. U.S. National Renewable Energy Laboratory website, "Wind Energy Resource Atlas of the United States," from a website (no date listed).
14. U.S. Nuclear Regulatory Commission (NRC), "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," NUREG-1437, Volumes 1 and 2, 1996.
15. American Wind Energy Association website, "Wind Energy and the Environment," October 26 2007.
16. U.S. Department of Energy (DOE) Energy Efficiency and Renewable Energy (EERE) website, "Alternative Resources in Virginia," October 26, 2007.
17. U.S. Energy Information Administration (EIA), "2005 Net Generation, Summary Capacity and Fuel Consumption for Utility Owned and Industrial Cogeneration Facilities," EIA-906/920, 2005.
18. U.S. Energy Information Administration (EIA), "Annual Electric Generator Report," EIA-860, 2006.

19. U.S. Environmental Protection Agency (EPA), "Decision Maker's Guide to Solid Waste Management," Vol II, Chapter 8, report, 1995.

20. U.S. Environmental Protection Agency, "Standards of Performance for Small Municipal Waste Combustion Units for Which Construction is Commenced After August 30, 1999 or for Which Modification or Reconstruction is Commenced After June 6, 2001," 40 CFR 60, Subpart AAAA, 65 FR 76355, December 16, 2000.

21. U.S. Environmental Protection Agency, "Emission Guidelines and Compliance Times for Small Municipal Waste Combustion Units Constructed on or Before August 30, 1999," 40 CFR 60, Subpart BBBB, 65 FR 76384, December 6, 2000.

22. U.S. Department of Energy, National Renewable Energy Laboratory (NREL), "A geographic perspective on the current biomass resource availability in the United States," Technical Report NREL/TP-560-39181, December 2005.

23. PJM Interconnection, LLC, "2007 PJM Load Capacity and Transmission Report," EIA-411 Report, July 25, 2007.

24. U.S. Department of Energy (DOE) and U.S. Department of Agriculture (USDA), "Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-ton Annual Supply," report, April 2005.

25. US Climate Change Technology Program - for the Near and Long Term, Technology Options Section 2.3.8 - Energy Crops," report, November 2003.

26. Oak Ridge National Laboratory website, "Relationship between Power Plant Efficiency and Capacity and Tons Biomass Required and Acres Required," October 15, 2007.

27. Tennenbaum, David, "Recycling - Switching to Switchgrass," In Environmental Health Perspectives, 110:A18, January 2002.

28. Concentric Energy Advisors, "Calculated average acreage planted of switchgrass required to fuel a 1,000 MW baseload facility," Inputs from SNL Energy, Annual Energy Outlook 2007, and USDA Fuel Value Calculator, Fifth Edition, USDA Forest Service, report, July 2004.

29. U.S. Department of Energy (DOE) National Renewable Energy Lab (NREL), Energy Consumption and Energy Development Potential on Indian Lands, "Chapter 3 - Potential for Renewable Energy," SR/CNEAF/2000-01, report, April 2000.

30. U.S. Department of Energy, Energy Information Administration (DOE/EIA), "Annual Energy Outlook 2007 With Projections to 2030," DOE/EIA-0383, February 2007.

31. U.S. Department of Energy, Energy Information Administration (DOE/EIA), "Electricity Market Module," report, April 2007.

32. DVP website, "Dominion Invests in Microcell Corporation," Press release, August 7, 2007.

33. U.S. Environmental Protection Agency (EPA) website, "Electricity from Municipal Solid Waste," October 26, 2007.

34. U.S. Nuclear Regulatory Commission (NRC), "Draft Environmental Impact Statement for an Early Site Permit (ESP) at the Vogtle Electric Generating Plant Site," NUREG-1872, Volumes 1 and 2, September 2007.

35. Commonwealth of Virginia, Department of Environmental Quality, "Solid Waste Managed in Virginia during Calendar Year 2006," report, June 2007.

36. U.S. Nuclear Regulatory Commission (NRC), "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," NUREG-1437, Volume 1, Office of Nuclear Reactor Regulation, 1996.

37. U.S. Environmental Protection Agency, "Air Pollution Control Technology Fact Sheet: Flue Gas Desulfurization (FGD)," EPA-452/F-03-034, report.

38. U.S. Environmental Protection Agency, "Air Pollution Control Technology Fact Sheet: Selective Catalytic Reduction (SCR)," EPA-452/F-03-031, report.

39. U.S. Environmental Protection Agency website, "AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume I, Chapter 3: Stationary Internal Combustion Sources," 2000.

40. U.S. Environmental Protection Agency website, "Clean Energy - Air Emissions, Coal and Natural Gas CO2 Emissions Rates," October 26, 2007.

41. Nuclear Energy Institute (NEI), "Nuclear Energy's Role in Reducing Demand for Natural Gas Through Diversification of Energy Sources Used for Electricity Generation," report, January 24, 2005.

42. Commonwealth of Virginia, Department of Environmental Quality, "PSD Permit, Possum Point Power Station, Reg. No. 70225," issued October 5, 2001, Amended November 18, 2002 and December 8, 2004.

43. Commonwealth of Massachusetts, Department of Environmental Protection, "Final Approval of Application No. MBR-00-COM-29," December 1, 2003.

44. U.S. Nuclear Regulatory Commission, "Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants: Supplement 7 Regarding North Anna Power Station, Units 1 and 2," NUREG-1437, Volumes 1 and 2, November 2002.

Table 9.2-1 Average Capacity Factors for Renewable Resources[a]

Capacity Factor By Sector (%)	2001	2002	2003	2004	2005	Average
Biomass	32.7	34.4	35.8	34.6	35.1	34.5
Wood/ Wood Waste	16.1	17.6	18.5	18.0	19.5	17.9
MSW/Landfill Gas	64.2	64.2	64.1	66.8	67.0	65.3
Other Biomass[b]	20.8	32.5	52.2	43.5	33.4	36.5
Geothermal	70.8	73.5	77.2	78.6	73.4	74.7
Conventional Hydroelectric	30.9	37.5	39.4	39.0	39.3	37.2
Solar	15.8	16.0	15.4	16.5	15.3	15.8
Wind	19.9	26.8	21.3	25.0	23.4	23.3

a. References 9 and 10 (the capacity factor was calculated using the following formula:
Capacity Factor = Annual generation (MW-hr)/(Annual net summer capacity * 24 hours * 365 days)).

b. Includes agriculture by-products/crops, sludge waste, tires, and other biomass solids, liquids, and gases.

Table 9.2-2 Wood-Derived Biomass Resource Potential

	Virginia (thousand tons)
Forest Residues	2,403
Primary Mill	2,147
Secondary Mill	62
Urban Wood	813
Total Wood Biomass	5,425

Table 9.2-3 Agriculture-Derived Biomass Resource Potential

	Virginia (Thousand tons)
Switchgrass	297
Crop Residues	502
Methane from Manure Management	23
Total Agriculture Biomass	822

Table 9.2-4 Coal-fired Power Plant Emission Calculations

Typical PC Power Plant A Emission Calculations

Typical Plant A output =	600	MW	
Typical Plant A heat rate =	8800	Btu/kW-hrs	
Typical Plant A heat input =	5280	MMBtu/hr	Heat Input = Heat Rate × Net output/1000
NAPS-U3 output =	1500	MW	(MMBtu/hr) = (Btu/kW-hrs) × (MW)/1000
Unit 3/Plant A Output ratio	2.500	ratio	
Hours per year	8760	hours/year	
Conversion factor lb/ton	2000	lb/ton	
Annual Capacity factor	90	%	

Emitted Compound	Plant A Emissions (lb/MMBtu)	Annual emission (tons) from Coal-Fired Plant Equivalent to NAPS-Unit 3 Electrical Generation						
		Emission	heat input	Hrs/ year	cap. fac	output ratio	lb/ ton	tons/ year
PM with Condensables	0.018	0.018*	5280*	8760*	0.9*	2.5/	2000 =	937
NO_x	0.04	0.04*	5280*	8760*	0.9*	2.5/	2000 =	2081
SO_2 Controlled	0.08	0.08*	5280*	8760*	0.9*	2.5/	2000 =	4163
VOC	0.0035	0.0035*	5280*	8760*	0.9*	2.5/	2000 =	182
CO	0.09	0.09*	5280*	8760*	0.9*	2.5/	2000 =	4683

Table 9.2-4 Coal-fired Power Plant Emission Calculations

Typical PC Power Plant B Emission Calculations

Typical Plant B output =	700	MW	
Typical Plant B heat rate =	8900	Btu/kW-hrs	
Typical Plant B heat input =	6230	MMBtu/hr	Heat Input = Heat Rate × Net output/1000
NAPS-U3 output =	1500	MW	(MMBtu/hr) = (Btu/kW-hrs) × (MW)/1000
Unit 3/Plant B Output ratio	2.143	ratio	
Hours per year	8760	hours/year	
Conversion factor lb/ton	2000	lb/ton	
Annual Capacity factor	90	%	

Emitted Compound	Plant B Emissions (lb/MMBtu)	Annual Emission (tons) from Coal-Fired Plant Equivalent to NAPS-Unit 3 Electrical Generation						
		Emission	heat input	Hrs/ year	cap. fac	output ratio	lb/ ton	tons/ year
PM with Condensables	0.029	0.029*	6230*	8760*	0.9*	2.143/	2000=	1526
NO_x	0.06	0.06*	6230*	8760*	0.9*	2.143/	2000=	3158
SO_2 Controlled	0.13	0.13*	6230*	8760*	0.9*	2.143/	2000=	6841
VOC	0.005	0.005*	6230*	8760*	0.9*	2.143/	2000=	263
CO	0.105	0.105*	6230*	8760*	0.9*	2.143/	2000=	5526

Table 9.2-4 Coal-fired Power Plant Emission Calculations

Typical PC Power Plant C Emission Calculations

Typical Plant C output =	800	MW	
Typical Plant C heat rate =	9000	Btu/kW-hrs	
Typical Plant C heat input =	7200	MMBtu/hr	Heat Input = Heat Rate × Net output/1000
NAPS-U3 output =	1500	MW	(MMBtu/hr) = (Btu/kW-hrs) × (MW)/1000
Unit 3/Plant C Output ratio	1.875	ratio	
Hours per year	8760	hours/year	
Conversion factor lb/ton	2000	lb/ton	
Annual Capacity factor	90	%	

