Applicant's

Environmental Report

Combined License Stage

Calvert Cliffs Nuclear Power Plant Unit 3

Constellation Generation Group
UniStar Nuclear Operating Services

Volume 6

6.0 Environmental Measurements and Monitoring Programs

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

6.1 Thermal Monitoring

6.1 THERMAL MONITORING

{This section presents the preapplication, preoperational, and operational thermal monitoring programs for the CCNPP) Unit 3. The objective of thermal monitoring during each phase is to comply with Federal and State water quality criteria and to protect aquatic life within the area of influence of the facility.

Pertinent CCNPP site and plant features, including boundaries and bathymetry of all water bodies adjacent to the site are described and shown in Section 2.3.1. The existing thermal monitoring stations are shown in Figure 6.1-1. Additional information related to field water temperature measurement and data analysis is described in Section 2.3.1. Hydrological and biological monitoring are described in Section 6.3 and Section 6.5. The extent of the predicted thermal plume is described in Section 5.3.2.1.

Temperature monitoring is described in each subsection below corresponding with the preapplication, preoperational, and operational phases of the project. Existing and planned monitoring equipment is similarly described below.

Thermal program acceptance criteria are based on relevant Federal, State, and Local requirements.

Consultation with the NPDES authority, the Maryland Department of the Environment, has been initiated and will continue throughout preapplication, preoperational, and operational phases of the project.}

6.1.1 PREAPPLICATION MONITORING

Preapplication monitoring for {CCNPP Unit 3} consists of {past and present thermal monitoring activities conducted for CCNPP Units 1 and 2 (BGE, 1970). CCNPP Unit 1 began commercial operations in May 1975 and Unit 2 in April 1977. More than 30 years of thermal monitoring activities associated with the existing plant establishes the basis for the thermal description and baseline water temperature conditions for CCNPP Unit 3.

Data collected during the studies before CCNPP Units 1 and 2 were constructed were used to design the existing cooling water systems to achieve rapid dispersion of effluents and to minimize water temperature variations in the area of plant influence.

Temperature measurements continue to be taken to monitor CCNPP Units 1 and 2 discharges from the CCNPP site, in accordance with the NPDES permit.

Existing CCNPP site features and the locations of the existing monitoring stations (Outfalls 001, 003, 004 and 005) are shown on Figure 6.1-1 and are further described in Section 6.6. Recent bathymetry characteristics adjacent to the CCNPP site are described in Section 2.3.1.

The CCNPP Units 1 and 2 NPDES permit requires thermal monitoring of wastewater discharges via Outfall 001. Once-through cooling water is discharged via Outfall 001 through tunnels to a discharge point approximately 400 yds (360 m) offshore (MDE, 2002). Outfall 001 is the main discharge monitoring station, representing over 96% of the water discharged by CCNPP Units 1 and 2 (MDE, 2002). Information on other effluents monitored via Outfall 001 is provided in Section 6.6.

Outfall 003 and Outfall 004 are the discharges for the intake screen backwash water. Outfall 005 is a discharge for the onsite swimming pool filter backwash that discharges into an unnamed tributary (i.e., a small swale) that flows into the Chesapeake Bay.

CCNPP Units 1 and 2 were originally licensed for a cooling water design temperature increase of 10°F (5.6°C) at maximum plant operating capacity. The current delta temperature limit of 12°F (6.7°C) is based on a comprehensive assessment of the plant's thermal performance and phytoplankton and zooplankton entrainment studies performed between 1979 and 1980 (ANSP, 1981). The assessment demonstrated compliance with all components of the State of Maryland's thermal mixing zone criteria for discharges to tidal waters. Subsequently, certification of thermal compliance was added to the CCNPP NPDES permit, indicating the State of Maryland's certification as required by the Federal Water Pollution Control Act (USC, 2007).

Inlet and discharge water temperatures at CCNPP Units 1 and 2 are measured using platinum resistance temperature detectors located in the circulating water inlet and waterfront discharge canal respectively. Discharge temperature is continuously monitored and recorded, as described in Section 6.3.

Thermal analysis requirements are specified in the CCNPP Units 1 and 2 Environmental Discharge Surveillance Program. Observed temperatures are calculated as the flow weighted average of individual instantaneous discharge measurements taken once per hour at the concrete surge pit (i.e., end of Discharge Road near northeast corner of plant). The difference in temperature between the intake and discharge is limited by a daily maximum temperature increase of 12°F (6.7°C). This temperature limit is on the daily average of the combined (CCNPP Units 1 and 2) discharge temperature above the inlet temperature. The daily average is the average of the 24 hourly readings each calendar day.

Temperature results are recorded on Discharge Monitoring Report Forms (EPA No. 3320-1) and submitted monthly to the Maryland Department of the Environment, Water Management Administration Compliance Program and to the U.S. Environmental Protection Agency Region III, Office of Compliance and Enforcement NPDES Branch. }

6.1.2 PREOPERATIONAL MONITORING

{Preoperational thermal monitoring consists of a continuation of the preapplication monitoring program. Thermal monitoring data collected during the preoperational monitoring program will supplement preapplication monitoring data and further serve to establish baseline bay water temperature conditions for comparative purposes in assessing potential environmental impact from new plant operations. Preoperational monitoring will be conducted during CCNPP Unit 3 site preparation and construction.

Construction related discharges will consist mainly of drainage that collects in sumps at the bottom of excavations which will be pumped to a storm water discharge point. Therefore, no change in thermal discharges is expected during the preoperational monitoring program.

The Maryland Department of the Environment will be notified of pending construction activities and approval of storm water management and erosion/sediment control plans will be obtained in accordance with the NPDES Construction General Permit as described in Section 1.3.

Refer to Section 4.2.1 for anticipated bathymetric characteristics of the Chesapeake Bay area adjacent to the CCNPP site following CCNPP Unit 3 construction activities.}

6.1.3 OPERATIONAL MONITORING

{Thermal monitoring will continue during operation of CCNPP Unit 3 to assess water temperature changes associated with effluents from the new plant.

CCNPP Unit 3 will utilize a closed-loop cooling water system. Blowdown from the Circulating Water Supply System (CWS) cooling tower and the Essential Service Water System (ESWS) cooling towers will collect in a retention basin where some of the water's heat will be released to the atmosphere and surrounding media prior to entering the discharge pipes. Additional heat will also be transferred to piping and the surrounding environ during its passage to the discharge outfall. Although the discharge temperature for CCNPP Unit 3 is anticipated to be higher than CCNPP Units 1 and 2, cooling water discharge and flow will be a small percentage of that for the existing units resulting in less energy being transferred to the Chesapeake Bay waters.

Title 26 of the Code of Maryland Regulations 26.08.03.03 (COMAR, 2007) requires temperature data be obtained for new plant effluents to monitor compliance with State of Maryland thermal mixing zone criteria for thermal discharges into tidal waters. These criteria are:

- The 24 hour average of the maximum radial dimension measured from the point of discharge to the boundary of the full capacity 2°C above ambient isotherm (measured during the critical periods) may not exceed 1/2 of the average ebb tidal excursion.
- The 24 hour average full capacity 2°C above ambient thermal barrier (measured during the critical periods) may not exceed 50% of the accessible cross section of the receiving water body. Both cross sections shall be taken in the same plane.
- The 24 hour average area of the bottom touched by waters heated 2°C or more above ambient at full capacity (measured during the critical periods) may not exceed 5% of the bottom beneath the average ebb tidal excursion multiplied by the width of the receiving water body.

Thermal plume modeling performed to estimate the distribution of additional heat load entering the Chesapeake Bay indicates that the combined thermal discharges from CCNPP Units 1, 2, and 3 would meet the State of Maryland thermal mixing zone criteria. Analyses of thermal impacts and the extent of the estimated thermal plume are provided in Section 5.2 and Section 5.3.2.

Although CCNPP Unit 3 will utilize a closed-loop cooling system, it is anticipated that locations of the monitoring stations supporting this unit will be similar to the existing monitoring stations supporting CCNPP Units 1 and 2 (i.e., near the intake screens and discharge structure). Thermal monitoring is likely to only be required at the discharge structure outfall for CCNPP Unit 3. CCNPP Unit 3 structures will occupy the area where the existing onsite swimming pool is located and the monitoring station for pool water discharge will be removed with removal of the associated discharge point.

The extent and duration of the operational monitoring program will conform to requirements of the NPDES permit applicable to CCNPP Unit 3. Water temperatures from CCNPP Unit 3 discharges will meet applicable Federal and State environmental regulatory requirements. As described above, consultation with the Maryland Department of the Environment has been initiated and will continue throughout preapplication, preoperational, and operational phases of the project. **}**

6.1.4 REFERENCES

ANSP, 1981. Assessment of Thermal Entrainment and Impingement Impacts on the Chesapeake Bay in the Vicinity of the Calvert Cliffs Nuclear Power Plant, Academy of Natural Sciences of Philadelphia, 1981.

BGE, 1970. Environmental Report Calvert Cliffs Nuclear Power Plant, Baltimore Gas and Electric Company, November 16, 1970.

COMAR, 2007. Code of Maryland Regulations, COMAR 26.08.0.03, Section 03, Water Quality Impact Assessment for Thermal Discharges. 2007.

MDE, 2002. Industrial Discharge Permits Division – Water Management Administration, Summary Report and Fact Sheet for Calvert Cliffs Nuclear Power Plant Inc, Maryland Department of the Environment, March 29, 2002.

USC, 2007. Title 33, United States Code, Part 125, Federal Water Pollution Control Act, 2007.

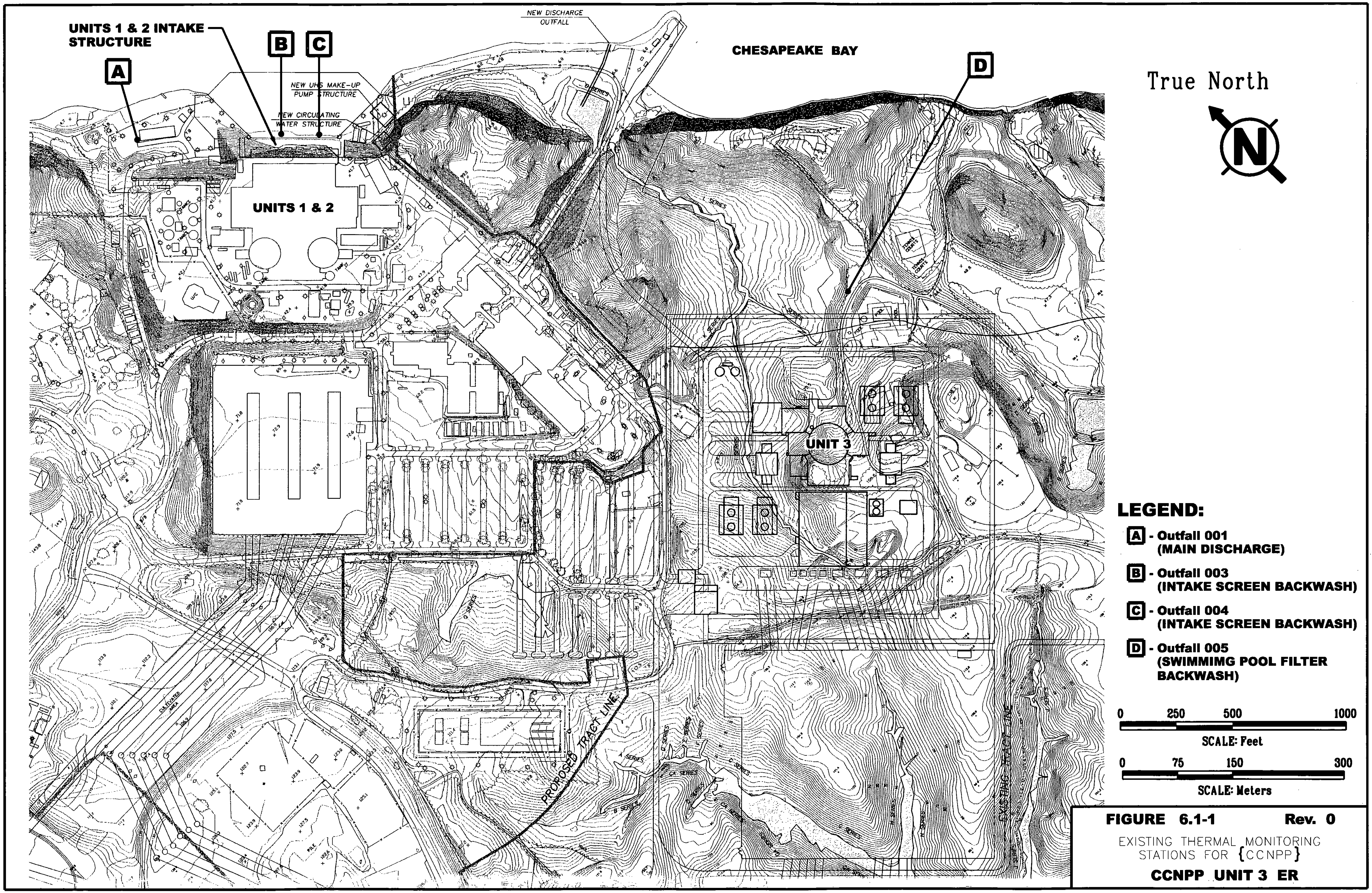

FIGURE 6.1-1 Rev. 0

EXISTING THERMAL MONITORING STATIONS FOR {CCNPP}

CCNPP UNIT 3 ER

6.2 Radiological Monitoring

6.2 RADIOLOGICAL MONITORING

{This section describes the objectives, basis, content, reporting and quality assurance aspects of the Calvert Cliffs Nuclear Power Plant (CCNPP) Units 1 and 2 site area Radiological Environmental Monitoring Program (REMP), including monitoring for the Independent Spent Fuel Storage Installation (ISFSI) located onsite, as well as that for Unit 3. The Unit 3 REMP will build upon this existing CCNPP site program where sample types, locations, collection frequencies, and analysis requirements are consistent with satisfying the program requirements (such as objectives, basis, and reporting) that are identified for Unit 3. The Unit 3 REMP is considered a separate program from that administered by CCNPP Units 1 and 2, even though many of the program elements are shared between operating companies on the CCNPP site. The existing REMP for CCNPP Units 1 and 2 covers the entire CCNPP site and environs surrounding the site and will be used to provide baseline information in support of the pre-operational phase of CCNPP Unit 3.

The pre-operational monitoring program for CCNPP Units 1 and 2 was implemented in the summer 1970 (BGE, 1970). CCNPP Unit 1 achieved criticality on October 7, 1974. CCNPP Unit 2 achieved criticality on November 30, 1976. Results of the existing monitoring program for both the pre-operational and operational periods' to date have been reported to the Nuclear Regulatory Commission (NRC) in a series of annual reports. Annual reporting of REMP activities, detected radioactivity, trends, and plant related impacts will continue through the construction and operation of CCNPP Unit 3 and will cover the influence of all three units in a series of reports called the Annual Radiological Environmental Operating Report (AREOR) (CCNPP, 2005b).

The objectives of the REMP for both the existing CCNPP Units 1 and 2 and the addition of Unit 3 are:

a. To verify that radioactivity and ambient radiation levels attributable to plant operations are within the limits specified in 10 CFR Part 50, Appendix I for maintaining doses to members of the public "As Low As Reasonably Achievable (ALARA)" (CFR, 2007b) and within the Environmental Protection Agency Radiation Protection Standards as stated in 40 CFR Part 190 (CFR, 2007a);

b. To detect any measurable buildup of long-lived radionuclides in the environment;

c. To monitor and evaluate ambient radiation levels; and

d. To determine whether any statistically significant increase occurs in concentration of radionuclides in important pathways. (CCNPP, 2005b)

The CCNPP Units 1 and 2 monitoring program was originally developed based on the guidance from Regulatory Guide 4.1 (NRC, 1975). The current environmental monitoring sampling program for the site is consistent with the guidance provided in standard radiological effluent technical specifications (CFR, 2007a) as described in NUREG-1301 (NRC, 1991) and NRC guidance (NRC, 1979b).

Expected changes to the existing Units 1 and 2 REMP to reflect the addition of CCNPP Unit 3 to the CCNPP site and changing monitoring requirements are noted in Section 6.2.7.}

6.2.1 PATHWAYS MONITORED

Environmental exposure pathways to man resulting from Unit 3 radiological effluents are described in Section 5.4.1. These are the same environmental pathways that apply to effluents from Units 1 and 2. Radioactive liquid pathways {include internal exposure due to ingestion of aquatic foods (fish and invertebrates) and external exposure due to recreational activities on the shoreline and in the water (swimming and boating).} Radioactive gaseous pathways include external exposure due to immersion in airborne effluents and exposure to a deposited material on the ground plane. Internal exposures are due to ingestion of food products grown in areas under the influence of atmospheric releases, and inhalation from airborne effluents. In additional, direct radiation exposure from the facility structures is also considered a potential pathway. The REMP for both Units 1 and 2 and Unit 3 are designed to evaluate detectable levels of radioactive materials in environmental media associated with these exposure pathways.

{The relationships between exposure pathways and environmental media included in the CCNPP Units 1 and 2 REMP sampling program are shown in Table 6.2-1and are applicable to Unit 3.}

The exposure pathways being monitored are listed in Tables 6.2-2 and 6.2-3 for the existing REMP. These same pathways and monitoring locations will be applied to the Unit 3 REMP, except as noted in Section 6.2.7.

6.2.2 LAND USE CENSUS

{A land use census for the CCNPP site area is conducted during the growing season at least once every 12 months as described in the Offsite Dose Calculation Manual (ODCM) (CCNPP, 2005a).} The same land use census requirement will be applied to Unit 3. The census identifies the following within each of the sixteen meteorological sectors in the 5 mi (8 km) vicinity:

- The nearest milk animal,
- The nearest residence, and
- The nearest garden of greater than 500 ft^2 (50 m^2) producing broad leaf vegetation.

The purpose of the land use census is to identify needed changes in the Radiological Environmental Monitoring Program. This insures that sampling locations associated with media that have the highest dose potential are included in the REMP as changes in land use patterns occur over time. The implementation of the land use census satisfies the requirement of 10 CFR Part 50, Appendix I (CFR, 2007b).

6.2.3 ENVIRIONMENTAL MONITORING PROGRAM SAMPLE TYPES

6.2.3.1 DIRECT RADIATION MONITORING

{Thermoluminescent dosimeters (TLDs) are used to measure ambient gamma radiation levels at many locations surrounding the existing units and the ISFSI. Current locations are shown in Tables 6.2-2 through 6.2-5, and Figures 6.2-1 through 6.2-4. Data collected as part of the existing Units 1 and 2 TLD program will be included as part of the Unit 3 REMP.}

TLDs are crystalline devices that store energy when they are exposed to radiation. They are processed after their exposure periods, with minimal loss of information, to read the amount of stored energy, or radiation, that they had accumulated during their exposure period in the field. This makes them well suited for quarterly environmental radiation measurements.

During TLD processing, stored energy is released as light, and is measured by a TLD reader. The light intensity is proportional to the radiation dose to which the TLD was exposed.

6.2.3.2 AIRBORNE ACTIVITY MONITORING

{Radioiodine and particulate samples are currently collected with continuously operating air pumps, particulate filters, and iodine collection cartridges at sample points A1 through A5, as shown in Table 6.2-2, Table 6.2-3, Figure 6.2-1 and Figure 6.2-2. Sampling frequencies are shown in Table 6.2-2. Filter elements and iodine cartridges are typically changed out on a weekly basis. Airborne activity monitoring data collected as part of the Units 1 and 2 REMP will be included as part of the Unit 3 monitoring program. Additions to the airborne monitoring program that are related directly to the Unit 3 REMP are identified in Section 6.2.7.}

6.2.3.3 WATERBORNE MONITORING

{Waterborne and sediment samples are currently collected at locations Wa1, Wa2, and Wb1 as shown in Table 6.2-2, Table 6.2-3, Figure 6.2-1 and Figure 6.2-2. Sampling frequencies are shown in Table 6.2-2. Waterborne activity monitoring data collected as part of the Units 1 and 2 REMP will be included as part of the Unit 3 monitoring program. Additions to the waterborne monitoring program that are related directly to the Unit 3 REMP are identified in Section 6.2.7.}

6.2.3.4 INGESTION PATHWAY MONITORING

{For liquid effluent pathways, fish and invertebrates are currently collected at locations Ia1 through Ia6 as shown in Table 6.2-2, Table 6.2-3, Figure 6.2-1, and Figure 6.2-2. Food products (vegetation) are currently sampled at locations Ib1 through Ib9 as also shown in Table 6.2-2, Table 6.2-3, Figure 6.2-1, and Figure 6.2-2. Environmental ingestion pathway media collected as part of the Units 1 and 2 REMP as shown on Tables 6.2-2 and 6.2-3 will be included as part of the Unit 3 monitoring program. Milk sampling is not currently part of the REMP for Units 1 and 2 due to a lack of milk animals in the surrounding environment and will not be part of the Unit 3 REMP unless the annual land use census identifies milk as significant exposure pathway in the site area.}

6.2.4 SAMPLE SIZES

Table 6.2-7 is an estimate of typical sample sizes for radiological analyses. These are approximations and may vary depending on such things as laboratory procedures and methods, available media obtained during sampling, lower limits of detection (LLDs), and split sampling, if applicable.

6.2.5 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM REPORTS

Routine REMP reports are submitted annually to the NRC. The annual REMP reports for both Units 1 and 2 and Unit 3 include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period. The reports also include comparisons with preoperational studies and with operational controls, as appropriate, and with previous environmental surveillance reports, and an assessment of any observed impacts of the plant operation on the environment. The reports also include the results of the land use census for Units 1 and 2, and Unit 3. Either a single joint report covering all three units on the CCNPP site, or two separate reports, one for Units 1 and 2 and one for Unit 3, will be submitted annually and include all data collected and shared between operating companies.

6.2.6 QUALITY ASSURANCE PROGRAM

The REMP quality assurance program for {CCNPP Unit 3} will be conducted in accordance with Regulatory Guide 4.15, Interim Revision 2 (NRC, 2007).

{The REMP quality assurance program at CCNPP Units 1 and 2 prior to Unit 3 has been conducted in accordance with Regulatory Guide 4.15, Revision 1 (NRC, 1979a). For site area environmental sample results that are to be shared between all three units, the most limiting quality assurance requirements of either revision of Regulatory Guide 4.15 will be applied, or independent sampling and analyses for Units 1 and 2 and Unit 3 will be performed in accordance with their respective versions of the Regulatory Guide 4.15 guidance document.

The quality assurance program also involves the use of "Interlaboratory Comparison Program" samples as discussed in the ODCM and split samples for all parameters listed in Table 6.2-6 (NRC, 1977). The comparisons are reported in annual REMP reports (CCNPP, 2005a). Since no NRC approved laboratory supplies TLDs as part of a comparison program, no TLDs are analyzed as part of the "Interlaboratory Comparison Program." The nature of TLDs precludes their use in the split sample program.}

6.2.7 REMP MODIFICATIONS FOR {CCNPP UNIT 3}

{CCNPP Unit 3 is located approximately 0.5 miles (0.8 km) south-southeast (SSE) of the center line between CCNPP Units 1 and 2. This places the CCNPP Unit 3 construction footprint in the site area where an existing REMP air particulate and radioiodine sampler (Station A1) and TLD location (DR7) are currently situated. This will require the relocation of the monitoring equipment to an area outside of that portion of the site area that is involved with CCNPP Unit 3 construction. Prior to initiation of construction activities for CCNPP Unit 3, replacement sampling equipment will be located in the southern sector from CCNPP Units 1 and 2 near the site boundary (as power availability and road access permit). Three vegetation species sample locations (Ib4, Ib5 and Ib6) also are impacted by the CCNPP Unit 3 construction footprint and will be relocated to be near the new site of the Station A1 air particulate and radioiodine collection equipment.

One additional air particulate and iodine sampler (including TLD) location will be added to the CCNPP Unit 3 REMP at least two years prior to startup to cover the south-southwest (SSW) site boundary area as viewed from CCNPP Unit 3 location. This sampler addition will provide coverage to satisfy REMP siting criteria which stipulates that there are at least three samplers close to CCNPP site boundary locations of highest calculated annual average ground-level deposition rates (D/Q's). The ODCM provides estimates (CCNPP, 2005a) of the annual D/Q for all sectors which indicate that for sectors not bordered by water, the southeast (SE), south (S), and south-southwest (SSW) sectors rank the highest potentially impacted sectors at 1 mi (1.6 km) (approximates the site boundary in those sectors) relative to CCNPP Unit 3 operations. Sample collections from this airborne monitoring location will include the same sample collection frequency, type of analysis and detection limits as applied to all other airborne samples as detailed in Tables 6.2-2 and 6.2-6.

An additional surface water sampling site near the CCNPP Unit 3 discharge location in the Chesapeake Bay will be added to the Unit 3 REMP since the CCNPP Unit 3 discharge point is several thousand feet south of the existing sampling location for the discharge from CCNPP Units 1 and 2. Sample collections from this surface station will be initiated at least two years prior to Unit 3 startup, and will include the sample collection frequency, type of analysis and detection limits as applied to all other surface water samples as detailed in Tables 6.2-2 and 6.2-6.

With respect to groundwater monitoring, the existing CCNPP site REMP for Units 1 and 2 and NRC regulations contain no explicit requirements to routinely monitor groundwater onsite near plant facilities. By design, liquid effluents are not released to groundwater or structures that discharge to groundwater, and as such, there is no expected or intended human exposure pathway associated with groundwater for CCNPP Unit 3. However, recent nuclear industry initiatives by the Nuclear Energy Institute, the Electric Power Research Institute and NRC assessments (NRC, 2006) of existing nuclear reactors, indicates that guidance documents covering the implementation of NRC regulation 10 CFR 20.1406 (CFR, 2007c) relating to groundwater monitoring for both operating and future nuclear reactors is being developed. Groundwater monitoring near plant facilities will provide an early indication if unexpected releases through system leaks or failures has occurred and is impacting the environment beyond expected pathways. Development of these guidance documents concerning ground water protection are being followed and future requirements will be addressed, as applicable, for inclusion in the CCNPP Unit 3 REMP.}

6.2.8 REFERENCES

BGE, 1970. Environmental Report, Calvert Cliffs Nuclear Power Plant, Baltimore Gas and Electric, November 17, 1970.

CFR, 2007a. Title 40, Code of Federal Regulations, Part 190, Environmental Protection Standards for Nuclear Power Operations, U.S. Environmental Protection Agency, 2007.

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NRC, 1991. Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors, NUREG-1301, Nuclear Regulatory Commission, 1991.

NRC, 2006. Liquid Radioactive Release Lessons Learned Task Force, Final Report, Nuclear Regulatory Commission, September 1, 2006.

NRC, 2007. Quality Assurance for Radiological Monitoring Programs (Inception Through Normal Operations to License Termination) – Effluent Streams and the Environment Regulatory Guide 4.15, Interim Revision 2, Nuclear Regulatory Commission, March 2007.

Table 6.2-1 {Effluent Exposure Pathways and Environmental Sampling Media

Effluent Exposure Pathways	REMP Sampling Media
Liquid Effluents: (1)	
Ingestion fish	Commercially and recreational fish species
Ingestion invertebrates	Commercially and recreational invertebrates
Shoreline exposure (external direct)	Sediments from shoreline
Swimming & boating (external direct)	Surface waters
Gaseous Effluents: (2)	
Cloud immersion (external direct)	TLDs
Ground plane (external direct)	TLDs
Inhalation	Air particulate sampling, Iodine sampling
Ingestion of agricultural products	Broadleaf vegetation

Notes:

(1) No drinking water or irrigation pathway due to brackish water of the Chesapeake Bay.

(2) No milk ingestion pathway included. No milk animals located within 5 mi (8 km) of the site. (Meat ingestion not a significant pathway contributor.)}

Table 6.2-2 {Existing Radiological Environmental Monitoring Program for CCNPP (Page 1 of 2)

Exposure Pathway And/Or Sample	Number of Representative Samples and Sample Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
Direct Radiation	23 routine monitoring stations (DR1-DR23) (Table 6.2-3) either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows: An inner ring of stations, one in each meteorological sector in the general area of the Site Boundary (DR1-DR9). An outer ring of stations, one in each meteorological sector in the 4 to 5 mi (6 to 8) km range from the site (DR10-DR18). The remaining stations (DR19-DR23) to be placed in special interest areas such as population centers, nearby residences, schools, and in one area to serve as a control station.	At Least Quarterly	Gamma Dose at Least Quarterly
Airborne Radioiodine and Particulates	Samples from 5 locations (A1-A5) (Table 6.2-3): 3 samples (A1-A3) from close to the 3 Site Boundary locations, in different sectors of the highest calculated annual average ground-level D/Q. 1 sample (A4) from the vicinity of a community having the highest calculated annual average ground-level D/Q. 1 sample (A5) from a control location, as for example 9 to 19 mi (15 to 30 km) distance and in the least prevalent wind direction.	Continuous sampler operation with sample collection weekly – or more frequently if required by dust loading.	<u>Radioiodine Canister</u>: I-131 analysis weekly <u>Particulate Sampler</u>: Gross beta radioactivity analysis following filter change. Gamma isotopic analysis of composite (by location) quarterly.

Table 6.2-2 {Existing Radiological Environmental Monitoring Program for CCNPP (Page 2 of 2)

Exposure Pathway And/Or Sample	Number of Representative Samples and Sample Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
Waterborne a. Surface	(Table 6.2-3) 1 sample at intake area (Wa1) 1 sample at discharge area (Wa2)	Composite Sample [Note: (a)] over 1 month period	Gamma Isotopic Analysis [Note: (b)] monthly. Composite for tritium analysis quarterly
b. Sediment from shoreline	1 sample from downstream area with existing or potential recreational value (Wb1)	Semiannually	Gamma Isotopic Analysis semiannually
Ingestion a. Fish and Invertebrates	(Table 6.2-3) 3 samples of commercially, and/or recreationally important species (2 fish species and 1 invertebrate species) in vicinity of plant discharge area (Ia1-Ia3). 3 samples of same species in areas not influenced by plant discharge (Ia4-Ia6).	Sample in season, or semiannually if they are not seasonal.	Gamma Isotopic Analysis on edible portions.
b. Food Products	Samples of 3 different kinds of broad leaf vegetation grown near the Site Boundary at 2 different locations of highest predicted annual average ground level D/Q (Ib1-Ib6) [Note: (c)]. 1 sample of each of the similar-broad leaf vegetation grown 9 to 19 mi (15 to 30 km) distant in the least prevalent wind direction (Ib7-Ib9).	Monthly during growing season.	Gamma isotopic and 1-131 analysis.

Notes:

(a) A Composite Sample is a combination of individual samples obtained at intervals that are short (e.g., hourly) in relation to the compositing time interval (e.g., monthly) to assure obtaining a representative sample.

(b) A Gamma Isotopic Analysis is an analytical method of measurement used for the identification and quantification of gamma emitting radionuclides.

(c) Broad leaf vegetation sampling of at least three different kinds of vegetation may be performed at the site boundary in each of two different direction sectors with the highest predicted D/Qs in lieu of the garden census.}

Table 6.2-3 {Existing Environmental Monitoring Sites for CCNPP
(Page 1 of 2)

Sample Site/Type	Sector	Distance		Description
		km	mi	
DR1	NW	0.6	0.4	Onsite, Along Cliffs
DR2	WNW	2.7	1.7	Rt. 765, Auto Dump
DR3	W	2.3	1.4	Rt. 765, Giovanni's Tavern (Knotty Pine)
DR4	WSW	2.0	1.2	Rt. 765, Across from White Sand Driv
DR5	SW	2.4	1.5	Rt. 765 at Johns Creek
DR6, A4	SSW	2.9	1.8	Rt. 765 at Lusby, Frank's Garage
DR7, A1, Ib4, Ib5, Ib6	S	0.7	0.5	Onsite, before entrance to Camp Conoy
DR8, A2	SSE	2.5	1.5	Camp Conoy Road at Emergency Siren
DR9, A3	SE	2.6	1.6	Bay Breeze Road
DR10	NW	6.4	4.0	Calvert Beach Rd and Decatur St.
DR11	WNW	6.6	4.1	Dirt Road off Mackall Rd and Parran Rd
DR12	W	6.7	4.2	Bowen Rd and Mackall Rd
DR13	WSW	6.1	3.8	Mackall Rd near Wallville
DR14	SW	6.4	4.0	Rodney Point
DR15	SSW	6.2	3.9	Mill Bridge Rd and Turner Rd
DR16	S	6.5	4.1	Across from Appeal School
DR17	SSE	5.9	3.7	Cove Point Rd and Little Cove Point Rd
DR18	SE	7.1	4.5	Cove Point
DR19	NW	4.4	2.8	Long Beach
DR20	NNW	0.4	0.3	Onsite, near shore
DR21, A5, Ib7, Ib8, Ib9	WNW	19.3	12.1	Emergency Operations Facility
DR22	S	12.5	7.8	Solomons Island
DR23	ENE	12.6	7.9	Taylors Island, Carpenter's Property
Wa1	NNE	0.2	0.1	Intake Area
Wa2, Ia1, Ia2	N	0.3	0.2	Discharge Area
Wb1	ESE	0.6	0.4	Shoreline at Barge Road
Ib1, Ib2, Ib3,	SSE	2.6	1.6	Garden Plot off Bay Breeze Rd
Ia4, Ia5	(Area not influenced by Plant Discharge)			Patuxent River

Table 6.2-3 {Existing Environmental Monitoring Sites for CCNPP
(Page 2 of 2)

Sample Site/Type	Sector	Distance		Description
		km	mi	
Ia3	E	0.9	0.6	Camp Conoy
Ia6	NNW	10.7	6.7	Kenwood Beach
Ia10	SSE	15.3	9.5	Hog Island

Note: Distance and direction are from the central point between the CCNPP Units 1 and 2 containment buildings.

Key: (where # is the sequential number of the sampling station)

DR# Direct Radiation, TLD Station
A# Airborne Sampling Station
Wa# Waterborne Sampling Station at Intake (Wa1) and Discharge (Wa2)
Wb1 Waterborne Sediment Sampling Station
Ia# Fish and Invertebrates Sampling Station
Ib# Broad Leaf Sampling Station }

Table 6.2-4 {Radiological Environmental Monitoring Program for the Independent Spent Fuel Storage Installation

Exposure Pathway And/Or Sample	Number of Representative Samples and Sample Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
Direct Radiation	Direct radiation dosimetry shall be collected from locations SFDR1-SFDR16, DR7, and DR30	At Least Quarterly	Gamma Dose at Least Quarterly
Airborne Radioiodine and Particulate Activity	Air particulate samples shall be collected from locations A1 and SFA1-SFA4	Continuous sampler operation with sample collection weekly - or more frequently if required by dust loading	Radioiodine Canister: I-131 analysis weekly Particulate Sampler: Gross beta radioactivity analysis weekly, following filter change. Gamma isotopic analysis of composite (by location) quarterly
Vegetation	Vegetation samples shall be collected at locations SFb1-SFb5	Sampled monthly during the growing season	Gamma Isotopic Analysis monthly
Soil	Soil samples shall be collected at locations SFS1-SFS5	At Least Quarterly	Gamma Isotopic Analysis quarterly}

Table 6.2-5 {Environmental Monitoring Sites for the ISFSI (Page 1 of 2)

Station	Description	Distance (km) [Note: (a)]	Direction (sector) [Note: (a)]
Air Samplers			
A1	Onsite before Entrance to Camp Conoy	0.3	ESE
SFA1	Meteorological Station	0.3	NW
SFA2	CCNPP Visitor's Center	0.8	N
SFA3	NNW of ISFSI	0.1	NNW
SFA4	SSE of ISFSI	0.1	SSE
TLD Locations			
SFDR1	SW of ISFSI	0.2	SW
SFDR2	N of ISFSI	0.2	N
SFDR3	N of ISFSI	0.1	N
SFDR4	NE of ISFSI	<0.1	NE
SFDR5	E of ISFSI	<0.1	E
SFDR6	ESE of ISFSI	0.1	ESE
SFDR7	CCNPP Visitor's Center	0.8	N
SFDR8	NNW of ISFSI	0.1	NNW
SFDR9	SSE of ISFSI	0.1	SSE
SFDR10	NW of ISFSI	0.1	NW
SFDR11	WNW of ISFSI	0.1	WNW
SFDR12	WSW of ISFSI	<0.1	WSW
SFDR13	S of ISFSI	<0.1	S
SFDR14	SE of ISFSI	0.1	SE
SFDR15	ENE of ISFSI	<0.1	ENE
SFDR16	SW of ISFSI	<0.1	SW
DR7 [Note: (b)]	On Site Before Entrance to Camp Conoy	0.3	ESE
DR30	Meteorological Station	0.3	NW
SFDR17	NNE of ISFSI	0.1	NNE
SFDR18	W of ISFSI	0.04	W
Vegetation			
SFb1	Meteorological Station	0.3	NW
SFb2	CCNPP Visitor's Center	0.8	N
SFb3	NNW of ISFSI	0.1	NNW
SFb4	SSE of ISFSI	0.1	SSE
SFb5	On Site Before Entrance to Camp Conoy	0.3	ESE

Table 6.2-5 {Environmental Monitoring Sites for the ISFSI (Page 2 of 2)

Station	Description	Distance (km) [Note: (a)]	Direction (sector) [Note: (a)]
Soil			
SFS1	Meteorological Station	0.3	NW
SFS2	CCNPP Visitor's Center	0.8	N
SFS3	NNW of ISFSI	0.1	NNW
SFS4	SSE of ISFSI	0.1	SSE
SFS5	Onsite Before Entrance to Camp Conoy	0.3	ESE

Notes:
(a) Distance and direction are from the Central Point of the ISFSI.
(b) DR7 is common to both the REMP and the ISFSI Monitoring Program.}

Table 6.2-6 {Lower Limits of Detection (LLD) for Environmental Media (Page 1 of 2)

Direct Radiation	Parameter	Units	Frequency	LLD
Direct Radiation:	Gamma Dose	mR	At Least Quarterly	[Note: (a)]
Airborne Activity:				
a. Radioiodine Canister	I-131	pCi/m^3	At Least Weekly	0.07
b. Particulate Filter	Gross Beta Activity	pCi/m^3	At least Weekly	0.01
	Cs-134	pCi/m^3	At Lease Quarterly	0.05
	Cs-137	pCi/m^3	At Lease Quarterly	0.06
Waterborne Activity:				
a. Surface Water Sample	H-3	pCi/l	At Lease Quarterly	2000
	Mn-54	pCi/l	At Least Monthly	15
	Fe-59	pCi/l	At Least Monthly	30
	Co-58	pCi/l	At Least Monthly	15
	Co-60	pCi/l	At Least Monthly	15
	Zn-65	pCi/l	At Least Monthly	30
	Zr-95/Nb-95	pCi/l	At Least Monthly	15
	I-131	pCi/l	At Least Monthly	1
	Cs-134	pCi/l	At Least Monthly	15
	Cs-137	pCi/l	At Least Monthly	18
	Ba-140/La-140	pCi/l	At Least Monthly	15
b. Shoreline Sediment Sample	Cs-134	pCi/kg, dry	At Least Semiannually	150
	Cs-137	pCi/kg, dry	At Least Semiannually	180
Ingestible Activity:				
a. Fish and Invertebrates	Mn-54	pCi/kg, wet	Note: (b)	130
	Fe-59	pCi/kg, wet	Note: (b)	260
	Co-58	pCi/kg, wet	Note: (b)	130
	Co-60	pCi/kg, wet	Note: (b)	130
	Zn-65	pCi/kg, wet	Note: (b)	260
	Cs-134	pCi/kg, wet	Note: (b)	130
	Cs-137	pCi/kg, wet	Note: (b)	150
b. Milk	I-131	pCi/l, wet	At Least Monthly, Note: (c)	1
	Cs-134	pCi/l, wet	At Least Monthly, Note: (c)	15

Table 6.2-6 {Lower Limits of Detection (LLD) for Environmental Media
(Page 2 of 2)

Direct Radiation	Parameter	Units	Frequency	LLD
	Cs-137	pCi/l, wet	At Least Monthly, Note: (c)	18
	Ba-140/La-140	pCi/l, wet	At Least Monthly, Note: (c)	15
c. Food Products	I-131	pCi/kg, wet	At Least Monthly, Note: (d)	60
	Cs-134	pCi/kg, wet	At Least Monthly, Note: (d)	60
	Cs-137	pCi/kg, wet	At Least Monthly, Note: (d)	80

Notes:

(a) LLD for TLDs used for environmental measurements shall be in accordance with the recommendations of Regulatory Guide 4.13.

(b) The fish and invertebrates shall be sampled at least once per year in season, or semiannually if they are not seasonal.

(c) The milk samples need be collected and analyzed only if the milk is commercially available in quantities greater than 130 liters (34.3 gal) per year.

(d) The food products shall be sampled during the growing season.}

Table 6.2-7 {Typical Sample Sizes for Environmental Media

Media	Approximate Weight/Volume
Air Particulate	100 m^3 (3,531 ft^3)
Algae	2 kg (4.4 lb)
Aquatic (Special)	2 kg (4.4 lb)
Aquatic Vegetation	2 kg (4.4 lb)
Benthic Organisms	2 kg (4.4 lb)
Biological Organisms	2 kg (4.4 lb)
Cattle Feed	1 - 2 kg (2.2 – 4.4 lb)
Charcoal Filter	100 m^3 (3,531 ft^3)
Crab	2 kg (4.4 lb)
Estuary Water	1 gallon (3.8 liters) [Note: (a)]
Fish	2 kg (4.4 lb)
Food Crop	0.5 – 1 kg (1.1 – 2.2 lb)
Fresh Water	1 quart (0.95 liters) [Note: (a)]
Green Leafy Vegetation	0.5 – 1 kg (1.1 – 2.2 lb)
Ground Water	1 gallon (3.8 liters) [Note: (a)]
Hard-Shell Clam	2 kg (4.4 lb)
Hard-Shell Clam, Shell	2 kg (4.4 lb)
Mixed Vegetation	0.5 – 1 kg (1.1 – 2.2 lb)
Mussel Body	2 kg (4.4 lb)
Mussel Shell	2 kg (4.4 lb)
Sediment	Cores as Required [Note: (b)]
Soft-Shell Clam (Mya arenaria)	2 kg (4.4 lb)
Soft-Shell Clam, Shell	2 kg (4.4 lb)
Soil	1 – 2 kg (2.2 – 4.4 lb)

Notes:

(a) One gallon (3.8 liters) is needed for gamma spectrometry/tritium analysis ONLY. An additional gallon (3.8 liters) is required for a gross beta analysis.

(b) Six core sections having a minimum depth of 6 in (15.2 cm) by means of a 2 in (5.1 cm) ID coring device.

(c) The sample sizes in this table should only be used as representative of approximate sizes needed. These may vary significantly depending on the LLD of the isotopes being measured.}

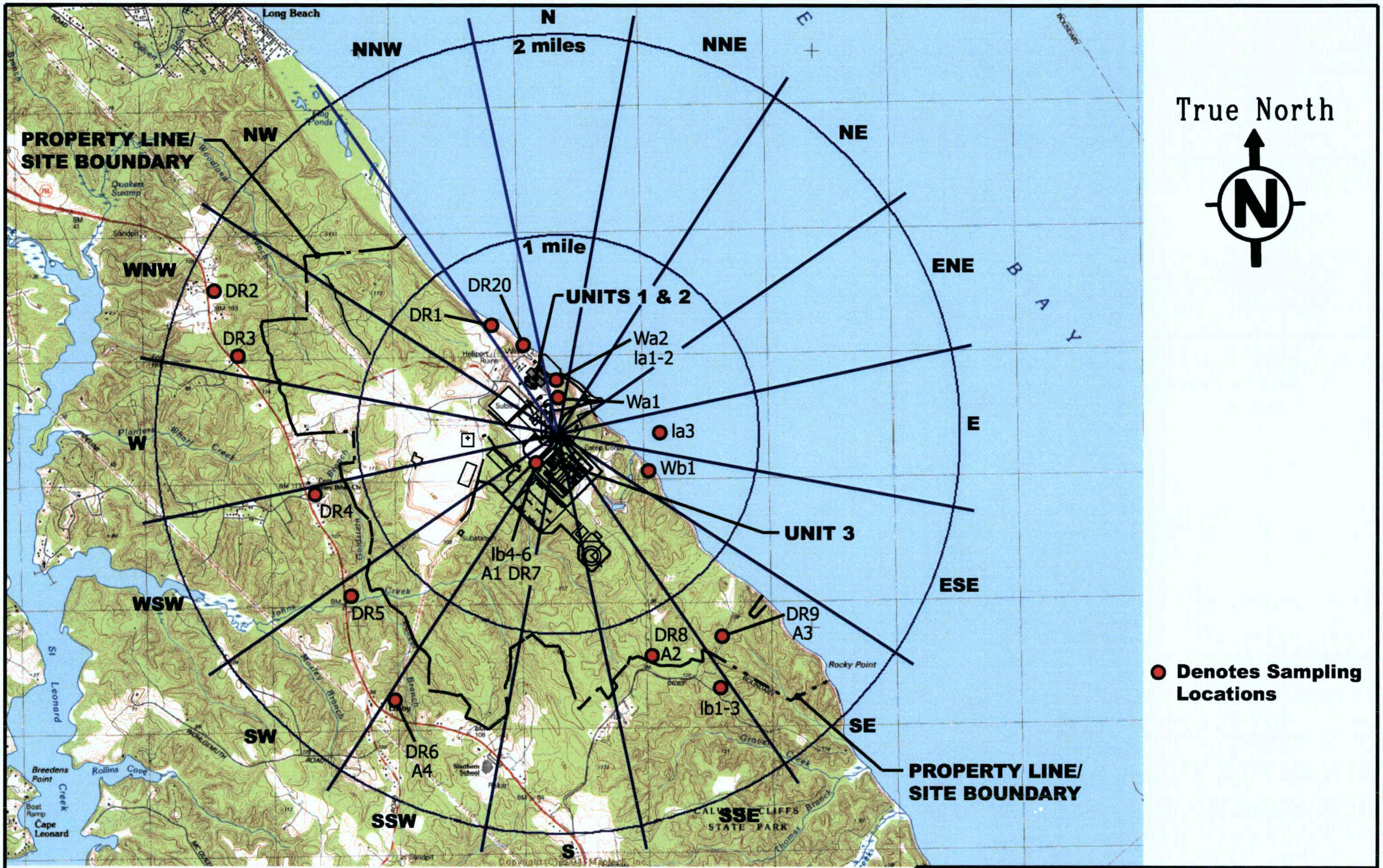


FIGURE 6.2-1 Rev. 0

{CCNPP} SAMPLING LOCATIONS
0–2 mi (0–3.2 km)

CCNPP UNIT 3 ER

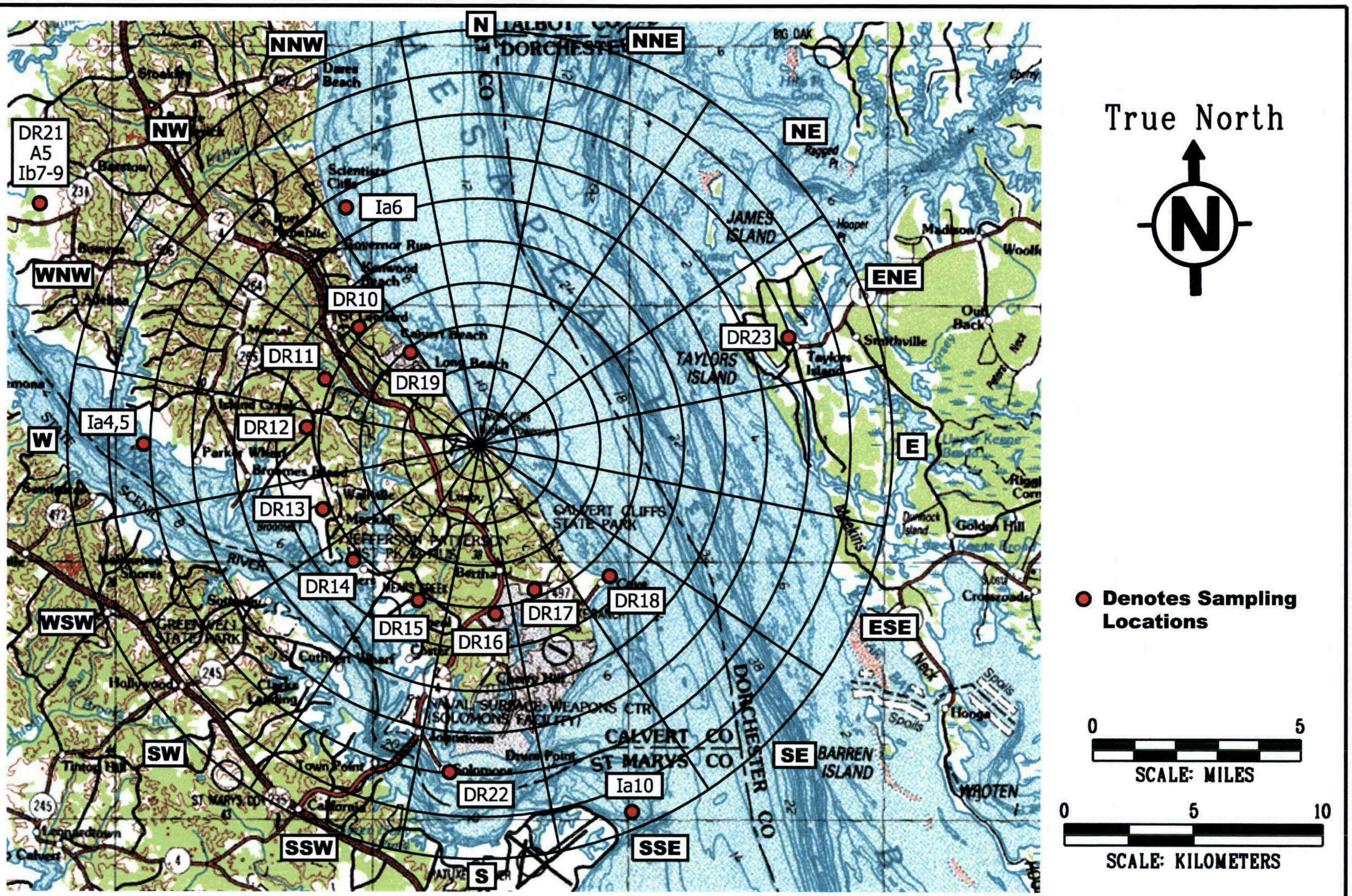


FIGURE 6.2-2 **Rev. 0**

{CCNPP} SAMPLING LOCATIONS
0–10 mi (0–16 km)

CCNPP UNIT 3 ER

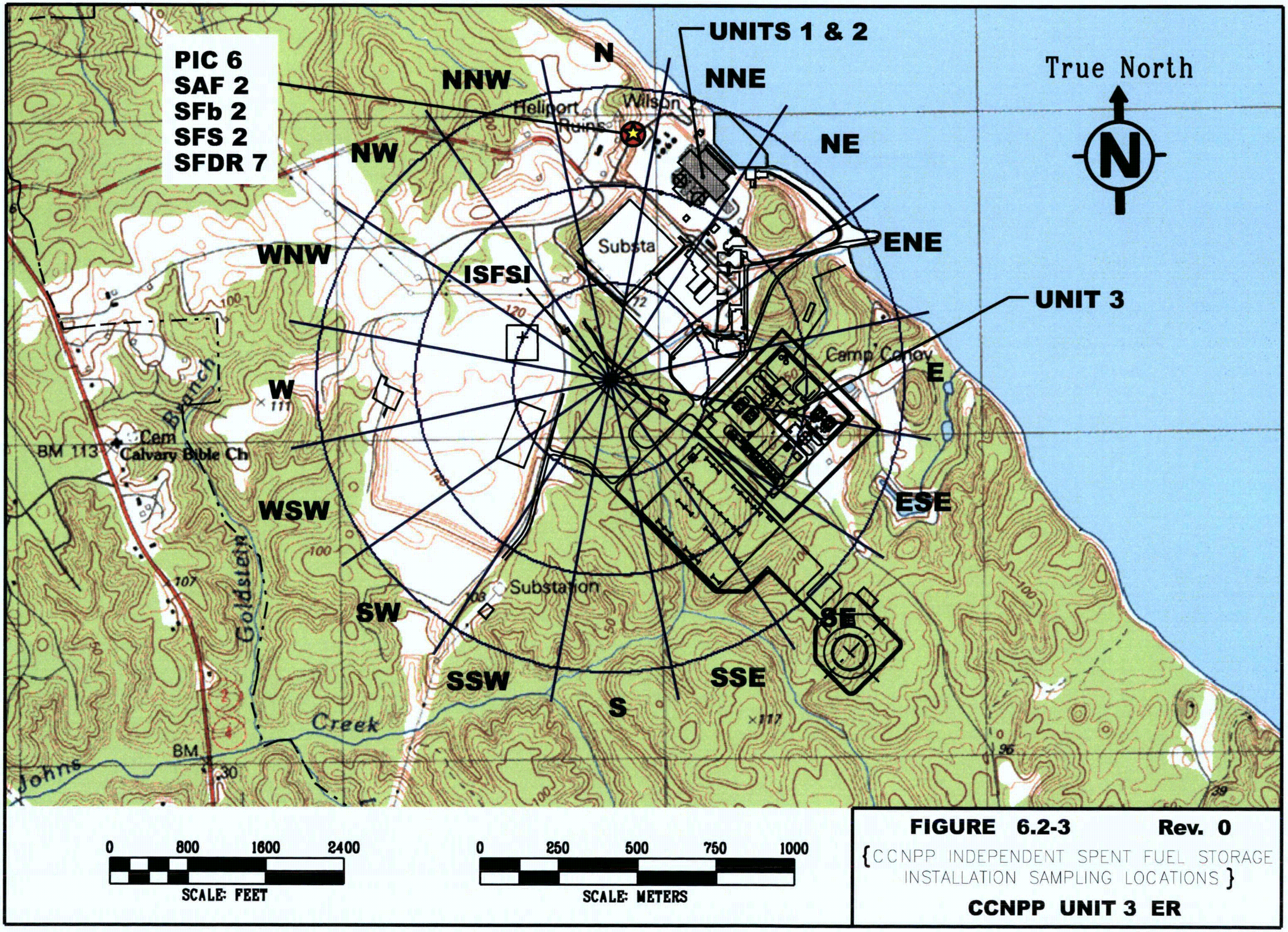


FIGURE 6.2-3 Rev. 0

{CCNPP INDEPENDENT SPENT FUEL STORAGE INSTALLATION SAMPLING LOCATIONS}

CCNPP UNIT 3 ER

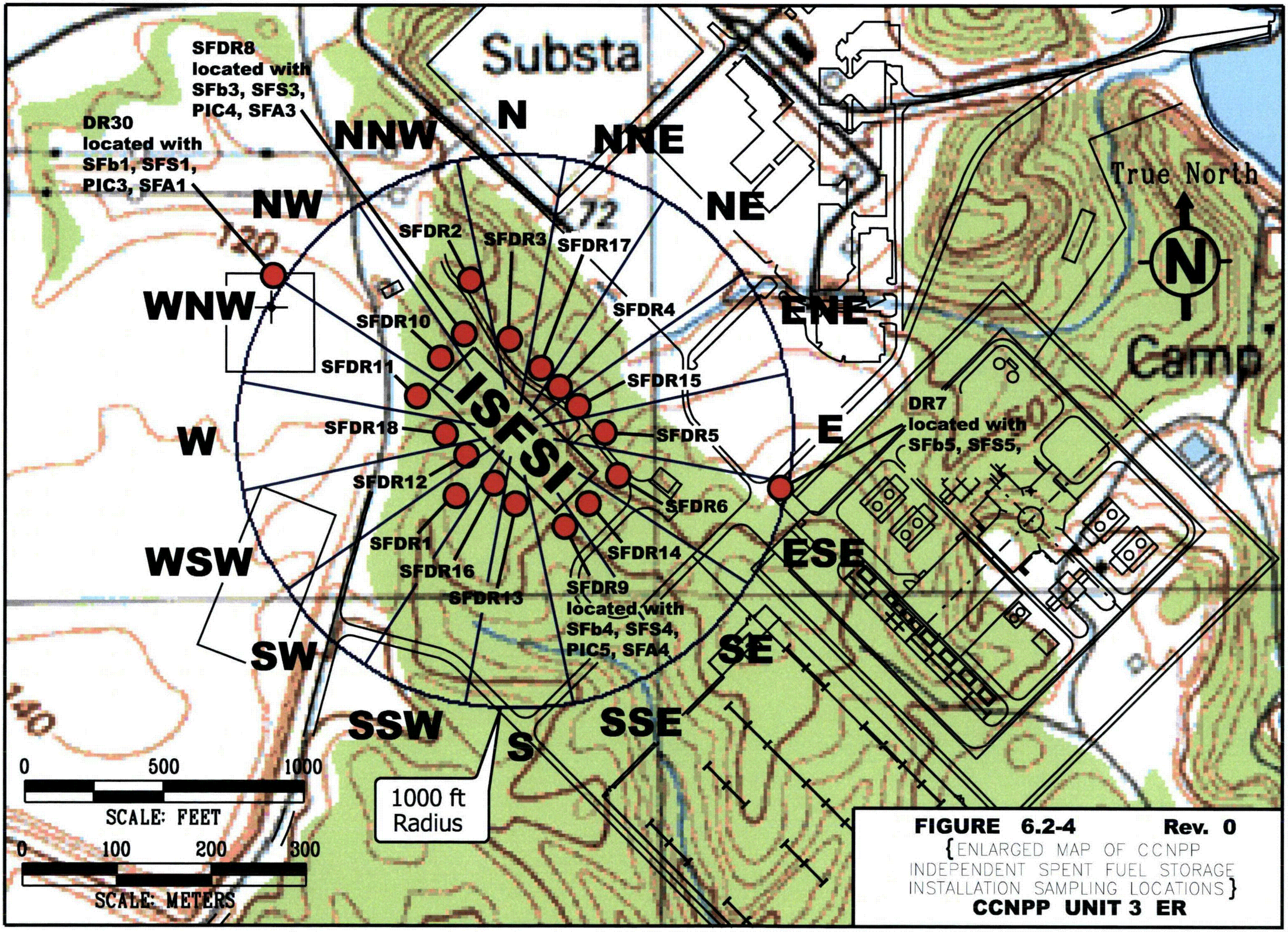


FIGURE 6.2-4 **Rev. 0**

{ENLARGED MAP OF CCNPP INDEPENDENT SPENT FUEL STORAGE INSTALLATION SAMPLING LOCATIONS}

CCNPP UNIT 3 ER

6.3 Hydrological Monitoring

6.3 HYDROLOGICAL MONITORING

This section describes the hydrological monitoring program that will be implemented to monitor the effects of the {Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3}. Elements of the hydrological program relating to thermal, radiological, and chemical monitoring are described separately in Section 6.1, Section 6.2, and Section 6.6, respectively.

This section includes the pre-application monitoring program that discusses the {existing hydrological monitoring program at CCNPP Units 1 and 2 as well as the Unit 3 site and the} programs to monitor {CCNPP Unit 3} during the construction/pre-operational and operational phases.

Section 2.3.1 describes the vicinity watershed and stream flow data collected by the U.S. Geological Survey and the {Maryland Geological Survey}. Groundwater velocities, flow rates and sediment transport characteristics and shore erosion are discussed in Section 2.3.1. Section 2.3.2 describes surface and groundwater uses. Features of the {CCNPP} site, including boundaries and bathymetry of all surface water bodies adjacent to the site are provided in Section 2.3.1. The location of groundwater monitoring wells are provided in Figure 2.3.1-40 (for the construction site), Figure 2.3.2-13 (for other existing wells onsite), and Figure 2.3.2.-18 (for regional monitoring wells). The existing thermal and biological monitoring stations are discussed in Section 6.1 and Section 6.6 for surface water. No thermal or biological monitoring stations exist for groundwater and none are planned. Figures showing major geomorphic features and regional geology are shown in Section 2.3.1 and Section 2.6.

6.3.1 PREAPPLICATION MONITORING

{Hydrological monitoring at the CCNPP site includes both surface water and groundwater. Both monitoring programs comply with and are controlled by regulatory permit requirements and conditions described below.}

6.3.1.1 Surface Water

{CCNPP Units 1 and 2 conduct hydrological monitoring of surface water in accordance with the National Pollutant Discharge Elimination System (NPDES) program (MDE, 2004). Flows from storm water and plant-associated activities such as equipment blowdown and various system effluents are measured at different monitoring locations. Table 6.3-1 lists the monitoring locations and the permit flow requirements. Refer to Section 6.6 for a description of the monitoring locations as well as the NPDES monitoring program data analysis and quality control procedures.

In addition, water withdrawn from the Chesapeake Bay that is used for plant system cooling is monitored as part of the {Maryland Department of Environment (MDE) Water Appropriation and Use (WAU) permit program (MDE, 2000a). Flow is monitored monthly at the CCNPP Units 1 and 2 Intake Structure and reported to MDE semiannually.

Beginning in February 2007, three of five planned water samples were collected at the CCNPP Units 1 and 2 cooling water intake structure. During each sampling event, water samples were collected towards the end of the incoming (flood) and the outgoing (ebb) tides. Sample results and analytical parameters are presented in Table 2.3.3-8. Because of differences in analytical suites, not all results are directly comparable to the water quality samples collected by the Chesapeake Bay Program (CBP) as shown in Table 2.3.3-6. In general, the intake analyte concentrations and measurements are similar to the values measured in CBP water samples collected at the stations closest to the CCNPP (locations CB4.3W, CB4.3C, CB4.3E, and CB4.4) indicating that there are no significant pollutants in the influent cooling water for CCNPP Units 1 and 2.

6.3.1.2 Groundwater

{The CCNPP site has five production wells that supply process and domestic water within the existing CCNPP Units 1 and 2 protected area. Nine additional site wells supply water for domestic and industrial use in out lying areas as discussed Section 2.3.2.2. MDE requires periodic monitoring of the five production wells as part of a site WAU permit (MDE, 2000b). Data are acquired monthly and reported semiannually. Section 2.3.2.2 describes the well locations, permit limits, and withdrawal volumes.

Forty groundwater observation wells were installed across the site as shown in Figure 2.3.1-40. They were completed in the Surficial aquifer and water-bearing materials in the Chesapeake Group. The wells were located in order to provide adequate distribution with which to determine site groundwater levels, subsurface flow directions, and hydraulic gradients beneath the site. Well pairs were installed at selected locations to determine vertical gradients. Field hydraulic conductivity tests (slug tests) were conducted in each observation well. Monthly water level measurements from the groundwater observation wells began in July 2006 and will continue until July 2007.

To evaluate vertical hydraulic gradients, several observation wells were installed as well clusters. Well clusters are a series of wells placed at the same location, with each well monitoring a distinct water bearing interval. Four well clusters were installed to evaluate the hydraulic gradient between the Surficial aquifer and the Upper Chesapeake unit, and three well clusters were installed to evaluate the gradient between the Upper Chesapeake and Lower Chesapeake units.

Monthly water levels in the observation wells were measured to characterize seasonal trends in groundwater levels and flow directions for the CCNPP site. Preliminary results are discussed and shown in Section 2.3.1. Additional information on bathymetric characteristics of surface water, soil and groundwater characteristics, and transient hydrological parameters in the site vicinity are discussed in Section 2.3.1. Section 3.4 discusses the cooling system employed and its operational modes. Section 3.6 discusses the type of sanitary and chemical waste retention method. Section 2.7 discusses the meteorological parameters in the vicinity.}

6.3.2 CONSTRUCTION AND PRE-OPERATIONAL MONITORING

{Hydrological monitoring during CCNPP Unit 3 construction will include both surface water and groundwater. Both monitoring programs will comply with regulatory permit requirements and conditions described below. The objective of each program will be to establish a baseline for evaluating potential hydrologic changes, monitor anticipated impacts from site preparation and construction, and detect unexpected impacts.}

6.3.2.1 Surface Water

Surface water onsite will be monitored as part of the NPDES Construction General Permit as described in Section 1.3. Conditions of the permit will include compliance with erosion/sediment control and storm water management plans, which will be detailed in a required Storm Water Pollution Prevention Plan (SWPPP). The SWPPP also requires inspections as well as monitoring and record keeping.

In addition, {Chesapeake Bay} surface water will be monitored during construction of {both the CCNPP Unit 3 intake and discharge structures as well as refurbishment of the Barge Unloading Facility.} Monitoring will be part of the U.S. Corps of Engineers 401 permit as described in Section 1.3 to ensure compliance with applicable water quality (e.g., turbidity) and sediment transport requirements.

6.3.2.2 Groundwater

Groundwater monitoring during {CCNPP Unit 3} construction will include, as needed, data from groundwater observation wells installed across the {CCNPP} site as part of COL preapplication studies described in Section 2.3.1.2. The purpose will be to monitor the potential effects of dewatering on perched water levels.

{Some of the existing CCNPP Unit 3 area observation wells will be taken out of service prior to construction activities due to anticipated earth moving and construction requirements. Prior to construction activities, the observation well monitoring network will be evaluated in order to determine groundwater data gaps and needs created by the abandonment of existing wells. These data needs will be met by the installation of additional observation wells, if required. Additionally, the hydrologic properties and groundwater flow regimes of the shallow water bearing units (Surficial aquifer, and to a lesser extent, the Chesapeake units) will be impacted by the proposed earthmoving, regrading, and construction of infrastructure (buildings, parking lots, etc.). Revisions to the observation well network will be implemented to ensure that the resulting changes in the local groundwater regime from construction activities will be identified.

A WAU permit (COMAR, 2007) is expected to be acquired to address temporary dewatering, because the duration of the dewatering is expected to be greater than 30 days.

Disturbances to existing drainage systems will be avoided, if possible. Environmental controls (i.e., silt screens, dams, settling basins, and spill containment measures), will be implemented to reduce potential pollutants in storm water runoff and to minimize construction impacts to aquatic habitats. Prior to the start of construction, approval of storm water management and erosion/sediment control plans will be obtained in accordance with the NPDES Construction General Permit as described in Section 1.3. These controls will be incorporated into a Storm Water Pollution Prevention Plan (SWPPP). Similar to the {existing SWPPP}, storm water system manholes and handholds will continue to be periodically inspected and cleaned.

6.3.3 OPERATIONAL MONITORING

Hydrological monitoring during {CCNPP Unit 3} operation will be designed, as needed, to monitor the potential impacts from plant operation as well as detect unanticipated operational impacts.

During {CCNPP Unit 3} operation, plant water supply will be from the {Chesapeake Bay} at a {new intake structure adjacent to the existing CCNPP Units 1 and 2 intake structure}. The principle potable (fresh water) source will be from {desalination of Chesapeake Bay} water. {The Desalination Plant will provide all fresh water needs to CCNPP Unit 3 systems. Consequently, CCNPP Unit 3 operation will not require use of groundwater.} Operation of the {new Intake Structure, however, will require surface water monitoring and reporting as part of the WAU permit program as described in Section 1.3. In addition, discharge effluents to the Chesapeake Bay from CCNPP Unit 3 and Desalination Plant} operation will require monitoring as discussed in Section 6.6.

{The CCNPP Unit 3 Waste Water Treatment Plant (WWTP) would collect sewage and waste water generated from the portions of the plant outside the radiological control areas of the power block and would treat them using an extensive mechanical, chemical, and biological treatment processes. The treated effluent would be combined with the discharge stream from the onsite wasterwater retention basin and discharged to Chesapeake Bay. The discharge would be in accordance with local and state safety codes. The dewatered sludge would be hauled offsite for disposal at municipal facilities. The treated waste water would meet all applicable health standards, regulations, and TMDLs set by the Maryland Department of the

Environment and the U.S. EPA. Table 3.6-5 lists anticipated liquid and solid effluents associated with the sewage treatment plant. Parameters are expected to include flow rates, pollutant concentrations, and the biochemical oxygen concentration at the point of release.

Non-radioactive liquid effluents that could potentially drain to the Chesapeake Bay are limited under the NPDES permit. An anticipated list of permitted outfalls is included in Table 3.6-7. Other non-radioactive liquid waste effluents from sources including laboratory chemicals, laundry solutions and other decontamination solutions are listed in Table 3.6-8. Table 3.6-1 provides information on the various chemicals anticipated to be used for the various plant water systems. All of these chemical additives will have limiting discharge concentrations specified in the NPDES permit that will require monitoring.}

Chemical monitoring will be performed at the {new outfall} to assess the effectiveness of retention methods and effluent treatment systems, as well as to detect changes in water quality associated with plant operations. {Similar to CCNPP Units 1 and 2,} chemical monitoring will also be performed at {storm water runoff} outfalls and at internal monitoring points (i.e., sanitary waste effluents, wastewater retention basin influent and/or effluent). Effluent water chemistry will meet applicable Federal and State environmental regulatory requirements.

Finally, NRC regulations do not explicitly require routine, onsite groundwater monitoring during plant operation. However, a recent nuclear industry initiative by the Nuclear Energy Institute (NEI) and Electric Power Research Institute (EPRI) and NRC assessment (NRC, 2006) of existing nuclear reactors indicates that regulations relating to groundwater monitoring during plant operation for present and future nuclear reactors may change.

6.3.4 REFERENCES

{COMAR, 1972. Title 26, Subtitle 17, Water Management, Chapter 06, Water Appropriation or Use, Annotated Code Of Maryland Regulations (COMAR 26.17.06), 1972.

MDE, 2004. State Discharge Permit No. 02-DP-0817 (NPDES Permit No. MD0002399), Maryland Department Of Environment, Effective June 1, 2004.

MDE, 2000a. Water Management Administration, Water Appropriation and Use Permit No. CA71S001(03), Maryland Department of Environment, Effective July, 1, 2000.}

MDE, 2000b. Water Management Administration, Water Appropriation and Use Permit No. CA69G010(05), Maryland Department Of Environment, Effective July 1, 2000.}

NRC, 2006. Liquid Radioactive Release Lessons Learned Task Force, Nuclear Regulatory Commission, Final Report, September 1, 2006.

Table 6.3-1 {CCNPP Units 1 and 2} NPDES Hydrological Monitoring Program (Page 1 of 1)

Monitoring Station	Description	Parameter	Frequency	Sample Type
001	Once-through cooling water, various system sump and blowdown, reverse osmosis reject water, low volume waste, sewage treatment plant, storm water	Flow	Continuous	Recorded
101A	Sewage treatment plant	Flow	1/Week	Measured
102A	Low volume sources, sump water, and storm water	Flow	1/Month	Measured
103A	Auxiliary boiler blowdown	Flow	1/Year	Measured
104A	Demineralizer backwash (i.e., reverse osmosis rejects water)	Flow	1/Month	Measured
106A	Secondary cooling blowdown	Flow	1/Year	Measured
003	Intake screen backwash	Note (a)		
004	Intake screen backwash	Note (a)		
005	Pool filter backwash	Flow	1/Month	Measured

Note:

(a) No flow requirements.

6.4 Meteorological Monitoring

6.4 METEOROLOGICAL MONITORING

This section describes the meteorological monitoring program that will be implemented for the {Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 on the CCNPP site}. It includes the pre-operational meteorological monitoring program consisting of {the existing meteorological monitoring program for CCNPP Units 1 and 2} and the operational meteorological monitoring program. There are no unusual circumstances anticipated during site preparation and construction that require additional meteorological monitoring.

{CCNPP onsite meteorological data were used as described below.} The other source of meteorological data used was from the U.S. National Weather Service (NWS). This data is certified by the National Climate Data Center (NCDC, 2007). {As such, a description of the data collection program is not included. No other sources of data were used.

The meteorological conditions of the CCNPP site and the surrounding area are taken into account by using onsite (CCNPP) and offsite (NWS) data sources. The onsite meteorological program which has been taking data since the 1970's provides an extensive data base for pre-application monitoring.}

6.4.1 PREOPERATIONAL METEOROLOGICAL MEASUREMENT PROGRAM

{The pre-operational meteorological measurement program described herein for Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 utilizes the existing operational meteorological measurement program and equipment established for CCNPP Units 1 and 2. Data from the CCNPP Units 1 and 2 operational meteorological measurement program were used in this analysis for CCNPP Unit 3. CCNPP Unit 3 is to be located approximately 2,000 ft (610 m) south of CCNPP Units 1 and 2.

This program was designed and maintained in accordance with the guidance provided in Safety Guide 23, "Onsite Meteorological Programs" (NRC, 1972). The pre-operational meteorological measurement program also meets the requirements of Regulatory Guide 1.23, Revision 1, "Meteorological Monitoring Programs for Nuclear Power Plants" (NRC, 2007), with the following deviations: no atmospheric moisture measurements (required for plants utilizing cooling towers), tower not sited at approximately the same elevation as finished plant grade, and tower, guyed wire, and anchor inspection performance of once every 5 years instead of an annual inspection for tower and guyed wire and an anchor inspection of once every 3 years. These deviations are discussed further in Section 6.4.7.}

6.4.1.1 Tower Location

{The meteorological tower for the CCNPP site is located in an open field off Calvert Cliffs Parkway north of the CCNPP Unit 1 and 2 Independent Spent Fuel Storage Installation (ISFSI). The elevation at the base of the tower is approximately 125 ft (38 m) above mean sea level.

Figure 6.4-1 shows the location of the meteorological tower as well as the topography of the CCNPP site. The meteorological tower has been sited for CCNPP Unit 1 and 2 according to the guidance provided in Safety Guide 23 (NRC, 1972). Figure 6.4-2 shows the general topographic features of the region.

The meteorological tower is located on level, open terrain at a distance at least 10 times the height of any nearby obstruction that exceeds one-half the height of the wind measurement with the exception of some trees that are located south of the tower. Even though there are no obstructions in any other sector and south is not the most prevalent wind direction, the tree heights and distances will be calculated and an evaluation performed to determine whether the trees should be removed. The tower is located far enough away from proposed CCNPP Unit 3 structures and topographical features to avoid airflow modifications. The terrain height difference between the meteorological tower and the CCNPP Unit 3 reactor area is approximately 40 ft (12 m). The distance between the meteorological tower and the CCNPP Unit 3 reactor is approximately 2,900 ft (884 m). Therefore, the terrain profile has a very gentle slope and has an insignificant impact on site dispersion conditions.}

6.4.1.2 Tower Design

{The meteorological tower is 197 ft (60 m) tall with a lattice frame. Data from instruments on the tower are sent to the Met Building which is located near the tower.

The meteorological tower is designed to be capable of withstanding wind speeds of up to 100 mph (44.7 m/sec).}

6.4.1.3 Instrumentation

{The tower instrumentation consists of wind speed, wind direction, and duplicate sets of aspirated temperature sensors located at 197 ft (60 m) and 33 ft (10 m) above ground level. A tipping bucket rain gauge is located approximately 30 ft (9.1 m) from the meteorological tower in an open field and a barometric pressure device is located in the Met Building. No moisture measurements (dew point or wet bulb temperature, relative humidity) are currently taken. Consequently, meteorological data needed in the analysis of the Ultimate Heat Sink and potential plumes from cooling tower operation will be taken from other sources.

