ENVIRONMENTAL REPORT

CHAPTER 3

PLANT DESCRIPTION

3.0 PLANT DESCRIPTION

3.1 EXTERNAL APPEARANCE AND PLANT LAYOUT

The site for the proposed nuclear power plant is the 2070 acre (838 hectares) Calvert Cliffs Nuclear Power Plant (CCNPP) property located on the western shore of the Chesapeake Bay in Lusby, Maryland. The terrain is flat to gently rolling with low to moderate relief as shown in Figure 3.1-1. Ground surface elevations range from mean sea level (msl) to approximately 130 ft (39.7 m), with an average elevation of approximately 100 ft (30.5 m). Nearly vertical cliffs, over 100 ft (30.5 m) high in places are located along the shoreline. References to elevation values in this section are based on National Geodetic Vertical Datum of 1929 (NGVD, 29), unless otherwise stated.

The CCNPP property contains two existing pressurized water reactors (PWRs) designated as CCNPP Units 1 and 2. Existing plant structures occupy approximately 220 acres (89.0 hectares), with most of the power block structures located near the east edge of the site, about at the center of the 10,000 ft (3,048.0 m) long CCNPP site shoreline. CCNPP Units 1 and 2 share a Turbine Building and other support structures. The Turbine Building is oriented parallel and adjacent to the shoreline of the Chesapeake Bay. The two Reactor Buildings and associated Auxiliary Buildings are located west of the Turbine Building. The Service Building, Intake Structure and Discharge Structure are located east of the Turbine Building. An Independent Spent Fuel Storage Installation is located near the center of the property, west of the existing switchyard, which is west of the Reactor Buildings. A former summer camp, Camp Conoy, is located on the property south of existing plant structures. The remainder of the property is mostly densely wooded areas. Access to the existing plant is via an onsite road which intersects the Maryland State Highway 2/4 (MD 2/4) west of the site, or by barge via the Chesapeake Bay.

The proposed plant is a U.S. Evolutionary Power Reactor (EPR), referred to as CCNPP Unit 3. The U.S. EPR is a pressurized water reactor design with a rated core thermal power of 4,590 MWt. The rated and design gross electrical output for the EPR is approximately 1,710 MWe. Electrical power consumption is approximately 130 MWe for auxiliary loads, plus another 18 MWe for the cooling tower fans, resulting in a rated and design net electrical output of approximately 1,562 MWe. The plant is proposed to be constructed south of the existing CCNPP Units 1 and 2, in the vicinity of Camp Conoy. Construction related and new plant structures will occupy approximately 460 acres (186 hectares). New plant structures will occupy approximately 320 acres (129 hectares) of the CCNPP site. CCNPP Unit 3 will be separated from CCNPP Units 1 and 2 by a distance of approximately 2,500 ft (762.0 m). The CCNPP Unit 3 Reactor Turbine Buildings will be located farther inland than Units 1 and 2 and is at least 1,000 ft (304.8 m) from the shoreline.

Due to the distance and location from CCNPP Units 1 and 2, CCNPP Unit 3 will have a separate protected area and plant access road. The plant access road will connect to the highway to the west and will be built south of the existing CCNPP Units 1 and 2 plant access road. The existing barge slip/heavy haul road will be extended to accommodate CCNPP Unit 3.

The CCNPP Unit 3 design is a four-loop, pressurized water reactor, with a Reactor Coolant System composed of a reactor pressure vessel that contains the fuel assemblies, a pressurizer including ancillary systems to maintain system pressure, one reactor coolant pump per loop, one steam generator per loop, associated piping, and related control systems and protection systems. The CCNPP Unit 3 Reactor Building and Turbine Building will be oriented side by side, with the Reactor Building oriented towards the east.