Emitted Compound	Plant C Emissions (lb/MMBtu)	Annual emission (tons) from Coal-Fired Plant Equivalent to NAPS-Unit 3 Electrical Generation						
		Emission	heat input	Hrs/ year	cap. fac	output ratio	lb/ ton	tons/ year
PM with Condensables	0.04	0.04*	7200*	8760*	0.9*	1.875/	2000=	2129
NO_x	0.08	0.08*	7200*	8760*	0.9*	1.875/	2000=	4257
SO_2 Controlled	0.18	0.18*	7200*	8760*	0.9*	1.875/	2000=	9579
VOC	0.0065	0.0065*	7200*	8760*	0.9*	1.875/	2000=	346
CO	0.12	0.12*	7200*	8760*	0.9*	1.875/	2000=	6386

Table 9.2-4 Coal-fired Power Plant Emission Calculations

Typical PC Power Plant Range of Emissions

Emitted Compound	Emission Range tons/year	Plant A	Plant B	Plant C	High	Low
PM with Condensables	940–2130	937	1526	2129	2130	940
NO_x	2080–4260	2081	3158	4257	4260	2080
SO_2 Controlled	4160–9580	4163	6841	9579	9580	4160
VOC	180–350	182	263	346	350	180
CO	4680–6390	4683	5526	6386	6390	4680

Notes:

1) The above is based on a typical state-of-the-art supercritical coal fired power plant burning Eastern Bituminous coal with 0.7% to 4.0% sulfur and typical higher heating values between 12,630 to 15,600 Btu/lb.

2) The emissions are in tons/year prorated to the electrical generation output of NAPS Unit-3 (1500 MW)

3) The PM with condensable is PM10, because the air quality controls system (baghouse) removes most of the particulate matter >10 microns in size.

4) The NO_x is reduced by SCR with approximately ~80% removal efficiency.

5) Although coal-fired plants may also be subject to other air emission limits including Hg, Pb, NH_3, HCl, etc., these were not calculated.

6) Annual Capacity factor is 90%. The high, low values, and the range have been rounded to the nearest 10 tons/year.

7) Emissions are based on a base loaded plant and thus, they do not include startup or part-load emissions.

Table 9.2-4a Coal Combustion By-Products and Air Emission Parameters (1500 MWe)

CCB	Annual CCB Quantity[1] (tons)	CCB Beneficial Reuse[2] (%)	CCB Industry Usage
Ash (recovered)	110,000 to 472,000	25	construction fill material, mine reclamation, raw material in manufacturing of cement products
Flue Gas Desulfurization (FGD) Gypsum	123,000 to 887,000	0	used as synthetic gypsum in wall board and cement manufacturing

Annual Air Emission Source	Emission Rates
Mercury (Hg)	0.37 to 0.94 tons/year
PM_{10}	940 to 2,130 tons/year
$PM_{2,5}$	540 to 1,240 tons/year

Lifetime Landfill Capacity Needed for Disposal of Recovered Ash[3] – 45 to 195 acres

Lifetime Landfill Capacity Needed for Disposal of FGD Gypsum[3] – 45 to 326 acres

Consumption of Limestone for Environmental Control of Air Emissions – 78,000 to 560,000 tons/year

Notes:

1. The ranges above are based on a typical state-of-the-art supercritical coal-fired power plant burning Eastern Bituminous coal with sulfur content between 0.7% and 4.0%, and typical heating values of 12,630 to 15,600 Btu/lb.
2. Industry usage for FGD gypsum is not as widespread as usage for ash, therefore, 0% is used as a conservative reuse value for FGD gypsum.
3. The lifetime of the plant is assumed to be 60 years.

Table 9.2-5 CO_2 Emissions of Coal Technologies

Coal (Assumes Annual Capacity Factor of 90%)

Emissions Rate: 2,249 lb/MW-hrs[a]

Annual CO_2 Emissions:

$$2249\,\text{lb/MW-hrs} \times \frac{1}{2000}\text{ton/lb} \times 1500\ \text{MW} \times 90\% \times 8760\ \text{hours/year} = 13{,}298{,}337\ \text{tons/year}$$

a. Reference 40

Table 9.2-6 Coal-Fired Power Plant Water Consumption

Coal Fired Plants

	Plant MW	Total Use (gpm)	Use Per MW (gpm)	Use per MW (Rounded per Section 3.3) (gpm)
Example 1	858	8477	9.88	9
Example 2	1600	18150	11.34	11
Example 3	568	7969	14.03	15

Table 9.2-7 Coal-Fired Power Plant Ash Generation

Typical PC Supercritical Plant Ash Generation Rate Calculations

	Typical Plant A	Typical Plant B	Typical Plant C
Net Electrical Output (E), MW	600	700	800
Plant Heat Rate (HR), BTU/kW-hr	8800	8900	9000
Coal Higher Heating Value (HV) - Low, BTU/lb	12630	12630	12630
Coal Higher Heating Value (HV) - High, BTU/lb	15600	15600	15600
Coal Firing Rate (F) - Low, tons/hr	169	200	231
Coal Firing Rate (F) - High, tons/hr	209	247	285
Percent Ash,% (Attachment 4)	3.3	9.1	11.2
Ash Generation Rate (A) - Low, tons/hr	5.6	18.2	25.8
Ash Generation Rate (A) - High, tons/hr	6.9	24.7	31.9
Annual Ash Recovery - Low, tons/yr	43985	143116	203567
Annual Ash Recovery - High, tons/yr	54328	194253	251437
Plant Power Adjustment Ratio (equal to 1500 MW divided by the rating of the Typical Plant, MW)	2.500	2.143	1.875
Equivalent Annual Recovery 1500 MW - Low, tons/yr	109963	306676	381689
Equivalent Annual Recovery 1500 MW - High, tons/yr	135821	416256	471444
Equivalent Annual Recovery per MW Net Output - Low, tons/yr	73	204	254
Equivalent Annual Recovery per MW Net Output - High, tons/yr	91	278	314

Table 9.2-7 Coal-Fired Power Plant Ash Generation

Typical PC Supercritical Plant Ash Generation Rate Calculations

	Typical Plant A	Typical Plant B	Typical Plant C

$$F = \frac{(E)MW(HR)\,{}^{BTU}\!/_{kWhr}(1000)\,{}^{kW}\!/_{MW}}{(HV)\,{}^{BTU}\!/_{lb}(2000)\,{}^{lb}\!/_{ton}} = \frac{(E)(HR)}{2(HV)}\,{}^{tons}\!/_{hr}$$

$$A = \frac{(\%\,Ash)(F)}{100}\,{}^{tons}\!/_{hr}$$

Annual Ash Recovery = $\frac{(0.9)(8760)\,{}^{hr}\!/_{yr}\,(99.9)\%\,(A)\,{}^{tons}\!/_{hr}}{(100)\%} = \frac{(0.9)(8760)(99.9)}{100}\,{}^{tons}\!/_{yr}$

These results are based on the following assumptions:

1. The plant capacity factor is assumed to be 90% based on Owner input.
2. The ash recovery efficiency is assumed to be 99.9%.
3. Plant heat rates are assumed to range from 8800 BTU/kW-hrs to 9000 BTU/kW-hrs.
4. Two values of coal higher heating value are assumed: 12,630 BTU/lb and 15,600 BTU/lb.
5. Assumed low, intermediate, and high values of ash content in the coal are obtained from Table 17 of *Steam/its generation and use*, 39th Edition, Babcock and Wilcox for coals ranked 9, 10, and 8, respectively.
6. All calculations are for continuous base load operation and do not include startup, shutdown and/or part load operation.

Table 9.2-7 Coal-Fired Power Plant Ash Generation

Typical PC Coal Fired plant A- Gypsum production

Typical Plant A Output	600	MW net
Typical Plant A heat rate	8800	Btu/kW-hrs
NAPS U3	1500	MW net
Plant size ratio	2.5	ratio
Capacity factor	90	%
Hours of opp. per year	8760	hrs/year
SO_2 removal rate	98	%
Limestone purity	95	%
Limestone Utilization factor	97	%
Coal sulfur content	0.7	%

Molecular weights	
Sulfur	32.064
SO_2	64.06
$CaCO_3$	100.09
Gypsum	172.174
lb/ton conversion	2000

Heat Input =	Heat Rate	×	Net Output/1000
(MMBtu/hr) =	(Btu/kW)	×	(MW) / 1000

	Net Output		Heat Input	Coal heating value		Coal firing rate		Gypsum Production		Limestone Usage
	MW		mmBtu/hr	Btu/lb		lb/hr		tons/year		tons/year
Typical Plant A	600		5,280.00	15,600	5280x1E6/15600=	338,462		49,147.33		31,004.71
NAPS U3 estimates:	1500	5280*2.5 =	13,200.00	15,600	13200x1E6/15600=	846,154	49147.33*2.5=	122,868	31004.71*2.5=	77,512

Table 9.2-7 Coal-Fired Power Plant Ash Generation

Typical PC Coal Fired plant A- Gypsum production

		Typical Plant A calculations:				
Sulfur load to firing chamber	=	0.007*	338,462	=	2,369	lb/hr
	Net Output	Heat Input		Coal heating value	Coal firing rate	
	MW		mmBtu/hr	Btu/lb		lb/hr
		2369/	32.064	=	73.89	lb-moles/hr
SO_2 in flue gas	=	73.89*	64.06	=	4,733	lb/hr
$S + O_2 \rightarrow SO_2$						

SO_2 captured and reacted	=	0.98*	4,733	=	4,639	lb/hr
		4639/	64.06	=	72.41	lb-moles/hr
SO2 reaction with gypsum production						
SO_2+$CaCO_3$ +½O_2 + $2H_2O$ ($CaSO_4.2H_2O$)+ CO_2						
Only reaction considered						
$CaCO_3$ consumed	=	72.41*	100.09	=	7,248	lb/hr
Considering limestone purity and utilization factors						
Limestone required	=	7248/	0.97/0.95	=	7,865	lb/hr
Limestone required annually	=	8760/2000 *0.9*	7,865	=	31,005	tons/year
Gypsum produced	=	72.41*	172.174	=	12,468	lb/hr
Gypsum produced annually	=	8760/2000 *0.9*	12,468	=	49,147	tons/year