CCNPP replaced their meteorological monitoring instrumentation in December 2005. The specifications of the previous instrumentation met or exceeded the accuracy and resolution requirements of the Regulatory Guide 1.23 Revision 1 (NRC, 2007).

The instruments are positioned on the meteorological tower in accordance with the guidance in Regulatory Guide 1.23, Revision 1 (NRC, 2007).

Table 6.4-1 provides the current meteorological instrument accuracy and resolution and compares them with regulatory guidance provided in Regulatory Guide 1.23, Revision 1, (NRC, 2007).

Signals from the sensors are collected and processed by two data loggers. Each data logger collects the data from the meteorological tower, and performs calculations of average values, wind direction sigma theta, and temperature difference between the 197 ft (60 m) and 33 ft (10 m) levels of the meteorological tower. The primary data logger sends the averaged data values to a personal computer (PC) that is dedicated to the meteorological measurement system. This PC is located in the Met Building and includes a printer for data output. The backup data logger is connected to a dial-up modem, which provides the capability for remote retrieval of meteorological data. The primary data logger and plant equipment are isolated from the telephone connection to the backup data logger.}

6.4.1.4 Instrument Maintenance and Surveillance Schedules

{The meteorological instruments are inspected and serviced at a frequency that assures at least a 90% data recovery rate for all parameters, including the combination of wind speed, wind direction, and delta temperature. The instrumentation specified in Regulatory Guide 1.23, Revision 1 are channel checked on a daily basis and instrument calibrations are performed semi-annually.

System calibrations encompass the entire data channel for each instrument, including recording devices and displays (those located at the tower, in emergency response facilities, and those used to compile the historical data set). The system calibrations are performed by either a series of sequential, overlapping, or total channel steps.}

6.4.1.5 Data Reduction and Compilation

{Wind and temperature data are averaged over 15 minute periods. The data loggers employ a validation mode that monitors the various sensors and activates alarms as necessary. The validation mode compares the data values from the 33 ft (10 m) and 197 ft (60 m) levels of the tower. The data loggers perform a daily check of the processor cards and will alarm if values are outside of specified limits.

Averaged data values from the data loggers are collected by the meteorological software, along with maximum and minimum values of ambient temperature and wind direction variance (sigma-theta). Hourly data values are determined from the 15 minute averaged values. Output options include various functions and averages as well as graphical displays.

The 15 minute averaged data are available for use in the determination of magnitude and continuous assessment of the impact of releases of radioactive materials to the environment during a radiological emergency (as required in 10 CFR 50.47 (CFR, 2007a) and 10 CFR 50 Appendix E (CFR, 2007b)). The hourly averaged data are available for use in:

1. Determining radiological effluent release limits associated with normal operations to ensure these limits are met for any individual located offsite.
2. Determining radiological dose consequences of postulated accidents meet prescribed dose limits at the Exclusion Area Boundary (EAB) and Low Population Zone (LPZ).
3. Evaluating personnel exposures in the control room during radiological and airborne hazardous material accident conditions.
4. Determining compliance with numerical guides for design objectives and limiting conditions for operation to meet the requirement that radioactive material in effluents released to unrestricted areas be kept as low as is reasonably achievable.
5. Determining compliance with dose limits for individual members of the public.

Annual summaries of meteorological data in the form of joint frequency distributions of wind speed and wind direction by atmospheric stability class are maintained onsite and are available upon request.

A summary of the 2000 through 2005 onsite meteorological data in the form of joint frequency distributions of wind speed and wind direction by atmospheric stability class are presented in Section 2.7. Wind roses (graphical depictions of joint frequency distribution tables) summarizing data from 1984 to 1992 for three National Weather Service (NWS) sites are also presented in Section 2.7.

A comparison of the CCNPP site and the Norfolk, Virginia, data (of the three NWS sites, the Norfolk, Virginia, site is closest to the Chesapeake Bay) reveals that both sites have the same prevailing wind direction – wind from the south-southwest. For the south-southwest wind direction, the wind speed is between 6.9 and 17.9 mph (3.1 and 8.0 mps) approximately 5% of the time at the CCNPP site and the wind speed is between 7.6 and 24.6 mph (3.4 and 11.0 mps) approximately 9% of the time at the Norfolk, Virginia, site. The most prevalent wind speed class at the CCNPP site, 4.7 to 6.7 mph (2.1 to 3.0 mps), occurs approximately 28% of the time. The most prevalent wind speed class at the Norfolk, Virginia, site, 7.6 to 12.5 mph (3.4 to 5.6 mps), occurs approximately 36% of the time. These results indicate that the CCNPP onsite data also represent long-term conditions at the site.}

6.4.1.6 Nearby Obstructions to Air Flow

{Downwind distances from the meteorological tower to nearby (within 0.5 mi (0.8 km)) obstructions to air flow were determined using U.S. Geological Survey topographical maps. Highest terrain is to the north and north-northwest. Lowest terrain is to the northeast, east-northeast, and east (Chesapeake Bay). Table 6.4-2 presents the distances to nearby obstructions to air flow in each downwind sector.

From the information provided in Table 6.4-2 and Figure 6.4-1 and Figure 6.4-2 and with the knowledge that the base of the tower is at an elevation of approximately 125 ft (38 m), it can be seen that there are no significant nearby obstructions to airflow.}

6.4.1.7 Deviations to Guidance from Regulatory Guide 1.23

{The pre-operational meteorological monitoring program for CCNPP Unit 3 complies with Regulatory Guide 1.23, Revision 1 (NRC, 2007), except as follows. No atmospheric moisture measurements are taken. Atmospheric moisture data needed in the analysis of the CCNPP Unit 3 Ultimate Heat Sink and potential plumes from CCNPP Unit 3 cooling tower operation will be taken from other sources. In addition, the meteorological tower is not sited at approximately the same elevation as finished CCNPP Unit 3 grade. This was done in order to assure that the meteorological tower is located on level, open terrain at a distance at least 10 times the height of any nearby obstruction that exceeds one-half the height of the wind measurement (i.e., the tower is located far enough away from CCNPP Unit 3 structures and topographical features to avoid airflow modifications). Further discussion is provided in Section 6.4.1.1.

The tower, guyed wire, and anchor inspections are performed once every 5 years instead of an annual inspection for tower and guyed wire and an anchor inspection of once every three years as provided in Regulatory Guide 1.23, Revision 1 (NRC, 2007). Note that this was not a requirement stipulated in Safety Guide 23 (NRC, 1972). Tower and guyed wire inspections will be performed annually and anchor inspections will be performed once every 3 years.}

6.4.2 OPERATIONAL METEOROLOGICAL MEASUREMENT PROGRAM

{The operational meteorological measurement program for CCNPP Unit 3 is based on the operational meteorological measurement program for CCNPP Units 1 and 2 with the addition of revised operational procedures. This program was designed according to the guidance provided in Safety Guide 23 (NRC, 1972) and has been upgraded for CCNPP Unit 3 to comply with Regulatory Guide 1.23, Revision 1 (NRC, 2007).}

6.4.2.1 Tower Location

{The meteorological tower for the CCNPP site is located in an open field off Calvert Cliffs Parkway north of the CCNPP Unit 1 and 2 ISFSI. The elevation at the base of the tower is approximately 125 ft (38 m) above mean sea level. Figure 6.4-1 shows the location of the meteorological tower as well as the topography of the CCNPP site. The tower is sited according to the guidance provided in Regulatory Guide 1.23, Revision 1 (NRC, 2007). Figure 6.4-2 shows the general topographic features of the region.

The meteorological tower is located on level, open terrain at a distance at least 10 times the height of any nearby obstruction that exceeds one-half the height of the wind measurement; i.e., the tower is located far enough away from CCNPP Unit 3 structures and topographical features to avoid airflow modifications. The terrain height difference between the meteorological tower and the CCNPP Unit 3 reactor area is approximately 40 ft (12 m). The distance between the meteorological tower and the CCNPP Unit 3 reactor is approximately 2,900 feet (884 m).

Therefore, the terrain profile has a very gentle slope and has an insignificant impact on site dispersion conditions.}

6.4.2.2 Tower Design

{The meteorological tower is 197 ft (60 m) tall with a lattice frame. Data from instruments on the tower are sent to the Met Building which is located near the tower. The primary meteorological tower is designed to be capable of withstanding wind speeds of up to 100 mph (44.7 m/sec).}

6.4.2.3 Instrumentation

{The tower instrumentation consists of wind speed, wind direction, and duplicate sets of aspirated temperature sensors located at 197 ft (60 m) and 33 ft (10 m) above ground level. A tipping bucket rain gauge is located approximately 30 ft (9.1 m) from the meteorological tower in an open field and a barometric pressure device is located in the Met Building.

The instruments are positioned on the meteorological tower in accordance with the guidance in Regulatory Guide 1.23, Revision 1 (NRC, 2007).

Table 6.4-1 presents meteorological instrument specifications and compares them with regulatory guidance provided in Regulatory Guide 1.23, Revision 1 (NRC, 2007).

Signals from the sensors are collected and processed by two data loggers. Each data logger collects the data from the meteorological tower, and performs calculations of average values, wind direction sigma theta, and temperature difference between the 197 ft (60 m) and 33 ft (10 m) levels of the meteorological tower. The primary data logger sends the averaged data values to a personal computer (PC) that is dedicated to the meteorological measurement system. This PC is located in the Met Building and includes a printer for data output. The backup data logger is connected to a dial-up modem, which provides the capability for remote retrieval of meteorological data. The primary data logger and plant equipment are isolated from the telephone connection to the backup data logger. In addition, the averaged data values are transmitted to the appropriate locations for operational and emergency response purposes (CCNPP Unit 3 Control Room, Technical Support Center, Emergency Operations Facility) and shall be submitted to the NRC's Emergency Response Data System as provided for in Section VI of Appendix E to 10 CFR Part 50 (CFR, 2007b).}

6.4.2.4 Instrument Maintenance and Surveillance Schedules

{The meteorological instruments are inspected and serviced at a frequency that assures at least a 90% data recovery rate for all parameters, including the combination of wind speed, wind direction, and delta temperature. The instrumentation specified in Regulatory Guide 1.23, Revision 1 are channel checked on a daily basis and instrument calibrations are performed semi-annually.

System calibrations encompass the entire data channel for each instrument, including recording devices and displays (those located at the tower, in emergency response facilities, and those used to compile the historical data set). The system calibrations are performed by either a series of sequential, overlapping, or total channel steps.

System calibrations encompass the entire data channel for each instrument, including recording devices and displays (those located at the tower, in emergency response facilities, and those used to compile the historical data set). The system calibrations are performed by either a series of sequential, overlapping, or total channel steps.}

6.4.2.5 Data Reduction and Compilation

{Wind and temperature data are averaged over 15 minute periods. The data loggers employ a validation mode that monitors the various sensors and activates alarms as necessary. The validation mode compares the data values from the 33 ft (10 m) and 197 ft (60 m) levels of the tower. The data loggers perform a daily check of the processor cards and will alarm if values are outside of specified limits.

Averaged data values from the data loggers are collected by the meteorological software, along with maximum and minimum values of ambient temperature and wind direction variance (sigma-theta). Hourly data values are determined from the 15 minute averaged values. Output options include various functions and averages as well as graphical displays.

The 15 minute averaged data are available for use in the determination of magnitude and continuous assessment of the impact of releases of radioactive materials to the environment during a radiological emergency (as required in 10 CFR 50.47 (CFR, 2007a) and 10 CFR 50 Appendix E (CFR, 2007b)). The hourly averaged data are available for use in:

1. Determining radiological effluent release limits associated with normal operations to ensure these limits are met for any individual located offsite.
2. Determining radiological dose consequences of postulated accidents meet prescribed dose limits at the EAB and LPZ.
3. Evaluating personnel exposures in the control room during radiological and airborne hazardous material accident conditions.
4. Determining compliance with numerical guides for design objectives and limiting conditions for operation to meet the requirement that radioactive material in effluents released to unrestricted areas be kept as low as is reasonably achievable.
5. Determining compliance with dose limits for individual members of the public.

Annual summaries of meteorological data in the form of joint frequency distributions of wind speed and wind direction by atmospheric stability class are maintained onsite and are available upon request.

A summary of the 2000 through 2005 onsite meteorological data in the form of joint frequency distributions of wind speed and wind direction by atmospheric stability class is presented in Section 2.7.

The impact of data from the two consecutive annual cycles, including the most recent one year period on the site-specific meteorological data will be evaluated and results provided in an update to this COL application.

Wind roses (graphical depictions of joint frequency distribution tables) summarizing data from 1984 to 1992 for three NWS sites are also presented in Section 2.7.

A comparison of the CCNPP site and the Norfolk, Virginia, data (of the three NWS sites, the Norfolk, Virginia, site is closest to the Chesapeake Bay) reveals that both sites have the same prevailing wind direction – wind from the south-southwest. For the south-southwest wind direction, the wind speed is 6.9 to 17.9 mph (3.1 to 8.0 mps) approximately 5% of the time at the CCNPP site and the wind speed is 7.6 to 24.6 mph (3.4 to 11.0 mps) approximately 9% of the time at the Norfolk, Virginia, site. The most prevalent wind speed class at the CCNPP site, 4.7 to 6.7 mph (2.1 to 3.0 mps), occurs approximately 28% of the time. The most prevalent wind speed class at the Norfolk, Virginia, site, 7.6 to 12.5 mph (3.4 to 5.6 mps), occurs approximately 36% of the time. These results indicate that the CCNPP onsite data also represent long-term conditions at the site.}

6.4.2.6 Nearby Obstructions to Air Flow

{Downwind distances from the meteorological tower to nearby (within 0.5 mi (0.8 km)) obstructions to air flow were determined using U.S. Geological Survey topographical maps. Highest terrain is to the north and north-northwest. Lowest terrain is to the northeast, east-northeast, and east (Chesapeake Bay). Table 6.4-2 presents the distances to nearby obstructions to air flow in each downwind sector.

From the information provided in Table 6.4-2, Figure 6.4-1, and Figure 6.4-2 and with the knowledge that the base of the tower is at an elevation of approximately 125 ft (38 m), it can be seen that there are no significant nearby obstructions to airflow.}

6.4.2.7 Deviations to Guidance from Regulatory Guide 1.23

{The meteorological tower is not sited at approximately the same elevation as finished plant grade. This was done in order to assure that the meteorological tower is located on level, open terrain at a distance at least 10 times the height of any nearby obstruction that exceeds one-half the height of the wind measurement; i.e., the tower is located far enough away from CCNPP Unit 3 structures and topographical features to avoid airflow modifications. Further discussion is provided in Section 6.4.2.1.}

6.4.3 REFERENCES

CFR, 2007a. Title 10, Code of Federal Regulations, Part 50.47, Emergency Plans, 2007.

CFR, 2007b. Title 10, Code of Federal Regulations, Part 50, Appendix E, Emergency Planning and Preparedness for Production and Utilization Facilities, 2007.

NRC, 1972. Onsite Meteorological Programs, Safety Guide 23 (Regulatory Guide 1.23 Revision 0), Nuclear Regulatory Commission, February 1972.

NRC, 2007. Meteorological Monitoring Programs for Nuclear Power Plants, Regulatory Guide 1.23, Revision 1, Nuclear Regulatory Commission, March 2007.

Table 6.4-1 Tower Instrument Specifications and Accuracies for Meteorological Monitoring Program (Preoperational and Operational) (Page 1 of 1)

Characteristics	Requirements*	Specifications
Wind Speed Sensor		
Accuracy	±0.2 m/s (±0.45 mph) OR ±5% of observed wind speed	±1%
Resolution	0.1 m/s (0.1 mph)	0.1 m/s (0.1 mph)
Wind Direction Sensor		
Accuracy	±5 degrees	±1.5 degrees
Resolution	1.0 degree	1.0 degree
Temperature Sensors		
Accuracy (ambient)	±0.5°C (±0.9°F)	±0.05°C (±0.09°F)
Resolution (ambient)	0.1°C (0.1°F)	0.1°C (0.1°F)
Accuracy (vertical temperature difference)	±0.1°C (±0.18°F)	±0.05°C (±0.09°F)
Resolution (vertical temperature difference)	0.01°C (0.01°F)	0.01°C (0.01°F)
Precipitation Sensor		
Accuracy	±10% for a volume equivalent to 2.54 mm (0.1 in) of precipitation at a rate < 50 mm/hr (< 2 in/hr)	±1%
Resolution	0.25 mm (0.01 in)	0.25 mm (0.01 in)
Time		
Accuracy	± 5 min	± 5 min
Resolution	1 min	1 min

- Accuracy and resolution criteria from Regulatory Guide 1.23, Revision 1

Table 6.4-2 Distances from Meteorology Tower to Nearby Obstructions to Air Flow
(Page 1 of 1)

Downwind Sector*	Approximate Distance miles (meters)
N	0.25 (402)
NNE	0.33 (531)
NE	N/A**
ENE	N/A**
E	N/A**
ESE	1 (1609)
SE	0.1 (161)
SSE	0.1 (161)
S	0.1 (161)
SSW	0.25 (402)
SW	0.33 (531)
WSW	0.1 (161)
W	0.25 (402)
WNW	0.33 (531)
NW	0.25 (402)
NNW	0.25 (402)

* With respect to True North
** Lower than tower base elevation and therefore no possible obstructions

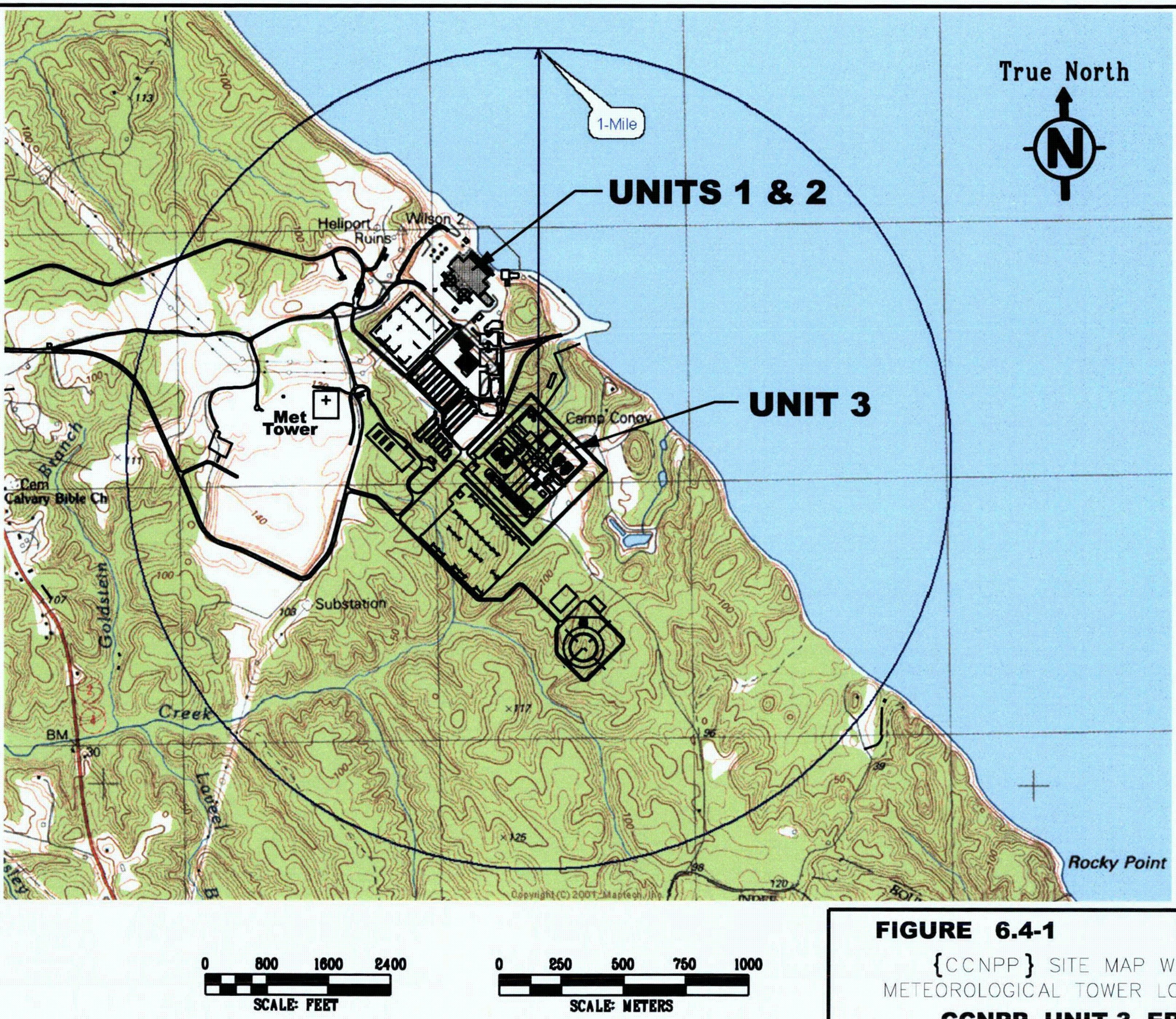
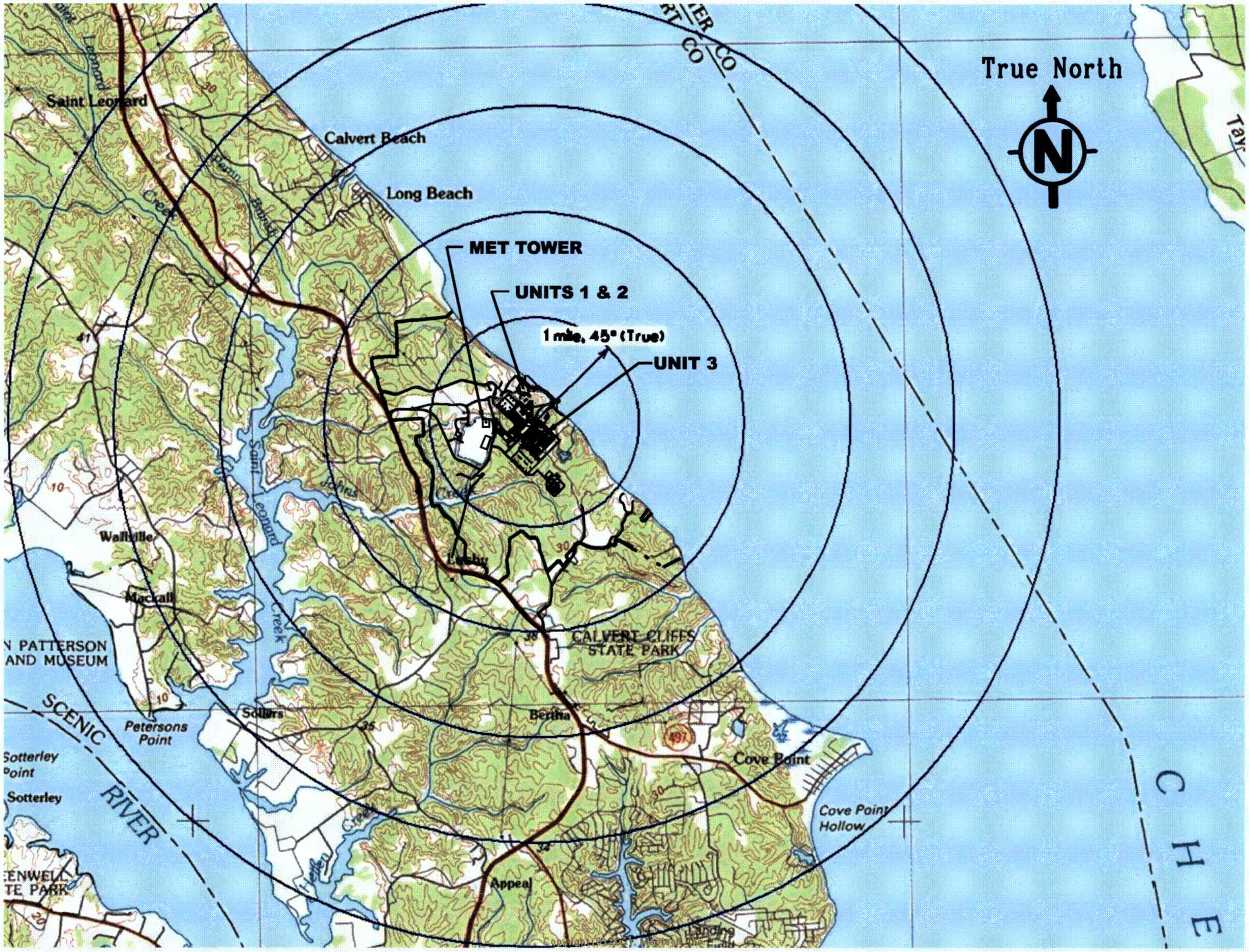


FIGURE 6.4-1 **Rev. 0**

{CCNPP} SITE MAP WITH METEOROLOGICAL TOWER LOCATION

CCNPP UNIT 3 ER



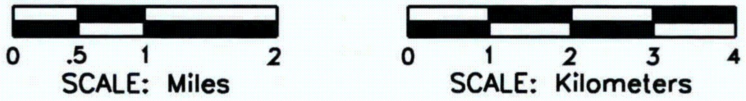


FIGURE 6.4-2 **Rev. 0**

DETAILED TOPOGRAPHY WITHIN
5 mi (8 km)

CCNPP UNIT 3 ER

6.5 Ecological Monitoring

6.5 ECOLOGICAL MONITORING

The following sections present information regarding ecological monitoring for terrestrial ecology, land use, and aquatic ecology of the {Calvert Cliffs Nuclear Power Plant (CCNPP) site} areas likely to be affected by site preparation, construction, and operation and maintenance of {CCNPP Unit 3}. The monitoring programs are designed based on anticipated environmental impacts through the various stages of {CCNPP Unit 3} project implementation. This section complies with NRC Regulatory Guide Sections 4.7 and 4.11 regarding general site suitability studies and terrestrial environmental studies to allow reasonably certain predictions that there are no significant impacts to the terrestrial ecology associated with the construction or operation of CCNPP Unit 3.

Monitoring programs to detect changes in the ecology begin before application submittal and continue during site preparation and construction and throughout station operation and maintenance. The monitoring programs cover elements of the ecosystem where a causal relationship between station construction and operation and adverse changes are established or strongly suspected. An evaluation of the standardization, adequacy and accuracy of data collection and analytical methods used in the monitoring programs is included.

6.5.1 TERRESTRIAL ECOLOGY AND LAND USE

The following sections present information on monitoring programs for terrestrial ecology and land use likely to be affected by site preparation, construction, or operation and maintenance of the facility. The monitoring programs are designed based on anticipated environmental impacts through the various stages of project implementation.

6.5.1.1 Preapplication Monitoring

Section 2.2.1 describes the site features and land use including a map showing these features. Section 2.2.2 describes the existing and proposed transmission line corridors and Section 2.4.1 describes the field studies performed to determine the major plant communities and important species and habitats. Note that the details of the type, frequency and duration of observations or samples taken at each location are contained in the individual reports for the field studies discussed in Section 2.4.1. The field studies and Section 2.4.1 discuss the distribution and abundance of important species and habitats. Critical life history information including parameters such as feeding areas, wintering areas and migration routes are also discussed in Section 2.4.1. Descriptions of modifications that may affect existing patterns of plant and animal communities including the development of cooling ponds and reservoirs, cooling towers, transmission line corridors and access routes is discussed in Section 4.3.1.

{Mitigation of the unavoidable wetland impacts will be guided by the permit requirements of the U.S. Army Corps of Engineers and Maryland Department of the Environment, according to the current regulations under Section 404 of the Federal Water Pollution Control Act and the Maryland Nontidal Wetlands Protection Act, respectively. Section 1.3 contains a list of the permits required for this project as well as the applicable Federal and State regulations. Monitoring of mitigation success will be defined and executed with reference to these regulations. All wetlands likely to be affected by CCNPP site preparation and construction associated with CCNPP Unit 3 were evaluated to determine their functions and values by a methodology accepted by the U.S. Army Corps of Engineers (USACE) (USACE, 1995) and the State of Maryland Department of Natural Resources. (MDE, 1995) Functions identified will be used as the basis of mitigating loss of wetlands during site development.}

As an essential record of overall project area baseline conditions, field surveys and aerial photography of the proposed site and transmission line system were obtained prior to construction. The resulting map of vegetation types by structure (e.g., herbaceous, shrub-scrub, sapling/small trees) and moisture regime (e.g., emergent wetland, droughty outcrops) serve as a guide to identify suitable habitats of Federal and State-listed species of plants and animals. Following the results of a listed-species field survey, access roads and staging areas within the proposed site were located so as to avoid such habitats to the extent possible. Management plans will be prepared that aim to enhance or at least perpetuate the habitat for target species. Repeated aerial photography every five years including some field observations to verify the information gathered from photo interpretation will serve as a record of forest regrowth in restored areas after completion of construction as proposed in Section 4.3.1.4. It would also provide evidence of any erosion around construction and other work areas, and indicate changes in vegetation that may call for corrective action (e.g., wind throws) or aid in the scheduling of routine transmission corridor right-of-way management.

{Additional baseline work included a survey for nesting activity of the Scarlet Tanager and other forest interior bird species and the Bald Eagle within 1,000 ft (330 m) of the proposed limits of work. Confirmation of breeding will follow accepted Federal and State protocols (Andrle, 1988).

There are no continuous monitoring programs required for terrestrial ecology and land use in this phase of the project. The surveys and studies performed to establish baseline conditions follow general guidelines published by the Maryland Department of Natural Resources as referenced in the field study reports.}

6.5.1.2 Site Preparation, Construction and Pre-Operational Monitoring

{A description of site preparation and construction impacts on terrestrial resources, including wetlands, is discussed in Section 4.1. As noted in Section 4.3.1.1, the Showy Goldenrod population identified at Camp Conoy will be relocated to avoid destruction by the CCNPP Unit 3 site preparation and construction area. Since the power line right-of-way require periodic vegetation management, and the resulting open old-field herbaceous plant community accommodates the Showy Goldenrod's habitat requirement for strong light, transplantation of the Showy Goldenrod to an appropriate part of the right-of-way or the open fields on the CCNPP site, followed by periodic monitoring, will prove to be a cost-effective form of mitigation.

Mitigating wetlands lost to CCNPP site development will commence concurrently with project construction through the development of new surface impoundments. Any monitoring required during site preparation, construction and preoperation will follow guidelines developed by the USACE and the State of Maryland in accordance with conditions specified in required permits listed in Table 1.3-1. Additional monitoring requirements including program elements, actions and reporting levels are specified in the CCNPP Stormwater Pollution Prevention Plan and the CCNPP Spill Prevention, Control and Countermeasures Program. This plan and program will be implemented during this phase in order to minimize impacts to wetlands, groundwater and aquatic ecology.

The Bald Eagle site survey will be conducted annually in this phase as well as annual monitoring for the first three years for the transplanted Showy Goldenrod locations in the transmission line corridor or open fields. Field observations versus a formal monitoring program will be documented for these surveys.

In accordance with the baseline studies performed during the preapplication timeframe and existing plant experience at the CCNPP site, no additional monitoring programs are proposed for:

- Bird collisions with plant structures, transmission lines and towers, and cooling towers;
- Salt deposition impacts on vegetation growth and habitat modifications; and

- Impacts to important species and habitats.

These parameters have all been determined to have a small impact on terrestrial ecology as discussed in Section 4.1.1, Section 4.1.2 and Section 4.3.1. Note that there is a commitment to place flashing lights or reduce lighting on the large cooling tower to minimize bird collisions once this structure is built.

There are no continuous monitoring programs required for terrestrial ecology and land use in this phase of the project. The surveys to monitor changes to terrestrial ecology from baseline conditions will follow general guidelines published by the Maryland Department of Natural Resources as referenced in the field study reports.}

6.5.1.3 Operational Monitoring

{Operation and maintenance impacts of the proposed transmission system are addressed in Section 5.6.1.

The transplanted Showy Goldenrod population will be monitored annually for the first three years, and every five or ten years thereafter, depending on the perceived need at the transplanted locations in the transmission line corridor or open fields. The Bald Eagle survey will be performed every five years in this phase. The Maryland Natural Heritage Program's Rare Species Reporting Form will serve as the core protocol for data collection (MDNR, 2007). The State passes this information to the National Biological and Conservation Data System operated by NatureServe. Database standards and protocols controlled by NatureServe are followed (NS, 2007).

Repeated aerial photography backed by field observations every five years will serve as a record of forest re-growth discussed in Section 4.3.1.4. It would also provide evidence of any erosion around future construction and other work areas, and indicate changes in vegetation that may call for corrective action (e.g., wind throws) or aid in the scheduling of routine transmission corridor right-of-way management.

There are no continuous monitoring programs required for terrestrial ecology and land use in this phase of the project. The surveys to monitor changes to terrestrial ecology from baseline conditions will follow general guidelines published by the Maryland Department of Natural Resources as referenced in the field study reports.}

6.5.2 AQUATIC ECOLOGY

The following sections present information regarding ecological monitoring for aquatic ecology likely to be affected by site preparation, construction, or operation and maintenance of the facility. The monitoring programs are designed based on anticipated environmental impacts through the various stages of project implementation.

Section 2.3.3 documents the pre-existing water quality characteristics of the freshwater bodies in the vicinity of the plant and the Chesapeake Bay. The principle aquatic ecological features of the {CCNPP} site and vicinity are described in Section 2.4.2, including freshwater systems on the {CCNPP} site and the intake and discharge areas of the {Chesapeake Bay}. Impacts to aquatic systems from construction of the facilities are described in Section 4.3.2. Impacts to aquatic systems from operation of the cooling system are described in Section 5.3.1.2 and Section 5.3.2.2. Impacts from waste discharges are described in Section 5.5.

6.5.2.1 Preapplication Monitoring

{Preapplication monitoring has been conducted, consisting of historical CCNPP Units 1 and 2 data, data collected and reported in Section 2.4.2, and the CCNPP Units 1 and 2 icthythoplankton in-plant entrainment and baffle wall study. The data provides a sufficient basis for describing the ecological resources existing on and in the vicinity of the CCNPP site. Sampling locations, sampling methods and quality control is discussed in these reports and in Section 2.4.2.

No rare or unique aquatic species were identified in nearby freshwater systems. The aquatic species that occur onsite are ubiquitous, common, and easily located in nearby waters. Typical fish species include the eastern mosquito fish and the bluegill and the American eel. The most important aquatic invertebrate species in the impoundments and streams are the juvenile stages of flying insects. Table 2.4-6 provides a list of important species and habitat found in the Chesapeake Bay. Figure 2.4-1 is a map showing open water areas.

One important species, because it is commercially harvested, is the American eel (Anguilla rostrata). It is found in most of the water bodies onsite and in the Chesapeake Bay. The American eel is abundant year round in all tributaries to the Chesapeake Bay (CBP, 2006a).

Critical life history information including parameters such as spawning areas, nursery grounds, food habits, feeding areas, wintering areas, and migration routes are discussed in Section 2.4.2. Descriptions of modifications that may affect existing patterns of plant and animal communities such as dams, impoundments, dredging, filling of wetlands, and clearing of stream banks is discussed in Section 4.3.2.

There are no continuous monitoring programs required for aquatic ecology in this phase of the project. The surveys performed to establish baseline conditions follow the guidelines published by the Maryland Department of Natural Resources and the U.S. Department of Environmental Protection as referenced in the aquatic field study report.}

6.5.2.2 Construction and Pre-Operational Monitoring

{Construction and preoperational monitoring programs are proposed for resources that may affect aquatic ecology, including thermal monitoring (as discussed in Section 6.1), hydrological monitoring (as discussed in Section 6.3) and chemical monitoring (as discussed in Section 6.6). No aquatic ecology monitoring in addition to the current monitoring requirements for CCNPP Units 1 and 2 in the Chesapeake Bay are proposed during CCNPP Unit 3 site preparation and plant construction and preoperational monitoring mainly consists of drainage from excavations which are pumped to a storm water discharge point. Approval of storm water management and erosion/sediment control plans will be obtained in accordance with the National Pollution Discharge Elimination System (NPDES) permit. The Maryland Department of Environment will issue a new permit to include pollutants typically found at a construction site such as turbidity and petroleum hydrocarbons.

Storm water discharges from impervious surfaces at the new facility will be controlled and minimized by provisions of the Storm Water Pollution Prevention Plan. This plan calls for periodic monitoring and record keeping of the engineered controls to ensure they are effective in minimizing silt runoff and evaluating the need to repair or replace the installed controls such as silt fences, hay bales, berms and settling ponds. The U.S. Army Corps of Engineers 404 Permit may contain requirements for aquatic monitoring as it relates to chemical spills or control of silt discharging into water bodies. Implementation of the Spill Prevention, Control and Countermeasures Plan requires periodic monitoring and record keeping ensuring spill controls are established and maintained to minimize impacts to the aquatic environment.

Details as to monitoring program elements, sampling procedures and equipment, data analysis, quality control and reporting will be contained in the various permits and approvals required for construction.

CCNPP Unit 3 will be designed to meet the Phase I, New Facility requirements published at 40 CFR 125.80 to 89, under Track I (CFR, 2007a). The cited EPA requirements meet the Clean Water Act 316(b) (USC, 2002) (CFR, 2007a) rules to verify there will be minimal increases in fish and benthic community impingement and entrainment for the new intake structure.

The following monitoring requirements are required by 40 CFR 125.87 (CFR, 2007a):

Biological monitoring for both impingement and entrainment of the commercial, recreational, and forage base fish and shellfish species identified in the Source Water Baseline Biological Characterization data required by 40 CFR 122.21(r)(3) (CFR, 2007b) will be required for CCNPP Unit 3 in order to comply with Track I.

The monitoring methods used are consistent with those used for the Source Water Baseline Biological Characterization data required in 40 CFR 122.21(r)(3). The monitoring frequencies identified below are followed for at least 2 years after the initial permit issuance. After that time, the State of Maryland may approve a request for less frequent sampling in the remaining years of the permit term and when the permit is reissued, if supporting data show that less frequent monitoring would still allow for the detection of any seasonal and daily variations in the species and numbers of individuals that are impinged or entrained.

Impingement samples are collected to monitor impingement rates (simple enumeration) for each species over a 24 hour period and no less than once per month when the cooling water intake structure is in operation.

Entrainment samples are collected to monitor entrainment rates (simple enumeration) for each species over a 24 hour period and no less than biweekly during the primary period of reproduction, larval recruitment, and peak abundance identified during the Source Water Baseline Biological Characterization required by 40 CFR 122.21(r)(3) (CFR, 2007b). Samples are collected only when the cooling water intake structure is in operation.

Velocity monitoring is required for surface intake screen systems to monitor head loss across the screens and correlate the measured value with the design intake velocity. The head loss across the intake screen must be measured at the minimum ambient source water surface elevation (best professional judgment based on available hydrological data). The maximum head loss across the screen for each cooling water intake structure must be used to determine compliance with the velocity requirement in 40 CFR Section 125.84(b)(2) or 40 CFR Section 125.84(c)(1) (CFR, 2007c). Head loss or velocity is monitored during initial facility startup, and thereafter, at the frequency specified in the NPDES permit, but no less than once per quarter.

Visual or remote inspections are conduced using visual inspections or employing remote monitoring devices during the period the cooling water intake structure is in operation. Visual inspections are conducted at least weekly to ensure that any design and construction technologies required in 40 CFR Section 125.84(b)(4) and (5), or 40 CFR Section 125.84(c)(3) and (4) (CFR, 2007c) are maintained and operated to ensure that they will continue to function as designed. Alternatively, inspection via remote monitoring devices to ensure that the impingement and entrainment technologies are functioning as designed is required.}

6.5.2.3 Operational Monitoring

{Operational aquatic ecology monitoring will be required as a condition of a new NPDES permit (CFR, 2007d) and for compliance with the Clean Water Act 316(b) (USC, 2002). The permit will require flow and temperature monitoring and monitoring of certain chemical constituents in the discharge.

Data has been collected for over 30 years in support of CCNPP Units 1 and 2. Some biological entrainment data has also been collected, but there is currently no program to monitor aquatic organisms. Special Condition N of the CCNPP Units 1 and 2 NPDES permit (CCNPP, 2004) does require 24 hour notification of any impingement on the water intake apparatus of aquatic organisms substantial enough to cause modification to plant operations. In addition, several organizations monitor the aquatic ecology of the Chesapeake Bay as part of ongoing restoration programs. These programs are described in Section 2.4.2. None of these monitoring programs collect data in the vicinity of the plant and therefore are not applicable for baseline data or to augment monitoring data related to the plant intake and discharge effects.

The Clean Water Act Section 316(b) (EPA, 2007a) requires that the location, design, construction and capacity of a cooling water intake structure reflect the best technology available (BTA) (CFR, 2007d) for minimizing adverse environmental impacts. The Phase II Rule, 40 CFR 125, addresses existing sources of cooling water intake at steam electric plants. A Proposal for Information Collection (PIC) for CCNPP Units 1 and 2 was created accordance with 40 CFR Section 125.95(b)(1) of the Phase II Rule (CFR, 2007e). The PIC was prepared before the start of information collection activities and identifies a plan to address the information requirements of the Comprehensive Demonstration Study (CDS), 40 CFR 125.95(a)(2) (CFR, 2007e) to ensure that the CDS will meet the requirements of the Phase II Rule.

A separate NPDES application will be prepared and submitted for CCNPP Unit 3. The CCNPP Unit 3 cooling water intake structure is designed to meet the Clean Water Act Section 316(b) Phase I requirements for new facilities under Track 1 (closed cycle cooling and intake screen velocity less than or equal to 0.5 fps (0.15 mps)).

CCNPP Units 1 and 2 withdraw more than 50 million gallons per day (maximum 3,456 million gallons per day) from the Chesapeake Bay, thus subjecting it to the Phase II Rule. The performance standards for CCNPP Units 1 and 2 call for a minimum reduction of 80% for impingement mortality, and a minimum reduction of 60% for entrainment. These reductions are calculated from a theoretical baseline cooling water intake with no operational or design features for fish conservation. However, a recent court decision has remanded much of the Phase II rule back to EPA for reconsideration. Until this issue can be resolved, the EPA has requested permit writers to use “Best Professional Judgment” in writing NPDES permits. It is expected that the remanded Phase II rule will influence the Best Professional Judgment of the permit writers. CCNPP Units 1 and 2 are currently operating under State Discharge Permit No. 02-DP-0187, NPDES MD0002399, with a permit expiration date May 31, 2009. A new NPDES permit will be required for CCNPP Unit 3.

Impingement and impingement mortality were monitored at CCNPP Units 1 and 2 from the late 1970s through 1995. Results indicate the cooling water is withdrawn from an aquatic community that is typical of a mid-Atlantic estuary. Data from the last year sampled indicated Blue Crab and Bay Anchovy were the dominant species of all organisms collected. The highest impingement period was July through September during which 79% of all organisms for the year were collected. Implementing additional impingement and post-impingement studies is not planned at this time. Data collected during the 1990s provides an accurate baseline calculation as required by the Phase II Rule.

Entrainment data from April 1978 through September 1980 were examined for trends. Hogchoker was the dominant species, accounting for almost 75% of all organisms and life stages collected, with Bay Anchovy eggs and post larvae accounting for 19%. Entrainment survival studies during this time period have inconclusive results, with data including a range of species and life stages. Entrainment data will be collected for CCNPP Units 1 and 2 to supplement the 20 year old data that exists to determine the calculation baseline required by the Phase II Rule.

Circulating water for both Units 1 and 2 nuclear generating units is withdrawn through a single cooling water intake structure. The existing cooling water intake structure closely resembles EPA's baseline definition with the following exceptions:

- a baffle wall sits in front of the screens to withdraw water from lower in the water column, potentially reducing impingement and entrainment rates,
- the existing traveling water screens reduce impingement mortality by returning fish and debris back to the Chesapeake Bay,
- the facility is operational at reduced flow, when necessary, with minimal losses in generation, which in turn reduces entrainment by a commensurate amount and measurably reduces impingement,
- two of the screens are dual-flow screens with a low pressure spray wash that potentially reduces impingement mortality.

While the addition of the new unit would increase water withdrawal, discharge rates, and thermal loading to the Chesapeake Bay, operation of the additional new unit would not increase withdrawal and discharge rates substantially over existing conditions. The planned new intake and discharge locations are located in the vicinity of the existing intake and discharge structures. Therefore, no additional monitoring programs are recommended in addition to those required by the NPDES permit and 40 CFR 125.80 to 40 CFR 125.89 (CFR, 2007a). The NPDES permit is required for the entire duration of plant operation. The permit is required to be renewed every five years with provisions for updating monitoring programs and parameters, as necessary. The NPDES permit builds upon the methodology and informational outputs of the previous monitoring programs and studies.

As noted in Section 5.5.1.2, the discharges to surface waters from plant operations will include cooling water blow down, permitted wastewater from auxiliary systems, and storm water runoff. Concentrations of chemicals in the cooling water discharge will be controlled by the NPDES permit. Additional sanitary wastes from CCNPP Unit 3 operations will be accommodated at a new sewage treatment plant, with effluent discharge also controlled by an NPDES permit. Note that the additional surface water discharges from the new unit are expected to be minor compared to the existing once-through cooling water discharges for CCNPP Units 1 and 2. Additional intake water requirements will also be minor compared to the existing intake flow.

Storm water discharges from impervious surfaces at the new facility will be controlled and minimized by provisions of the Storm Water Pollution Prevention Plan and the Spill Prevention, Control and Countermeasures Plan. A Stormwater Pollution Prevention Plan is required to be implemented at an industrial site under Maryland Department of the Environment regulations (MDE, 2007) The plan is submitted with an application for a general stormwater permit. The plan provides detailed descriptions of various best management practices that can be implemented on site to reduce stream channel erosion, pollution, siltation and sedimentation and local flooding. A Spill Prevention, Control and Countermeasures Plan is reguired by US EPA regulation 40 CFR 112 (EPA, 2007). The plan describes measures to prevent, contain and clean up oil, gasoline, and chemical spills All plans are certified by a Professional Engineer and kept on site available for inspection by the US EPA or the Maryland Department of the Environment

In addition, water withdrawn from the Chesapeake Bay is monitored as part of the Maryland Department of Environment Water Appropriation and Use permit program. This water will be used for makeup to plant cooling and to create potable water from the desalination plant. Flow is monitored monthly and reported semi-annually. Groundwater diversion is also controlled under a CCNPP site Water Appropriation and Use permit. CCNPP Unit 3 operation will not require use of groundwater. Discharge effluents from CCNPP Unit 3 and the desalination plant also are monitored under the NPDES permit.

A recent nuclear industry initiative by the Nuclear Energy Institute and NRC assessment (NRC, 2006) of existing nuclear reactors indicates that requirements related to groundwater monitoring during plant operation may change for present and future nuclear reactors. Therefore, this developing issue will continued to be followed and future requirements will be addressed, as applicable.}

6.5.3 REFERENCES

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6.6 Chemical Monitoring

6.6 CHEMICAL MONITORING

Chemical monitoring of surface water is performed to control and minimize adverse impacts to the {Chesapeake Bay} and will be implemented in three phases: preapplication, construction and preoperational, and operational monitoring. The scope for each monitoring phase will be predicated by the findings for the preceding phase.

Section 6.1 discusses discharged wastewater temperature requirements and Section 6.3 discusses flow sampling requirements.

6.6.1 PREAPPLICATION MONITORING

{Preapplication monitoring provides a baseline for assessment of effects from pre-operation and operation of CCNPP Unit 3 on the aquatic environment in the vicinity of the CCNPP site. Information on past studies performed to determine thermal characteristics of Chesapeake Bay water are discussed in Section 6.1.

Surface Water

The following water quality databases, maintained by Federal agencies, State agencies, and non-profit groups, were accessed to locate available and applicable water quality data relevant to the Chesapeake Bay water in the area of the CCNPP site:

- Chesapeake Bay Program (CBP) Water Quality Database (1984 to present)
- Chesapeake Bay Institute (CBI) Water Quality Database (1949 to 1982)
- CBP Toxics Database
- Alliance Citizen Monitoring Database
- U.S. Geological Survey (USGS) River Input Monitoring Database
- USGS Monthly Stream Flow Data
- Susquehanna River Basin Commission (SRBC) Nutrient Assessment Program
- National Estuarine Research Reserve System (NERRS)
- CBP Nutrient Point Source Database

After examining these databases, the most available data was found within the CBP Water Quality Database (1984 to present). Using this database, the CBP manages water quality data recorded at monitoring stations throughout the Chesapeake Bay and its tributaries, including stations in the area of the CCNPP site. Data from three mainstream monitoring stations (identified on Figure 2.3.3-1) north of the CCNPP site (CB4.3W, CB4.3C, and CB4.3E) and three mainstream monitoring stations south of the CCNPP site (CB4.4, CB5.1, and CB5.1W) were used to characterize seasonal water quality trends for the Chesapeake Bay waters within the vicinity of the CCNPP site. Water quality data presented in this report were therefore obtained from these monitoring stations using the CBP database, unless otherwise noted (SBP, 2007).

Data reviewed for this environmental report was based on water year (WY) 2005 (i.e., the natural, annual water cycle from October 2004 through September 2005). Availability of water quality data varies by parameter and not all data were collected at the same collection events. However, where possible, trends in the available data sets were evaluated for discussion herein. Quality assurance/ quality control methodologies utilized can be found at the CBP website. Values with quality assurance/quality control issues noted by CBP were not included.

Most of the Chesapeake Bay mainstream, all of the tidal tributaries, and numerous segments of non-tidal rivers and streams are listed as Federal Water Pollution Control Act (USC, 2007)

Section 303(d) "impaired waters" largely because of low dissolved oxygen levels and other problems related to nutrient pollution (MDE, 2006a). The CCNPP site lies within the Lower Maryland Western Shore watershed, characterized by inflow from the Patuxent River, Fishing Creek, Parkers Creek, Plum Point Creek, Grays Creek and Grover Creek. According to the Maryland Department of Environment (MDE) listing of Section 303(d) waters, the Patuxent River is the only contributing water body within the watershed with Section 303(d) status. The discussion of Section 303(d) waters is limited to those in the watershed in the area of the CCNPP site. Although NUREG-1555 (NRC, 1999b) requests "State 303(d) lists of impaired waters," there are significant portions of state waters, including waters outside of Chesapeake Bay that are well removed from the CCNPP site and could not possibly be affected by discharges from the CCNPP site.

The Patuxent River Lower Basin was identified on the 1996 Section 303(d) list submitted to U.S. Environmental Protection Agency (EPA) by the Maryland Department of the Environment (MDE) as impaired by nutrients and sediments, with listings of bacteria for several specified tidal shellfish waters added in 1998, and listings of toxics, metals and evidence of biological impairments added in 2002 (USEPA, 2005). The Section 303(d) segments within the Patuxent River have been identified as having low priority (MDE, 2004). Only waters that may require the development of Total Maximum Daily Loads (TMDLs) or that require future monitoring need have a priority designation (MDE, 2004). Two approved TMDLs are already established within Calvert County, including TMDL of fecal coliform for restricted shellfish harvesting areas and a TMDL for mercury in Lake Lariat. While the current Section 303(d) list identifies the lower Patuxent River and greater Chesapeake Bay as low priority for TMDL development, it does not reflect the high level of effort underway to identify and document pollution loadings in the watersheds.

Pursuant to the Federal Water Pollution Control Act (USC, 2007), the water quality of effluent discharges to the Chesapeake Bay and its tributaries is regulated through the National Pollutant Discharge Elimination System (NPDES). CCNPP Units 1 and 2 maintain a current NPDES permit. When the permit required renewal in June 1999, the MDE was unaware of any major issue that would prevent the permit renewal, and it was granted at that time. At the time, the MDE noted that any new regulations promulgated by the U.S. EPA or the MDE would be included in future permits and those may include development and implementation of TMDLs (NRC, 1999a). NPDES data collected in 2005 was reviewed to determine the nature of effluent discharges from the CCNPP site. Discharge parameters including biologic oxygen demand, chlorine (total residual), chlorine (total residual, bromine), cyanuric acid, fecal coliform, oil and grease, pH, temperature, and total suspended solids, were reported. Based upon the data reviewed, all discharges were within the acceptable range and no discharge violations were reported (USEPA, 2006).

Based upon the data, the following water quality trends were evident.

- Seasonal fluctuations in ammonia concentrations were observed throughout the year; however the highest variability was observed during the summer months. A minimum concentration of 0.003 mg/l was recorded at nearly all six monitoring stations during all seasons, while a maximum concentration of 0.344 mg/l was recorded during the summer. The annual average concentration of ammonia was 0.074 mg/l.
- Nitrite concentrations reached their peaks in the fall at all six monitoring stations; the greatest absolute fluctuation was at monitoring station CB4.3C, also during the fall. The annual average concentration was 0.0134 mg/l. Nitrate concentrations fluctuated seasonally throughout the year, with peak concentrations reached in the spring at all six

monitoring stations. The highest concentration was 0.971 mg/l at CB4.3W. The annual average concentration was 0.2014 mg/l.

- Concentrations of total organic nitrogen fluctuated, but did not show a defined seasonal trend. A minimum concentration, 0.2698 mg/l, was recorded at monitoring station CB4.4 during the summer, while a maximum concentration of total organic nitrogen, 1.2507 mg/l, was recorded at monitoring station CB4.3W, also during the summer. The annual average concentration of total organic nitrogen was 0.5066 mg/l.
- Orthophosphate and total phosphorus concentrations remained relatively stable throughout the year, with no notable spatial or temporal variations. The highest concentrations for both parameters was reached at CB4.3W during the summer, with concentrations of 0.0932 mg/l and 0.1223 mg/l for orthophosphate and total phosphorus, respectively. The annual average concentration of orthophosphate was 0.0103 mg/l. The annual average concentration of total phosphorus was 0.392 mg/l.
- Concentrations of Chlorophyll A varied substantially at five of the six monitoring stations during nearly all seasonal periods. Peak concentrations were generally reached in spring or summer. Monitoring station CB5.1W had the lowest peak concentrations and the lowest variability. A minimum concentration of 0.449 µg/l was observed at monitoring station CB4.4 in the fall; while a maximum concentration 53.827 µg/l was recorded at CB4.3W during the summer. This high concentration corresponds to a rise in total available organic nitrogen and orthophosphates within the surface waters. The annual mean concentration was 9.764 µg/l.
- Total suspended solids concentrations fluctuated widely throughout the year, reaching peak concentrations at four of the six monitoring stations during the spring. Minimum concentrations of 2.4 mg/l were recorded at several monitoring stations. The maximum concentration of 53.827 mg/l was recorded during the summer at monitoring station CB4.3W. The lowest annual mean total suspended solids were 6.57 mg/l at Station CB5.1W. The average total suspended solids at Station CB4.4, nearest to CCNPP, range from 7.71 mg/l in the fall to 30.40 mg/l in the winter. The annual mean concentration for the six monitoring stations was 9.06 mg/l.
- Surface water pH fluctuated throughout the year from 7.0 to 8.6, averaging 7.764 standard units, with the lowest values generally reached during spring and summer. The average low pH across the stations was 7.7 standard units; the average maximum was 8.4 standard units. No spatial variations are noted.

In response to concerns about nutrient pollution, the U.S. EPA developed Chesapeake Bay-specific water quality criteria for dissolved oxygen, water clarity, and Chlorophyll A in 2003. Chlorophyll A is an indicator parameter used to measure the abundance and variety of microscopic plants or algae that form the base of the food chain in the Chesapeake Bay (USEPA, 2003). Excessive nutrients can stimulate algae blooms, resulting in reduced water clarity, reduced amount of good quality food, and depleted oxygen levels in deeper water. Chlorophyll A is, therefore, used to evaluate attainment of various water quality criteria including dissolved oxygen and water clarity (USEPA, 2003). Based on the 2005 water quality data as shown in Table 2.3.3-6, mesotrophic to eutrophic water conditions may have been present in the vicinity of CCNPP site during the spring and summer months, and indicated that water quality criteria for DO would not be attained for the spring months.

Beginning in February 2007, three of five planned water samples were collected at the CCNPP Units 1 and 2 cooling water intake structure. During each sampling event, water samples were collected towards the end of the incoming (flood) and the outgoing (ebb) tides. Sample results and analytical parameters are presented in Table 2.3.3-8. Because of differences in analytical suites, not all results are directly comparable to the water quality samples collected by the CBP as shown in Table 2.3.3-6. In general, the intake analyte concentrations and measurements are similar to the values measured in CBP water samples collected at the stations closest to the CCNPP (locations CB4.3W, CB4.3C, CB4.3E, and CB4.4) indicating that there are no significant pollutants in the influent cooling water for CCNPP Units 1 and 2.

Groundwater

Forty (40) groundwater observation wells were installed across the CCNPP site. They were completed in the Surficial aquifer and water-bearing materials in the Chesapeake Group. The wells were located in order to provide adequate distribution with which to determine site groundwater levels, subsurface flow directions, and hydraulic gradients beneath the CCNPP site. Well pairs were installed at selected locations to determine vertical gradients. Field hydraulic conductivity tests (slug tests) were conducted in each observation well. Monthly water level measurements from the groundwater observation wells began in July 2006 and will continue until July 2007.

To evaluate vertical hydraulic gradients, several observation wells were installed as well clusters. Well clusters are a series of wells placed at the same location, with each well monitoring a distinct water bearing interval. Four well clusters were installed to evaluate the hydraulic gradient between the Surficial aquifer and the Upper Chesapeake unit, and three well clusters were installed to evaluate the gradient between the Upper Chesapeake and Lower Chesapeake units.}

Well water quality data are described in Section 2.3.3.2.

6.6.2 CONSTRUCTION AND PREOPERATIONAL MONITORING

{Chemical monitoring during construction will aid in controlling adverse impacts to the Chesapeake Bay and will provide additional water quality data that can be used to measure water-quality changes from operation of CCNPP Unit 3. Accordingly, chemical monitoring of surface water during construction related activities for CCNPP Unit 3 will be an extension of more than 30 years of pre-application monitoring. Construction and preoperational chemical monitoring will be performed during the planned two year and four year periods for site preparation and plant construction, respectively. Sample collection, laboratory analyses, data evaluation and reporting practices will comply with permit modifications.

Although storm water discharges will increase during construction, primarily due to water pumped from excavation sumps, disturbance to existing drainage systems will be avoided, if possible. Environmental controls (i.e., silt screens, dams, settling basins, and spill containment measures), will be implemented to reduce potential pollutants in storm water runoff and to minimize construction impacts to aquatic habitats. Prior to the start of construction, approval of storm water management and erosion/sediment control plans will be obtained in accordance with the NPDES Construction General Permit as discussed in Section 1.3. These controls will be incorporated into a Storm Water Pollution Prevention Plan (SWPPP). Similar to the existing plant's SWPPP, storm water system manholes and handholds will continue to be periodically inspected and cleaned.

Considering that the CCNPP Unit 3 footprint is in the vicinity of the former Camp Conoy site, as discussed in Section 2.2 and Section 3.1, the existing swimming pool will be demolished and Outfall 005 replaced or eliminated.

Groundwater monitoring (water level observation) of the CCNPP Unit 3 area is currently being implemented through the use of the groundwater observation wells installed in 2006 for the CCNPP Unit 3 site area subsurface investigation and through the periodic review of water levels from selected wells within the Calvert County Groundwater Level Monitoring Network. Some of the existing CCNPP Unit 3 area observation wells will be taken out-of-service prior to construction activities due to anticipated earth moving and construction requirements. Prior to construction activities, the observation well monitoring network will be evaluated in order to determine groundwater data gaps and needs created by the abandonment of existing wells. These data needs will be met by the installation of additional observation wells, if required. Additionally, the hydrologic properties and groundwater flow regimes of the shallow water bearing units (Surficial aquifer, and to a lesser extent, the Chesapeake units) will be impacted by the proposed earthmoving, regrading, and construction of infrastructure (buildings, parking lots, etc.). Revisions to the observation well network will be implemented to ensure that the resulting changes in the local groundwater regime from construction activities will be identified. No chemical monitoring is planned at this time for groundwater.}

6.6.3 OPERATIONAL MONITORING

{Operational monitoring will commence from the date of the first appropriation and use of Chesapeake Bay water and first discharge and continue as long as required by the NPDES permit applicable for CCNPP Unit 3. Although operational monitoring elements will be developed in consultation with the MDE, it is anticipated that sampling locations, frequency and analyses will be similar to those for CCNPP Units 1 and 2.

Similar to the CCNPP Units 1 and 2 intake structure, the CCNPP Unit 3 intake structures will house debris screens, screen wash pumps, makeup water pumps and related equipment so that a new outfall for intake screen backwash will be likely. However, similar to CCNPP Units 1 and 2, chemical monitoring at the CCNPP Unit 3 intake and outfall will be limited by the new NPDES permit to certain chemical parameters to ensure the differences between the intake water and discharge water are within the limits specified in the permit.

Unlike the once-through cooling water system utilized by CCNPP Units 1 and 2, CCNPP Unit 3 will utilize a closed-loop cooling water system, resulting in significantly less discharge water. Fresh water for CCNPP Unit 3 will be supplied by a desalination plant, in lieu of groundwater. Prior to discharge into the Chesapeake Bay, normal cooling tower blowdown will be directed to a retention basin, provided as an intermediate discharge reservoir, and held for a period of time to reduce the concentration of solids and chlorine in the water. Essential Service Water System cooling tower blowdown, treated sanitary effluents, desalination plant discharge (brine), and other wastewater will also collect in the retention basin. Piping will transfer retention basin wastewater by gravity to the new discharge structure, which will provide a flow path for the discharge of water into the Chesapeake Bay via a submerged outfall.

The CCNPP Unit 3 Waste Water Treatment Plant (WWTP) would collect sewage and waste water generated from the portions of the plant outside the radiological control areas of the power block and would treat them using an extensive mechanical, chemical, and biological treatment processes. The treated effluent would be combined with the discharge stream from the onsite waster water retention basin and discharged to Chesapeake Bay. The discharge would be in accordance with local and state safety codes. The dewatered sludge would be hauled offsite for disposal at municipal facilities. The treated waste waster would meet all applicable health standards, regulations, and TMDLs set by the Maryland Department of the Environment and the U.S. EPA.

Table 3.6-3 lists anticipated liquid and solid effluents associated with the WWTP. Parameters are expected to include flow rates, pollutant concentrations, and the biochemical oxygen concentration at the point of release.

Non-radioactive liquid effluents that could potentially drain to the Chesapeake Bay are limited under the NPDES permit. Table 3.6-1 provides information on the various chemicals anticipated to be used for the various plant water systems. All of these chemical additives will have limiting discharge concentrations specified in the NPDES permit that will require monitoring.

Chemical monitoring will be performed at the new outfall to assess the effectiveness of retention methods and effluent treatment systems, as well as to detect changes in water quality associated with plant operations. Similar to CCNPP Units 1 and 2, chemical monitoring will also be performed at storm water runoff outfalls and at internal monitoring points (i.e., sanitary waste effluents, wastewater retention basin influent and/or effluent). Effluent water chemistry will meet applicable federal and state environmental regulatory requirements.

The following discussion provides a basis for the type of data and information that is expected to be required by the NPDES permit for CCNPP Unit 3. The CCNPP Units 1 and 2 NPDES permit specifies the monitoring conditions that the existing plant must meet to protect water quality. It is expected that NPDES permit requirements for CCNPP Unit 3 will be similar. Table 6.6-1 summarizes the required water sampling protocol for the existing monitoring stations. A map showing the monitoring station locations is provided in Section 6.1. Although the sampling station for Outfall 001 is located onshore, its discharge point is offshore (Special Condition A.1 of NPDES, 2004). Past and present chemical characteristics of monitoring station discharges are provided in Section 2.3.3. Well water not consumed by various plant systems discharges into the Chesapeake Bay via authorized Outfall 001 or Outfall 005.

Sampling for CCNPP Unit 3 NPDES permit requirements will be performed in accordance with the quality standards outlined in a Chemical Quality Assurance (QA) and Quality Control (QC)} Program. This Chemical QA and QC Program will provide performance instructions for chemical/reagent control, instrumentation control, program control (e.g., sampling methodologies, analysis), minimum quantifiable concentration control, use and evaluation of charts, and data reporting.

Samples representative of the system or stream will be collected and preserved as necessary to prevent contamination or deterioration. Treated sewage effluent samples will be collected with an automatic compositor. Sampling and analytical methods will conform to procedures for the analysis of pollutants as identified in 40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants." Toxicity testing will be conducted in accordance with procedures described in EPA/600/4-90/027F (USEPA, 1993). To ensure accuracy of measurements, monitoring and analytical instrumentation is maintained and periodically calibrated in accordance with manufacturer specifications or those per the Chemical QA and QC Program, whichever are more restrictive. The Chemical QA and QC Program will also provide instructions for calibration standards, prepared or purchased, used for preparing calibration curves and performing calibration checks. Statistical reliability will be achieved by calculating the mean and standard deviation of the data at a 95% confidence level. Data quality objectives include producing accurate, reliable and cost effective measurements and data, adequate for their intended use.

Monthly monitoring results will be summarized on Discharge Monitoring Reports and submitted to the MDE. Sampling data collected during pre-application monitoring serve to document existing water quality conditions.

There are currently no plans to monitor groundwater for chemicals during the operational phase of CCNPP Unit 3.}

6.6.4 REFERENCES

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Table 6.6-1 {NPDES Required Water Sampling Protocol for CCNPP Units 1 and 2 (Page 1 of 3)

Monitoring Station[a]	Monitoring Location[b]	System(s) Sampled[b]	Parameter Sampled	Sample Type[i]	Sampling Frequency
Outfall 001[c]	Surge pit at end of Discharge Road near the northeast corner of the plant	• Once-through Cooling Water • Sewage Treatment • Low Volume Waste, Sump Water and Storm Water Runoff • Auxiliary Boiler Blowdown • Reverse Osmosis Reject Water • Secondary Cooling Blowdown	TRC[d]	Grab	1/Week
Monitoring Point 101A	Discharge for the de-chlorination chamber	Sewage Treatment	BOD TSS Fecal Coliform[e] TRC	8 hour Composite 8 hour Composite Grab Grab	1/Week 1/Week 1/Week 1/Week
Monitoring Point 102A[f]	Pipe outlet beside the Sewage Treatment Plant access road	• Low Volume Waste, • Sump Water • Storm Water Runoff	TSS Oil and Grease pH	Grab Grab Grab	1/Month 1/Month 1/Month
Monitoring Point 103A[g]	Auxiliary Boiler Room	Auxiliary Boiler Blowdown	TSS Oil and Grease pH	Grab Grab Grab	1/Year 1/Year 1/Year

Table 6.6-1 {NPDES Required Water Sampling Protocol for CCNPP Units 1 and 2
(Page 2 of 3)

Monitoring Station[a]	Monitoring Location[b]	System(s) Sampled[b]	Parameter Sampled	Sample Type[i]	Sampling Frequency
Monitoring Point 104A	Discharge from the neutralization tank	Reverse Osmosis Reject Water (Demineralizer Backwash)	TSS Oil and Grease pH	Grab Grab Grab	1/Month 1/Month 1/Discharge
Monitoring Point 106A[g]	Plant sample sink	Secondary Cooling Blowdown	TSS Oil and Grease pH	Grab Grab Grab	1/Year 1/Year 1/Year
Outfall 003[h]	Intake Structure	Intake Screen Backwash	N/A	N/A	N/A
Outfall 004[h]	Intake Structure	Intake Screen Backwash	N/A	N/A	N/A
Outfall 005[j]	Plastic pipe across road north of pool	Swimming Pool Filter Backwash	TRC TRB Cyanuric Acid	Grab Grab Grab	1/Month 1/Month 1/Month

Notes:

a. Refer to Section 6.1 for a map showing the location of the monitoring stations. The sampling location for Outfall 001 is onshore, but its discharge point is offshore.

b. Monitoring station locations and systems sampled are specified in the NPDES permit.

c. Includes discharges from internal Monitoring Points 101A, 102A, 103A, 104A and 106A.

d. The monthly Discharge Monitoring Reports indicate when chlorine compounds are not in use. Discharge of residual chlorine from any unit is limited to two hours per day.

e. Average limitations are calculated as Geometric Mean.

Table 6.6-1 {NPDES Required Water Sampling Protocol for CCNPP Units 1 and 2

(Page 3 of 3)

f. Limitations and monitoring requirements are applicable during periods of no storm water runoff.

g. Closed loop system. Makeup water is supplied by the reverse osmosis system. Monitoring is performed annually since the discharged water is essentially pure.

h. Since the water is not changed by the screen backwash process, it is not limited by the NPDES permit.

i. "Grab sample" means an individual sample collected in less than 15 minutes. Grab samples collected for pH and TRC are analyzed within 15 minutes of time of sample collection. "Composite sample" means a combination of individual samples obtained at least at hourly intervals over a time period. Although 'time periods' as noted above and in Note 'j' below are specified for sample collection in the NPDES permit, the 'time of day' that samples are collected, is not mandated.

j. Discharge is to an unnamed tributary (a small swale) which flows into the Chesapeake Bay.}

6.7 Summary of Monitoring Programs

6.7 SUMMARY OF MONITORING PROGRAMS

This section summarizes the monitoring environmental programs described in Chapter 6. The summary is divided into three sections:

- Pre-application monitoring
- Construction and Pre-Operational monitoring
- Operational monitoring

6.7.1 PREAPPLICATION MONITORING

Pre-Application monitoring for {CCNPP Unit 3} will be fulfilled by the ongoing thermal, radiological, hydrological, meteorological, and chemical monitoring programs (Sections 6.1 through 6.6) for the existing {CCNPP Units 1 and 2}. This represents {30} years of monitoring for the site. Pre-application ecological monitoring was provided through field studies. Summaries of the pre-application monitoring activities are included in Tables 6.7-1 through 6.7-7.

6.7.2 CONSTRUCTION AND PREOPERATIONAL MONITORING

The current thermal, radiological, hydrological, meteorological, and chemical monitoring programs will be continued through the construction and preoperational phases of {CCNPP Unit 3}. Construction and pre-operational ecological monitoring will be provided by follow-up field studies and monitoring of intake structure impingement and entrainment, and quality monitoring for water withdrawn from the Chesapeake bay. Summaries are included in Tables 6.7-1 through 6.7-7.

6.7.3 OPERATING MONITORING

While specific operational monitoring requirements and programs for {CCNPP Unit 3} have not yet been fully established, they will be similar to and tiered from or added to those monitoring programs described in the previous sections which currently monitor the impacts of {CCNPP Units 1 and 2} on the surrounding environment. Summaries are included in Tables 6.7-1 through 6.7-7.

The existing and future operational monitoring programs could be modified as a result of future consultations with state regulatory agencies. The need for modifications to established monitoring locations, parameters, collection techniques, or analytical procedures will be assessed prior to and during the course of operation, as is done now for {CCNPP Units 1 and 2}.

6.7.4 REFERENCES

None

Table 6.7-1 Thermal Monitoring
(Page 1 of 1)

Phase	Summary	Permit
Pre-Application	{The National Pollutant Discharge Elimination System (NPDES) permit for CCNPP Units 1 and 2 requires thermal monitoring of plant discharges via Outfall 001, and provides a cooling water temperature increase limit of 12 °F (6.7 °C). Once-through cooling water for CCNPP Units 1 and 2 is discharged through tunnels approximately 400 yards (365.8 meters) offshore.}	NPDES Permit issued for {CCNPP Units 1 and 2}
Construction and Pre-Operation	Construction and pre-operational thermal monitoring will be a continuation of the pre-application program. Construction related discharges will mainly consist of surface drainage that collects in sumps at the bottom of excavations, which will be pumped to a storm water discharge point. Consequently, no changes in thermal discharges are expected to the construction and preoperational monitoring program from those provided during the pre-application phase. {The Maryland Department of Environment (MDE) will be notified of pending construction activities and approval of storm water management and erosion/sediment control plans will be obtained in accordance with the NPDES Construction General Permit.}	General NPDES Construction Permit
Operation	{CCNPP Unit 3 will utilize a closed-loop cooling systems. Thermal monitoring will be performed at the discharge structure outfall for CCNPP Unit 3, and will conform to the requirements of the NPDES permit issued for CCNPP Unit 3. It is anticipated that the location of the thermal monitoring station for the new outfall structure will be similar to the existing monitoring stations (i.e., near the intake screens and discharge structure).}	NPDES Permit issued for {CCNPP Unit 3} Operation

Table 6.7-2 Radiological Monitoring
(Page 1 of 1)

Pre-application monitoring for {CCNPP Unit 3} site location will be provided by the existing Radiological Environmental Monitoring Program (REMP) for {CCNPP Units 1 and 2}. Annual reporting of these REMP activities, detected radioactivity, trends, and plant related impacts will continue through the construction and operation of {CCNPP Unit 3}. Existing sampler locations, sampling frequency, and type of analysis are described further in Tables 6.2-2 through 6.2-7.

Construction and pre-operational radiological monitoring will be a continuation of the pre-application monitoring program. {Prior to commencing construction, an existing REMP air particulate and iodine sampler (A1) and a Thermoluminescence Dosimetry location (DR7) will be relocated to an area that is outside the construction footprint for CCNPP Unit 3 (see Figure 6.2-4 for monitoring locations). Also, three vegetation species sample locations (Ib4, Ib5, Ib6) that are located within the construction footprint for CCNPP Unit 3 (see Figure 6.2-1) will be relocated near the new location for sampler A1.}

For the operational phase, an additional air particulate and iodine sampler and Thermoluminescence Dosimetry location will be provided at the SSW site boundary area to satisfy REMP siting criteria. A surface water sampler will also be provided near the {CCNPP Unit 3 discharge point}.

Effluent Exposure Pathways	REMP Sampling Media	Frequency	Phase
Liquid Effluents			
{Ingestion Fish	Commercial & Recreational Fish Species	In season, or semiannually if not seasonal	All Phases
Ingestion Invertebrates	Commercial & Recreational Fish Species	In season, or semiannually if not seasonal	All Phases
Shoreline Exposure (External Direct)	Sediments from Shoreline	Semiannually	All Phases
Swimming & Boating (External Direct)	Surface Waters	Composite sample over one month period	All Phases}
Gaseous Effluents			
{Cloud Immersion (External Direct)	Thermoluminescence Dosimetry (TLD)	At least quarterly	All Phases
Ground Plane (External Direct)	Thermoluminescence Dosimetry (TLD)	At least quarterly	All Phases
Inhalation	Air Particulate Sampling, Iodine Sampling	Continuous sampler with weekly sample collection	All Phases
Ingestion of Agricultural Products	Broadleaf Vegetation	Monthly during growing season	All Phases}

Notes:

1. No milk ingestion pathway. No milk animals within 5 mi (8 km) of the site. Meat ingestion is not a significant pathway contributor.
2. The REMP for CCNPP Unit 1 and 2 does not include groundwater monitoring. By design, there are no liquid effluent releases to groundwater or structures that discharge to groundwater. Therefore there is no human ingestion pathway associated with groundwater for CCNPP Unit 3.