The Reactor Building will be surrounded by the Fuel Pool Building, four Safeguard Buildings, two Emergency Diesel Generator Buildings, the Reactor Auxiliary Building, the Radioactive Waste Processing Building and the Access Building. Figure 3.1-1 shows the layout for CCNPP Unit 3, depicting the following features: exclusion area boundary (EAB), site boundary, liquid and gaseous release points (i.e., discharge piping, and vent stack and ESWS Cooling Towers and CWS Cooling Tower, respectively) and their elevations and distances from the Reactor Building, meteorological towers, the construction zone, land to be cleared, waste disposal areas, and other buildings and structures both temporary (i.e., construction offices/ warehouses) and permanent. Figure 3.1-2 shows the layout of the Powerblock and identifies the major structures.

The CCNPP Unit 3 Reactor Building is an upright cylinder concrete structure, capped with a spherical dome. The Reactor Building is 186 ft (56.7 m) in diameter with an overall height of 244 ft (74.3 m). The plant grade for CCNPP Unit 3 will be at an elevation of approximately 85 ft (25.9 m). With the bottom of the Reactor Building foundation 40 ft (12.2 m) below grade (approximately at elevation 44 ft. msl), the new Reactor Building will rise 204 ft (62.2 m) above grade. The top of the Reactor Building will be at an elevation of approximately 289 ft (88.1 m).

The vent stack for CCNPP Unit 3 will be the tallest new structure at approximately 211 ft (64 m) above grade or about 7 ft (2.1 m) above the Reactor Building. In contrast to CCNPP Units 1 and 2, which uses a once-through cooling system, CCNPP Unit 3 will have a closed-loop cooling system cooling system. The CCNPP Unit 3 Cooling Tower will be a round concrete structure with an overall diameter of 528 ft (161 m) and approximate height of 164 ft (50.0 m). Similar to CCNPP Units 1 and 2 , other CCNPP Unit 3 buildings will be concrete or steel with metal siding. Figure 3.1-3 depicts an aerial view of CCNPP Units 1 and 2 with the proposed CCNPP Unit 3 superimposed on the photograph.

The CCNPP Unit 3 ultimate heat sink (UHS) function will be provided by four mechanical forced draft Essential Service Water System (ESWS) cooling towers situated above storage basin pools. Each of the four pools will be approximately 0.19 acres (0.08 hectares) in size and will not occupy significant land area beyond the tower footprint. The pools will normally be supplied with makeup water from the non-safety-related CCNPP Unit 3 desalination plant.

In the event of a design basis accident, the pools will be supplied with water from a safety-related makeup water system using Chesapeake Bay water. The ESWS cooling towers will be 96 ft (29 m) tall. The desalination plant footprint will be approximately 65 ft by 165 ft (20 m x 50 m) and situated adjacent to the east of the Circulating Water Supply System Cooling Tower. Bay water to the Desalination Plant will be taken from the Circulating Water Supply System makeup line to the Cooling Tower.

Figure 3.1-4 through Figure 3.1-6 are ground-level photographs of the CCNPP property taken from adjacent properties to the north, south and west. Major structures associated with CCNPP Unit 3 have been superimposed on these photographs to depict potential visual impacts as viewed from Calvert County Flag Ponds Nature Park to the north, Calvert Cliffs State Park to the south, and from Maryland State Highway 2/4 and residential properties to the west.

Due to heavily forested onsite areas, screening is provided by trees so that only the tops of the taller structures may be visible from adjacent properties at ground level. Due to the hybrid design of the CWS cooling tower, no water vapor plume will be visible. Many of the CCNPP Unit 3 buildings will not be visible since the taller structures will mask the lower rise structures. Due to onsite elevation changes, topographical features such as hills and valleys will also help to screen and seclude plant structures from surrounding properties even when foliage is seasonally absent. In addition, since CCNPP Unit 3 will be located approximately 3,000 ft to 4,000 ft (914.4 m to 1,219.2 m) from the nearest residential properties, distance will help shield the plant from view.

From the east, considering that the approximate 2 mi (3.2 km) long shoreline bordering the CCNPP property comprises steep cliffs with little beach area, views of the new plant from the shoreline should be limited due to elevation differences between the Chesapeake Bay and land, and the forested, 1,000 ft (304.8 m) setback. The Intake Structure and Pump House, and associated discharge piping at the shoreline for CCNPP Unit 3 should also have minimal visual impact considering the proposed locations near the CCNPP Units 1 and 2 intake structure and barge slip facility, respectively. No other visual impacts from nearby ground level vantage points are expected.