Table 9.2-7 Coal-Fired Power Plant Ash Generation

Typical PC Coal Fired plant B- Gypsum production

Typical Plant B Output	700	MW net
Typical Plant B heat rate	8900	Btu/kW-hrs
NAPS U3	1500	MW net
Plant size ratio	2.142857	ratio
Capacity factor	90	%
Hours of opp. per year	8760	hrs/year
SO_2 removal rate	98	%
Limestone purity	95	%
Limestone Utilization factor	97	%
Coal sulfur content	2.2	%

Molecular weights	
Sulfur	32.064
SO_2	64.06
$CaCO_3$	100.09
Gypsum	172.174
lb/ton conversion	2000

Heat Input =	Heat Rate	×	Net Output/1000
(MMBtu/hr) =	(Btu/kW)	×	(MW) / 1000

	Net Output	Heat Input		Coal heating value	Coal firing rate		Gypsum Production		Limestone Usage	
	MW		mmBtu/hr	Btu/lb	lb/hr		tons/year		tons/year	
Typical Plant B	700		6,230.00	14,115	6230x1E6/ 14115=	441,374	201,429.19		127,072.10	
NAPS U3 estimates:	1500	6230*2.142857=	13,350.00	14,115	13350x1E6/14115=	945,802	201429.19*2.142857=	431,634	127072.1*2.142857=	272,297

Table 9.2-7 Coal-Fired Power Plant Ash Generation

Typical PC Coal Fired plant B- Gypsum production

		Typical Plant B calculations:				
Sulfur load to firing chamber	=	0.022*	441,374	=	9,710	lb/hr
		9710/	32.064	=	302.84	lb-moles/ hr
SO_2 in flue gas	=	302.84*	64.06	=	19,400	lb/hr
$S + O_2 \rightarrow SO_2$						
SO_2 captured and reacted	=	0.98*	19,400	=	19,012	lb/hr
		19012/	64.06	=	296.78	lb-moles/ hr
SO2 reaction with gypsum production						
SO_2+$CaCO_3$ +½O_2 + 2H_2O ($CaSO_4$.2H_2O)+ CO_2						
Only reaction considered						
$CaCO_3$ consumed	=	296.78*	100.09	=	29,705	lb/hr
Considering limestone purity and utilization factors						
Limestone required	=	29705/	0.97/0.95	=	32,235	lb/hr
Limestone consumed annually	=	8760/2000*0.9*	32,235	=	127,072	tons/year
Gypsum produced	=	296.78*	172.174	=	51,098	lb/hr
Gypsum produced annually	=	8760/2000*0.9*	51,098	=	201,429	tons/year

Table 9.2-7 Coal-Fired Power Plant Ash Generation

Typical PC Coal Fired plant C- Gypsum production

Typical Plant C Output	800	MW net
Typical Plant C heat rate	9000	Btu/kW-hrs
NAPS U3	1500	MW net
Plant size ratio	1.875	ratio
Capacity factor	90	%
Hours of opp. per year	8760	hrs/year
SO_2 removal rate	98	%
Limestone purity	95	%
Limestone Utilization factor	97	%
Coal sulfur content	4.00	%

Molecular weights	
Sulfur	32.064
SO_2	64.06
$CaCO_3$	100.09
Gypsum	172.174
lb/ton conversion	2000

Heat Input =	Heat Rate	X	Net Output/1000
(MMBtu/hr) =	(Btu/kW)	X	(MW) / 1000

	Net Output	Heat Input		Coal heating value	Coal firing rate		Gypsum Production		Limestone Usage	
	MW	mmBtu/hr		Btu/lb		lb/hr	tons/year		tons/year	
Typical Plant C	800		7,200.00	12,630	7200x1E6/12630=	570,071	473,022.39		298,407.33	
NAPS U3 estimates:	1500	7200*1.875=	13,500.00	12,630	13500x1E6/12630=	1,068,884	473022.39*1.875=	886,917	298407.33*1.875=	559,514

Table 9.2-7 Coal-Fired Power Plant Ash Generation

Typical PC Coal Fired plant C- Gypsum production

Typical Plant C calculations:						
Sulfur load to firing chamber	=	0.04*	570,071	=	22,803	lb/hr
		22803/	32.064	=	711.17	lb-moles/hr
SO_2 in flue gas	=	711.17*	64.06	=	45,557	lb/hr
S + O_2 SO_2						
SO_2 captured and reacted	=	0.98*	45,557	=	44,646	lb/hr
		44646/	64.06	=	696.94	lb-moles/hr
SO2 reaction with gypsum production						
SO_2+$CaCO_3$ +½O_2 + 2H_2O ($CaSO_4$.2H_2O)+ CO_2						
Only reaction considered						
$CaCO_3$ consumed	=	696.94*	100.09	=	69,757	lb/hr
Considering limestone purity and utilization factors						
Limestone required	=	69757/	0.97/0.95	=	75,699	lb/hr
Limestone required annually	=	8760/2000*0.9*	75,699	=	298,407	tons/year
Gypsum produced	=	696.94*	172.174	=	119,996	lb/hr
Gypsum produced annually	=	8760/2000*0.9*	119,996	=	473,022	tons/year

Table 9.2-7 Coal-Fired Power Plant Ash Generation

Typical Supercritical PC Fired plant

Gypsum Production & Limestone Consumption summary:

	Annual Range	Plant A	Plant B	Plant C	High	Low
	Tons/year	Tons/year	Tons/year	Tons/year	Tons/year	Tons/year
Gypsum Produced	123000 - 887000	122,868	431,634	886,917	887,000	123,000
Limestone Consumed	78000 - 560000	77,512	272,297	559,514	560,000	78,000

Notes:

1) The calculation is based on Eastern Bituminous Coal with a typical sulfur content of 0.7 to 4.0% (0.7%, 2.2%, & 4.0% used) typical higher heating values of 12,630 to 15,600 Btu/lb.

2) Calculation based on typical pulverized coal fired supercritical plants with heat rates between 8800 to 9000 Btu/kW-hrs.

3) The calculation uses a 90% capacity factor. All annual rates are based on the 90% capacity factor.

4) Gypsum production for typical plant is based on a 98% SO_2 removal efficiency.

5) The calculation has been corrected for the expected net output from NAPS-U3 of 1500 MW net.

6) Gypsum production for typical plant is based on a 90% dry gypsum (for landfill).

7) Limestone purity is assumed to be 95%, and utilization factor is assumed to be 97%, this is typical.

8) The High, Low, and the annual range has been rounded of to the nearest 1,000.

Table 9.2-8 Gas-Fired Generation (Combined-Cycle) Operational Characteristics

Assumption	Source
Station Capacity 1500 MW (net)	Assumed Capacity of three combined-cycle units
Heat Rate 7000 Btu/kW-hrs	DVP's experience with similar units
Primary Fuel Natural Gas	
Emissions Control Technology SCR (Selective Catalytic Reduction)	
Emissions Removal Rate (Reference 38) 80%	Assumed Removal Rate for NO_x and CO
NO_x Emissions Rate (References 42 and 43) 0.01 lb/MMbtu	Water-steam injection with SCR- control technology
SO_x Emissions Rate (Reference 39) 0.0034 lb/MMbtu	
CO Emissions Rate (Reference 39) 0.006 lb/MMbtu	Water-steam injection with SCR- control technology
PM-10 Emissions Rate (References 42 and 43) 0.011 lb/MMbtu	
VOC Emissions Rate (Reference 39) 0.0021 lb/MMbtu	
Capacity Factor (High) 90%	

Table 9.2-9 Emissions Logic – Gas-fired Combined Cycle, 90% Capacity Factor

Annual Gas Burn

$$1500\ \text{MW} \times \frac{7000\ \text{BTU}}{\text{kW-hr}} \times \frac{1\ \text{MMBTU}}{10^6\ \text{BTU}} \times \frac{1000\ \text{kW}}{1\ \text{MW}} \times \frac{90\%}{\text{Capacity Factor}} \times \frac{8760\ \text{hours}}{1\ \text{year}} = 82{,}782{,}000\ \text{MMBTU/year}$$

NO_x Emissions

$$\frac{0.01\ \text{lb}}{\text{MMBTU}} \times \frac{1\ \text{ton}}{2000\ \text{lb}} \times \frac{82{,}782{,}000\ \text{MMBTU}}{\text{year}} = 414\ \text{tons/year}$$

SO_x Emissions

$$\frac{0.0034\ \text{lb}}{\text{MMBTU}} \times \frac{1\ \text{ton}}{2000\ \text{lb}} \times \frac{82{,}782{,}000\ \text{MMBTU}}{\text{year}} = 141\ \text{tons/year}$$

CO Emissions

$$\frac{0.006\ \text{lb}}{\text{MMBTU}} \times \frac{1\ \text{ton}}{2000\ \text{lb}} \times \frac{82{,}782{,}000\ \text{MMBTU}}{\text{year}} = 248\ \text{tons/year}$$

PM-10 Emissions

$$\frac{0.011\ \text{lb}}{\text{MMBTU}} \times \frac{1\ \text{ton}}{2000\ \text{lb}} \times \frac{82{,}782{,}000\ \text{MMBTU}}{\text{year}} = 455\ \text{tons/year}$$

VOC Emissions

$$\frac{0.0021\ \text{lb}}{\text{MMBTU}} \times \frac{1\ \text{ton}}{2000\ \text{lb}} \times \frac{82{,}782{,}000\ \text{MMBTU}}{\text{year}} = 87\ \text{tons/year}$$

Table 9.2-10 CO_2 Emissions of Natural Gas Technologies

Natural Gas (Assumes Annual Capacity Factor of 90%)

Emissions Rate: 1135 lb/MW-hrs (Reference 40)