Table 6.7-3 Hydrological Monitoring
(Page 1 of 1)

Phase	Surface Water	Groundwater
Pre-Application	{Hydrological Monitoring of surface water is in accordance with the NPDES program. Table 6.3-1 lists monitoring locations and frequencies. Water from the Chesapeake Bay is used for plant system cooling in accordance with a water appropriation and use (WAU) permit.}	{Groundwater monitoring is conducted of five production wells that supply process and domestic water in the CCNPP Unit 1 and 2 protected area. Nine additional wells supply water for domestic and industrial use in the outlying areas. These are monitored in accordance with a WAU permit.}
Construction and Pre-Operation	{Surface water on site will be monitored as part of the NPDES Construction General Permit. Erosion/sediment control and storm water management will be monitored by the Storm Water Pollution Prevention Plan (SWPPP). Chesapeake Bay surface water will be monitored during construction of the CCNPP Unit 3 intake and discharge structures as part of the U.S. Army Corps of Engineers 404 permit.}	{Groundwater monitoring during construction of CCNPP Unit 3 will be conducted with groundwater observation wells installed across the CCNPP site as part of the COL pre-application studies. This is to monitor for potential dewatering of perched water levels. Generally, temporary dewatering is exempt from a WAU permit unless pre-established limits are exceeded.}
Operation	{During CCNPP Unit 3 operation, plant water supply will be from two sources. Makeup water for plant cooling will be withdrawn from the Chesapeake Bay at a new intake structure. Potable (fresh water) will be provided from a desalination plant using Chesapeake Bay water. Operation of the new intake structure and desalination plant, as well as discharge to the Chesapeake Bay, will require monitoring via WAU and NPDES permits. }	{The desalination plant will provide all fresh water needs for CCNPP Unit 3 under a WAU permit. CCNPP Unit 3 will not require use of groundwater. }

Table 6.7-4 Meteorological Monitoring
(Page 1 of 1)

Phase	Primary Tower	Backup Tower	Additional Sensors	Detailed Descriptions
Pre-Application	Wind Speed Sensor, Wind Direction Sensor, Temperature Sensors, Precipitation Sensor	Wind Speed Sensor, Wind Direction Sensor, Temperature Sensors	{A tipping bucket rain gauge is located about 30 ft (9.1 m) from the primary tower in an open field and a barometric pressure instrument is located in the Meteorology Building.}	Table 6.4-1 Table 6.4-2
Construction and Pre-Operation	Wind Speed Sensor, Wind Direction Sensor, Temperature Sensors, Precipitation Sensor	Wind Speed Sensor, Wind Direction Sensor, Temperature Sensors	{A tipping bucket rain gauge is located about 30 ft (9.1 m) from the primary tower in an open field and a barometric pressure instrument is located in the Meteorology Building.}	Table 6.4-1 Table 6.4-2
Operation	Wind Speed Sensor, Wind Direction Sensor, Temperature Sensors, Relative Humidity Sensor (Added for CCNPP Unit 3), Precipitation Sensor	Wind Speed Sensor, Wind Direction Sensor, Temperature Sensors	{A tipping bucket rain gauge is located about 30 ft (9.1 m) from the primary tower in an open field and a barometric pressure instrument is located in the Meteorology Building.}	Table 6.4-3 Table 6.4-4

Notes:

1 Pre-Application, and Construction and Pre-Operation, meteorological monitoring to be performed as an extension of the existing meteorological monitoring program for {CCNPP Units 1 and 2}

2 Primary tower – {197 ft [60 m] and 33 ft [10 m] elevations above ground level}

3 Backup Tower – {33 ft [10 m] elevation above ground level}

Table 6.7-5 Terrestrial Ecology Monitoring (Page 1 of 3)

Phase	Summary	Permits
Pre-Application	[{There are currently no program or regulatory requirements to monitor terrestrial ecology. Extensive terrestrial ecology field studies were performed during the pre-application phase, including studies for rare plants, flora, fauna, wetlands, and two federally threatened tiger beetles. These studies included baseline surveys of the scarlet tanager and other forest-interior birds, and the bald eagle within 1,000 ft of the construction area. Aerial photographic records of the project area have been performed to establish baseline conditions for vegetation types and moisture regimes, and to identify suitable habitats for Federal and State protected species of plant and animals. Mitigation of unavoidable wetland impacts due to construction activities for CCNPP Unit 3 will be guided by permit requirements of the US Army Corps of Engineers and Maryland Department of the Environment. Wetlands likely to be affected by construction will be evaluated to determine their functions and values by methodology accepted by the US Army Corps of Engineers and Maryland Department of the Natural Resources.}	{US Army Corps of Engineers Maryland Department of the Environment Maryland Department of the Natural Resources}

Table 6.7-5 Terrestrial Ecology Monitoring (Page 2 of 3)

Phase	Summary	Permits
Construction and Pre-Operation	{There are no continuous monitoring program requirements for terrestrial ecology during this phase. Mitigation of wetlands lost to development will commence concurrently with project construction. Monitoring will follow guidelines developed by the US Army Corps of Engineers, State of Maryland permit requirements, the CCNPP Stormwater Pollution Prevention Plan, and the CCNPP Spill Prevention, Control and Countermeasures Program. The Showy Goldenrod population at Camp Conoy will be relocated to avoid destruction during site preparation and construction of CCNPP Unit 3. Power line right-of-ways require periodic vegetable management and the resulting open old-field herbaceous plant community matches the Showy Goldenrod's requirements for transplantation. Relocation followed by annual monitoring for the first three years will be performed and will be documented as field surveys. Aerial photographic records will be obtained every five years, including some field observations, to verify the information gathered from photo interpretation. This will serve as a record of forest growth in restored areas following construction, identify areas of erosion, and indicate changes in vegetation that require corrective action. Bald eagle surveys will be performed annually during the construction and pre-operation phase.}	{US Army Corps of Engineers Maryland Department of the Environment Maryland Department of the Natural Resources}

Table 6.7-5 Terrestrial Ecology Monitoring
(Page 3 of 3)

Phase	Summary	Permits
Operation	{There are no continuous monitoring program requirements for terrestrial ecology during this phase. The transplanted Showy Goldenrod population will be monitored annually for the first three years following relocation, and every five or ten years thereafter, based on perceived need. A refined version of the Maryland Natural Heritage Program's Rare Species Reporting Form will serve as the core protocol for data collection. Aerial photographic monitoring, backed by field observations, will continue to be performed every five years during operations to serve as a record of forest growth, and to identify erosion or changes in vegetation requiring corrective action. Bald eagle surveys will be performed every five years during the operational phase.}	{US Army Corps of Engineers Maryland Department of the Environment Maryland Department of the Natural Resources Maryland Natural Heritage Program}

Table 6.7-6 Aquatic Ecology Monitoring (Page 1 of 2)

Phase	Summary	Permit
Pre-Application Monitoring	{There are currently no program or regulatory requirements to monitor aquatic ecology. Extensive aquatic ecology field studies were performed during the pre-application phase. These studies evaluated submerged aquatic vegetation, sediment quality and benthic macroinvertebrates, and oysters. Other pre-application monitoring included review of historical data for CCNPP Units 1 and 2, and the CCNPP Unit 1 and 2 icthyplankton in-plant entrainment and baffle wall study Surveys performed to establish baseline conditions follow the guidelines published by the Maryland Department of Natural Protection and US Department of Environmental Protection, as referenced in the aquatic field study report.}	{None applicable}
Pre-Operation and Construction Monitoring	{Construction and pre-operation monitoring programs are proposed for resources that may affect aquatic ecology, including thermal monitoring (Section 6.1), hydrological monitoring (Section 6.3), and chemical monitoring (Section 6.6). The existing monitoring locations for Outfall 001 are expected to remain the same as those for pre-application monitoring (see Table 6.6-1 for location). Engineered controls minimizing silt runoff from impervious surfaces on the CCNPP Unit 3 construction site will be periodically monitored for effectiveness. The monitoring requirements of the Army Corps of Engineers 404 permit and the Spill Prevention, Control and Countermeasures Plan will be implemented as they relate to spills and spill controls, as required. Biological monitoring for fish impingement and entrainment of the commercial, recreational, and forage base fish and shellfish identified in the Source Water Baseline Characterization data will be performed to meet 40CFR122..21(r)(3), Tier I requirements. • Impingment samples will be taken over a 24 hour period no less than once per month when the cooling water intake structure is in operation. • Entrainment samples will be taken over a 24 hour period no less than bi-weekly during the identified period of primary reproduction, larval recruitment, and peak abundance when the cooling water intake structure is in operation.}	{General NPDES Construction Permit Army Corps of Engineers 404 Permit Spill Prevention, Control and Countermeasures Plan}

Table 6.7-6 Aquatic Ecology Monitoring
(Page 2 of 2)

Phase	Summary	Permit
Operational Monitoring	{Operational monitoring will be part of compliance with the new NPDES permit and the Clean Water Act 316(b) Phase II rule. The Phase II rule addresses existing sources of cooling water intake at steam electric plants. Entrainment data will be collected for CCNPP Units 1 and 2 to supplement older data that exists to determine the calculation baseline required by the Phase II Rule. A year long seasonally stratified entrainment sampling program that includes monitoring inside and outside of the baffle wall has been proposed. This will provide a baseline for implementation of the Phase II rule. Biological monitoring for fish impingement and entrainment of the commercial, recreational, and forage base fish and shellfish identified in the Source Water Baseline Characterization data will be performed to meet 40CFR122..21(r)(3), Tier I requirements. • Impingment samples will be taken over a 24 hour period no less than once per month when the cooling water intake structure is in operation. • Entrainment samples will be taken over a 24 hour period no less than bi-weekly during the identified period of primary reproduction, larval recruitment, and peak abundance when the cooling water intake structure is in operation. • Velocity monitoring will be performed for surface intake screens that correlate the measure value with the design intake velocity at the minimum source water elevation. Monitoring will be performed during initial startup, and thereafter at the frequency specified in the NPDES permit, but no less than once per quarter Water withdrawn from the Chesapeake Bay will be monitored monthly in accordance with a Maryland Department of Environment Water Appropriation and Use (WAU) permit }	{NPDES issued for CCNPP Unit 3 Operations}

Table 6.7-7 Chemical Monitoring
(Page 1 of 1)

Phase	Summary	Permit
Pre-Application	{Pre-application chemical monitoring will be performed in accordance with the existing NPDES permit for CCNPP Units 1 and 2. Details of the existing chemical monitoring program are shown in Table 6.6-1. This includes the monitoring locations, systems sampled, parameter sampled, sample type, and sampling frequency.}	{Existing NPDES permit for CCNPP Units 1 and 2}
Construction and Pre-Operation	{Construction and Pre-Operational chemical monitoring will be performed in accordance with the existing NPDES permit for CCNPP Units 1 and 2. Sample collection, laboratory analyses, data evaluation and reporting practices will comply, as needed, the General NPDES Construction Permit. A Storm Water Pollution Prevention Plan will be implemented for construction of CCNPP Unit 3. }	{General NPDES Construction Permit}
Operation	{Operational chemical monitoring of the new CCNPP Unit 3 outfall, stormwater runoff outfalls, and internal monitoring points (i.e., sanitary waste effluents, wastewater retention basin influent/effluent) will be conducted in accordance with the new NPDES permit for CCNPP Unit 3 to determine the effectiveness of the retention methods and effluent treatment systems and to detect changes in water quality associated with Unit 3 operations.}	{NPDES permit issued for Unit 3 Operations}

7.0 Environmental Impacts of Postulated Accidents Involving Radioactive Materials

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (Cont.)

LIST OF FIGURES

7.1 Design Basis Accidents

7.1 DESIGN BASIS ACCIDENTS

Design basis accidents (DBAs) are events that are not expected to occur, but are evaluated to demonstrate the adequacy of the plant design since the consequences of their occurrence have the potential for radioactive material to be released to the environment. DBAs having a potential for radiological releases to the environment are identified in Section 7.1, Appendix A of NUREG-1555 (NRC, 1999) and are listed in Table 7.1-1 along with DBAs applicable for the U.S. EPR. The DBAs are based on Chapter 15 of NUREG-0800 (NRC, 2007) and Regulatory Guide 1.183 (NRC, 2000).

Sources of radioactivity are generated within the reactor core. Radioactivity releases are dependent on the specific accident and may be released from the primary coolant, from the secondary coolant, and from the core if the accident involves fuel failures. Design input used in the DBA radiological consequences evaluations for the U.S. EPR follows the Alternative Source Term Methodology outlined in Regulatory Guide 1.183 (NRC, 2000). The design basis primary and secondary coolant source term activity concentrations for the U.S. EPR are provided in Table 7.1-2 and Table 7.1-3, respectively. Table 7.1-4 lists the design basis source term inventories for the core.

Primary and secondary coolant concentrations are based on the proposed U.S. EPR Technical Specification limits for halogens and noble gases, the American National Standards Institute/American Nuclear Society (ANSI/ANS)-18.1 Standard (ANS, 1999) for activation products and tritium, and 0.25% fuel defects for remaining radionuclides. For certain accidents (i.e., Steam System Piping Failures, Feedwater Pipe Break and Steam Generator Tube Rupture), the radiological consequences analyses account for iodine spiking which causes the concentration of various radioactive iodines in the primary coolant to significantly increase to levels described in Table 7.1-2. The iodine appearance rates (i.e., rates at which iodine isotopes are transferred from the core to the primary coolant via assumed fuel cladding defects) used in DBA analyses for the U.S. EPR were based on a conservative Reactor Coolant System letdown purification flow rate. Referring to Table 7.1-3, no secondary coolant noble gas source term is applicable since noble gas leakage from the Reactor Coolant System is assumed to enter the steam phase directly. Design basis core source terms were determined for a power level of 4,612 MWt, which is equivalent to the rated core thermal power of 4,590 MWt plus 22 MWt (approximately 1/2% of rated thermal power) to account for heat balance measurement uncertainty. Core inventories are bounding for U-235 fuel enrichments ranging between two and five percent and burnups up to 62,000 MWd/MTU.

For each of the accident scenarios listed in Table 7.1-1, it is postulated that some quantity of radioactivity is released at the accident location inside a plant building and eventually released into the environment. Radiological consequences of these accidents depend on the type and amount of radioactivity released and meteorological conditions. Potential consequences are assessed to demonstrate that environmental impacts, quantified in doses to individuals at the exclusion area boundary (EAB) distance of 0.5 mi (0.8 km) and the low population zone (LPZ) distance of **{**1.5 mi (2.4km)**}**, meet regulatory dose acceptance criteria.

The accident doses are expressed as total effective dose equivalent (TEDE). For each applicable DBA, TEDE/accident doses are calculated based on time-dependent activities released to the environment. Dose receptor variables include the exposure interval, the atmospheric dispersion of the activity during transport from the release point to the EAB and LPZ, the breathing rate of an individual at the EAB and LPZ, and dose conversion factors for the inhalation and external exposure pathways. In accordance with Section C.4.1.5 of Regulatory Guide 1.183 (NRC, 2000), the period of most adverse release of radioactive materials to the environment was assumed to occur coincident with the period of most unfavorable atmospheric dispersion. Except for atmospheric dispersion, the other variables are independent of the {Calvert Cliffs Nuclear Power Plant (CCNPP)} site and specific to the U.S. EPR design.

{CCNPP} site-specific atmospheric dispersion characteristics are provided in Section 2.7. To determine {CCNPP} site-specific TEDE doses, TEDE doses for the U.S. EPR were multiplied by the ratio of {CCNPP} site atmospheric dispersion factors to the U.S. EPR atmospheric dispersion factors. Atmospheric dispersion factors are referred to as 'χ/Q'. The accident χ/Q values for the subject site are based on site-specific meteorological data. U.S. EPR accident χ/Q values were derived based on five years of meteorological data. The accident χ/Q values for use in the U.S. EPR DCD are the highest values determined using both Calvert Cliffs and Nine Mile meteorological data. Two runs using different meteorological data were made and the largest χ/Q values for each sector/distance combination were used. The site-specific values for CCNPP Unit 3 used Calvert Cliffs meteorological data. For the EAB and LPZ accident χ/Q values, all compass headings/wind direction sectors were calculated and the maximum χ/Q values were used in accordance with Regulatory Guide 1.145. Therefore, for the dose comparison to determine whether the CCNPP Unit 3 doses are less than the DCD values, it does not matter that different meteorological data were used. For the EAB, the postulated DBA doses and χ/Q values are calculated for a short-term (i.e., 0 to 2 hours). For the LPZ, doses and χ/Q values are calculated for the accident duration (i.e., 0 to 2 hours, 2 to 8 hours, 8 to 24 hours, 1 to 4 days and 4 to 30 days). No credit for building wake was taken for the accident χ /Q values for the EAB and LPZ determined for either the generic U.S. EPR or the site-specific CCNPP Unit 3 χ/Q s. For the generic U.S. EPR and the site-specific CCNPP Unit 3 EAB and LPZ, ground level releases were assumed; therefore, according to Regulatory Guide 1.145, the release point and receptor elevations were assumed to be the same (i.e., no terrain heights were input for the receptors). Since the growing season is taken into account for normal effluent χ/Qs and doses (i.e., not for accident scenarios), annual data were used to generate both sets of accident χ/Q values. Table 7.1-5 contains the 50th percentile {CCNPP} site-specific and U.S. EPR accident χ/Q values at the EAB and LPZ, and the {CCNPP} site to U.S. EPR atmospheric dispersion ratios. For DBAs applicable to the U.S. EPR, the time-dependent, postulated doses at the EAB and LPZ for the subject site are provided in Table 7.1-6 to Table 7.1-13. Table 7.1-14 summarizes the {CCNPP} site-specific TEDE doses and the applicable regulatory TEDE dose acceptance criteria.

As indicated by Table 7.1-5, considering that the χ/Q values for the subject site are bounded by those for the U.S. EPR, {CCNPP} site-specific TEDE doses are bounded by the U.S. EPR TEDE doses. Referring to Table 7.1-14, {CCNPP} site-specific accident doses are below regulatory dose acceptance criteria.

7.1.1 REFERENCES

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NRC, 1999 Environmental Standard Review Plan, NUREG-1555, Nuclear Regulatory Commission, October 1999.

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Table 7.1-1 Design Basis Accidents
(Page 1 of 3)

NUREG-1555 DBA Description	U.S. EPR DBA Description	Remarks
Radiological Consequences of Main Steam Line Failures Outside Containment of a PWR	Steam System Piping Failures	Following the guidance provided in Section 15.0.3 of NUREG-0800 and Regulatory Guide 1.183, the limiting accident for the U.S. EPR was determined to be a double-ended guillotine break of a main steam line in one of the Safeguards Buildings.
Feedwater System Pipe Breaks Inside and Outside Containment (PWR)	Feedwater Pipe Break	Using the analytical approach and acceptance criteria described in Section 15.0.3 of NUREG-0800 and Regulatory Guide 1.183 for a Main Steam Line Break, the radiological consequences of a Feedwater Line Break (FWLB) were evaluated. The limiting FWLB accident was determined to be a double-ended guillotine break of a feedwater line to one of the steam generators inside Containment.
Reactor Coolant Pump Rotor Seizure	Reactor Coolant Pump Locked Rotor Accident	For the U.S. EPR, this postulated accident scenario is based on Section 15.0.3 of NUREG-0800 and the Alternate Source Term Methodology in Appendix G of Regulatory Guide 1.183.
Reactor Coolant Pump Shaft Break	Reactor Coolant Pump Shaft Break	This postulated accident scenario is based on Section 15.0.3 of NUREG-0800 and the Alternate Source Term Methodology in Appendix G of Regulatory Guide 1.183. U.S EPR radiological consequences are the same as those for the locked rotor accident.
Radiological Consequences of Control Rod Drop Accident (BWR)	Not Applicable	The U.S. EPR is a pressurized water reactor.

Table 7.1-1 Design Basis Accidents
(Page 2 of 3)

NUREG-1555 DBA Description	U.S. EPR DBA Description	Remarks
Radiological Consequences of the Failure of Small Lines Carrying Primary Coolant Outside Containment	Failure of Small Lines Carrying Primary Coolant Outside Containment	Based on the guidance in Section 15.6.2 of NUREG-0800, the limiting accident scenario for the U.S. EPR was determined to be a double-ended guillotine break in the Fuel Building.
Radiological Consequences of Steam Generator Tube Failures (PWR)	Steam Generator Tube Rupture	The analysis was based on guidance in Section 15.0.3 of NUREG-0800 and in Regulatory Guide 1.183 and incorporated the clarifications provided in NRC Regulatory Issue Summary 2006-04, Section 9, namely, the inclusion of the alkalis (in addition to the halogens and noble gases). Two alternative accident scenarios were postulated: A Steam Generator Tube Rupture (SGTR) with a pre-accident iodine spike and a SGTR with a concurrent iodine spike.
Radiological Consequences of a Design Basis Loss of Coolant Accident Including Containment Leakage Contribution	Loss of Coolant Accidents resulting from a Spectrum of Postulated Piping Breaks within the Reactor Coolant Pressure Boundary	For the U.S. EPR, a STARDOSE analysis was performed to determine the EAB and LPZ cloud immersion and inhalation doses at the EAB and LPZ for Loss of Coolant Accidents using the Alternate Source Term Methodology.
Radiological Consequences of a Design Basis Loss of Coolant Accident: Leakage from Engineered Safety Feature Components Outside Containment	Loss of Coolant Accidents resulting from a Spectrum of Postulated Piping Breaks within the Reactor Coolant Pressure Boundary	For the U.S. EPR, a STARDOSE analysis was performed to determine the EAB and LPZ cloud immersion and inhalation doses at the EAB and LPZ for Loss of Coolant Accidents using the Alternate Source Term Methodology.
Radiological Consequences of a Design Basis Loss of Coolant Accident: Leakage from Main Steam Isolation Valve Leakage Control System (BWR)	Not Applicable	The U.S. EPR is a pressurized water reactor.

Table 7.1-1 Design Basis Accidents
(Page 3 of 3)

NUREG-1555 DBA Description	U.S. EPR DBA Description	Remarks
Radiological Consequences of Fuel Handling Accidents	Fuel Handling Accident	The postulated accident scenario followed the guidance in Section 15.0.3 of NUREG-0800 and in Regulatory Guide 1.183, and was postulated to occur in either an open Containment or in the Fuel Building.
Not Applicable	Rod Ejection Accident	The analysis was based on the guidance in Section 15.0.3 of NUREG-0800 and in Regulatory Guide 1.183. The recent NRC concern regarding the fission-product gap inventory for reactivity-induced accidents and the interim acceptance criteria and guidance, were also considered.

Table 7.1-2 U.S. EPR Design Basis Primary Coolant Activity[a, b] (Page 1 of 3)

Radionuclide	Activity µCi/gm (Bq/gm)	Radionuclide	Activity µCi/gm (Bq/gm)
Noble Gases		**Tellurium Group**	
Kr-83m	1.28E-01 (4.74E+03)	Sb-125	1.56E-06 (5.77E-02)
Kr-85m	5.71E-01 (2.11E+04)	Sb-127	6.99E-06 (2.59E-01)
Kr-85	5.31E+00 (1.96E+05)	Sb-129	8.53E-06 (3.16E-01)
Kr-87	3.26E-01 (1.21E+04)	Te-127m	6.19E-04 (2.29E+01)
Kr-88	1.03 E+00 (3.81E+04)	Te-127	3.05E-03 (1.13E+02)
Kr-89	2.42E-02 (8.95E+02)	Te-129m	1.79E-03 (6.62E+01)
Xe-131m	1.08E+00 (4.00E+04)	Te-129	3.00E-03 (1.11E+02)
Xe-133m	1.35E+00 (5.00E+04)	Te-131m	4.36E-03 (1.61E+02)
Xe-133	9.47E+01 (3.50E+06)	Te-131	3.01E-03 (1.11E+02)
Xe-135m	1.95E-01 (7.22E+03)	Te-132	4.70E-02 (1.74E+03)
Xe-135	3.40E+00 (1.26E+05)	Te-134	6.80E-03 2.52E+02)
Xe-137	4.57E-02 (1.69E+03)	**Barium/Strontium Group**	
Xe-138	1.64E-01 (6.07E+03)	Sr-89	6.35E-04 (2.35E+01)
Halogens		Sr-90	4.32E-05 (1.60E+00)
Br-83	3.16E-02 (1.17E+03)	Sr-91	1.02E-03 (3.77E+01)
Br-84	1.67E-02 (6.18E+02)	Sr-92	1.73E-04 (6.40E+00)
Br-85	2.01E-03 (7.44E+01)	Ba-137m	1.50E-01 (5.55E+03)
I-129	4.59E-08 (1.70E-03)	Ba-139	2.30E-02 (8.51E+02)
I-130	4.97E-02 (1.84E+03)	Ba-140	6.74E-04 (2.49E+01)

Table 7.1-2 U.S. EPR Design Basis Primary Coolant Activity[a, b] (Page 2 of 3)

Radionuclide	Activity µCi/gm (Bq/gm)	Radionuclide	Activity µCi/gm (Bq/gm)
I-131	7.43E-01 (2.75E+04)	**Noble Metals**	
I-132	3.71E-01 (1.37E+04)	Mo-99	1.21E-01 (4.48E+03)
I-133	1.25E+00 (4.63E+04)	Tc-99m	5.24E-02 (1.94E+03)
I-134	2.40E-01 (8.88E+03)	Ru-103	1.00E-04 (3.70E+00)
I-135	7.90E-01 (2.92E+04)	Ru-105	1.47E-04 (5.44E+00)
Alkalis		Ru-106	5.83E-05 (2.16E+00)
Rb-86m	5.32E-07 (1.97E-02)	Rh-103m	8.85E-05 (3.27E+00)
Rb-86	3.66E-03 (1.35E+02)	Rh-105	6.62E-05 (2.45E+00)
Rb-88	1.02E+00 (3.77E+04)	Rh-106	5.84E-05 (2.16E+00)
Rb-89	4.72E-02 (1.75E+03)	**Cerium Group**	
Cs-134	4.18E-01 (1.55E+04)	Ce-141	9.12E-05 (3.37E+00)
Cs-136	1.00E-01 (3.70E+03)	Ce-143	7.96E-05 (2.95E+00)
Cs-137	1.60E-01 (5.92E+03)	Ce-144	6.93E-05 (2.56E+00)
Cs-138	2.35E-01 (8.07E+03)	Pu-238	5.97E-07 (2.21E-02)
Cerium Group (cont'd)		**Lanthanides** (cont'd)	
Pu-239	2.51E-08 (9.29E-04)	Cm--242	5.35E-06 (1.98E-01)
Pu-240	5.72E-08 (2.12E-03)	Cm--244	2.83E-06 (1.05E-01)
Pu-241	1.03E-05 (3.81E-01)	**Activation Products**	
Np-239	1.41E-03 (5.22E+01)	Na-24	3.7E-02 (1.37E+03)
Lanthanides		Cr-51	2.0E-03 (7.40E+01)
Y-90	1.03E-05 (3.81E-01)	Mn-54	1.0E-03 (3.70E+01)
Y-91m	5.23E-04 (1.94E+01)	Fe-55	7.6E-04 (2.81E+01)

Table 7.1-2 U.S. EPR Design Basis Primary Coolant Activity[a, b] (Page 3 of 3)

Radionuclide	Activity µCi/gm (Bq/gm)	Radionuclide	Activity µCi/gm (Bq/gm)
Y-91	8.10E-05 (3.00E+00)	Fe-59	1.9E-04 (7.03E+00)
Y-92	1.41E-04 (5.22E+00)	Co-58	2.9E-03 (1.07E+02)
Y-93	6.50E-05 (2.41E+00)	Co-60	3.4E-04 (1.26E+01)
Zr-95	9.31E-05 (3.44E+00)	Zn-65	3.2E-04 (1.18E+01)
Zr-97	7.37E-05 (2.73E+00)	W-187	1.8E-03 (6.66E+01)
Nb-95	9.35E-05 (3.46E+00)	**Tritium**	
Ag-110m	9.87E-07 (3.65E-02)	H-3	1.0E+00 (3.70E+04)
Ag-110	4.72E-08 (1.75E-03)		
La-140	1.76E-04 (6.51E+00)		
La-141	5.77E-05 (2.13E+00)		
La-142	3.38E-05 (1.25E+00)		
Pr-143	9.20E-05 (3.40E+00)		
Pr-144	6.94E-05 (2.57E+00)		
Nd-147	3.77E-05 (1.39E+00)		
Am-241	1.18E-08 (4.37E-04)		

Key:
µCi/gm – microcuries per gram
Bq/gm – Becquerels per gram

Notes:

(a) This table lists the design basis source term activity and the magnitude of source terms for offsite releases for the U.S. EPR primary coolant.

(b) Following an accident, iodine spiking causes the concentration of radioactive iodines I-131 through I-135 to significantly increase.

Table 7.1-3 U.S. EPR Design Basis Secondary Coolant Activity[a,b] (Page 1 of 2)

Radionuclide	Activity µCi/gm (Bq/gm)	Radionuclide	Activity µCi/gm (Bq/gm)
Halogens		**Barium/Strontium Group** (cont'd)	
Br-83	1.61E-03 (5.96E+01)	Sr-90	4.81E-08 (1.78E-03)
Br-84	3.05E-04 (1.13E+01)	Sr-91	9.01E-07 (3.33E-02)
Br-85	3.93E-06 (1.45E-01)	Sr-92	1.00E-07 (3.70E-03)
I-129	4.81E-09 (1.78E-04)	Ba-137m	3.01E-04 (1.11E+01)
I-130	4.33E-03 (1.60E+02)	Ba-139	1.03E-05 (3.81E-01)
I-131	7.67E-02 (2.84E+03)	Ba-140	7.45E-07 (2.76E-02)
I-132	2.27E-02 (8.40E+02)	**Noble Metals**	
I-133	1.17E-01 (4.33E+03)	Mo-99	1.30E-04 (4.81E+00)
I-134	6.68E-03 (2.47E+02)	Tc-99m	7.47E-05 (2.76E+00)
I-135	5.99E-02 (2.22E+03)	Ru-103	1.11E-07 (4.11E-03)
Alkalis		Ru-105	1.09E-07 (4.03E-03)
Rb-86m	3.99E-12 (1.48E-07)	Ru-106	6.49E-08 (2.40E-03)
Rb-86	7.27E-06 (2.69E-01)	Rh-103m	9.97E-08 (3.69E-03)
Rb-88	1.26E-04 (4.66E+00)	Rh-105	7.58E-08 (2.80E-03)
Rb-89	5.02E-06 (1.86E-01)	Rh-106	6.49E-08 (2.40E-03)
Cs-134	8.38E-04 (3.10E+01)	**Cerium Group**	
Cs-136	1.98E-04 (7.33E+00)	Ce-141	1.01E-07 (3.74E-03)
Cs-137	3.21E-04 (1.19E+01)	Ce-143	8.24E-08 (3.05E-03)
Cs-138	5.00E-05 (1.85E+00)	Ce-144	7.72E-08 (2.86E-03)
Tellurium Group		Pu-238	6.65E-10 (2.46E-05)
Sb-125	1.74E-09 (6.44E-05)	Pu-239	2.80E-11 (1.04E-06)
Sb-127	7.60E-09 (2.81E-04)	Pu-240	6.37E-11 (2.36E-06)
Sb-129	6.01E-09 (2.22E-04)	Pu-241	1.15E-08 (4.26E-04)
Te-127m	6.89E-07 (2.55E-02)	Np-239	1.50E-06 (5.55E-02)
Te-127	2.82E-06 (1.04E-01)	**Lanthanides**	
Te-129m	1.99E-06 (7.36E-02)	Y-90	1.29E-08 (4.77E-04)
Te-129	1.94E-06 (7.18E-02)	Y-91m	5.38E-07 (1.99E-02)
Te-131m	4.48E-06 (1.66E-01)	Y-91	9.17E-08 (3.39E-03)
Te-131	1.33E-06 (4.92E-02)	Y-92	1.33E-07 (4.92E-03)
Te-132	5.07E-05 (1.88E+00)	Y-93	5.81E-08 (2.15E-03)
Te-134	1.64E-06 (6.07E+00)	Zr-95	1.04E-07 (3.85E-03)

Table 7.1-3 U.S. EPR Design Basis Secondary Coolant Activity[a, b] (Page 2 of 2)

Radionuclide	Activity µCi/gm (Bq/gm)	Radionuclide	Activity µCi/gm (Bq/gm)
Barium/Strontium Group		Zr-97	7.15E-08 (2.65E-03)
Sr-89	7.16E-07 (2.64E-02)	Nb-95	1.04E-07 (3.85E-03)
Lanthanides (cont'd)		**Activation Products**	
Ag-110m	1.10E-09 (4.07E-05)	Na-24	3.53E-05 (1.31E+00)
Ag-110	1.47E-11 (5.44E-07)	Cr-51	2.22E-06 (8.21E-02)
La-140	2.28E-07 (8.44E-03)	Mn-54	1.11E-06 (4.11E-02)
La-141	4.06E-08 (1.50E-03)	Fe-55	8.47E-07 (3.13E-02)
La-142	1.51E-08 (5.59E-04)	Fe-59	2.11E-07 (7.81E-03)
Pr-143	1.02E-07 (3.77E-03)	Co-58	3.23E-06 (1.20E-01)
Pr-144	7.72E-08 (2.86E-03)	Co-60	3.79E-07 (1.40E-02)
Nd-147	4.16E-08 (1.54E-03)	Zn-65	3.56E-07 (1.32E-02)
Am-241	1.32E-11 (4.88E-07)	W-187	1.81E-06 (6.70E-02)
Cm-242	5.96E-09 (2.21E-04)	**Tritium**	
Cm-244	3.15E-09 (1.17E-04)	H-3	1.0E-03 (3.70E+01)

Key:
µCi/gm – microcuries per gram
Bq/gm – Becquerels per gram

Notes:

(a) This table lists the design basis source term activity and the magnitude of source terms for offsite releases for the U.S. EPR secondary coolant.

(b) Noble gases are not applicable since they are assumed to enter the steam phase.

Table 7.1-4 U.S. EPR Bounding Core Inventory[a,b,c]
(Page 1 of 2)

Radionuclide	Inventory Ci (Bq)	Radionuclide	Inventory Ci (Bq)
Noble Gases		**Tellurium Group**	
Kr-83m	1.96E+07 (7.25E+17)	Sb-125	3.83E+06 (1.42E+17)
Kr-85m	4.50E+07 (1.67E+18)	Sb-127	1.80E+07 (6.66E+17)
Kr-85	2.10E+06 (7.77E+16)	Sb-129	4.85E+07 (1.79E+18)
Kr-87	9.02E+07 (3.34E+18)	Te-127m	2.43E+06 (8.99E+16)
Kr-88	1.28E+08 4.74E+18)	Te-127	1.79E+07 (6.62E+17)
Kr-89	1.61E+08 (5.96E+18)	Te-129m	7.08E+06 (2.62E+17)
Xe-131m	1.54E+06 (5.70E+16)	Te-129	4.78E+07 (1.77E+18)
Xe-133m	8.92E+06 (3.30E+17)	Te-131m	2.04E+07 (7.55E+17)
Xe-133	2.89E+08 (1.07E+19)	Te-131	1.24E+08 (4.59E+18)
Xe-135m	5.49E+07 (2.03E+18)	Te-132	1.98E+08 (7.33E+18)
Xe-135	9.26E+07 (3.43E+18)	Te-134	2.50E+08 (9.25E+18)
Xe-137	2.52E+08 (9,32E+18)	**Barium/Strontium Group**	
Xe-138	2.45E+08 (9.07E+18)	Sr-89	1.61E+08 (5.96E+18)
Halogens		Sr-90	1.69E+07 (6.25E+17)
Br-83	1.96E+07 (7.25E+17)	Sr-91	2.07E+08 (7.66E+18)
Br-84	3.62E+07 (1.34E+18)	Sr-92	2.14E+08 (7.92E+18)
Br-85	4.45E+07 (1.65E+18)	Ba-137m	2.34E+07 (8.66E+17)
I-129	8.33E+00 (3.08E+11)	Ba-139	2.62E+08 (9.69E+18)
I-130	1.32E+07 (4.88E+17)	Ba-140	2.52E+08 (9.32E+18)
I-131	1.39E+08 (5.14E+18)	**Noble Metals**	
I-132	2.01E+08 (7.44E+18)	Mo-99	2.59E+08 9.58E+18)
I-133	2.90E+08 (1.07E+19)	Tc-99m	2.27E+08 (8.40E+18)
I-134	3.18E+08 (1.18E+19)	Ru-103	2.42E+08 (8.95E+18)
I-135	2.69E+08 (9.95E+18)	Ru-105	1.96E+08 (7.25E+18)
Alkalis		Ru-106	1.43E+08 (5.29E+18)
Rb-86m	5.53E+04 (2.05E+15)	Rh-103m	2.18E+08 (8.07E+18)
Rb-86	5.80E+05 (2.15E+16)	Rh-105	1.75E+08 (6.48E+18)
Rb-88	1.29E+08 (4.77E+18)	Rh-106	1.58E+08 (5.85E+18)
Rb-89	1.67E+08 (6.18E+18)	**Cerium Group**	
Cs-134	6.48E+07 (2.40E+18)	Ce-141	2.24E+08 (8.29E+18)
Cs-136	1.61E+07 (5.96E+17)	Ce-143	2.28E+08 (8.44E+18)
Cs-137	2.47E+07 (9.14E+17)	Ce-144	1.70E+08 (6.29E+18)

Table 7.1-4 U.S. EPR Bounding Core Inventory[a, b,c] (Page 2 of 2)

Radionuclide	Inventory Ci (Bq)	Radionuclide	Inventory Ci (Bq)
Cerium Group (cont'd)		**Lanthanides** (cont'd)	
Cs-138	2.69E+08 (9.95E+18)	Pu-238	1.46E+06 (5.40E+16)
Pu-239	6.14E+04 (2.27E+15)	Ag-110m	2.42E+06 (8.95E+16)
Pu-240	1.40E+05 (5.18E+15)	Ag-110	7.15E+07 (2.65E+18)
Pu-241	2.53E+07 (9.36E+17)	La-140	2.54E+08 (9.40E+18)
Np-239	3.82E+09 (1.41E+20)	La-141	2.41E+08 (8.92E+18)
Lanthanides		La-142	2.35E+08 (8.70E+18)
Y-90	1.79E+07 (6.62E+17)	Pr-143	2.26E+08 (8.36E+18)
Y-91m	1.20E+08 (4.44E+18)	Pr-144	1.72E+08 (6.36E+18)
Y-91	1.96E+08 (7.25E+18)	Nd-147	9.44E+07 (3.49E+18)
Y-92	2.14E+08 (7.92E+18)	Am-241	2.88E+04 (1.07E+15)
Y-93	2.34E+08 (8.66E+18)	Cm-242	1.31E+07 (4.85E+17)
Zr-95	2.29E+08 (8.47E+18)	Cm-244	6.94E+06 (2.57E+17)
Zr-97	2.43E+08 (8.99E+18)		
Nb-95	2.29E+08 (8.47E+18)		

Key:
Ci – curies
Bq - Becquerels

Notes:

(a) This table lists the design basis source term inventories for radiological consequences for the U.S. EPR core.

(b) Core inventories are bounding for U-235 fuel enrichment ranging between 2% and 5% and burnups up to 62,000 MWd/MTU.

(c) The design basis power level is 4,612 MWt.

Table 7.1-5 {CCNPP} Site and U.S. EPR Atmospheric Dispersion Factors (Page 1 of 1)

Location	Time Period[c] (hours)	50th Percentile {CCNPP} Site χ/Q[a] (sec/m^3)	U.S. EPR Accident χ/Q[b] (sec/m^3)	χ/Q Ratio CCNPP Site / U.S. EPR
EAB 0.5 mi (0.80 km)	0 to 2	{8.035E-05}	1.00E-03	{8.04E-02}
LPZ {1.5 mi (2.4 km)}	0 to 2	{1.542E-05}	1.75E-04	{8.80E-02}
	2 to 8	{1.183E-05}	1.35E-04	{8.76E-02}
	8 to 24	{9.337E-06}	1.00E-04	{9.34E-02}
	24 to 96	{6.496E-06}	5.40E-05	{1.20E-01}
	96 to 720	{3.858E-06}	2.20E-05	{1.75E-01[c]}

Key:

χ/Q – atmospheric dispersion factor

sec/m^3 – seconds per cubic meter

Notes:

(a) For the 50th percentile χ/Q values, refer to Section 2.7.

(b) The indicated U.S. EPR χ/Q values are those used in the accident radiological evaluations.

(c) Bounding value used for the entire 720 hours (i.e., 30 day) interval for LOCA. At the LPZ, the worst χ/Q ratio at the end of the accident release applies.

Table 7.1-6 Steam System Piping Failure (Page 1 of 1)

Location	Time Period (hours)	U.S. EPR TEDE Dose[a] (rem / Sieverts)	χ/Q Ratio[b] (Site / U.S. EPR)	{CCNPP} Site TEDE Dose[c] (rem / Sieverts)
Pre-accident Iodine Spike				
EAB	0 to 2	2.40E-01 / 2.40E-03	{8.04E-02}	{1.93E-02/1.93E-04}
LPZ	0 to 9	6.00E-02 / 6.00E-04	{9.34E-02}	{5.60E-03/5.60E-05}
Concurrent Iodine Spike				
EAB	0 to 2	2.70E-01 / 2.70E-03	{8.04E-02}	{2.17E-02/2.17E-04}
LPZ	0 to 9	2.00E-01 / 2.00E-03	{9.34E-02}	{1.87E-02/1.87E-04}
3.3% Fuel-Rod Clad Failure				
EAB	0 to 2	5.30E+00 / 5.30E-02	{8.04E-02}	{4.26E-01/4.26E-03}
LPZ	0 to 9	2.60E+00 / 2.60E-02	{9.34E-02}	{2.43E-01/2.43E-03}
0.58% Full-Rod Fuel Melt				
EAB	0 to 2	5.80E+00 / 5.80E-02	{8.04E-02}	{4.66E-01/4.66E-03}
LPZ	0 to 9	2.80E+00 / 2.80E-02	{9.34E-02}	{2.62E-01/2.62E-03}

Key:
χ/Q – atmospheric dispersion factor
TEDE – Total effective dose equivalent

Notes:

(a) Doses for the U.S. EPR at the EAB were calculated for a 2 hour period. Doses at the LPZ were calculated for the duration of the releases (i.e., 9 hours).

(b) Obtained from Table 7.1-5.

(c) Per Regulatory Guide 1.183 (Table 6) the regulatory TEDE dose acceptance criteria for this accident is 25 rems (0.25 Sieverts) for the pre-accident iodine spike, fuel-rod clad failure and full-rod fuel melt and 2.5 rems (0.025 Sieverts) for the concurrent iodine spike.

Table 7.1-7 Feedwater System Line Break (Page 1 of 1)

Location	Time Period (hours)	U.S. EPR TEDE Dose[a] (rem / Sieverts)	X/Q Ratio[b] (Site / U.S. EPR)	{CCNPP} Site TEDE Dose[c] (rem / Sieverts)
Coolant Concentrations at TS Limits				
EAB	0 to 2	2.90E-01 / 2.90E-03	{8.04E-02}	{2.33E-02/2.33E-04}
LPZ	0 to 8	5.00E-02 / 5.00E-04	{8.80E-02}	{4.40E-03/4.40E-05}
Pre-accident Iodine Spike				
EAB	0 to 2	4.10E-01/ 4.10E-03	{8.04E-02}	{3.30E-02/3.30E-04}
LPZ	0 to 8	7.00E-02 / 7.00E-04	{8.80E-02}	{6.16E-03/6.16E-05}
Concurrent Iodine Spike				
EAB	0 to 2	5.00E-01 / 5.00E-03	{8.04E-02}	{4.02E-02/4.02E-04}
LPZ	0 to 8	9.00E-02 / 9.00E-04	{8.80E-02}	{7.92E-03/7.92E-05}
4.4% Fuel-Rod Clad Failure				
EAB	0 to 2	1.57E+01 / 1.57E-01	{8.04E-02}	{1.26E+00/1.26E-02}
LPZ	0 to 8	2.90E+00 / 2.90E-02	{8.80E-02}	{2.55E-01/2.55E-03}
0.76% Full-Rod Fuel Melt				
EAB	0 to 2	1.61E+01 / 1.61E-01	{8.04E-02}	{1.29E+00/1.29E-02}
LPZ	0 to 8	3.10E+00 / 3.10E-02	{8.80E-02}	{2.73E-01/2.73E-03}

Key:
X/Q – atmospheric dispersion factor
TEDE – Total effective dose equivalent
TS – U.S. EPR Standard Technical Specifications

Notes:
(a) Doses for the U.S. EPR at the EAB were calculated for a 2 hour period. At the LPZ, the doses were calculated for an 8 hour release of primary coolant activity.
(b) Obtained from Table 7.1-5.
(c) Per Regulatory Guide 1.183 (Table 6), the regulatory TEDE dose acceptance criteria for this accident is 25 rems (0.25 Sieverts) for the pre-accident iodine spike, fuel-rod clad failure and full-rod fuel melt and 2.5 rems (0.025 Sieverts) for the coolant concentrations at TS limits and concurrent iodine spike.

Table 7.1-8 Reactor Coolant Pump Locked Rotor Accident / Broken Shaft (Page 1 of 1)

Location	Time Period (hours)	U.S. EPR TEDE Dose[a] (rem / Sieverts)	χ/Q Ratio[b] (Site / U.S. EPR)	{CCNPP} Site TEDE Dose[c,d] (rem / Sieverts)
EAB	0 to 2	2.25E+00 / 2.25E-02	{8.04E-02}	{1.81E-01/1.81E-03}
LPZ	0 to 8	8.70E-01/ 8.70E-03	{8.80E-02}	{7.66E-02/7.66E-04}

Key:
χ/Q – atmospheric dispersion factor
TEDE – Total effective dose equivalent

Notes:

(a) Doses for the U.S. EPR at the EAB were calculated for a 2 hour period starting at t=0 hours (i.e., the assumed time at which releases to the atmosphere commence). At the LPZ, the doses were calculated for 8 hours.

(b) Obtained from Table 7.1-5.

(c) Per Regulatory Guide 1.183 (Table 6), the regulatory TEDE dose acceptance criterion for this accident is 2.5 rem (0.025 Sieverts).

Table 7.1-9 Failure of Small Lines Carrying Primary Coolant Outside Containment (Page 1 of 1)

Location	Time Period (hours)	U.S. EPR TEDE Dose[(a)] (rem / Sieverts)	χ/Q Ratio[(b)] (Site / U.S. EPR)	{CCNPP} Site TEDE Dose[(c)] (rem / Sieverts)
Nuclear Sampling System Line Break (1/4 inch line)				
EAB	0 to 0.5	1.80E+00 / 1.80E-02	{8.04E-02}	{1.45E-01/1.45E-03}
LPZ	0 to 0.5	3.16E-01 / 3.16E-03	{8.80E-02}	{2.78E-02/2.78E-04}
Chemical and Volume Control System Line Break (6 inch line)				
EAB	0 to 0.5	7.15E-02 / 7.15E-04	{8.04E-02}	{5.75E-03/5.75E-05}
LPZ	0 to 0.5	1.25E-02 / 1.25E-04	{8.80E-02}	{1.10E-03/1.10E-05}

Key:
χ/Q – atmospheric dispersion factor
TEDE – Total effective dose equivalent

Notes:

(a) Doses for the U.S. EPR at the EAB and LPZ are for the accident duration of 0.5 hour.

(b) Obtained from Table 7.1-5.

(c) Per NUREG-0800 (Section 15.6.2, II) the regulatory TEDE dose acceptance criterion for this accident is 2.5 rem (0.25 Sieverts).

Table 7.1-10 Steam Generator Tube Rupture
(Page 1 of 1)

Location	Time Period (hours)	U.S. EPR TEDE Dose[a] (rem / Sieverts)	χ/Q Ratio[b] (Site / U.S. EPR)	CCNPP Site TEDE Dose[c] (rem / Sieverts)
Pre-Accident Iodine Spike				
EAB	0 to 2	2.51E+00 / 2.51E-02	{8.04E-02}	{2.02E-01/2.02E-03}
LPZ	0 to 8	6.20E-01 / 6.20E-03	{8.80E-02}	{5.46E-02/5.46E-04}
Concurrent Iodine Spike				
EAB	0 to 2	2.39E+00 /2.39E-02	{8.04E-02}	{1.92E-01/1.92E-03}
LPZ	0 to 8	1.06E+00 / 1.06E-02	{8.80E-02}	{9.33E-02/9.33E-04}

Key:
χ/Q – atmospheric dispersion factor
TEDE – Total effective dose equivalent

Notes:

(a) Doses for the U.S. EPR at the EAB and LPZ are for the accident duration of 8 hours.

(b) Obtained from Table 7.1-5.

(c) The regulatory TEDE limits are 25 rem (0.25 Sieverts) and 2.5 rem (0.025 Sieverts) for the pre-accident iodine spike and 8 hour concurrent iodine spike, respectively.

Table 7.1-11 Loss of Coolant Accident
(Page 1 of 1)

Location	Time Period (hours)	U.S. EPR TEDE Dose[a] (rem / Sieverts)	χ/Q Ratio[b] (Site / U.S. EPR)	{CCNPP} Site TEDE Dose[c] (rem / Sieverts)
EAB	0 to 2	1.37E+01 / 1.37E-01	{8.04E-02}	{1.10E+00/1.10E-02}
LPZ	0 to 720	2.14E+01 / 2.14E-01	{1.75E-01}	{3.75E+00/3.75E-02}

Key:
χ/Q – atmospheric dispersion factor
TEDE – Total effective dose equivalent

Notes:

(a) Doses for the U.S. EPR at the EAB are for the worst two-hour period (i.e., 1.5 to 3.5 hours) and those at the LPZ are for 30 days (i.e., 720 hours).

(b) Obtained from Table 7.1-5.

(c) The regulatory TEDE limit is 25 rem (0.25 Sieverts).

Table 7.1-12 Fuel Handling Accident
(Page 1 of 1)

Location	Time Period (hours)	U.S. EPR TEDE Dose[a] (rem / Sieverts)	χ/Q Ratio[b] (Site / U.S. EPR)	{CCNPP} Site TEDE Dose[c] (rem / Sieverts)
EAB	0 to 2	5.62E+00 / 5.62E-02	{8.04E-02}	{4.52E-01/4.52E-03}
LPZ	0 to 2	1.04E+00 / 1.04E-02	{8.80E-02}	{9.15E-02/9.15E-04}

Key:
χ/Q – atmospheric dispersion factor
TEDE – Total effective dose equivalent

Notes:

(a) Doses for the U.S. EPR at the EAB and LPZ are for an accident scenario where the release of all activity from the Reactor Building or the Fuel Building occurs within a 2 hour interval.

(b) Obtained from Table 7.1-5.

(c) The regulatory TEDE limit is 6.3 rem (0.063 Sieverts).

Table 7.1-13 Rod Ejection Accident (Page 1 of 1)

Location	Time Period (hours)	U.S. EPR TEDE Dose[a] (rem / Sieverts)	χ/Q Ratio[b] (Site / U.S. EPR)	{CCNPP} Site TEDE Dose[c] (rem / Sieverts)
EAB	0 to 2	5.67E+00 / 5.67E-02	{8.04E-02}	{4.56E-01/4.56E-03}
LPZ	0 to 8	3.25E+00 / 3.25E-02	{8.80E-02}	{2.86E-01/2.86E-03}

Key:
χ/Q – atmospheric dispersion factor
TEDE – Total effective dose equivalent

Notes:

(a) Doses for the U.S. EPR at the EAB are for a two hour period and those at the LPZ are for the accident duration (i.e., 8 hour Reactor Coolant System leakage).

(b) Obtained from Table 7.1-5.

(c) The regulatory TEDE limit is 6.3 rem (0.063 Sieverts).

Table 7.1-14 Summary of DBA {CCNPP} Site-Specific Doses (Page 1 of 1)

Design Basis Accident	EAB TEDE Dose[(a)] (rem / Sieverts)	LPZ TEDE Dose[(a)] (rem / Sieverts)	Regulatory TEDE Dose Acceptance Criteria[(b)] (rem / Sieverts)
Steam System Piping Failures			
Pre-accident Iodine Spike	{1.93E-02/1.93E-04}	{5.60E-03/5.60E-05}	25 / 0.25
Concurrent Iodine Spike	{2.17E-02/2.17E-04}	{1.87E-02/1.87E-04}	2.5 / 0.025
3.3% Fuel-Rod Clad Failure	{4.26E-01/4.26E-03}	{2.43E-01/2.43E-03}	25 / 0.25
0.58% Full-Rod Fuel Melt	{4.66E-01/4.66E-03}	{2.62E-01/2.62E-03}	25 / 0.25
Feedwater System Line Break			
Coolant Concentrations at TS Limits	{2.33E-02/2.33E-04}	{4.40E-03/4.40E-05}	2.5 / 0.025
Pre-accident Iodine Spike	{3.30E-02/3.30E-04}	{6.16E-03/6.16E-05}	25 / 0.25
Concurrent Iodine Spike	{4.02E-02/4.02E-04}	{7.92E-03/7.92E-05}	2.5 / 0.025
4.4% Fuel-Rod Clad Failure	{1.26E+00/1.26E-02}	{2.55E-01/2.55E-03}	25 / 0.25
0.76% Full-Rod Fuel Melt	{1.29E+00/1.29E-02}	{2.73E-01/2.73E-03}	25 / 0.25
Reactor Coolant Pump Locked Rotor Accident / Broken Shaft	{1.81E-01/1.81E-03	{7.66E-02/7.66E-04}	2.5 / 0.025
Failure of Small Lines Carrying Primary Coolant Outside Containment			
NSS Line Break (1/4 inch line)	{1.45E-01/1.45E-03}	{2.78E-02/2.78E-04}	2.5 / 0.025
CVCS Line Break (6 inch line)	{5.75E-03/5.75E-05}	{1.10E-03/1.10E-05}	2.5 / 0.025
Steam Generator Tube Rupture			
Pre-accident Iodine Spike	{2.02E-01/2.02E-03}	{5.46E-02/5.46E-04}	25 / 0.25
Concurrent Iodine Spike	{1.92E-01/1.92E-03}	{9.33E-02/9.33E-04}	2.5 / 0.025
LOCA	{1.10E+00/1.10E-02}	{3.75E+00/3.75E-02}	25 / 0.25
Fuel Handling Accident	{4.52E-01/4.52E-03}	{9.15E-02/9.15E-04}	6.3 / 0.063
Rod Ejection Accident	{4.56E-01/4.56E-03}	{2.86E-01/2.86E-03}	6.3 / 0.063

Key:
TEDE – Total effective dose equivalent
TBD – To be determined
NSS – Nuclear Sampling System
CVCS – Chemical and Volume Control System

Notes:

(a) For EAB and LPZ TEDE dose, see Tables 7.1-6 through 7.1-13.
(b) For Regulatory TEDE dose acceptance criteria, refer to Note (c) of appropriate table (Table 7.1-6 to Table 7.1-13).

7.2 SEVERE ACCIDENTS

This section discusses the frequencies and consequences of severe accidents, which as a class, are considered to be more severe, yet less likely, than design basis accidents. Because of the potential for more severe consequences, these severe accidents are considered important to both the environmental impact and to the associated offsite costs.

{Severe accidents can be distinguished from design basis accidents in the following two ways. First, they involve substantial physical deterioration of the fuel in the reactor core, including overheating to the point of melting, and second, they involve conditions that could threaten the integrity of the containment. In NUREG-1437 (NRC, 1996), the Nuclear Regulatory Commission (NRC) generically assessed the impacts of severe accidents during license renewal periods, using the results of existing analyses and site-specific information to conservatively predict the environmental impacts of severe accidents for each plant during the renewal period. This methodology is used as a basis for evaluating the severe accident environmental impacts of the proposed U.S. EPR to be built at the Calvert Cliffs Nuclear Power Plant (CCNPP) site (i.e., CCNPP Unit 3).

In addition, site-specific consequence analysis has been performed for the existing CCNPP units as documented in Supplement 1 of the Generic Environmental Impact Statement (GEIS) (NRC, 1999) and is shown to provide a conservative upper bound of severe accident risk for the proposed U.S. EPR. This information is used to demonstrate that the risk from a postulated severe accident for the U.S. EPR is extremely small and is conservatively bounded by existing analyses.}

7.2.1 APPLICABILITY OF EXISTING GENERIC SEVERE ACCIDENT STUDIES

Section 5.3.3 of the GEIS presents the NRC staff assessment of impacts of severe accidents during a license renewal period. Methodologies were developed to evaluate each of the dose pathways by which a severe accident may result in adverse environmental impacts and to estimate offsite costs of severe accidents. Three pathways for release of radioactive material to the environment were evaluated in the GEIS and assessed for each plant site in the U.S. The NRC evaluation addressed release pathways (1) directly to the air, (2) air to surface water, and (3) groundwater to surface water. This assessment methodology and the resulting conclusions are considered, for reasons discussed below, applicable beyond the license renewal context, including evaluation of severe accident impacts associated with operation of a new nuclear power plant. The economic impacts from severe accidents are also comparatively evaluated in this section. As stated in the GEIS, the NRC staff believed that "current regulatory practices ensure that the basic statutory requirement, adequate protection to the public, is met".

Final Environmental Impact Statements (FEISs) generated since 1980 include the evaluation of the risk from postulated severe accidents. These evaluations largely relied on the source term (radioactive release characteristics) assessment from the re-baselined reactor safety study, NUREG-0773 (NRC, 1981b). These source terms were then used in conjunction with site-specific demographic and meteorological data to compute the offsite risk at specific plant sites. In addition, the NUREG-1150 study (NRC, 1990) analyzed the risk at five U.S. nuclear power plants. These analyses used (at the time) state-of-the-art technology to calculate the release frequency, source term characteristics, and the consequences for a variety of severe accident sequences. Finally, additional studies have been performed that provide specific health effects assessments of the risk due to severe accidents. Two such studies are NUREG-0440 (NRC, 1978), a generic study of the radiological risks that could result from a severe accident that releases contamination into the groundwater, and NUREG-0769 (NRC, 1981a), which estimated the risks from conta of the Great Lakes due to fallout from a postulated severe accident at the

Enrico Fermi 2 plant. All of the above risk analyses are used in the GEIS to provide a projection of risk from postulated severe accidents.

As described in the GEIS, the purpose of the evaluation of severe accidents was "to use, to the extent possible, the available severe accident results, in conjunction with those factors that are important to risk and that change with time to estimate the consequences of nuclear plant accidents for all plants for a time period that exceeds the time frame of existing analyses." This estimation process was completed by predicting increases or decreases in consequences as the plant lifetime was extended past the normal license period by considering the projected changes in the risk factors. The primary assumption in the GEIS analysis was that regulatory controls ensure that the physical plant condition is maintained at a constant level during the renewal period; therefore, the frequency and magnitude of a release remains relatively constant. In other words, significant changes in consequences would result only from changes in the plant's external environment. The logical approach, then, would be to incorporate the most significant environmental factors into calculations of consequences for subsequent correlation with existing analyses.

The staff concluded in the GEIS that the primary factors affecting risk are the site population (which reflects the number of people potentially at risk to severe accident exposure) and wind direction (which reflects the likelihood of exposure). Secondary factors, such as terrain, rainfall, and wind stability, also have some effect on risk, but their impact was judged to be much smaller than the effects of population and wind direction. These factors were included in the FEIS analyses whose results are the bases for the GEIS analyses. Consequently, their effects are indirectly considered in the prediction of future risks and are reflected within the uncertainty bounds generated by the regression of the FEIS risk values. To ensure that the existing FEIS analyses covered a range of secondary factors representative of the total population of plants, the more significant secondary factors were also examined in the GEIS. Variations in these factors (precipitation, 50 mi (80 km) population, 50 mi (80 km) population in the direction of highest wind frequency, general terrain and emergency planning) were found to be enveloped by the FEIS analyses and thus reasonably accounted for in the GEIS evaluation of severe accidents.

Detailed severe accident consequence (early and latent fatalities, and total dose) evaluations were not available for all plants considered in the GEIS. Therefore, a predictor for these consequences was developed using correlations based upon results from the existing FEIS severe accident analyses. This predictor was then used to infer the future consequence level of all individual nuclear plants. Correlations were developed using two environmental parameters that are available for all plants. This correlation process was well described in NUREG-1437.

While the NUREG-1437 (NRC, 1999) discussions dealt with the environmental impacts of accidents during operation after license renewal, the primary assumption for this evaluation was that the frequency (or likelihood of occurrence) of an accident at a given plant would not increase during the plant lifetime (inclusive of the license renewal period) because regulatory controls ensure the plant's licensing basis is maintained and improved, where warranted. Similarly, for a new unit at the CCNPP site the frequency of an accident is not likely to increase during the plant lifetime because regulatory controls will ensure that the plant's licensing basis is maintained and improved, where warranted. The GEIS use of severe accident risk per reactor-year of operation as the principal metric for evaluating severe accident environmental impacts and the assumption that this risk remains constant over the life of the plant are equally applicable and appropriate in both the license renewal and combined license context. Therefore, the thorough generic analysis of severe accident impacts presented in the GEIS also provides an appropriate basis and method for evaluating severe accident impacts for an application for a new facility.

As described above, it was recognized in the GEIS that the changing environment around the plant is not subject to regulatory controls and introduces the potential for changing risk. Thus, the site-specific environmental considerations, i.e., population and meteorology, were evaluated in the GEIS, and are also considered in the following subsections.

Specifically, the following evaluation of the significant factors associated with the environment shows these factors for the proposed facility at the CCNPP site are not substantially different from the corresponding factors identified for previously analyzed sites. Thus, it follows that the environmental impacts for the U.S. EPR will not be substantially different from the acceptable environmental impacts identified for the previously analyzed sites.}

7.2.2 EVALUATION OF POTENTIAL SEVERE ACCIDENT RELEASES

This section evaluates impacts of severe accidents from air, surface water, and groundwater pathways.

The safety record for the existing U.S. nuclear plants is very good. Through evolutionary and innovative design, the U.S. EPR has enhanced the ability to both prevent potential core damage events and to mitigate them should they occur. A list of example U.S. EPR design features which reduce plant risk is provided below:

- Increased redundancy and separation
- Four independent safety trains including four independent Emergency Feedwater divisions
- Separate power divisions for each safety train, each with dedicated battery division and Emergency Diesel Generator
- Two divisions each have a backup alternate ac diesel generator for Station Blackout (SBO)-type scenarios
- State-of-the-art digital Instrumentation and Control
- Stand-still Seal System for backup to Reactor Coolant Pump seals
- Main Feedwater System with Startup and Shutdown System
- In-containment Refueling Water Storage Tank (IRWST) to eliminate transfer to long term recirculation
- Two, dedicated severe accident battery divisions
- Dedicated severe accident depressurization valves to prevent high pressure melt scenarios which can challenge containment due to postulated direct containment heating
- Containment combustible gas control system, including passive autocatalytic recombiners and gas mixing system
- Core stabilization system

Dedicated severe accident heat removal system including:

- Passive cooling of molten core debris
- Active spray for environmental control of the containment atmosphere
- Active recirculation cooling of the molten core debris and containment atmosphere.

7.2.2.1 Evaluation of Potential Releases via Atmospheric Pathway

{Supplement 1 to the GEIS (NRC, 1999) provides a detailed evaluation of severe accident risk at the CCNPP Unit 1. Supplement 1 of the GEIS used the Core Damage Frequency (CDF) and consequences for CCNPP Unit 1. These results were based on the CCNPP Unit 1 PRA model and any differences between CCNPP Unit 1 and Unit 2 were considered in the screening and value/impact analysis. The total CDF for CCNPP Unit 1 for both internally and externally initiated events is estimated to be 3.3E-4 per reactor-year. The offsite risk to the population within 50 mi (80 km) of the CCNPP site is estimated to be about 68 person-rem/reactor-year. These metrics were established by evaluating the consequences of dominant core damage events at CCNPP Unit 1 using site-specific demographics and meteorology.

Extrapolation of these results to the proposed U.S. EPR to be located at the same site can be done by looking at differences between CCNPP Unit 1 and the U.S. EPR relative to prevention of core damage and mitigation of potential releases. First, the U.S. EPR design is reviewed to determine if there are any new or unique types of core damage sequences that are not currently represented by the CCNPP Unit 1 risk profile. Table 7.2-1 was obtained from Supplement 1 to the GEIS (Table 5-3) and shows the overall CCNPP Unit 1 CDF profile.

Considering only the internal events (transients, loss of coolant accidents (LOCAs), and internal flood), the CDF for CCNPP Unit 1 is equal to approximately 2.4E-4 (73% of 3.3E-4). For internal events only, the profile for CCNPP Unit 1 yields:

- Transients - 66%
- LOCAs - 27%
- Internal Flood - 7%

Preliminary PRA Level 1 results for the U.S. EPR show that the current internal events CDF is dominated by loss of offsite power (LOOP) events that contribute greater than 50% to the total to CDF. LOOP is considered a transient event. Thus, the contribution of transient events for the U.S. EPR is comparable to the CCNPP Unit 1 contribution. The preliminary U.S. EPR results also show that approximately 40% of the internal events CDF comes from seal LOCA events, which again agrees generally well with the CCNPP Unit 1 LOCA contribution. Even though the reported U.S. EPR CDF for internal events is approximately two orders of magnitude less than that for CCNPP Unit 1, the above comparison combined with a review of the preliminary U.S. EPR CDF results (for internal events at power) shows that the dominant contributors for the U.S. EPR are similar to events analyzed for CCNPP Unit 1 and do not include any new or unique types of events.

Applying the CCNPP Unit 1 consequence results to the U.S. EPR needs to address not only the CDF contribution, as is done above, but also the expected release characteristics. Supplement 1 to the GEIS shows a total dose from all severe accidents to be about 68 person-rem/reactor-year. The dose contribution as presented in Supplement 1 to the GEIS (Table 5-4) is provided in Table 7.2-2.

A direct comparison to the U.S. EPR is not possible at this time as the U.S. EPR Design Certification Document (DCD) is under development with submittal to NRC scheduled later in 2007. However, a review of the CCNPP Unit 1 results in relationship to the specific U.S. EPR containment design yields important insights to estimate the potential offsite consequences. Table 7.2-3 lists each of the CCNPP Unit 1 release categories with a brief description of the typical scenario that contributes to that release mode and provides the significance to the U.S. EPR design.

From Table 7.2-3, it would be reasonable to expect most of the U.S. EPR core damage accidents to result in a containment intact release mode. As seen from the CCNPP Unit 1 consequence results presented in Table 7.2-2, this release mode contributes a very small amount to the overall consequences. Despite this, for demonstrating the small risk from postulated severe accidents, the same release category contributors will be assumed for the U.S. EPR. The preliminary internal events CDF for the U.S. EPR Probabilistic Risk Assessment (PRA) is estimated to be less than 1E-6 per reactor-year. This value is about 240 times smaller than the documented internal events CDF for CCNPP Unit 1. U.S. EPR risk from external events is not specifically quantified but judged to be low based on a combination of redundant systems, building separation, and hardened structures. The EPR design includes four independent and redundant safety trains, each housed in separate buildings designed to withstand external event phenomena, e.g., Safe Shutdown Earthquake, tornado. In addition, the structural design of two safety division buildings, the reactor building (containment) and fuel building considers aircraft hazard. Based on inspection of the EPR standard plant external design basis requirements, there is margin over the CCNPP site design basis characteristics. Also, the preliminary PRA-based seismic margins assessment of the EPR design has not identified any seismic vulnerability relative to the CCNPP site.

The CCNPP Unit 1 results show that these external events contribute about one third to the total CDF. Other documented License Renewal applications have shown that external event risk can be on the order of the internal events CDF when conservative assumptions are made. Given the robust U.S. EPR external event design, the redundant and separate safety system trains for the U.S. EPR, along with the enhanced emergency power capabilities, external event risk is expected to be well bounded by the internal event CDF for the U.S. EPR. However, making a conservative assumption that the external event CDF is equal to internal events CDF, results in a U.S. EPR CDF (1E-6 x 2) that is approximately a factor of 165 smaller than the documented total CDF for CCNPP Unit 1.

Another consideration in applying the CCNPP Unit 1 consequence results to the U.S. EPR is the difference in operating power along with differences in core design. The U.S. EPR operating power is approximately 4,600 MWth compared to 2,700 MWth for CCNPP Unit 1. A comparison of the U.S. EPR bounding core inventories (with the input provided in Table F.1-1 of Supplement 1 of the GEIS for CCNPP shows that the inventories are about twice as high for the U.S. EPR design. Thus, a factor of two in expected core inventory is assumed. Where the lower CDF will reduce the overall risk metrics, the larger core inventory can potentially increase the consequences. Based on a factor of 165 reduction in CDF and a factor of two increase due to the larger core inventories, an overall scaling factor of 0.01 [0.01 ≈ (1/165) x 2] is selected to apply to the CCNPP Unit 1 consequence results for the U.S. EPR. This factor, when applied to the Supplement 1 dose assessment for CCNPP Unit 1 yields an estimated dose risk from severe accidents of about 1 person-rem/reactor-year (0.01 x 68). This is an extremely small dose value and demonstrates the small environmental impact due to the U.S. EPR.

Further confirmation of the severe accident risk for the U.S. EPR can be derived from NUREG-1437 (NRC, 1999). The site-specific significant factors of demography and meteorology are considered in the evaluation of the atmospheric exposure pathway for the CCNPP site. For this evaluation, NUREG-1437 (NRC, 1999) calculated an exposure index (EI) for use in comparing the relative risk for the current fleet of nuclear power plants.

NUREG-1437 (NRC, 1999) provides the following discussion of EI:

> Population, which changes over time, defines the number of people within a given distance from the plant. Wind direction, which is assumed not to change from year to year, helps determine what proportion of the population is at risk in a given direction, because radionuclides are carried by the wind. Therefore, an EI relationship was developed by multiplying the wind direction frequency (fraction of the time per year) for each of 16 (22.5°) compass sectors times the population in that sector for a given distance from the plant and summing all products.

Population varies with population growth and movement, and with the distance from any given plant. As the population changes for that plant, the EI also changes (the larger the EI, the larger the number of people at risk). Thus, EI is proportional to risk and an EI for a site for a future year can be used to predict the risk to the population around that site in that future year.

Thus, the EI is a function of population surrounding the plant, weighted by the site-specific wind direction frequency, and is, therefore, a site-specific parameter. Because meteorological patterns, including wind direction frequency, tend to remain constant over time, the site meteorology will not be significantly different for the proposed U.S. EPR at the CCNPP site than the meteorology considered in NUREG-1437 (NRC, 1999) for the CCNPP site and only population can significantly affect the resulting risk in any given year of reactor operation. It is important to realize that the EI method is used to compare sites with relatively similar CDFs as this method does not include a consideration of the frequency of release. Given that the U.S. EPR release frequency will be orders of magnitude below existing plants, the conclusions using this technique are judged to be bounding by a substantial margin.

Two EIs were evaluated in NUREG-1437 (NRC, 1999). A 10 mi (16 km) EI was found to best correlate with early fatalities, and a 150 mi (241 km) EI was found to best correlate with latent fatalities and total dose. Using these indices, it was determined that the risk of early and latent fatalities from individual nuclear power plants is small and represents only a small fraction of the risk to which the public is exposed from other sources. The 10 mi (16 km) EI for the CCNPP site was 1,232, as shown in NUREG-1437, Table 5.7, for the year 2030. The 10 mi (16 km) EI range provided in Table 5.7 of NUREG-1437 for the current generation of nuclear power plant sites has a low of 96 and a high of 18,959. Thus, the CCNPP site with a U.S. EPR is well within the range of EI values calculated for the existing fleet of nuclear power plants.

The 150 mi (241 km) EI for the CCNPP site was 1,459,323, as shown in NUREG-1437 (NRC, 1999), Table 5.8, for the year 2030. The 150 mi (241 km) EI range provided in Table 5.8 of NUREG-1437 (NRC, 1999) for the current generation of nuclear power plant sites has a low of 132,195 and a high of 2,863,844. Again, the CCNPP site with a U.S. EPR is within the range of EI values calculated for the existing fleet of nuclear power plants.

Section 5.5.2.1 of NUREG-1437 (NRC, 1999) indicated these predicted effects of a severe accident for sites with EIs within the range of EIs for the current generation of nuclear power plant sites "are not expected to exceed a small fraction of that risk to which the population is already exposed."}

7.2.2.2 Evaluation of Potential Releases Via Atmospheric Fallout Onto Open Bodies of Water

{This section examines radiation exposure risk for a nuclear power reactor at the CCNPP site in the event of a severe reactor accident in which radioactive contaminants are released into the atmosphere and subsequently deposited onto open bodies of water. In the GEIS (NRC, 1996), the drinking water pathway was treated separately while the aquatic food, swimming, and shoreline pathways were addressed collectively. Population dose estimates for both the drinking water and aquatic food pathways were then compared with estimates from the atmospheric pathway.

As reported in NUREG-1437 (NRC, 1999), analyses for both the drinking water and aquatic food pathways were performed with and without considering interdiction. In the case of the drinking-water pathway, the Great Lakes and the estuarine sites (applicable to the CCNPP site) are bound by those of a previous site evaluation (i.e., Fermi); while small river sites with relatively low annual flow rates, long residence times, and large surface-area-to-volume ratios may potentially not be bound by the previous analysis. In all cases, however, interdiction can reduce relative risk to levels at or below that of the previous acceptable analysis and significantly below that for the atmospheric pathway. River sites that may have relatively high concentrations of contaminants but which remove contaminants within short periods of time (hours to several days) are amenable to short-term interdiction. A similar level of reduced risk can be achieved at those sites with longer residence times (months) by more extensive interdictive measures.

For the aquatic food pathway, population dose and population exposure per reactor-year are directly related to aquatic food harvest. For river sites, un-interdicted population exposure is an order of magnitude lower than that for the atmospheric pathway. For Great Lakes sites, the un-interdicted population exposure is a substantial fraction of that predicted for the atmospheric pathway but is reduced significantly by interdiction. For estuarine sites with large annual aquatic food harvests, dose reduction of a factor of two to ten through interdiction provides essentially the same population exposure estimates as the atmospheric pathway.

For these reasons, population dose for the drinking-water pathway was found to be a small fraction of that for the atmospheric pathway. Risk associated with the aquatic food pathway was found to be small relative to the atmospheric pathway for most sites and essentially the same as the atmospheric pathway for the few sites with large annual aquatic food harvests.

Environmental parameters important for input in performing the above analyses, and for use in analyses of additional sites, are (1) the surface area of the receiving body, (2) the volume of water in the body, and (3) the flow rate. In the absence of rigorous site-specific analyses, these data can provide estimates of the extent of contamination in the receiving water body and the residence time of the contaminant in the affected water body. Comparing these estimates and site environmental parameters with those for the previously evaluated site, i.e., Fermi, can provide some indication of the comparative hazard associated with drinking contaminated surface water among sites and the need for site-specific analyses. Accounting for population and meteorological data in the comparison can provide further indication of relative risk among sites.

Sites with the greatest aquatic harvest result in the highest values of population exposure. Table 5.16 of the GEIS provides estimates of the population dose from aquatic food harvests for several sites, including the CCNPP site. The population dose is on the order of two times the comparable dose from air; however, interdiction is expected to reduce the ingestion dose by a factor of two to ten. As concluded in the GEIS, "Risk associated with the aquatic food pathway is found to be small relative to the atmospheric pathway for most sites and essentially the same as the atmospheric pathway for the few sites with large annual aquatic food harvest." The above evaluation in addition to the significant reduction in the potential of a release from the U.S. EPR located at the CCNPP site would further support the conclusion that consequences from the hypothetical release via atmospheric fallout onto open bodies of water are extremely small.}

7.2.2.3 Evaluation of Potential Releases to Groundwater

{This section discusses the potential for radiation exposure from the groundwater pathway as the result of postulated severe accidents at a nuclear reactor on the CCNPP site. Severe accidents are the only accidents capable of producing significant groundwater contamination.