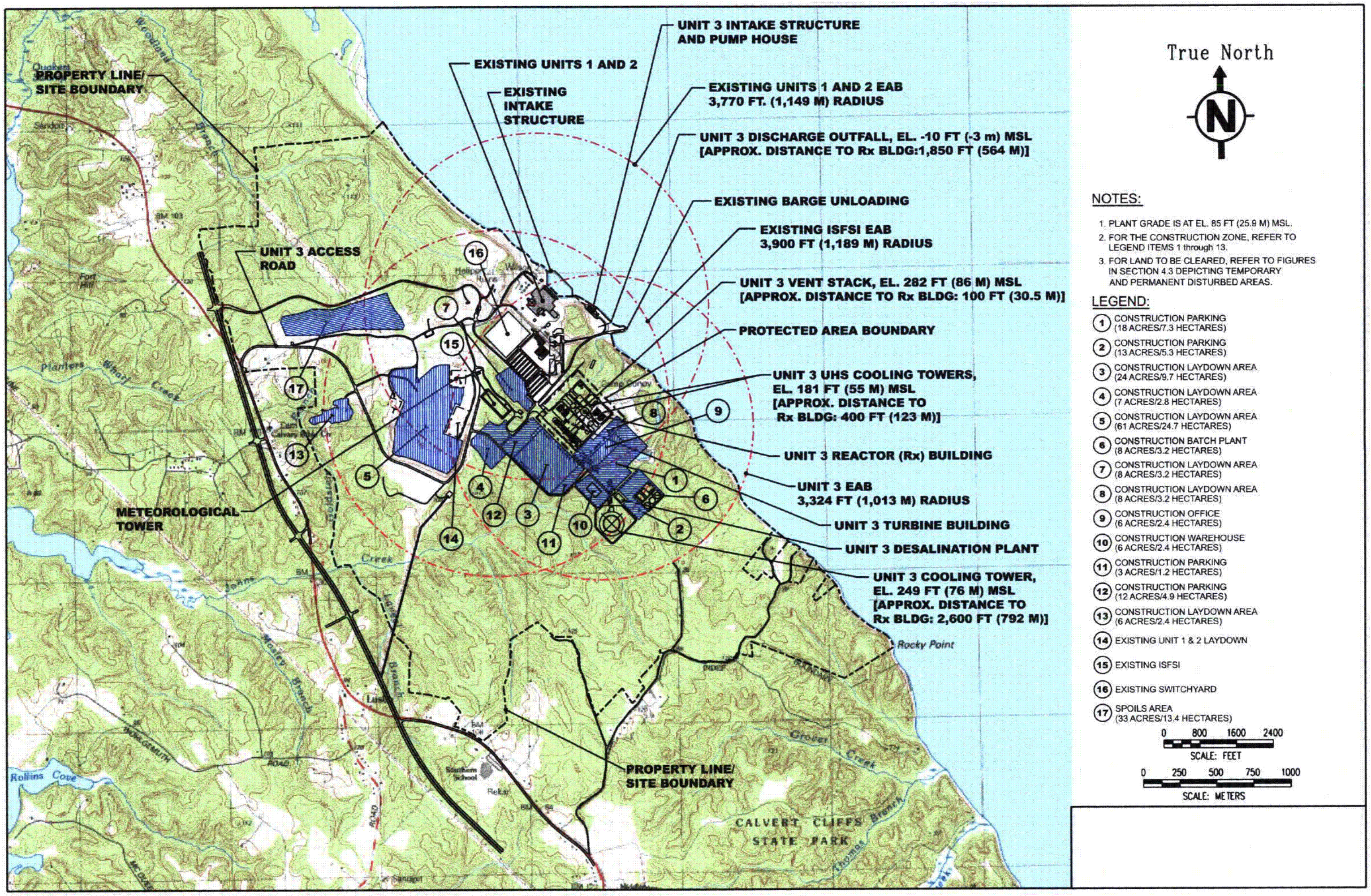
Aesthetic principles and concepts used in the design and layout of CCNPP Unit 3 include the following:

- Woodlands on site have been avoided as much as possible.
- Developing land zoned for industrial use for portions of the construction and operation of the new plant to minimize the development of land zoned as Farm and Forest District.
- Selecting the southern portion of the CCNPP property, where natural valleys exist, for the location of the new power block structures. This area will provide a low profile for the new plant and should require less excavation for site preparation and clearing due to pre-existing, cleared areas around Camp Conoy.
- Utilizing a hybrid cooling tower with a plume abatement system to minimize visible vapor plume.
- Locating most of the plant structures beyond the 1,000 ft (304.8 m) Chesapeake Bay Critical Area (CBCA) although security perimeter fencing, gravel path, water intake and discharge structures, and heavy haul road and construction staging area will be constructed in the CBCA.
- Placing the Intake Structure and Pump House and associated discharge piping in the existing, developed section of shoreline.
- Constructing buildings similar in shape, size and material to existing buildings.
- Utilizing cooling systems that minimize visual impacts.
- Minimizing tree removal by locating the , construction lay-down areas, parking areas and construction offices and warehouses in pre-existingdredge spoil areas, cleared fields or lightly forested areas, where practical.
- Transporting excavated and dredged material to an onsite spoils area outside designated wetlands.
- Upgrading existing onsite roads as applicable to minimize the addition of new roads. However, proposed new roads will provide direct routes to CCNPP Unit 3 for

construction and are necessary to minimize disruption of CCNPP Units 1 and 2 traffic patterns.

In addition to the above, exterior finishes for plant buildings will be similar in color and texture to those of the CCNPP Units 1 and 2 buildings. This provides for a consistent, overall appearance, by architecturally integrating the buildings on the CCNPP site. Areas that are cleared supporting construction activities will be either maintained or restored by reseeding and replanting with native trees and vegetation, so that the CCNPP Unit 3 landscape blends with the CCNPP Units 1 and 2 landscapes and the remaining undisturbed areas on the CCNPP site. Figure 3.1-7 is an architectural rendering of CCNPP Unit 3, depicting profiles of major buildings and landscaping features.