Annual CO_2 Emissions:

$$\frac{1135\ \text{lb}}{\text{MW-hr}} \times \frac{1\ \text{ton}}{2000\ \text{lb}} \times 1500\ \text{MW} \times 90\% \times \frac{8760\ \text{hours}}{\text{year}} = 6{,}711{,}255\ \text{tons/year}$$

Table 9.2-11 Recent Gas-Fired Power Plant Water Consumption

Gas Fired Plants

	Plant MW	Total Use (gpm)	Use (gpm/MW)	Use (rounded per Section 3.3) (gpm/MW)
Example 1	600	2603	4.34	4
Example 2	1611	10340	6.42	6
Example 3	514	3892	7.57	8

Table 9.2-12 Impacts Comparison Summary

Impact Category	Proposed Action Unit 3	Coal-Fired Generation	Gas-Fired Generation
Land Use	Small	Small	Small
Water Quality/Use	Small	Small to Moderate	Small to Moderate
Air Quality	Small	Moderate	Moderate
Ecological Resources	Small	Small	Small
Threatened and Endangered Species	Small	Small	Small
Human Health	Small	Small	Small
Socioeconomics	Small to Moderately Beneficial	Small to Moderately Beneficial	Small to Moderately Beneficial
Waste Management	Small	Moderate	Small
Aesthetics	Small	Small to Moderate	Small
Cultural Resources	Small	Small	Small
Accidents	Small	Small	Small

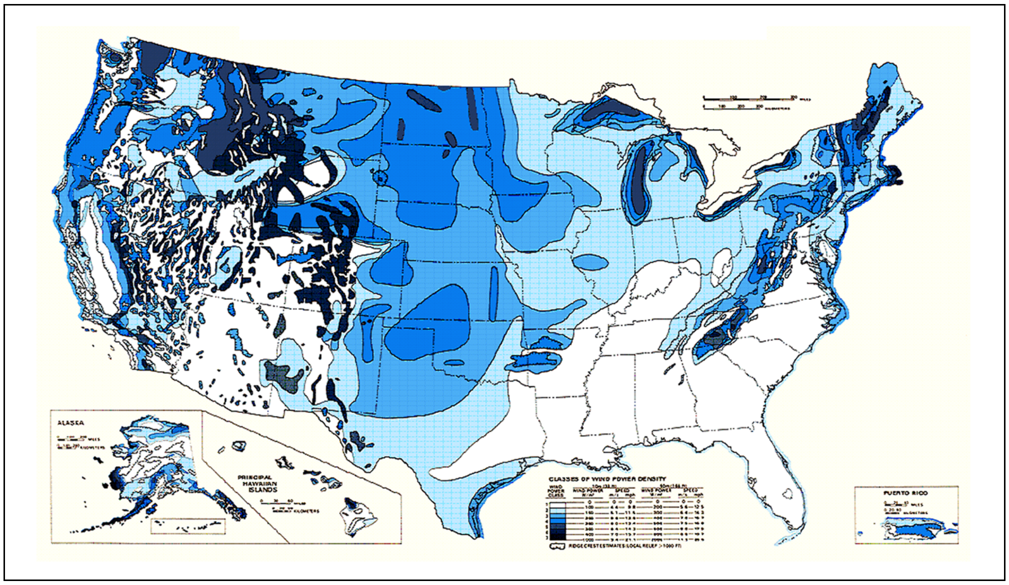
Notes:

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 destabilize, any important attribute of the resource.

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

Figure 9.2-1 United States Annual Average Wind Power



Source: Reference 13

9.3 Alternative Sites

Alternative sites are evaluated in ESP-ER Section 9.3 and finally resolved in FEIS Section 9.3. In accordance with 10 CFR 51.92(e)(3), and consistent with the ESP Finality on Environmental Issues in SECY-06-0220, no further discussion is required.

9.4 Alternative Plants and Transmission Systems

The information for this section is provided in ESP-ER Section 9.4, and the evaluation of system design alternatives for heat dissipation systems and circulating water systems is resolved in FEIS Section 8.2.

Dominion has conducted the IFIM study, as required in ESP Condition 3.I(2), and has further evaluated lake management operations as part of the study. Supplemental information on Lake Anna and watershed enhancements is provided in Section 5.10.1 that addresses specifically lake mitigating actions based on the results of the IFIM study.

At the time of the ESP-ER and based on an initial evaluation, the existing transmission lines were thought to have sufficient capacity for the total output of the existing and new units. On that basis, it was determined that there were no environmentally equivalent or more advantageous alternatives to "no action." However, it has now been determined that a new transmission line and other system reinforcements are required for grid reliability in association with the interconnection of Unit 3. Thus, the ESP-ER discussion is supplemented by the following information concerning the transmission lines.

PJM Generator Interconnection Q65 North Anna 500kV (1594 MW) System Impact Study (Reference) determined that an additional 500 kV transmission line from the North Anna Substation to the Ladysmith Switching Substation is required for grid stability in association with the interconnection of Unit 3. As part of the study, three existing corridors were considered for this new line: 1) NAPS-to-Ladysmith (east); 2) NAPS-to-Midlothian (south); and 3) NAPS-to-Morrisville (north) (see Figure 9.4-1). Only these corridors were considered because they would require no new land use and they already connect to NAPS at the 500 kV level. Construction of new 500 kV substations would be cost-prohibitive and require more land use.

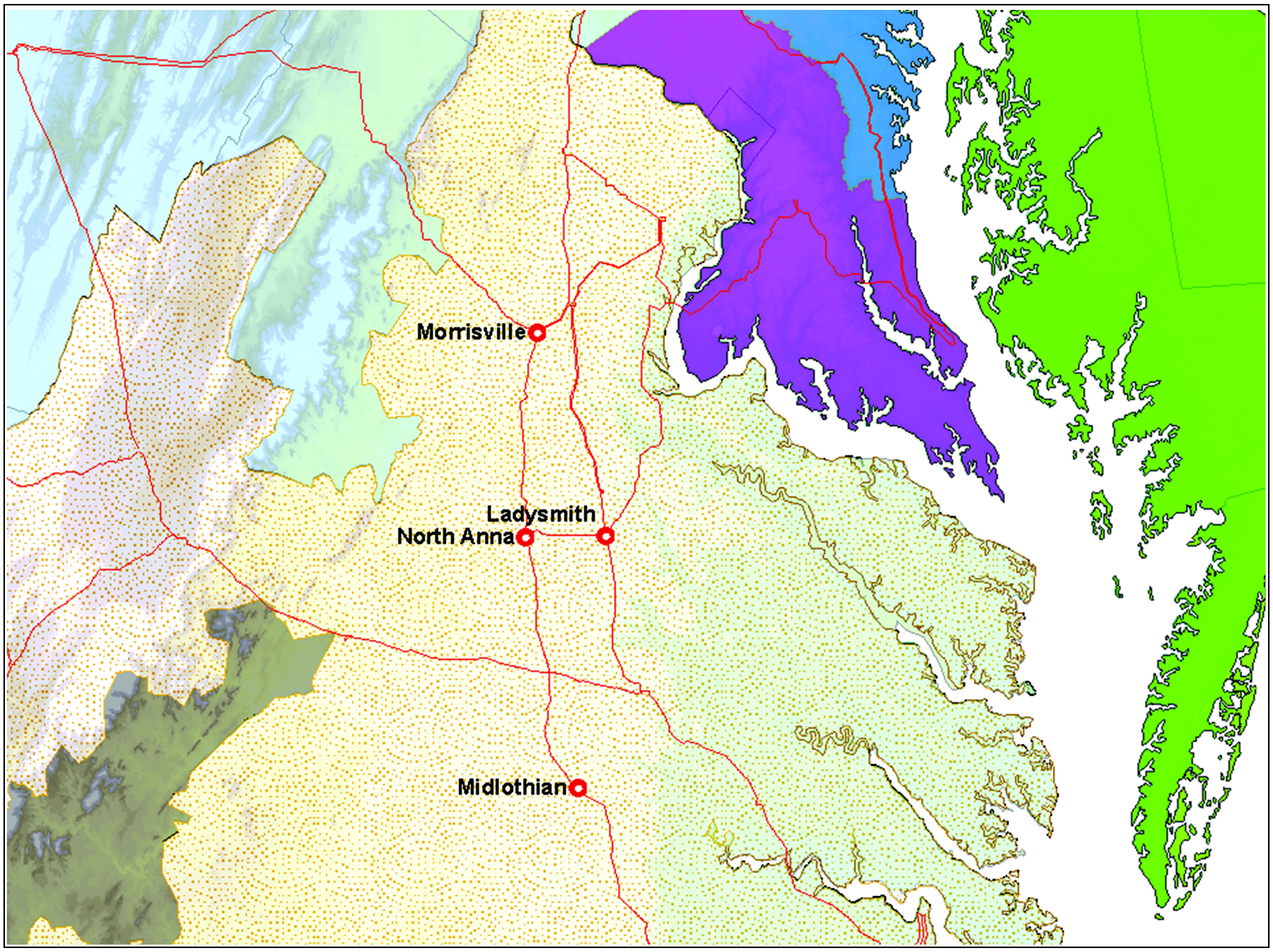
The PJM Study selected the NAPS-to-Ladysmith (east) corridor as the best alternative because it is sufficiently wide for a new 500 kV line, including the space needed for structure separation. Additionally, it is the shortest existing corridor. The NAPS-to-Midlothian (south) and NAPS-to-Morrisville (north) corridors are at least twice the length of the NAPS-to-Ladysmith corridor.

Because new transmission corridors are not required, the impacts of the new transmission line will be SMALL as described in Sections 4.1, 4.2, 4.3, 4.4, 5.1, and 5.6. New corridors for the new transmission line would pose greater impacts on land use, ecological systems, cultural resources, and local populations. Thus, the development of a new transmission corridor for installation of the new 500 kV line is not an environmentally preferable alternative.

Section 9.4 References

PJM System Planning Division, "PJM Generator Interconnection Q65 North Anna 500 kV (1570 MW Capacity/1594 Energy) Revised System Impact Study & Facilities Study Report Resulting from Necessary Studies," September 2013.