As identified in NUREG-1437 (NRC, 1999), groundwater contamination due to severe accidents has been evaluated generically in NUREG-0440, the liquid pathway generic study (LPGS) (NRC, 1978). The LPGS assumes that core melt with subsequent basemat melt-through occurs, and evaluates the consequences. The LPGS conservatively assumes that the probability of a core damage event multiplied by the conditional probability of a basemat melt-through is on the order of 1E-4. It is important to note that the U.S. EPR containment is specifically designed with features to eliminate the potential for core-concrete interaction at the basemat and possible basemat melt-through. These design features will essentially eliminate the potential for a groundwater release. However, as a conservative assumption, if 50% of all core damage events (0.5 x 2E-6) (accounting for internal and external events) were to result in basemat failure, the U.S. EPR design would still result in a total basemat melt-through probability that is over 100 times lower (1E-4/(0.5 x 2E-6)) than the value assumed in the LPGS.

Per NUREG-1437 (NRC, 1999), the LPGS results are believed to provide generally conservative un-interdicted population dose estimates in the six generic plant-site categories. Five of these categories are site groupings in common locations adjacent to small rivers, large rivers, the Great Lakes, oceans, and estuaries. In a severe accident, contaminated groundwater could reach nearby surface water bodies, and the population could be exposed to this source of contamination through drinking of surface water, ingestion of fish, and shoreline contact. Exposure by drinking contaminated groundwater is considered to be minor or nonexistent in these five categories because of a limited number of drinking-water wells. The sixth category is a "dry" site located either at a considerable distance from surface water bodies or where groundwater flow is away from a nearby surface water body. In this case, the only liquid-path population exposure results from drinking contaminated groundwater.

NUREG-1437 (NRC, 1999) concludes that the risk from the groundwater exposure pathway generally contributes only a small fraction of that risk attributable to the population from the atmospheric pathway, but in a few cases may contribute a comparable risk.

In the GEIS analysis, site-specific information on groundwater travel time; retention-adsorption coefficients; distance to surface water; and soil, sediment, and rock characteristics is compared with previous groundwater contamination analyses. Previous analyses are contained in the LPGS and site-specific FEISs. These environmental parameters have been identified in the GEIS for two estuary sites similar to the CCNPP site. These representative sites are Hope Creek and Indian Point. The conclusion for those sites is that the un-interdicted population doses are significantly less than the generic LPGS estuary site. In fact, simply based on the basemat failure probability, the conservative U.S. EPR core damage events dose would be expected to be more than 50 times (50 to 100 times) less than the LPGS generic site.

Therefore, the estimated risk from the groundwater exposure pathway for the U.S. EPR located at the CCNPP site will be within the range of those considered as "Small" in NUREG-1437.}

7.2.3 EVALUATION OF ECONOMIC IMPACTS OF SEVERE ACCIDENTS

{This section discusses the potential economic impact as the result of postulated severe accidents at an U.S. EPR located at the CCNPP site. Similar to Section 7.2.2.1, the EI is used as a predictor of cost because, as identified in the GEIS (NRC, 1996), the cost should be dependent upon the economic impact in the same way and for the same reason that population dose estimates are dependent on the EI values.

As noted in NUREG-1437 (NRC, 1999), FEIS analyses used the "Calculation of Reactor Accident Consequences" (CRAC) computer code to estimate offsite severe accident costs for the area contaminated by the accident. The offsite costs that were considered relate to avoidance of adverse health effects and are categorized as follows:

- Evacuation costs;
- Value of crops contaminated and condemned;
- Value of milk contaminated and condemned;

- Costs of decontamination of property where practical; and
- Indirect costs resulting from the loss of use of property and incomes derived there from (including interdiction to prevent human injury).

For those FEIS analyses that addressed severe accidents, the offsite accident costs were estimated to be to be as high as 6 billion dollars to 8 billion dollars (1994 dollars) but with accident frequencies that were extremely low (1E-6 per reactor-year), as would be expected for this class of events. Because key variables (used in the FEIS cost analyses) are strongly related to population density, NUREG-1437 (NRC, 1999) further evaluated the FEIS results using normalization techniques and the 150 mi (241 km) EI values.

In addition, the generic NUREG-1437 (NRC, 1999) predicted conditional land contamination is small (10 acres/year (4 hectares/year) at most). The GEIS concluded that land contamination values for the evaluated plants can be considered representative of all plants since they cover the major vendor and containment types, and include sites at the upper end of annual rainfall. However, even considering that land contamination values can vary at other sites, it is not expected that predicted land contamination from plants at other sites would vary more than one or two orders of magnitude from the values listed above and would, therefore, still be a small impact. Based on the evaluations of the expected economic costs and land contamination as a result of a severe accident, the GEIS concludes, in Section 5.5.2.4, that the conditional impacts in both cases are of small significance for all plants. As for other aspects of the GEIS evaluation of severe accident impacts, this evaluation and conclusion is broadly applicable to beyond the license renewal context. Thus the economic impacts and land contamination resulting from postulated severe accidents at a new nuclear reactor on the CCNPP site should be comparable as well (i.e., within the range of those considered as "Small" in NUREG-1437).}

7.2.4 CONSIDERATION OF COMMISSION SEVERE ACCIDENT POLICY

In 1985, the NRC adopted a Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants (FR, 1985). This policy statement indicated:

> The Commission fully expects that vendors engaged in designing new standard (or custom) plants will achieve a higher standard of severe accident safety performance than their prior designs. This expectation is based on:
>
> The growing volume of information from industry and government-sponsored research and operating reactor experience has improved our knowledge of specific severe accident vulnerabilities and of low-cost methods for their mitigation.
>
> The inherent flexibility of this Policy Statement (that permits risk-risk tradeoffs in systems and sub-systems design) encourages thereby innovative ways of achieving an improved overall systems reliability at a reasonable cost.
>
> Public acceptance, and hence investor acceptance, of nuclear technology is dependent on demonstrable progress in safety performance, including the reduction in frequency of accident precursor events as well as a diminished controversy among experts as to the adequacy of nuclear safety technology.

Thus, implementation of the Commission's Severe Accident Policy for a new design such as the U.S. EPR can be expected to show that the environmental impact of any new reactor(s) on the CCNPP site will be within the range of risk previously determined to be "Small."

A significant factor in the risk associated with the plant design is the probability of the postulated severe accident sequences. As indicated above, the U.S. EPR design demonstrates a "higher standard of severe accident safety performance than the prior designs." Thus, the Severe Accident Policy Statement expectation has been met for the U.S. EPR and is expected to continue to be met for the future design certification and combined license approvals.

7.2.5 CONCLUSION

{The GEIS (NRC, 1996) concludes, based on the generic evaluations presented, that the probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water and societal and economic impacts from severe accidents are small for all existing plants.

The methodology and evaluations of the GEIS are applicable to the consideration of new plants. Evaluation of design and site-specific factors for purposes of this application has shown that the CCNPP site is within the range of sites considered in the GEIS. Thus, it is concluded that the GEIS conclusion is applicable to the proposed U.S. EPR at the CCNPP site.

In summary, the environmental impacts considered in NUREG-1437 (NRC, 1999) evaluations include potential radiation exposures to individuals and to the population as a whole, the risk of near- and long-term adverse health effects that such exposures could entail, and the potential economic and societal consequences of accidental contamination of the environment. These impacts could be severe, but due to their extremely low likelihood of occurrence, the impacts are judged to be small. For the proposed U.S. EPR to be located on the CCNPP site, this conclusion is based on extrapolation of existing CCNPP Unit 1 severe accident analysis results in support of License Renewal, design-specific attributes, and a comparison to existing plant evaluations.

Specifically, based on the NRC and industry implementation of the 1985 Policy Statement (FR, 1985), the U.S. EPR design, the generic NUREG-1437 (NRC, 1999) risk evaluations, and the CCNPP site specific demography and meteorology, the probability weighted consequences of atmospheric and (surface and ground) water pathways, and the societal and economic impacts for severe accidents for the U.S. EPR to be located at the CCNPP site will be small.}

7.2.6 REFERENCES

FR, 1985. Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants, 50 FR 32138, Nuclear Regulatory Commission, August 8, 1986.

{**NRC, 1978.** Generic Study: Impacts of Accidental Radioactive Releases to the Hydrosphere from Floating and Land-Based Nuclear Power Plants, Liquid Pathway, NUREG-0440, Nuclear Regulatory Commission, 1978.}

{**NRC, 1981a.** Final Environmental Statement Related to the Operation of Fermi, Unit 2, NUREG-0769, Nuclear Regulatory Commission, August 1981.}

{**NRC, 1981b.** The Development of Severe Reactor Accident Source Terms: 1957-1981, NUREG 0773, Nuclear Regulatory Commission, November 1981.}

{**NRC, 1990.** Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants, NUREG-1150, Nuclear Regulatory Commission, (Volume 1) December 1990, (Volume 2) December 1990, (Volume 3) January 1991.}

{**NRC, 1996.** Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437, Nuclear Regulatory Commission, May 1996.}

{**NRC, 1999.** Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Calvert Cliffs Nuclear Power Plant, NUREG-1437, Supplement 1, Nuclear Regulatory Commission, October 1999.}

{Table 7.2-1 CCNPP Unit 1 CDF Profile
(Page 1 of 1)

Accident Category	% of Total CDF
Transients	48
Fire	22
LOCAs	20
Internal Flood	5
Earthquake	4
Wind	1

}

Table 7.2-2 {CCNPP Unit 1 Dose Contribution
(Page 1 of 1)

Containment Release Category	Contribution to Containment Release Frequency (%)	Contribution to Population Dose (%)
Intact Containment	42	1
Late Containment Failure	49	2
Early Containment Failure	7	94
Containment Bypass	2	3

}

Table 7.2-3 {CCNPP Unit 1 Release Categories}
(Page 1 of 1)

Containment Release Category	Typical CCNPP Unit 1 Release Scenarios	U.S. EPR Design Features
Intact Containment	These core damage events are either recovered in-vessel or result in core material on the containment floor. In both cases, core cooling and containment heat removal are available to prevent containment failure.	U.S. EPR includes specific design features to limit the consequences of a severe accident. Given these features, in general, it is expected that most severe accidents would result in an intact containment.
Late Containment Failure	Scenarios of this type typically involve vessel breach with failure to cool the core debris and remove decay heat. In a large containment, the pressurization rate due to core-concrete attack or long-term steam generation is slow and results in a late overpressure failure.	The U.S. EPR is designed with dedicated features in containment to cool the core debris and prevent core-concrete interaction of the containment basemat. In addition, a dedicated spray system with a heat exchanger and dedicated heat sink is provided for long term cooling. Contributions from this release category are expected to be small.
Early Containment Failure	Early failure of containment is either due to energetic events that occur as a result of high pressure failure of the reactor pressure vessel, or containment overpressure failure before vessel breach.	U.S. EPR is equipped with valves dedicated to preventing high-pressure core melt, thereby reducing the likelihood of high pressure vessel failure and the associated challenges to containment integrity. U.S. EPR is also equipped with passive catalytic hydrogen recombiners, reducing the likelihood of early containment failure due to hydrogen combustion.
Containment Bypass	Events of this type are typically of very low frequency and involve interfacing system LOCAs, failures to isolate containment and steam generator tube ruptures.	Specific U.S. EPR design features reduce the potential for a liquid release from a Steam Generator Tube Rupture. These include enhanced steam generator pressure control, reactor coolant system depressurization, and medium head safety injection to reduce primary-to-secondary leakage. Interfacing System LOCA preventive features include enhanced boundary interfaces such as multiple check valves, isolation valves and heavier wall piping.

7.3 Severe Accident Mitigation Alternatives

7.3 SEVERE ACCIDENT MITIGATION ALTERNATIVES

The purpose of severe accident mitigation alternatives (SAMA) analysis is to review and evaluate plant-design alternatives that could significantly reduce the radiological risk from a postulated severe accident. Plant changes are reviewed that would reduce the likelihood of a core damage event and that could mitigate the consequences should an accident occur.

{As part of the License Renewal at the Calvert Cliffs Nuclear Power Plant (CCNPP) site, a detailed SAMA evaluation was completed. As discussed in Section 7.2.2.1, scaling of the CCNPP Unit 1 results for the U.S. EPR is possible and would result in a multiplication factor of approximately 0.01 on the consequence results. This reduction when applied to the CCNPP Unit 1 results would yield a conservative estimate for the total severe accident population dose out to 50 mi (80 km) of about 1 person-rem/reactor-year. As described in Supplement 1 of the GEIS (NRC, 1999), elimination of all risk from severe accidents at the CCNPP site is estimated to equate to approximately $8.6 million, with the inclusion of the additional onsite economic costs. Applying the scaling factor would yield a maximum averted cost risk for the U.S. EPR at the CCNPP site of $86,000 (0.01 x $8.6E6). This cost refers to the maximum benefit obtained by the elimination of all severe accident risk and serves as a conservative upper bound cost for screening out potential plant modifications. Beyond what has already been implemented into the U.S. EPR design (refer to Section 7.2.2 for a list of unique features which reduce the severe accident risk and have already been incorporated into the U.S EPR design), there are no additional modifications costing less than $86,000 that would be determined to be cost beneficial. This maximum averted cost risk is judged to be conservative relative to the U.S. EPR design.

The SAMA cost benefit evaluation compares the cost associated with the incremental reduction in consequences for a particular plant modification with the actual cost of implementation. Supplement 1 of the GEIS for CCNPP Units 1 and 2 (NRC, 1999) includes the cost benefit obtained for the top ten potential plant modifications. Using best estimate methods for assessing the benefit of candidate plant modifications, the maximum estimated cost benefit among the top ten SAMAs for CCNPP Units 1 and 2 was approximately $882,000. This represents about 10% of the maximum obtainable reduction if all severe accident risk was eliminated ($882,000 / $8.6E6). Applied to the estimated maximum averted cost risk for the U.S. EPR, the benefit cost would be $8,600 ($86,000 x 0.1). Implementation costs for any additional plant changes would be expected to exceed this maximum value.}

To further investigate the potential for additional cost effective plant modifications, a review of recent License Renewal submittals has been performed to investigate the types of plant changes being considered for pressurized water reactors (PWRs). While there is some variability among different plants, there seems to be several common issues that are included in all of the evaluations. Table 7.3-1 provides a list of some of the more common SAMAs that have been considered to be cost beneficial and a brief description of how the issue is being addressed in the U.S. EPR design.

As can be seen in Table 7.3-1, the typical PWR SAMA candidates are already considered as part of the U.S. EPR design. Since the U.S. EPR is specifically designed to prevent and mitigate severe accidents, no additional plant changes are judged to be cost beneficial.

7.3.1 REFERENCES

{**NRC, 1999.** Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Calvert Cliffs Nuclear Power Plant, NUREG-1437, Supplement 1, Nuclear Regulatory Commission, October 1999.}

Table 7.3-1 Candidate SAMAs for PWRs
(Page 1 of 1)

Common SAMA Candidates from License Renewal Applications	U.S. EPR Design Features
Backup AC/DC power	Four battery divisions Two severe accident battery divisions Two Station Black Out Diesel Generators Four Emergency Diesel Generators
Prevention/Mitigation of Seal LOCA	Innovative Stand-still Seal System: a pneumatic "metal-to-metal" seal providing backup seal capability independent of the normal seal and can prevent reactor coolant pump shaft leakage
Improve injection recirculation switch over	Four independent safety trains Refueling water storage tank is inside containment thus eliminates the need for switch over
Internal flood mitigation	Four independent safety trains in separate buildings
Improve Steam Generator capability	Main Feedwater System Startup Shutdown Feedwater System Four Emergency Feedwater System Divisions

7.4 Transportation Accidents

7.4 TRANSPORTATION ACCIDENTS

The NRC evaluated the environmental effects of transportation of fuel and waste for light water reactors in WASH-1238, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Plants" (AEC, 1972) and NUREG-75/038, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, Supplement 1" (NRC, 1975) and found the impacts to be small. These NRC analyses provided the basis for Table S-4 in 10 CFR 51.52 (CFR, 2007) which summarizes the environmental impacts of transportation of fuel and radioactive wastes to and from a reference reactor.

10 CFR 51.52 requires that:

> Every environmental report prepared for ... a light-water-cooled nuclear power reactor... contain a statement concerning transportation of fuel and radioactive wastes to and from the reactor. That statement shall indicate that the reactor and this transportation either meet all of the conditions in paragraph (a) of this section or all of the conditions in paragraph (b) of this section.

Table S-4 of 10 CFR 51.52 addresses two categories of environmental considerations: (1) normal conditions of transport and (2) accidents in transport.

The U.S. EPR design varies from the conditions of 10 CFR 51.52(a). Specifically,

- The reactor has a core thermal power level exceeding 3,800 MWth,
- The reactor fuel has a uranium-235 enrichment that may exceed 4% by weight,
- The uranium dioxide pellets are not encapsulated in Zircaloy rods,
- The average level of burnup of the irradiated fuel removed from the reactor will exceed 33,000 MWd/MTU.

Because the U.S. EPR varies from the conditions of 10 CFR51.52(a), a full description and analysis of transportation environmental impacts is required in accordance with 10 CFR 51.52(b). This section describes the environmental impact of postulated transportation accidents involving the shipment of radioactive materials including unirradiated (new) fuel, irradiated fuel, and radioactive waste as required by 10 CFR 51.52. The environmental impacts from the incident-free transportation of fuel and wastes to and from the new reactor is summarized in Section 5.11.

These evaluated impacts are compared to the respective impacts in 10 CFR 51.52 as shown in Table 7.4-1.

Radiological and non-radiological types of accident effects are analyzed. Two computer programs were used to perform this analysis. The TRAGIS (ORNL, 2003) computer code was used to determine the distance traveled by truck, the roads taken, and the population density along the routes. The RADTRAN 5.6 computer code was used to calculate population doses from the shipment (direct and effluent sources, not ingestion) given the routes defined by TRAGIS. The inputs to these codes are listed in Tables 7.4-2 through 7.4-7 and Tables 7.4-9 through 7.4-11.

7.4.1 RADIOLOGICAL IMPACTS

The radiological impact population dose was calculated using the RADTRAN computer code. The population dose impact from postulated accidents associated with the transportation of unirradiated fuel, irradiated fuel, and radioactive waste are provided in Table 7.4-12. The dose impact from all postulated transportation accident sources is {2.0E-4 person-rem/year (2.0E-6 person-Sv/year)}.

7.4.1.1 Unirradiated (New) Fuel

The WASH-1238 analysis (AEC, 1972) of postulated accidents during the transportation of unirradiated fuel found accident impacts to be negligible. The analysis states "the impact on the environment from radiation in transportation accidents involving unirradiated (current) fuel is considered to be negligible."

Additionally, as noted in NUREG-1815 (NRC, 2006), accident frequencies are likely to be lower in the future than those used in the analysis in WASH-1238 (AEC, 1972) because traffic accident, injury, and fatality rates have fallen since the initial analyses were performed.

Finally, advanced fuel behaves like fuel evaluated in the analyses provided in WASH-1238 (AEC, 1972). Again as noted in NUREG-1815 (NRC, 2006), there is no significant difference in the consequences of accidents severe enough to result in a release of unirradiated fuel particles to the environment between advanced LWRs and previous-generation LWRs because the fuel form, cladding, and packaging are similar to those analyzed in WASH-1238 (AEC, 1972).

Based on this information, the dose impact from nuclides released from postulated accidents involving new fuel is assumed to be negligible when compared to dose impact from postulated irradiated fuel and radiation waste transportation accidents. Therefore, quantitative analysis of dose from new fuel accidents was not performed.

7.4.1.2 Irradiated Fuel

The dose impact from postulated accidents during the shipment of irradiated fuel was evaluated using the TRAGIS code (ORNL, 2003) to define appropriate routing and population density along the route. This information was used as input to the RADTRAN code with U.S. EPR-specific design information to calculate a postulated annual dose from irradiated fuel transportation accidents.

The evaluation model assumed that irradiated fuel will be shipped to the site of the proposed Yucca Mountain repository. The distance from the {Calvert Cliffs Nuclear Plant (CCNPP)} site to the proposed repository is {2,680 mi (4,313 km)} based on a TRAGIS Highway Route Controlled Quantity (HRCQ) distance.

The model accident rate is the probability that an accident will occur during the trip along each route through each state. The route's average accident rate is the sum of the distance weighted accident rate through each state.

State-specific accident data from Table 4 of ANL/ESD/TM-150 (ANL, 1999) are shown in Table 7.4-4. Only the interstate data are used because the HRCQ route is mainly on Interstate roads.

The distance and demographic data for input to RADTRAN are listed in Table 7.4-2. The U.S. EPR average annual quantity of irradiated fuel shipped is assumed, consistent with NUREG-1815 (NRC, 2006), to equal the average annual reload quantity. For the U.S. EPR this is 37.5 MTU of irradiated fuel per year (as provided in Section 5.11) to be shipped.

The source term in Table 7.4-3 is based on an equilibrium burnup of 52 GWd/MTU. The activity was decayed 5 years to account for the minimum decay period prior to shipment of irradiated fuel to the proposed geologic repository at Yucca Mountain, NV. The nuclides evaluated are those dominant nuclides described and listed in Appendix G of NUREG-1815 (NRC, 2006).

In addition to the source term assumed above, Cobalt-60 was used to represent fuel surface contamination and added at a level of 0.2 Ci/rod. This use of Cobalt-60 in the model was consistent with previously performed studies (SNL, 1991) (NRC, 2000) (DOE, 2002) that quantified fuel rod contamination levels and that concluded the maximum contribution from contamination is Cobalt-60. NUREG/CR-6672 estimated the maximum contamination from Cobalt-60 for PWR fuel at zero year decay is 0.168 Ci/rod (6.22E9 Bq/rod) (or approximately 0.2 Ci/rod (7.4E9 Bq/rod)). A U.S. EPR-specific calculation of Ci/rod was carried out that confirmed the 0.2 Ci/rod (7.4E9 Bq/rod) value was conservative.

The accident severity categories and related releases from Appendix G of NUREG-1815 (NRC, 2006) were used and are presented in Table 7.4-5. The model deposition velocities were consistent with Appendix E in DOE/EIS-0250 (DOE, 2002). The model severity fractions, release fractions, aerosol and respirable fractions are the conditional probabilities, given an accident occurs, for specific severity categories. The model severity and release fractions are for the 19 severity categories and the 5 chemical groups identified in NUREG-1815 (NRC, 2006), and are presented in Table 7.4-5. Gases are not deposited and have a 0.0 m/s deposition velocity. All other chemical groups are defined consistent with DOE/EIS-0250 (DOE, 2002) at 0.03 ft/s (0.01 m/s). Other RADTRAN parameters used were the default values from the RADCAT 2.3 User Guide (SNL, 2006), and from Appendix G of NUREG-1815 (NRC, 2006).

The evaluation determined that the dose impact from postulated transportation accidents involving irradiated fuel was {5.14E-06 person-rem/MTU (5.14E-08 person-Sv/MTU)}. Using the average annual reload requirements for a U.S. EPR of 37.5 MTU, the annual population dose impact is {1.9E-04 person-rem/year (1.9E-06 person-Sv/year)} from postulated transportation accidents involving irradiated fuel.

7.4.1.3 Radioactive Waste

The population risk from radwaste transportation accidents is {8.2E-06 person-rem/yr (8.2E-08 person-Sv/year).} This is the population dose for an accident divided by the mean number of years between accidents.

The TRAGIS computer code was used to calculate the routes, distances, and demographics along the route. It was conservatively assumed that all radwaste would be shipped to the farthest disposal repository in commercial mode. The route was from the plant to the {Hanford site located in Washington State.} It was along roads which allowed trucks and avoided ferry crossings. TRAGIS calculated the total one-way distance to be {2,733 mi (4,399 km)}. The distances through each state are listed in Table 7.4-11. The distances and population densities through the rural, suburban and urban settings are listed in Table 7.4-9 as well as the time spent stopped. These were all used as inputs to RADTRAN.

The RADTRAN computer code was used to calculate accident probability and population risk for the route. In an average year 2.54E+03 Ci (9.41E+13 Bq), is forecast to be shipped. This is described in Table 7.4-8 and will involve 15 shipments per year (as described in Section 5.11). The fraction of various nuclides released, by accident category, are listed in Table 7.4-5. These release fractions are a function of 19 accident severity categories and 5 chemical groups. The values are from NUREG-1815 (NRC, 2006). The model release fractions, aerosol and respirable fractions are the conditional probabilities, given an accident occurs, for specific severity categories.

The model deposition velocities are consistent with Appendix E in DOE/EIS-0250 (DOE, 2002). All chemical groups are defined at 0.01 m/s.

Other RADTRAN parameters were the default values from the RADCAT 2.3 User Guide (SNL, 2006), and from Appendix G of NUREG-1815 (NRC, 2006).

The source term in Table 7.4-10 is based on the sum of all waste type expected (average) annual activities. The radionuclides chosen are >1% of the total activity (with the exception of Ag-110m, which is not in the RADTRAN 5.6 Library), and those in Table G-9 of NUREG-1815 (NRC, 2006) plus isotopes in the same family (such as Co-58 and Ru-103). On page G-23 of that report the NRC performed a screening analysis that showed that these were the dominant nuclides.

The model accident rate is the probability that an accident will occur during the trip along each road through each state. The route's average accident rate is the sum of the distance weighted accident rate through each state. Table 7.4-11 presents the individual state accident rate data compiled from ANL/ESD/TM-150 (ANL, 1999) and the associated average rate. Since the commercial route is mainly on Interstate roads, only the interstate rate data was used in the model.

The result from RADTRAN is the annual population dose per year of {8.2E-06 person-rem/yr (8.2E-08 person-Sv/yr)}.

7.4.2 NON-RADIOLOGICAL IMPACTS

Two non-radiological impacts associated with the postulated accidents during transportation of new fuel, irradiated fuel, and radioactive waste were calculated, the fatal injury rate per 100 reactor years and the nonfatal injury rate per 10 reactor years.

7.4.2.1 New Fuel

TRAGIS (ORNL, 2003) was used to calculate the commercial routing through each state. Interstate travel is the dominant road designation and was used for all route types. It was assumed that all shipments came from the fuel fabrication facility furthest from {CCNPP located in Richland, WA.}

As described in Section 5.11.3.1, the average number of new fuel shipments was assumed to be 7.5 per year, each covering the {2,723 mi (4,381 km)} distance, including the return of the empty truck the same distance. This is based on the distances and road types from the calculation of radiological impacts above and the fatal injury rates from Table 4 of ANL/ESD/TM-150 (ANL, 1999).

Based on the above and the average fatality rate from Table 7.4-7 of {1.63E-08 fatalities/truck-mi (1.01E-08 fatalities/truck-km)}, the non-radiological fatal injury rate impact associated with postulated accidents as a result of new fuel shipments is {6.6E-02} per 100 reactor years.

Based on the same routes, distances, and assumptions above and the average nonfatal injury rate from Table 7.4-7 of {3.68E-07 nonfatal injuries/truck-mi (2.29E-07 nonfatal injuries/truck-km)}, the non-radiological nonfatal injury rate impact associated with postulated accidents as a result of new fuel shipments is {1.5E-01} nonfatal injuries per 10 reactor years.

7.4.2.2 Irradiated Fuel

The methodology for evaluating the fatal and nonfatal injury rates as a result of postulated accidents during the transportation of irradiated fuel is the same as that described in Section 7.4.2.1 above with the exceptions of the number of trips and the routing assumed in the TRAGIS evaluation. Twenty-one irradiated fuel shipments from the {CCNPP} site to the proposed Yucca Mountain repository per year were evaluated (as discussed in Section 5.11) and the TRAGIS Highway Route Controlled Quantity was utilized as the basis to calculate the shipping distance.

Based on the above and the accident rates from Table 7.4-4, the non-radiological fatal injury rate impact associated with postulated accidents as a result of irradiated fuel shipments is {1.78E-01} per 100 reactor years.

Based on the above and the accident rates from Table 7.4-6, the non-radiological nonfatal injury rate impact associated with postulated accidents as a result of irradiated fuel shipments is {4.08E-01} nonfatal injuries per 10 reactor years.

7.4.2.3 Radioactive Waste

The fatal injury rate for accidents associated with radwaste shipments is {1.06E-01} fatal injuries per 100 reactor years. This is based on the fatality rates from Table 4 of ANL/ESD/TM-150 (ANL, 1999). TRAGIS was used to calculate the commercial routing through each state. Interstate travel is the dominant road designation and was used for all route types.

It is assumed that all shipments go from the CCNPP site to the farthest potential disposal repository located in {Hanford, WA 2,733 mi (4,399 km)} and that the truck conservatively returns to the plant empty (doubling the traveled distance.) The state-specific fatality rates are in Table 7.4-11. The number of radwaste shipments from the site to {Hanford} per year is 15 as described in Section 5.11.3.3. The distance weighted fatality rate from Table 7.4-11 is {1.29E-08 fatalities/truck-mi (8.00E-09 fatalities/truck-km)}. The Radwaste Fatality (SFF) rate was calculated to be {1.06E-01 fatal injuries/100 reactor years.}

The nonfatal injury rate associated with radwaste shipments is {3.06E-01} nonfatal injuries per 10 reactor years. This is based on the distances and road types from the radiological impact calculations and the injury rates from Table 4 of ANL/ESD/TM-150 (ANL, 1999). TRAGIS was used to calculate the commercial routing through each state. Interstate travel is the dominant road designation and was used for all route types.

It is assumed that all shipments go from the site to the farthest potential disposal repository located in {Hanford, WA 2,733 mi (4,399 km)} and that the truck conservatively returns to plant empty (doubling the traveled distance.) The state-specific fatality rates are in Table 7.4-11. The number of radwaste shipments from the site to {Hanford} per year is 15 as described in Section 5.11.3.3. The average injury rate from Table 7.4-11 is {3.73E-07 injuries/truck-mi (2.32E-07 injuries/truck-km)}. The nonfatal Radwaste Injury rate was calculated to be {3.06E-01} nonfatal injuries/10 reactor years.

7.4.3 SUMMARY AND CONCLUSION

A detailed accident analysis of the environmental impacts for the transportation of unirradiated fuel, irradiated fuel, and radioactive waste (DOE, 1981) transported to and from the {CCNPP} site has been performed in accordance with 10 CFR 51.52(b) (CFR, 2007).

Table 7.4-12 summarizes the radiological impact, and Table 7.4-13 summarizes the non-radiological impact. These environmental impact results are bounded by 10 CFR 51.52(c) (CFR, 2007), Table S-4. These impacts represent the contribution of postulated transportation accidents to the environmental costs of operating the proposed facility.

As shown in Table 7.4-13, the calculated impacts from transportation accidents are less than those corresponding impacts listed in Table S-4 of 10 CFR 51.52 (CFR, 2007). Therefore the corresponding impacts from transportation accidents for the transportation of fuel and waste to and from the proposed facility are small and will be less than those accepted by 10 CFR 51.52 (CFR, 2007).

7.4.4 REFERENCES

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SNL, 2006. RADCAT 2.3 User Guide, SAND2006-6315, Sandia National Laboratories, R. Weiner, D. Osborn, G. Mills, D. Hinojosa, T. Heames, and D. Orcutt, 2006.

Table 7.4-1 10 CFR 51.52 Summary Table S-4 Excerpt Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor Accidents in Transport (Page 1 of 1)

Types of Effects	Environmental Risk
Radiological Effects	**Small**
Common (nonradiological) causes	1 fatal injury in 100 reactor years 1 nonfatal injury in 10 reactor years $475 property damage per reactor year

Table 7.4-2 RADTRAN/TRAGIS Model Irradiated Fuel Input Parameters
(Page 1 of 1)

Parameter	CCNPP Model U.S. EPR (English Units)	CCNPP Model U.S. EPR (SI Units)
TRAGIS Input:		
Route Mode	HRCQ	
Route Origin	CCNPP	
Route Destination	Yucca Mt, NV	
RADTRAN Input TRAGIS:		
Total Shipping Distance	2,680 mi	4,312.7 km
Travel Distance – Rural	2,036 mi	3,275.2 km
Travel Distance – Suburban	568 mi	914 km
Travel Distance – Urban	77 mi	123.8 km
Population Density – Rural	30 person/mi^2	11.5 person/km^2
Population Density – Rural	817 person/mi^2	315.5 person/km^2
Population Density – Rural	6,166 person/mi^2	2,381.8 person/km^2
Stop Time, hr/trip	5.0 (1)	
RADTRAN Input from NRC Models		
Vehicle Speed	55 mph	88.49 km/hr
Traffic Count – Rural	329 mph	530 km/hr
Traffic Count – Suburban	472 mph	760 km/hr
Traffic Count – Urban	1,492 mph	2,400 km/hr
Dose Rate at 3.3 ft (1 m) from Vehicle	14 mrem/hr	0.14 mSv/hr
Packaging Length	17 ft	5.2 m
Packaging Diameter	3 ft	1.0 m
Number of Truck Crew	2	
Population Density at Stops (radii: 3.3 to 33 ft (1 to 10 m))	77,666 person/mi^2	30,000 person/km^2
Population Density at Stops (radii: 33 to 2,625 ft (10 to 800 m))	880 person/mi^2	340 person/km^2
Shielding Factor at Stops (radii: 3.3 to 33 ft (1 to 10 m))	1	
Shielding Factor at Stops (radii: 33 to 2,625 ft (10 to 800 m))	0.2	

Note:

(1) Based on TRAGIS output: 10 stops at 30 minutes each.

Table 7.4-3 Irradiated Fuel Source Term
(Page 1 of 1)

Radionuclide (a)	CCNPP Model U.S. EPR 5 Year Decay Ci/MTU	CCNPP Model U.S. EPR 5 Year Decay Bq/MTU
Am-241	1.25E+03	4.62E+13
Am-242m	2.38E+01	8.82E+11
Am-243	3.22E+01	1.19E+12
Cm-144	1.52E+04	5.62E+14
Cm-242	4.35E+01	1.61E+12
Cm-243	3.19E+01	1.18E+12
Cm-244	4.84E+03	1.79E+14
Cm-245	6.19E-01	2.29E+10
Co-60	7.59E+01	2.81E+12
Cs-134	5.84E+04	2.16E+15
Cs-137	1.42E+05	5.25E+15
Eu-154	1.16E+04	4.31E+14
Eu-155	5.73E+03	2.12E+14
I-129	4.65E-02	1.72E+09
Kr-85	1.05E+04	3.88E+14
Pm-147	3.54E+04	1.31E+15
Pu-238	6.95E+03	2.57E+14
Pu-239	4.24E+02	1.57E+13
Pu-240	7.24E+02	2.68E+13
Pu-241	1.17E+05	4.34E+15
Pu-242	2.28E+00	8.44E+10
Ru-106	2.05E+04	7.59E+14
Sb-125	5.35E+03	1.98E+14
Sr-90	1.03E+05	3.81E+15
Y-90	1.03E+05	3.82E+15

Table 7.4-4 Irradiated Fuel CCNPP Model Accident and Fatality Rates (Page 1 of 1)

State	Accident Rate Accidents / truck-mi (Accidents / truck-km)	Fatality Rate Fatalities / truck-mi (Fatalities / truck-km)	Distance mi (km)	Accident Rate distance weighted fraction accident / truck-mi (accident / truck-km)	Fatality Rate distance weighted fraction fatality / truck-mi (fatality / truck-km)
AZ	2.12E-07 (1.32E-07)	1.51E-08 (9.40E-09)	29.3 (47.1)	2.32E-09 (1.44E-09)	1.66E-10 (1.03E-10)
IL	3.57E-07 (2.22E-07)	1.34E-08 (8.30E-09)	162.2 (261.7)	2.17E-08 (1.35E-08)	8.11E-10 (5.04E-10)
IN	3.62E-07 (2.25E-07)	1.08E-08 (6.70E-09)	151.2 (243.4)	2.04E-08 (1.27E-08)	6.08E-10 (3.78E-10)
IA	1.80E-07 (1.12E-07)	1.51E-08 (9.40E-09)	307.0 (494.1)	2.06E-08 (1.28E-08)	1.74E-09 (1.08E-09)
MD	8.69E-07 (5.40E-07)	1.05E-08 (6.50E-09)	235.4 (378.8)	7.63E-08 (4.74E-08)	9.19E-10 (5.71E-10)
NE	5.13E-07 (3.19E-07)	2.20E-08 (1.37E-08)	456.6 (734.8)	8.75E-08 (5.44E-08)	3.75E-09 (2.33E-09)
NV	3.62E-07 (2.25E-07)	1.06E-08 (6.60E-09)	167.5 (269.5)	2.27E-08 (1.41E-08)	6.63E-10 (4.12E-10)
OH	2.64E-07 (1.64E-07)	6.28E-09 (3.90E-09)	239.9 (386.1)	2.37E-08 (1.47E-08)	5.62E-10 (3.49E-10)
PA	8.27E-07 (5.14E-07)	2.17E-08 (1.35E-08)	107.2 (172.6)	3.32E-08 (2.06E-08)	8.69E-10 (5.40E-10)
UT	4.67E-07 (2.90E-07)	1.92E-08 (1.19E-08)	379.2 (610.3)	6.6E-08 (4.10E-08)	2.70E-09 (1.68E-09)
WV	2.77E-07 (1.72E-07)	2.70E-08 (1.68E-08)	43.3 (69.7)	4.47E-09 (2.78E-09)	4.28E-10 (2.72E-10)
WY	1.08E-06 (6.74E-07)	1.74E-08 (1.08E-08)	400.5 (644.6)	1.63E-07 (1.01E-07)	2.59E-09 (1.61E-09)
Sum:			2680 (4312.7)	5.41E-07 (3.36E-07)	1.58E-08 (9.84E-09)
				Fatalities per Accident (1) :	2.93E-02

Note:

(1) Fatalities per accident = Fatality Rate / Accident Rate.

Table 7.4-5 Irradiated Fuel and Radioactive Waste Models Severity and Release Fractions (Page 1 of 1)

			Release Fractions			
Severity Category	Severity Fraction	Gas	Cesium	Ruthenium	Particulate	Corrosion Product
0	1.53E-08	0.8	2.40E-08	6.00E-07	6.00E-07	2.00E-03
1	5.88E-05	0.14	4.10E-09	1.00E-07	1.00E-07	1.40E-03
2	1.81E-06	0.18	5.40E-09	1.30E-07	1.30E-06	1.80E-03
3	7.49E-08	0.84	3.60E-05	3.80E-06	3.80E-06	3.20E-03
4	4.65E-07	0.43	1.30E-08	3.20E-07	3.20E-07	1.80E-03
5	3.31E-09	0.49	1.50E-08	3.70E-07	3.70E-07	2.10E-03
6	0	0.85	2.70E-05	2.10E-06	2.10E-06	3.10E-03
7	1.13E-08	0.82	2.40E-08	6.10E-07	6.10E-07	2.00E-02
8	8.03E-11	0.89	2.70E-08	6.70E-07	6.70E-07	2.20E-03
9	0	0.91	5.90E-06	6.80E-07	6.80E-07	2.50E-03
10	1.44E-10	0.82	2.40E-08	6.10E-07	6.10E-07	2.00E-03
11	1.02E-12	0.89	2.70E-08	6.70E-07	6.70E-07	2.20E-03
12	0	0.91	5.90E-06	6.80E-07	6.80E-07	2.50E-03
13	7.49E-11	0.84	9.60E-05	8.40E-05	1.80E-05	6.40E-03
14	0	0.85	5.50E-05	5.00E-05	9.00E-06	5.90E-03
15	0	0.91	5.90E-06	6.40E-06	6.80E-07	3.30E-03
16	0	0.91	5.90E-06	6.40E-06	6.80E-07	3.30E-03
17	5.86E-06	0.84	1.70E-05	6.70E-08	6.70E-08	2.50E-03
18	0.99993	0	0	0	0	0

Note:

Aerosol and Respirable Fractions set to 1.0.

Table 7.4-6 Irradiated Fuel CCNPP Transportation Injury Rates (Page 1 of 1)

State	Injury Rate Injury / truck-mi (Injury / truck-km)	Distance mi (km)	Injury Rate Distance Weighted Fraction Injury / truck-mi (Injury / truck-km)
AZ	1.88E-07 (1.17E-07)	29.3 (47.1)	2.06E-09 (1.28E-09)
IL	2.41E-07 (1.50E-07)	162.6 (261.7)	1.46E-08 (9.10E-09)
IN	2.25E-07 (1.40E-07)	151.2 (243.4)	1.27E-08 (7.90E-09)
IA	1.38E-07 (8.60E-08)	307.0 (494.1)	1.59E-08 (9.85E-09)
MD	7.39E-07 (4.59E-07)	235.4 (378.8)	6.49E-08 (4.03E-08)
NE	3.17E-07 (1.97E-07)	456.6 (734.8)	5.41E-08 (3.36E-08)
NV	2.38E-07 (1.48E-07)	167.5 (269.5)	1.49E-08 (9.25E-09)
OH	2.25E-07 (1.40E-07)	239.9 (386.1)	2.01E-08 (1.25E-08)
PA	6.16E-07 (3.83E-07)	107.2 (172.6)	2.46E-08 (1.53E-08)
UT	4.07E-07 (2.53E-07)	379.2 (610.3)	5.76E-08 (3.58E-08)
WV	1.80E-07 (1.12E-07)	43.3 (69.7)	2.91E-09 (1.81E-09)
WY	5.20E-07 (3.23E-07)	400.5 (644.6)	7.77E-08 (4.83E-08)
	Sum:	2680 (4312.7)	3.62E-07 (2.25E-07)

Table 7.4-7 New Fuel CCNPP Transportation Fatality and Injury Rates
(Page 1 of 1)

State	Fatality Rate Fatalities / Truck-mi (fatality / truck-km)	Injury Rate Injuries Truck-mi (injury / truck-km)	Distance mi (km)	Fatality Rate Distance Weighted Fraction Fatality / Truck-mi (fatality / truck-km)	Injury Rate Distance Weighted Fraction Injury / Truck-mi (injury / truck-km)
ID	6.12E-09 (3.80E-09)	4.94E-07 (3.07E-07)	275.6 (443.5)	6.20E-10 (3.85E-10)	5.01E-08 (3.11E-08)
IL	1.34E-08 (8.30E-09)	2.41E-07 (1.50E-07)	162.6 (261.7)	7.98E-10 (4.96E-10)	1.44E-08 (8.96E-09)
IN	1.08E-08 (6.70E-09)	2.25E-07 (1.40E-07)	151.2 (243.4)	5.99E-10 (3.72E-10)	1.25E-08 (7.78E-09)
IA	1.51E-08 (9.40E-09)	1.38E-07 (8.60E-08)	305.3 (491.3)	1.69E-09 (1.05E-09)	1.55E-08 (9.64E-09)
MD	1.05E-08 (6.50E-09)	7.39E-07 (4.59E-07)	153.7 (247.4)	5.91E-10 (3.67E-10)	4.17E-08 (2.59E-08)
NE	2.20E-08 (1.37E-08)	3.17E-07 (1.97E-07)	452.7 (728.5)	3.67E-09 (2.28E-09)	5.28E-08 (3.28E-08)
OH	6.28E-09 (3.90E-09)	2.25E-07 (1.40E-07)	239.9 (386.1)	5.54E-10 (3.44E-10)	1.98E-08 (1.23E-08)
OR(1)	3.28E-08 (2.04E-08)	2.19E-07 (1.36E-07)	208.5 (335.5)	2.51E-09 (1.56E-09)	1.67E-08 (1.04E-08)
PA	2.17E-08 (1.35E-08)	6.16E-07 (3.83E-07)	187.3 (301.5)	1.50E-09 (9.29E-10)	4.25E-08 (2.64E-08)
UT	1.92E-08 (1.19E-08)	4.07E-07 (2.53E-07)	149.1 (240)	1.05E-09 (6.52E-10)	2.24E-08 (1.39E-08)
WA	2.90E-09 (1.80E-09)	2.90E-07 (1.80E-07)	35.7 (57.4)	3.80E-11 (2.36E-11)	3.80E-09 (2.36E-09)
WY	1.74E-08 (1.08E-08)	5.20E-07 (3.23E-07)	400.5 (644.6)	2.56E-09 (1.59E-09)	7.64E-08 (4.75E-08)
		Sum:	2723 (4380.9)	1.63E-08 (1.01E-08)	3.68E-07 (2.29E-07)

Note:

Interstate data not provided.

Table 7.4-8 EPR Radwaste Annual Generation
(Page 1 of 1)

Waste Type	Annual Activity [a] Bq	Ci
Evaporator Concentrates	5.55E+12	1.50E+02
Spent Resins (other)	3.96E+13	1.07E+03
Spent Resins (Radwaste Demineralizer System)	5.55E+12	1.50E+02
Wet Waste from Demineralizers	5.55E+12	1.50E+02
Waste Drum for Solids Collection from Centrifuge System of KPF	5.55E+12	1.50E+02
Filters (quantity)	2.54E+13	6.86E+02
Sludge	5.55E+12	1.50E+02
Mixed Waste	1.48E+09	4.00E-02
Non-Compressible Dry Active Waste (DAW)	1.10E+10	2.97E-01
Compressible DAW	2.22E+11	6.01E+00
Combustible DAW	1.18E+12	3.19E+01
Total	9.41E+13	2.54E+03

Note:

(a) Refer to Section 3.5.

Table 7.4-9 RADTRAN/TRAGIS Radwaste Model Input Parameters (Page 1 of 1)

Parameter		CCNPP Model EPR
TRAGIS Input:		
Route Mode		Commercial
Route Origin		CCNPP
Route Destination		Hanford, WA
RADTRAN Input from TRAGIS:		
Total Shipping Distance, mi (km)		2,733 (4,399)
Travel Distance - Rural, mi (km)		2,063 (3,320)
Travel Distance - Suburban, mi (km)		594 (955.5)
Travel Distance - Urban, mi (km)		76.5 (123.2)
Population Density - Rural, person/mi^2 (person/km^2)		30 (11.6)
Population Density - Suburban, person/mi^2 (person/km^2)		835 (322.4)
Population Density - Urban, person/mi^2 (person/km^2)		6,085 (2,349.5)
Stop Time, hr/trip		5.0 [(b)]
RADTRAN Input from NRC Models [(a)]		
Vehicle Speed, mph (km/hr)		55 (88.49)
Traffic Count - Rural, vehicles/hr		530
Traffic Count - Suburban, vehicles/hr		760
Traffic Count - Urban, vehicles/hr		2,400
Dose Rate at 3 ft (1 m) from Vehicle, mrem/hr (mSv/hr)		14 (0.14)
Packaging Length, ft (m)		17 (5.2)
Packaging Diameter, ft (m)		3.3 (1.0)
Number of Truck Crew		2
Population Density at Stops (radii: 3.3 to 33 ft (1 to 10 m)), person/mi^2 (person/km^2)		77,700 (30,000)
Population Density at Stops (radii: 33 to 2,655 ft (10 to 800 m)), person/mi^2 (person/km^2)		881 (340)
Shielding Factor at Stops (radii: 3.3 to 33 ft (1 to 10 m))		1
Shielding Factor at Stops (radii: 33 to 2,655 ft (10 to 800 m))		0.2

Notes:

(a) From NUREG-1815 for spent fuel shipments.
(b) Based on TRAGIS output: 11 stops at 30 minutes each.

Table 7.4-10 Radwaste Annual Source Term
(Page 1 of 1)

Radionuclide	RADTRAN Input Annual Activity Bq	Ci
Ce-144	3.89E+10	1.05E+00
Co-58	5.36E+12	1.45E+02
C0-60	9.87E+12	2.67E+02
Cs-134	1.06E+13	2.85E+02
Cs-137	1.94E+13	5.25E+02
Fe-55	1.98E+13	5.36E+02
I-129	3.35E+07	9.06E-04
I-131	3.39E+08	9.16E-03
Mn-54	1.55E+13	4.18E+02
Pu-241	1.26E+10	3.39E-01
Ru-103	8.04E+11	2.17E+01
Ru-106	1.04E+12	2.80E+01
Sb-124	4.22E+08	1.14E-02
Sb-125	1.38E+09	3.74E-02
Sr-89	4.92E+08	1.33E-02
Sr-90	1.24E+11	3.36E+00
Y-90	1.21E+11	3.27E+00
Zn-65	4.06E+12	1.10E+02

Table 7.4-11 Radwaste CCNPP Transportation Accident, Fatality and Injury Rates (Page 1 of 1)

State	Accident Rate Accidents / truck-mi (Accidents / truck-km)	Fatality Rate Fatalities / truck–mi (Fatalities / truck-km)	Injury Rate Injuries / truck–mi (Injuries / truck-km)	Distance mi (km) (a)	Distance Weighted Fraction Accident Rate	Distance Weighted Fraction Fatality Rate	Distance Weighted Fraction Injury Rate
ID	4.75E-07 (2.95E-07)	6.12E-09 (3.80E-09)	4.94E-07 (3.07E-07)	72 (116.6)	7.82E-09	1.01E-10	8.14E-09
IL	3.57E-07 (2.22E-07)	1.34E-08 (8.30E-09)	2.41E-07 (1.50E-07)	118 (190.7)	9.62E-09	3.60E-10	6.50E-09
IN	3.62E-07 (2.25E-07)	1.08E-08 (6.70E-09)	2.25E-07 (1.40E-07)	151 (243.4)	1.24E-08	3.71E-10	7.75E-09
MD	8.69E-07 (5.40E-07)	1.05E-08 (6.50E-09)	7.39E-07 (4.59E-07)	154 (247.4)	3.04E-08	3.66E-10	2.58E-08
MN	2.75E-07 (1.71E-07)	4.82E-09 (3.00E-09)	1.35E-07 (8.40E-08)	275 (442.4)	1.72E-08	3.02E-10	8.45E-09
MT	9.98E-07 (6.20E-07)	2.19E-08 (1.36E-08)	4.12E-07 (2.56E-07)	552 (888.5)	1.25E-07	2.75E-09	5.17E-08
OH	2.64E-07 (1.64E-07)	6.28E-09 (3.90E-09)	2.25E-07 (1.40E-07)	240 (386.1)	1.44E-08	3.42E-10	1.23E-08
PA	8.27E-07 (5.14E-07)	2.17E-08 (1.35E-08)	6.16E-07 (3.83E-07)	187 (301.5)	3.52E-08	9.25E-10	2.62E-08
SD	3.75E-07 (2.33E-07)	9.82E-09 (6.10E-09)	2.77E-07 (1.72E-07)	412 (662.4)	3.51E-08	9.19E-10	2.59E-08
WA	4.26E-07 (2.65E-07)	2.90E-09 (1.80E-09)	2.90E-07 (1.80E-07)	175 (281.5)	1.70E-08	1.15E-10	1.15E-08
WI	7.23E-07 (4.49E-07)	1.46E-08 9.10E-09	5.36E-07 3.33E-07	188 (301.9)	3.08E-08	6.25E-10	2.29E-08
WY	1.08E-07 (6.74E-07)	1.74E-08 (1.08E-08)	5.20E-07 (3.23E-07)	209 (336.7)	5.16E-08	8.27E-10	2.47E-08
Sum:				2,733 mi (4,399 km)	6.23E-07 (3.87E-07)	1.29E-08 (8.00E-09)	3.73E-07 (2.32E-07)
						Per truck-mi (per truck-km)	
Fatalities per Accident (b) :						2.07E-02 Fatalities per accident	

Notes:

(a) From TRAGIS.

(b) Fatalities per accident = Fatality Rate / Accident Rate.

Table 7.4-12 Population Dose from Transportation Accidents (Page 1 of 1)

Environmental Impact	New Fuel	Irradiated Fuel	Radwaste	Total
U.S. EPR Dose Person-rem/ U.S. EPR-reactor-year (person-Sv/ U.S. EPR-reactor-year)	See below	1.9E-04 (1.9E-06)	8.2E-06 (8.2E-08)	2.0E-04 (2.0E-06)
Normalized Dose Person-rem/1000 MWe reactor-year (person-Sv/1000 MWe reactor-year)	See below	1.1E-04 (1.1E-06)	4.6E-06 (4.6E-08)	1.1E-04 (1.1E-06)
The dose from new fuel accidents is assumed to be negligible compared to the doses from Irradiated Fuel and Radioactive Waste as described in Section 7.4.2.				

Table 7.4-13 U.S. EPR Summary of Annual Transportation Accident Non-Radiological Impact (Page 1 of 1)

Environmental Impact	New Fuel	Irradiated Fuel	Radwaste	Total	10 CFR 51.52 Table S-4
Fatal Injury per 100 reactor years	0.066	0.18	1.1E-01	0,36	1.0
Non-Fatal Injury per 10 reactor years	0.15	0.41	3.1E-01	0.87	1.0

8.0 Need for Power

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

8.0 NEED FOR POWER

This chapter provides an assessment of the need for electric power in support of the COL application for the proposed {Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3}. Also provided is a description of the existing regional electric power system, current and future demand for electricity, and present and planned power supplies.

The assessment of power needs is based on input provided by the {Maryland Public Service Commission (PSC) on the need to sustain a safe and reliable electric system in the state and reduce the state's reliance on imported electric power. Maryland is one of several states that have restructured their regulatory programs for electric utilities. Restructuring has changed the PSC role relative to the pricing of electricity generation and establishes that retail electric choice will be available to all customers (MDPSC, 2006).

Effective July 2000, the Maryland Electric Customer Choice and Competition Act of 1999 restructured the electric utility industry in Maryland to allow electric retail customers to shop for power from various suppliers (MD, 1999). These retail suppliers can generally be grouped into two categories:

- Local Utility – Entity that supplies electricity as a regulated monopoly and is the current default provider of electricity supply for customers who do not choose an alternative competitive electricity supplier.
- Competitive Suppliers – Competing entities that began supplying electricity in the competitive marketplace when the market was restructured.

Prior to restructuring, the local electric utility operated as a regulated, franchised monopoly. It supplied all end-use customers within its franchised service area with the three principal components of electric power service: generation, transmission, and distribution. With the restructuring of the electric power industry in Maryland, generation of electricity is now provided in a competitive marketplace (transmission and distribution remain regulated monopolies). Prices for power supply are determined by a competitive electric power supply market rather than by the PSC in a regulated environment.

Retail customers of the investor-owned utilities in Maryland have been allowed to select their own electric supplier since 2000. Electric restructuring has been gradually implemented since then, but the PSC still monitors and reports on the adequacy and reliability of electric power supply in the state.

However, no new generating capacity has been built in Maryland for a number of years. The PSC role in licensing of new generation facilities is discussed in Section 8.1.

Additionally, to gain the efficiency and reliability benefits of interstate and intrastate power transactions, the Maryland utilities participate in multi-utility power markets called the PJM Interconnection LLC (PJM), which also includes all or part of 13 states, including most of Pennsylvania, New Jersey, Delaware and the District of Columbia. The PJM reliability planning process is discussed further in Section 8.1.}

As noted in NUREG-1555, "Standard Review Plan for Environmental Reviews of Nuclear Power Plants" (ESRP) Section 8.1 (NRC, 1999):

> Affected States and/or regions are expected to prepare a need-for-power evaluation. NRC will review the evaluation and determine if it is (1) systematic, (2) comprehensive, (3) subject to confirmation, and (4) responsive to

forecasting uncertainty. If the need for power evaluation is found acceptable, no additional independent review by NRC is needed, and the analysis can be the basis for ESRPs 8.2 through 8.4 (NRC, 1999).

Additionally, the NRC recognizes that the "need for power" should be analyzed on an individualized basis:

> The guidance in [ESRP 8.0] is limited because changes in the regulatory structure are occurring as the guidance is being revised. Reviewers of issues related to the need for power should identify current NRC policy before beginning their review. Deregulation in the electricity market will have a significant impact on the analysis of the need for power. Applicants may be power generators rather than utilities; <u>therefore, analysis of the need for power must be sufficiently flexible to accommodate the applicant type</u> [emphasis added]. (NRC, 1999)

The following sections show that the licensing process and other regulatory reviews occurring in the restructured utility market in Maryland meet the characteristics of an acceptable analysis of the need for power that satisfies NUREG-1555.

8.0.1 REFERENCES

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8.1 Description of Power System

8.1 DESCRIPTION OF POWER SYSTEM

This section evaluates the following criteria described in NUREG-1555 (NRC, 1999):

> Affected States and/or regions are expected to prepare a need-for-power evaluation. NRC will review the evaluation and determine if it is (1) systematic, (2) comprehensive, (3) subject to confirmation, and (4) responsive to forecasting uncertainty. If the need for power evaluation is found acceptable, no additional independent review by NRC is needed, and the analysis can be the basis for ESRPs 8.2 through 8.4.
>
> As part of their analyses of the need for power, States and/or regional authorities are expected to describe and assess the regional power system. <u>The reviewer should evaluate the description and determine if it is comprehensive and subject to confirmation</u>. [emphasis added] If it is found acceptable, no additional data collection by NRC should usually be needed. These data may be supplemented by information sources such as the Energy Information Administration, FERC [Federal Energy Regulatory Commission], the North American Electric Reliability Council, and others. (NRC, 1999)

{In 1999, the State of Maryland restructured the manner in which it regulates the state's utilities by allowing for customer choice of electricity suppliers and by deregulating the price of electric supply. In the Electric Customer and Competition Act of 1999, the Maryland state legislature outlined the goals of electric restructuring and the Maryland Public Service Commission's (PSC) role in its implementation under the new statute:

> In assessing and approving each electric company's restructuring plan, and overseeing the transition process and regulation of the restructured electric industry, the Commission shall provide that the transition to a competitive electricity supply and electricity supply services market shall be orderly, maintain electric system reliability, and ensure compliance with federal and State environmental regulations, be fair to customers, electric company investors, customers of municipal electric utilities, electric companies, and electricity suppliers, and provide economic benefits to all customer classes (MD, 1999).

Despite the deregulation of the *price* of electric supply and generation in Maryland, electric power generators must obtain a "Certificate of Public Convenience and Necessity" (CPCN) from the PSC to build or modify power plants and transmission lines in the state. The CPCN is a single, comprehensive licensing process for the State. The CPCN encompasses the requirements of the Clean Air Act (CAA), including the Prevention of Significant Deterioration (PSD) approval, which the PSC, on behalf of Maryland, has been authorized by the U.S. Environmental Protection Agency (USEPA) to issue to power developers.

For a CPCN to be approved, the applicant must submit an application that will be processed and reviewed under the regulations promulgated by the Maryland PSC (MD, 2007). The application must include descriptions of the site and existing power plant installations, all proposed changes or alterations of the site and plant, the new or altered associated facilities, the environmental and other impacts of the project, and the environmental and other benefits to be realized from the project.

The CPCN application is filed with the PSC pursuant to the PUC Article Section 7-207 (MD, 2007). The Power Plant Research Program (PPRP) of the Maryland Department of Natural Resources (MDNR) coordinates and receives recommendations from various federal, state, and local agencies regarding the CPCN application with ultimate disposition of these recommendations and the application itself by the PSC.

The information in the CPCN application presents the scope and impacts of the project and contains the information required by Maryland regulations (COMAR, 2007). It addresses the environmental and socioeconomic aspects of the project by presenting information on the existing natural and human environment, the facilities proposed to be constructed and operated, and the impacts of those new facilities on the environment. The MDNR, through the PPRP, also monitors construction of new power plants.

As part of the review, the PPRP performs the following functions:

- Consolidates issue analysis involving the MDNR, Environment, Agriculture, Business and Employment Development, and Transportation; the Office of Planning; and the Energy Administration. The PPRP usually represents those agencies in the PSC CPCN hearing process.
- Evaluates potential impacts of the proposed facility on environmental resources, including air, surface water and groundwater, terrestrial resources, and cultural and historic resources, while assessing overall site suitability.
- Manages the development of a consolidated set of recommendations to be included as conditions within the CPCN.

In addition, the PPRP provides a Cumulative Environmental Impact Report, which provides biennial information about potential environmental impacts of existing plants and power transmission on Maryland natural resources, cultural foundation, and economic situation, including power demand forecasts and growth factors.

Figure 8.1-1 provides an overview of the power plant construction approval process in Maryland.}

8.1.1 SYSTEMATIC PROCESS

{In Maryland, two state agencies are primarily responsible for the review and approval of applications to build new electric generating facilities in the state. Public concern about potential environmental damage to Chesapeake Bay prompted the creation of the PPRP (within the MDNR) to ensure a comprehensive, objective evaluation, based on sound science, to resolve environmental and economic issues before decisions were made regarding whether and where to build additional power-generating facilities. The PPRP, as noted above, coordinates the analysis of new generating plants by the various state agencies and the recommendations made by those agencies concerning the conditions to be imposed by the PSC upon the authorization of the new generating plants. The PSC approves the construction of the new facilities by issuing the necessary CPCN license after conducting hearings on each CPCN application. The PSC also provides an annual report to the MDNR describing the composition, fuel type, and adequacy of Maryland's existing electric generation facilities as well as proposed generation resources planned for construction in the state.

The PPRP coordinates the comprehensive review of all proposed power generation and transmission facilities and develops technically based licensing recommendations. The PPRP evaluates impacts to Maryland surface water, groundwater, air, land, and socioeconomics for all proposed power facilities, including new plants, expansions of existing plants, and transmission lines.

Within the CPCN process, PPRP facilitates extensive interagency cooperation and planning. The PPRP may meet with representatives of potential applicants who are considering new generating station or transmission line projects to discuss whether and how all relevant concerns will be addressed and to ensure that the applicant understands the PSC regulations and procedures. Once the applicant submits an application to the PSC, the PPRP prepares a project description and summary of key issues to inform the other state agencies and the public at large. This discussion includes a review of power and reliability reports developed by the PSC and PPRP. (PPRP, 2006a)

The adjudicatory process starts with the filing of the CPCN application, summarizing the impact analyses that have been performed and discussing the mitigation that the applicant has proposed to undertake to address environmental concerns. The applicant prepares prefiled testimony that addresses the criteria established by Maryland law and regulation for the issuance of a CPCN and then responds to discovery requests from intervenors. Thereafter, the PPRP and any other parties that have intervened in the process may cross examine this testimony and present their own analyses in direct testimony. The PPRP testimony, presented on behalf of the various state agencies, presents initial recommended licensing conditions.

Other intervening parties, including the PSC staff, Office of People's Counsel (a state agency charged with protecting the interests of electricity ratepayers), and citizen's groups, can prepare and submit direct testimony. The Commission, a panel of Commissioners, or a Hearing Examiner (appointed by the PSC) takes into consideration the recommended license conditions, testimony, and briefs filed by the PPRP, the applicant, and any other parties, and issues a decision in the form of a proposed order on whether the CPCN should be granted and any associated conditions. Where a Hearing Examiner is utilized, after a period during which an appeal can be made to the full Commission, a final order is released granting or denying the application.

PJM Interconnection, LLC (PJM) also performs systematic reliability planning (PJM 2007a). The PJM Capacity Adequacy Planning (CAP) Department is responsible for determining and monitoring the generation reliability requirements of PJM. This includes analyzing the growth of electrical peak load within the region (Brattle, 2006). As part of its reliability planning obligations as a Regional Transmission Organization (RTO), PJM also focuses on planning the enhancement and expansion of transmission capability on a regional basis.

PJM has recently developed independent load forecasting procedures to enhance reliability planning and transmission expansion. For example, reliability planning was previously based on individual reports from each transmission zone within the PJM. Each submitting entity produced its forecast based on its own methodology, though it was common that the energy forecast was derived from the company's retail sales forecast and the energy forecast was then used to derive the peak load forecast. After receiving these individual forecasts, PJM would then prepare a report showing the aggregate coincident and non-coincident peak reports and release these to the public (PJM, 2007a).

With the advent of electric industry restructuring, PJM, as the RTO, determined that a single independent forecast should replace the diversified "sum of zones" report. In 2004, PJM began developing its forecast model and framework. PJM still relies on data from its members, but performs an independent forecast to determine the need for transmission improvements and expansion. The latest transmission expansion report notes plans for new capacity as well as dynamic growth forecasts (PJM, 2007b).

In order to reliably and cost efficiently operate the region's electricity grid, PJM employs an operating procedure known as security constrained economic dispatch. With security constrained economic dispatch, PJM maximizes the use of its lowest cost generating units (coal and nuclear plants) and only uses more expensive units (oil or gas-fired units) when the lower cost units are already running at their maximum levels.

Additionally, the mission of the North American Electric Reliability Corporation (NERC), the "electric reliability organization" as certified by the FERC, is to improve the reliability and security of the bulk power system in North America. To achieve that, NERC develops and enforces reliability standards; monitors the bulk power system; assesses future adequacy; audits owners, operators, and users for preparedness; and educates and trains industry personnel.

NERC develops and publishes long-term reliability assessment reports annually to assess the adequacy of the bulk electric system in the U.S. and Canada over a 10 year period, including summer and winter assessments, and special regional, interregional, or interconnection assessment as needed. These reports project electricity supply and demand, evaluates transmission system adequacy, and discusses key issues and trends that could affect reliability (NERC, 2007).

These processes provide the necessary regulatory reviews and approvals to ensure that proposed power plants can be built to provide reliable, reasonably priced electricity without improperly harming the state's natural resources.}

8.1.2 COMPREHENSIVE PROCESS

{The PSC performs an assessment of the generating or transmission capacity in Maryland. The Maryland Power Plant Research Act (MD, 2006) provides the process for analyzing forecasted energy consumption and peak demand in the restructured Maryland electricity marketplace.

The PSC is required to "assess the amount of electricity generated in Maryland as well as the amount of electricity imported from other states in order to determine whether a sufficient supply of electricity is available to customers in the State" (MD, 2006). Within the PSC, the Energy Resources and Markets Division (ERMD) is responsible for monitoring developments in the energy markets as they affect Maryland, and promoting PSC policies that accomplish more-robust and competitive energy markets, including at PJM, the RTO for the region that includes Maryland. Because retail electricity customers in Maryland either obtain electricity supply from a competitive retail supplier or from their distribution utility acting as the default supplier who purchases electricity through competitive auctions, the ERMD does not "plan" what is the best mix of energy supplies and method of delivery.

ERMD (formerly known as the Integrated Resource Planning (IRP) Division) was established in March 1993 to assess the capability for reliably meeting Maryland customers' electricity and natural gas energy demands. Division members have analytical and/or oversight responsibilities on a wide range of subjects, including regional power supply and transmission planning; applications for construction of major electric facilities; oversight of the Standard Offer Service competitive solicitations; developments in the wholesale energy markets, focusing on prices and availability; air emission compliance plans and emission monitoring as they affect the availability of power supplies; Maryland renewable portfolio standard; load management and conservation programs; and certification of natural gas and electricity suppliers.

During 2006, ERMD performed the following activities:

- Prepared the 10 Year Plan (2006 through 2015) of Electric Companies in Maryland (MDPSC, 2006). In this report, the ERMD notes that Maryland imports over 27% of its electricity from other states over the transmission grid. The report also outlines the PSC efforts to evaluate the status of restructuring in the state. The report notes the PSC reliability concerns and congestion issues. Further, it highlights an overall concern in the state and region over the predicted decline in capacity margins, volatility in the price of electricity, and the lack of in-state generation capacity in Maryland.
- Prepared the Electric Supply Adequacy Report of 2007 (MDPSC, 2007). This report is required by Section 7-505 of Maryland Code Annotated, and describes the amount of electricity generated in Maryland, as well as the amount of electricity imported from other states. This assessment determines whether there is a sufficient, reliable supply of electricity to customers as part of electric market restructuring in Maryland. The report concludes that Maryland's electric supply has become "uncertain, if not precarious." In addition, the in-state electricity supply is inadequate to meet current demand. If new generating capacity is not built and/or upgrades to the transmission system are not made, the likelihood of a reliability crisis in Maryland will increase and may become unavoidable. This report is discussed further, along with its relationship to regional reliability planning efforts, in Section 8.3.
- Monitored wholesale electricity prices in Maryland, including spot prices as measured by locational marginal prices.
- Participated in the PJM planning processes to put in place a new long-term transmission planning protocol addressing both reliability and market efficiency. PJM manages price and transmission reliability, and operates a centrally dispatched wholesale market within the region (PJM, 2007a).
- Actively participated in several PJM committees and working groups, including the Transmission Expansion Advisory Committee, the Markets and Reliability Committee, the Planning Committee, the Market Implementation Committee, the Members Committee, the Demand Response Working Group, and the Regional Planning Process Working Group (PJM, 2007b).

The PPRP is authorized by the Maryland Power Plant Research Act to prepare a Cumulative Environmental Impact Report (CEIR) each biennium. The intent of the CEIR is to assemble and summarize information regarding the impacts of electric power generation and transmission on Maryland's natural resources, cultural foundations, and economic situation. The CEIR report provides analysis of resource impacts and provides a topical discussion of current trends in the electricity industry (PPRP, 2006).

The PPRP also provides the PSC with energy consumption forecasts. PPRP provides statewide and regional energy consumption forecasts within the state based on multiple scenarios with low and high case alternatives (PPRP, 2006).

Accordingly, both the PPRP and the PSC, work to monitor the conditions supporting sufficient energy supply to serve Maryland electricity customers. As a result, the process is comprehensive.}

8.1.3 CONFIRMATION PROCESS

{Consolidated review of power plants and transmission lines by the State of Maryland provides an important opportunity for coordination and confirmation within state government. The PPRP serves as a central point of contact for input from various state agencies. PPRP staff members communicate with other agencies to ensure that all issues are identified, and the program undertakes impact evaluations with input and involvement of those agencies. The PPRP represents seven state agencies before the PSC during the licensing process. Through the development of a consolidated set of recommended licensing conditions, the CPCN process is a valuable tool for bringing together the perspectives of various government bodies and evaluating them within a common framework.

The PPRP has historically conducted a program of independent electric load forecasts as part of its responsibility to monitor the adequacy of future power supplies and to independently evaluate the potential for excess generating capacity. With the restructuring of the retail electric industry in Maryland brought about by the enactment of the Maryland Electric Customer Choice and Competitive Act of 1999, the preparation of load forecasts (energy sales and peak demands) for the individual investor-owned electric utilities operating within Maryland is not sufficient to provide the information required for the PPRP to assess the adequacy of planned supply.

Under restructuring, the primary issues relating to power supply affecting Maryland consumers are the adequacy of generating capacity and the adequacy of transmission system capacity. These assessments remain the responsibility of the PPRP, using the 10 year plans developed by ERMD. To assess and monitor the sufficiency of generating and transmission capacity, the PPRP now forecasts energy requirements and peak demands for the state as a whole and for the various regions within the state.

The PPRP forecast studies, including those historically performed for the service areas of the individual utilities as well as the state-wide forecast, use economic theory as the organizing principle to model the demand for electricity, and rely on econometric methods for estimation and projection. The data that are used to run these models, both historical and projected, are comprised of variables assumed to significantly affect the demand for electricity. Economic variables include income, the price of electricity, and employment; non-economic variables include population and weather. Historical information is required for estimating purposes, while projected data are necessary to forecast the demand for power econometrically. The uncertainty associated with these predictions is discussed in Section 8.1.4.

The PSC reviews certain of these assessments and market demand forecasts in Commission proceedings. The agency also provides the PPRP and the legislature with assessments of transmission reliability and demand projections. Further, the PSC is in the process of conducting a major policy review covering the provision of electricity to retail customers.}

8.1.4 CONSIDERATION OF UNCERTAINTY

{In its annual reliability report, the PSC notes the basic uncertainties of forecasting electricity consumption on a long-term basis and that actual demand could vary significantly, particularly in the years calculated for the end of the 10 year analysis period. A number of Maryland-specific factors add to this unpredictability. For example, the elasticity of consumer response to sharply higher electricity prices, on both a short-term and long-term basis, is very difficult to forecast.

Customers might not reduce demand for electricity as much as one might otherwise expect in the face of higher prices and widespread availability of demand-reduction programs. On the other hand, these price signals could help force demand response and energy efficiency programs and ultimately cause consumer demand to fall short of levels projected by PJM reliability studies and the utilities. Given the long lead times required to plan and construct generation and transmission facilities, and current shortages of both forms of infrastructure in

Maryland, the PSC recognizes that it needs to assess the extent to which it can rely on the most optimistic and most pessimistic of the load forecasts.

Both the PPRP and the PSC recognize that uncertainties in market trends, income, rapid increase in population and demand, and fuel supply diversity will remain significant uncertainties in forecast methodology. }

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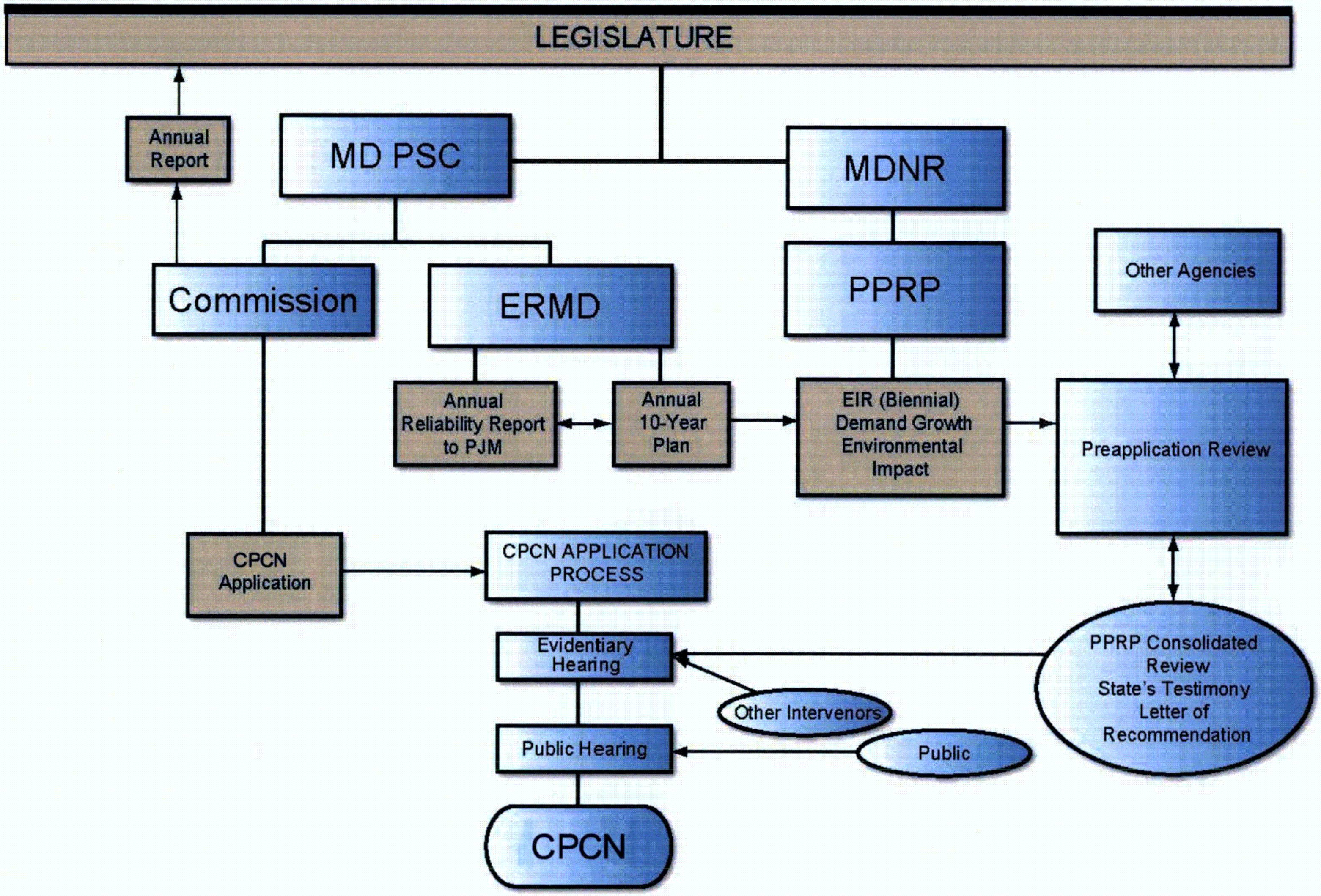

FIGURE 8.1-1 **Rev. 0**

{POWER PLANNING AND PLANT CONSTRUCTION APPROVAL – MARYLAND}

CCNPP UNIT 3 ER

8.2 Power Demand

8.2 POWER DEMAND

The guidance in NUREG-1555, "Standard Review Plan for Environmental Reviews of Nuclear Power Plants" (ESRP) 8.2 (NRC, 1999), allows that a state program describing current power demand and forecasts may support the need for power described in this chapter. This section describes the power resource adequacy review performed by the Maryland Public Service Commission (PSC) and the Power Plant Research Program (PPRP) of the Maryland Department of Natural Resources (MDNR).