Figure 3.1-1— Site Area Topography Map



See Figure 2.1-1 and Figure 3.1-2 for Site and Powerblock layout

Figure 3.1-2— CCNPP Unit 3 Powerblock Layout

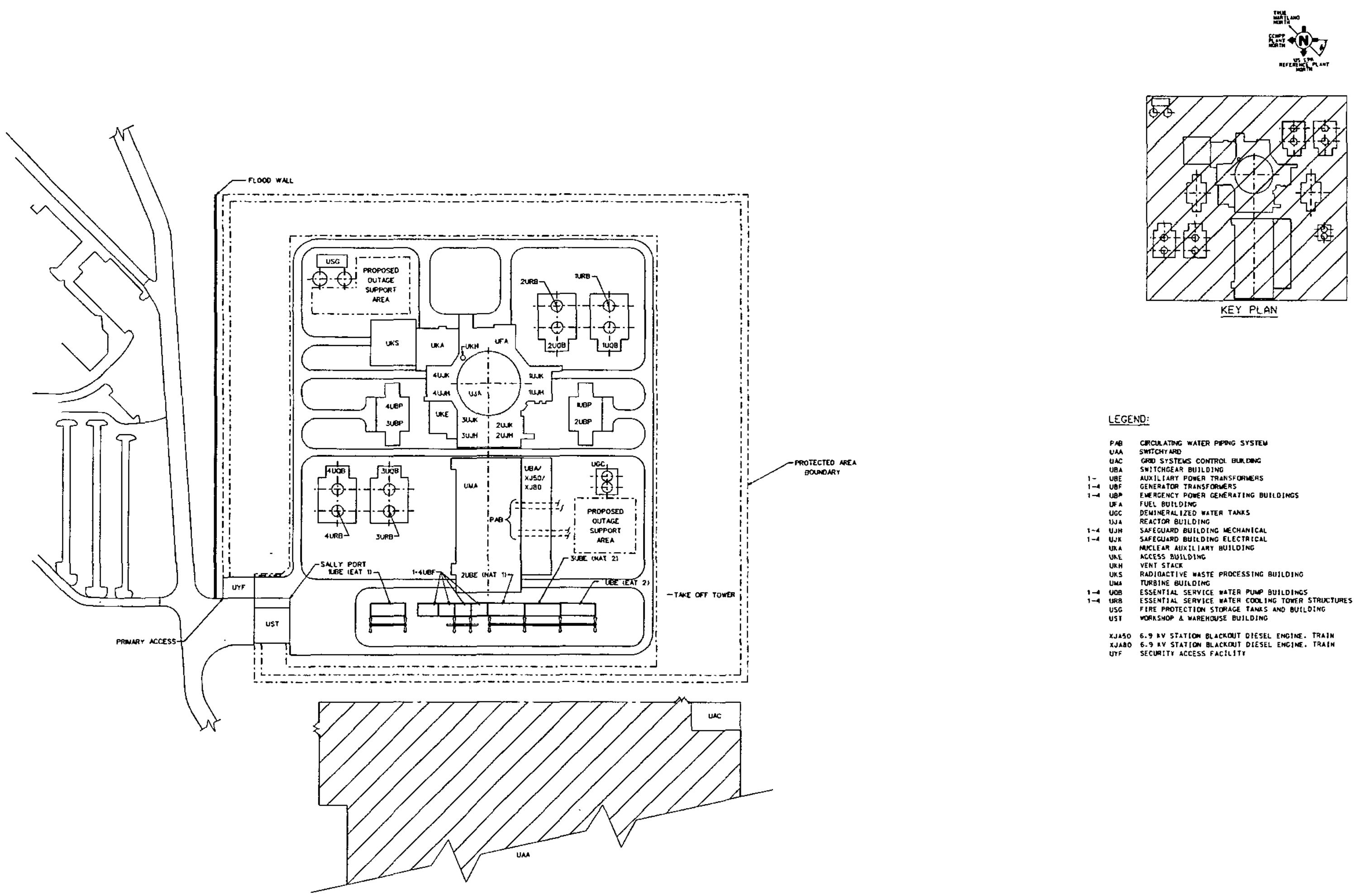


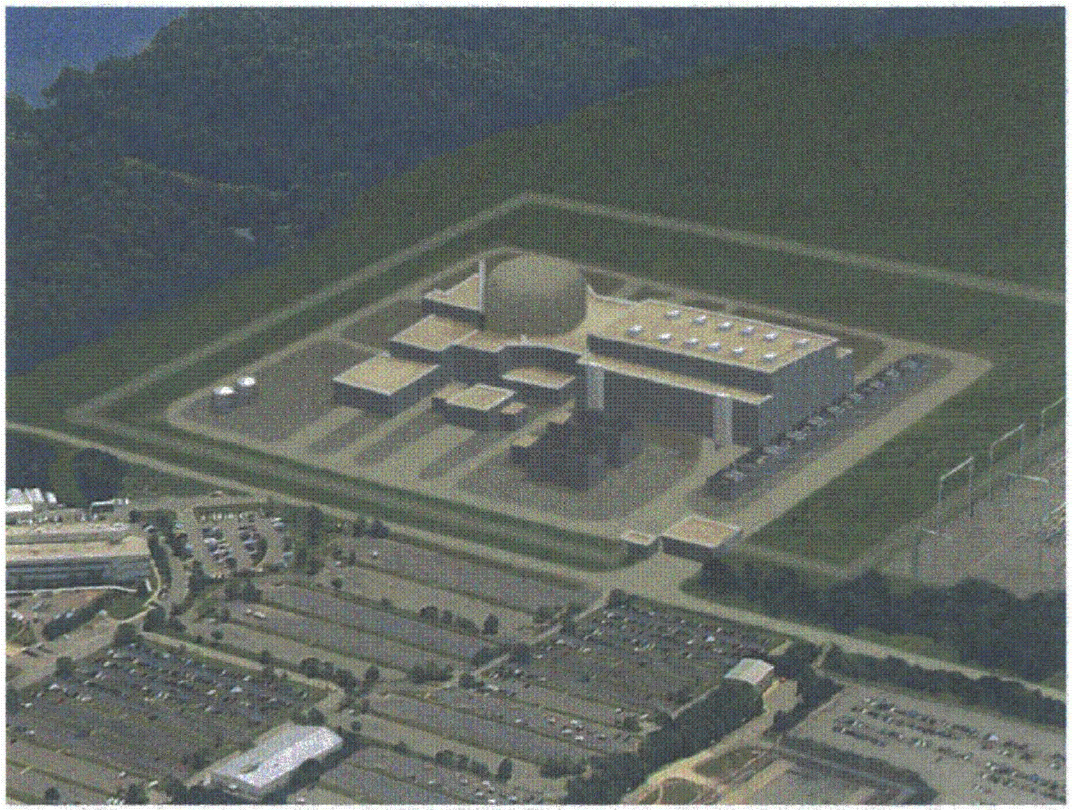
Figure 3.1-3— Aerial View of CCNPP Units 1 and 2 with CCNPP Unit 3 Superimposed