Figure 9.4-1 Existing Corridors or Routes Considered for the New North Anna Transmission Line



Chapter 10 Environmental Consequences of the Proposed Action

The potential environmental consequences of constructing and operating new units at the NAPS site are discussed in the ESP-ER Chapter 10 and associated issues are resolved in FEIS Section 10.1 and discussed in FEIS Sections 10.2, 10.4, and 10.5. Supplemental information is provided below.

10.1 Unavoidable Adverse Environmental Impacts

This section addresses the additional environmental impacts that have been identified in this ER.

10.1.1 Unavoidable Adverse Environmental Impacts During Construction

Table 10.1-1 lists the expected impacts from the construction of proposed Unit 3, and the mitigation measures that are practical to reduce these impacts. Those instances where adverse environmental impacts would remain after all reasonable means have been taken to avoid or mitigate them are identified in Table 10.1-1. A "Y", under the column labeled "Unavoidable Adverse Impacts" indicates that there are such impacts, and "N" indicates that the specified mitigation measures are sufficient to reduce the impacts to insignificant or small.

10.1.2 Unavoidable Adverse Environmental Impacts During Operation

Table 10.1-2 lists the expected impacts from the operation of proposed Unit 3, and the mitigation measures that are practical to reduce these impacts. Those instances, where adverse environmental impacts would remain after practical means to avoid or mitigate them have been applied, are identified in Table 10.1-2. A "Y" under the column labeled "Unavoidable Adverse Impacts" indicates that there are such impacts, and "N" indicates that the specified mitigation measures are sufficient to reduce the impacts to insignificant or small.

10.1.3 Summary of Adverse Environmental Impacts

As may be seen from Table 10.1-1 and Table 10.1-2, all the newly identified potential adverse environmental impacts associated with construction and operation of the proposed Unit 3 are reduced to insignificant or eliminated through the application of the listed mitigation measures, including those identified in the ESP-ER.

10.1.4 Irreversible and Irretrievable Commitment of Resources

Irreversible or irretrievable commitment of resources are addressed in Section 10.2.

Table 10.1-1 Newly Identified Construction-Related Unavoidable Adverse Environmental Impacts

Category/ ER Section	Construction-Related Issue/ Adverse Environmental Impact	Mitigation Measure	Unavoidable Adverse Environmental Impacts
The Site and Vicinity Section 4.1.1	Modifications to offsite roadways, bridges, and railway crossings to accommodate heavy hauls. – Additional land use outside NAPS site boundary.	Upon completion of the transports, temporary structures would be removed, interferences would be reinstalled, and disturbed areas would be restored back to their original condition or better.	N
Transmission Line Rights-of-Way and Offsite Areas Section 4.1.2	Based on a recent evaluation of the existing transmission lines, network improvements would be required to reliably connect Unit 3. This would include an additional 500 kV line, and associated equipment. – Additional land use outside North Anna site boundary.	The new transmission line would be located in an existing corridor and constructed and maintained under practices and procedures applicable to the existing transmission lines.	N
Transmission Line Rights-of-Way and Offsite Areas Section 4.1.2	Based on a recent evaluation of the existing transmission lines, network improvements would be required to reliably connect Unit 3. This would include an additional 500 kV line, and associated equipment. – Additional land use outside North Anna site boundary.	Clearing methods for small trees, bushes and vegetation would be performed in a manner which would protect natural resources and control erosion of the landscape and siltation of streams. Trees and brush located within an approximately 100-foot buffer of a stream or ditch with running water would be hand-cleared and material approximately three inches in diameter and above would be removed from the buffer, leaving material less than three inches undisturbed.	N
Transmission Line Rights-of-Way and Offsite Areas Section 4.1.2	Based on a recent evaluation of the existing transmission lines, network improvements would be required to reliably connect Unit 3. This would include an additional 500 kV line, and associated equipment. – Additional land use outside North Anna site boundary.	Once all the construction of transmission lines has been completed, Dominion would restore disturbed areas by means such as: 1) rehabilitating land by discing, fertilizing, seeding, and installing erosion control devices (e.g., water bars and mulch); 2) properly removing and disposing debris left or caused by construction; and 3) restoring damaged property to its original condition and to the satisfaction of the property owner.	N

Table 10.1-1 Newly Identified Construction-Related Unavoidable Adverse Environmental Impacts

Category/ ER Section	Construction-Related Issue/ Adverse Environmental Impact	Mitigation Measure	Unavoidable Adverse Environmental Impacts
Transmission Line Rights-of-Way and Offsite Areas Sections 4.1.2 and 4.1.3	Based on a recent evaluation of the existing transmission lines, network improvements would be required to reliably connect Unit 3. This would include an additional 500 kV line, and associated equipment. – Potential impacts to cultural or prehistoric resources.	Appropriate actions would be taken (e.g., stop work) following discovery of potential historic or archaeological resources.	N
Historic Properties and Cultural Resources Section 4.1.3	Upon completion of the transportation of large components disruptions to cultural resources including a historic train depot in Beaverdam, a ferry landing at the roll-off point, and the North Anna Battlefield are possible.	To the extent practicable, historic properties and cultural resources would be avoided. Mitigation measures for the impacts of the proposed large component transport route include the rehabilitation of land, removal of debris, and restoration of damaged property to its original condition or as close as possible.	N
Historic Properties and Cultural Resources Section 4.1.3	A newly discovered archaeological site lies within the NAPS-to-Ladysmith corridor. – Potential impacts to cultural or prehistoric resources.	Site will be flagged prior to and during construction activities to prevent disturbance.	N
Historic Properties and Cultural Resources Section 4.1.3	A newly discovered architectural resource is approximately 1/4 of a mile to the north of the NAPS-to-Ladysmith corridor. – Potential impacts to cultural resources.	The expected visual impact will be minimized by limiting the new tower heights to no greater than 20 ft. taller than existing towers. Depending on the final tower design, a photo simulation analysis may be required. The visual impact will be further minimized by selection of material colors that help the towers blend in to the natural surroundings.	N

Table 10.1-1 Newly Identified Construction-Related Unavoidable Adverse Environmental Impacts

Category/ ER Section	Construction-Related Issue/ Adverse Environmental Impact	Mitigation Measure	Unavoidable Adverse Environmental Impacts
Surface Water Hydrologic Alterations Section 4.2.1	Based on a recent evaluation of the existing transmission lines, network improvements would be required to reliably connect Unit 3. This would include an additional 500 kV line, and associated equipment. – Potential impact to surface water bodies and wetlands.	Clearing methods for small trees, bushes and vegetation would be performed in a manner which protect natural resources and control erosion of the landscape and siltation of streams. Trees and brush located within an approximately 100-foot buffer of a stream or ditch with running water would be hand-cleared and material approximately three inches in diameter and above would be removed from the buffer, leaving material less than three inches undisturbed.	N
Surface Water Hydrologic Alterations Section 4.2.1	Based on a recent evaluation of the existing transmission lines, network improvements would be required to reliably connect Unit 3. This would include an additional 500 kV line, and associated equipment. – Potential impact to surface water bodies and wetlands.	To the extent practicable, construction would avoid shorelines and wetland areas. Should wetlands be impacted, the U.S. Army Corps of Engineers (and other appropriate agencies) would be consulted, and permits and approvals would be obtained as necessary.	N
Surface Water Hydrologic Alterations Section 4.2.1	Based on a recent evaluation of the existing transmission lines, network improvements would be required to reliably connect Unit 3. This would include an additional 500 kV line, and associated equipment. – Potential impact to surface water bodies and wetlands.	Soil disturbances would be controlled within an approximately 100-foot buffer of streams and ditches with running water. Erosion and sedimentation control measures and buffer zone maintenance around water bodies to reduce runoff and erosion. These measures would be left in place, until stabilization of the area is achieved. Work sites would be stabilized prior to moving to the next area.	N
Hydrologic Alterations Section 4.2.1	Based on a recent evaluation of the existing transmission lines, network improvements would be required to reliably connect Unit 3. This would include an additional 500 kV line, and associated equipment. – Potential impact to surface water bodies and wetlands.	Potential impacts to streams and creeks would be mitigated by performing work related to stream crossings in accordance with state standards and specifications. In addition, streams and creeks would be crossed at right angles at one location on the corridor using culverts, temporary bridges, or large aggregate stone. Materials would be removed from the temporary crossing at the completion of the project.	N

Table 10.1-1 Newly Identified Construction-Related Unavoidable Adverse Environmental Impacts

Category/ ER Section	Construction-Related Issue/ Adverse Environmental Impact	Mitigation Measure	Unavoidable Adverse Environmental Impacts
Terrestrial Ecosystem- Transmission Corridors Section 4.3.1.1	Based on a recent evaluation of the existing transmission lines, network improvements would be required to reliably connect Unit 3. This would include an additional 500 kV line, and associated equipment. – Potential impacts to terrestrial ecosystem.	Once all the construction of transmission lines has been completed, Dominion would restore disturbed areas by means such as: (1) rehabilitating land by discing, fertilizing, seeding, and installing erosion control devices (e.g. water bars and mulch); (2) properly removing and disposing debris left or caused by construction; and (3) restoring damaged property to its original condition and to the satisfaction of the property owner.	N
Terrestrial Ecosystem- Transmission Corridors Section 4.3.1.1	Based on a recent evaluation of the existing transmission lines, network improvements would be required to reliably connect Unit 3. This would include an additional 500 kV line, and associated equipment. – Potential impacts to terrestrial ecosystem.	The new transmission line would be located in an existing corridor and constructed and maintained under practices and procedures applicable to the existing transmission lines.	N
Terrestrial Ecosystem- Transmission Corridors Section 4.3.1.1	Based on a recent evaluation of the existing transmission lines, network improvements would be required to reliably connect Unit 3. This would include an additional 500 kV line, and associated equipment. – Potential impacts to terrestrial ecosystem.	Clearing methods for small trees, bushes and vegetation would be performed in a manner which would protect natural resources and control erosion of the landscape and siltation of streams. Trees and brush located within an approximately 100-foot buffer of a stream or ditch with running water would be hand-cleared and material approximately three inches in diameter and above would be removed from the buffer, leaving material less than three inches undisturbed.	N
Terrestrial Ecosystem- Transmission Corridors Section 4.3.1.1	Based on a recent evaluation of the existing transmission lines, network improvements would be required to reliably connect Unit 3. This would include an additional 500 kV line, and associated equipment. – Potential impacts to terrestrial ecosystem.	Land clearing necessary to accommodate the new transmission tower foundations would be controlled by existing transmission line procedures, good construction practices, and established best management practices, as well as applicable regulations.	N