8.2.1 POWER AND ENERGY REQUIREMENTS

NUREG-1555 (NRC, 1999) provides the following guidance in ESRP 8.2.1:

> Affected States and/or regions continue to prepare need-for-power evaluations for proposed energy facilities. The NRC will review the evaluation and determine if it is (1) systematic, (2) comprehensive, (3) subject to confirmation, and (4) responsive to forecasting uncertainty. If the need for power evaluation is found acceptable, no additional independent review by the NRC is needed, and the analysis can be the basis for ESRPs 8.2 through 8.4 (NRC, 1999).

{In Maryland's restructured marketplace, power and energy requirements are defined by customer demand (energy consumption), supply adequacy, and reliability. Section 7-505(e)(1) of the Public Utility Companies (PUC) Article (MD, 1999) requires the PSC to "assess the amount of electricity generated in Maryland as well as the amount of electricity imported from other states in order to determine whether a sufficient supply of electricity is available to customers in the State." The report on supply adequacy was filed with the General Assembly every two years beginning January 2001 until January 2007. In its 2007 report (MDPSC, 2007), the PSC noted:

> Maryland imports over 25% of its electric energy needs. On an absolute basis, Maryland is the fifth largest electric energy importer in the U.S. Virginia and New Jersey are in a comparable situation, being respectively the third and fourth largest energy importers in the country. Delaware and the District of Columbia, neighboring jurisdictions, are also large electricity importers, particularly given their relative small size. Thus, not only is Maryland a large importer of electricity, but so are states to the south, east and north of it as well. This makes much of the mid-Atlantic region deficient in generating capacity or, in industry parlance, a "load sink." Of states in the surrounding area, Maryland can import electricity in appreciable amounts only from West Virginia and Pennsylvania, and is competing with Delaware, Virginia, New Jersey, and the District of Columbia for the available exports from those states.
>
> Exacerbating this situation is that Maryland's dependence on out of state electricity supplies will likely increase over the next several years. On the supply side, little new in-state electric generation is scheduled to be built in the next five years. Additionally, some fossil-fired generating capacity may be de-rated or retired in order to comply with both federal and State air emission requirements, including the sulfur dioxide and mercury provisions of Maryland's Healthy Air Act. On the demand side, Maryland's electric utilities and PJM forecast that electricity demand will continue to rise, albeit at a modest pace of between 1% and 2% per year, further increasing Maryland's need for additional electricity supplies.

> Maryland's position as a large net importer and the fact many other jurisdictions in PJM are in a similar situation gives the State little margin for error in ensuring electric reliability. Significantly, Maryland has no in-state reserve margin. Existing in-state generating capacity would have to be increased by over 4,000 MW to bring load and electric supply into balance if Maryland was forced to rely on in-state resources alone. De-rating or retiring any existing instate generation would further increase this need. Maryland has been relying on the bulk electric transmission grid to make up the difference between available in-State supply and demand. However, Maryland's ability to import additional electricity over that grid, particularly during times of peak demand, is limited at best. This is because the current transmission facilities that allow the importation of electricity into the State is operating at peak capacity during peak load periods. In other words, even though generators in Pennsylvania, West Virginia and states farther west may have excess generation to sell to Maryland, the transmission network is unable to deliver that power during times of peak demand.

Additionally, the PPRP recently noted that base demand will continue to rise through 2015 (PPRP, 2006a). However, the PPRP also predicts that consumption may slow because of increases in the real price of electricity over the forecast period, resulting from the expiration of fixed prices for power purchased from the local investor-owned distribution utilities that prevailed following implementation of restructuring.

The expiration of fixed prices, combined with market factors that cause increases in wholesale electricity prices (such as fuel price increases), have resulted in significant increases in electricity prices for the latest customer base (created when the latest price restrictions were lifted in Maryland). Additional price increases will be borne by those customers that continue to be served under the frozen rates – the last of which are set to expire shortly.

To prevent long-term reliability issues, Maryland requires the adoption of long-term energy policies that encourage:

- The construction of generation capacity in-state;
- Siting and building of new transmission facilities that give increased access to out-of-state generation; and
- Energy conservation and demand management programs that will reduce the need for new electric supplies, and make more efficient use of both existing and planned electric infrastructure.}

8.2.2 FACTORS AFFECTING GROWTH AND DEMAND

{The PPRP has historically conducted a program of independent electric load forecasts as part of its effort to monitor the adequacy of future power supplies. Due to the restructuring of the retail electric industry in Maryland, brought about by the enactment of the Maryland Electric Customer Choice and Competitive Act of 1999, the preparation of load forecasts (energy sales and peak demands) for the individual investor-owned electric utilities operating within Maryland no longer provides sufficient information for the PPRP to assess the adequacy of planned supply.

Peak demand occurs when consumers in aggregate use the greatest amount of electricity. Over the course of a year, peak demand usually occurs on hot summer afternoons and cold winter evenings. The load profile diagram presented in Figure 8.2.2-1 shows how electricity demand within a region changes during a typical summer day.

Virtually all power plants operate by using some form of energy to drive a generator to produce electricity. The needed energy can come in the form of steam created from coal, oil, natural gas, or nuclear fission. Gas turbines and internal combustion engines can also be used to drive generators directly. Hydroelectric plants use moving water to spin generators, while wind turbines use wind. Each of these technologies has different performance characteristics, entails different capital costs, and carries different operation and maintenance costs.

The power plants that are least expensive to run operate almost continuously to meet the minimum level of electricity that is demanded by a system (the base load). Also, known as baseload facilities, these continually running generators are predominantly coal-fired and nuclear plants. During periods when consumers demand more electricity, the power plants that can be quickly fired up to meet the peak load are put into operation. These "peaking plants," while expensive to operate due to fuel costs (typically oil or natural gas), are relatively inexpensive to construct (PPRP, 2006b).

Based on the projected load forecasts, both the PSC and the PPRP review the adequacy of generating capacity and the adequacy of transmission system capacity. The PPRP has modified its load forecasting program. Rather than focusing on the individual electric utilities serving consumers in the state, the PPRP now forecasts energy requirements and peak demands for the state as a whole and for the various regions within the state. The PPRP notes (PPRP, 2006a):

> The total demand for any good or service, including electricity, is simply the sum of the demands of the individual consumers in the market. The portion of market demand for residential use of electricity is driven by factors to which individual residential consumers are sensitive. Similarly, for the commercial and industrial sectors of the market demand for electricity, the factors affecting demand are those to which producers are sensitive.
>
> In the case of residential demand, electricity forms part of the basket of goods and services purchased by the consumer. The residential demand for electricity is assumed to result from the exercise of choice by which the consumer maximizes his welfare subject to a budget constraint. Consumer demand for electricity is taken to be a function of its price, consumer income, weather, and the price of related commodities (i.e., substitutes and complements). It is important to note that electricity, in and of itself, conveys no benefits to the consumer. Rather, the consumer benefits from the services of the stock of appliances that require electricity. These services include space conditioning, refrigeration, cooking, clothes washing and drying, and numerous other services and functions. Consequently, the demand for electricity can be appropriately viewed as a derived demand; that is, it results from the demand for the services provided by electricity-consuming appliances.

For commercial and industrial factors, the PPRP assumes that the decisions about consumption are made by the consumer to maximize profits. Thus, the demand for power will be driven by price, the price of related inputs, and the level of output, and other factors – including weather. The PPRP also looks at the following in predicting demand: per capita income trends, employment trends, and population trends.

These three trends all show increases in the 10 year analysis period, with a predicted annual growth rate in demand of about 1.5% through the year 2015. Similar predictions of load growth were provided by the PJM in their 2007 Strategic Report (PJM, 2007).}

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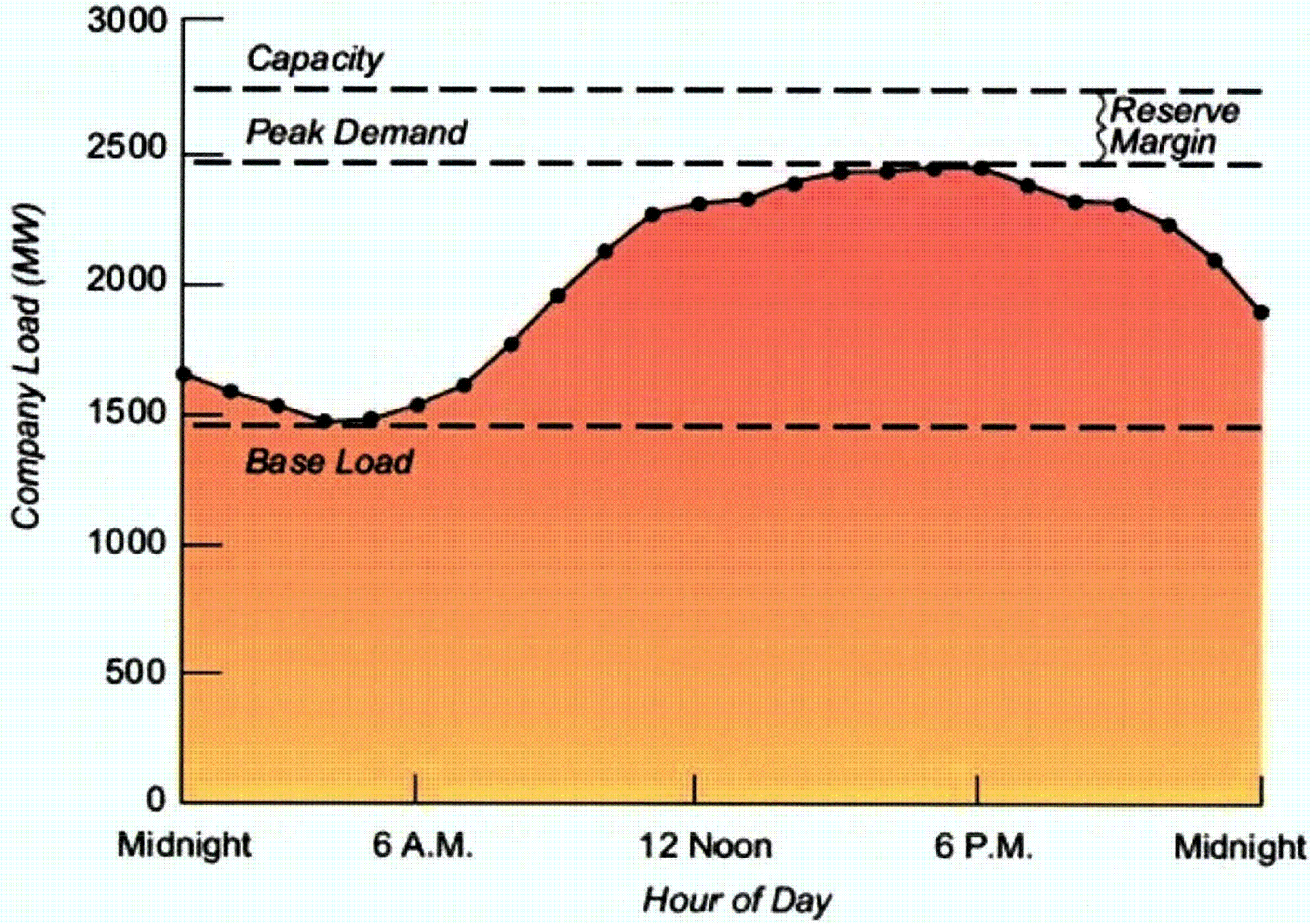

FIGURE 8.2.2-1 **Rev. 0**

SUMMER POWER DEMAND

CCNPP UNIT 3 ER

8.3 Power Supply

8.3 POWER SUPPLY

{In Maryland, the Public Service Commission (PSC) is tasked with assessing and reporting on the adequacy of the power supply in the region to meet the state's forecasted demand. The legislature has required the PSC to report its assessments of the reliability of the power supply and transmission to the Maryland marketplace.

The PSC describes a challenging power outlook in Maryland (MDPSC, 2007), despite increases in energy efficiency and voluntary conservation measures from consumers:

> If new generating capacity is not built, and/or upgrades to the transmission system are not made, the likelihood of a reliability crisis in Maryland, and eastern PJM generally, will increase, and may become unavoidable. As shown in earlier sections, not only will Maryland likely become more capacity deficient in the near-term but PJM is also projecting that capacity reserve margins will decline throughout the system. By the middle of the next decade, reserve margins in PJM may decline below the levels generally associated with ensuring reliable service. Maryland is in a large capacity deficit position, with little new capacity likely to be added and some older generating units possibly being de-rated or retired. Maryland will likely be confronted with a large and growing capacity deficiency unless transmission upgrades are made that will provide increased access to generating resources in western PJM.
>
> Renewables do not appear to be a substitute for traditional enhancements to the electric generation and transmission network. Renewable sources (excepting large hydroelectric projects) supply less than one percent of Maryland's and PJM's energy and capacity. This contribution may grow somewhat with time, but not by enough to meet electric load growth or replace older fossil units that may be de-rated or retired. Siting renewable resources can also be controversial (e.g., siting wind generation in Maryland is opposed by elements of the environmental community).
>
> In closing, Maryland faces major challenges in securing reliable and economic electricity supplies that will support its economy. The Commission recognizes that a balanced approach is required to ensure adequate electricity supplies, including adding new generation, upgrading the transmission system, preserving existing generation resources, and encouraging cost-effective conservation and demand response actions on the part of energy consumers. The Commission has been proactive in each of these areas and is committed to sustaining its efforts. The Commission is also committed to working with Maryland utilities, energy suppliers, and consumers; PJM and its stakeholders; and Maryland policymakers in moving initiatives forward in each of these areas.

The outlook for the adequacy of Maryland's electricity supply can perhaps be best characterized as fragile. Greater reliability depends on several electric grid infrastructure additions and upgrades whose timing may be problematic.}

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8.4 Assessment of Need for Power

8.4 ASSESSMENT OF NEED FOR POWER

In assessing the costs and benefits of the project, NUREG-1555, "Standard Review Plan for Environmental Reviews of Nuclear Power Plants" (ESRP) 8.4 (NRC, 1999), provides the following review criterion:

> If a need-for-power analysis conducted by or for one or more relevant regions affected by the proposed plant concludes there is a need for new generating capacity, that finding should be given great weight provided that the analysis was systematic, comprehensive, subject to confirmation, and responsive to forecast uncertainty.
>
> Although this criterion does not show a need for baseload capacity, it does demonstrate a need for new capacity that is independent of type. This criterion, coupled with an affirmative indication that there is a need for baseload capacity, justifies a baseload addition within the time span determined by the ... forecast analysis.

8.4.1 ASSESSMENT OF THE NEED FOR NEW CAPACITY

{As the Maryland Public Service Commission (PSC) noted in its latest adequacy supply report (MDPSC, 2007), the need for in-state generating capacity is increasing rapidly. The PSC assessed the following factors as contributing to its growing concern about reliability and power supply:

- Maryland's growing reliance on imported electricity.
- Need for infrastructure additions and new transmission.
- Energy efficiency, wholesale, and retail opportunities.

Maryland's Growing Reliance on Imported Electricity

Maryland's dependence on out-of-state generation resources will likely increase over the next 5 to 10 years because of both growth in electricity demand and the possible de-rating or retirement of existing generating units. Both Maryland utilities and PJM are forecasting electricity demand to grow by between 1% and 2% per year. Military base realignments, proximity to the national capital, Maryland's attractive port facilities, its central location in the Atlantic economic corridor, and Maryland's attractiveness as a recreational destination lends credence to these forecasts.

Need for Infrastructure Additions and New Transmission

Further contributing to uncertainty in the power supply adequacy outlook is that over the next 10 years only a small number of new electricity generators will likely be built in Maryland. In 2003 the PSC granted a CPCN for a new 640 MWe generating unit to be built at the Doubs substation near Frederick, Maryland; however, the site developer has taken no action to initiate construction, and no prospective action appears to be likely.

As described in Section 2.8.6, the only other significant baseload generation plants in the PJM generation project queue are the addition of two combustion turbine generating units at an existing power plant near Easton, Maryland, and the addition of four combustion turbine generating units at an existing power plant near Eagle Harbor, Maryland. These units, even if built, would not provide sufficient baseload generating capacity to alleviate current generating capacity shortfalls in the region and future demand growth without reliance on additional new baseload generating capacity. The proposed CCNPP Unit 3, if licensed and built in a timely fashion, would enter service in 2015 at the earliest.

In addition, federal and Maryland regulations require sharp reductions in sulfur dioxide, nitrous oxide, and mercury emissions from fossil-fired generating plants. Some of the older generating units may have difficulty in satisfying the stricter emission limits, or may be unable to satisfy them at all. If they are unable to comply, it is possible they would discontinue operations.

Even units that achieve compliance may see net energy output reduced because of parasitic losses associated with operation of the emission control equipment. Other states in PJM have also put in place strict air emission requirements, with similar potential effects on fossil-fired generating units. Maryland has also joined the Regional Greenhouse Gas Initiative (RGGI), which will place further limitations on fossil-fueled generation.

Energy Efficiency, Wholesale, and Retail Opportunities

More efficient use of electricity is occurring in Maryland. Electricity demand growth has been moderate despite strong economic growth. Since restructuring legislation was implemented, electric consumption in Maryland has increased at an average annual rate of 2.5%. The recent increase in wholesale electricity rates will likely reduce this rate of electric load growth. Both the Maryland utilities and PJM are forecasting that, over the next 10 years, electricity demand growth will be about 1.5% per year. Regional efforts under PJM, such as load response programs to encourage consumers to voluntarily reduce consumption, also contribute to efficiency. The long-term objective of these efficiency programs is to establish market conditions so that demand response and generation are, in effect, competing with one another (MDPSC, 2007).}

8.4.2 OTHER BENEFITS OF NEW NUCLEAR CAPACITY

The guidance in NUREG-1555 (NRC, 1999) allows for an applicant to assess the need for the proposed facility on other grounds. The following criteria suggest the continuing benefits of, and the need for, a new nuclear baseload generating facility in the state independent of the need for power:

- {The relevant region's need to diversify sources of energy (e.g., using a mix of nuclear fuel and coal for baseload generation).

  Although new generation should be sufficient to meet established reliability criteria within the region, the PSC is concerned about the lack of fuel diversity exhibited by generation additions. Combustion turbine capacity in eastern PJM is expected to remain the predominant source of quickly built generation for at least the next 5 years. Natural gas prices have of course risen sharply in recent years and remain volatile.

  In the PJM region, many projects have been withdrawn because of unsatisfactory profit forecasts, general financial market instability, and, more recently, the much higher fuel costs for gas-fired plants, making them less economical to operate (MDPSC, 2002). The addition of new nuclear would help diversify the fuel mix and reduce dependence on gas-fired plants.

- The potential to reduce the average cost of electricity to consumers.

  The PSC and the Power Plant Research Program (PPRP) of the Maryland Department of Natural Resources (MDNR) note that the potential for new power generation to increase availability to in-state consumers is essential to ensure reliability and a robust competitive market. The addition of a new nuclear plant to Maryland's electricity supply would provide an additional source of baseload power that would help stabilize the cost of electricity for consumers.

- The national need to reduce reliance on fossil fuels generally and increase energy security.

The current national policy is to develop ways to reduce dependence on fossil fuels. New baseload nuclear generating capacity is required to enhance U.S. energy supply diversity and energy security, a key National Energy Policy (NEP) objective (WH, 2001). The national policy in support of new nuclear is also apparent in Nuclear Power 2010, which is a joint government/industry cost-shared effort to identify sites for new nuclear plants, develop and bring to market advanced nuclear plant technologies, evaluate the business case for building new nuclear power plants, and demonstrate untested regulatory processes (DOE, 2007). The Energy Policy Act of 2005 (PL, 2005) also encourages needed investment in the national energy infrastructure, helps boost electric reliability, and promotes a diverse mix of fuels, including nuclear, to generate electricity. The Energy Policy Act of 2005 includes a number of provisions that directly encourage the development of new nuclear facilities, including the following:

- Authorizes construction cost-overrun support of up to $2 billion total for up to six new nuclear power plants;
- Authorizes a production tax credit of up to $125 million total per year, estimated at 1.8 US¢/kWh during the first eight years of operation for the first 6000 MW of new nuclear capacity;
- Authorizes a loan guarantee program to support advanced nuclear energy facilities.

The addition of nuclear baseload power to the nation's electricity supply supports national policy objectives and increases energy security.

Other recent national policy statements assert the benefits of baseload capacity that reduces GHG, including nuclear power. The concern over GHG, and the resulting climate change, has triggered a number of policy trends:

- During the 109th Congress, both houses of the U.S. Congress introduced resolutions calling for a national program of carbon reduction (USC, 2006) (USS, 2006).
- Several states, including Maryland, have joined regional GHG initiatives (MD, 2007). In addition to the RGGI, several western states have likewise joined the trend (WCGGWI, 2004). California has recently passed stringent requirements in order to curtail GHG (CAB, 2007).
- The 110th Congress continues its exploration of legislation that would limit carbon emissions in the U.S. Known as "cap and trade" legislation, the legislation seeks to bring carbon emissions down through a series of industry caps and trading strategies (USS, 2007b).

Costs of climate change have also triggered concerns about the economic effects of continuing carbon emission growth. The following examples highlight the growing concern in the U.S.:

- A British study reviewed by the U.S. Senate notes that unabated climate change will sharply affect economic systems globally, ultimately costing more than 20 percent annually of gross domestic product by the year 2050 (USS, 2007a).

- U.S. economic reviews of the British study support it with "high confidence" (Yohe, 2007)."

Because nuclear power plants do not produce significant GHG emissions, the addition of nuclear baseload power to the nation's electricity supply supports national policy objectives and furthers national efforts to reduce GHG emissions.

- The Maryland need to reduce reliance on fossil fuels generally.

  The state recently placed drastic limits on emissions from coal- and natural gas-fired plants. The Maryland Healthy Air Act (MDE, 2006) will provide larger reductions in NOx, SO2, and mercury in a faster timeframe than the federal Clean Air Interstate Rule (CAIR) and Clean Air Mercury Rule (CAMR). The Maryland Healthy Air Act prohibits Maryland power plants from acquiring out-of-state emissions allowances (trading credits) in lieu of adding pollution controls locally.

  Maryland has also recently joined RGGI to combat state reliance on fossil fuels, as well as to reduce greenhouse gases (GHG). RGGI is a cap-and-trade program to control carbon dioxide emissions and is aimed primarily at reducing carbon dioxide pollution through a mandatory emissions cap on the electric generating sector, coupled with a market-based trading program (MD, 2007).

  Because nuclear power plants do not produce significant GHG emissions, new nuclear plants provide the benefits of baseload power without the environmental costs of other fossil-fueled facilities. The addition of nuclear baseload power to Maryland's electricity supply supports state policy objectives and furthers state programs that aim to reduce GHG emissions.}

8.4.3 SUMMARY OF NEED FOR POWER

In summary:

- The State of Maryland has a well-defined, systematic, and comprehensive resource monitoring, assessment, and reporting process that reviews the State's resources and growing demand for additional baseload capacity, eliminating the need for additional NRC review.
- The Maryland PSC has concluded that there is a need for new baseload capacity, and this conclusion has been given "great weight," herein as allowed for by the guidance in NUREG-1555 (NRC, 1999).
- The Maryland PSC/PPRP/CPCN process gives NRC assurance that construction would not proceed without the State's due consideration of the project's impact on supply adequacy and on the stability and reliability of the electric system in the state.
- The growing demand for new capacity shows benefits to be derived from CCNPP Unit 3.
- Given State concerns about climate change and carbon emissions, CCNPP Unit 3 serves another important need by reducing carbon emissions in Maryland. The new plant will offset significant amounts of carbon, as compared to a coal-fired generating plant.
- Decreased reliance on fossil fuels.
- The potential to reduce the average cost of electricity to consumers by increasing availability of low cost power generation to in-state consumers through the competitive marketplace.

- Improved diversity of the sources of energy relied upon for baseload generation.

Section 9.2 discusses the viability of various baseload energy alternatives. Section 10.4 further reviews the costs and benefits of CCNPP Unit 3.}

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9.0 Alternatives to the Proposed Action

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

9.0 ALTERNATIVES TO THE PROPOSED ACTION

This chapter assesses alternatives to the proposed siting and construction of a new nuclear power plant at the {existing Calvert Cliffs Nuclear Plant (CCNPP) site}.

Chapter 9 describes the alternatives to construction and operation of a new nuclear unit with closed cycle cooling adjacent to the {CCNPP Units 1 and 2} site location, and alternative plant and transmission systems. The descriptions provide sufficient detail to facilitate evaluation of the impacts of the alternative generation options or plant and transmission systems relative to those of the proposed action. The chapter is divided into four sections:

- "No-Action" Alternative
- Energy Alternatives
- Alternative Sites
- Alternative Plant and Transmission Systems

9.1 No-Action Alternative

9.1 NO ACTION ALTERNATIVE

The "No-Action" alternative refers to a scenario where a new nuclear power plant, as described in Chapter 2, is not constructed and no other generating station, either nuclear or non-nuclear, is constructed and operated.

The most significant effect of the No-Action alternative would be loss of the potential 1,600 MWe additional generating capacity that {CCNPP Unit 3} would provide, which could lead to a reduced ability of existing power suppliers to maintain reserve margins and supply lower cost power to customers. Chapter 8 describes a {1.5%} annual increase in electricity demand in Maryland over the next 10 years. Under the No-Action alternative, this increased need for power would need to be met by means that involve no new generating capacity.

As discussed in Chapter 8, this area of the country where {CCNPP Unit 3 would be sited currently imports a large portion of its electricity, so the ability to import additional resources is limited}. Demand-side management is one alternative; however, even using optimistic projections, demand-side management will not meet future demands.

Implementation of the No-Action alternative could result in the future need for other generating sources, including continued reliance on carbon-intensive fuels, such as coal and natural gas. Therefore, the predicted impacts, as well as other unidentified impacts, could occur in other areas.

9.2 ENERGY ALTERNATIVES

This section discusses the potential environmental impacts associated with electricity generating sources other than a new nuclear unit at the {CCNPP} site. These alternatives include: purchasing electric power from other sources to replace power that would have been generated by a new unit at the {CCNPP} site, a combination of new generating capacity and conservation measures, and other generation alternatives that were deemed not to be viable replacements for a new unit at the {CCNPP} site.

Alternatives that do not require new generating capacity were considered, including energy conservation and Demand-Side Management (DSM). Alternatives that would require the construction of new generating capacity, such as wind, geothermal, oil, natural gas, hydropower, municipal solid wastes (MSW), coal, photovoltaic (PV) cells, solar power, wood waste/biomass, and energy crops, as well as any reasonable combination of these alternatives, were also analyzed.

{The proposal to develop a nuclear power plant on land adjacent to the existing nuclear plant was primarily based on market factors such as the proximity to an already-licensed station, property ownership, transmission corridor access, and other location features conducive to the plant's intended merchant generating objective.}

Alternatives that do not require new generating capacity are discussed in Section 9.2.1, while alternatives that do require new generating capacity are discussed in Section 9.2.2. Some of the alternatives discussed in Section 9.2.2 were eliminated from further consideration based on their availability in the region, overall feasibility, and environmental consequences. Section 9.2.3, describes the remaining alternatives in further detail relative to specific criteria such as environmental impacts, reliability, and economic costs.

9.2.1 ALTERNATIVES NOT REQUIRING NEW GENERATING CAPACITY

The Federal Energy Regulatory Commission (Commission) issued a Final Rule, in 1996, requiring all public utilities that own, control or operate facilities used for transmitting electric energy in interstate commerce to have on file open access non-discriminatory transmission tariffs that contain minimum terms and conditions of nondiscriminatory service. The Final Rule also permitted public utilities and transmitting utilities to seek recovery of legitimate, prudent and verifiable stranded costs associated with providing open access and Federal Power Act section 211 transmission services. The Commission's goal was to remove impediments to competition in the wholesale bulk power marketplace and to bring more efficient, lower cost power to the Nation's electricity consumers (FERC, 1996).

This section describes the assessment of the economic and technical feasibility of supplying the demand for energy without constructing new generating capacity. Specific alternatives include:

- Initiating conservation measures (including implementing DSM actions)
- Reactivating or extending the service life of existing plants within the power system
- Purchasing power from other utilities or power generators
- A combination of these elements that would be equivalent to the output of the project and therefore eliminate its need.

9.2.1.1 Initiating Conservation Measures

Under the Energy Policy Act of 2005 (PL, 2005) a rebate program was established for homeowners and small business owners who install energy-efficient systems in their buildings. The rebate was set at $3,000, or 25% of the expenses, whichever was less. The Act authorized

$150 million in rebates for 2006 and up to $250 million in 2010. This new legislation was enacted in the hope that homeowners and small business owners would become more aware of energy-efficient technologies, lessening energy usage in the future.

Historically, state regulatory bodies have required regulated utilities to institute programs designed to reduce demand for electricity. DSM has shown great potential in reducing peak-load consumption (maximum power requirement of a system at a given time). In 2005, peak-load consumption was reduced by approximately 25,710 MWe, an increase of 9.3% from the previous year (EIA, 2006a). However, DSM costs increased by 23.4% (EIA, 2006b).

The following DSM programs can be used to directly reduce summer or winter peak loads when needed:

- Large load curtailment - This program provides a source of load that may be curtailed at the Company's request in order to meet system load requirements. Customers who participate in this program receive a credit on their bill.
- Voltage control - This procedure involves reducing distribution voltage by up to 5% during periods of capacity constraints. This level of reduction does not adversely affect customer equipment or operations.

9.2.1.1.1 Conservation Programs

{In 1991, the Maryland General Assembly enacted an energy conservation measure that is codified as Section 7-211 of the Public Utility Companies (PUC) Article (MGA, 1991). This provision requires each gas and electric company to develop and implement programs to encourage energy conservation. In response to this mandate and continuing with preexisting initiatives under its existing authority, the Maryland Public Service Commission (PSC) directed each affected utility to develop a comprehensive conservation plan. The PSC further directed each utility to engage in a collaborative effort with staff, the Office of People's Counsel (OPC), and other interested parties to develop its conservation plan. The result of these actions was that each utility implemented conservation and energy efficiency programs. (MDPSC, 2007a)

The PSC requires Maryland electric utilities to implement DSM as a means to conserve energy and to take DSM energy savings into account in long-range planning. Baltimore Gas and Electric Company, the regulated electric distribution affiliate of Constellation Generation Group, has an extensive program of residential, commercial, and industrial programs designed to reduce both peak demands and daily energy consumption (i.e., DSM). Program components include the following:

- Peak clipping programs - Include energy saver switches for air conditioners, heat pumps, and water heaters, allowing interruption of electrical service to reduce load during periods of peak demand; dispersed generation, giving dispatch control over customer backup generation resources; and curtailable service, allowing customers' load to be reduced during periods of peak demand.
- Load shifting programs - Use time-of-use rates and cool storage rebate programs to encourage shifting loads from peak to off-peak periods.
- Conservation programs - Promoting use of high-efficiency heating, ventilating, and air conditioning; encouraging construction of energy-efficient homes and commercial buildings; improving energy efficiency in existing homes; providing incentives for use of energy-efficient lighting, motors, and compressors.

It is estimated that the Baltimore Gas and Electric DSM program results in an annual peak demand generation reduction of about 700 MWe, and believed that generation savings can continue to be increased from DSM practices. The load growth projection anticipates a DSM savings of about 1,000 MWe in 2016. These DSM savings are an important part of the plan for meeting projected regional demand growth in the near-tem (BGE, 1998).

However, since the most viable and cost-effective DSM options are pursued first, it is not likely that demand reductions of similar size will be available or practical in the future. Consequently, DSM is not seen as a viable "offset" for the additional baseload generation capacity that will be provided by CCNPP Unit 3, and UniStar Nuclear Operating Services does not foresee the availability of another 1,600 MWe (equivalent to the CCNPP Unit 3 capacity) of viable and cost-effective DSM to meet projected load demand and baseload power needs. Therefore, it is concluded that DSM is not a feasible alternative for the CCNPP Unit 3 facility.}

9.2.1.2 Reactivating or Extending Service Life of Existing Plants

{Maryland's dependence on out-of-state electricity supplies will likely increase over the next several years. On the supply side, few new in-state electric generating facilities are scheduled to be built during the next 5 years. Additionally, some fossil-fired generating capacity may be de-rated or retired in order to comply with both federal and state air emission requirements, including the sulfur dioxide and mercury provisions of Maryland's Healthy Air Act (HAA). On the demand side, Maryland's electric utilities and PJM Interconnection, LLC (PJM), the regional electricity grid operator, forecast that electricity demand will continue to rise, albeit at a modest pace of between 1% and 2% per year, further increasing Maryland's need for additional electricity supplies (MDPSC, 2007a).

There has been very little change to the amount and the mix of electrical power generation in Maryland this decade. No significant generation has been added in the past 3 years, and no units have been retired since the Gould Street plant (101 MWe) ceased operations in November 2003 (MDPSC, 2007a).

It is possible that some older units that cannot meet stricter environmental standards at the federal or state level may eventually be retired. Certificate of Public Convenience and Necessity (CPCN) filings have been made to the State of Maryland by six Maryland coal-fired facilities for various environmental upgrades for compliance with the HAA. However, some of these units and other older Maryland coal units may have to be retired if the emissions restrictions (including those for carbon dioxide that may be mandated by the Regional Greenhouse Gas Initiative) make these plants uneconomic to operate in the future (MDPSC, 2007a).

Scheduled retirement of older generating units will also occur elsewhere in PJM. In New Jersey, four older facilities are scheduled to retire in the next 2 years: 285 MWe at Martins Creek (September 2007), 447 MWe at B.L. England (December 2007), 453 MWe at Sewaren (September 2008), and 383 MWe at Hudson (September 2008) (MDPSC, 2007a).

Retired fossil fuel plants and fossil fuel plants slated for retirement tend to be those old enough to have difficulty economically meeting today's restrictions on air contaminant emissions. In the face of increasingly stringent environmental restrictions, delaying retirement or reactivating plants in order to forestall closure of a large baseload generation facility would require extensive construction to upgrade or replace plant components. Upgrading existing plants would be costly and at the same time would neither increase the amount of available generation capacity, nor alleviate the growing regional need for additional baseload generation capacity. A new baseload facility would allow for the generation of needed power and would meet future power needs within the region of interest (ROI), which is Maryland. This ROI is further evaluated in Section 9.3. Therefore, extending the service life of existing plants or reactivating old plants may not be feasible.}

9.2.1.3 Purchasing Power from Other Utilities or Power Generators

{The uncertainty of Maryland's supply adequacy begins with Maryland's status as one of the largest electric energy importing states in the country. Maryland currently imports more than 25% of its electric energy needs. On an absolute basis, Maryland is the fifth-largest electric energy importer in the U.S. Neighboring states Virginia and New Jersey are in a comparable situation, being respectively the third and fourth largest energy importers in the country, and Delaware and the District of Columbia are also large electricity importers.

Consequently, not only is Maryland a large importer of electricity, but so are states to the south, east and north of it. This makes much of the mid-Atlantic region deficient in generating capacity, or what is referred to in the industry as a "load sink." Of the states in the surrounding area, Maryland can only import electricity in appreciable amounts from West Virginia and Pennsylvania, and is competing with Delaware, Virginia, New Jersey, and the District of Columbia for the available exports from those states (MDPSC, 2007a).

Maryland has been relying on the bulk electric transmission grid to make up the difference between economically dispatched in-state supply and demand. However, Maryland's ability to import additional electricity over that grid, particularly during times of peak demand, is limited at best. The current transmission facilities that allow the importation of electricity into the State already operate at peak capacity during peak load periods. In other words, even though generators in Pennsylvania, West Virginia, and states farther west may have excess power to sell to Maryland, the transmission network is unable to deliver that power during times of peak demand (MDPSC, 2007a).

Imported power from Canada or Mexico is also unlikely to be available to supply the equivalent capacity of the proposed facility. In Canada, 62% of the country's electricity capacity is derived from renewable sources, principally hydropower. Canada has plans to continue developing hydroelectric power, but the plans generally do not include large-scale projects. Canada's nuclear power generation is projected to decrease by 1.7% by 2020, and its share of power generation in Canada is projected to decrease from 14% currently to 13% by 2020 (EIA, 2001b).

The Department of Energy projects that total gross U.S. imports of electricity from Canada and Mexico will gradually increase from 47.4 billion kWh in 2000 up until year 2005, and then gradually decrease to 47.4 billion kWh in 2020 (EIA, 2001b). Therefore, imported power from Canada or Mexico is not a viable option to alleviate the growing regional need for power, or the need for additional baseload generation capacity to meet projected power demands.

In conclusion, because there is not enough electricity to import from nearby states or Canada and Mexico, purchasing power from other utilities or power generators is not considered feasible.}

9.2.2 ALTERNATIVES THAT REQUIRE NEW GENERATING CAPACITY

Although many methods are available for generating electricity and many combinations or mixes can be assimilated to meet system needs, such expansive consideration would be too unwieldy to reasonably examine in depth, given the purposes of this alternatives analysis. The alternative energy sources considered are listed below.

- Wind
- Geothermal
- Hydropower
- Solar Power
    - Concentrating Solar Power Systems

- Photovoltaic (PV) Cells
- Wood Waste
- Municipal Solid Waste
- Energy Crops
- Petroleum liquids (Oil)
- Fuel Cells
- Coal
- Natural Gas
- Integrated Gasification Combined Cycle (IGCC)

Based on the installed capacity of 1,600 MWe that {CCNPP Unit 3} will produce, not all of the above-listed alternative sources are competitive or viable. Each of the alternatives is discussed in more detail in later sections, with an emphasis on coal, solar, natural gas, and wind energy. As a renewable resource, solar and wind energies, alone or in combination with one another, have gained increasing popularity over the years, in part due to concern over greenhouse gas emissions. Air emissions from solar and wind facilities are much smaller than fossil fuel air emissions. Although the use of coal and natural gas has undergone a slight decrease in popularity, it is still one of the most widely used fuels for producing electricity.

{The current mix of power generation options in Maryland is one indicator of the feasible choices for electric generation technology within the state. Constellation Generation Group and UniStar Nuclear Operating Services evaluated Maryland's electric power generating capacity and utilization characteristics. "Capacity" is the categorization of the various installed technology choices in terms of their potential output. "Utilization" is the degree to which each choice is actually used.

Combined heat and power systems that are geographically dispersed and located near customers were identified as a potential option for producing heat and electrical power. However, distributed energy generation was not seen as a competitive or viable alternative and was not given detailed consideration.

In 2005, electricity imports amounted to 27.5% of all the electricity consumed in Maryland, about 10% more than the imported 17.7% of the electricity consumed in 1999. Consumption increased 15.7% from 1999 to 2005, while generation only increased by 1.9% during the same period. In effect, nearly all the electricity load growth in Maryland between 1999 and 2005 was met by importing electricity from other states within the region. This growing dependence on imported power means that Maryland has an enormous stake in the reliability of the regional transmission grid and the existence of a robust wholesale power market. (MDPSC, 2007a)

As required by Section 7-505(e) of the PUC Article, the Electric Supply Adequacy Report of 2007 included an assessment of the regional need for power. This review of the need for power in this region takes into account conservation, load management, and other demand-side options along with new utility-owned generating plants, non-utility generation, and other supply-side options in order to identify the resource plan that will be most cost-effective for the ratepayers consistent with the provision of adequate, reliable service (MDPSC, 2007a).

- The need for power assessment contains the following information:
- A description of the power system in Maryland
- An assessment of power demand and predictions
- An evaluation of present and planned capacity (including other utility company providers

- A concluding assessment of the need for power

In 2006, the Department of Energy released a transmission congestion study that shows that the region from New York City to northern Virginia (which includes Maryland) is one of the two areas of the country most in need of new bulk power transmission lines (MDPSC, 2007a).

This section includes descriptions of power generating alternatives that Constellation Generation Group and UniStar Nuclear Operating Services have concluded are not reasonable and the basis for this conclusion. This COL application is premised on the installation of a facility that would primarily serve as a large base-load generator and that any feasible alternative would also need to be able to generate baseload power. In performing this evaluation, Constellation Generation Group and UniStar Nuclear Operating Services have relied heavily upon the NRC Generic Environmental Impact Statement (GEIS) (NRC, 1996).}

The GEIS is useful for the analysis of alternative sources because NRC has determined that the technologies of these alternatives will enable the agency to consider the relative environmental consequences of an action given the environmental consequences of other activities that also meet the purpose of the proposed action. To generate the set of reasonable alternatives that are considered in the GEIS, common generation technologies were included and various state energy plans were consulted to identify the alternative generation sources typically being considered by state authorities across the country.

From this review, a reasonable set of alternatives to be examined was identified. These alternatives included wind energy, PV cells, solar thermal energy, hydroelectricity, geothermal energy, incineration of wood waste and municipal solid waste, energy crops, coal, natural gas, oil, and delayed retirement of existing non-nuclear plants. These alternatives were considered pursuant to the statutory responsibilities imposed under the National Environmental Policy Act of 1969 (NEPA) (NEPA, 1982).

Although the GEIS is provided for license renewal, the alternatives analysis in the GEIS can be compared to the proposed action to determine if the alternative represents a reasonable alternative to the proposed action.

Each of the alternatives is discussed in the subsequent sections relative to the following criteria:

- The alternative energy conversion technology is developed, proven, and available in the relevant region within the life of the COL.
- The alternative energy source provides baseload generating capacity equivalent to the capacity needed and to the same level as the proposed nuclear plant.
- The alternative energy source does not create more environmental impacts than a nuclear plant would, and the costs of an alternative energy source do not make it economically impractical.

Each of the potential alternative technologies considered in this analysis are consistent with national policy goals for energy use and are not prohibited by federal, state, or local regulations. Based on one or more of these criteria described above, several of the alternative energy sources were considered technically or economically infeasible after a preliminary review and were not considered further. Alternatives considered to be technically and economically feasible are described in greater detail in Section 9.2.3.

9.2.2.1 Wind

In general, areas identified by the National Renewable Energy Laboratory (NREL) as wind resource Class 4 and above are regarded as potentially economical for wind energy production with current technology. Class 4 wind resources are defined as having mean wind speeds between 15.7 and 16.8 mph (25.3 to 27.0 kph) at 50 m elevation.

As a result of advances in technology and the current level of financial incentive support, a number of additional areas with a slightly lower wind resource (Class 3+) may also be suitable for wind development. These would, however, operate at a lower annual capacity factor and output than used by National Renewable Energy Laboratory (NREL) for Class 4 sites. Class 3 wind resources are defined as having mean wind speeds between 14.3 and 15.7 mph (23.0 to 25.3 kph) at 50 m (164 ft) elevation, with Class 3+ wind resources occupying the high end of this range.

{Wind Powering America indicates that Maryland has wind resources consistent with utility-scale production. Several areas are estimated to have good-to-excellent wind resources. These are the barrier islands along the Atlantic coast, the southeastern shore of Chesapeake Bay, and ridge crests in the western part of the state, west of Cumberland. In addition, small wind turbines may have applications in some areas (EERE, 2006a).

Wind resource maps show that much of Maryland has a Class 1 or 2 wind resource, with mean wind speeds of 0.0 to 14.3 mph (0.0 to 23.0 kph) at 50 m (164 ft) elevation. The reason for the moderate wind speeds overall, despite strong winds aloft much of the year, is the high surface roughness of the forested land. The wind resource in central Maryland is moderate, but it improves near the coast because of the influence of the Atlantic Ocean and Chesapeake Bay. Offshore, especially on the Atlantic side, the wind resource is predicted to reach 16.8 to 19.7 mph (27.0 to 31.7 kph) at 50 m (164 ft), or NREL Class 4-5 (EERE, 2003).}

For any wind facility, the amount of land needed for operation could be significant. Wind turbines must be sufficiently spaced to maximize capture of the available wind energy. If the turbines are too close together, they can lose efficiency. A 2 MWe turbine requires approximately 10,890 ft^2 (1000 m^2) of dedicated land for the actual placement of the wind turbine, allowing landowners to use the remaining acreage for some other purpose that does not affect the turbine, such as agricultural use.

For illustrative purposes, if all of the resources in Class 3+ and 4 sites were developed using 2 MWe turbines, with each turbine occupying 10,890 ft^2 (1,000 m^2) (i.e., 100 ft (30.5 m) spacing between turbines), 9,000 MWe of installed capacity would utilize 1.8 mi^2 (4.6 km^2) just for the placement of the wind turbines alone. Based upon the NERC capacity factor, it would create an average output of 1,530 MWe requiring approximately 31,800 ft^2 (2,954 m^2) per MWe. This is a conservative assumption because Class 3+ sites will have a lower percentage of average annual output.

If a Class 3+ site were available and developed using 2 MWe turbines within the ROI, 9,400 MWe of installed capacity would be needed to produce the equivalent 1,600 MWe of baseload output. This would encompass a footprint area of approximately 1.9 mi^2 (4.9 km^2), which is more than half the size of the entire {CCNPP site (Units 1 and 2 and proposed Unit 3)}. The {CCNPP site is a Class 1 site; therefore, it would not be feasible to construct a wind power facility at the CCNPP} site (EERE, 2003).

Technological improvements in wind turbines have helped reduce capital and operating costs. In 2000, wind power was produced in a range of \$0.03 to \$0.06 per kWh (depending on wind speeds), but by 2020 wind power generating costs are projected to fall to \$0.03 to \$0.04 per kWh.

The installed capital cost of a wind farm includes planning, equipment purchase, and construction of the facilities. This cost, typically measured in \$/kWe at peak capacity, has decreased from more than $2,500 per kWe in the early 1980s to less than $1,000 per kWe for wind farms in the U.S, but "economies of scale" may not be available in the ROI, given the availability of the resource.

The EIA's "Annual Energy Outlook 2004" provides some unique insights into the viability of the wind resource (EIA, 2004a):

- In addition to the construction, operating, and maintenance costs for wind farms, there are costs for connection to the transmission grid. Any wind project would have to be located where the project would produce economical generation, but that location may be far removed from the nearest connection to the transmission system. A location far removed from the power transmission grid might not be economical, because new transmission lines would be required to connect the wind farm to the distribution system.

  Existing transmission infrastructure may need to be upgraded to handle the additional supply. Soil conditions and the terrain must be suitable for the construction of the towers' foundations. Finally, the choice of a location may be limited by land use regulations and the ability to obtain the required permits from local, regional, and national authorities. The farther a wind energy development project is from transmission lines, the higher the cost of connection to the transmission and distribution system.

- The distance from transmission lines at which a wind developer can profitably build depends on the cost of the specific project. For example, the cost of construction and interconnection for a 115 kV transmission line that would connect a 50 MWe wind farm with an existing transmission and distribution network. The EIA estimated, in 1995, the cost of building a 115 kV line to be $130,000 per mile, excluding right-of-way costs (EIA, 2003b).

  This amount includes the cost of the transmission line itself and the supporting towers. It also assumes relatively ideal terrain conditions, including fairly level and flat land with no major obstacles or mountains (more difficult terrain would raise the cost of erecting the transmission line). In 1993, the cost of constructing a new substation for a 115 kV transmission line was estimated at $1.08 million, and the cost of connection for a 115 kV transmission line with a substation was estimated to be $360,000 (EIA, 1995).

- In 1999, the DOE analyzed the total cost of installing a wind facility in various North American Electric Reliability Corporation (NERC) regions. The agency first looked at the distribution of wind resources and excluded land from development based on the classification of land. For example, land that was considered wetlands and urban were totally excluded, whereas land that was forested had 50% of its land excluded. Next, resources that were sufficiently close to existing 115 kV to 230 kV transmission lines were classified into three distinct zones and an associated standard transmission fee for connecting the new plant with the existing network was applied. DOE then used additional cost factors to account for the greater distances between wind sites and the existing transmission networks. Capital costs were added based on whether the wind resource was technically accessible at the time and whether it could be economically accessible by 2020.
- Another consideration on the integration of the wind capacity into the electric utility system is the variability of wind energy generation. Wind-driven electricity generating facilities must be located at sites with specific characteristics to maximize the amount of wind energy captured and electricity generated. In addition, for transmission purposes, wind generation is not considered "dispatchable," meaning that the generator can control output to match load and economic requirements. Since the resource is intermittent, wind, by itself, is not considered a firm source of baseload capacity. The inability of wind alone to be a dispatchable, baseload producer of electricity is inconsistent with the objectives for the {CCNPP} site.

Finally, wind facilities pose environmental impacts, in addition to the land requirements posed by large facilities, as follows:

- Large-scale commercial wind farms can be an aesthetic problem, obstructing viewsheds and initiating conflict with local residents.
- High-speed wind turbine blades can be noisy, although technological advancements continue to lessen this problem.
- Wind facilities sited in areas of high bird use can expect to have avian fatality rates higher than those expected if the wind facility were not there.

Recently, the Center for Biological Diversity (CBD) has voiced mixed reviews regarding wind farms along migratory bird routes. The CBD supports wind energy as an alternative energy source and as a way to reduce environmental degradation. However, wind power facilities, such as the Altamont Pass Wind Resource Area (APWRA) in California, are causing mortality rates in raptor populations to increase as a result of turbine collisions and electrocution on power lines. The APWRA kills an estimated 881 to 1,300 birds of prey each year. Birds that have been affected to the greatest extent include golden eagles, red-tailed hawks, burrowing owls, great horned owls, American kestrels, ferruginous hawks, and barn owls (CBD, 2007).

{Maryland's Renewable Energy Portfolio Standard, enacted in May 2004, and revised in 2007, requires electricity suppliers (all utilities and competitive retail suppliers) to use renewable energy sources to generate a minimum portion of their retail sales. Beginning in 2006, electricity suppliers are required to provide 1% of retail electricity sales in the State from Tier 1 renewable resources, such as wind. The requirement to produce electricity from Tier 1 renewable resources increases to 9.5% by 2022. (MDPSC, 2007b)}

Wind energy will not always be dependable due to variable wind conditions, and there is no proven storage method for wind-generated electricity. Consequently, in order to use wind energy as a source of baseload generation it would be necessary to also have an idle backup generation source to ensure a steady, available power supply. With the inability of wind power to generate baseload power due to low capacity factors and limited dispatchability, the projected land use impacts of development of Class 3+ and Class 4 sites, the cost factors in construction and operation, along with the impacts associated with development, and cost of additional transmission facilities to connect turbines to the transmission system, a wind power generating facility by itself is not a feasible alternative to the new plant. Off-shore wind farms are not competitive or viable with a new nuclear reactor at the {CCNPP} site, and were therefore not considered in more detail.

Many renewable resources, such as wind, are intermittent (i.e., they are not available all of the time). The ability to store energy from renewable energy sources would allow supply to more closely match demand. For example, a storage system attached to a wind turbine could store captured energy around the clock, whenever the wind is blowing, and then dispatch that energy into higher demand times of the day (NREL, 2006). However, these technologies are not competitive or viable at this time.

9.2.2.2 Geothermal

As illustrated by Figure 8.4 in the GEIS (NRC, 1996), geothermal plants might be located in the western continental U.S., Alaska, and Hawaii, where hydrothermal reservoirs are prevalent.

Maryland is not a candidate for large scale geothermal energy and could not produce the proposed 1,600 MWe of baseload power. Therefore, geothermal energy is non competitive with a new nuclear unit at the CCNPP site. }

9.2.2.3 Hydropower

The GEIS (NRC, 1996) estimates land use of 1,600 mi^2 (4,144 km^2) per 1,000 MWe generated by hydropower. Based on this estimate, hydropower would require flooding more than 2,600 mi^2 (6,734 km^2) to produce a baseload capacity of 1,600 MWe, resulting in a large impact on land use.

According to a study performed by the Idaho National Engineering and Environmental Laboratory (INEEL), Maryland has 36 possible hydropower sites: 1 developed and with a power-generating capacity of 20 MWe, 32 developed and without power and a possible generating capacity of 10 MWe, and 3 undeveloped sites with a possible 0.10 MWe of generating capacity. Only one site had the potential generating capacity of 20 MWe or more (INEEL, 1998). Therefore, hydropower is non-competitive with a new nuclear unit at the CCNPP site. }

9.2.2.4 Solar Power

Solar energy depends on the availability and strength of sunlight (strength is measured as kWh/m^2), and solar power is considered an intermittent source of energy. Solar facilities would have equivalent or greater environmental impacts than a new nuclear facility at the {CCNPP} site. Such facilities would also have higher costs than a new nuclear facility.

The construction of solar power-generating facilities has substantial impacts on natural resources (such as wildlife habitat, land use, and aesthetics). {In order to look at the availability of solar resources in Maryland, two collector types must be considered: concentrating collectors and flat-plate collectors. Concentrating collectors are mounted to a tracker, which allows them to face the sun at all times of the day. In Maryland, approximately 3,500 to 4,000 $W\text{-}hr/m^2/day$ can be collected using concentrating collectors. Flat-plate collectors are usually fixed in a tilted position to best capture direct rays from the sun and also to collect reflected light from clouds or the ground. In Maryland, approximately 4,500 to 5,000 $W\text{-}hr/m^2/day$ can be collected using flat-plate collectors.} (EERE, 2006a). The footprint needed to produce a 1,600 MWe baseload capacity is much too large to construct at the proposed plant site.

9.2.2.4.1 Concentrating Solar Power Systems

Concentrating solar plants produce electric power by converting solar energy into high temperature heat using various mirror configurations. The heat is then channeled through a conventional generator, via an intermediate medium (i.e., water or salt). Concentrating solar plants consist of two parts: one that collects the solar energy and converts it to heat, and another that converts heat energy to electricity.

Concentrating solar power systems can be sized for "village" power (10 kWe) or grid-connected applications (up to 100 MWe). Some systems use thermal energy storage (TES), setting aside heat transfer fluid in its hot phase during cloudy periods or at night. These attributes, along with solar-to-electric conversion efficiencies, make concentrating solar power an attractive renewable energy option in the southwest part of the U.S. and other Sunbelt regions worldwide (EERE, 2006b). Others can be combined with natural gas. This type of combination is discussed in Section 9.2.3.3.

There are three kinds of concentrating solar power systems—troughs, dish/engines, and power towers – classified by how they collect solar energy (EERE, 2006b).

Concentrating solar power technologies utilize many of the same technologies and equipment used by conventional power plants, simply substituting the concentrated power of the sun for the combustion of fossil fuels to provide the energy for conversion into electricity. This "evolutionary" aspect – as distinguished from "revolutionary" or "disruptive" – allows for easy integration into the transmission grid. It also makes concentrating solar power technologies the most cost-effective solar option for the production of large-scale electricity generation (10 MWe and above).

While concentrating solar power technologies currently offer the lowest-cost solar electricity for large-scale electricity generation, these technologies are still in the demonstration phase of development and cannot be considered competitive with fossil or nuclear-based technologies (CEC, 2003). Current concentrating solar collection technologies cost $0.09 to $0.12 per kWh. In contrast, nuclear plants are anticipated to produce power in the range of $0.031 to $0.046 per kWh (DOE, 2002). In addition, concentrating solar power plants only perform efficiently in high-intensity sunlight locations, specifically the arid and semi-arid regions of the world (NREL, 1999). {This does not include Maryland.}

9.2.2.4.2 "Flat Plate" Photovoltaic Cells

The second common method for capturing the sun's energy is through the use of PV cells. A typical PV or solar cell might be a square that measures about 10 cm (4 in) on a side. A cell can produce about 1 watt of power—more than enough to power a watch, but not enough to run a radio.

When more power is needed, some 40 PV cells can be connected to form a "module." A typical module is powerful enough to light a small light bulb. For larger power needs, about 10 such modules are mounted in PV arrays, which can measure up to several meters on a side. The amount of electricity generated by an array increases as more modules are added.

"Flat-plate" PV arrays can be mounted at a fixed angle facing south, or they can be mounted on a tracking device that follows the sun, allowing them to capture more sunlight over the course of a day. Ten to 20 PV arrays can provide enough power for a household; for large electric utility or industrial applications, hundreds of arrays can be interconnected to form a single, large PV system (NREL, 2007). The land requirement for this technology is approximately 14 ha (0.054 mi^2, or 0.14 km^2) per MWe (NRC, 1996). In order to produce the 1,600 MWe baseload capacity as {CCNPP Unit 3}, 22,660 hectares (87.3 mi^2, or 560 km^2) would be required for construction of the photovoltaic modules.

Some PV cells are designed to operate with concentrated sunlight, and a lens is used to focus the sunlight onto the cells. This approach has both advantages and disadvantages compared with flat-plate PV arrays. Economics of this design turn on the use of as little of the expensive semi-conducting PV material as possible, while collecting as much sunlight as possible. The lenses cannot use diffuse sunlight, but must be pointed directly at the sun and moved to provide optimum efficiency. Therefore, the use of concentrating collectors is limited to the west and southwest areas of the U.S.

Available PV cell conversion efficiencies are in the range of approximately 15% (SS, 2004). {In Maryland, solar energy can produce an annual average of 4.5 to 5.0 $kWh/m^2/day$ and even slightly higher in the summer. This value is highly dependent on the time of year, weather conditions, and obstacles that may block the sun (NREL, 2004).}

Currently, PV solar power is not competitive with other methods of producing electricity for the open wholesale electricity market. When calculating the cost of solar systems, the totality of the system must be examined. There is the price per watt of the solar cell, price per watt of the module (whole panel), and the price per watt of the entire system. It is important to remember that all systems are unique in their quality and size, making it difficult to make broad generalizations about price. The average price for modules (dollars per peak watt) increased 9%, from $3.42 in 2001 to $3.74 in 2002. For cells, the average price decreased 14%, from

$2.46 in 2001 to $2.12 in 2002. (EIA, 2003a) The module price, however, does not include the design costs, land, support structure, batteries, an inverter, wiring, and lights/appliances.

With all of these included, a full system can cost anywhere from $7 to $20 per watt. (Fitzgerald, 2007) Costs of PV cells in the future may be expected to decrease with improvements in technology and increased production. Optimistic estimates are that costs of grid-connected PV systems could drop to $2,275 per kWe and to $0.15 to $0.20 per kWh by 2020 (ELPC, 2001). These costs would still be substantially in excess of the costs of power from a new nuclear plant. Therefore, PV cells are non-competitive with a new nuclear plant at the {CCNPP} site.

Environmental impacts of solar power systems can vary based on the technology used and the site specific conditions.

- Land use and aesthetics are the primary environmental impacts of solar power.
- Land requirements for each of the individual solar energy technologies are large, compared to the land used by a new nuclear plant. The land required for the solar power generating technologies ranges from 56,660 to 141,640 ft^2 (60,000 to 140,000 m^2) per MWe compared to 10,000 ft^2 (1,000 m^2) per MWe for nuclear technology.
- Depending on the solar technology used, there may be thermal discharge impacts. These impacts are anticipated to be small. During operation, PV and solar thermal technologies produce no air pollution, little or no noise, and require no transportable fuels.
- PV technology creates environmental impacts related to manufacture and disposal. The process to manufacture PV cells is similar to the production of a semiconductor chip. Chemicals used in the manufacture of PV cells include cadmium and lead. Potential human health risks also arise from the manufacture and deployment of PV systems because there is a risk of exposure to heavy metals such as selenium and cadmium during use and disposal (CEC, 2004). There is some concern that landfills could leach cadmium, mercury, and lead into the environment in the long term.

  Generally, PV cells are sealed and the risk of release is considered slight; however, the long-term impact of these chemicals in the environment is unknown. Another environmental consideration with solar technologies is the lead-acid batteries that are used with some systems. The impact of these lead batteries is lessening; however, as batteries become more recyclable, batteries of improved quality are produced and better quality solar systems that enhance battery lifetimes are created (REW, 2001).

Concentrating solar power systems could provide a viable energy source for small power generating facilities, with costs as low as $0.09 to $0.12 per kWh. However, concentrating solar power systems are still in the demonstration phase of development and are not cost competitive with nuclear-based technologies. PV cell technologies are increasing in popularity as costs slowly decrease. However, the cost per kWh is substantially in excess of the cost of power from a new nuclear plant. Additionally, for all of the solar power options, because the output of solar-based generation is dependent on the availability of light, it would require a supplemental energy source to meet the {CCNPP Unit 3} baseload capacity. The large estimate of land required for a solar facility is another limitiation.

{Therefore, based on the lack of information and experience regarding large scale systems able to produce the 1,600 MWe baseload capacity, concentrating solar power systems are non-competitive with a new nuclear plant at the CCNPP site.}

9.2.2.5 Wood Waste and Other Biomass

The use of wood waste and other biomass to generate electricity is largely limited to states with significant wood resources, such as California, Maine, Georgia, Minnesota, Oregon, Washington, and Michigan. Electric power is generated in these states by the pulp, paper, and paperboard industries, which consume wood and wood waste for energy, benefiting from the use of waste materials that could otherwise represent a disposal problem. However, the largest wood waste power plants are 40 to 50 MWe in size. This would not meet the proposed 1,600 MWe baseload capacity.

Nearly all of the wood-energy-using electricity generation facilities in the U.S. use steam turbine conversion technology. The technology is relatively simple to operate and it can accept a wide variety of biomass fuels. However, at the scale appropriate for biomass, the technology is expensive and inefficient. Therefore, the technology is relegated to applications where there is a readily available supply of low, zero, or negative cost delivered feedstock.

Construction of a wood-fired plant would have an environmental impact that would be similar to that for a coal-fired plant, although facilities using wood waste for fuel would be built on smaller scales. Like coal-fired plants, wood-waste plants require large areas for fuel storage, processing, and waste (i.e., ash) disposal. Additionally, the operation of wood-fired plants creates environmental impacts, including impacts on the aquatic environment and air (NRC, 1996).

{According to a technical report (NREL, 2005), the availability of biomass resources in Maryland are as follows in thousand metric tons/year (thousand tons/year): Crop Residues 530 (584), switchgrass on CRP lands 246 (271), forest residues 239 (263), methane from landfills 185 (204), methane from manure management 5.4 (6), primary mill 125 (138), secondary mill 30 (33), urban wood 566 (624), and methane from domestic wastewater 8.2 (9). This totals approximately 1,933 thousand metric tons/year (2,131 thousand tons/year)) total biomass availability in the State of Maryland (NREL, 2005).}

Biomass fuel can be used to co-fire with a coal-fueled power plant, decreasing cost from \$0.023/ to \$0.021 per kWh. This is only cost effective if biomass fuels are obtained at prices equal to or less than coal prices. In today's direct-fired biomass power plants, generation costs are about \$0.09 per kWh (EERE, 2007), which is significantly higher than the costs associated with a nuclear power plant (\$0.031 to \$0.046 per kWh) (DOE, 2002). Because of the environmental impacts and costs of a biomass-fired plant, biomass is non-competitive with a new nuclear unit at the {CCNPP} site.

9.2.2.6 Municipal Solid Waste

The initial capital costs for municipal solid waste (MSW) plants are greater than for comparable steam turbine technology at wood-waste facilities (NRC, 1996). This is because of the need for specialized waste separation and handling equipment.

The decision to burn MSW to generate energy is usually driven by the need for an alternative to landfills, rather than by energy considerations. The use of landfills as a waste disposal option is likely to increase in the near term; however, it is unlikely that many landfills will begin converting waste to energy because of the numerous obstacles and factors that may limit the growth in MSW power generation. Chief among them are environmental regulations and public opposition to siting MSW facilities.

Estimates suggest that the overall level of construction impacts from a waste-fired plant should be approximately the same as those for a coal-fired plant. Additionally, waste-fired plants have the same or greater operational impacts (including impacts on the aquatic environment, air, and waste disposal) (NRC, 1996). Some of these impacts would be moderate, but still larger than the proposed action.

{In 2003, 12,337,018 metric tons (13,599,235 tons) of solid waste was managed or disposed of in Maryland, with 1,310,270 metric tons (1,444,325 tons) of that amount being incinerated (MDE, 2004).} As an MSW reduction method, incineration can be implemented, generating energy and reducing the amount of waste by up to 90% in volume and 75% in weight (USEPA, 2006b).

The U.S. has about 89 operational MSW-fired power generation plants, generating approximately 2,500 MWe, or about 0.3% of total national power generation. However, economic factors have limited new construction. This comes to approximately 28 MWe per MSW-fired power generation plant, and would not meet the proposed 1,600 MWe baseload capacity. Burning MSW produces nitrogen oxides and sulfur dioxide as well as trace amounts of toxic pollutants, such as mercury compounds and dioxins. MSW power plants, much like fossil fuel power plants, require land for equipment and fuel storage. The non-hazardous ash residue from the burning of MSW is typically deposited in landfills (USEPA, 2006a).

The cost of power for MSW-fired power generation plants would be partially offset by savings in waste disposal fees. However, MSW-fired power generation remains significantly more costly than nuclear power, even when disposal fee savings are included into the cost of power. A study performed for a proposed MSW-fired power facility in 2002 found that cost of power varied from \$0.096 to \$0.119¢ per kWh in the case with low MSW disposal fees, and from \$0.037 to \$0.055 per KWh in the case with high MSW disposal fees (APT, 2004). These costs, accounting for the disposal fees, are significantly higher than the costs associated with a nuclear power plant (\$0.031 to \$0.046 per kWh) (DOE, 2002). Therefore, MSW is non-competitive with a new nuclear unit at the {CCNPP} site.

9.2.2.7 Energy Crops

In addition to wood and MSW fuels, there are several other concepts for fueling electric generators, including burning energy crops, converting crops to a liquid fuel such as ethanol (ethanol is primarily used as a gasoline additive), and gasifying energy crops (including wood waste). None of these technologies has progressed to the point of being competitive on a large scale or of being reliable enough to replace a baseload plant capacity of 1,600 MWe.

Estimates suggest that the overall level of construction impacts from a crop-fired plant should be approximately the same as those for a wood-fired plant. Additionally, crop-fired plants would have similar operational impacts (including impacts on the aquatic environment and air) (NRC, 1996). In addition, these systems have large impacts on land use because of the acreage needed to grow the energy crops.

Ethanol is perhaps the best known energy crop. It is estimated that 3.0 mi^2 (7.69 km^2) of corn are needed to produce 1 million gallons of ethanol, and in {2005 Maryland produced approximately 727 mi^2 (1,882 km^2) of corn. Currently in Maryland, more corn is used for grain products than any other purpose. If ethanol were to be proposed as an energy crop, Maryland would have to supplement its corn production from nearby states. (USDA, 2006) Surrounding states also use corn for grain products and do not have the resources to supplement ethanol-based fuel facilities.}

The energy cost per KWh for energy crops is estimated to be similar to, or higher than, other biomass energy sources (EIA, 2004b). A DOE forecast concluded that the use of biomass for power generation is not projected to increase substantially in the next ten years because of the cost of biomass relative to the costs of other fuels and the higher capital costs relative to those for coal- or natural-gas-fired capacity (EIA, 2002). Therefore, energy crops are non-competitive with a new nuclear unit at the {CCNPP} site.

9.2.2.8 Petroleum Liquids (Oil)

From 2002 to 2005, petroleum costs almost doubled, increasing by 92.8%, and the period from 2004 to 2005 alone produced an average petroleum increase of 50.1% (EIA, 2006c). {As a result, from 2005 to 2006, net generation of electricity from petroleum liquids dropped by about 84% in Maryland (EIA, 2007b).} In the GEIS for License Renewal, the staff estimated that construction of a 1,000 MWe oil-fired plant would require about 0.19 mi^2 (0.49 km^2) (NRC, 1996).

Operation of oil-fired plants would have environmental impacts (including impacts on the aquatic environment and air) that would be similar to those from a coal-fired plant. Oil-fired plants also have one of the largest carbon footprints of all the electricity generation systems analyzed. Conventional oil-fired plants result in emissions of greater than 650 grams of CO_2 equivalent/kilowatt-hour (gCO_2eq/kWh). This is approximately 130 times higher than the carbon footprint of a nuclear power generation facility (approximately 5 gCO_2eq/kWh). Future developments such as carbon capture and storage and co-firing with biomass have the potential to reduce the carbon footprint of oil-fired electricity generation (POST, 2006).

Apart from fuel price, the economics of oil-fired power generation are similar to those for natural gas-fired power generation. Distillate oil can be used to run gas turbines in a combined-cycle system; however, the cost of distillate oil usually makes this type of combined-cycle system a less competitive alternative when natural gas is available. Oil-fired power generation experienced a significant decline in the early 1970s. Increases in world oil prices have forced utilities to use less expensive fuels; however, oil-fired generation is still an important source of power in certain regions of the U.S. (NRC, 1996).

On these bases, an oil-fired generation plant is non-competitive with a new nuclear unit at the {CCNPP} site.

9.2.2.9 Fuel Cells

Phosphoric acid fuel cells are the most mature fuel cell technology, but they are only in the initial stages of commercialization. During the past three decades, significant efforts have been made to develop more practical and affordable fuel cell designs for stationary power applications, but progress has been slow. Today, the most widely marketed fuel cells cost about $4,500 per kWh of installed capacity.

By contrast, a diesel generator costs $800 to $1,500 per kWh of installed capacity, and a natural gas turbine can cost even less. DOE has launched an initiative – the Solid State Energy Conversion Alliance – to bring about dramatic reductions in fuel cell cost. The DOE goal is to cut costs to as low as $400 per kWh of installed capacity by the end of this decade, which would make fuel cells competitive for virtually every type of power application. (DOE, 2006)

As market acceptance and manufacturing capacity increase, natural-gas-fueled fuel-cell plants in the 50 to 100 MWe range are projected to become available. This will not meet the proposed 1,600 MW(e) baseload capacity. At the present time, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation and that the fuel cell alternative non-competitive with a new nuclear unit at the {CCNPP} site.

9.2.2.10 Coal

Coal-fired steam electric plants provide the majority of electric generating capacity in the U.S., accounting for about 52% of the electric utility industry's total generation, including co-generation, in 2000 (EIA, 2001a). Conventional coal-fired plants generally include two or more generating units and have total capacities ranging from 100 MWe to more than 2,000 MWe.

Coal is likely to continue to be a reliable energy source well into the future, assuming environmental constraints do not cause the gradual substitution of other fuels (EIA, 1993).

The U.S. has abundant low-cost coal reserves, and the price of coal for electric generation is likely to increase at a relatively slow rate. Even with recent environmental legislation, new coal capacity is expected to be an affordable technology for reliable, near-term development and for potential use as a replacement technology for nuclear power plants (NRC, 1996).

The environmental impacts of constructing a typical coal-fired steam plant are well known because coal is the most prevalent type of central generating technology in the U.S. The impacts of constructing a 1,000 MWe coal plant at a greenfield site can be substantial, particularly if it is sited in a rural area with considerable natural habitat. An estimated 2.66 mi^2 (6.88 km^2) would be needed, resulting in the loss of the same amount of natural habitat and/or agricultural land for the plant site alone, excluding land required for mining and other fuel cycle impacts (NRC, 1996).

{Currently, the state of Maryland produces 60% of its electricity through coal-fired power plants. These plants produce more than 80 of the carbon dioxide released via electricity production. Data collected by the EIA shows that electricity generation is the single biggest source of carbon dioxide emissions in Maryland.}

An existing coal-fueled power plant usually averages about $0.023/kWh. However, co-firing with inexpensive biomass fuel can decrease the cost to $0.021/kWh. This is only cost effective if biomass fuels are obtained at prices equal to or less than coal prices (EERE, 2007).

The operating impacts of new coal plants would be substantial for several resources. Concerns over adverse human health effects from coal combustion have led to important federal legislation in recent years, such as the Clean Air Act and Amendments (CAAA). Although new technology has improved emissions quality from coal-fired facilities, health concerns remain. Air quality would be degraded by the release of additional carbon dioxide, regulated pollutants, and radionuclides.

Carbon dioxide has been identified as a leading cause of global warming. Sulfur dioxide and oxides of nitrogen have been identified with acid rain. Substantial solid waste, especially fly ash and scrubber sludge, would be produced and would require constant management. Losses to aquatic biota would occur through impingement and entrainment and discharge of cooling water to natural water bodies. However, the positive socioeconomic benefits can be considerable for surrounding communities in the form of several hundred new jobs, substantial tax revenues, and plant spending.

Based on the well-known technology, fuel availability, and generally understood environmental impacts associated with constructing and operating a coal gas-fired power generation plant, it is considered a competitive alternative and is therefore discussed further in Section 9.2.3.

9.2.2.11 Natural Gas

{Currently, there are 15 natural gas-fired plants or plants with natural gas-fired components in Maryland. Together, they are able to generate more than 6,700 MWe of energy (PPRP, 2006).}

Most of the environmental impacts of constructing natural gas-fired plants are similar to those of other large central generating stations. Land-use requirements for gas-fired plants are small, at 0.17 mi^2 (0.45 km^2) for a 1,000 MWe plant, so land-dependent ecological, aesthetic, erosion, and cultural impacts should be small. Siting at a greenfield location would require new transmission lines and increased land-related impacts, whereas co-locating the gas-fired plant with an existing nuclear plant would help reduce land-related impacts. Also, gas-fired plants, particularly combined cycle and gas turbine facilities, take much less time to construct than other plants (NRC, 1996).

{According to the EIA, net generation from natural gas in the state of Maryland decreased by almost 16% between 2005 and 2006 (EIA, 2007a).}

Based on the well-known technology, fuel availability, and generally understood environmental impacts associated with constructing and operating a natural gas-fired power generation plant, it is considered a competitive alternative and is therefore discussed further in Section 9.2.3.

9.2.2.12 Integrated Gasification Combined Cycle (IGCC)

Integrated Gasification Combined Cycle (IGCC) is an emerging, advanced technology for generating electricity with coal that combines modern coal gasification technology with both gas turbine and steam turbine power generation. The technology is substantially cleaner than conventional pulverized coal plants because major pollutants can be removed from the gas stream prior to combustion.

The IGCC alternative generates substantially less solid waste than the pulverized coal-fired alternative. The largest solid waste stream produced by IGCC installations is slag, a black, glassy, sand-like material that is potentially a marketable byproduct. Slag production is a function of ash content. The other large-volume byproduct produced by IGCC plants is sulfur, which is extracted during the gasification process and can be marketed rather than placed in a landfill. IGCC units do not produce ash or scrubber wastes.

At present, IGCC technology still has insufficient operating experience for widespread expansion into commercial-scale, utility applications. Each major component of IGCC has been broadly utilized in industrial and power generation applications. But the integration of coal gasification with a combined cycle power block to produce commercial electricity as a primary output is relatively new and has been demonstrated at only a handful of facilities around the world, including five in the U.S. Experience has been gained with the chemical processes of gasification, coal properties and their impact on IGCC design, efficiency, economics, etc.

However, system reliability is still relatively lower than conventional pulverized coal-fired power plants. There are problems with the integration between gasification and power production as well. For example, if there is a problem with gas cleaning, uncleaned gas can cause various damages to the gas turbine. (PU, 2005)

Overall, IGCC plants are estimated to be about 15% to 20% more expensive than comparably sized pulverized coal plants, due in part to the coal gassifier and other specialized equipment. Recent estimates indicate that overnight capital costs for coal-fired IGCC power plants range from $1,400 to $1,800 per kilowatt (EIA, 2005). The production cost of electricity from a coal-based IGCC power plant is estimated to be about $0.033 to $0.045 per kilowatt-hour. The projected cost associated with operating a new nuclear facility similar to {CCNPP Unit 3} is in the range of $0.031 to $0.046 cents per kWh.

To advance the development of IGCC technology, a $557 million advanced IGCC facility will be constructed in Central Florida as part of the U.S. Department of Energy's (DOE) Clean Coal Power Initiative. The 285 MW plant will gasify coal using state-of-the-art emissions controls. The DOE will contribute $235 million and commercial entities will contribute $322 million. (OUC, 2004)

Because IGCC technology currently requires further research to achieve an acceptable level of reliability, an IGCC facility is not a competitive alternative to {CCNPP Unit 3}.

9.2.3 ASSESSMENT OF REASONABLE ALTERNATIVE ENERGY SOURCES AND SYSTEMS

For the viable alterative energy source options identified in Section 9.2.2, the issues associated with these options were characterized based on the significance of impacts, with the impacts characterized as being either Small, Moderate, or Large. This characterization is consistent with the criteria that NRC established in 10 CFR 51, Appendix B, Table B-1, Footnote 3, as follows:

- SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small.
- MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource.
- LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize any important attributes of the resource (NRC, 1996).

Table 9.2-1 provides a comparison of the alternatives regarding environmental categories.

9.2.3.1 Coal-Fire Generation

The environmental impacts from coal-fired generation alternatives were evaluated in the GEIS (NRC, 1996). It was concluded that construction impacts for coal-fired generation could be substantial, in part because of the large land area required (for the plant site alone; 2.65 mi^2 (6.88 km^2) for a 1,000 MWe plant), which would be in addition to the land resourced required for mining and other fuel cycle impacts. These construction impacts would be decreased to some degree by siting a new coal-fired plant where an existing nuclear plant is located.

9.2.3.1.1 Air Quality

The air quality impacts of coal-fired generation are considerably different from those of nuclear power. A coal-fired plant would emit sulfur dioxide (SO_2, as SO_x surrogate), oxides of nitrogen (NO_x), particulate matter (PM), and carbon monoxide (CO), all of which are regulated pollutants. Air quality impacts from fugitive dust, water quality impacts from acidic runoff, and aesthetic and cultural resources impacts are all potential adverse consequences of coal mining.

Air emissions were estimated for a coal-fired generation facility based on the emission factors contained EPA document, AP-42 (USEPA, 1995). The emissions from this facility are based on a power generation capacity of 1,600 MWe. The coal-fired generation facility assumes the use of bituminous coal fired in a circulating fluidized bed combustor (FBC). The sulfur content of the coal was assumed to be 2% by weight. Emissions control included the use of lime in the combustor unit, a wet scrubber system to control acid gas emissions, selective catalytic reduction to minimize NOx emissions and a baghouse to control PM. Table 9.2-2 summarizes the air emissions produced by a 1,600 MWe coal-fired facility.

Operating impacts of a new coal plant include concerns over adverse human health effects, such as increased cancer and emphysema. Air quality would be impacted by the release of CO_2, regulated pollutants, and radionuclides. CO_2 has been identified as a leading cause of global warming, and SO_2 and oxides of nitrogen have been identified with acid rain. Substantial solid waste, especially fly ash and scrubber sludge, would be also be produced and would require constant management. Losses of aquatic biota due to cooling water withdrawals and discharges would also occur.

{The Maryland Healthy Air Act proposes to limit future emissions of nitrous oxides (NO_x), sulfur dioxide (SO_2), and mercury from coal-fired power plants (MDE, 2006). Maryland is also planning to participate in the Regional Greenhouse Gas Initiative (RGGI), which would cap carbon dioxide (CO_2) emissions from power plants unless the plants obtain emission offsets from qualified CO_2 emission offset projects.}

Coal burning power systems have the largest carbon footprint of all the electricity generation systems analyzed. Conventional coal systems result in emissions of greater than 1,000 grams of CO_2 equivalent/kilowatt-hour (gCO_2eq/kWh). This is approximately 200 times higher than the carbon footprint of a nuclear power generation facility (approximately 5 gCO_2eq/kWh). Lower emissions can be achieved using new gasification plants (less than 800 gCO_2eq/kWh), but this is still an emerging technology so and not as widespread as proven combustion technologies. Future developments such as carbon capture and storage (CCS) and co-firing with biomass have the potential to reduce the carbon footprint of coal-fired electricity generation. (POST, 2006)

Based on the emissions generated by a coal-fired facility, air impacts would be MODERATE to LARGE.

9.2.3.1.2 Waste Management

Substantial solid waste, especially fly ash and scrubber sludge, would be produced and would require constant management (NRC, 1996).

With proper placement of the facility, coupled with current waste management and monitoring practices, waste disposal would not destabilize any resources. There would also need to be an estimated 34.4 mi^2 (89 km^2) for mining the coal and disposing of the waste could be committed to supporting a coal plant during its operational life (NRC, 1996).

As a result of the above mentioned factors, waste management impacts would be MODERATE.

9.2.3.1.3 Economic Comparison

DOE has estimated the cost of generating electricity from a coal facility to be approximately $0.049 per kWh. The projected cost associated with operating a new nuclear facility similar to the CCNPP Unit 3 facility is in the range of $0.031 to $0.046 per kWh (DOE, 2002) (DOE, 2004).

9.2.3.1.4 Other Impacts

{Construction of the power block and coal storage area would disturb approximately 0.47 mi^2 (1.21 km^2) of land and associated terrestrial habitat and 0.94 mi^2 (2.42 km^2) of land would be needed for waste disposal (MDPSC, 2007a). As a result, land use impacts would be MODERATE.

Impacts to aquatic resources and water quality would be minimized but could be construed as MODERATE to LARGE as a result of the plant using a new cooling water system design. Losses to aquatic biota would occur through impingement and entrainment and discharge of cooling water to natural water bodies. Physical impacts are discussed in Section 4.2.

Three new, 200 ft (61 m) power plant structures and 600 ft (183 m) stacks potentially visible for 40 mi (64 km) in a relatively non-industrialized area would need to be constructed along with a possible 520 ft (159 m) cooling tower and associated plumes (MDPSC, 2007a). As a result, aesthetic impacts would be LARGE.

Cultural resources, ecological resources, and threatened and endangered species impacts would be SMALL as a result of an already disturbed CCNPP site.

Socioeconomic impacts would result from the additional staff needed to operate the coal-fired facility, and several hundred mining jobs and additional tax revenues would be associated with the coal mining. As a result, socioeconomic impacts would be MODERATE.

As a result of increased safety technologies, accident impacts would be SMALL.

As a result of increased air emissions and public health risks such as cancer and emphysema associated with those emissions, human health impacts would be MODERATE.}

9.2.3.1.5 Summary

In order for a coal-fired plant constructed on the {CCNPP} site to be competitive with a nuclear plant on the same site, the coal-fired plant would need to generate power in excess of 1,600 MWe. The nuclear plant requires a much smaller construction footprint, whereas the coal-fired plant would require more than 2.66 mi^2 (688 km^2), and greenhouse gas emissions would be significantly greater (NRC, 1996). Therefore, a 1,600 MWe coal-fired generation plant would not be viable with the land area currently available.

9.2.3.2 Natural Gas Generation

Most environmental impacts related to constructing natural gas-fired plants should be approximately the same for steam, gas-turbine, and combined-cycle plants. These impacts, in turn, generally will be similar to those of other large central generating stations. The environmental impacts of operating gas-fired plants are generally less than those of other fossil fuel technologies of equal capacity.

9.2.3.2.1 Air Quality

Natural gas is a relatively clean-burning fossil fuel. Also, because the heat recovery steam generator does not receive supplemental fuel, the combined-cycle operation is highly efficient (56% vs. 33% for the coal-fired alternative). Therefore, the gas-fired alternative would release similar types of emissions, but in lesser quantities than the coal-fired alternative. Control technology for gas-fired turbines focuses on the reduction of NO_x emissions.

Human health effects are SMALL based on decreased air quality impacts. Natural gas technologies produce fewer pollutants than other fossil technologies, and SO_2, a contributor to acid rain, is not emitted at all (NRC, 1996). Air emissions were estimated for a natural gas-fired generation facility based on the emission factors contained EPA document, AP-42 (USEPA, 1995). Emissions from the facility were based on a power generation capacity of 1,600 MWe.

Current gas powered electricity generation has a carbon footprint around half that of coal (approximately 500 gCO_2eq/kWh), because gas has a lower carbon content than coal. This is approximately 100 times higher than the carbon footprint of a nuclear power generation facility (approximately 5 gCO_2eq/kWh). Like coal-fired plants, gas plants could co-fire biomass to reduce carbon emissions in the future (POST, 2006).

The natural gas-fired generation facility assumes the use of a combined cycle gas turbine generator (GTG). Water injection is used to control nitrogen oxides emissions. Table 9.2-2 summarizes the air emissions produced by a 1,600 MWe natural gas-fired facility. Based on the emissions generated from a natural gas-fired facility, air impacts would be MODERATE.

9.2.3.2.2 Waste Management

Gas-fired generation would result in almost no waste generation, producing minor (if any) impacts. As a result, waste management impacts would be SMALL.

9.2.3.2.3 Economic Comparison

DOE has estimated the cost of generating electricity from a gas-fired facility to be $0.047 per kWh. The projected cost associated with operating a new nuclear facility similar to {CCNPP Unit 3} is in the range of $0.031 to $0.046 per kWh (DOE, 2002) (DOE, 2004).

9.2.3.2.4 Other Impacts

{Construction of the power block and would disturb approximately 0.1 mi^2 (0.24 km^2) of land and associated terrestrial habitat, and 435,600 ft^2 (40,000 m^2) of land would be needed for pipeline construction (MDPSC, 2007a). As a result, land use impacts would be SMALL.

Consumptive water use is about the same for steam cycle plants as for other technologies, although water consumption is likely to be less for gas turbine plants. There are potential impacts to aquatic biota through impingement and entrainment and increased water temperatures in receiving water bodies (NRC, 1996). Water quality impacts would be SMALL. Physical impacts are discussed in Section 4.2.

A new 100 ft (30 m) turbine building and 230 ft (70 m) exhaust stacks would need to be constructed. A closed-cycle cooling alternative could also introduce plumes (MDPSC, 2007a). As a result, aesthetic impacts would be MODERATE.

Cultural resources, ecological resources, and threatened and endangered species impacts would be SMALL as a result of an already disturbed CCNPP site.

Socioeconomic impacts would result from the approximately 150 people needed to operate the gas-fired facility, as estimated in the GEIS (NRC, 1996). As a result, socioeconomic impacts would be SMALL.

Due to increased safety technologies, accidents and human health impacts would be SMALL.}

9.2.3.2.5 Summary

The gas-fired alternative discussed in Section 9.2.2.11 would be located at the {CCNPP} site. The natural gas generation alternative at the {CCNPP} site would require less land area than the coal-fired plant but more land area than the nuclear plant. The plant site alone would require 0.17 mi^2 (0.45 km^2) for a 1,000 MWe generating capacity. {An additional 5.6 mi^2 (14.6 km^2) of land would be required for wells, collection stations, and pipelines to bring natural gas to the generating facility.} (NRC, 1996) This is significantly greater than the 0.35 mi^2 (0.92 km^2) required for construction of a new nuclear unit. Therefore, constructing a natural gas generation plant would not be viable on the {CCNPP} site.

9.2.3.3 Combination of Alternatives

{CCNPP Unit 3} will have a baseload capacity of approximately 1,600 MWe. Any alternative or combination of alternatives would be required to generate the same baseload capacity.

Because of the intermittent nature of the resources and the lack of cost-effective technologies, wind and solar energies are not sufficient on their own to generate the equivalent baseload capacity or output of {CCNPP Unit 3}, as discussed in Section 9.2.2.1 and Section 9.2.2.4. As noted in Section 9.2.3.1 and Section 9.2.3.2, fossil fuel fired technology generates baseload capacity, but the associated environmental impacts are greater than for a nuclear facility.

A combination of alternatives may be possible, but should be sufficiently complete, competitive, and viable to provide NRC with appropriate comparisons to the proposed nuclear plant.

9.2.3.3.1 Determination of Alternatives

{A number of combinations of alternative power generation sources could be used satisfy the baseload capacity requirements of the CCNPP facility. Some of these combinations include renewable sources, such as wind and solar. Wind and solar do not, by themselves, provide a reasonable alternative energy source to the baseload power to be produced by the CCNPP facility. However, when combined with fossil fuel-fired plant(s), wind and solar may be a reasonable alternative to nuclear energy produced by the CCNPP facility.

CCNPP Unit 3 will operate as a baseload, merchant independent power producer. The power produced will be sold on the wholesale market without specific consideration to supplying a traditional service area or satisfying a reserve margin objective. The ability to generate baseload power in a consistent, predictable manner meets the business objective of CCNPP Unit 3. Therefore, when examining combinations of alternatives to CCNPP Unit 3, the ability to consistently generate baseload power must be the determining feature when analyzing the reasonableness of the combination. This section reviews the ability of the combination alternative to have the capacity to generate baseload power equivalent to CCNPP Unit 3.

When examining a combination of alternatives that would meet business objectives similar to that of CCNPP Unit 3, any combination that includes a renewable power source (either all or part of the capacity of CCNPP Unit 3) must be combined with a fossil-fueled facility equivalent to the generating capacity of CCNPP Unit 3. This combination would allow the fossil-fueled portion of the combination alternative to produce the needed power if the renewable resource is unavailable and to be displaced when the renewable resource is available.

For example, if the renewable portion is provided by some amount of wind generation and that resource became available, then the output of the fossil fueled generation portion of the combination alternative could be lowered to offset the increased generation from the renewable portion. This facility, or facilities, would satisfy business objectives similar to those of the CCNPP facility in that it would be capable of supporting fossil-fueled baseload power.

Greenhouse gas emissions are another factor that must be considered when evaluating alternative power generation combinations. CCNPP Unit 3 will not rely on carbon-based fuels for power generation, and will produce only a small amount of carbon dioxide (CO_2) emissions. Carbon dioxide is the principal greenhouse gas from power generating facilities that combust solid or liquid fuels. If the source of the carbon is biomass or derived from biomass (ethanol), then the impact is carbon neutral. If the source of the carbon is fossil fuel, then there is a net increase in atmospheric CO_2 concentrations and global climate change unless the carbon emissions are offset or sequestered.

Coal-fired and gas-fired generation have been examined as having environmental impacts that are equivalent to or greater than the impacts of CCNPP Unit 3. Based on the comparative impacts of these two technologies, as shown in Table 9.2-1, it can be concluded that a gas-fired facility would have less of an environmental impact than a comparably sized coal-fired facility. In addition, the operating characteristics of gas-fired generation are more amenable to the kind of load changes that may result from inclusion of renewable generation such that the baseload generation output of 1,600 MWe is maintained.

"Clean Coal" power plant technology could decrease the air pollution impacts associated with burning coal for power. Demonstration projects show that clean coal programs reduce NOx, SOx, and particulate emissions. However, the environmental impacts from burning coal using these technologies, if proven, will still be greater than the impacts from natural gas (NETL, 2001). Therefore, for the purpose of examining the impacts from a combination of alternatives to CCNPP Unit 3, a facility equivalent to that will be used in the environmental analysis of combination alternatives.

The analysis accounts for the reduction in environmental impacts from a gas-fired facility when generation from the facility is displaced by the renewable resource. The impact associated with the combined-cycle natural gas-fired unit is based on the gas-fired generation impact assumptions discussed in Section 9.2.3.2. Additionally, the renewable portion of the combination alternative would be any combination of renewable technologies that could produce power equal to or less than CCNPP Unit 3 at a point when the resource was available.

This combination of renewable energy and natural gas fired generation represents a viable mix of non-nuclear alternative energy sources. Many types of alternatives can be used to supplement wind energy, notably solar power. PV cells are another source of solar power that would complement wind power by using the sun during the day to produce energy while wind turbines use windy and stormy conditions to generate power. Wind and solar facilities in combination with fossil fuel facilities (coal, petroleum) could also be used to generate baseload power.

However, wind and solar facilities in combination with fossil fuel facilities would have equivalent or greater environmental impacts relative to a new nuclear facility at the CCNPP site. Similarly, wind and solar facilities in combination with fossil fuel facilities would have costs higher than a new nuclear facility at the CCNPP site. Therefore, wind and solar facilities in combination with fossil fuel facilities are non-competitive with a new nuclear unit at the CCNPP site.}

9.2.3.3.2 Environmental Impacts

{The environmental impacts associated with a gas-fired power generation facility sized to produce power equivalent to CCNPP Unit 3 have already been analyzed. Depending on the level of potential renewable output included in the combination alternative, the level of impact of the gas-fired portion will be comparably lower. If the renewable portion of the combination alternative were not enough to displace the power produced by the fossil fueled facility, then there would be some level of impact associated with the fossil fueled facility.

Consequently, if the renewable portion of the combination alternative were enough to fully displace the output of the gas-fired facility, then, when the renewable resource is available, the output of fossil fueled facility could be eliminated, thereby eliminating its operational impacts. Determination of the types of environmental impacts of these types of 'hybrid' plants or combination of facilities can be surmised from analysis of past projects.

For instance, in 1984, Luz International, Ltd. built the Solar Electric Generating System (SEGS) plant in the California Mojave Desert. The SEGS technology consists of modular parabolic-trough solar collector systems, which use oil as a heat transfer medium. One unique aspect of the Luz technology is the use of a natural-gas-fired boiler as an oil heater to supplement the thermal energy from the solar field or to operate the plant independently during evening hours. SEGS I was installed at a total cost of $62 million (approximately $4,500/kW) and generates power at $0.24 per kWh (in 1988 real levelized dollars).

The improvements incorporated into the SEGS III-VI plants (approximately $3,400/kW) reduced generation costs to about $0.12 per kWh, and the third-generation technology, embodied in the 80 MW design at an installed cost of $2,875/kW, reduced power costs still further, to $0.08 to $0.10 per kWh. Because solar energy is not a concentrated source, the dedicated land requirement for the Luz plants is large compared to conventional plants--on the order of 5 acres/MWe (2 hectares/MWe) (NREL, 1993), compared to 0.23 acres/MWe (0.093 hectares/MWe) for a nuclear plant.

Parabolic trough plants require a significant amount of land; typically the use is preemptive because parabolic troughs require the land to be graded level. A report, developed by the California Energy Commission (CEC), notes that 5 to 10 acres (2 to 4 hectares) per MWe is necessary for concentrating solar power technologies such as trough systems (CEC, 2003).

The environmental impacts associated with a solar or wind facility equivalent to CCNPP Unit 3 have already been analyzed. It is reasonable to expect that the impacts associated with an individual unit of a smaller size would be similarly scaled. If the renewable portion of the combination alternative is unable to generate an equivalent amount of power as CCNPP Unit 3, then the combination alternative would have to rely on the gas-fired portion to meet the equivalent capacity of CCNPP Unit 3.

Consequently, if the renewable portion of the combination alternative has a potential output that is equal to that of CCNPP Unit 3, then the impacts associated with the gas-fired portion of the combination alternative would be lower but the impacts associated with the renewable portion would be greater. The greater the potential output of the renewable portion of the combination alternative, the closer the impacts would approach the level of impacts. The gas-fired facility alone has impacts that are larger than CCNPP Unit 3; some environmental impacts of renewables are also greater than or equal to CCNPP Unit 3. The combination of a gas-fired plant and wind or solar facilities would have environmental impacts that are equal to or greater than those of a nuclear facility.

- All of the environmental impacts of a new nuclear plant at the CCNPP site and all of the impacts from a gas-fired plant are small, except for air quality impacts from a gasfired facility (which are moderate). Use of wind and/or solar facilities in combination with a gas-fire facility would be small, and therefore would be equivalent to the air quality impacts from a nuclear facility.
- All of the environmental impacts of a new nuclear plant at the CCNPP site and all of the impacts from wind and solar facilities are small, except for land use and aesthetic impacts from wind and solar facilities (which range from moderate to large). Use of a gas-fired facility in combination with wind and solar facilities would reduce the land usage and aesthetic impacts from the wind and solar facilities. However, at best, those impacts would be small, and therefore would be equivalent to the land use and aesthetic impacts from a nuclear facility.

Therefore the combination of wind and solar facilities and gas-fired facilities is not environmentally preferable to CCNPP Unit 3.}

9.2.3.3.3 Economic Comparison

As noted earlier, the combination alternative must generate power equivalent to the capacity of {CCNPP Unit 3}. DOE has estimated the cost of generating electricity from a gas-fired facility ($0.047 per kWh), a biomass facility ($0.09 per KWh), a coal facility ($0.049 per kWh), a wind facility ($0.057 per kWh), and a solar facility ($0.04 to $0.05 per kWh). The cost for a gas-fired facility in combination with a renewable facility would increase, because the facility would not be operating at full availability when it is displaced by the renewable resource.

As a result, the capital costs and fixed operating costs of the gas facility would be spread across fewer kWh from the gas facility, thereby increasing its cost per kWh. The projected cost associated with operating a new nuclear facility similar to {CCNPP Unit 3} is in the range of $0.031 to $0.046 per kWh (DOE, 2002) (DOE, 2004). The projected costs associated with forms of generation other than from a nuclear unit would be higher. Therefore, the cost associated with the operation of the combination alternative would be non-competitive with {CCNPP Unit 3}.

9.2.3.3.4 Summary

As noted earlier, the combination alternative must generate power equivalent to the capacity of {CCNPP Unit 3}. DOE has estimated the cost of generating electricity from a gas-fired facility ($0.047 per kWh), a biomass facility ($0.09 per KWh), a coal facility ($0.049 per kWh), a wind facility ($0.057 per kWh), and a solar facility ($0.04 to $0.05 per kWh). The cost for a gas-fired facility in combination with a renewable facility would increase, because the facility would not be operating at full availability when it is displaced by the renewable resource.

As a result, the capital costs and fixed operating costs of the gas facility would be spread across fewer kWh from the gas facility, thereby increasing its cost per kWh. The projected cost associated with operating a new nuclear facility similar to {CCNPP Unit 3} is in the range of $0.031 to $0.046 per kWh (DOE, 2002) (DOE, 2004). The projected costs associated with forms of generation other than from a nuclear unit would be higher. Therefore, the cost associated with the operation of the combination alternative would be non-competitive with {CCNPP Unit 3}.

9.2.4 CONCLUSION

Based on environmental impacts, it has been concluded that neither a coal-fired, gas-fired,or a combination of alternatives, including wind-powered and solar-powered facilities would appreciably reduce overall environmental impacts when compared to a nuclear plant. Furthermore, each of these types of alternatives, with the possible exception of the combination alternative, would entail a significantly greater environmental impact on air quality than a nuclear plant would.

To achieve the small reduction in air quality impact in the combination alternative; however, a moderate to large impact on land use would be incurred. It is therefore concluded that neither a coal-fired, gas-fired, nor a combination of alternatives would be environmentally preferable to a nuclear plant. Furthermore, these alternatives would have higher economic costs and therefore are not economically preferable to a nuclear plant.

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Table 9.2-1 Impacts Comparison Table

Impact Category	CCNPP Unit 3	Coal-Fired Generation	Gas-Fired Generation	Combinations
Air Quality MT (tons)/yr	Small	Moderate to Large SO_2 = 415 (457) NO_2 = 734 (809) CO = 4,402 (4,852)	Moderate SO_2 = 17 (19) NO_2 = 661 (729) CO = 152 (168)	Small to Large
Waste Management MT (tons)/yr	Small	Moderate Substantial amount scrubber sludge and fly ash produced	Small	Small to Moderate
Land Use mi^2 (km^2)	Small	Moderate Waste disposal -- 0.94 (2.43) Coal storage and power block area 0.47 (1.21)	Small	Small to Large
Water Quality	Small	Moderate to Large Cooling water system losses to biota through impingement/entrainment, discharge of cooling water to natural water bodies	Moderate to Large Cooling water system losses to biota through impingement/entrainment, discharge of cooling water to natural water bodies	Small to Large
Aesthetics m (ft)	Small to Moderate Plant structures	Large Plant structures 61(200) high Stacks 183 (600) high	Moderate Turbine building 30 (100) high Stacks 70 (230) high	Small to Large
Cultural Resources	Small	Small	Small	Small
Ecological Resources	Small	Small	Small	Small
Threatened & Endangered Resources	Small	Small	Small	Small
Socioeconomics	Small	Moderate Staff needed to operate facility, several hundred mining jobs and additional tax revenues	Small	Small to Moderate
Accidents	Small	Small	Small	Small
Human Health	Small	Moderate (see air quality)	Small	Small to Moderate

Notes:

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

MEDIUM – Environmental effects are sufficient to alter noticeably, nut not destabilize, any important attribute of the resource.

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

Table 9.2-2 Air Emissions from Alternative Power Generation Facilities (Page 1 of 1)

Fuel	Bituminous Coal	Natural Gas
Combustion Facility	Circulating FBC	Combined Cycle GTG
Generation Capacity	1,600 MWe	1,600 MWe
Air Pollutant Emissions – metric tons (tons) per year		
Sulfur Dioxide (SO_2)	415 (457)	17 (19)
Nitrogen Dioxide (NO_2)	734 (809)	661 (729)
Carbon Monoxide (CO)	4,402 (4,852)	152 (168)
Particulate Matter (PM)	21 (23)	34 (37)
PM less than 10μm (PM10)	15 (17)	24 (26)
Carbon Dioxide, equiv. (CO_2e)	1,731,000 (1,908,000)	565,000 (623,000)

CO_2e – CO_2 equivalent
FBC – fluidized bed combustor
GTG – gas turbine generator

9.3 Alternative Sites

9.3 ALTERNATIVE SITES

This section identifies and evaluates a set of alternative site locations to the {Calvert Cliffs Nuclear Power Plant (CCNPP)} site. The object of this evaluation is to verify that there are no "obviously superior" sites to build and operate the {CCNPP Unit 3} facility.

Siting new units at existing nuclear sites has provided another option to the way alternatives are reviewed and selected. Existing sites offer decades of environmental and operational information about the impact of a nuclear plant on the environment. Because these sites are licensed nuclear facilities, the Nuclear Regulatory Commission (NRC) has already found them to be acceptable relative to other undeveloped sites in the region of interest. The NRC recognizes (in NUREG-1555, (NRC, 1999), Section 9.3(III)(8)) that proposed sites may not be selected as a result of a systematic review:

> Recognize that there will be special cases in which the proposed site was not selected on the basis of a systematic site-selection process. Examples include plants proposed to be constructed on the site of an existing nuclear power plant previously found acceptable on the basis of a NEPA review and/or demonstrated to be environmentally satisfactory on the basis of operating experience, and sites assigned or allocated to an applicant by a State government from a list of State-approved power-plant sites. For such cases, the reviewer should analyze the applicant's site-selection process only as it applies to candidate sites other than the proposed site, and the site-comparison process may be restricted to a site-by-site comparison of these candidates with the proposed site. As a corollary, all nuclear power plant sites within the identified region of interest having an operating nuclear power plant or a construction permit issued by the NRC should be compared with the applicant's proposed site (NRC, 1999).
>
> The information provided in this section is consistent with the special case noted in NUREG-1555, (NRC, 1999), Section 9.3(III)(8). This section identifies and discusses the evaluation of a set of alternative locations for the proposed plant and compares the suitability of these alternative sites with the suitability of the proposed site. The objective of this assessment is to verify that no site is "environmentally preferable" (and thus, no site is "obviously superior") for the siting of a new nuclear plant exists. In addition to three existing nuclear sites, this section evaluates the characteristics of a generic greenfield site and a non-nuclear brownfield site.

9.3.1 SITE SELECTION PROCESS

The site selection process focuses on identifying and evaluating locations that represent a range of reasonable alternative sites for the proposed project. The primary objective of the site-selection process is to determine if any alternative site is "obviously superior" to the preferred site for eventual construction and operation of the proposed reactor units. The preferred site is chosen from within the candidate sites, and then compared with the remaining candidate sites to demonstrate that none are "environmentally preferable." The basic constraints and limitations applicable to the site-selection process are the currently implemented rules, regulations, and laws within the federal, state, and local agency levels. These provide a comprehensive basis and an objective rationale under which this selection process is performed.

9.3.1.1 Region of Interest and Candidate Areas

{The proposed new nuclear unit will be a merchant plant, that is, a plant that is connected to the grid for the purpose of selling energy to customers in a wholesale market. UniStar Nuclear

Operating Services and Constellation Generation Group evaluated the market in the northeastern region of the U.S. and chose Maryland and New York} as candidate areas based on the location of nuclear and non-nuclear sites to which it had access. Chapter 8 discusses the need for power in this region.

Potential sites within the candidate areas were evaluated further for the proposed new nuclear facility. The potential sites included a brownfield/non-nuclear site, existing nuclear sites, and a greenfield site. The non-nuclear site chosen for further analysis is a {coal burning power plant that is currently owned and operated by Constellation Energy.

The nuclear sites include CCNPP and two located in the New York candidate area on the south shore of Lake Ontario. The sites in New York were chosen because they are owned by Constellation (with ready access to the site and other information), are in relatively close proximity to the CCNPP site, and are within the applicant's candidate areas. Other nuclear sites within the candidate area were not evaluated because none of these sites are owned or controlled by Constellation Generation Group or its subsidiaries.}

Purchase of, or access to, a competitor's nuclear site would be cost prohibitive and therefore would not be viable options for siting of a new reactor by the applicant. Furthermore, detailed information concerning competitor-owned plants is not readily available for analysis.

9.3.1.2 Candidate Sites

An initial review of potential sites was conducted. Due to the cost of acquiring existing generating facilities that are currently owned by competitors, only those locations already owned by {Constellation} were considered for further evaluation as candidate sites. To be considered as candidate sites, a location must meet the following criteria as outlined in NUREG-1555, (NRC, 1999), Section 9.3 (III)(4c):

- Consumptive use of water should not cause significant adverse effects on other users.
- There should not be any further endangerment of Federal, State, regional, local, and affected Native American tribal listed threatened, endangered, or candidate species.
- There should not be any potential significant impacts to spawning grounds or nursery areas of populations of important aquatic species on Federal, State, regional, local, and affected Native American tribal lists.
- Discharges of effluents into waterways should be in accordance with Federal, State, regional, local, and affected Native American tribal regulations and would not adversely impact efforts to meet water-quality objectives.
- There would be no preemption of or adverse impacts on land specially designated for environmental, recreational, or other special purposes.
- There would not be any potential significant impact on terrestrial and aquatic ecosystems, including wetlands, which are unique to the resource area.
- Population density and numbers conform to 10 CFR 100.
- There are no other significant issues that affect costs by more than 5% or that preclude the use of the site.

In addition to meeting all applicable regulations and guidelines, the following factors influenced the decision to review sites.

- The site would be suitable for the design parameters contemplated for the new plant design.
- The location would be compatible with the applicant's current system and transmission capabilities.

- The site's expected licensing and regulatory potential must minimize the schedule and financial risk for establishing new baseload generation.

{Given the factors listed above, three existing nuclear sites and a non-nuclear (or brownfield) site were carried forward as candidate sites for further review. The three existing nuclear sites include the CCNPP site, the Nine Mile Point site, and the R.E. Ginna site. The Crane Generating Station is the non-nuclear site. Additionally, a generic greenfield site was considered.}

A greenfield site is a location that has not previously been developed for any use. The NRC has noted that the general environmental impact of new nuclear construction on a greenfield site is generally severe (NRC, 1996), and greater than the impacts associated with construction and operation of a facility at an existing nuclear plant site. However, for the purposes of this site analysis, the possible general impacts of a greenfield site were reviewed.

It was assumed that the greenfield site would be located in an area that met the siting criteria of 10 CFR 100. As a result the characteristics of the site could be largely rural, or at least in an area with low population in {Maryland. For the purposes of this analysis, it was also assumed that the site would be near a possible supply of cooling water such as Chesapeake Bay. It was assumed that the site would consist of at least 500 to 1000 acres (200 to 400 hectares) to accommodate construction and operation needs (for comparison, the CCNPP Unit 3 project area requires about 420 acres (170 hectares).} It was also assumed that a supply of cooling water would be available. Additionally, it was assumed that the general environmental considerations associated with construction and operation at a greenfield site would be similar to those discussed in NUREG-1555 (NRC, 1999) and Chapters 4 and 5 of this Environmental Report. The greenfield site was not the environmentally preferable location for several reasons:

- Aesthetic impact will be greater than similar impacts at the other candidate sites. In its analysis. While the environmental impacts of construction and operation would be similar to those described in Chapters 4 and 5, much of the existing infrastructure at the CCNPP site would have to be developed to access the new site. Additionally, large areas of land would be cleared, graded and modified to accommodate construction and operation. Chapters 4 and 5 describe construction, operation, and associated mitigation strategies that rely on existing infrastructure and other {CCNPP} specific factors to arrive at the predicted impacts. However, these infrastructure advantages would likely not be available at most of the potential greenfield sites in {Maryland}. Any aesthetic impacts to the greenfield site would thus be MODERATE to LARGE
- Socioeconomic impacts at the postulated greenfield site will generally be equal to or greater than those at the other candidate sites. It was assumed that the general socioeconomic impacts described in Section 4.5 and Section 5.8 would apply at the greenfield site. However, it is notable that in a rural and somewhat undeveloped area of {Maryland}, housing and transportation impacts would be greater that those postulated for the other sites. Agricultural lands and historically important sites may also be adversely affected as the property and necessary cooling water facilities are built. Noise levels are likely to increase during construction and operation. Education, recreation, and other public facilities would likely be adversely affected by the increase in worker population for construction and operation. Air quality will be temporarily affected by construction dust and diesel fuel emissions. On the other hand, tax benefits and increased employment for area residents would be beneficial. With these postulations in mind, it was concluded that socioeconomic impacts at the greenfield site would be MODERATE to LARGE, with an additional MODERATE beneficial impact due to increased tax bases and new employment

- Terrestrial and aquatic resources: Impacts to the terrestrial and aquatic resources at the greenfield site would be greater than the impact at the other candidate sites. Impacts to the terrestrial and aquatic resources were identified based on the descriptions of similar impacts to resources in Chapters 4 and 5. It was further assumed that no endangered or threatened species were present at the site, and that the impacts during construction would temporarily disturb most aquatic habitats, while permanently disturbing some forest and open areas. With these general assumptions in mind, it was concluded that the impacts from construction and operation at a greenfield site would be SMALL to LARGE, depending on the mitigation strategies used at the greenfield site.
- Land use impacts: Impacts to land use are expected to be greater than impacts at the other candidate sites. Given the assumption that the land use in the area would be largely recreational or agricultural, changes in the land use at the site would likely be permanent. Thus, impacts to land use are expected to be MODERATE to LARGE and more significant than developed sites.
- Air Quality Impacts: It was assumed that air quality at the greenfield site would be equal to the impacts of construction and operation at the proposed {CCNPP} site. During construction, air quality would be short term and include construction dust and diesel emissions. However, impacts would be expected to be SMALL and comparable to other candidate sites during operations.
- Cost of obtaining additional land: UniStar Nuclear Operating Services and Constellation Generation Group do not own an area with the necessary characteristics for siting a nuclear unit within the ROI, the land, or access to it (including any easements), would have to be obtained from one or more third parties. An undeveloped site would require 500 to 1,000 acres (200 to 400 hectares), including an exclusion area. Acquisition of this land would increase the cost of construction and could potentially result in adverse economic impact. In addition, it is likely that new transmission lines and corridors would be necessary to connect the new reactor to the existing transmission system. As such, impacts would not be limited to the immediate vicinity of the new reactor.

In summary, the environmental impacts from construction and operation of a nuclear power plant at a greenfield site range from MODERATE to LARGE, and greater than the impacts at other candidate sites. Therefore, the use of a greenfield site is not carried forward as an Alternative site in this evaluation.

9.3.2 PROPOSED AND ALTERNATIVE SITE EVALUATION

The alternative sites that are compared with the CCNPP site (the preferred site) include the Crane Generating Station Brownfield site, the Nine Mile Point Nuclear Power Plant site, and the R.E. Ginna Nuclear Power Plant site.}

The alternatives sites were compared to the preferred site based on information about the existing nuclear plants and the surrounding area, as well as existing environmental studies and Final Environmental Impact Statements issued by the Atomic Energy Commission and/or the U.S. Nuclear Regulatory Commission. This comparison is preformed to determine whether or not any alternative sites are environmentally preferable to the proposed site.

Throughout this section, environmental impacts of the alternatives are assessed using the NRC three-level standard of significance – SMALL, MODERATE, or LARGE. This standard of significance was developed using Council on Environmental Quality guidelines set forth in the footnotes to Table B-1 of 10 CFR 51, Subpart A, Appendix B (NRC, 1984):

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

- MODERATE: Environmental effects are sufficient to alter noticeably but not to destabilize important attributes of the resource.
- LARGE: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

In order to analyze the effects of building a new nuclear plant at each of these locations, it was assumed the construction and operation practices described in Chapters 4 and 5 would generally be carried to each site. In this manner, it was possible to apply a consistent description of the impacts to each site. For example, in order to assess impacts to transportation infrastructure, a traffic impact study, prepared for construction and outage activities at {CCNPP}, was reviewed. The study findings were applied to each site to determine potential impacts from construction.

9.3.2.1 {Crane Generating Station Brownfield Site

A brownfield is a site that has been previously developed and can be redeveloped for a more profitable use. The brownfield site chosen for analysis is the Crane Generating Station on the Chesapeake Bay in Baltimore County, Maryland. This site is currently owned and operated by Constellation Energy as a coal burning power plant.

9.3.2.1.1 Land Use

The Crane Generating Station is located in an area of mixed land use. The site area is 157 acres (63 hectares), which is much smaller than the area required for siting a nuclear plant, and both the site and the surrounding land have been designated as critical areas under the 1984 Chesapeake Bay Critical Area (CBCA) law. The adjacent land area is predominantly wetlands and is zoned for resource conservation.

Given the identified size of the proposed plant, additional land would need to be purchased for the siting of a new nuclear plant at this site. Additionally, it would be necessary to obtain some variances from zoning ordinances on surrounding land. The land currently owned by Constellation Energy Group is zoned appropriately for power generation; however, because the use of much of any newly purchased land would likely need to be changed to accommodate the new nuclear site, the impact on land use in this area would be MODERATE.

9.3.2.1.2 Air Quality

Baltimore County is designated in attainment for most air pollutants except ozone and fine particulate matter ($PM_{2.5}$). Non-attainment for these two pollutants is a general problem that affects the northeastern U.S. and is not specific to Baltimore County. Closing the coal burning power plant at the Crane site and replacing this generating capacity with a nuclear plant would reduce the amount of particulate matter as well as the amount of greenhouse gases that are released into the atmosphere. It was concluded that the impact of reduced particulates and greenhouse gases on the general air quality in the northeastern U.S. would be SMALL, but the local impact may be MODERATE. In both cases, the overall impact of this transformation would be beneficial.

9.3.2.1.3 Water

Baltimore County is designated in attainment for most air pollutants except ozone and fine particulate matter ($PM_{2.5}$). Non-attainment for these two pollutants is a general problem that affects the northeastern U.S. and is not specific to Baltimore County. Closing the coal burning power plant at the Crane site and replacing this generating capacity with a nuclear plant would reduce the amount of particulate matter as well as the amount of greenhouse gases that are released into the atmosphere. It was concluded that the impact of reduced particulates and greenhouse gases on the general air quality in the northeastern U.S. would be SMALL, but the local impact may be MODERATE. In both cases, the overall impact of this transformation would be beneficial.

9.3.2.1.4 Terrestrial Ecology and Sensitive Species

The Crane site is located in Maryland's Piedmont Plateau Province. As is typical for this region, the area is characterized by rolling hills and steep stream valleys with hardwood and mixed pine-oak forests. Wetlands do occur on the site, but no Special State Concern wetlands, Natural Heritage Areas, agricultural preservation lands, or forest legacy lands are found in the vicinity.

Although no State or Federally listed species or sensitive habitats are located in the immediate vicinity of the site, the adjacent land area is predominantly wetlands and is zoned for resource conservation. Because the new nuclear plant would replace the existing coal plant, little or no additional area would need to be cleared and developed. The impacts to the terrestrial ecosystem at the site would therefore be SMALL and would predominantly occur during the conversion of the plant from coal to nuclear power. Construction Best Management Practices would be followed to minimize these impacts.

9.3.2.1.5 Aquatic Ecology and Sensitive Species

The Gunpowder River and Seneca Creek are tidal estuaries. The average tide at the site is less than 1.5 ft (46 cm). The submergent and emergent vegetation in these tidal wetlands is adapted to the fluctuating water levels at this location. As is common for estuaries, the fauna in this tidal habitat is very diverse and many sport and commercial fish and shellfish use the area for spawning and as a nursery. No State or Federally listed aquatic species occur in the area; however the tidal estuaries have been designated as Chesapeake Bay Critical Areas.

These areas are considered essential to the water quality and ecological health of the Chesapeake Bay. Because the site is already being used for power generation and construction Best Management Practices would be followed, the impacts of plant conversion on the aquatic ecology would be SMALL to MODERATE and temporary. These impacts would primarily be related to runoff and siltation. However, the impacts of operation would be much greater. The impact of impingement and entrainment from the cooling water intake system and the thermal impact that would result from cooling water discharge would likely be MODERATE or even LARGE despite permit restrictions and mitigation requirements.

9.3.2.1.6 Socioeconomics

Baltimore County is a relatively populated area, and is the third most populated county in Maryland with a population of approximately 787,384. Other socioeconomic facts related to Baltimore County are as follows (USCB, 2007a) :

- The county has experienced a 4.4% population increase since the 2000 census.
- Median household income is $52,308 per year.
- 8.2% of the county's population lives below the poverty level.
- The nearest large city is Baltimore, Maryland.
- The mean value of owner-occupied housing units was $127,300.
- There were 63,064 firms doing business in the county in 2002.

The Crane Generating Station site is currently being used for power generation, and it expected that the shift from coal to nuclear power would not initiate any substantial shifts in population or real estate, therefore, the effect of the proposed new facility on the population and demographics of Baltimore County, Maryland is expected to be SMALL.

9.3.2.1.7 Transportation

The site is located in a developed area of suburban Baltimore, Maryland. The site is characterized by commercial and residential development, highways, roads, and railroad tracks. The project site is located in relative close proximity to major roadways, including Highway 150, Interstate 95, and Interstate 695. Some modest traffic increase on Carroll Island Road, which is a rural, two-lane highway may be noticeable during construction.

A traffic study prepared for construction of the proposed Unit 3 at CCNPP predicts that construction traffic will peak above 1,450 vehicles per hour (vph). Heavy vehicle shipments and construction traffic will make up most of the traffic, assuming a peak construction workforce of about 3,950 workers (calculated at 1.3 drivers per vehicle). It is anticipated that Carroll Island Road may be adversely affected during construction, but the impacts would occur during morning and evening commutes to the plant. Impacts on that road would be temporary, and likely end after construction was finished. Other roadways will likely be able to sustain the increase in traffic.

There are several ways to mitigate the potential transportation impacts during construction such as developing a construction traffic management plan prior to construction to address potential impacts on local roadways. If necessary, coordinating with local planning authorities for the upgrading of local roads, intersections, and signals to handle increased traffic loads could be considered. Schedules during workforce shift changes and for the delivery of larger pieces of equipment or structures could be coordinated to limit impacts on local roads.

In addition the use of shared (e.g., carpooling) and multi-person transport (e.g., buses) during construction and/or operation of the facility could be encouraged. By implementing the appropriate measures, it is expected that there would be SMALL to MODERATE impacts on transportation during construction activities and SMALL impact during operation of the facility.

9.3.2.1.8 Historic, Cultural, and Archeological Resources

No known archeological or historical resources are located in the immediate vicinity of the site. It is assumed that no impacts to these resources would occur during construction or operation of a nuclear facility at this site. Therefore, the impacts would be classified as SMALL.

9.3.2.1.9 Environmental Justice

Table 9.3-1 (USCB, 2007b) presents demographic information for Baltimore County, Maryland, and the U.S. These data demonstrate that the population of this area is similar in composition to the State of Maryland and to the U.S. as a whole. Although the Crane site is located in a largely urban area, the likelihood of minority communities being disproportionately and adversely affected by this plant is low. Furthermore, this site has been operating as a power generating facility for a number of years. Therefore, it is anticipated that environmental justice impacts at this site would be SMALL.

9.3.2.1.10 Transmission Corridors

The site has been in use for electrical generation for many years. Although it may be necessary to build new infrastructure to accommodate the new output for the plant, it is anticipated that existing corridors would be sufficient to accommodate construction. The plant site and surrounding corridors are generally developed or are limited from much further development by zoning and land use designations. In addition, the current transmission system could be used with few or no modifications. It is anticipated that the impacts due to transmission corridors would be SMALL.}

9.3.2.2 Evaluation of Existing Nuclear Sites

Collocating the new reactor is preferable to both the brownfield alternative, and the greenfield alternative. Collocation reduces the costs when compared to either greenfield or brownfield development because the new reactor will be able to take advantage of the infrastructure that serves the existing reactor(s). In addition to reducing costs, collocation negates the need for many of the preliminary analyses because these analyses have already been performed for the existing site license.

Preliminary analyses of site suitability, appropriate seismicity and geological setting, federal, state, and local regulatory restrictions, and many other significant issues have already been conducted for the existing unit(s). This further reduces both costs and uncertainties associated with construction and operation of the new unit. Discussion of resource commitments for the preferred alternative site is provided in Section 10.1 through Section 10.3.

A cost-benefit analysis for the preferred site is detailed in Section 10.4. The costs and resource commitments needed for construction and operation of the new facility would be similar regardless of the site at which the unit is collocated. The information presented in Section 10.1 through Section 10.4 is therefore applicable to the candidate sites described below.

9.3.2.2.1 {CCNPP (Preferred Location)

The CCNPP site is the preferred site for locating the new nuclear reactor. The CCNPP site is located in Maryland on the Chesapeake Bay. A detailed description of the CCNPP} site and surroundings, as well as the impacts of construction and operation, is given in Chapter 2, Chapter 4, and Chapter 5. This information is summarized below.

9.3.2.2.1.1 Land Use

{Land use in the area surrounding the CCNPP site is predominantly rural. Hunting is common in the region surrounding the plant because large areas are rural and forested. Less than 5% of the county land uses are classified as commercial or industrial. Calvert County has open space and land preservation plans in place that direct commercial development toward town centers in order to preserve the rural character. The impacts to land use at this site would be expected to be SMALL because the new reactor would be placed near existing nuclear.}

9.3.2.2.1.2 Air Quality

{Calvert County is in attainment with all National Ambient Air Quality Standards except for ozone. Because of its proximity to Washington, DC, the county is classified as a serious non-attainment zone for ozone. Moreover, because the CCNPP site is located in a serious non-attainment zone for ozone and has the potential to emit greater than 50 tons per year for both volatile organic compounds and nitrogen oxides, the facility is classified as a major source of these substances). Based on the design of the new nuclear unit and the actions that will be taken to comply with permit requirements for emissions, it is expected that siting the unit at this location would have a SMALL impact on air quality.}

9.3.2.2.1.3 Water

{The CCNPP site is located on the western shore of the Chesapeake Bay, which is an estuary approximately 200 mi (320 km) long and up to 35 mi (56 km) wide.

Makeup water for the plant would be drawn from Chesapeake Bay as discussed in Chapters 4 and 5. The impacts to water resources are expected to be SMALL and would be less than or similar to impacts due to the existing reactors at the site. Groundwater at the site occurs at depths near 30 ft (9 m) and flows toward the Chesapeake Bay. The artesian aquifer from which water is drawn during contruction is approximately 550 ft (167 m) below ground surface and approximately 100 ft (30 m) thick. This aquifer underlies much of Maryland. Current groundwater use at the site for existing operational and domestic use does not noticeably alter offsite groundwater characteristics.

Operational fresh water needs will be provided by desalination of Chesapeake Bay water, so there will be no impacts on groundwater.

Additional groundwater withdrawals required for constructing the new reactor are not expected to destabilize offsite groundwater resources. Due to the large size of both the surface water and groundwater resources and the current rural nature of the area and resultant low usage of these resources, impacts to water resources at the site from construction and operation of the new reactor unit are anticipated to be SMALL.}

9.3.2.2.1.4 Terrestrial Ecology and Sensitive Species

{The CCNPP site is largely forested and situated among other large forested tracts. Together these tracts form one contiguous and predominantly undeveloped forested area. The State of Maryland prepared a Wildlife Management Plan for the CCNPP site in 1987, and Baltimore Gas and Electric updated the plan in 1993 to include several habitat enhancement projects. The Wildlife Habitat Council has certified and registered the CCNPP site as a valuable corporate wildlife habitat.

The federally listed threatened puritan tiger beetle *(Cicindela puritana)* and the northeastern beach tiger beetle *(Cicindela dorsaliscan)* can be found at the base of the cliffs on the CCNPP site along the beach south of the barge dock. The federally listed threatened bald eagle has active nests on the CCNPP site. The Maryland Natural Heritage Program lists species that are rare to uncommon, and lists one terrestrial species, a showy goldenrod *(Solidago speciosa)* as present at the site.

No significant impacts to the terrestrial ecosystems would be expected once construction of the new reactor is complete. Therefore, the impacts of construction may be MODERATE; however, the impacts of operation would be SMALL.}

9.3.2.2.1.5 Aquatic Ecology and Sensitive Species

{The area of the Chesapeake Bay where the CCNPP site is located is in the mesohaline zone, which is characterized by moderate salinity. Recreationally and commercially important shellfish and finfish found in large numbers in the vicinity of the plant during pre-operational surveys included the eastern oyster (Crassostrea virginica), blue crab (Callinectes sapidus), striped bass (Morone saxatilis), and weakfish (Cynoscion regalis). One aquatic state-listed endangered species, the shortnose sturgeon (Acipenser brevirostrum), is known to inhabit the Chesapeake Bay. However, impingement studies conducted at the CCNPP site area over the past 30 years have never collected a shortnose sturgeon.

Federal and state agencies are working to reintroduce the Atlantic sturgeon (Acipenser oxyrhynchus), a species that the Maryland Natural Heritage Program lists as rare, into the Chesapeake Bay. There is no record of this species at the CCNPP site.

Construction impacts would be primarily due to runoff and siltation and will be controlled by best management practices and compliance with permit requirements. Because no sensitive species are known to occur in the vicinity and the new reactor is expected to have a similar impact to the existing reactor, construction and operation of the new reactor at this site would have a SMALL impact on the aquatic ecology in the Chesapeake Bay. }

9.3.2.2.1.6 Socioeconomics

{The estimated population of Calvert County in 2005 was nearly 88,000 people. Other socioeconomic facts related to Baltimore County are as follows (USCB, 2007a):

- Calvert County experienced an 18% population increase from the 2000 census population of nearly 75,000 people.
- The median household income is slightly higher than $70,000 per year.
- Approximately 5% of the county's population lives below the poverty level.
- The nearest large city is Washington, D.C.

By the year 2010, the estimated population within 10 mi (16 km) of the CCNPP site is estimated to be approximately 63,000 people. By 2040, the population estimate for the same area is increased to approximately 124,000 people. Estimates for population growth within a 50 mi (80 km) radius of the plant are 4,757,810 for the year 2010, with a drop to 4,719,000 for the year 2040. Calvert County also has a large transient seasonal population. These people are attracted to the county's recreational opportunities such as the area parks and marinas. The seasonal population is estimated to increase the county population by nearly 25% (BGE, 1998).

Although construction and operation of a new reactor would create both temporary and permanent jobs, the percent of the population employed by the new plant, and therefore the effect of the new reactor on the area's population, is expected to be SMALL. }

9.3.2.2.1.7 Transportation

{Calvert County has one main four-lane road (Maryland State Highway 2/4) bisecting the County north to south with smaller roads running like veins from the main road to the water on each side. Very few of the smaller roads off Maryland State Highway 2/4 connect with each other; therefore, this highway services the bulk of the traffic for the length of the County. This highway runs adjacent to the CCNPP site and provides the only access to the site.

A traffic study prepared for construction at CCNPP predicts that construction traffic will peak above 1,450 vehicles per hour (Vph). Heavy vehicle shipments and construction traffic will make up most of the traffic, assuming a peak construction workforce of about 3,950 workers (calculated at 1.3 drivers per vehicle). It is anticipated that Calvert Beach Road and Nursery Road will be most heavily affected, but the impacts would occur during morning and evening commutes to the plant. Impacts on that road would be temporary, and likely end after construction was finished. Other roadways will likely be able to sustain the increase in traffic.

There are several ways to mitigate the potential transportation impacts during construction such as developing a construction traffic management plan prior to construction to address potential impacts on local roadways. If necessary, coordinating with local planning authorities for the upgrading of local roads, intersections, and signals to handle increased traffic loads could be considered.

Schedules during workforce shift changes and for the delivery of larger pieces of equipment or structures could be coordinated to limit impacts on local roads. In addition the use of shared (e.g., carpooling) and multi-person transport (e.g., buses) during construction and/or operation of the facility could be encouraged. By implementing the appropriate measures, it is expected that there would be SMALL to MODERATE impacts on transportation during construction activities and SMALL impact during operation of the facility.}

9.3.2.2.1.8 Historic, Cultural, and Archeological Resources

{There are eight historic sites within a 5 mi (8.0 km) radius of CCNPP site listed on the National Register of Historic Places. As described in Sections II.D and XII.E of the Final Environmental Statement for CCNPP Units 1 and 2, two historic dwellings located on the original Calvert Cliffs site were evaluated by the Maryland Historical Trust and found to be too derelict to be nominated for inclusion on the National Register (BGE, 1998). However, photographs and some architectural elements of the structures were salvaged and are displayed in the Visitors Center (a remodeled old tobacco barn) onsite.

During 1992 and 1993, archeological surveys were conducted along a proposed South Circuit transmission line and right-of-way. As a result, two archeological sites were examined extensively during an evaluatory testing phase. One prehistoric site was found to retain sufficient subsurface integrity to be considered eligible for inclusion on the National Register of Historic Places. The impact areas of the site were evaluated extensively, and towers were located in areas that would not affect any intact subsurface deposits (BGE, 1998).

From the air, the principal visual features of the CCNPP site region are the Chesapeake Bay, the Patuxent River, and countryside that is generally wooded. The distance across the Chesapeake Bay in the vicinity of CCNPP site is approximately 6 mi (10 km) and, from the shore, the far shore is a dark line on the horizon; the view up-Bay or down-Bay is water to the horizon. From the Chesapeake Bay, the shoreline is wooded with widely spaced small housing developments and marinas. The CCNPP site has a 1,500 ft (457 m) wide developed area approximately in the middle of 6 mi (9.7 km) of undeveloped, wooded shoreline featuring 100 ft (30 m) cliffs. These scenic resources have remained unchanged since the construction of CCNPP Units 1 and 2.

Scenic resources inland have changed since the construction of CCNPP Units 1 and 2 due to area population growth. This growth has resulted in housing, commercial, and road development supplanting agricultural and wooded areas. However, Maryland State Highway 2/4, which transects the area, is a scenic highway, affording views of gently rolling, wooded countryside with interspersed development and occasional agricultural areas. It is anticipated that historic and cultural impacts would be SMALL given the secluded location of the CCNPP site and that appropriate mitigation will occur with the State Historic Preservation Officer prior to and during construction of the facility.}

9.3.2.2.1.9 Environmental Justice

{Table 9.3-2 presents demographic information for Calvert County, Maryland, and the U.S. These data demonstrate that the population of this area is similar in composition to the State of Maryland and to the U.S. as a whole. Although the CCNPP site is located in a largely rural area, the likelihood of minority communities being disproportionately and adversely affected by this plant is low. Furthermore, this site has been operating as a nuclear power generating facility for a number of years. Therefore, it is anticipated that environmental justice impacts would be SMALL. }

9.3.2.2.1.10 Transmission Corridors

{The existing CCNPP transmission facilities consist of three separate three-phase, 500 kV transmission lines. Two circuits deliver power to the Waugh Chapel substation and a third line connects to the Chalk Point generating station.

Transmission corridors and towers would be situated (if possible) in existing right-of-way to avoid critical or sensitive habitats/species as much as possible. Specific monitoring requirements for new transmission lines and corridors, and associated switchyards will be designed to meet conditions of applicable Federal, State, and Local permits, to minimize adverse environmental impacts, and to ensure that organisms are protected against transmission line alterations. Due to the rural nature of the areas that would be transected by these transmission lines, any impacts are expected to be SMALL in nature.}

9.3.2.2.2 {Nine Mile Point

The Nine Mile Point (NMP) nuclear plant is located in Scriba, New York, in Oswego County. The site is adjacent to the J.A. Fitzpatrick nuclear plant. Currently, NMP consists of two boiling water reactor units with a combined net capacity of approximately 1,750 MW(e). The site, on the southeastern shore of Lake Ontario, encompasses approximately 900 acres (364 hectares) with about a mile of shoreline. Approximately 188 acres (70 hectares) are used for power generation and support facilities, while the remaining area is largely undeveloped (NMPNS, 2004).

9.3.2.2.2.1 Land Use

Oswego County has developed a comprehensive growth management plan that sets standards for growth and development. However, land use planning and zoning are primarily the responsibility of individual municipalities within the county, and there are no county-wide measures to limit residential growth. Land use within a 1 mi (1.6 km) radius of NMP is designated as either industrial or as a Valued Natural Resource, so residential growth within this area is limited.

In addition to the adjacent J.A. Fitzpatrick nuclear plant, there is a natural gas-fueled power plants approximately 2 mi (3.2 km) from NMP. There are also several state and national parks and natural areas in the vicinity of NMP (NMPNS, 2004). The impacts to land use at this site would be expected to be SMALL because the new reactor would be placed near existing nuclear facilities in an area that is currently zoned appropriately for power generation.

9.3.2.2.2.2 Air Quality

NMP is not located in an area designated as a maintenance or nonattainment area for any air pollutants by the U.S. Environmental Protection Agency (NMPNS, 2004). Localized emissions sources include commercial, residential, and transportation sources. Emissions are low enough at the existing NMP facilities to be exempt from any permit requirements (NRC, 2006a). Based on the design of the new reactor and the actions that will be taken to comply with permit requirements for emissions, it is expected that siting the unit at this location would have a SMALL impact on air quality.

9.3.2.2.2.3 Water

NMP is not located in an area designated as a maintenance or nonattainment area for any air pollutants by the U.S. Environmental Protection Agency (NMPNS, 2004). Localized emissions sources include commercial, residential, and transportation sources. Emissions are low enough at the existing NMP facilities to be exempt from any permit requirements (NRC, 2006a). Based on the design of the new reactor and the actions that will be taken to comply with permit requirements for emissions, it is expected that siting the unit at this location would have a SMALL impact on air quality.

9.3.2.2.2.4 Terrestrial Ecology and Sensitive Species

The predominant land cover at the NMP site is woodlands. Federal and State designated wetlands (including shrub wetlands, bogs, emergent marshes, and forested wetlands) and inactive agricultural lands also occur on the site. Flora and fauna found on or near the site are typical of disturbed areas in the coastal communities of the region.

The area is part of the Atlantic Flyway, so bird numbers and species vary seasonally as birds migrate through or return to breed. There are no designated critical terrestrial habitats for endangered species in the vicinity of the NMP site; however, three areas in the vicinity of the NMP site or the transmission line corridor are considered to be significant habitats by the New York State Department of Environmental Conservation (NYSDEC) (NYSDEC, 2007).

The impacts of construction would be MODERATE, but would be minimized by searching for sensitive species and complying with permit and mitigation requirements before beginning work. Because no land will be disturbed once construction is complete, the impacts of operation would be SMALL.

9.3.2.2.2.5 Aquatic Ecology and Sensitive Species

There are no Federally-listed threatened or endangered aquatic species in the vicinity of the NMP site. The potential for occurrence of the state-endangered deepwater sculpin (*Myoxocephalus thompsoni*) exists in the NMP site vicinity in Lake Ontario; however, it is a deepwater species (NYSDEC, 2007). No state-listed endangered aquatic species, including the deepwater sculpin, has been collected in the extensive lake sampling and impingement monitoring efforts at the NMP site or the nearby J.A. Fitzpatrick nuclear plant and Oswego Steam Station (NMPNS, 2004).

Construction impacts would be primarily due to runoff and siltation and will be controlled by best management practices and compliance with permit requirements. Because no sensitive species are known to occur in the vicinity and the new reactor is expected to have a similar impact to the existing reactor, siting a new reactor at NMP would have a SMALL impact on the aquatic ecology in the area.

9.3.2.2.2.6 Socioeconomics

The estimated population of Oswego County in 2005 was slightly more than 123,000 people. Other socioeconomic facts related to Oswego County are as follows:

- According to the U.S. Census Bureau, the number of people living in Oswego County in 2005 was up only 1,000 people from the 2000 census.
- The median household income is about $38,000.
- 13% of the population lives below the poverty level (USCB, 2007b).
- The closest large city to the NMP site is Syracuse, New York, which falls within the plant's 50 mi (80 km) radius. An estimated 914,668 people live within 50 mi (80 km) of NMP; however, only approximately 109,440 live within 20 mi (32 km) (NMPNS, 2004).
- Small seasonal fluctuations in regional population occur because of the number of colleges and recreational facilities in the area (NMPNS, 2004).

The number of jobs created by the construction and operation of a second nuclear reactor at NMP are insignificant in comparison with the number of jobs currently available in the area. Therefore, the construction and operation of a new reactor would have a SMALL impact on the area's population.

9.3.2.2.2.7 Transportation

Land access to NMP is Lake Road (County Route 1A), a two-lane paved roadway that is formed east of the intersection of County Route 1A and Lakeview Road, approximately 1 mi (1.6 km) from the NMP site. County Road 1 is another major throughway that intersects with both County Route 1A and Lakeview Road in the vicinity of the site. It is likely that the proposed work force (construction and operation) would use these routes to gain access to the site.

A traffic study prepared for construction at CCNPP predicts that construction traffic will peak above 1,450 vehicles per hour (Vph) at key intersections. Heavy vehicle shipments and construction traffic will make up most of the traffic, assuming a peak construction workforce of about 3,950 workers (calculated at 1.3 drivers per vehicle). It is anticipated that all of the roads would be heavily affected, but the impacts would occur during morning and evening commutes to the plant. Impacts on roadways would be temporary, and likely end after construction was finished.

There are several ways to mitigate the potential transportation impacts during construction such as developing a construction traffic management plan prior to construction to address potential impacts on local roadways. If necessary, coordinating with local planning authorities for the upgrading of local roads, intersections, and signals to handle increased traffic loads could be considered.

Schedules during workforce shift changes and for the delivery of larger pieces of equipment or structures could be coordinated to limit impacts on local roads. In addition the use of shared (e.g., carpooling) and multi-person transport (e.g., buses) during construction and/or operation of the facility could be encouraged. By implementing the appropriate measures, it is expected that there would be SMALL to MODERATE impacts on transportation during construction activities and SMALL impact during operation of the facility.

9.3.2.2.2.8 Historic, Cultural, and Archeological Resources

No significant historic, cultural, or archeological resources have been found at the NMP site during previous site surveys or previous construction activities. The State Historic Preservation Officer lists no known historic sites at NMP; however, portions of the site have high potential for discovery of archeological resources (NRC, 2006a). Investigation would be required before siting a new reactor at this location.

Consultation with the State Historic Preservation Officer would occur if any significant historic, cultural, or archeological resources were identified and any appropriate mitigation measures put in place prior to construction and operation. Therefore, it is expected that the impacts of constructing and operating an additional reactor at this site would be SMALL.

9.3.2.2.2.9 Environmental Justice

Table 9.3-3 (USCB, 2007b) presents demographic information for Oswego County, New York, and the U.S. These data demonstrate that the population of this area is similar in composition to the state of New York and to the U.S. as a whole. Therefore, minority and low income communities would not be disproportionately affected. Furthermore, this site has been operating as a power generating facility for a number of years. Therefore, it is anticipated that environmental justice impacts would be SMALL.

9.3.2.2.2.10 Transmission Corridors

This site is capable of supporting the required 345 kV transmission lines, but will require upgrades to the switchgear. However, the tie in is currently congested with limited transmission corridor space. Further evaluation would be required to determine the need for additional transmission corridors, but existing right-of-ways would be used for any necessary upgrades, so impacts are expected to be SMALL from the development of new transmission corridors.}

9.3.2.2.3 {R. E. Ginna

The R.E. Ginna Nuclear Power Plant (Ginna) site is located in Ontario, in the northwest corner of Wayne County, New York. Like NMP, Ginna is situated on the south shore of Lake Ontario and includes about 1.5 mi (2.4 km) of shoreline. The site encompasses 488 acres (197 hectares), approximately half of which is currently leased for agricultural uses. The power station and accompanying support facilities occupy an additional quarter of the area. The remaining quarter is left largely undisturbed. The existing facility consists of a single unit, pressurized light water reactor, with a net capacity of 490 MW(e) (NRC, 2004).

9.3.2.2.3.1 Land Use

Agriculture plays a large and important role in Wayne County. The majority of the land surrounding the Ginna site is used for growing apples, cherries, grapes, and field crops.. The Ginna site and the transmission right-of-ways are zoned industrial, and the majority of the surrounding land is zoned for large lot residential use. Nearby Monroe County is home to Rochester and is much more urbanized than Wayne County. None of the Wayne County towns along the Lake Ontario shoreline have overly restrictive growth ordinances, so it is likely that building will continue to increase in these areas in the foreseeable future. Despite this expected growth, the impacts to land use at this site would still be expected to be SMALL because the new reactor would be placed near existing nuclear facilities on land currently appropriately zoned for power generation.

9.3.2.2.3.2 Air Quality

Air quality in the Ginna region exceeds national standards for all measured parameters. There are no nearby areas designated as areas of nonattainment or maintenance. Emissions from plant activities are below state and federal thresholds; therefore operations at Ginna do not require any air quality permits. Based on the design of the new reactor and the actions that will be taken to comply with permit requirements for emissions, it is expected that siting the unit at this location would have a SMALL impact on air quality.

9.3.2.2.3.3 Water

The features of Lake Ontario are described in the previous section. In addition to Lake Ontario, surface water features at the Ginna site include Mill Creek, which enters the site from the south, and Deer Creek, which enters the site from the west. Mill Creek has a continuous yield, while Deer Creek dries up during the summer months. Ginna does not use groundwater resources for plant operations or domestic purposes.

Impacts from construction of a new reactor at the Ginna site would be SMALL to MODERATE and would depend on the location of the new reactor relative to the streams. Because of the size of the surface water body and the expected compliance with any permit requirements, anticipated operational impacts of a new reactor unit on the surface and groundwater at this location would be SMALL.

9.3.2.2.3.4 Terrestrial Ecology and Sensitive Habitat

The Ginna site is surrounded by a variety of habitat types, such as mature woodlands, meadows, and abandoned farm fields, all typical of central and western New York. There is no State or Federal regulated wetlands at Ginna, and no federally-listed threatened or endangered terrestrial breeding species are known to occur at the site. Occasionally, bald eagles will be observed in the vicinity, but the nearest known nesting site is approximately 55 mi (88 km) away (NYSDEC, 2007).

Of the 3 reptile species, 13 bird species, 4 mammal species, and 8 plant species listed by the State of New York as threatened, endangered, rare, or otherwise of concern, none are known to occur at the Ginna site (NYSDEC, 2005). Surveys for sensitive species would be conducted before constructing a new reactor at the Ginna site and permit and mitigation requirements fulfilled before beginning work. Impacts to the terrestrial ecology at the Ginna site would be

MODERATE during the construction of a new reactor. Because no land will be disturbed once construction is complete, operational impacts would be SMALL.

9.3.2.2.3.5 Aquatic Ecology and Sensitive Habitat

Although the Ginna site is situated on the shore of Lake Ontario, there are no aquatic species federally-listed as threatened or endangered in the vicinity of the site. Two state-listed aquatic species are known to occur within Wayne County - the pugnose shiner (*Notropis anogenus*) and the lake sturgeon (*Acipenser fulvescens*). The pugnose shiner is not known to exist near the Ginna site. A single lake sturgeon was netted several years ago approximately 6 mi (10 km) from the Ginna site.

Construction impacts would be primarily due to runoff and siltation and will be controlled by best management practices and compliance with permit requirements. Because no sensitive species are known to occur in the vicinity and the new reactor is expected to have a similar impact to the existing reactor. Depending on the proximity of the new reactor to the streams onsite, construction activities would have a SMALL TO MODERATE impact on the aquatic ecology at the Ginna site. Operational impacts would be anticipated to be SMALL.

9.3.2.2.3.6 Socioeconomics

The estimated population of Wayne County in 2005 was just under 94,000 people. Other socioeconomic facts related to Wayne County are as follows (USCB, 2007c):

- The population within 20 mi (32 km) of the Ginna site is approximately 564,000.
- An estimated 1.25 million people live within 50 mi (80 km).
- Rochester, in Monroe County, is the largest city within 50 mi (80 km) of the Ginna site, with a population of 219,773 people.
- There is a Tribal Designated Statistical Area for the Cayuga Nation within 50 mi (80 km) of the facility.
- The estimated 2005 population for Wayne County was nearly the same as the 2000 population.
- The median household income is approximately $44,000
- 10% of the population lives below the poverty level.
- The summertime population near the site increases very slightly because of the proximity to recreational opportunities on Lake Ontario.

It is expected that no significant increase in employment will take place due to the construction or operation of the new reactor, therefore, the impacts to the area's population from construction and operation of a new reactor would be SMALL.

9.3.2.2.3.7 Transportation

There are 13 counties wholly or partially within the 50 mi (80 km) radius of the Ginna site. The 13 county area is served by a network of interstate freeways including Interstate 90 (I-90), I-390, I-490, and I-81. In addition to interstate freeways, the region's transportation network includes the Greater Rochester International Airport in southwest Rochester and a train network. The Port of Rochester, at the mouth of the Genesee River, is also available to a limited number of cargo ships and passenger ferries.

The main east-west transportation routes providing access to the Ginna site are County Route 101 (Lake Road) and NYS Route 104. Lake Road, a two-lane road, provides direct access to Ginna along much of the southern border of the site. NYS Route 104, the predominant east-west corridor near the plant, runs parallel to Lake Road, approximately 3.6 mi (5.8 km) south of Ginna. Ontario Center Road in the town of Ontario runs north-south, connecting NYS Route 104 to Lake Road immediately south of Ginna. Several other secondary roads run north-south providing access to Lake Road from NYS Route 104.

Employees commuting from Monroe County and other points west of the Ginna site are likely to use NYS Route 104, Route 441, or Route 286 to access Lake Road. Employees commuting from the south and east are likely to use north-south corridors NYS Route 21 and Route 350 to reach NYS Route 104, and then use Ontario Center Road to Lake Road.

A traffic study prepared for construction at the CCNPP site predicts that construction traffic will peak above 1,450 vehicles per hour (Vph) at key intersections. Heavy vehicle shipments and construction traffic will make up most of the traffic, assuming a peak construction workforce of about 3,950 workers (calculated at 1.3 drivers per vehicle). It is anticipated that roadways will be equally affected by the increased traffic, but the impacts would occur during morning and evening commutes to the plant. Impacts on these roadways would be temporary, and likely end after construction was finished.

There are several ways to mitigate the potential transportation impacts during construction such as developing a construction traffic management plan prior to construction to address potential impacts on local roadways. If necessary, coordinating with local planning authorities for the upgrading of local roads, intersections, and signals to handle increased traffic loads could be considered.

Schedules during workforce shift changes and for the delivery of larger pieces of equipment or structures could be coordinated to limit impacts on local roads. In addition the use of shared (e.g., carpooling) and multi-person transport (e.g., buses) during construction and/or operation of the facility could be encouraged.

By implementing the appropriate measures, it is expected that there would be SMALL to MODERATE impacts on transportation during construction activities and SMALL impact during operation of the facility.

9.3.2.2.3.8 Historic, Cultural, and Archeological Resources

The area surrounding the Ginna site was historically occupied by Native American tribes. No significant Native American artifacts or evidence of villages has been found or identified on or in close proximity to Ginna. In addition, no archeological sites are known to exist in the vicinity of the plant. However, because archeological sites have been found along the creeks and lakeshore, the New York State Preservation Office considers the area surrounding Ginna an archeologically sensitive area (NRC, 2004).

It is reasonable to expect that, because no historic sites are known to occur at Ginna, impacts to historical, cultural, and archeological resources construction and operation of an additional reactor unit at this site would be SMALL, but investigations of the site would be needed before siting a new reactor at this location.

9.3.2.2.3.9 Environmental Justice

Table 9.3-4 (USCB, 2007c) presents demographic information for Wayne County, New York, and the U.S. These data demonstrate that the population of this area is similar in composition to the state of New York and to the U.S. as a whole. Although the area is somewhat urbanized, there is no indication that minority or low income populations would be more adversely affected by a second plant at the Ginna site than the general population. Furthermore, this site has been operating as a power generating facility for a number of years. Therefore, it is anticipated that environmental justice impacts would be SMALL.