Table 10.1-1 Newly Identified Construction-Related Unavoidable Adverse Environmental Impacts

Category/ ER Section	Construction-Related Issue/ Adverse Environmental Impact	Mitigation Measure	Unavoidable Adverse Environmental Impacts
Terrestrial Ecosystem- Transmission Corridors Section 4.3.1.1	Based on a recent evaluation of the existing transmission lines, network improvements would be required to reliably connect Unit 3. This would include an additional 500 kV line, and associated equipment. – Potential impacts to terrestrial ecosystem.	Soil disturbances would be avoided or reduced to the extent practicable within an approximately 100-foot buffer of streams and ditches with running water. Erosion and sedimentation control measures and buffer zone maintenance around water bodies would be implemented to reduce runoff and erosion. These measures would be left in place, until stabilization of the area is achieved. Work sites would be stabilized prior to moving to the next area.	N
Terrestrial Ecosystem- Transmission Corridors Section 4.3.1.1	Based on a recent evaluation of the existing transmission lines, network improvements would be required to reliably connect Unit 3. This would include an additional 500 kV line, and associated equipment. – Potential impacts to terrestrial ecosystem.	Dust suppression techniques would be utilized and equipment maintenance employed to reduce airborne emissions	N
Section 4.3.1.4 Transportation of Large Components	The transportation of large components may potentially cause disruptions to wetlands adjacent to the proposed large component transport route include cutting, filling, and road improvements to these wetland areas.	To the extent practicable, impacts to shorelines and wetland areas would be avoided. Mitigation measures for wetlands and waterways located along the proposed large component transport route would include maintaining temporary erosion and sedimentation controls until permanent stabilization is achieved, removal of all debris, and rehabilitation of disturbed lands as close to their original condition as possible.	N
Socioeconomic Impacts Section 4.4	Based on a recent evaluation of the existing transmission lines, network improvements would be required to reliably connect Unit 3. This would include an additional 500 kV line, and associated equipment. – Potential impacts on public access to the area for recreational activities.	As a safety precaution, during installation of the transmission line across Lake Anna, access to the area would be temporarily restricted from recreational use.	N

Table 10.1-1 Newly Identified Construction-Related Unavoidable Adverse Environmental Impacts

Category/ ER Section	Construction-Related Issue/ Adverse Environmental Impact	Mitigation Measure	Unavoidable Adverse Environmental Impacts
Wetlands and Surface Water– Environmental Information Concerning Additional Property Appendix 4A	Additional property contiguous with the NAPS site will be utilized for Unit 3 project construction support. – Potential wetland impacts.	Impacts to wetlands within the additional property may be mitigated through preservation of onsite streams or purchasing offset credits from an approved mitigation bank.	N
Land Use – Environmental Information Concerning Additional Property Appendix 4A	Additional property contiguous with the NAPS site will be utilized for Unit 3 project construction support. – Potential land-use impacts.	The additional property area will be stabilized and facilities will be removed upon completion of the construction of Unit 3.	N

Table 10.1-2 Newly Identified Operations-Related Unavoidable Adverse Environmental Impacts

Category/COL ER Section	Operations-Related Issue/Adverse Environmental Impact	Mitigation Measure	Unavoidable Adverse Environmental Impacts
Water-Use Impacts Section 5.2.2	New wet cooling towers and a separate sanitary waste system would be added for Unit 3. – Potential for additional chemical effluents.	Nonradioactive effluents, including sanitary waste and blowdown from the Unit 3 cooling towers, would be governed by limits established in VPDES permit.	N
Water-Use Impacts Section 5.2.2	New wet cooling towers and a separate sanitary waste system would be added for Unit 3. – Potential for additional chemical effluents.	Operation of a dechlorination system to neutralize chlorine in the circulating water and plant service water cooling tower blowdown before discharge to the WHTF and eventually to the North Anna Reservoir. (Section 5.2.2)	N
Nonradioactive-Waste-System Impacts Section 5.5.1	Separate Unit 3 sanitary waste system would be added. – Potential for additional chemical effluents.	Sanitary wastes from the new sanitary system will be managed on site and disposed of off site in compliance with applicable laws, regulations, and permit conditions imposed by federal, Virginia, and local agencies (Section 5.5.1)	N
Nonradioactive-Waste-System Impacts Section 5.5.1	New wet cooling towers and a separate sanitary waste system would be added for Unit 3. – Potential for additional chemical effluents.	Nonradioactive effluents, including sanitary waste and blowdown from the Unit 3 cooling towers, would be governed by limits established in VPDES permit.	N
Mitigating Actions Based on the Results of the IFIM Study Section 5.10.1	The addition of Unit 3 to the existing NAPS site would create a further need on water resources of Lake Anna.	The normal pool level would be increased from Elevation 250.0 to 250.25 ft msl to reduce impacts on the ecology, wetland and recreation in Lake Anna and downstream.	N

10.2 Irreversible and Irretrievable Commitments of Resources

Irreversible and irretrievable commitments of resources are addressed in ESP-ER Section 10.2 and were resolved in FEIS Section 10.5, with the exception of an actual estimate of construction materials. The following supplemental information is provided to address the estimate of construction materials.

The irreversible and irretrievable commitments of material resources during the construction of proposed Unit 3 would be similar to that of any major construction project. Use of materials considered hazardous will be minimized, in accordance with safety regulations and practices. A Department of Energy report (Reference) provides the following new reactor construction estimates:

- 12,239 cubic yards of concrete and 3,107 tons of rebar for a reactor building
- 2,500,000 LF of cable for a reactor building
- 6,500,000 LF of cable for a single unit
- Up to 275,000 LF of piping (≥2.5") for a single 1300 MWe unit

The amounts of these materials are typical of other large power-generating facilities, such as hydroelectric and coal-fired power plants, that are constructed throughout the United States. The use of construction materials in the quantities associated with those expected for a nuclear power plant, while irreversible and irretrievable unless they are recycled at decommissioning, would be of small consequence, with respect to the availability of such resources.

The conclusion in the FEIS that the irreversible and irretrievable commitments would be of only small consequence will remain valid.

Section 10.2 References

Application of Advanced Construction Technologies to New Nuclear Power Plants, MPR-2610, Rev. 2, September 24, 2004, U.S. Department of Energy, Washington, D.C.

10.3 Relationship Between Short-Term Uses and Long-Term Productivity of the Human Environment

The relationship between short-term uses and long-term productivity of the human environment is addressed in ESP-ER Section 10.3. Further information on the benefits of the proposed action is provided in Chapter 8.

The principal short-term benefit of construction and operation of the proposed Unit 3 would be the production of electricity. The enhancement of regional productivity resulting from the electricity produced by Unit 3 would not be equaled by any other use of the NAPS site. In addition, most long-term impacts resulting from land-use preemption by plant structures would be eliminated by removing these structures or by converting them to other productive uses during decommissioning.

No new unavoidable adverse environmental impacts of construction and operation of the proposed Unit 3 have been identified to have significant impact on long-term productivity. Therefore, none of the adverse environmental impacts represent a long-term effect that would preclude any options for future use of the NAPS site.

10.4 Benefit – Cost Balance

The benefits and costs associated with construction and operation of proposed Unit 3 are summarized in Tables 10.4-1 and 10.4-2, respectively.

10.4.1 **Benefits**

The evaluation of monetary and non-monetary benefits of constructing and operating proposed Unit 3, including benefits related to tax revenues and to local and state economies, is provided in Chapter 8. These benefits are summarized in Table 10.4-1.

10.4.2 **Costs**

This section identifies both internal and external costs associated with the construction and operation of proposed Unit 3. The term "internal" generally refers to the monetary costs associated with a project, while the term "external" refers to non-monetary environmental costs of constructing and operating a new plant. These costs are summarized in Table 10.4-2.

Many of the cost attributes described in this section are detailed in Section 10.1 (Unavoidable Adverse Environmental Impacts), Section 10.2 (Irreversible and Irretrievable Commitments of Resources), and Section 10.3 (Relationship Between Short-term Uses and Long-term Productivity of the Human Environment) of the ESP-ER and this ER.

10.4.2.1 **Internal Costs**

This section describes the monetary costs of constructing and operating the proposed Unit 3. Internal costs include capital costs of the plant and transmission lines and operating costs, including staffing and maintenance (O&M), and fuel, as well as decommissioning costs.

10.4.2.1.1 Construction

The estimated cost of constructing Unit 3 is provided in COLA Part 1.

10.4.2.1.2 Operation

The U.S. Department of Energy study (Reference 2, Table 3.9, p. 111) estimates the annual O&M costs of a 1340 MWe ESBWR plant to be $74,178,482, which is calculated as $6.83 per MW-hr. This cost is expressed as unit of electric net generation, or megawatts electric, and reflects all costs that are incurred to operate and maintain the plant. Included in this cost are salaries and benefits for the plant staff, parts, material and equipment costs for maintaining plant equipment, fees, insurance, overhead costs, and short-term contract services.

Nuclear fuel cost and decommissioning cost are calculated separately. The Organisation for Economic Co-Operation and Development (OECD) Study (Reference 1, Table 3.9, p. 44) estimates that the average fuel cost for a nuclear generating plant is $4.64 per MW-hr at a 5 percent discount rate. A decommissioning cost estimate is provided in Part 1 of this COL Application.

10.4.2.2 External Costs

This section describes the external (non-monetary) environmental and social costs of constructing and operating proposed Unit 3. The environmental effects of construction and operation of proposed Unit 3 are described in Section 10.1 and ESP-ER Section 10.1. Details are also provided in Tables 10.1-1 and 10.1-2 of the ESP-ER and this ER regarding potential mitigation measures for each unavoidable adverse impact related to a construction or operation activity.

10.4.2.2.1 Land Use

Approximately 133 acres will be affected by the construction of proposed Unit 3 as a result of permanent facilities. An additional 160 acres, including approximately 111 acres outside the EAB on the additional property, will be disturbed on a short-term basis as a result of temporary activities and construction of temporary facilities and laydown areas. Clearing and removal of trees growing within the NAPS site will be required. Loss of land use is an external cost of the construction of Unit 3. A detailed description of land use impacts is provided in Section 4.1 and ESP-ER Section 4.1.

10.4.2.2.2 Hydrological and Water Use

Section 4.2 and ESP-ER Sections 4.2 and 5.2 describe hydrologic alterations for construction and operation. As discussed in these sections, there are some costs associated with providing water for various needs during construction and operation. The majority of water used for Unit 3 operations will be surface water drawn from the North Anna Reservoir. As resolved in FEIS Section 5.3.2, this water use represents only a small fraction of available water even at low flow conditions. The FEIS concluded that the impact of Unit 3 operation on downstream water users would be SMALL for most and MODERATE for drought years. There are also costs associated with groundwater consumption. The effects related to groundwater use are described as small (see ESP-ER Sections 2.3.2.2 and 5.2, and FEIS Section 2.6.2). Use of groundwater by the site will not affect off-site users in terms of either water availability or water quality.

Relatively small levels of nonradioactive and radioactive effluents will be introduced into the lake. Water quality impacts of chemical effluents discharged during Unit 3 operations are discussed in Section 5.2.2 and will be SMALL. FEIS Section 5.9.3.3 resolved that effects upon humans as a result of liquid radiological effluents released from new units would be SMALL. Cooling water blowdown that discharges to the North Anna Reservoir results in a thermal plume. FEIS Section 5.4.2.4 resolved that effects of a thermal plume on Lake Anna would be SMALL and localized.

10.4.2.2.3 **Terrestrial and Aquatic Biology**

Ecological effects, related to plant construction and operation, are described in Section 4.3 and in ESP-ER Sections 4.3 and 5.3, respectively. Some cost due to mortality of wildlife during construction is anticipated. These losses are not expected to be large enough to affect the long term stability of wildlife populations. FEIS Section 5.4.1 resolved that effects on terrestrial ecosystems would be SMALL. The cooling system, in addition to the makeup water intake structures, is designed to reduce loss of aquatic biota as a result of impingement and entrainment. The construction of the new intake structure will result in only minor and temporary effects to aquatic biology. In FEIS Section 5.4.2.8, the NRC determined that effects upon aquatic ecosystems as a result of operations of new nuclear units would be SMALL.

Relatively small amounts of air emissions from gas turbine and diesel generators, auxiliary boilers and equipment, and vehicles are generated from nuclear power plant operation.

Cooling tower drift deposits some salt on the surrounding vicinity, but the level is unlikely to result in any measurable impact on plants and vegetation. The Unit 3 cooling towers are designed to abate atmospheric vapor plume produced.

Small amounts of hazardous effluents are components of the Unit 3 plant discharges into Lake Anna. Relatively small amounts of hazardous wastes will be generated that need to be managed and disposed of pursuant to the Resource Conservation and Recovery Act (RCRA). Section 3.6 and ESP-ER Section 3.6 discuss nonradioactive waste systems.

10.4.2.2.4 **Hazardous and Radioactive Emissions, Effluents, and Wastes**

Operation of proposed Unit 3 will include minor radioactive air emissions to the atmosphere. Relatively small levels of radioactive effluents will be generated and discharged into Lake Anna.

Low-Level radioactive wastes will be generated that need to be stored, treated, and disposed of in a licensed landfill. High-level radioactive spent fuel will be generated that will need to be isolated (or possibly reprocessed) in a geological repository for thousands or tens of thousands of years. FSAR Chapter 11 describes the radioactive waste management systems.

10.4.2.2.5 **Materials, Energy, and Uranium**

Construction of proposed Unit 3 will result in an irreversible and irretrievable commitment of materials and energy (see Section 10.2 and ESP-ER Section 10.2). Operation of the new reactor will contribute to the depletion of uranium.

10.4.2.2.6 **Potential for Nuclear Accident**

The potential effects of various types of nuclear accidents are described in FEIS Section 5.10. In Section 5.10.3, the NRC concluded that the potential environmental impacts from a postulated accident from the operation of two additional advanced light water reactor (LWR) nuclear units at NAPS would be SMALL.

10.4.2.2.7 **Socioeconomic Costs**

Sections 4.4 and 5.8 and ESP-ER Sections 4.4 and 5.8 describe socioeconomic costs related to construction and operation of new units at NAPS. Additional public and social services may be required to meet the demands of people moving into the area during construction and operation of the new unit at NAPS. Increased tax revenues from those individuals and from NAPS should offset these costs.

10.4.3 **Summary**

As described in Section 8.4, there is a growing baseload demand and growing baseload supply shortfall for the region of interest. Without additional capacity, Dominion's electricity network will fail to maintain an adequate power reserve margin, will fail to meet its public service obligations to provide adequate power, and will jeopardize Dominion's commitment to provide power to other electric service providers within the region. Proposed Unit 3 will help meet growing baseload shortfall in the region by supplying an average annual electrical-energy generation of about 12,000,000 MW-hrs.

Proposed Unit 3 is designed to generate electricity that results in significant reduction in CO_2 emissions with respect to comparably-sized coal- or gas-fired alternatives. As described in this section, proposed Unit 3 would also have important strategic implications in terms of lessening the dependence of the U.S. on foreign energy supplies, and their potential interruption, as well as vulnerability to volatile price changes or political whims. While the additional direct and indirect creation of jobs places some temporary burden on local services and infrastructure, the annual taxes and revenue generated by the new workers contribute to the local economy and fuels future growth.

On balance, the benefits of the new plant would significantly outweigh the economic, environmental, and social costs.

Section 10.4 References

1. Organisation for Economic Co-operation and Development (OECD) and Nuclear Energy Agency, "Projected Costs of Generating Electricity, 2005 Update," In Proceedings of GLOBAL 2005, report, October 9-13, 2005.

2. U.S. Department of Energy, "Study of Construction Technologies and Schedules, O&M Staffing and Cost, Decommissioning Costs and Funding Requirements for Advanced Reactor Designs," Volume 1, May 27, 2004.

Table 10.4-1 Monetary and Non-Monetary Benefits of Proposed Unit 3

Category of Benefit	Description of Benefit
Net Electrical Generating Benefits	
Net Generating Capacity	~1,500 MWe
Electricity Generated	~12,000,000 MW-hrs (operating at 90% capacity)
Taxes and Revenue During Plant Operation Period (Transfer Payments – Not Independent Benefits)	
Annual State Taxes	NAPS Unit 3 pays $14.8 million.
Annual Property Taxes	NAPS Unit 3 pays $3.5 million.
Annual Sales Taxes	NAPS Unit 3 pays $24.2 million.
Effects on Regional Productivity	
Land Use	Co-location of additional generating capacity on land already designated as industrial use and dedicated to power generation results in no acres of land-use conversion, thus leaving other land for continued current use or conversion for other projects that would benefit the region's productivity.
Hydrological	Co-location of additional generating capacity on existing water source already used for power generation eliminates impacts to other water resources and watersheds. Annual minimum Lake Anna elevation will average 0.26 feet lower[a] than existing conditions and 0.31 acres of non-tidal wetlands and 757 linear feet of stream bed are expected to be permanently disturbed for construction of Unit 3. Thus, the region's existing water resources and watersheds would remain largely as-is, which would conserve the resource or make it available for other uses deemed necessary for the region's productivity.
Construction Workers	Approximately 2,500 workers create an incremental increase of 1,550 indirect jobs within the region for the duration of the construction period. The increase in population would result in positive impacts to the local economy. Peak construction workforce is estimated at 4,100.
Operational Workers	500 operations workers would create an additional 1,035 indirect permanent jobs within the region for a total of approximately 1,500 additional jobs, for at least 40 years of plant operations. These people and their families would reside in the area, purchase homes, goods and services, and pay property and sales taxes, increasing the economic base of the region.

Table 10.4-1 Monetary and Non-Monetary Benefits of Proposed Unit 3

Category of Benefit	Description of Benefit
Socioeconomics	Increased tax revenue from NAPS payments as well as property and sales taxes paid by workers supports improvements, expansions, or additions to public infrastructure and social services, making the region attractive for future growth and development. Influx of money from workers' wages spurs future growth and development in the private sector. Influx of money from workers' wages will be in addition to current tourist dollars because Lake Anna recreational opportunities will not be adversely affected by Unit 3. (The annual minimum Lake Anna elevation will average 0.26 feet[a] lower than existing conditions and there will be indistinguishable biological impacts to the general aquatic community of the North Anna River and the striped bass spawning and early rearing areas of the Pamunkey River.)
Technical and Other Non-Monetary Benefits	
Fuel Diversity	Reduces exposure to supply and price risk associated with reliance on any single fuel source.
Price Volatility	Dampens potential for fuel price volatility.
Fossil Fuel Supplies	Offsets usage of finite fossil fuel supplies.
Electrical Reliability	Enhances electrical reliability.
Emissions Reduction	Significant beneficial impact in terms of avoidance of air emissions.
Carbon Dioxide Emissions	Baseload generation with no carbon dioxide emissions.
Wastes	Compared with fossil-fueled plants, nuclear plants produce less nonradioactive waste products. A comparable coal-fired plant would generate 5.6 to 31.9 tons of ash per hour.

a. The 0.26 ft difference between the annual minimum lake elevations with Unit 3 in operation and the existing condition was a prediction from the water budget model described in the ESP, which simulated lake levels from October 1978 to October 2003. The model has been extended to October 2007 to evaluate the 3-inch pool level rise mitigating action based on results of the IFIM study. The 0.26 ft value from the ESP model would be conservative if the IFIM lake mitigating action is adopted when Unit 3 begins operation because, with the potential 3-inch increase in normal pool level, the difference in the average annual minimum lake levels from the existing condition would be less than 0.26 ft.