9.3.2.2.3.10 Transmission Corridors

Currently, no right of way capable of supporting the necessary 345 kV transmission lines exists. No current right-of-way exists for transmission expansion. The nearest 345 kV substation is near the NYS Thruway, approximately 20 mi (32 km) from the plant. The tie in with the existing 345 kV transmission corridor would require 20 mi (32 km) of new transmission lines and right-of-way. Because new right-of-ways would need to be constructed to accommodate the new transmission lines, it is anticipated that impacts from the development of new transmission corridors would be MODERATE. }

9.3.3 SUMMARY AND CONCLUSIONS

The advantages of the {CCNPP} site over the alternative sites are summarized as follows:

- {The postulated consumptive use of water by a new unit at the CCNPP site would be no greater than water use at the alternative sites.
- The CCNPP site contains habitat suitable for three Federally-listed threatened species: the bald eagle and two tiger beetle species. Four bald eagle nests are present on the site, although all may not be active. One nest is in the construction footprint and would be impacted by the development. The suitable beach habitat for the tiger beetles is south of the barge dock and would not be impacted by the development. Therefore, impacts of development of a new unit at the proposed site on endangered species are not greater than impacts postulated for the alternative sites after the proposed mitigation measures are considered.
- The CCNPP site does not contain spawning grounds for any threatened or endangered species. Thus, the impacts on spawning areas are not greater than impacts at the alternative sites.
- The CCNPP site impact review does not postulate effluent discharge beyond the limits of existing National Pollutant Discharge Elimination System permits or regulations. Based on the information available for the alternative sites, the impacts from effluent discharge at the proposed site would be no greater than impacts at the alternative sites.
- The siting of the new unit at the CCNPP site would require the pre-emption of lands currently zoned farm and forest district, and light industrial for construction and operation. Therefore, land impacts at the proposed site would be greater than the impacts at the alternative sites.
- The potential impacts of a new nuclear facility on terrestrial and aquatic environments at the CCNPP site would be no greater than the impacts at the alternative sites.
- The CCNPP site is in a generally rural setting and has a population density that meets the population criteria of 10 CFR Part 100.
- The CCNPP site does not require decommissioning or dismantlement of an existing facility, as would be required for the Crane Generating Station.

As summarized in Table 9.3-5 no alternative sites are environmentally preferable, and therefore cannot be considered obviously superior, to the CCNPP site. Development of a greenfield or brownfield site would offer no advantages and would increase both the cost of the new facility and the severity of impacts. Collocation of the new reactor unit at an existing site would allow existing infrastructure and transmission lines to be used.

Alternative nuclear sites offer no environmental advantages over the preferred site. Although the CCNPP site offers no distinct environmental advantages over the NMP site, the CCNPP site is more centrally located to serve the southwest portion of the PJM region. The existing facility currently operates under an NRC license, and the proposed location has already been found acceptable under the requirements for that license. Further, operational experience at the CCNPP site has shown that the environmental impacts are SMALL, and operation of a new unit at the site should have essentially the same environmental impacts.}

9.3.4 REFERENCES

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Table 9.3-1 Profile of Demographic Characteristics – Baltimore County, Maryland (Page 1 of 1)

Geographic Area	RACE						
	One Race						Two or More Races
	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Other Race	
Baltimore County	534,409 69.6%	183,984 24.0%	918 0.1%	30,307 3.9%	415 0.1%	7,121 0.9%	10,443 1.4%
Maryland	3,356,489 61.5%	1,564,914 28.7%	16,711 0.3%	258,529 4.7%	2,554 0.0%	168,909 3.1%	93,212 1.7%
U.S.	215,333,394 74.4%	34,962,569 12.1%	2,357,544 0.8%	12,471,815 4.3%	397,030 0.1%	17,298,601 6.0%	5,557,184 1.9%

Table 9.3-2 Profile of Demographic Characteristics – Calvert County, Maryland (Page 1 of 1)

Geographic Area	RACE						
	One Race						Two or More Races
	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Other Race	
Calvert County	72,898 83.6%	11,328 13.0%	129 0.1%	1,092 1.3%	0 0.0%	1,077 1.2%	691 0.8%
Maryland	3,356,489 61.5%	1,564,914 28.7%	16,711 0.3%	258,529 4.7%	2,554 0.0%	168,909 3.1%	93,212 1.7%
U.S.	215,333,394 74.4%	34,962,569 12.1%	2,357,544 0.8%	12,471,815 4.3%	397,030 0.1%	17,298,601 6.0%	5,557,184 1.9%

Table 9.3-3 Profile of Demographic Characteristics – Oswego County, New York
(Page 1 of 1)

Geographic Area	RACE						
	One Race						Two or More Races
	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Other Race	
Oswego County	115,102 97.1%	714 0.6%	46 0.0%	775 0.7%	0 0.0%	322 0.3%	1,601 1.4%
New York	12,508,643 67.1%	2,858,062 15.3%	67,460 0.4%	1,246,567 6.7%	6,123 0.0%	1,684,562 9.0%	283,858 1.5%
U.S.	215,333,394 74.4%	34,962,569 12.1%	2,357,544 0.8%	12,471,815 4.3%	397,030 0.1%	17,298,601 6.0%	5,557,184 1.9%

Table 9.3-4 Profile of Demographic Characteristics – Wayne County, New York (Page 1 of 1)

Geographic Area	RACE						
	One Race						Two or More Races
	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Other Race	
Wayne County	85,795 93.3%	2,995 3.3%	212 0.2%	285 0.3%	0 0.0%	1,378 1.5%	1,289 1.4%
New York	12,508,643 67.1%	2,858,062 15.3%	67,460 0.4%	1,246,567 6.7%	6,123 0.0%	1,684,562 9.0%	283,858 1.5%
U.S.	215,333,394 74.4%	34,962,569 12.1%	2,357,544 0.8%	12,471,815 4.3%	397,030 0.1%	17,298,601 6.0%	5,557,184 1.9%

Table 9.3-5 Summary Comparison of Candidate and Potential Sites (Page 1 of 1)

Location	CCNPP	NMP	Ginna	Greenfield	Crane Brownfield
Land use	Small	Small	Small	Moderate to Large	Moderate
Air Quality	Small	Small	Small	Small	Beneficial Small to Moderate
Water	Small	Small	Small to Moderate	Small to Large	Moderate to Large
Terrestrial Ecology	Moderate	Moderate	Moderate	Moderate to Large	Small
Aquatic Ecology	Small	Small	Small to Moderate	Small to Large	Small to Large
Socioeconomics	Small	Small	Small	Moderate to Large	Small to Moderate
Historic, Cultural, and Archeological Resources	Small	Small	Small	Not Evaluated	Small
Environmental Justice	Small	Small	Small	Not Evaluated	Small
Transmission Corridors	Small	Small	Moderate	Not Evaluated	Small
Transportation	Small to Moderate	Small to Moderate	Small to Moderate	Not Evaluated	Small to Moderate
Is this Site a Candidate Site (Yes or No)	Yes	Yes	Yes	Yes	Yes
Is this Candidate Site a good Alternative Site to the Proposed Site	Yes	Yes	Yes	No	Yes
Is the Site Obviously Superior?	Preferred alternative	No	No	No	No
Is the Site Environmentally Preferable?	Preferred alternative	No	No	No	No

9.4 Alternative Plant and Transmission Systems

9.4 ALTERNATIVE PLANT AND TRANSMISSION SYSTEMS

The information presented in this section describes the evaluation of the alternative plant and transmission systems for heat dissipation, circulating water, and power transmission associated with the 1,562 MWe {CCNPP Unit 3} facility. The information provided in this section is consistent with the items identified NUREG-1555 (NRC, 1999).

Throughout this chapter, environmental impacts of the alternatives will be assessed based on the significance of impacts, with the impacts characterized as being Small, Moderate, or Large. This standard of significance was developed using the guidelines set forth in the footnotes to Table B-1 of 10 CFR 51, Appendix B to Subpart A (CFR, 2007a):

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

The impact categories evaluated in this chapter are the same as those used in the "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437, (NRC, 1996).

Section 9.4.1 discusses alternative heat dissipation systems. Section 9.4.2 discusses alternative circulating water systems. Section 9.4.3 discusses the transmission systems.

9.4.1 HEAT DISSIPATION SYSTEMS

This section discusses alternatives to the proposed heat dissipation system that was described in Section 3.4, and is presented using the format provided in NUREG-1555 (NRC, 1999), i.e., Environmental Standard Review Plan (ESRP) 9.4.1. The information provided in this section is based on two studies: a Cooling Tower and Circulating Water System study, and an Ultimate Heat Sink (UHS) and Intake/Discharge Structures Location study.

These alternatives are generally included in the broad categories of "once-through" and "closed-loop" systems. The once-through method involves the use of a large quantity of cooling water, withdrawn from a water source and returned to that source (receiving water body) following its circulation through the normal heat sink (i.e., main condenser). Closed-loop cooling systems use substantially less water because the water performing the cooling is continually recirculated through the normal heat sink (i.e., the main condenser), and only makeup water for evaporative losses and blowdown is required.

In closed-loop systems, two pumping stations are usually required—a makeup water system and a cooling water circulation system. Closed-loop systems include cooling towers, and a cooling pond or spray pond. As a result of the evaporation process, the concentration of chemicals in the water will increase. To maintain acceptable water chemistry, water must be discharged at a small rate (blowdown) and compensated by a makeup water source.

Heat dissipation systems are also categorized as wet or dry, and the use of either system depends on the site characteristics. Both wet and dry cooling systems use water as the heat exchange medium. Wet heat dissipation systems cool water by circulating it through a cooling tower. Heat from the water is dissipated by direct contact with air circulating through the tower. The heat transfer takes place primarily by evaporation of some of the water into the air stream (latent heat transfer).

Generally, a relatively minor amount of sensible heat transfer (heating of the air and cooling of the water) also occurs. During very cold weather, the amount of sensible heat transfer can be fairly substantial. On the other hand, during a warm, dry summer day, the amount of sensible heat transfer may be nil or even negative (when negative, the air discharged from the tower is cooler than the ambient dry bulb). This does not adversely affect the cold water performance of mechanical draft towers, but does affect evaporation rate. The wet cooling tower is used widely in the industry and is considered a mature technology.

Because wet cooling towers provide direct contact between the cooling water and the air passing through the tower some of the liquid water may be entrained in the air stream and be carried out of the tower as "drift" droplets. The magnitude of drift loss is influenced by the number and size of the droplets produced within the cooling tower, which in turn are influenced by the fill design, the air and water patterns, and other interrelated factors. Tower maintenance and operation levels can influence the formation of drift droplets. For example, excessive water flow, excessive air flow, and water bypassing the tower drift eliminators can promote and/or increase drift emission.

To reduce the drift from cooling towers, drift eliminators are usually incorporated into the tower design to remove as many droplets as practical from the air stream before exiting the tower. The drift eliminators rely on inertial separation of the droplets, caused by direction changes, while passing through the eliminators. Types of drift eliminator configurations include herringbone, wave form, and cellular (or honeycomb) designs. The cellular units are generally the most efficient. Drift eliminators may include various materials, such as ceramics, fiber-reinforced cement, fiberglass, metal, plastic, and wood installed or formed into closely spaced slats, sheets, honeycomb assemblies, or tiles. The materials may include other features, such as corrugations and water removal channels, to enhance the drift removal further (USEPA, 1995).

Dry cooling systems transfer heat to the atmosphere without the evaporative loss of water. There are two types of dry cooling systems: direct dry cooling and indirect dry cooling. Direct dry cooling systems use air to directly condense steam, while indirect dry cooling systems use a closed-loop water cooling system to condense steam and air to cool the heated water.

The most common type of direct dry cooling system is a recirculated cooling system with mechanical draft towers. For dry cooling towers, the turbine exhaust steam exits directly to an air-cooled, finned-tube condenser. Because dry cooling systems do not evaporate water for heat transfer, dry cooling towers are quite large in comparison to similarly sized wet cooling towers. Also, because dry cooling towers rely on sensible heat transfer, a large quantity of air must be forced across the finned tubes by fans to improve heat rejection. This results in a larger number of fans being required for a mechanical draft dry cooling tower than would be needed for a mechanical draft wet cooling tower.

The key feature of dry cooling systems is that no evaporative cooling or release of heat to the surface water occurs. As a result, water consumption rates are very low compared to wet cooling. Because the unit does not rely in principle on evaporative cooling like the wet cooling tower, large volumes of air must be passed through the system compared to the volume of air used in wet cooling towers. As a result, dry cooling towers need larger heat transfer surfaces and therefore tend to be larger than comparable wet cooling towers.

Dry cooling towers require high capital and operating and maintenance costs that are sufficient to pose a barrier to entry to the marketplace for some facilities (USEPA, 2001b). Dry cooling technology has a detrimental effect on electricity production by reducing the energy efficiency of steam turbines. Dry cooling requires the facility to use more energy than would be required with wet cooling towers to produce the same electricity. This energy penalty is most significant in warmer southern regions during summer months, when the demand for electricity is at its peak. The energy penalty would result in an increase in environmental impacts because replacement generating capacity would be needed to offset the loss in efficiency from dry cooling.

9.4.1.1 Evaluation of Alternative Heat Dissipation Systems

Heat dissipation system alternatives were identified and evaluated. The alternatives considered were those generally included in the broad categories of "once- through" and "closed-loop" systems. The evaluation includes the following types of heat dissipation systems:

- Other heat dissipation systems
    - Cooling Ponds
    - Spray Ponds
- Once-through cooling
- Natural draft cooling tower
- Mechanical draft cooling tower
- Hybrid (plume abated) cooling towers
- Dry cooling systems (closed-loop cooling system)

An initial evaluation of the once-through cooling alternative and the closed-loop alternative designs was performed to eliminate systems that are unsuitable for use at {CCNPP Unit 3}. The evaluation criteria included aesthetics, public perception, space requirements, environmental effects, noise impacts, fog and drift, water requirements, capital and operating costs, and legislative restrictions that might preclude the use of any of the alternatives.

The screening process identified the {hybrid, cooling tower, without plume abatement, as the preferred closed-loop heat dissipation system for CCNPP Unit 3. The analysis of this alternative is discussed in Section 9.4.1.2. The discussion of non-preferred alternatives that were considered is provided below. Selection of the preferred heat dissipation alternative was supported by detailed net present value (NPV) analysis.

Table 9.4-1 provides a summary of the screening of Circulating Water Supply (CWS) System heat dissipation system alternatives, and Table 9.4-2 provides a summary of the environmental impacts of the heat dissipation system alternatives. Cooling ponds and spray ponds were not included in the alternatives study since neither alternative is reasonable given the plant location and existing infrastructure at the CCNPP site. However, a discussion of cooling ponds and spray ponds as a non-preferred alternative is provided below.}

<u>Cooling Ponds and Spray Ponds</u>

Cooling ponds are usually man-made water bodies that are used by power plants and large industrial facilities for heat dissipation. In a conventional static-type cooling pond, warmed cooling water exiting the main condenser and other plant heat loads would be routed to the cooling pond where some of the water would evaporate, and the remaining water would be cooled and recirculated to the plant. The primary heat transfer mechanism in a cooling pond is evaporation. If there is no vertical mixing in the pond, layers (or thermoclines) of warm and cold water can form causing horizontal flows which in turn, can restrict the movement of warmer water to the surface for evaporation and cooling. This can result in only portions of the pond cooling capacity being used.

Although the conventional static-type cooling pond is probably the oldest form of water cooling it is not preferred for several reasons. The modern spray pond offers the following advantages over a conventional cooling pond: (1) a spray pond requires less than 10% of the land area required for a conventional pond, and (2) they provide over 30 times the cooling capacity of a conventional pond on a BTU/ft^2 basis.

A spray pond is typically a bentonite-lined structure in the ground, and is typically long and narrow to improve efficiency. The spray pond structure contains a volume of water and consists of an intake structure that houses pumps to transfer the water from the pond through their respective loops and back to the pond through a network of sprays located in the pond. The spray pond size depends on the number of nozzles required. It is important that the long, narrow spray pond have its long side perpendicular to the prevailing summer wind direction in order to benefit from a better spray droplet surface area and air contact interface. Generally, a spray pond long side dimension would be in the range of two to four times that of the narrow side dimension.

The area of the pond is determined by the quantity of water which it can treat per hour per unit area of the pond. Accepted industry practice for sizing spray ponds is based on values that are typically between 120 $lb/ft^2/hr$ (585 $kg/m^2/hr$) and 150 $lb/ft^2/hr$ (732 $kg/m^2/hr$). In actual practice, a spray pond will only cool the water to a point approximately midway between the hot water and wet bulb temperatures. Because of the various factors in spray pond applications, it is virtually impossible to accurately calculate the expected cooled water temperature. The 50% design efficiency factor (cooling to halfway point between hot water and wet bulb temperature) is considered to be a reasonable value for a well designed and located, long and narrow, spray pond.

Due to loss of water from the pond, a fresh water make up system operating on pond level is required. The water levels in cooling and spray ponds are usually maintained by rainfall or augmented by a makeup water system using fresh, salt, or reclaimed water.

{Given the relatively large amount of land that would be required for a cooling pond or spray pond option, and expected thermal performance, neither the spray pond, nor the cooling pond alternative is reasonable for CCNPP Unit 3. Cooling ponds and spray ponds were not considered in the alternatives study. }

Once-through Cooling System Using {Chesapeake Bay Water}

In a once-through cooling system, water is withdrawn from a water body, passes through the heat exchanger, and is discharged back to the same water body. The discharged water temperature is higher than the intake by the temperature gained when passing through the heat exchanger. A once-through cooling water system for a single unit plant would require either an onshore intake design or an offshore design.

If an onshore intake is proposed, the onshore structure would need to accommodate upwards of {2.5 million gpm (9.5 million Lpm) considering a 10°F (5.6°C) temperature rise across the condenser.}

{For CCNPP Unit 3, it is estimated that an onshore intake structure/pump house would need to be approximately 1,200 ft (365.8 m) long, by 170 ft (51.8 m) wide, and 66 ft (20.1 m) deep below the site grade. The pump house would need to have 6, 417,000 gpm (1.6 million Lpm) volute type pumps. The intake screens would include 24 to 60 ft (7.3 to 18.3 m) diameter drum screens (two per pump) with the width of the screen panel would need to be about 15 ft (4.6 m). Additionally, 72 bar screens (trash racks) that are 12 ft (3.7 m) wide would be required, with four rakes to clean the screens.

An offshore structure would require twelve, 12 ft (3.7m) diameter concrete pipes routed at least 3,000 ft (914.4 m) into the Chesapeake Bay, at a depth 35 ft (10.7 m). At the offshore end of each pipe there would need to be one bank of wedge wire screens arranged with interconnecting manifolds to supply about 420,000 gpm (1.6 million Lpm). It is expected that twelve, 8 ft (2.4 m) diameter T-type wedge wire screens would be needed for each bank because the wire mesh slot would be very small (1.75 mm or smaller). Wire mesh material would need to be copper-nickel for bio-fouling protection.

At the outlet for each screen, biocide agent supply piping would be necessary to protect intake pipes from bio-fouling. It is expected that a total of 144, 8 ft (2.4 m) diameter T-screens could be required. The onshore pump house structure for this would be approximately 800 ft (243.8 m) long, 120 ft (36.6 m) wide, and 66 ft (20.1 m) deep. The total offshore intake area covered by the wedge wire screens would be approximately 10 acres (4.0 hectares). The long trench to place the intake pipes would cover approximately 20 acres (8.1 hectares) of the bottom of the Chesapeake Bay.

The discharge structure would consist of a common onshore seal well structure. This structure would need to be approximately 250 ft (76.2 m) long, 80 ft (24.4 m) wide, and 50 ft (15.2 m) deep. The discharge piping would consist of 12 ft (3.7 m) diameter concrete pipes. It is expected that the discharge pipe length would be about 2,000 ft (610 m). The pipes could be placed in a large trench in a cut-and-fill operation, backfilled, and covered with riprap. At the end of each discharge pipe would be a multiple port diffuser. The diffuser main body would also be 12 ft (3.7 m) diameter pipe.

On top of the diffuser pipe would be six, 54 in (1.4 m) risers that discharge heated effluent to the ambient water. The large discharge flow would necessitate large separation distance between offshore intakes and offshore distances to prevent thermal recirculation from reaching an unacceptable level. The estimated separation distance would be 4,000 ft (1,219 m). The offshore diffuser area would be approximately 10 acres (4.0 hectares) at the bottom of Chesapeake Bay, approximately 2,000 ft (609.6 m) offshore. The long trench to place the discharge pipes would cover approximately 12 acres (4.9 hectares) of the bottom of the Chesapeake Bay.}

Once-through cooling systems are required to comply with Federal and State regulations for thermal discharges into the {Chesapeake Bay}. Additionally, U.S. Environmental Protection Agency (EPA) regulations governing cooling water intake structures under Section 316(b) of the (USC, 2007) make it difficult for steam electric generating plants to use once-through cooling systems (FR, 2004).

{Based on the large size of the intake and discharge structures and offshore pipes and potential permitting issues under U.S. EPA Section 316(b) Phase I or Phase II Rules, the once-through cooling system would be cost-prohibitive, and is therefore is not considered feasible for the use at CCNPP Unit 3. Additional discussion of Federal and State regulations under Section 316(b) governing cooling water intake structures for existing power plants is found in Section 9.4.2.1.}

Natural Draft Cooling Tower

Wet cooling towers predominantly rely on the latent heat of water evaporation to exchange heat between the water and the air passing through the tower. In a natural draft cooling tower, warm water is brought into direct contact with cooler air. When the air enters the cooling tower, its moisture content is generally less than saturation. When the air exits, it emerges at a higher temperature and with moisture content at or near saturation.

Even at saturation, cooling can take place because a temperature increase results in an increase in heat capacity, which allows more sensible heat to be absorbed. A natural draft cooling tower receives its air supply from natural wind currents that result in a convective flow up the tower. This air convection cools the water on contact.

Because of the significant size of natural draft cooling towers (typically 500 ft (152.4 m) high, 400 ft (121.9 m) in diameter at the base), their use is generally reserved for use at flow rates above 200,000 gpm (757,000 Lpm) (Young, 2000). They are typically sized to be loaded at about 2 to 4 gpm/ft^2 (1.4 to 2.7 Lps/m^2). {The size of and cost of the natural draft towers preclude them from further consideration for the CCNPP site.}

Mechanical Draft Cooling Tower

A wet mechanical draft cooling tower system, operated completely as a wet-type cooling tower, would consist of multi-cell cooling tower banks, and associated intake/discharge, pumping, and piping systems. This closed-loop system would receive makeup water from the {Chesapeake Bay and transfer heat to the environment via evaporation and conduction. These towers would have a relatively low profile of approximately 80 ft (24.4 m). Mechanical draft towers use fans to produce air movement.

A mechanical draft cooling tower would typically consist of a continuous row of rectangular cells in a side-by-side arrangement sharing a common cold water basin. Water to be cooled is pumped to a hot water distribution system above the fill, and then falls over the fill to the cold water basin. Air is drawn through the falling water by fans, which results in the transfer of heat from the water to the air, and the evaporation of some of the water. The fill serves to increase the air-water contact surface and contact time, thereby promoting heat transfer.

A mechanical draft cooling tower employs large fans to either force or induce a draft that increases the contact time between the water and the air maximizing the heat transfer. A forced draft tower has the fan mounted at the base, forcing air in at the bottom and discharging air at low velocity through the top. An induced draft tower uses fans to create a draft that pulls air through the cooling tower fill.

Hybrid Plume Abatement Cooling Tower

A cooling tower plume occurs when the heated and saturated air leaving a wet cooling tower mixes with the relatively cooler ambient air under atmospheric conditions, and a supersaturated condition occurs during the process of mixing and dispersion. The excess vapor condenses (the amount in excess of saturation vapor) and becomes a visible plume.

A cooling tower plume may be visually objectionable or may result in problems of fogging or icing. A plume abatement hybrid cooling tower (i.e., combination wet-dry tower) combines dry cooling and wet cooling to reduce the cooling tower plume. The dry cooling section adds heat to the discharge air without adding moisture (sensible heat transfer). This results in a subsaturated air stream leaving the tower (less than 100% relative humidity) and therefore reduced plume potential.

Although the hybrid plume abatement cooling tower results in reduced water consumption and no visible plume, construction costs, operating and maintenance costs, and land use requirements are significantly higher. {Therefore, the hybrid plume abatement cooling tower was not the preferred alternative for CCNPP Unit 3.}

Dry Cooling System

{A dry-type helper tower system could be utilized to assist a once-through cooling system by reducing circulating water discharge temperature before it re-enters the Chesapeake Bay. Use of a helper tower would be most beneficial when ambient air temperatures are low enough for a dry tower system to be functional.

A dry tower helper system would have the benefit of reduced environmental impact due to the fact that it would not experience cooling tower drift or evaporative losses. The water savings, however, are outweighed by the additional cost to construct and operate the air cooled condenser. Additionally, during periods of high ambient air temperature, the only way to reduce water temperature to within 7°F (13.9°C) of ambient dry bulb temperature would be to use evaporative cooling. The thermal performance limitations under high ambient air temperature conditions would result in either a very large dry tower array, or plant efficiency would have to be significantly reduced during high ambient air conditions due to high condenser water temperature and the consequential increase in steam turbine backpressure.

Use of a dry system would require a significant increase in dry tower land use. It is estimated that a dry (fin-fan) tower array would consist of 550 bays with a moderate profile (150 ft (45.7 m) high). Total land use for a dry cooling tower system is approximately 39.1 acres (15.8 hectares). An air-cooled condenser, where steam turbine exhaust is transported directly to a steam-to-air heat exchanger, was not considered because of the limitations of its use. The distances from the main steam turbine condensers to the air-cooled condensers and the size of the steam ducting required for this application (at approximately 26 ft (7.9 m) in diameter) would render the design not feasible. The steam duct would need to be uncommonly large and would far exceed the largest steam duct ever attempted.

There are, however, specific environmental advantages that would be realized with an air-cooled condenser (dry tower) scenario. These advantages include:

- Makeup water use limited to that necessary to compensate for system leakage,
- No environmental impacts to terrestrial or estuarine habitat due to presence of intake and discharge structure and flows, and
- No environmental impacts to terrestrial or estuarine habitat due to cooling tower drift.
- Specifically, there would be no impact to the Chesapeake Bay due to effluent discharges from CCNPP Unit 3 in a 100% dry cooling tower option.

For a completely dry tower system, the material cost ($269.9 million) and the operation and maintenance costs ($5.4 million) are significantly greater than a wet type or wet/dry type of cooling tower, land use would be significant, and the system would require periods of significant unit power output reduction during periods of high ambient air temperatures.

Therefore, for the reasons stated above, the use of a dry tower is not a feasible alternative for CCNPP Unit 3.}

9.4.1.2 Analysis of the Hybrid Cooling Tower Without Plume Abatement Alternative

{A hybrid cooling tower system without plume abatement was identified as the preferred option for use at CCNPP Unit 3 to transfer heat loads from the CWS to the environment. The cooling tower design will consist of a hybrid cooling tower shell, with provisions to allow installation of plume abatement equipment at a later date if desired. The cooling tower will operate as a wet-type mechanical draft cooling tower, and will have drift eliminators installed.

The hybrid cooling tower system for CCNPP Unit 3 would be wholly situated on the CCNPP site. The cooling tower will be constructed of concrete. It will have a round hybrid shell, and drift eliminators will be installed. The base of the concrete hybrid cooling tower structure will have an overall diameter of 528 ft (161 m) and the tower will have an approximate height of 164 ft (50 m). Internal construction materials will include fiberglass-reinforced plastic (FRP) or polyvinyl chloride (PVC) for piping laterals, polypropylene for spray nozzles, and PVC for fill material.

The hybrid tower without plume abatement is the preferred alternative to transfer heat loads from the circulating water system to the environment. This type of cooling tower provides the greatest degree of operational flexibility. This approach offers all the benefits of a mechanical cooling tower, and offer the ability to take action in the future if the plume is deemed objectionable.

9.4.1.3 Summary of Alternative Heat Dissipation Evaluation

As discussed earlier in this section, **{**a hybrid cooling tower system without plume abatement provides the greatest degree of operational flexibility and provides quiet performance under a wide range of environmental conditions**}**, and is therefore the preferred alternative to transfer heat loads from the CWS to the environment.

{Although the dry cooling tower system and the hybrid plume abated cooling tower system may be considered environmentally equivalent alternatives, as stated earlier, the construction costs and operation and maintenance costs for these options are significantly greater than for the hybrid cooling tower system without plume abatement. Additionally, the dry cooling system would require periods of significant unit power output reduction during periods of high ambient air temperatures.**}**

9.4.2 CIRCULATING WATER SYSTEMS

In accordance with NUREG-1555 (NRC, 1999), ESRP 9.4.2, this section discusses alternatives to the following components of the CWS for **{**CCNPP Unit 3**}**. These components include the intake systems, discharge systems, water supply, and water treatment processes. The information provided in this section is based on two studies: a Cooling Tower and Circulating Water System study, and an Ultimate Heat Sink (UHS) and Intake/Discharge structures location study. A summary of the environmental impacts of the circulating water intake and discharge system alternatives for **{**CCNPP Unit 3**}** are provided in Table 9.4-1 and Table 9.4-2.

The CWS is an integral part of the heat dissipation system. It provides the interface between (1) the normal heat sink (i.e., main steam turbine condenser) where waste heat is discharged from the steam cycle and is removed by the circulating water, and (2) the heat dissipation system where the heat energy is then dissipated or transferred to the environment.

Essentially, two types of CWSs are available for removing this waste heat: once-through (open-loop) and recycle (closed-loop) systems. In once-through cooling systems, water is withdrawn from a cooling source, passed through the condenser, and then returned to the source (receiving water body). In the recycle (closed-loop) cooling system, heat picked up from the condenser by the circulating water is dissipated through auxiliary cooling facilities, after which the cooled water is recirculated to the condenser.

As discussed in Section 9.4.1, the CWS for **{**CCNPP Unit 3 will be a closed-loop system, with volute pumps and piping, a water retention basin, and a round mechanical draft hybrid cooling tower with drift eliminators that will be operated as a wet cooling tower (i.e., without plume abatement) year-round.

The cooling water withdrawal rate for the CWS will normally be approximately 34,800 gpm (131,500 lpm), and maximum makeup will be approximately 40,440 gpm (153,000 lpm). These withdrawals include consideration of losses due to evaporation, drift and blowdown. A fraction of the intake water will be used to clean debris from the traveling screens.

Blowdown from the CWS cooling tower will be routed to a retention basin prior to being returned to the Chesapeake Bay. The blowdown water will enter the retention basin at the cold water temperature for the cooling tower basin (approximately 90°F (32.2°C)). The water will then give up additional heat to the atmosphere before entering the discharge pipe, and will transfer additional heat to the discharge piping during its passage to the outfall. The normal circulating water system blowdown discharge is estimated to be 17,400 gpm (65,700 lpm). The discharge is not likely to produce tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected.

CCNPP Unit 3 will utilize methods similar to those employed at CCNPP Units 1 and 2 to minimize fish impingement and entrainment at the intake structure (e.g., low-velocity approach and screens). It is expected that addition of a new nuclear unit using closed-loop cooling systems will increase fish impingement and entrainment by less than 3.5% over the existing condition. The flow velocity into the intake channel from the Chesapeake Bay will be less than 0.5 fps (0.2 m/s). Therefore, it is anticipated that use of closed-loop cooling systems at CCNPP Unit 3 will have minimal impact on fish impingement and entrainment.

9.4.2.1 Intake and Discharge Systems

For both once-through and closed-loop cooling systems, the water intake and discharge structures can be of various configurations to accommodate the source water body and to minimize impact to the aquatic ecosystem. The intake structures are generally located along the shoreline of the body of water and are equipped with fish protection devices. The discharge structures are generally of the jet or diffuser outfall type and are designed to promote rapid mixing of the effluent stream with the receiving body of water. Biocides and other chemicals used for corrosion control and for other water treatment purposes may be mixed with the condenser cooling water and discharged from the system.

Cooling water intake structures (CWIS) are typically regulated under Section 316(b) of the Federal CWA and its implementing regulations (FR, 2004), and under the Code of Maryland Regulation 26.08.03.05 (COMAR, 2007). A federal court decision in January 2007 changed that regulatory process. The regulations that implement Section 316(b) were effectively suspended, and U.S. EPA recommended that all permits for Phase II facilities should include conditions under Section 316(b) developed on a best professional judgment basis (USEPA, 2007).

The Maryland CWIS regulation implements Section 316(b) at the state level and defines acceptable levels of impingement and entrainment (COMAR, 2007). The Maryland regulation requires the facility to mitigate impingement loss to the extent that the costs for the mitigation are not greater than the benefits. Specifically, the location, design, construction and capacity of cooling water intake structures must reflect the best technology available for minimizing adverse environmental impact. For entrainment, Maryland requires that the facility must determine whether the entrainment loss causes an adverse environmental impact and must mitigate the entrainment loss if the facility does cause an adverse environmental impact.

Intake and discharge structures will be required for operation of CCNPP Unit 3. Three alternative locations for the intake and discharge structures were considered:

- Alternative 1a and 1b - New intake and discharge structures near CCNPP Units 1 and 2. The intake structure would be located between the existing CCNPP Units 1 and 2 intake curtain wall and screens, near the existing intake structures for CCNPP Units 1 and 2. This location would provide not only physical protection but also facilitate the intake of cooler water afforded by the existing curtain wall. This location would also be likely to incur lower construction costs because dredging a new or expanded approach channel may not be required.

  For Alternative 1a, a new discharge structure would be built near the existing CCNPP Unit 1 and 2 intake structure to provide a flow path for discharge from the CCNPP Unit 3 retention basin, into the Chesapeake Bay.

Alternative 1b would be very similar to 1a, with the exception of the intake piping. The Alternative 1b intake piping would extend approximately 3,500 ft (1,067 m) offshore. The suction end of the offshore intake piping would be fitted with velocity caps.

- Alternative 2 - New intake structure near CCNPP Units 1 and 2 intake structure and new discharge structure north of existing barge slip. The intake structure would be located close to CCNPP Units 1 and 2 intake structure (same as Option 1).
- Alternative 3 - New intake and discharge structures at Camp Conoy (south of the existing intake and discharge structures). The new intake and discharge structures would be located at Camp Conroy to provide a flow path for the intake and discharge loads.

For additional details, see Table 9.4-3.

Alternative 2 is the environmentally preferable alternative for locating the new intake and discharge systems. As stated above, the new outfall structure would be just north of the existing barge slip. In addition, the discharge concept will be a shoreline type discharge (unless there is restriction for a shoreline structure). This concept is based on the assumption that the blowdown discharge will meet the Water Quality Standard of the State of Maryland for discharge to Chesapeake Bay at end of pipe.

Discharge into the Chesapeake Bay at this location would have no/insignificant impact on plant operation caused by recirculation back to the existing intake channel. It also requires the fewest additional environmental permits because the intake and the discharge structures would be located in the existing IDA and would require shorter runs of piping. In addition, access and security constraints during construction would be avoided because construction would occur on the site of operating CCNPP Units 1 and 2.

Intake System

The Chesapeake Bay intake system would consists of the CCNPP Units 1 and 2 intake channel; the CCNPP Unit 3 non-safety-related CWS makeup water intake structure and associated equipment, including the non-safety-related CWS makeup pump; the safety-related UHS makeup water intake structure and associated equipment, including the safety-related UHS makeup water pumps; and the makeup water chemical treatment system.

The intake channel will be an approximately 100 ft (30.4 m) long, by 123 ft (37.5 m) wide structure, with an earthen bottom at elevation –20 ft, 6 in (-6.2 m) msl, and vertical sheet pile sides extending to elevation 10 ft (3.0 m) msl. The general site location of the new intake system is shown in Figure 3.1-3, while Figure 3.4-2 and Figure 3.4-3 show the intake structure and channel in more details.

The CCNPP Unit 3 CWS makeup water intake structure will be an approximately 70 ft (21.3 m) long, 68 ft (20.7 m) wide concrete structure with individual pump bays. Three 50% capacity pumps will provide saltwater makeup to the CWS. The UHS makeup water intake will be an approximately 66 ft (20.1 m) long, 84 ft (25.6 m) wide concrete structure with individual pump bays. Four 100% capacity, makeup pumps will be available to provide makeup water.

In both the CWS and UHS makeup intake structures, one makeup pump is located in each pump bay, along with one dedicated traveling band screen and trash rack. Debris collected by the trash racks and the traveling water screens will be collected in a debris basin for cleanout and disposal as solid waste. The through-trash rack and through-screen mesh flow velocities will be less than 0.5 fps (0.15 m/s). Table 9.4-3 summarizes the environmental impacts of the circulating water intake alternatives for CCNPP Unit 3.

Section 316(b) of the federal CWA requires the U.S. EPA to ensure that the location, design, construction, and capacity of CWIS reflect the best technology available (BTA) for minimizing adverse environmental impact. The objective of any CWIS design is to have adequate sweeping flow past the screens to meet entrainment and impingement reduction goals established under Section 316(b) requirements. In addition to the impingement and entrainment losses associated with CWIS, there are the cumulative effects of multiple intakes, re-siting or modification of CWIS contributing to environmental impacts at the ecosystem level. These impacts include disturbances to threatened and endangered species, keystone species, the thermal stratification of water bodies, and the overall structure of the aquatic system food web.

Consequently, in addition to evaluating alternative screen operations and screening technologies, such as fine mesh traveling water screens or wedge wire screens, additional means of reducing impingement, such as curtain walls, fish return systems, or other physical barriers, must also be assessed. There are a number of different alternatives for reducing impingement and entrainment impacts, including changes in intake structure operation, fish handling, external structure design; however no single operational or technological change will have the same effects or benefits at all facilities so therefore site specific studies and evaluations are critical to successful, cost-effective reductions of CWIS impacts.

The new intake channel will be located off the existing intake channel for CCNPP Units 1 and 2, which is perpendicular to the tidal flow of the Chesapeake Bay to minimize the component of the tidal flow parallel to the channel flow and the potential for fish to enter the channel and intake structure. Flow velocities at the intake structure will depend on the Chesapeake Bay water level. At the minimum Chesapeake Bay water level of -4.0 ft (-1.2 m) msl the flow velocity along the new intake channel will be less than 0.5 fps (0.15 m/s) based on the maximum makeup demand of 43,480 gpm (164,590 lpm).

It is expected that addition of the CCNPP Unit 3 using closed cycle cooling will increase fish impingement and entrainment by less than 3.5% (based on preliminary cooling tower performance) over the existing condition. CCNPP Unit 3 will utilize methods similar to those employed at CCNPP Units 1 and 2 to minimize fish impingement and entrainment at the intake structure (e.g., low-velocity approach and screens). Therefore, it is anticipated that use of closed-loop cooling systems at CCNPP Unit 3 will have minimal impact on fish impingement and entrainment.

CCNPP Unit 3 relies on makeup water from the Chesapeake Bay for safe shutdown, and is designed for a minimum low water level of -4.0 ft (-1.2 m) msl and can continue to operate at an extreme low water elevation of -6.0 ft (-1.8 m) msl. The Essential Service Water System (ESWS) cooling towers will typically be supplied with fresh water makeup from storage tanks that are supplied from the desalinization plant.

Flow velocities at the CWS makeup water intake structure and the UHS makeup water intake structure will be sufficiently low that the intake channel may also act as a siltation basin. As a result, dredging may be required to maintain the channel depth. However, operating experience at CCNPP Units 1 and 2 has not indicated that siltation will be a problem, or that dredging will be required.}

Discharge System

The final plant discharge consists of cooling tower blowdown from both the CWS and ESWS cooling towers and site wastewater streams, including the domestic water treatment and circulation water treatment systems. Only biocides or chemical additives approved by the U.S. EPA {and the State of Maryland} as safe for humans and the constituent discharged to the environment will meet requirements established in the NPDES permit.

{An NPDES permit will be obtained for CCNPP Unit 3 prior to startup. This permit will specify threshold concentrations of "free available chlorine" (when chlorine is used) and "free available oxidants" (when bromine or a combination of bromine and chlorine is used) in cooling tower blowdown when the dechlorination system is not in use. Lower discharge limits will apply to effluent from the dechlorination system (which will be released into the Chesapeake Bay) when it is in use. The CCNPP Unit 3 NPDES permit will contain discharge limits for discharges from the cooling towers for two priority pollutants, chromium and zinc, which are widely used in the U.S. as corrosion inhibitors in cooling towers.

During operation, discharge flow to the Chesapeake Bay will be from the retention basin, which collects all site non-radioactive wastewater and tower blowdown. Discharge from the retention basin would be through an a 30 in (76.2 cm) diameter discharge pipe. Before the discharge point, the pipe will branch into three nozzles. The normal discharge flow will be up to 18,540 gpm (70,180 lpm) and the maximum discharge flow will be approximately 37,080 gpm (140,360 lpm).

The proposed discharge structure will be designed to meet all applicable navigation and maintenance criteria and to provide an acceptable mixing zone for the thermal plume per state regulations for thermal discharges. Figure 3.4-4 shows details of the discharge system. The proposed discharge point will be near the southwest bank of Chesapeake Bay, approximately 1,200 ft (365.8 m) south of the intake structure for CCNPP Unit 3 and extending about 550 ft (167.6 m) into the Chesapeake Bay.

The preliminary centerline elevation of the discharge pipe will be 3 ft (0.9 m) above the bottom of the Chesapeake Bay. Riprap will be placed around the discharge point to resist potential erosion as a result of the discharge jet from the pipe. A summary of the environmental impacts of the circulating water discharge system alternatives for CCNPP Unit 3 are provided in Table 9.4-4.}

9.4.2.2 Water Supply (Makeup Water System Alternatives)

{CCNPP Unit 3 will require makeup water to the CWS and ESWS cooling towers to replace water inventory lost to evaporation, drift, and blowdown. As described in Section 9.4.2, during normal operations fresh water makeup to the ESWS cooling towers and UHS will be provided either directly from the non-safety related desalination plant, or from storage tanks that are supplied from desalination plant. Makeup water for the desalination plant will be extracted from the CWS cooling tower makeup line, which draws water from the Chesapeake Bay. Brackish water from the Chesapeake Bay will provide an backup source of makeup water to the ESWS and UHS when the fresh water supply is unavailable.

The following makeup water system alternatives were analyzed:

- Potential Groundwater Sources
- Recycled plant water
- Desalination plant

As noted in Chapters 4 and 5, the preferred water supply alternative (desalination) would have SMALL construction and operational impacts. As a result, mitigation alternatives are not discussed in this section.

Groundwater Sources

There are five aquifers in the vicinity of the CCNPP site: Surficial, Chesapeake, Castle-Hayne – Aquia, Severn-Magothy, and Potomac (includes the Patapsco Aquifer and Potomac Confining Unit). The characteristics of these aquifers are described within Section 2.3.

Groundwater is the primary water supply in most areas of Maryland within the Atlantic Coastal Plain. The aquifers in this region are the primary water supply for southern Maryland (which includes Calvert County) and the Eastern Shore. Withdrawals from Coastal Plain aquifers have caused groundwater levels in confined aquifers to decline by tens to hundreds of feet from their original levels.

The current rate of decline in many of the confined aquifers has been estimated at about 2 ft (0.6 m) per year. Declines have been especially large in southern Maryland and parts of the Eastern Shore, where groundwater pumping is projected to increase by more than 20% between 2000 and 2030. Some regions are expected to experience significantly greater increases. Continued water level declines at current rates could affect the long-term sustainability of the region's groundwater resources and introduce saltwater intrusion concerns.

Groundwater withdrawals will not be used to support CCNPP Unit 3 operations; however, construction water needs may be met through a combination of limited groundwater withdrawals and haulage. These limited groundwater withdrawals would be performed within the limits of the existing groundwater permit for CCNPP Units 1 and 2, and will require prior discussions with the MDE. Groundwater withdrawals made to support construction of CCNPP Unit 3 will use existing wells.}

Recycled Plant Water

{ Unit 3 waste water treatment plant effluent could be used to reduce groundwater demand or desalinization plant output to provide fresh water for the proposed CCNPP Unit 3. This source would only provide 20 gpm (75.7 lpm) and fresh water from the desalinization plant will still be required for the plant potable/sanitary water system and demineralized water system. As a result, recycled plant water cannot, on its own, provide the makeup water need to support construction and operation of the proposed unit.}

{Desalinization Plant

A desalinization plant is also a viable option for fresh water. The desalinization plant will use Chesapeake Bay water as its raw water input and will therefore not affect existing groundwater resources. Placing a desalinization plant at plant grade instead of near the intake structures at the shoreline significantly reduces the head requirement for the effluent transfer pump(s) used to send the desalination plant fresh water output to the proposed storage tank.

About half of all of the desalinated water produced is produced through thermal processes, in which salt water is heated to produce vapor that is then condensed into fresh water. The main objective of any thermal process is to minimize the amount of heat required to produce a gallon of fresh water. Two principal competitive types of thermal processes produce desalinated water, multi-stage flash evaporation (MSF) and multiple effect distillation (MED). An alternative, non-thermal process used to produce desalinated water is reverse osmosis (RO).

Although the MED and MSF desalination processes are more often employed on larger desalinization plants, and thus are more mature technologies, they were not considered to be viable options for the relatively small water output requirement at CCNPP. As a result of advancements in technology, seawater desalination using RO membranes has become more attractive for this type of application and will be used for CCNPP Unit 3. The desalinization plant considered will be required to provide 3,040 gpm (11,508 lpm) of product flow using stage media filtration, a one-pass sea water reverse osmosis (SWRO) at 40% recovery.

The desalinization system will also provide the initial fill for the 72 hour inventory of the ESWS cooling tower basins system. The system will include seawater feed pumps, multimedia filters, chemical injection system, and an RO permeate tank. The RO reject stream will be diluted using a holding pond or by mixing with the CCNPP Units 1 and 2 cooling water discharge. A 500 gpm (31.6 l/s) desalinization plant will require a building with an approximate size of 65 ft (19.8 m) by 165 ft (50.3 m). This building will be located adjacent to the circulating water cooling towers, on the southwest end of the CCNPP site (approximate Elevation 100 ft (30.5 m)) as shown in Figure 3.1-1.

Summary of Makeup Water Alternatives

{The operation of CCNPP Unit 3 will require a consistent source of fresh makeup water for cooling purposes. It has been determined that CCNPP Unit 3 will not withdraw any groundwater for use at the site during operations, but will make limited groundwater withdrawals to support construction within the limitations of the existing groundwater permit for CCNPP Units 1 and 2. The SWRO desalinization plant will provide fresh water for the plant demineralized water system, potable and sanitary water systems, and normal makeup for the ESWS cooling towers. The Chesapeake Bay is the source of water for the desalination plant. The desalinization plant will withdraw an estimated 3,040 gpm (11,508 Lpm) from the Chesapeake Bay via a connection to the CWS makeup line.}

9.4.2.3 Water Treatment

Evaporation of water from cooling towers leads to an increase in chemical and solids concentrations in the circulating water, which in turn increases scaling tendencies of the cooling water. {A water treatment system is required at CCNPP Unit 3 to minimize bio-fouling, prevent or minimize growth of bacteria (especially *Legionella* in the case of cooling towers), and inhibit scale on system heat transfer surfaces. Water treatment will be required for both influent and effluent water streams. Considering that water sources for CCNPP Unit 3 are the same as those for CCNPP Units 1 and 2, treatment methodologies will be similar.

The circulating water treatment system provides treated water for the CWS and consists of three phases: makeup treatment, internal circulating water treatment, and blowdown treatment. Makeup treatment will consist of a biocide injected into Chesapeake Bay water influent during spring, summer, and fall months to minimize marine growth and control fouling on heat exchanger surfaces. Treatment also improves makeup water quality.

Similar to CCNPP Units 1 and 2, an environmental permit to operate this treatment system will be obtained from the State. For prevention of *Legionella*, treatment for internal circulating water components (i.e., piping between the new intake structure and condensers) will include existing power industry control techniques consisting of hyperchlorination (chlorine shock) in combination with intermittent chlorination at lower levels, biocide and scale inhibitor addition. Blowdown treatment will depend on water chemistry, but is anticipated to include application of biocide dechlorinator, and scale inhibitor to control biogrowth, reduce residual chlorine and protect against and scaling, respectively. Since seawater has a tendency to foam due to the presence of organics, a small amount of antifoam may also be added to blowdown.

ESWS cooling tower water chemistry will be maintained by the SW water treatment system, which is designed to treat desalinated water from the SWRO desalinization plant for normal operating and shutdown conditions. This treatment system will also be capable of treating Chesapeake Bay water for design basis accident conditions. Treatment of system blowdown will also control the concentration of various chemicals in the ESWS cooling towers.

Desalinated water from the SWRO desalinization plant will be treated by the demineralized water treatment system, which provides demineralized water to the demineralized water distribution system. During normal operation, demineralized water is delivered to power plant users. Treatment techniques will meet makeup water treatment requirements set by the Electric

Power Research Institute and include the addition of a corrosion inhibitor, similar to the service water system for the existing plant that uses demineralized water.

The drinking water treatment system, which supplies water for the potable and sanitary distribution system, will treat desalinated water so that it meets the State of Maryland potable (drinking) water program and U.S. EPA standards for drinking water quality under the National Primary Drinking Water Regulation and National Secondary Drinking Water Regulation. The system will be designed to function during normal operation and outages (i.e., shutdown).}

Liquid wastes generated by the plant during all modes of operation will be managed by the liquid waste storage and processing systems. The liquid waste storage system collects and segregates incoming waste streams, provides initial chemical treatment of those wastes, and delivers them to one or another of the processing systems. The liquid waste processing system separates waste waters from radioactive and chemical contaminants. The treated water is returned to the liquid waste storage system for monitoring and eventual release. Chemicals used to treat wastewater for both systems include sulfuric acid for reducing pH, sodium hydroxide for raising pH, and an anti-foaming agent for promoting settling of precipitates.

{CCNPP Unit 3 will use a Waste Water Treatment System for the treatment of sewage similar to that of CCNPP Units 1 and 2. This treatment system removes and processes raw sewage so that discharged effluent conforms to applicable Local and State health and safety codes, and environmental regulations. Sodium hypochlorite (chlorination) is used to disinfect the effluent by destroying bacteria and viruses, and sodium thiosulfate (dechlorination) reduces chlorine concentration to a specified level before final discharge. Soda ash (sodium bicarbonate) is used for pH control. Alum and polymer are used to precipitate and settle phosphorus and suspended solids in the alum clarifier; polymer is also used to aid flocculation.}

9.4.3 TRANSMISSION SYSTEMS

Section 9.4.3 of NUREG-1555 (NRC, 1999) provides guidelines for the preparation of summary discussion that identifies the feasible and legislatively compliant alternative transmission systems . {As discussed in Section 3.7, the existing CCNPP Units 1 and 2 power transmission system consists of two circuits, which connects CCNPP to the Waugh Chapel Substation in Anne Arundel County and to the Potomac Electric Power Company Chalk Point generating station in Prince Georges County. The northern CCNPP to Waugh Chapel circuit is composed of two separate three-phase 500 kV transmission lines on a single right-of-way from CCNPP, while the southern CCNPP to Chalk Point circuit is a single 500, three-phase 500-kV line.

The north and south circuits of the CCNPP power transmission system are located in corridors totaling approximately 65 mi (105 km) of 350 to 400 ft (100 to 125 m) right-of-way that is owned by Baltimore Gas and Electric Company. Land use within these corridors is well established, stable, does not interfere with Federal, State, Regional, or Local land use plans, and is without Native American tribal communities. The lines cross mostly secondary-growth hardwood and pine forests, pasture, and farmland.

The transmission lines to support CCNPP Unit 3 will be constructed within the CCNPP site. Thus, environmental impacts are limited to CCNPP Unit 3 construction area on the CCNPP site.

No new corridors, widening of existing corridors, or crossings over main highways, primary and secondary roads, waterways, or railroad lines will be required. Therefore, there would be no impacts from land use changes. The impact to humans and animals resulting from increased transmission-line induced currents is minimized due to conformance with the consensus electrical code, and is SMALL. Access to the existing corridors would be through existing access roads in compliance with existing negotiated easement agreements.

The transmission line work to support CCNPP Unit 3 will, however, require new towers and transmission lines to connect the CCNPP Unit 3 switchyard to the CCNPP Units 1 and 2 switchyard. Line routing would be conducted to avoid or minimize impacts to the existing Independent Spent Fuel Storage Installation, wetlands, and threatened and endangered species (bald eagle nest) identified in the local area. Based on the results of a feasibility study, numerous breaker upgrades and associated modifications will also be required at Waugh Chapel, Chalk Point, and other substations, but all of these changes would be implemented within the existing substations.

The power transmission needs of CCNPP Unit 3 can be satisfied with relatively minimal changes to the existing transmission corridor and power transmission system for CCNPP Units 1 and 2. Based on this conclusion, and the small expected impact to the environment from utilizing the existing transmission corridor and equipment, no other alternatives were considered since all other alternatives were obviously less preferable.}

9.4.4 REFERENCES

CFR, 2007a. Title 10, Code of Federal Regulations, Part 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions, Appendix B to Subpart A, Table B-1, 2007.

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Young, 2000. Cooling Towers, Bay Area Air Quality Management District Air Permit Program Handbook, Source Specific Guidance, Miscellaneous Operations, B. Young and E. Ciammaichella, July 17, 2000.

Table 9.4-1 {Comparison of Cooling Tower Evaluation Criteria} (Page 1 of 2)

Type of Cooling	Footprint per Plant Unit (1,562 MWe) [(a)]	Maximum Height	Materials of Construction	Plant Efficiency Impact	Auxiliary Load	Water Makeup [(b)]	Drift Rate	Pump Head	Visible Plume	Noise	O&M Cost [(c)]	Capital Cost
	Acres	Ft (m)		%	MW	gpm (Lpm)	% of Full Flow	Feet H_2O (kg/cm^2)		dBA @ 1m	USD	USD
Natural Draft Wet Cooling Tower	10	439 (134)	Concrete	0.5	0	43,000 (162,800)	<0.005	38 (1.16)	Yes	82	1,320,000	66,000,000
Rectangular Mechanical Draft (Wet)	23	58 (17.7)	Fiberglass (FRP)	0.5	8.3	43,000 (162,800)	0.005	31 (0.94)	Yes	85	760,000	38,000,000
Round Mechanical Draft (Wet)	11	65 (19.8)	Concrete	0.5	7.2	43,000 (162,800)	0.005	32 (0.97)	Yes	85	1,080,000	54,000,000
Rectangular Plume Abated (Hybrid)	28	67 (20.4)	FRP Structure Titanium Coils	0.5	15.5	38,700 (146,500)	0.005	32 (0.97)	No	88	1,000,000	100,000,000
Round Plume Abated (Hybrid)	8.	164 (50)	Concrete Structure Titanium Coils	0.5	17.9	38,700 (146,500)	0.005	44 (1.34)	No	88	900,000	90,000,000
Round Plume Abated (Hybrid) Without Plume Abatement Option	5	164 (50)	Concrete Structure	0.5	11.6	38,700 (146,500)	0.005	44 (1.34)	Yes	85	200,000	60,000,000

Table 9.4-1 {Comparison of Cooling Tower Evaluation Criteria} (Page 2 of 2)

Type of Cooling	Footprint per Plant Unit (1,562 MWe) [a]	Maximum Height	Materials of Construction	Plant Efficiency Impact	Auxiliary Load	Water Makeup [b]	Drift Rate	Pump Head	Visible Plume	Noise	O&M Cost [c]	Capital Cost
	Acres	Ft (m)		%	MW	gpm (Lpm)	% of Full Flow	Feet H_2O (kg/cm^2)		dBA @ 1m	USD	USD
Dry Tower (Air Cooled)	39	122 (37.2)	Hot Dipped Galvanized Steel, Titanium Tubes	25	78.7	None	None	0 (0)	No	88	5,398,000	269,900,000

Notes:
(a) Footprint includes the required separation between towers, if applicable.
(b) Water total makeup includes drift, evaporation, and blowdown (at 2 cycles of concentration).
(c) O&M costs are calculated at 1% or 2% of the capital cost, based on vendor input.

Table 9.4-2 {Environmental Impacts of Alternative Cooling Tower Systems}
(Page 1 of 9)

Factors Affecting System Selection	Once-Through Cooling System	Dry Tower (Air-Cooled Condenser)	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)	Hybrid (plume-abated) Cooling Tower (HCT)	Hybrid Cooling Tower (HCT) without Plume Abatement Option
Land Use: Onsite Land Requirements	N/A Rejected from range of alternatives before land use evaluated Impacts would be small.	39.1 acres (15.8 hectares) Impacts would be small.	10.0 acres (4 hectares) Impacts would be small.	23 acres (10.1 hectares) for rectangular MDWCT and 11 acres for a round MDWCT. Impacts would be small.	8 acres (3.2 hectares) for a round HCT and 27.5 acres (11.1hectares) for a rectangular HCT. Impacts would be small.	5.0 acres (2.0 hectares) for a round HCT without plume abatement option. Impacts would be small.
Land Use: Terrain Considerations	N/A Rejected from range of alternatives before land use evaluated Impacts would be small.	Terrain features of the CCNPP site are suitable for a dry tower air-cooled system. Impacts would be small.	Terrain features of the CCNPP site are suitable for an NDWCT system. Impacts would be small.	Terrain features of the CCNPP site are suitable for a MDWCT system. Impacts would be small.	Terrain features of the CCNPP site are suitable for an HCT. Impacts would be small.	Terrain features of the CCNPP site are suitable for an HCT without plume abatement option. Impacts would be small.

Table 9.4-2 {Environmental Impacts of Alternative Cooling Tower Systems}
(Page 2 of 9)

Factors Affecting System Selection	Once-Through Cooling System	Dry Tower (Air-Cooled Condenser)	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)	Hybrid (plume-abated) Cooling Tower (HCT)	Hybrid Cooling Tower (HCT) without Plume Abatement Option
Water Use	2,500,000 gpm (9.5 million Lpm) for an on-shore intake. 420,000 gpm (1.6 million Lpm) for an off-shore intake. Potential for large impacts to aquatic biota. Impacts would be large.	No makeup water needed for use of a dry tower air-cooled system. No significant impacts to aquatic biota. Impacts would be small.	43,000 gpm (163,000 Lpm) for water makeup. Total water makeup includes drift, evaporation, and blowdown (@ 2 cycles of concentration). Potential for small to moderate impacts to aquatic biota. Impacts would be small to moderate.	43,000 gpm (163,000 Lpm) for water makeup for both a rectangular and round MDWCT. Total water makeup includes drift, evaporation, and blowdown (@ 2 cycles of concentration). Potential for small to moderate impacts to aquatic biota. Impacts would be small to moderate.	38,700 gpm (146,500 Lpm) for water makeup for both a rectangular and round HCT. Total water makeup includes drift, evaporation, and blowdown (@ 2 cycles of concentration). Potential for small to moderate impacts to aquatic biota. Impacts would be small to moderate.	38,700 gpm (146,500 Lpm) for water makeup for a round concrete HCT without plume abatement option. Total water makeup includes drift, evaporation, and blowdown (@ 2 cycles of concentration). Potential for small to moderate impacts to aquatic biota. Impacts would be small to moderate.

Table 9.4-2 {Environmental Impacts of Alternative Cooling Tower Systems}
(Page 3 of 9)

Factors Affecting System Selection	Once-Through Cooling System	Dry Tower (Air-Cooled Condenser)	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)	Hybrid (plume-abated) Cooling Tower (HCT)	Hybrid Cooling Tower (HCT) without Plume Abatement Option
Atmospheric Effects	Some plume associated with discharge canal. Impacts would be small.	No visible plume associated with a dry tower air-cooled system. Impacts would be small.	Visible plume. NDWCT presents greater potential for fogging and salt deposition. Impacts would be small	Short average and median visible plume. Drift eliminators minimize salt deposition. Impacts would be small.	Reduced plume potential with an HCT. Impacts would be small	Short average and median visible plume. Drift eliminators minimize salt deposition. Impacts would be small
Thermal and Physical Effects	Enormous size of the intake and discharge structures and offshore pipes are needed. Thermal Discharges associated with the once-through cooling system would need to meet applicable	Discharges associated with a dry tower air-cooled system would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. The discharge is not likely to produce	Discharges associated with the NDWCT would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. The discharge is not likely to produce tangible	Discharges associated with the MDWCT would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. Cooling water will be sent to a retention basin,	Discharges associated with the HCT would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. Therefore, the discharge is not likely to produce	Discharges associated with the HCT without the plume abatement option would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. Therefore, the discharge is not likely to produce

Table 9.4-2 {Environmental Impacts of Alternative Cooling Tower Systems} (Page 4 of 9)

Factors Affecting System Selection	Once-Through Cooling System	Dry Tower (Air-Cooled Condenser)	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)	Hybrid (plume-abated) Cooling Tower (HCT)	Hybrid Cooling Tower (HCT) without Plume Abatement Option
Thermal and Physical Effects (cont.)	water quality standards and be in compliance with applicable thermal discharge regulations. Thermal discharge study needed to identify environmental impacts on Chesapeake Bay. Impacts would be large.	tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small to moderate.	thus reducing thermal impacts to receiving waters. The discharge is not likely to produce tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.

Table 9.4-2 {Environmental Impacts of Alternative Cooling Tower Systems}
(Page 5 of 9)

Factors Affecting System Selection	Once-Through Cooling System	Dry Tower (Air-Cooled Condenser)	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)	Hybrid (plume-abated) Cooling Tower (HCT)	Hybrid Cooling Tower (HCT) without Plume Abatement Option
Noise Levels	N/A Rejected from range of alternatives before noise evaluated	A dry tower air-cooled system would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive Impacts would be small.	NDWCT would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive Impacts would be small.	MDWCT would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive Impacts would be small.	HCT would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive. Impacts would be small.	HCT without plume abatement would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive Impacts would be small.

Table 9.4-2 {Environmental Impacts of Alternative Cooling Tower Systems}
(Page 6 of 9)

Factors Affecting System Selection	Once-Through Cooling System	Dry Tower (Air-Cooled Condenser)	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)	Hybrid (plume-abated) Cooling Tower (HCT)	Hybrid Cooling Tower (HCT) without Plume Abatement Option
Aesthetic and Recreational Benefits	No likely tangible aesthetic or recreational impacts; no effect on navigation or recreational use of Chesapeake Bay is expected. Impacts would be small.	No visible plume with the use of a dry tower air-cooled system. The heavily forested onsite areas, onsite elevation changes and topographical features (i.e., hills and valleys), and the new plant's location approximately 3,000 to 4,000 ft (914.4 to 1,219.2 m) from the nearest residential properties will help to shield the new plant from view.	NDWCT plumes resemble clouds and would not disrupt the viewscape. The heavily forested onsite areas, onsite elevation changes and topographical features (i.e., hills and valleys), and the new plant's location approximately 3,000 to 4,000 ft (914.4 to 1,219.2 m) from the nearest residential properties will help to shield the new plant from view.	MDWCT plumes resemble clouds and would not disrupt the viewscape. The heavily forested onsite areas, onsite elevation changes and topographical features (i.e., hills and valleys), and the new plant's location approximately 3,000 to 4,000 ft (914.4 to 1,219.2 m) from the nearest residential properties will help to shield the new plant from view.	No visible plume with the use of an HCT. The heavily forested onsite areas, onsite elevation changes and topographical features (i.e., hills and valleys), and the new plant's location approximately 3,000 to 4,000 ft (914.4 to 1,219.2 m) from the nearest residential properties will help to shield the new plant from view.	Visible plume. The heavily forested onsite areas, onsite elevation changes and topographical features (i.e., hills and valleys), and the new plant's location approximately 3,000 to 4,000 ft (914.4 to 1,219.2 m) from the nearest residential properties will help to shield the new plant from view. The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts. Impacts would be small.

Table 9.4-2 {Environmental Impacts of Alternative Cooling Tower Systems}
(Page 7 of 9)

Factors Affecting System Selection	Once-Through Cooling System	Dry Tower (Air-Cooled Condenser)	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)	Hybrid (plume-abated) Cooling Tower (HCT)	Hybrid Cooling Tower (HCT) without Plume Abatement Option
Aesthetic and Recreational Benefits (cont.)		The discharge is not likely to produce tangible aesthetic or recreational impacts No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts; no effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts; no effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts; no effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.

Table 9.4-2 {Environmental Impacts of Alternative Cooling Tower Systems}
(Page 8 of 9)

Factors Affecting System Selection	Once-Through Cooling System	Dry Tower (Air-Cooled Condenser)	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)	Hybrid (plume-abated) Cooling Tower (HCT)	Hybrid Cooling Tower (HCT) without Plume Abatement Option
Legislative Restrictions	Potential compliance issues with Section 316(b) of the CWA. Also, potential significant NPDES thermal discharge issues surrounding discharges back into Chesapeake Bay. Impacts would be large.	Potential compliance issues with the requirements for emissions under the federal Clean Air Act. These regulatory restrictions would not negatively affect implementation of this heat dissipation system, but they may impact overall operational cost.	Intake structure would meet Section 316(b) of the CWA and implementing regulations, as applicable. NPDES discharge permit thermal discharge limitation would address thermal load from blowdown to Chesapeake Bay. These restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be small to moderate.	Intake structure would meet Section 316(b) of the CWA and implementing regulations, as applicable. NPDES discharge permit thermal discharge limitation would address thermal load from blowdown to Chesapeake Bay. These restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be small.	Intake structure would meet Section 316(b) of the CWA and implementing regulations, as applicable. NPDES discharge permit thermal discharge limitation would address thermal load from blowdown to Chesapeake Bay. These restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be small.	Intake structure would meet Section 316(b) of the CWA and the implementing regulations, as applicable. NPDES discharge permit thermal discharge limitation would address thermal load from HCT blowdown to Chesapeake Bay. These restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be small.

Table 9.4-2 {Environmental Impacts of Alternative Cooling Tower Systems} (Page 9 of 9)

Factors Affecting System Selection	Once-Through Cooling System	Dry Tower (Air-Cooled Condenser)	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)	Hybrid (plume-abated) Cooling Tower (HCT)	Hybrid Cooling Tower (HCT) without Plume Abatement Option
Environmental impacts	Large	Small	Small to Moderate	Small to moderate	Small	Small
Is this an environmentally suitable alternative heat dissipation system?	No	No	No	No	Yes	Yes

Table 9.4-3 {Alternate Intake Systems}
(Page 1 of 2)

	Proposed System (closed loop)	Alternative Systems (open loop)	Intake location (Alternative 1a – Nearshore)	Intake location (Alternative 1b – Offshore)	Intake Location (Alternative 2)	Intake Location (Alternative 3)
Construction Impacts	Some adverse impacts as discussed in Section 4.1, but mitigated as noted in Section 4.6. Small	Adverse impacts due to large intake structure required. Large	Impacts minimal: use existing structures – avoid new channel dredging. But construction could interfere with operations at CCNPP Units 1 and 2. Small	Impacts moderate: use existing structures – new offshore channel dredging for pipeline needed. But construction could interfere with operations at CCNPP Units 1 and 2. Moderate	Impacts minimal; for minor dredging, similar to Alternative 1; Better flow for construction traffic, less impact on operations at CCNPP Units 1 and 2. Small	New intake structures would require new trenching for intake – higher costs due to longer pipe runs. Moderate
Aquatic Impacts	No expected long-term impacts; entrainment and impingement expected to be minimal. Small	Adverse impacts from entrainment of resident species. Large	Short term adverse impact from dredging and sediment. Mitigation plans (barriers and coffer dams) would limit impact. Small	Short to moderate term adverse impact from dredging and sediment. Mitigation plans (barriers and coffer dams) would limit impact. Moderate	Short term aquatic impacts associated with dredging and sediment. Mitigation plans (barriers and coffer dams) would limit impact. Small	Short term aquatic impacts from sedimentation; sedimentation would be greater with construction of new trench and structure. Small
Water Use Impacts	No expected long term impacts; water consumption minimal. Small	High water use would require large intake structure from Chesapeake Bay Large	Impact on surface and groundwater expected to be minimal. Small	Impact on surface and groundwater expected to be minimal. Small	Impact on surface and groundwater expected to be minimal. Small	Surface and groundwater impact. Moderate

Table 9.4-3 {Alternate Intake Systems}
(Page 2 of 2)

	Proposed System (closed loop)	Alternative Systems (open loop)	Intake location (Alternative 1a – Nearshore)	Intake location (Alternative 1b – Offshore)	Intake Location (Alternative 2)	Intake Location (Alternative 3)
Compliance with Regulations	Satisfies regulatory performance standards for CWA and Maryland regulations.	Does not meet current CWA and Maryland criteria for entrainment	Would comply with current CWA and Maryland regulations with additional permits.	Would comply with current CWA and Maryland regulations with additional permits.	Compliance with CWA and Maryland regulations. Similar permitting structure as Alternative 1, intake and discharge in intensely disturbed areas.	Compliance with CWA and Maryland regulations; extensive new permitting may be required.
Environmental Preferability	Environmentally preferable: limits entrainment and lower water use.	Cost prohibitive not compliant with regulations.	No; construction may interfere with operation at CCNPP Units 1 and 2.	No; construction may interfere with operations at CCNPP Units 1 and 2.	Yes; minimal impacts to current operation, better flow for construction traffic and laydown.	No, would require significant construction activities in previously undisturbed areas.}

Table 9.4-4 Alternate Discharge Systems (Page 1 of 2)

	Proposed System (closed loop)	Alternative Systems (open loop)	Discharge Location south of intake structure (nearshore – closed loop)	Deep Water Discharge Location (offshore - open loop)
Construction Impacts	{Some sedimentation for construction of subsurface diffuser	Adverse impacts due to large discharge structure required.	Impacts minimal: use existing structures – dredging into the Chesapeake Bay would result in some sedimentation that would be mitigated per Section 4.6.	Offshore diffuser area would be approximately 10 acres at the bottom of Chesapeake Bay. Discharge pipe trench to disturb approximately 12 acres of Chesapeake Bay bottom. Large intake and discharge structures necessary for large volume of water.
Aquatic Impacts	No expected long-term impacts; thermal diffusion is expected to reduce impacts from thermal discharge and mixing zones.	Adverse impacts from entrainment – best fish return technology not feasible.	Short term disturbance to benthic organisms; short term effect on fin-fish from sediment and other construction – mitigation per Section 4.2 and Section 4.6.	Greater impact to fish and shellfish from potential impingement and entrainment. Potential for long-term thermal impacts to local ecology.
Water-Use Impacts	No expected long term impacts; water consumption minimal.	Large discharge flow – impact on water quality and aquatic biota from discharge.	Impact on surface and groundwater expected to be minimal.	Large intake/discharge flow from/into Chesapeake Bay for system cooling. Potential for greater impacts from large volume of heated thermal discharge.
Compliance with Regulations	Meets regulatory temperature limit standards for CWA and Maryland regulations – Discharge of chemicals or other constituents limited by Maryland NPDES permit.	Does not meet current CWA and Maryland criteria for thermal discharge or best technology.	Location would limit mixing and impact to intake system. Meets current CWA and Maryland criteria for thermal discharge or best technology.	Necessary location for compliance with mixing zone standards Potential issues with compliance under Section 316 (a) and (b) of Maryland NPDES permit.

Table 9.4-4 Alternate Discharge Systems
(Page 2 of 2)

	Proposed System (closed loop)	Alternative Systems (open loop)	Discharge Location south of intake structure (nearshore – closed loop)	Deep Water Discharge Location (offshore - open loop)
Environmental Preferability	Environmentally preferable: limits thermal impacts.	Cost prohibitive not compliant with regulations.	Yes. Greater diffusion and less mixing issues.	No. Regulatory compliance issues, aquatic biota impacts, and potential for public perception controversy}.

10.0 Environmental Consequences of the Proposed Action

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

10.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

This chapter presents the potential environmental consequences of constructing and operating a new U.S. EPR at the {Calvert Cliffs Nuclear Power Plant (CCNPP)} site. The environmental consequences are evaluated in five sections:

- Unavoidable adverse impacts of construction and operations
- Irreversible and irretrievable commitments of resources
- Relationship between short-term uses and long-term productivity of the human environment
- Benefit-Cost balance
- Cumulative impacts

10.1 Unavoidable Adverse Environmental Impacts

10.1 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

This section summarizes adverse impacts of {CCNPP Unit 3} construction and operation that cannot otherwise be avoided, and for which there may be no practical means of mitigation. Chapter 4 and Chapter 5 provide supporting details.

10.1.1 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS OF CONSTRUCTION

Most construction related environmental impacts can be avoided or minimized through the application of best management construction plans and conformance with applicable Federal, State and Local regulations that protect the environment. {CCNPP Unit 3} requires use of a site footprint where permanent structures and roads are located. Construction activities, on the other hand, can be managed in ways that limit long-term loss of habitat and impacts to workers and the public.

Construction impacts and potential mitigation measures are discussed in Section 4.6, and summarized here in Table 10.1-1 summarizes the potential environmental impacts of construction and their mitigation. Considering the planned mitigation measures, the level of unavoidable adverse impacts from construction is expected to be small.

10.1.2 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS OF OPERATIONS

Operational impacts of {CCNPP Unit 3} are discussed in Chapter 5. Expected impacts and their mitigation are summarized in Table 10.1-2. Unavoidable impacts are limited to operation of the cooling water systems and the generation of additional non-radioactive and radioactive waste. Actions to minimize these impacts include use of closed-cycle cooling and waste minimization. As a result, the unavoidable adverse impacts of operation are also expected to be small.

10.1.3 SUMMARY OF UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS FROM CONSTRUCTION AND OPERATIONS

Construction and operation will require the disturbance of {approximately 420 acres (170 hectares) of land for construction, of which 281 acres (114 hectares) will be permanently committed to power plant structures and roads for CCNPP Unit 3. Temporary storage and lay-down areas will be restored following construction to reduce the size of the footprint affected during operations. The infrastructure required for CCNPP Unit 3 will be consistent with existing site use, with exception of the cooling tower that is being installed to limit water consumption and related ecological impacts. The use of existing offsite transmission right-of-ways for CCNPP Unit 3 will eliminate the need for construction of new corridors further limiting the plant's utilization of available land.

Protection of surface and subsurface water resources during construction will require limitations on the amount of groundwater withdrawn and the discharge of construction waste waters from dewatering activities. Best Management Practices will be implemented to limit construction related erosion and sedimentation of surface waters. Water quality monitoring will be conducted to verify that control measures are adequate. Use of groundwater during construction will be within existing appropriations and, to further limit long-term groundwater use, CCNPP Unit 3 will employ desalination technology to produce freshwater for use in the essential service water system during operations. Long-term protection of surface waters will be managed through an onsite Storm Water Pollution Prevention Plan required under current regulations.

Certain natural resources on site will be affected including unavoidable encroachment on non-tidal wetlands and surface waters. Activities within these areas will conform to applicable state and federal regulations to ensure that impacts are limited and controlled. Impacts to aquatic resources are expected to be minimal given the limited area to be committed to permanent use and the absence of threatened and/or endangered species in these freshwaters.

Construction of permanent CCNPP Unit 3 structures such as the reactor and turbine buildings and the cooling towers will require the removal of mixed deciduous forest occupying this portion of the site. Available old field will allow for reforestation efforts following construction.

There are sensitive archaeological and architectural sites located in the construction area and their protection and/or mitigation of impacts will be administered through cooperative efforts with the Maryland State Historic Preservation Officer (SHPO).

Measures to promote public health and safety will be implemented during construction and operation. The temporary increase in workforce during construction will require actions to minimize traffic congestion. A new access road and interconnection with Maryland State Highway 2/4 will facilitate traffic flow during shift change over. Noise levels at the site boundary are predicted to conform to applicable state and federal environmental standards. Non-routine noise, such as blasting, will be limited to day time. Measures to control fugitive dust and emissions from equipment will be implemented along with a general Safety and Health Plan. Emissions from the testing of diesel generators will conform to applicable Maryland state permit requirements and related federal emission standards.

Radiological dose to workers on site and to the general public have been calculated and are estimated to be well within applicable regulatory limits. Continuing monitoring of radioactivity in the environment surrounding the CCNPP site will ensure that radiological consequences of station operation are maintained within applicable environmental and health based standards. While some radioactive solid wastes will be created, efforts to control and limit their production will be implemented.

Impacts associated with the CCNPP Unit 3 cooling water systems include construction and operation of the intake and discharge structures, as well as evaporative losses from the operating cooling towers. Construction of the CCNPP Unit 3 circulating water supply system makeup water intake structure and the ultimate heat sink makeup intake structure will take place within the existing CCNPP Unit 1 and 2 embayment behind a temporary sheet pile coffer dam. As a result, sedimentation potentially released either into the CCNPP Unit 1 and 2 intakes, or into the Chesapeake Bay, will be limited. Periodic maintenance dredging of the combined intake area will be required for the continued operation of all three CCNPP units. These activities will conform to applicable State and U.S. Army Corps of Engineers regulations, including proper disposal of dredge spoils.

Since CCNPP Unit 3 will employ a closed-cycle cooling water system that conforms to the U.S. Environmental Protection Agency (EPA) Phase I Clean Water Act 316(b) regulations, the withdrawal of cooling water from the Chesapeake Bay will be small. The effect will be to limit impact on near shore hydrology and the potential effects of impingement and entrainment. Measures to further reduce impingement will include intake approach velocities less than 0.5 ft/sec (0.15 m/sec).

Evaporative loss from the cooling tower will create a visible plume. The extent of the plume will vary seasonally. The median plume length is predicted to be less than 1 mi (1.6 km), except during the winter when it will be approximately 4 mi (6.4 km), and does not extend offsite except during winter. Salt deposition is likely to occur but will be below NUREG-1555 (NRC, 1999) significance levels at which visible vegetation damage may occur. Offsite noise from tower operations is predicted to be within applicable state regulatory requirements.

A portion of the CWS and ESWS cooling towers water will be discharge back into the Chesapeake Bay as blowdown to maintain water quality of the cooling water as it is recirculated. The maximum blowdown water temperature rise will be approximately 12°F (6.7°C). The resulting thermal plume is predicted to be small and should not pose a threat to marine biota. The thermal discharge will contain small amounts of chemicals used in plant systems and small quantities of radioactive liquids. Concentrations of these waste water constituents will be limited by NPDES permit requirements and applicable NRC radiological release limitations.

Socioeconomic impacts of CCNPP Unit 3 construction and operation are expected to be SMALL. It is estimated that many of the skilled construction laborers will commute to the site from outside the immediate geographic area and temporary housing and other related public services appear to be adequate to absorb both the temporary increase in workers during construction and the long-term, but smaller, increase in operational staff. Beneficial increases to the local economy from taxes and spending are likely to occur but are estimated to be a small percentage of the existing economy. There are no unique minority or low-income populations within the comparative environmental impact areas surrounding the CCNPP site. Therefore, it is not likely that these groups would be disproportionately affected by construction or operation.

10.1.4 REFERENCES

(NRC, 1999). Environmental Standard Review Plan, NUREG-1555, Nuclear Regulatory Commission, October 1999.

Table 10.1-1 Construction-Related Unavoidable Adverse Environmental Impacts (Page 1 of 6)

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
Land Use	{Approximately 420 acres (170 hectares) of land will be disturbed of which 281 acres (114 hectares) will be permanently committed to power plant structures and roads for CCNPP Unit 3.}	{Comply with applicable federal, state and local construction permits/approvals including Coastal Zone Management guidelines. Clear only areas necessary for installation of power plant infrastructure and implement construction Best Management and Storm Water Protection Plans. Limit activities in the 500 year flood plain to those associated with the intake structures. Implement a Site Resource Management Plan. Acreage will be restored/revegetated following construction to the maximum extent possible. Use of existing transmission corridor right-of-ways. Implement Storm Water Pollution Prevention Plan (SWPPP), including sediment and erosion control. Implement Spill Prevention Control and Countermeasures (SPCC) Plan. Use site Resource Management Plan and Best Management Practices (BMP) to protect resources such as wetlands and streams in vicinity; also, onsite land is not used for farmland nor is it considered prime or unique. Obtain individual U.S. Army Corps of Engineers 404 Permit; comply with BMP requirements. Obtain Maryland Non-Tidal Wetlands Protection Act permit; comply with BMP requirements.}	{281 acres (114 hectares) of land will be permanently occupied by nuclear plant infrastructure.}

Table 10.1-1 Construction-Related Unavoidable Adverse Environmental Impacts
(Page 2 of 6)

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
Land Use (continued)	Potential to disturb archaeological and architectural sites during construction	Undertake extensive archaeological survey of site prior to construction. Review significance of sites with the {Maryland State Historic Preservation Officer (SHPO)} and develop plans to avoid and/or minimize impacts to these sites. Develop procedures compliant with Federal and State laws to protect cultural, historical or paleontological resources or human remains in the event of discovery during construction.	Small potential for destruction of unanticipated historic and/or cultural resources.
Hydrologic and Water Use	Construction has the potential to change drainage characteristics, flood handling, and erosion and sediment transport.	Implement BMP and Storm Water Pollution Prevention (SWPPP) Plans according to applicable Local and State regulations to limit erosion and contamination of surface waters. Comply with the U.S. Army Corps of Engineers 404 Permit.	Potential erosion of sediments into surface waters {and local, temporary depression in the water table due to dewatering activities}.
	Construction will require approximately {250 gpm} of groundwater withdrawal.	{Water use controlled within the existing CCNPP Units 1 and 2 allowable withdrawal appropriations. Monitor perched and groundwater water levels. Use offsite water supply, as needed. Following construction, use of groundwater will be replaced with water provided by a desalinization unit. Dewatering ponds will assist with groundwater recharge and sediment control.}	{Temporary drawdown of the aquifer and redirection of recharge source water during construction.}
	Surface and subsurface water quality could be affected by construction activities.	Implement BMP and SWPPP. Monitor water quality in construction impoundments and compare to applicable criteria and historic data. Comply with the U.S. Army Corps of Engineers 404 Permit requirements. Use site Resource Management Plan to protect resources such as wetlands and streams in vicinity. Implement Spill Prevention, Control, and Countermeasures (SPCC) Plan.	Potential for contamination of subsurface groundwater.

Table 10.1-1 Construction-Related Unavoidable Adverse Environmental Impacts (Page 3 of 6)

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
Aquatic Ecology	{Two onsite ponds and a small stream will be permanently affected; others will experience temporary impairment resulting in elimination and/or displacement of aquatic species.}	{Implement BMP and SWPPP to limit erosion and sedimentation. Review CCNPP historic survey database to identify important aquatic species; conduct new surveys, as needed. Use site Resource Management Plan and BMP to protect resources.}	{Aquatic resources in the ponds and stream will be permanently lost.}
	{Chesapeake Bay marine life may be affected due to increased suspended sediment, dredging for the intake, and removal of substrate for the discharge structure.}	{Activities at the intake will occur within a sheet pile barrier. Dredging for the discharge will be confined to a small area and will quickly recolonize based on prior experience. Implement SWPPP, including sediment and erosion control and the construction of new impoundments, as appropriate. Comply with the U.S. Army Corps of Engineers 404 Permit requirements. Implement SPCC Plan. No marine or aquatic endangered species are expected to be impacted.}	{Benthic organisms in the dredged areas will be temporarily removed.}

Table 10.1-1 Construction-Related Unavoidable Adverse Environmental Impacts (Page 4 of 6)

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
Terrestrial Ecology	{Vegetation loss will occur in certain construction areas, including mixed forest, old field, and wetlands habitats.}	{Restore available old field not impacted by CCNPP with mixed deciduous forest to provide an overall net gain and provide a suitable location to transplant the showy goldenrod from the Camp Conoy area. Perform activities in wetlands in accordance with permit requirements of Section 404 of the Clean Water Act and the Maryland Non-tidal Wetlands Protection Act including setbacks and erosion controls. Facilities will be sited to limit wetland encroachment. Review CCNPP historic survey database to identify important terrestrial species; conduct new surveys, as needed. Use site Resource Management Plan and BMP to protect resources. Preserve aesthetically outstanding tree clusters, as practical; harvest merchantable timber; use or recycle other woody material, as appropriate; develop reforestation plan. Obtain individual U.S. Army Corps of Engineers 404 Permit; comply with BMP requirements. Obtain Maryland Non-Tidal Wetlands Protection Act Permit; comply with BMP requirements. Acreage will be restored following construction to the maximum extent possible.}	{A limited amount of mixed deciduous forest will be lost. A portion of onsite wetlands will be lost.}

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
Terrestrial Ecology (continued)	{Designated bird species may be displaced or disturbed.}	{Manage forest habitat specific to key bird species to limit habitat fragmentation. Reclamation of old fields will contribute to added forest habitat. Consult with appropriate agencies regarding avoidance and appropriate mitigation measures, if necessary, for bald eagle nests. Design construction footprint to account for Chesapeake Bay Critical Area and other important habitat, including bald eagle nests. Minimize lighting, as practicable and allowed by regulation. No activities will take place in the most favorable habitat area for the two threatened beetles, thereby avoiding impact.	{No unavoidable impacts.}
Socioeconomic	Construction workers, existing employees and local residents could be affected by increased dust, noise, emissions and traffic.	{Onsite noise will be maintained within applicable Maryland limits and OSHA noise-exposure limits. Limit construction activities resulting in non-routine noise levels to day time. Train construction workers and employees in use of appropriate personal protective equipment Develop fugitive dust and vehicle emissions control strategies in conformance with air quality standards and best management practices. Ameliorated traffic congestion with improvements to site access road from Maryland State Route 2/4 and with onsite shift changes. Comply with applicable U.S. EPA and Maryland Department of the Environment (MDE) air quality regulations. Install new site perimeter and access road.	{No unavoidable impacts.}

Table 10.1-1 Construction-Related Unavoidable Adverse Environmental Impacts (Page 6 of 6)

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
Socioeconomic (continued)	Public services supporting construction activities and expanded work force may be impacted.	{Available housing is adequate and many skilled laborers will be commuting from outside the region of influence. Minor aggregate socioeconomic impacts anticipated; mitigation not required.}	{No unavoidable adverse impacts.}
Radiological	{Construction workers will be exposed to small doses of radiation from existing units.}	{All doses will be within 10 CFR 20.1301 limits. Implement ALARA practices at construction site.}	{Small doses to construction workers.}
Atmospheric and Meteorological	Construction will cause increased air emissions from traffic and construction equipment, and fugitive dust.	Train construction workers and employees on appropriate personal protective equipment. Develop fugitive dust and vehicle emissions control strategies in conformance with air quality standards and best management practices. Equipment maintenance plans. Comply with applicable U.S. EPA {and MDE} air quality regulations.	No unavoidable adverse impacts.
Environmental Justice	{No disproportionate impacts to low income or minority groups were identified.}	{None.}	{No unavoidable adverse impacts.}
Non-radiological Health Impacts	Risk to workers from accidents and occupational illness.	Implement construction site-wide health and safety program.	Industrial worker accidents may occur.

Table 10.1-2 Operations-Related Unavoidable Adverse Environmental Impacts
(Page 1 of 4)

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
Land Use	{The CCNPP Unit 3 footprint will permanently occupy a portion of the site. Operation of the new unit will increase radioactive and non-radioactive waste disposal in landfills and onsite in long-term storage facilities.}	{Limit area required during design and construction. Implement a waste minimization, pollution prevention program to limit waste generation.}	{Land use is consistent with current operations at the site. Some land will be dedicated to offsite and onsite waste storage and will not be available for other uses.}
Hydrologic and Water Use	{Circulating water supply system makeup water will be withdrawn from Chesapeake Bay potentially affecting near-shore hydrology. Evaporative loss of water from the cooling tower represents a consumptive use.}	{Implement closed-cycle cooling and reduce water use. Use desalination to supply makeup water; minimize use of groundwater resources.}	{No unavoidable impact. A limited amount of cooling water taken from Chesapeake Bay will be consumed through evaporative loss.}
Aquatic Ecology	{Cooling water withdrawal will result in impingement and entrainment. Thermal plume may impact aquatic species abundance and distribution.	{Implement closed-cycle cooling. Limit intake velocity. Meet all applicable state and federal regulatory requirements regarding the discharge of heat. The diffuser is being designed to rapidly disperse the thermal discharge.	{Some limited entrainment and impingement will occur. A small thermal plume will be created.}

Table 10.1-2 Operations-Related Unavoidable Adverse Environmental Impacts
(Page 2 of 4)

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
Aquatic Ecology (continued)	Biofouling and other process control chemicals will be discharged. Recreational and commercial fishing may be impacted by impingement and entrainment.}	Meet all applicable state and federal Clean Water Act and NPDES permit regulations and limitations. Implement closed-cycle cooling.}	Chemicals will be discharged in small quantities. No unavoidable adverse impacts.}
Terrestrial Ecology	{Operation of the cooling tower would result in a visible plume, fogging, icing and salt deposition. Salt deposition from the cooling tower operations will have some impact on terrestrial vegetation. Bird collisions with the tower may occur.}	{Use of low-profile cooling tower with drift eliminators to limit evaporative loss and deposition. Use of low-profile cooling tower and lower lighting.}	{The tower plumes will be visible from beyond the site boundary and from Chesapeake Bay No unavoidable adverse impacts. {No unavoidable adverse impacts.}
Socioeconomic	{Operating nuclear plants emit low noise. The additional transmission line has potential to cause electric shock onsite Cooling tower and plume may impact existing site aesthetics.	Studies demonstrate noise levels on and offsite will meet applicable regulations. Design to NESC code to minimize potential impacts. Site contours and the forest canopy limit landward visibility. The new facilities will be consistent with existing uses. The towers will have a low-profile.	No unavoidable adverse impacts. No unavoidable adverse impacts. The cooling tower plume will be visible from Chesapeake Bay, and inland offsite during winter.

Table 10.1-2 Operations-Related Unavoidable Adverse Environmental Impacts (Page 3 of 4)

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
Socioeconomic (continued)	An additional 363 permanent staff will increase traffic during shift changes.	A new access road and interconnection with Maryland State Route 2/4 will limit traffic congestion. Heavy plant components will be barged in.	No unavoidable adverse impacts.
	Air quality could potentially be affected due to onsite diesel generators.	Conform to state and federal emission standards and permit requirements.	No unavoidable adverse impacts.
	Population increases due to added staff may affect public services.}	Existing capacity exists to absorb the increased population related services.}	No unavoidable adverse impacts.}
Radiological	{Potential doses to members of the public from releases to air and surface water.	All releases will be well below regulatory limits.	{No unavoidable adverse impacts.
	General public and worker exposure to radiation during incident-free transport of fuel and wastes.}	Detailed analysis performed in accordance with 10 CFR 51.52(b), yielding conservative results.}	No unavoidable adverse impacts.}
Atmospheric and Meteorological	{The cooling tower plume will traverse the site.}	{Use of cooling tower drift eliminators to limit drift losses.}	{During certain times of the year, the plume will be visible offsite.}

Table 10.1-2 Operations-Related Unavoidable Adverse Environmental Impacts
(Page 4 of 4)

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
Environmental Justice	{No disproportionately high or adverse impacts on minority or low income populations are predicted}	{None required.}	{No unavoidable adverse impacts.}
Non-radiological Health Impacts	{Potential growth of infectious organisms within the Essential Service Water System coolong towers. Risk to workers from occupational related accidents and illnesses.}	{Apply best management biocide treatment to limit growth and dispersal of harmful organisms.} Implement site-wide Safety and Medical Program.}	{No unavoidable adverse impacts. Some accidents are likely to occur.}

10.2 Irreversible and Irretrievable Commitments of Resources

10.2 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

This section describes the expected irreversible and irretrievable environmental resource commitments used in the construction and operation of {Calvert Cliffs Nuclear power Plant (CCNPP) Unit 3}. The information contained in this section satisfies the requirements of 10 CFR 51.45(b)(5) (CFR, 2007) and 10 CFR 51, Appendix A to Subpart A (CFR, 2007), with respect to consideration of irreversible and irretrievable commitment of resources (CFR, 2007).

Irreversible resource commitments are those that could not be restored at a later time to pre-existing conditions. Irretrievable resources are materials that will be used that could not, by practical means, be recycled or restored for other uses.

10.2.1 IRREVESIBLE ENVIRONMENTAL COMMITTMENTS

Irreversible environmental commitments resulting from installation of {CCNPP Unit 3} in addition to materials used for nuclear fuel fabrication and onsite structural components include:

- Surface water
- Land
- Aquatic and terrestrial biota, and
- Releases to air and surface water

10.2.1.1 SURFACE WATER

{Surface waters will be withdrawn from the Chesapeake Bay to support the Circulating Water Supply System (CWS) and Essential Service Water Systems (ESWS). Some of this water will be consumed as a result of evaporative loss from the cooling towers. The remainder will be returned to the Chesapeake Bay. The amount of water potentially lost from the CWS cooling tower due to evaporation is expected to be approximately 17,400 gpm (65,920 lpm). Evaporative loss from the ESWS cooling tower will be approximately 940 gpm (3,560 Lpm) during operation. Because evaporative loss is consumptive, it will be unavailable for other uses.

The onsite water courses and non-tidal wetlands that will be filled or otherwise modified to accommodate the construction of CCNPP Unit 3 represent a small percent of the existing areas occupied by these natural resources. While the overall percent of area to be affected is small, those areas included within the CCNPP Unit 3 footprint will be permanently unavailable for reclamation in the future.

The groundwater limits currently permitted for CCNPP Units 1 and 2 will be adhered to in meeting water demands during construction of CCNPP Unit 3. Groundwater withdrawals will not be needed to support operation of CCNPP Unit 3. Groundwater that is removed from the aquifer to support construction will be consumed or managed as surface water run off. The impact to this resource will be temporary and small. Because the resource use is consumptive, it will not be available for other uses.}

10.2.1.2 LAND USE

Land designated for the storage of radioactive and non-radioactive waste on and offsite is dedicated to that use and will be unavailable for other uses during the operational period. Following decommissioning and the development of permanent offsite storage, the onsite waste storage areas could be reclaimed.

10.2.1.3 AQUATIC AND TERRESTRIAL BIOTA

{Construction of CCNPP Unit 3 will require the removal of a portion of the onsite mixed deciduous forest and will encroach on landward surface waters and wetlands. These areas will be permanently occupied by plant structures during operations and will be unavailable for reclamation. However, the construction areas represent a small percentage of the overall site acreage and do not contain any unique or otherwise protected aquatic or wetland species.}

10.2.1.4 RELEASES TO AIR AND SURFACE WATER

Radioactivity, air pollutants and chemicals will be released to the environment during routine operations of {CCNPP Unit 3}. Since these releases will conform to applicable Nuclear Regulatory Commission, U.S. Environmental Protection Agency and the {State of Maryland} regulations, their impact to the public health and the environment would be limited. Routine long-term monitoring of radioactivity in the environment and the measurement of chemical concentrations discharged will be performed to verify regulatory compliance.

10.2.2 IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irretrievable commitments of resources during construction of {CCNPP Unit 3} will be similar to that required for other major energy construction projects. Studies performed for the U.S. Department of Energy have summarized the amount of materials historically consumed for nuclear power plant construction (DOE, 2004a) (DOE, 2005).

For a typical new 1,300 MWe nuclear power plant, it can be estimated that reactor building steel-plate reinforced structures would require 12,239 yards of concrete and 3,107 tons of rebar. Approximately 2,500,000 linear feet of cable would be required for the reactor building, and 6,500,000 linear feet of cable and up to 275,000 feet of piping for the unit. Based on historical information from operating reactors (DOE, 2005), it is estimated that pressurized water reactors between 1,000 and 1,300 MWe require a total of approximately 182,900 cubic yards of concrete to construct the reactor building, major auxiliary buildings, turbine generator building and the turbine generator pedestal. A total of 20,512 tons of structural steel was typically required.

The rated electrical output for {CCNPP Unit 3} is 1,710 MWe. This is approximately 30% higher than the largest plant referenced in the historical data. However, these historical estimates are representative of the quantities of materials that will be consumed during construction. Historical data for materials consumed for domestic nuclear power plant construction in the 1970's is summarized in Table 10.2-1 (DOE, 2005).

While these quantities are large, their use provides a cost-effective allocation of resources given that energy from nuclear power plants is now increasingly cost competitive (DOE, 2004a) (DOE, 2005). Furthermore, nuclear energy provides environmental benefits consistent with current concerns relative to overall life cycle environmental effects caused by fuel extraction, emission of air pollutants and solid waste disposal typically associated with fossil fuel (DOE, 2004b) (WNA, 2005).

Irretrievable resources include uranium and the energy used to fabricate fuel. However, available supplies of uranium suggest that there is a considerable degree of security of supply to ensure the continued operation and expansion of nuclear power for the foreseeable future (NEA, 2002) (WNA, 2006).

While a given quantity of material consumed during construction and operation of {CCNPP Unit 3} will be irretrievable, except for materials recycled during decommissioning, the impact on their availability is expected to be small.

10.2.3 REFERENCES

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Table 10.2-1 Summary of Historical Data – Materials Consumed by Nuclear Power Plant Construction in the United States During the 1970's (Page 1 of 1)

	BWR 1074-1308 MWE	PWR 1116-1311 MWE	LWR 1074-1311 MWE
Building Volume			
Building Volume 1,000,000 ft^3 (1,000,000 m^3)	14.6 (0.41)	15.9 (0.45)	15.3 (0.43)
Concrete (Reactor Building, Major Auxiliary Buildings, Turbine Generator Building, Turbine Generator Pedestal, Other)			
Concrete 1,000 yds^3 (1,000 m^3)	195.7 (149.6)	182.9 (139.8)	188.7 (144.3)
Concrete yds^3/net KW (m^3/net KW)	173.2 (132.4)	152.8 (116.8)	162.1 (123.9)
Concrete yds^3/building 1,000 ft^3 (m^3/building 1,000 ft^3)	12.5 (9.6)	11.3 (8.6)	11.8 (9.0)
Structural Steel (supports, shield plate, miscellaneous steel)			
Structural Steel Tons (MT)	13,642 (12,376)	20,512 (18,608)	17,389 (15,775)
Structural Steel lb/net KW (kg/net KW)	23.9 (10.8)	34.1 (15.5)	29.5 (13.4)
Structural Steel TN/building 1,000 ft^3 (MT/building 1,000 m^3)	0.94 (.024)	1.30 (0.033)	1.13 (0.029)

BWR – Boiling water reactor
PWR – Pressurized water reactor
LWR – Light water reactor

10.3 Relationship between Short-term Uses and Long-term Productivity of the Human Environment

10.3 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY OF THE HUMAN ENVIRONMENT

The {CCNPP Unit 3} environmental report provides information associated with the environmental and socioeconomic impacts of activities that occur during construction and operation. These activities are considered short-term for purposes of this section and include that period through prompt decommissioning. Long-term is considered to be that period from construction to end of plant life and beyond that required for delayed decommissioning. This section reviews the extent to which the proposed project use of the environment precludes any future, long-term use of the site.

The information contained in this Section satisfies the requirements of 10 CFR 51.45(b)(4) (CFR, 2007) and 10 CFR 51, Appendix A to Subpart A (CFR, 2007), with respect to consideration of irreversible and irretrievable commitment of resources.

10.3.1 CONSTRUCTION AND LONG-TERM PRODUCTIVITY

Section 10.1 summarizes the potential unavoidable adverse environmental impacts of {CCNPP Unit 3} construction including measures being implemented to mitigate those impacts. While some impacts will remain following construction, none should preclude the future use of the site following decommissioning.

{CCNPP Unit 3} is being constructed on the {existing nuclear power plant site for CCNPP Units 1 and 2. As a result, construction related activities and permanent structures will be consistent with established site use. Construction activities will occupy a footprint larger than the permanent structures required for operations because of the need for additional temporary work force parking, equipment and material lay-down areas and construction buildings.}

The acreage to be disturbed includes {existing mixed deciduous forest and a small portion of the site's existing surface waters and non-tidal wetlands. Current plans call for reclaiming those areas affected by construction including use of old field onsite for supplemental forest plantings}. These mitigation measures will limit terrestrial impacts and protect long-term productivity.

Groundwater and surface waters will be temporarily disturbed during construction due to water withdrawal and creation of dewatering basins. Following completion of construction these impacts will cease and groundwater should recharge to pre-construction levels with no long-term loss of surface or subsurface water resources.

Potential archaeological and architectural sites located in the construction area will be managed in cooperation with the {Maryland State Office of Historic Preservation} so that appropriate mitigative actions are implemented.

{Construction of the CCNPP Unit 3 intake and discharge structures will require some disturbance of sediments within the intake embayment and in the area of the proposed discharge multi-port diffuser. Existing ecological studies performed for CCNPP Units 1 and 2 show that these impacts are temporary and will not affect long-term ecological productivity of the Chesapeake Bay in the Calvert Cliffs area}.

Noise above ambient levels will occur onsite due to some construction activities. However, at the site boundary, construction related noise is expected to conform to applicable state and federal environmental standards. Non-routine noise, such as blasting, will be limited to day time. Since construction noise is temporary, there would be not long-term impacts.

Temporary traffic increases will occur due to the numbers of additional workers required to support construction. {A new site access road is proposed to alleviate onsite and offsite traffic during this period and through operations and decommissioning with no long-term impact.}

Economic benefits during construction accrue from the need for temporary housing and local spending. It is predicted that while this benefit is substantial, it will represent a small increment to the total economic base of the {CCNPP site two-county area}.

10.3.2 OPERATION AND LONG-TERM PRODUCTIVITY

The potential unavoidable adverse environmental impacts of {CCNPP Unit 3} operation are also summarized in Section 10.1 along with proposed mitigation measures. Some impacts will occur during {CCNPP Unit 3} operations but will largely terminate upon plant shut down and any residual environmental issues resolved during decommissioning such that long-term uses of the site are not precluded.

Environmental impacts during operations are largely related to operation of the CWS system and ESWS and the generation of radioactive wastes. Impacts of the cooling water systems stem from withdrawal of water from the {Chesapeake Bay via the intake structures, evaporative loss from the systems' cooling towers and the return of cooling water back to the Chesapeake Bay}.

The use of closed-cycle cooling systems will substantially reduce these potential impacts such that during and following operations there would be no long-term loss of ecological productivity of marine resources in the {Chesapeake Bay}. The long-term reproductive viability of marine species potentially affected by entrainment or impingement is expected to be unaffected, resulting in no long-term power plant related loss in biomass.

Discharge of the thermal plume and associated power plant chemical additives will meet applicable permit regulatory requirements during operations and are not expected to have any long-term consequences for water quality in the {Chesapeake Bay}. Due to the use of closed-cycle cooling, the thermal plume is predicted to occupy a comparatively small area. Similarly the concentrations of chemicals released will be limited and will quickly dissociate in marine waters with little or no long-term accumulation.

Evaporative loss of water from the cooling towers represents a consumptive use during operations but will cease following plant shutdown. {Salt deposition during cooling tower operations is not predicted to cause visible vegetative impacts, yet this potential impact will also cease following shutdown as well. It is expected that terrestrial plants and/or soil will quickly recover should impacts be observed.}

Emission of fossil fuel combustion byproducts will increase during the periodic testing of the {CCNPP Unit 3} diesel generators. The amount of emissions will be governed by applicable state permits and federal standards for air pollutants. Since the emissions are periodic and transient, and will cease following {CCNPP Unit 3} shutdown, long term impacts to air quality are not expected.

Radiological releases will be controlled according to applicable state and federal standards to ensure protection of terrestrial and marine biota, and protection of workers and the general public. Onsite storage of radioactive wastes will be temporary and ultimately removed from site. Reclamation of the site including removal of any radioactive contamination will occur such that future long-term uses of the site are not precluded.

Socioeconomic benefits to the counties surrounding the {CCNPP} site will result from increased taxes, additional spending and housing. While the relative impact to the economic base is small, some benefit will continue up to and through decommissioning, particularly where increased tax revenues have been used to enhance public infrastructure and services.

10.3.3 SUMMARY OF RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

{The construction and operation of CCNPP Unit 3 will result in some limited short-term and unavoidable impacts to the environment. Mitigation measures have been proposed to limit both the short-term impacts of construction and those that may occur during the operational life of Unit 3. Benefits accrue from the production of electricity and increases in the tax base that could support public infrastructure and services. Following site decommissioning, it is expected there will be no long-term impacts on productivity or the human environment that would preclude alternative uses of the site.}

10.3.4 REFERENCES

CFR, 2007. Title 10, Code of Federal Regulations, Part 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions, 2007.

10.4 Benefit-Cost Balance

10.4 BENEFIT-COST BALANCE

This section describes the benefit-cost balance resulting from the proposed construction and operation of {Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3}. It was prepared in accordance with the guidance provided in NUREG-1555 (NRC, 1999) i.e., "Environmental Standard Review Plan" (ESRP). Section 10.4.1 describes the benefits of the proposed project; Section 10.4.2 discusses the costs associated with the proposed project; and Section 10.4.3 provides a benefit-cost balance summary.

The information contained in this Section satisfies the requirements of 10 CFR 51.45(d) (NRC, 2007) and 10 CFR 51, Appendix A to Subpart A (NRC,2007), with respect to consideration of irreversible and irretrievable commitment of resources.

10.4.1 BENEFITS

This section discusses the benefits resulting from the proposed construction and operation of {CCNPP Unit 3}. The information provided in this section was prepared in accordance with the guidance provided in NUREG-1555, ESRP 10.4.1 (NRC, 1999). Information provided in this section includes a summary of the following information:

- The evaluation that was performed to determine if there is sufficient demand for new electric power in Maryland;
- The evaluation that was performed to determine an electric power generation source (i.e., coal, gas, nuclear, solar, wind);
- The evaluation that was performed to choose a location for the selected electric power generation source; and
- Benefits that the new electric power generation facility will provide.

Table 10.4-1 summarizes the benefits and costs of the proposed action. Section 10.5 summarizes the potential cumulative adverse environmental impacts at the site. These benefits and costs include:

- Identification of appropriate plant production benefits;
- Calculation of the plant average annual electrical-energy generation in kilowatt-hours (kWh);
- Evaluation of the reliability of the electrical distribution system;
- Identification of other project benefits, including state and local tax revenues, regional productivity, enhancement of recreational and aesthetic values, environmental enhancement, creation and improvement of local roads or other facilities, and intangible benefits (e.g., reduced dependence on scarce fossil fuels);
- Quantification of benefits in monetary or other appropriate terms;
- Evaluation of the significance of the benefits on a political boundary or regional basis; and
- Assessment of any potential social or economic impacts as a result of the proposed project construction and operation

The potential cumulative adverse impacts at the site resulting from construction of a new power plant are summarized in Section 10.5

10.4.1.1 Need for Power

{As discussed in Section 8.4, the Maryland Public Service Commission (PSC) noted in its adequacy supply report that the need for in-state generating capacity is increasing rapidly. The PSC assessed the following factors for its growing concern about reliability and power supply:

Maryland's growing reliance on imported electricity and the need for infrastructure additions and new transmission.

Maryland's dependence on out-of-state generation resources will likely increase over the next 5 to 10 years because of both growth in electricity demand, and the possible de-rating or retirement of existing generating units. Further contributors to the uncertain outlook for supply adequacy is that over the next 10 years only a small amount of new electricity generation will likely be built in Maryland. The conclusion that there is a need for new baseload generating capacity in Maryland based on the following:

- Maryland has a well-defined, systematic, and comprehensive resource monitoring, assessment, and reporting process that adequately reviews the state's resources and growing demand for additional baseload, eliminating the need for additional Nuclear Regulatory Commission (NRC) review; and
- The PSC/ Power Plant Research Program (PPRP)/ Certificate of Public Convenience and Necessity (CPCN) process in Maryland assures the NRC that construction would not proceed without Maryland's due consideration of the projects impact on the adequacy, stability, and reliability of the electrical system in the state; and
- The PSC has concluded that there is a need for new baseload capacity, and this conclusion has been given "great weight" in this ER, as allowed by NUREG-1555 (NRC, 1999).**}**

10.4.1.2 Energy Alternatives

{The following paragraphs provide a summary of the evaluation that was conducted in Section 9.2, to determine a suitable electric generating power source to meet the demand for new power in Maryland. The evaluation identified alternatives that would require the construction of new generating capacity—such as wind, geothermal, oil, natural gas, hydropower, municipal solid wastes (MSW), coal, photovoltaic (PV) cells, solar power, wood waste/biomass, and energy crops, as well as any combination of these alternatives. In addition, alternatives that would not require new generating capacity were evaluated, including initiating energy conservation measures and Demand-Side Management (DSM), reactivating or extending the service life of existing plants within the power system, and purchasing electric power from other sources.

The evaluation indicated that neither a coal-fired nor a gas-fired facility would appreciably reduce overall environmental impacts relative to a new nuclear plant. Furthermore, a coal-fired and a gas-fired facility would entail a significantly greater environmental impact on air quality than would a new nuclear plant. The analysis indicated that wind and solar facilities in combination with fossil facilities could be used to generate baseload power. However, wind and solar facilities in combination with fossil facilities would have higher costs and larger land requirements than a new nuclear facility and therefore are not preferable to a new nuclear facility.

Based on environmental impacts, it has been concluded that neither a coal-fired, nor a gas-fired, nor a combination of alternatives, including wind and solar facilities, would appreciably reduce overall environmental impacts relative to a new nuclear plant; therefore making nuclear power a suitable electric power generation source.**}**

10.4.1.3 Alternative Locations for the Proposed Facility

The following paragraphs provide a summary of the evaluation that was conducted in Section 9.3 to identify a preferred location for the new nuclear power facility. The objective of the evaluation was to verify that no obviously superior location for the siting of a new nuclear unit exists.

{Two alternative nuclear sites were chosen for the analysis: 1) Nine Mile Point Nuclear Plant, Oswego County, Scriba, New York; and 2) R.E. Ginna Nuclear Power Plant, Wayne County, Ontario, New York. The analysis also evaluated a brownfield site located at the Crane Generating Station on the Chesapeake Bay in Baltimore County, Maryland. These sites were chosen because they are owned by Constellation and they are in relatively close proximity to the CCNPP site.} In addition, a preliminary evaluation was done on a generic undeveloped greenfield site. The sites were evaluated based on potential impacts to land use, air quality water, terrestrial ecology and sensitive species, aquatic ecology and sensitive species, demographics, and historic, cultural, and archeological resources.

{The evaluation concluded that the preferred location for the new nuclear facility is collocation with an existing nuclear facility.} Siting a new reactor at an existing nuclear facility offers a number of benefits:

- By collocating nuclear reactors, the total number of generating sites is reduced.
- No additional land acquisitions are necessary, and the applicant can readily obtain control of the property. This reduces both initial costs to the applicant and the degree of impact to the surrounding anthropogenic and ecological communities.
- Site characteristics, including geologic/seismic suitability, are already known, and the site has already undergone substantial review through the National Environmental Policy Act (NEPA) process during the original selection procedure.
- No new analysis of site appropriateness is necessary, which can reduce start-up costs. In addition, the environmental impacts of both construction and operation of the existing unit are known. It can be expected that the impacts of a new unit should be comparable to those of the operating nuclear plant.
- Collocated sites can share existing infrastructure, reducing both development costs and environmental impacts associated with construction of new access roads, waste disposal areas, and other important supporting facilities and structures. Construction of new transmission corridors may be eliminated or reduced because of the potential use of existing corridors.
- Existing nuclear plants have nearby markets, the support of the local community, and the availability of experienced personnel.

The analysis concluded that the greenfield site could be dismissed from further evaluation based on high costs and potential adverse environmental impacts. Development of the brownfield site would offer no advantages and would increase both the cost of the new facility and the severity of impacts. Development of either of the two alternative nuclear sites offers no environmental advantages over locating the new nuclear facility at the existing {CCNPP} site.

10.4.1.4 Benefits of the Proposed Facility

Locating the proposed new nuclear facility at the existing {CCNPP} property will afford benefits to the local economy. The {CCNPP} owners will pay property taxes on the proposed new unit for the duration of the operating licenses. {CCNPP} owners estimate that annual property tax payments could reach approximately {[ ] million in 2015, the year of plant startup and a maximum of [ ] million as described in Section 4.4.2.6.2.} Most people consider large tax payments a benefit to the taxing entity because they support the development of infrastructure that supports further economic development and growth.

{Approximately 833 people are employed at the existing CCNPP facility (BGE, 1998). It is anticipated that construction and operation of the new facility would require a skilled workforce of 363 people.} New jobs within approximately a 50 mi (80 km) radius of the plant would be

10.4.2.2 Monetary - Operation

Operation costs for CCNPP Unit 3 are in the process of being estimated. Operation costs are frequently expressed as the levelized cost of electricity, which is the price at the busbar needed to cover operating costs and annualized capital costs. Overnight capital costs account for a third of the levelized cost, and interest costs on the overnight costs account for another 25% (UC, 2004). At this time, levelized cost estimates ranging from $31 to $46 per MWh ($0.031 to $0.046 per kWh) has been selected. Factors affecting the range include choices for discount rate, construction duration, plant life span, capacity factor, cost of debt and equity and split between debt and equity financing, depreciation time, tax rates, and premium for uncertainty.

- Estimates include decommissioning but, because of the effect of discounting a cost that would occur as much as 40 years in the future, decommissioning costs have relatively little effect on the levelized cost. In addition, the Energy Policy Act of 2005 instituted a production tax credit for the first advanced reactors brought on line in the U.S. (PL, 2005) would tend to lower this estimate.

10.4.3 SUMMARY

Table 10.4-1 summarizes the benefits and costs associated with the proposed construction and operation of {CCNPP Unit 3}. Costs that are environmental impacts are those anticipated after proposed mitigation measures are implemented. Section 10.5 addresses the environmental costs and cumulative impacts.

10.4.4 REFERENCES

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Information withheld in accordance with 10 CFR 2.390, "Public inspections, exemptions, requests for withholding," paragraph (d)(1).

Table 10.4-1 Benefit and Costs of the Proposed Project Summarized (Page 1 of 7)

Cost Category	{CCNPP Site	Brownfield Site	Nine Mile Point Site	Ginna Site}
		INTERNAL COSTS		
Construction Cost	[ ] (It is anticipated that CCNPP Unit 3 will have a net electrical output of approximately 1,600 MWe. Using the value of [ ] per kW results in a CCNPP Unit 3 construction cost of approximately [ ].	[ ] (It is anticipated that the installed reactor will be similar to CCNPP Unit 3 (net electrical output of approximately 1,600 MWe. Using the value of [ ]per kW results in a construction cost of approximately [ ].	[ ] (It is anticipated that the installed reactor will be similar to CCNPP Unit 3 (net electrical output of approximately 1,600 MWe. Using the value of [ ] per kW results in a construction cost of approximately [ ]	[ ] (It is anticipated that the installed reactor will be similar to the CCNPP Unit 3 (net electrical output of approximately 1,600 MWe. Using the value of [ ] per kW results in a construction cost of approximately [ ]}
Operating Cost	{$0.031 to $0.046 per kilowatt-hour	$0.031 to $0.046 per kilowatt-hour	$0.031 to $0.0 46 per kilowatt-hour	$0.031 to $0.046 per kilowatt-hour}
Land	{The CCNPP site is 2,057 acres (832 hectares). Co-located on the CCNPP site with CCNPP Units 1 and 2. Impact on land use is minimal compared to a new site. SMALL	Existing power plant site is 157 acres (63 hectares) Co-located with existing power plant facility. Impact on land use is minimal compared to new site. Potential wetland issues. MODERATE	900 acres (364 hectares) of available space is available at the existing NMP site for the new facility. Co-located with existing nuclear facility. Impact on land use is minimal compared to new site. SMALL	425 acres (172 hectares) of available space is available at the existing Ginna site for the new facility. Co-located with existing nuclear facility. Impact on land use is minimal compared to new site. SMALL}
Labor	{Add 363 direct new jobs, 660 indirect new jobs to the benefits. SMALL	It is assumed that similar size workforce to that which is anticipated for the proposed CCNPP facility. SMALL	It is assumed that similar size work force to that which is anticipated for the proposed CCNPP facility. SMALL	It is assumed that similar size workforce to that which is anticipated for the proposed CCNPP facility. SMALL}

Table 10.4-1 Benefit and Costs of the Proposed Project Summarized (Page 2 of 7)

Cost Category	{CCNPP Site	Brownfield Site	Nine Mile Point Site	Ginna Site}
Materials	{Construction materials include: concrete, aggregate, rebar, conduit, cable, piping, building supplies, and tools. Operating material includes uranium	Construction materials include: concrete, aggregate, rebar, conduit, cable, piping, building supplies, and tools. Operating material includes uranium	Construction materials include: concrete, aggregate, rebar, conduit, cable, piping, building supplies, and tools. Operating material includes uranium	Construction materials include: concrete, aggregate, rebar, conduit, cable, piping, building supplies, and tools. Operating material includes uranium}
Equipment	{Typical construction equipment will include cranes, cement trucks, excavation equipment, dump truck, and graders. Equipment for the new facility would include all of the necessary components for the facility such as the reactor, turbine, cooling system, water processing/ treatment system, cooling tower, etc.	Typical construction equipment will include cranes, cement trucks, excavation equipment, dump truck, and graders. Equipment for the new facility would include all of the necessary components for the facility such as the reactor, turbine, cooling system, water processing/treatment system, cooling tower, etc.	Typical construction equipment will include cranes, cement trucks, excavation equipment, dump truck, and graders. Equipment for the new facility would include all of the necessary components for the facility such as the reactor, turbine, cooling system, water processing/treatment system, cooling tower, etc.	Typical construction equipment will include cranes, cement trucks, excavation equipment, dump truck, and graders. Equipment for the new facility would include all of the necessary components for the facility such as the reactor, turbine, cooling system, water processing/treatment system, cooling tower, etc.}
Services	{Support services and supplies would be needed during construction. Security, maintenance, trash removal, and/or landscaping services may be needed during operation of the facility.	Support services and supplies would be needed during construction. Security, maintenance, trash removal, and/or landscaping services may be needed during operation of the facility.	Support services and supplies would be needed during construction. Security, maintenance, trash removal, and/or landscaping services may be needed during operation of the facility.	Support services and supplies would be needed during construction. Security, maintenance, trash removal, and/or landscaping services may be needed during operation of the facility.}

Table 10.4-1 Benefit and Costs of the Proposed Project Summarized (Page 3 of 7)

Cost Category	{CCNPP Site	Brownfield Site	Nine Mile Point Site	Ginna Site}
Water Use	{Chesapeake Bay water demand equals an estimated total 43,480 gpm (164,590 lpm). Surface and groundwater use will be mitigated by construction of desalinization plant for cooling water systems. SMALL	Adequate surface water (Gunpowder River, Chesapeake Bay) for plant use SMALL	Groundwater not used at current facility. Adequate surface water (Lake Ontario) for plant use. SMALL	Groundwater not used at current facility. Adequate surface water (Lake Ontario, Mill and Deer Creeks) for plant use. SMALL}
EXTERNAL COSTS				
Land Use	{Existing CCNPP site is 2,057 acres (832 hectares) Co-located on the CCNPP site with CCNPP Units 1 and 2. Impact on land use is minimal compared to new site. SMALL	The site is much smaller than the area required for siting a nuclear plant. Both the site and the surrounding land have been designated as critical areas. Impact on land use is MODERATE given the potential wetland issues. MODERATE	This site is capable of supporting the required 345 kV transmission lines, but will require upgrades to the switchgear. However, the tie in is currently congested with limited transmission corridor space. Two existing meteorological towers and firing range would need to be relocated since they would be affected by the new facility. No barge off-loading facility is located at the site. Rail would require licensing and reinstallation. Co-located with existing nuclear facility. Impact on land use is moderate because the new reactor would be placed near existing nuclear facilities given the potential wetland issues. SMALL-MODERATE	Currently, no right of way capable of supporting the necessary 345 kV transmission lines exists. The tie in with the existing 345 kV transmission corridor would require 20 mi (6 km) of new transmission lines and right-of-way. Estimated cost of transmission lines is $3 million per mile (not including the cost of the land). An existing meteorological tower and a proposed firing range would need to be relocated since they would be affected by the new facility. No barge off-loading facility is located at the site. Rail is not routed to the site. Impact on land use is minimal because the new reactor would be placed near existing power generating facilities. SMALL-MODERATE }

Table 10.4-1 Benefit and Costs of the Proposed Project Summarized (Page 4 of 7)

Cost Category	{CCNPP Site	Brownfield Site	Nine Mile Point Site	Ginna Site}
Air Quality	{Calvert County is in attainment with all National Ambient Air Quality Standards except for ozone. Based on the design of the new reactor, siting the unit at this location would have a SMALL impact on air quality. SMALL	The existing power facility must meet all applicable federal, state, and local air quality permitting regulations. Based on the design of the new reactor, siting the unit at this location would have a SMALL impact on air quality. SMALL	NMP is not located in an area designated as a maintenance or non-attainment area for any air pollutants by the U.S. Environmental Protection Agency. Emissions are low enough at the existing NMP facilities to be exempt from any permit requirements. Based on the design of the new reactor, siting the unit at this location would have a SMALL impact on air quality. SMALL	Air quality in the Ginna region exceeds national standards for all measured parameters. There are no nearby areas designated as areas of non-attainment or maintenance. (Emissions from existing plant activities are below state and federal thresholds; therefore operations at Ginna do not require any air quality permits. Based on the design of the new reactor, siting the unit at this location would have a SMALL impact on air quality. SMALL}
Terrestrial Biology	{The CCNPP site is largely forested and situated among other large forested tracts. Together these tracts form one contiguous and predominantly undeveloped forested area. The Wildlife Habitat Council has certified and registered the CCNPP site as a valuable corporate wildlife habitat SMALL-MODERATE	Both the site and the surrounding land have been designated as critical areas. Although no State or Federally listed species or sensitive habitats, archeological or historical resources, or scenic views are located in the immediate vicinity of the site, the adjacent land area is predominantly wetlands and is zoned for resource conservation. MODERATE-LARGE	The predominant land cover at the NMP site is woodlands. Federal- and state-designated wetlands including shrub wetlands, bogs, emergent marshes, and forested wetlands and inactive agricultural lands also occur on the site. Flora and fauna found on or near the site are typical of disturbed areas in the coastal communities of the region. The area is part of the Atlantic Flyway, so bird numbers and species vary seasonally as birds migrate through or return to breed. SMALL-MODERATE	The Ginna site is surrounded by a variety of habitat types, such as mature woodlands, meadows, and abandoned farm fields, all typical of central and western New York. There is no State or Federally regulated wetlands at Ginna, and no federally-listed threatened or endangered terrestrial breeding species are known to occur at the site. SMALL-MODERATE}

Table 10.4-1 Benefit and Costs of the Proposed Project Summarized (Page 5 of 7)

Cost Category	{CCNPP Site	Brownfield Site	Nine Mile Point Site	Ginna Site}
Aquatic Biology	{The area of the Chesapeake Bay where CCNPP is located is in the mesohaline zone, which is characterized by moderate salinity. Mitigation/monitoring with applicable federal, state, and local permitting regulatory entities will occur during construction and operation. SMALL	Both the site and the surrounding land have been designated as critical areas. Although no State or Federally listed species or sensitive habitats, are located in the immediate vicinity of the site, the adjacent land area is predominantly wetlands and is zoned for resource conservation. MODERATE-LARGE	There are no Federally listed threatened or endangered aquatic species in the vicinity of the NMP site. No state-listed endangered aquatic species has been collected in the extensive lake sampling and impingement monitoring efforts at the NMP site or the nearby J.A. Fitzpatrick nuclear plant and Oswego Steam Station. SMALL	Although Ginna is situated on the shore of Lake Ontario, there are no aquatic species federally listed as threatened or endangered in the vicinity of the Ginna site. SMALL}
Socioeconomic	{75,000 county population $70,000 median household income SMALL	732,700 county population $74,388 median household income SMALL	123,000 county population $38,000 median household income SMALL	94,000 county population $44,000 median household income SMALL}
Housing	{May be short term negative impact on availability of housing units in the area during construction SMALL	May be short term negative impact on availability of housing units in the area during construction SMALL-MODERATE	May be short term negative impact on availability of housing units in the area during construction SMALL	May be short term negative impact on availability of housing units in the area during construction SMALL}
Local Infrastructure	{Increased traffic at beginning and end of shifts may increase traffic on highways to and from plant. Little impact on availability of services; CCNPP Unit 3 will be built and operated in a large urbanized area. SMALL	Increased traffic at beginning and end of shifts may increase traffic on highways to and from plant. Little impact on availability of services. The proposed unit will be built and operated in an urban/rural area. SMALL-MODERATE	Increased traffic at beginning and end of shifts may increase traffic on highways to and from plant. Little impact on availability of services. The proposed unit will be built and operated in a large urbanized area. SMALL	Increased traffic at beginning and end of shifts may increase traffic on highways to and from plant. Little impact on availability of services. The proposed unit will be built and operated in a large urbanized area. SMALL}

Table 10.4-1 Benefit and Costs of the Proposed Project Summarized
(Page 6 of 7)

Cost Category	{CCNPP Site	Brownfield Site	Nine Mile Point Site	Ginna Site}
Radiological Heath	{Radiological exposure below limits to workers and public SMALL	Radiological exposure below limits to workers and public SMALL	Radiological exposure below limits to workers and public SMALL	Radiological exposure below limits to workers and public SMALL}
Loss of resources	{Loss of resources is discussed in Sections 10.1 through 10.3. It is expected that losses will be mitigated to minimize the impact of the loss. SMALL	Loss of resources is discussed in Sections 10.1 through 10.3. It is expected that losses will be mitigated to minimize the impact of the loss. SMALL	Loss of resources is discussed in Sections 10.1 through 10.3. It is expected that losses will be mitigated to minimize the impact of the loss. SMALL	Loss of resources is discussed in Sections 10.1 through 10.3. It is expected that losses will be mitigated to minimize the impact of the loss. SMALL}

Table 10.4-1 Benefit and Costs of the Proposed Project Summarized (Page 7 of 7)

Cost Category	{CCNPP Site	Brownfield Site	Nine Mile Point Site	Ginna Site}
Measures and Controls to reduce environmental impact	{Costs associated with mitigation will be small, since this unit will be built on an existing nuclear site. Existing mitigation and environmental monitoring programs will be expanded to account for the new unit. Construction and operational impacts are expected to be small. SMALL	Costs associated with mitigation will be small, since this unit will be built on an existing power plant site. Existing mitigation and environmental monitoring programs will be expanded to account for the new unit. Construction and operational impacts are expected to be small. SMALL	Costs associated with mitigation will be small, since this unit will be built on an existing nuclear site. Existing mitigation and environmental monitoring programs will be expanded to account for the new unit. Construction and operational impacts are expected to be small. SMALL	Costs associated with mitigation will be small, since this unit will be built on an existing nuclear site. Existing mitigation and environmental monitoring programs will be expanded to account for the new unit. Construction and operational impacts are expected to be small. SMALL}

10.5 Cumulative Impacts

10.5 CUMULATIVE IMPACTS

Sections 10.1 through 10.3 summarize the adverse environmental impacts from construction and operation of {Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3} that are potentially unavoidable, irreversible or irretrievable. Measures to mitigate these impacts are also discussed. Section 10.4 compares the environmental and economic costs and benefits of the facility. This section summarizes the potential cumulative adverse environmental impacts to the {CCNPP} region. Cumulative impacts include those that are incremental to past and ongoing activities on the site, along with those that are reasonably foreseeable in the future.

This evaluation of cumulative impacts is based on a comparison between the existing environmental conditions presented in Chapter 2 and the potential adverse environmental impacts of construction and operation detailed in Chapter 4 and Chapter 5, respectively. The evaluation also considers continued operation and license renewal of {CCNPP Units 1 and 2}.

{CCNPP Unit 3 will be co-located on the existing nuclear power plant site currently occupied by CCNPP Units 1 and 2. CCNPP Units 1 and 2 occupy approximately 220 acres (89 hectares), while CCNPP Unit 3 construction is expected to utilize approximately 420 acres (170 hectares) of which 281 acres (114 hectares) will be permanently committed to structures and roads.

The CCNPP site consists of approximately 2,057 acres (832 hectares) located in Calvert County, Maryland, on the west bank of the Chesapeake Bay. Other major facilities located nearby include the Patuxent Naval Air Test Center 10 mi (16 km) south of the CCNPP site, and the Dominion Cove Point Liquefied Natural Gas site 3.6 mi (5.8 km) to the south. The 50 mi (80 km) radius surrounding the site includes parts of Maryland, Virginia, Delaware and Washington D.C.

Land use in Calvert County is predominantly farm, forest and residential housing. The CCNPP site consists mostly of mixed deciduous forest in various stages of succession, with a smaller percentage occupied by fields associated with an employee recreational campground and an area consisting of dredge spoils. None of the construction area is farmland. Topography is gently rolling, with steeper slopes along water courses. The site average height above sea level is approximately 100 ft (30 m).

The eastern boundary of the CCNPP site is the Chesapeake Bay. The Chesapeake Bay is approximately 195 mi (313 km) long and varies in width from 3 to 35 mi (5 to 56 km). Freshwater input comes from several major tributaries throughout its length, the largest being the Susquehanna River. The average depth is approximately 21 ft (9 m).

The Chesapeake Bay is a valuable natural resource in that it sustains active commercial and recreational fisheries for blue crab, oyster and several migratory fish species. Harvest, transport and marketing these resources are culturally and economically important to the region.}

10.5.1 CUMULATIVE IMPACTS FROM CONSTRUCTION

Construction impacts associated with {CCNPP Unit 3} include grading and clearing, allocation of land to material lay-down and parking, use of ground and surface waters, equipment noise and emissions, increased traffic and use of public resources. These activities are consistent with those conducted during the construction of {CCNPP Units 1 and 2}. Many of the impacts will be temporary and most can be mitigated through the use of best management construction practices and stormwater pollution prevention planning required under State and Federal regulation.

{Groundwater is currently utilized by CCNPP Units 1 and 2 for domestic, plant service and demineralized makeup water needs. Groundwater use conforms to an allocation imposed by the Maryland Department of the Environment. Of the 450,000 gpd (1,700,000 lpd) allocated, CCNPP Units 1 and 2 utilize, on average, approximately 388,000 gpd (1,470,000 lpd). Groundwater use during construction will remain within that allocated and its use will eventually be replaced with an onsite desalinization plant for CCNPP Unit 3. However, to date, neither saltwater intrusion nor land subsidence has been reported.

Additional impacts on wetlands, surface waters and groundwater resources may occur due to excavation or other activities that change flow patterns such as construction of sedimentation impoundments, stormwater runoff and dewatering, or that receive construction related waste effluents. It is anticipated that several vernal streams and impoundments will be affected by these activities. Environmental controls will conform to applicable regulations to minimize these effects. Efforts to reclaim areas not occupied by permanent structures or to provide offsetting habitat such as constructed wetlands will also be undertaken.

Protection of important or otherwise unique terrestrial habitats, flora and fauna were also considered in developing the construction plan for CCNPP Unit 3. Surveys of the site were undertaken to identify sensitive locations and protected species and efforts made to limit encroachment on these areas. Examples include the Chesapeake Bay Critical Area that encompasses lands within 1,000 ft (305 m) of mean sea high tide, locations with federally or state designated threatened or endangered species, wetland buffers and contiguous forest blocks. While certain state or federal designated vegetation and faunal species were found onsite, their presence was not found to be unique to areas potentially affected by construction.

Impacts to aquatic organisms found within freshwater impoundments and streams may be realized to the extent these surface waters are removed or water quality is affected. A survey of aquatic resources identified no unique aquatic species occurring with the construction zone. Typical fauna included the eastern mosquito fish, bluegill sunfish, invertebrate larvae, and submerged vegetation. Construction activities that may affect these natural resources, such as erosion and waste water discharge, will be managed using best management practices in conformance with applicable State and Federal permits and regulations.

Because of the preventive measures and corrective actions identified above and the short-term nature of construction activities, the cumulative impact on surface and groundwater from CCNPP Unit 3 construction in conjunction with the continued operation of CCNPP Units 1 and 2 should be small. Further, use of the existing offsite transmission right-of-way will limit the amount of land and related natural resources potentially impacted by construction.

An archaeological survey identified 14 sites potentially eligible for listing on the National Register of Historic Places. Four of these are located within the construction footprint. Phase II archaeological investigations, and subsequent consultation with the Maryland State Historic Preservation Officer (SHPO) will be performed for the four potentially eligible archeology sites to determine their National Register of Historic Places eligibility if they cannot be avoided.

Potential impacts to the Chesapeake Bay would be associated with construction of the cooling water intake and discharge structures and improvements to the barge unloading facility. The Circulating Water Supply System (CWS) and the Essential Service Water System (ESWS) (Ultimate Heat Sink) will utilize independent structures located in the southern portion of the existing CCNPP Units 1 and 2 intake embayment.

Dredging of the areas approaching the new structures and the installation of sheet pile may create some suspended sediment and removal of benthic substrate. Similarly, the dredging required for installation of the subsurface multi-port discharge structure will also require removal of sediment. Refurbishment of the barge slip will include new sheet pile and widening of the slip to receive heavy equipment. Activities in navigable waters will conform to applicable State of Maryland and U.S. Army Corps of Engineers regulations.

Impacts to marine biota will be negligible as previous studies conducted for CCNPP Units 1 and 2 indicate that the benthic substrate will reestablish following construction and that benthic species will quickly recolonize. Further there are no endangered or threatened marine species in the CCNPP site area that could be affected by sedimentation or sediment removal. As a result, cumulative construction impacts in the Chesapeake Bay are not expected.

Potential adverse cumulative impacts to public health and wellbeing stem from construction related noise, increased vehicular traffic, aesthetics and emissions. Noise levels will increase during construction with operation of heavy equipment and vehicles. The State of Maryland has established maximum decibel levels for different land use zones, the most sensitive being residential housing. Estimated noise levels that may occur during construction indicate that due to distance, topography and surrounding forest, levels at the site boundary are expected to meet applicable criteria. For onsite workers, it will be necessary to meet Occupational Safety and Health Administration (OSHA) exposure limits through training and use of personal protective equipment. Cumulative impacts are not expected as construction related noise will cease upon completion of the construction activities.

Traffic will increase during construction as workers commute from within and outside Calvert County. The main highway, Maryland State Highway 2/4, will experience additional traffic during shift change over. A new access road and an additional perimeter road will be constructed onsite to accommodate the excess traffic resulting from CCNPP Unit 3 construction. The access road will remain the primary entrance for CCNPP Unit 3 during operation when the number of workers is dramatically reduced. Heavy equipment and plant components will be barged in avoiding temporary blockage of local highways. Construction of the access road, use of the barge slip for heavy equipment and the decrease in workers following construction will limit cumulative impacts of traffic.

Dust, engine exhaust and other facility operations will result in construction related emissions. Protective actions will be required to ensure that applicable ambient air quality and hazardous pollutant regulations are met. Applicable permits will be obtained and construction practices, such as dust control, will be implemented so that cumulative impacts onsite from emissions are limited and are discontinued following construction.

Topography of the site and its forest canopy will limit visibility of construction activities. The Chesapeake Bay shoreline consists of high 100 ft (31 m) vertical cliffs. Construction activities, except for activities related to intake and discharge construction, will occur inland of the 1,000 ft (305 m) set back further reducing visibility from the water surface. Following construction, the multi-port diffuser will be beneath the surface. The intake structures will be confined to the southern end of the intake embayment and will be visible from certain portions of the Chesapeake Bay but their appearance will be consistent with CCNPP Units 1 and 2 intake structure.

Socioeconomic benefits accrue from capital expenditures as well as the increased number of jobs created during construction and the additional spending the results. It is estimated that peak construction workforce will exceed 3,900 full time equivalents. While it is difficult to predict the number of new jobs created for local county residents compared to those from the greater Washington D.C. area and beyond, it is clear that spending will augment the regional economy.

For example, it is estimated that for each dollar spent an additional \$0.69 of indirect revenue would be generated within the region of influence. However, the extent to which construction workers temporarily relocate to within a reasonable commuting distance, will place some added pressure on the availability of housing and public services. No disproportionate impact on minority or low income populations is expected since no specific minority populations were found to exist in Calvert County and St. Mary's County and only one of 55 census groups in St. Mary's County contained a low-income population. None were found in Calvert County.

Construction workers onsite will receive some radiation dose from the continued operation of CCNPP Units 1 and 2. Doses were calculated based on exposure to direct radiation, gaseous effluents and liquid effluents. Total collective dose during the construction period from all onsite sources is calculated to be approximately 14.6 person-rem (0.146 person-Sieverts). The annual maximum dose was calculated to be 38.8 mrem per yr (388 μSv/yr) compared to the public dose criteria of 100 mrem/yr year (1,000 μSv/yr).

In summary, the construction of CCNPP Unit 3 will not result in long-term cumulative impacts that are inconsistent with existing land use. Activities that occur during construction will be managed using best management practices and compliance with applicable regulations to limit both short-term and long-term adverse impacts. Furthermore, impacts will cease following completion of CCNPP Unit 3 and efforts made to reclaim those areas not required for operations.}

10.5.2 CUMULATIVE IMPACTS OF OPERATIONS

{Potential cumulative adverse impacts from operations include the withdrawal of water from the Chesapeake Bay, discharge of cooling tower blowdown, radiological dose consequences, waste generation, noise from the new hybrid cooling tower and socioeconomic changes. Each of these potential impacts is discussed below.

Because CCNPP Unit 3 will utilize closed-cycle cooling, the amount of cooling water withdrawn from the Chesapeake Bay will be significantly reduced below that required for once-through cooling. The CWS cooling tower is a circular, wet type, mechanical draft tower with drift eliminators, and is approximately 164 ft (50 m) high. It is estimated that the CCNPP Unit 3 CWS will withdraw approximately 34,800 gpm (143,00 lpm) on average to replace evaporative loss, drift, and blowdown from the one mechanical draft cooling tower. Blowdown from the CWS to the retention basin, and ultimately to the Chesapeake Bay will be approximately 17,400 gpm (65,700 lpm). Maximum CWS cooling water makeup demand is approximately 40,400 gpm (153,080 lpm).

The ESWS will utilize closed-cycle cooling, and will have 4 mechanical draft cooling towers. The ESWS cooling towers will each be rectilinear structures, 96 ft (29 m) high, by 60 ft (18.3 m) long, by 60 ft (18.3 m) wide. The ESWS cooling towers will typically be supplied with fresh water makeup from storage tanks that are supplied from a desalinization plant. Makeup flow to the ESWS cooling towers during normal operations will be approximately 1,880 gpm (7,100 lpm). Blowdown from the ESWS cooling towers will be routed to the retention basin, and ultimately the Chesapeake Bay, and will be approximately 940 gpm. Maximum ESWS cooling water makeup demand is approximately 3,764 gpm (14,248 lpm).

Physical impacts of cooling system water withdrawal could include alteration of site hydrology in the immediate vicinity of the intakes structures. Previous hydrodynamic modeling for CCNPP Units 1 and 2 indicated that their operation would represent less than 1% of tidal flow. Since the amount of cooling water to be used for CCNPP Unit 3 is a small fraction of the intake flow from CCNPP Units 1 and 2, there should be no incremental cumulative adverse impact to the Chesapeake Bay hydrology.

Aquatic impacts attributable to operation of the CCNPP Unit 3 intake structures and cooling water systems include impingement of organisms on the traveling screens and entrainment of fish and invertebrate eggs and larvae within the cooling system. Use of closed-cycle cooling systems at CCNPP Unit 3 will significantly reduce these impacts compared to power plants that operate open-cycle (once-through). In addition, CCNPP Unit 3 will incorporate additional design criteria to limit impingement including intake approach velocities to less than 0.5 ft/sec (0.15 m/sec).

Although some small amount of entrainment will occur, studies indicate that the CCNPP site area is not a spawning area for key species of commercial or recreational value, and that entrainment at CCNPP Units 1 and 2 has not resulted in detectable changes in population levels. Further, the dominant species that occur in the CCNPP site area of the Chesapeake Bay have not been identified as requiring habitat protection.

Blowdown from the cooling towers is returned to the Chesapeake Bay through a submerged multi-port diffuser. The temperature of this discharge will be several degrees above ambient creating a small thermal plume. Modeling of this plume shows that its size and distribution will meet all State water quality criteria and will be sufficiently small that it is unlikely to cause impacts to marine benthos or motile organisms migrating through the area.

Included in the blowdown discharge are chemicals used in biocide treatment and in plant process control. The concentrations discharged will be in conformance with National Pollutant Discharge Elimination System (NPDES) permit conditions and applicable water quality criteria. Further the amount of water being discharge from the closed-cycle system will be small compared to tidal flow such that concentrations of chemicals discharged will rapidly disperse. Solids will be allowed time for settlement and chemical treatment in an onsite retention basin, if required.

Because the use of closed-cycle cooling will limit cooling water requirements, the incremental impact from operation of CCNPP Unit 3 should not result in cumulative adverse ecological impacts.

Excess heat within the CWS will be dissipated to the environment using a hybrid mechanical draft cooling tower with drift eliminators installed. A visible plume is created when a portion of the cooling water evaporates as it leaves the tower and undergoes partial condensation. Typical impacts from the resulting plume include fogging, icing, and water and solids deposition. The extent of these impacts was simulated using predictive models. The plume length varies with season, being larger in winter.

The average plume length for the CCNPP Unit 3 CWS cooling tower is estimated to be 2.1 mi (4.2 km) during summer months, 3.5 mi (5.6 km) during winter months, and would average 2.1 mi (3.3 km). Fogging is predicted to occur most frequently onsite and is expected to occur less than 38 hours annually in the vicinity of the cooling towers, reaching the site boundary less than 8 hours annually. Icing is likely to occur most frequently onsite, and is estimated to occur less than 2 hours in all directions on an annual basis. Cloud shadowing is predicted to occur for 38 hours during the spring season, and a total of 113 hours annually on Maryland State Highway 2/4. The relative small size of the four ESWS towers is not expected to contribute to offsite impacts.

Salt deposition from CWS cooling tower operations will occur since the source of makeup water is the Chesapeake Bay. The extent of deposition will be limited through installation of drift eliminators that restrict the amount and size of water particles released from the tower. Model predictions indicate that the maximum salt deposition from the condenser cooling water tower is expected to be below NUREG-1555 (NRC, 1999) significance levels for possible vegetation damage.

While the new cooling towers to be installed and operated as part of the CCNPP Unit 3 closed-cycle cooling water system will create a visible plume, the cumulative impact offsite is expected to vary by season and primarily be a function of viewpoint.

Elevated temperatures within cooling tower systems are known to promote the growth of thermophilic bacteria such as Legionella sp., amoeba such as Naegleria sp., and fungi. Thermophilic organisms are typically associated with freshwater and the Nuclear Regulatory Commission (NRC) has linked health issues to power plants that use cooling ponds, lakes and canals, and that discharge to small rivers. Given that Chesapeake Bay water withdrawn to supply the CWS cooling tower is mesohaline (salinity between 5 to 18 parts per thousand), the growth and dispersion of thermophilic organisms from the CWS cooling tower is not expected to create a public health issue at CCNPP Unit 3.

Makeup water for the ESWS cooling towers will be supplied by a desalinization plant. Biocide treatment will limit the propagation and dispersal of thermophilic organisms in this system including the four small mechanical ESWS cooling towers. Blowdown will combine with the saline discharge of the CWS cooling tower prior to its discharge to the Chesapeake Bay.

Cumulative impacts on land use and the terrestrial environment are expected to be minimal given that the final footprint of the CCNPP Unit 3 structures will be permanently established following construction and no new transmission corridors offsite will be required. Sensitive onsite species that require protection include the bald eagle.

Terrestrial vegetative and faunal species that are critical to structure and function have been identified and will be managed within the Site Management Program. Implementation of the Stormwater Pollution Prevention Plan will also serve to limit future impacts of erosion and inadvertent releases from industrial activities onsite.

Bird mortality from collision is a concern particularly at sites where tall structures such as natural draft cooling towers extend will beyond the tree canopy. The CWS cooling tower to be installed for CCNPP Unit 3 is a low-profile design that will extend 164 ft (50 m) above ground. This compares to the height of a natural draft tower that is typically in excess of 400 ft (122 m).

The sources of noise from operations include the switchyard, transformers, cooling towers and traffic. A baseline noise survey of existing conditions showed that there was no observed offsite audible noise from the operation of CCNPP Units 1 and 2. A modeled prediction of noise from the new CCNPP Unit 3 cooling towers shows that day and nighttime noise levels beyond the site boundary will be below maximum allowable levels. Traffic noise will be limited to normal work day business hours during shift changes. Noise from the new onsite switchyard and transformers will be similar to that currently associated with CCNPP Units 1 and 2. Taken together, the additional noise associated with CCNPP Unit 3 is not expected to alter predictions that noise levels offsite will not represent an adverse cumulative impact.

Air emissions are limited by U.S. EPA standards and permits as well as by OSHA worker health based standards. The primary sources of operational related emissions are the four emergency diesel generators and two station blackout diesel generators. Periodic testing of the diesels is required to ensure their operability. The diesel generator engines are designed to meet the increasingly stringent emission standards.

Additional emissions reductions from the diesel generators will be achieved through the purchase of low sulfur fuels. Carbon dioxide production will be limited to that small amount attributed to testing of the diesel generators. By contrast, CCNPP Unit 3 operation would avoid the emission of approximately 1,908,000 CO_2e (CO_2 equivalent) from coal combustion and 623,000 CO_2e from natural gas combustion.

Exposure of the general public to radiation from the operation of CCNPP Unit 3 is a function of meteorology, relative location, population density, land use practices, harvest and consumption of food sources, as well as the allowable radiological release limits. Dose consequences result from liquid and gaseous releases and from direct radiation. Each of these potential pathways has been analyzed to ensure that applicable public health exposure limits are met.

In addition, the potential dose from the operation of CCNPP Unit 3 has been combined with that predicted for CCNPP Units 1 and 2. Results show that applicable NRC exposure limits are met, and that while there will be dose consequences resulting from operation of CCNPP Unit 3, exposure will remain within applicable limits and will not represent an adverse cumulative impact.

Conservative estimates of radiological dose to biota also demonstrate that exposure to key selected species should result in no observable effects. An existing long-term radiological monitoring program will continue to verify that dose consequences to the general public are as low as reasonably achievable (ALARA).

The uranium fuel cycle will contribute to cumulative impacts from fuel production, transportation, storage and disposal. Related environmental impacts are attributed to land and water use, electrical consumption, chemical effluents, radioactive effluents and waste generation. The cumulative impacts from each of these sources has been reviewed based on an NRC mandated comparative assessment detailed in 10 CFR 51.51(a) (CFR, 2007).

Non-radioactive and mixed-wastes will be produced during CCNPP Unit 3 operations. Typically these consist of recyclables, solid waste debris, and sewage. Cumulative impacts will be managed through implementation of waste minimization practices including the procurement process, allocation of material for work, storage and recycling. Wastes that can not be recycled will be stored and disposed in accordance with applicable state and federal hazardous and non-hazardous waste regulations, and at licensed liquid and solid waste disposal locations. Properly sized and designed onsite facilities for storage will be provided and procedures put in place to deal with potential spills and emergency response.

Socioeconomic impacts (benefits) from long-term CCNPP Unit 3 operation result from the increased operational work force, facility taxes, and generation of competitively priced electricity. Approximately 363 additional employees will be required to support CCNPP Unit 3 operations. Most of these employees are expected to reside primarily within Calvert County and St. Mary's County. The CCNPP Unit 3 workforce will result in increased indirect employment of approximately 1,400 jobs or about 1.9% of the existing two-county work force.

An overall increase in population is expected as families relocate, acquire housing and utilize public services. It is estimated that the additional workforce will increase population within Calvert County and St. Mary's County by approximately 2,500 people compared to the existing 160,774 people. An analysis of available housing suggests that adequate supply is currently available to support the influx of operational employees.

Although some existing police, fire, EMS, and school districts are operating at, or near, capacity, operation of CCNPP Unit 3 would only add 545 direct and indirect households to the region of influence. Representatives of these agencies have indicated that this limited addition would either have no or small impact and would not require mitigation.

While there will be an overall socioeconomic benefit from the operation of CCNPP Unit 3, the cumulative impact, as a percentage, appears to be small. Further, because there are no minority populations prevalent in the area and only one small low-income population in St. Mary's County, there should be no disproportionate impact on these groups.

As described in Section 2.8, several projects have been identified within the CCNPP site area that may contribute to cumulative socioeconomic and environmental impacts. Dominion LNG is planning to expand the Cove Point Liquid Natural Gas Plant located approximately 3.6 mi (5.8 km) south of the CCNPP site. Construction is expected to be completed in 2008. Impacts include construction related activities, use of additional land for on and offsite infrastructure including pipeline expansion, increased shipping, emissions from additional onsite power generation and noise. In addition, approximately 38 new employees will be added to the operational workforce. Potential construction and operational impacts have been reviewed and mitigation measures identified (FERC, 2006).

In addition to expansion of the Dominion LNG facility, additional electrical capacity is being installed at two locations in the CCNPP site region. Two combustion turbine generating units are being added in Easton, Maryland and two at the Chalk Point Generating Station.

Since construction of the LNG facility is to be completed in 2008, there should be limited if any overlap in activities that might impact planned activities at CCNPP Unit 3. Operation of the LNG facility and the addition of additional electrical capacity in Easton and at Chalk Point will contribute to increased emissions but these facilities will be required to meet air quality standards. As a result, the cumulative impacts of these projects should be small.}

10.5.3 CUMULATIVE IMPACTS SUMMARY

{The potential adverse short-term and long-term impacts from the construction and operation of CCNPP Unit 3 have been identified and actions to mitigate those impacts proposed. Activities to be undertaken during construction and operation of CCNPP Unit 3 are consistent with those currently in place for CCNPP Units 1 and 2. Except for the construction footprint, available land use and the terrestrial environmental will remain unchanged.

Operation of the new unit will require the use of certain natural resources including water withdrawal from the Chesapeake Bay for cooling and will result in the release of process gaseous, liquid and solid wastes, all in conformance with applicable Local, State, and Federal permit requirements and standards. Economic benefits accrue from capital expenditures, additional tax revenue and the jobs created during construction and operation. The environmental assessment demonstrates that cumulative adverse impacts to the vicinity and to the region will be small.}

10.5.4 REFERENCES

CFR, 2007. Title 10, Code of Federal Regulations, Part 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions, 2007.

FERC, 2006. Final EIS Dominion Cove Point LNG Project Expansion, Docket Nos. CP05-310-000 et al., U.S. Federal Energy Regulatory Commission, April 28, 2006, Website: www.ferc.gov/industries/lng/enviro/eis/04-28-06-eis-cove.asp, Date accessed: May 26, 2006

NRC, 1999. Standard Review Plans for Environmental Reviews for Nuclear Power Plants, NUREG-1555, Nuclear Regulatory Commission, 1999.