Table 10.4-2 Internal and External Costs of Proposed Unit 3

Category of Cost	Description of Cost
Internal Costs	
Construction (Overnight Cost)	$8,206 per kW
Operation	$6.83 per MW-hr for O&M $4.64 per MW-hr for fuel cycle
Decommissioning (NRC Minimum)	$672,826,269
External Costs	
Land and Land Use	SMALL. Unit 3 occupies approximately 133 acres of the approximately 1043 acres (422 ha.) of the existing NAPS site. Unit 3 would require no acres for new transmission corridors (existing transmission corridor would be used for the new transmission line).
Hydrological and Water Use	SMALL for most years; MODERATE during drought years. There are some costs associated with providing water for various needs during construction and operation. Cooling water would be taken from Lake Anna at the rate of 15,376 gpm (Maximum Water Conservation (MWC) mode) or 22,260 gpm (Energy Conservation Mode (EC) mode.) The blowdown return to the WHTF would be 3,837 gpm in the MWC mode and 5,558 gpm in the EC mode. The cooling water consumption rate (withdrawal minus blowdown) would be 11,532 gpm in the MWC mode and 16,695 gpm in the EC mode. The effect of consumption of cooling water is relatively small. Small concentrations of hazardous chemicals and radioactive effluents would be introduced into Lake Anna. Concentrations of chemicals and solids would be below applicable VPDES permit limits at the point of compliance. Blowdown discharge would be at a maximum temperature of 100°F and at a rate of 12.4 cfs. The small increase in velocity and volume would not increase scour or erosion problems. There would be no perceptible impact on the water temperature (estimated temperature increase attributable to Unit 3 would be a maximum of one-tenth of a degree Fahrenheit) or stratification in Lake Anna. Annual minimum lake elevations with Unit 3 will be 0.01 to 0.89 feet lower than existing conditions, with this difference averaging 0.26 feet.[a] Relatively small levels of hazardous and/or radioactive effluents introduced into Lake Anna. Thermal plume resulting from cooling water blowdown discharged to Lake Anna. The effect of consumption of cooling water is relatively small.

Table 10.4-2 Internal and External Costs of Proposed Unit 3

Category of Cost	Description of Cost
Terrestrial and Aquatic Species	SMALL. Some cost to wildlife due to mortality during construction operations is anticipated. However, these costs do not affect long term wildlife populations. Construction activities would impact North Anna Reservoir due to increased turbidity and the potential for sedimentation as a result of the modification of the cofferdam. Construction would permanently disturb approximately 0.31 acres of non-tidal wetlands and 757 linear feet of ephemeral streams. No federal or state-listed protected fish species occur in Lake Anna, its tributary streams, or North Anna River. No critical habitats for aquatic or terrestrial species occur in the area. Wildlife mortality, including aquatic biota, during operations is expected to be minimal. The addition of Unit 3 would increase total impingement for three units by <3%. A new station water system for Unit 3 in combination with the current once-through system for Units 1 and 2 would remove approximately the following portions of Lake Anna's standing crop by impingement: 0.33% by weight of gizzard shad annually, 3.9% of black crappie, just over 1.4% of yellow perch, 0.02% of bluegill, and 0.1% of white perch. The addition of Unit 3 would increase total estimated entrainment by <3%. The Lake Anna fishes are prolific, exhibit high reproductive potential, and have compensatory responses that would offset these losses. Lake Anna minimal average lake level during non-drought years would be 248.6 ft msl. There will be no measurable biological impacts to the aquatic community of the North Anna River or the striped bass spawning and early rearing areas of the Pamunkey River from reductions in freshwater inflows due to the additional evaporative water loss from a new Unit 3. The increase in discharge flow would range from 0.2% (the MWC mode maximum blowdown rate of 3,844 gpm added to two-unit, open-cycle flow of approximately 1,900,000 gpm) to 0.6% (maximum blowdown rate of 5,565 gpm added to one-unit, open-cycle flow of approximately 950,000 gpm). Discharge flow would range from 3,844 gpm (Units 1 and 2 offline; Unit 3 operating and discharging blowdown at maximum MWC mode rate) to 1,905,565 gpm (Units 1, 2, and 3 operating; Unit 3 discharging blowdown at maximum rate). Blowdown discharge's velocity would have negligible impact. Concentrations of chemicals and solids would be below applicable VPDES permit limits at the point of compliance and would have a small impact on aquatic ecology. *(continued)*

Table 10.4-2 Internal and External Costs of Proposed Unit 3

Category of Cost	Description of Cost
Terrestrial and Aquatic Species *(continued)*	There would be no perceptible impact on the temperature (estimated temperature increase attributable to Unit 3 would be a maximum of one-tenth of a degree Fahrenheit at the end of the discharge canal) and there would be no impact on aquatic communities of Lake Anna.
Radioactive Effluents and Emissions, Radioactive Dose	SMALL. Radioactive waste is generated. The plant would produce radioactive air emissions. Low concentrations of radioactive liquid effluents are introduced into Lake Anna. The estimated radioactive doses from all sources would be as follows: • occupational dose: 84.5 person-rem/yr • total body dose to the MEI: 5.5 mrem/yr • collective total body dose to population within 50 miles: 5.3 person-rem/yr • dose to biota: 0.5 to 18 mrad/yr (liquid), 3.4 mrad/yr (gaseous)
Hazardous and Radioactive Waste	SMALL. Storage, treatment, and disposal of high-level radioactive spent nuclear fuel would occur, with a commitment of underground geological resources for disposal of radioactive spent fuel. Generation of 16,742 ft^3/yr of solid radioactive wastes with activity of 1,718 Curies would be expected. Generation of 15 ft^3/yr mixed liquid waste and 5 ft^3/yr mixed solid waste, and maximum generation of 30 ft^3/yr mixed liquid waste and 10 ft^3/yr of mixed solid waste would also be expected.
Air Emissions	SMALL. Air emissions from gas turbine and diesel generators, auxiliary boilers and equipment, and vehicles that have a small impact on workers and local residents would occur. Cooling tower drift would deposit some salt in the immediate vicinity, but the level is unlikely to result in any measurable impact on vegetation. Cooling tower atmospheric plume discharge would be abated by cooling tower design.
Meteorological	SMALL. Heated air from Unit 3's cooling towers would not increase the atmospheric and ground temperature beyond the NAPS site boundary. Blowdown from Unit 3 to the WHTF would lead to negligible additional steam fog. Cooling tower atmospheric plume discharge would be abated by cooling tower design.
Noise	SMALL. Construction activities would have a noise level of 60–80 dBA at 120 m (400 ft) from the Unit 3 construction site. Noise levels from cooling tower operation will be confirmed to be < 65 dBA at the EAB. Other noises would be as they are currently for Units 1 and 2.

Table 10.4-2 Internal and External Costs of Proposed Unit 3

Category of Cost	Description of Cost
Non-Radiological Human Health	SMALL. Estimated temperature increase attributable to Unit 3 would be a maximum of one-tenth of a degree Fahrenheit at the end of the discharge canal, which would dissipate to an undetectable level within a short distance of travel in the WHTF. Further, the blowdown from the Unit 3 wet cooling towers would contain a biocide. Therefore, Unit 3 would not contribute to an environment conducive to the growth of thermophilic organisms in the WHTF. Unit 3's sewage would be treated in a new sewage treatment facility and the discharge would meet local and state regulations for effluent quality in accordance with the VPDES permit. Noise levels from cooling tower operation will be confirmed to be < 65 dBA at the EAB.
Socioeconomics	SMALL, with the exception that transportation impacts would be MODERATE. Peak construction workforce is estimated at 2,500 to 4,100. The temporary in-migration to the region of interest is estimated to be 20% of the construction workforce. Traffic during peak employment of 4,100 construction workers would be divided into two 10-hour shifts, and the current existing workforce of approximately 1,000 would continue to be divided into two 12-hour shifts, so the shift changes would be staggered. Using an average of 1.8 persons per vehicle, the number of vehicles attributable to NAPS during the peak hour of traffic (shift change for construction workforce) would be about 2,300 vehicles and the total traffic attributable to NAPS would be about 2,850 vehicles per day. This increase in traffic could increase congestion from a Level of Service (LOS) of B to a LOS of D, even with the application of mitigation measures. During outages with an additional 1,000 outage workers on two 12-hour shifts that also would be staggered, the number of vehicles attributable to NAPS during the peak hour of traffic would continue to be the 2,300 vehicles associated with the construction workforce shift change. However, the total traffic attributable to NAPS during an outage day would be about 3,400 vehicles (assuming 1.8 persons per vehicle for the outage workers as well). Operation of Unit 3 would require approximately 500 workers or an increase in the population in the region of interest by 2,000, assuming each new employee represents a family of four and relocates to the region. This increased population due to the operations workers and their families would be a small fraction of the expected population growth in the vicinity and region around the NAPS site, therefore no unforeseen demands for educational, medical, fire, or police services would result from the operation of Unit 3. The visual impact study indicates that the impact to the public from Unit 3 would be similar to the visual impact from the existing units, therefore small.

Table 10.4-2 Internal and External Costs of Proposed Unit 3

Category of Cost	Description of Cost
Materials, Energy, and Uranium	SMALL. There would be irreversible and irretrievable commitments of materials and energy, including uranium. Construction of Unit 3 would require an estimated 12,239 cubic yards of concrete for the Reactor Building, 3,107 tons of rebar for the Reactor Building, 6,500,000 linear feet of cable, and 275,000 linear feet of piping greater than 2.5 inches in diameter.
Decommissioning	SMALL. The estimated radioactive doses would be substantially less than the estimated doses for operations.

a. The annual minimum lake elevation with Unit 3 in operation and the differences from the existing condition were predictions of the water budget model described in the ESP, which simulated lake levels from October 1978 to October 2003. The model has been extended to October 2007 to evaluate the 3-inch pool level rise mitigating action based on results of the IFIM study. These values from the ESP model would be conservative if the IFIM lake mitigating action is adopted when Unit 3 begins operation because, with the potential 3-inch increase in normal pool level, the difference in the average annual minimum lake levels from the existing condition would be less than 0.26 ft and the non-drought year average minimum lake level would be higher than Elevation 248.6 ft msl.