Figure 3.1-4— Ground Level View Looking South with CCNPP Unit 3 Structures Superimposed

Figure 3.1-5— Ground Level View Looking North with CCNPP Unit 3 Structures Superimposed

Figure 3.1-6— Ground Level View Looking East with CCNPP Unit 3 Structures Superimposed

Figure 3.1-7— Architectural Rendering of CCNPP Unit 3



3.2 REACTOR POWER CONVERSION SYSTEM

3.2.1 General

CalvertCliffs 3 Nuclear Project, LLC (Calvert Cliffs 3 Nuclear Project) and UniStar Nuclear Operating Services (UNOS), LLC propose construction and operation of a new nuclear power plant to be designated Calvert Cliffs Nuclear Power Plant (CCNPP) Unit No. 3 located directly adjacent to the existing Calvert Cliffs site, on property that was formerly a part of the existing Calvert Cliffs site, but is now owned by the Calvert Cliffs 3 Nuclear Project. Calvert Cliffs 3 Nuclear Projec and UniStar Nuclear Operating Services are applying for a combined license for the proposed nuclear power plant.

[Text in this section refers to ownership and has been intentionally removed.]

UniStar Nuclear Operating Services has been formed to be a licensee and to operate Areva's advanced reator, the U.S. Evolutionary Power Reactor (EPR), in the United States. The principal offices of UniStar Nuclear Operating Services are located in Baltimore, MD. The UniStar Operating Services is organized under the laws of the State of Delaware pursuant to the Limited Liability Company Agreement of UniStar Nuclear Operating Services dated May 10, 2006, by Constellation Energy UniStar Holdings, LLC, the predecessor to UniStar Nuclear Holdings, LLC. UniStar Nuclear Operating Services will be one of the lincensees and will operate CCNPP, Unit 3.

In addition, Bechtel Power Corporation has been contracted to perform the Architect/Engineer function.

The U.S. EPR design has a rated core thermal power of 4,590 MWt. The rated and design gross electrical output for the U.S. EPR is approximately 1,710 MWe. Electrical power consumption for auxiliary loads is approximately 130 MWe, with another 18 MWe required for the cooling tower fans, resulting in a rated and design net electrical output of approximately 1,562 MWe. Although the U.S. EPR is to be licensed for 40 years, the proposed operating life of the U.S. EPR is 60 years.

The U.S. EPR design is a four-loop, pressurized water reactor, with a Reactor Coolant System (RCS) composed of a reactor pressure vessel that contains the fuel assemblies, a pressurizer including ancillary systems to maintain system pressure, one reactor coolant pump per loop, one steam generator per loop, associated piping, and related control systems and protection systems. Referring to Figure 3.2-1, which provides a simplified depiction of the reactor power conversion system for the U.S. EPR, the RCS transfers the heat generated in the reactor core to the steam generators where steam is produced to drive the turbine generator. Water is utilized to remove the heat formed inside the reactor core. The reactor coolant pumps provide forced circulation of water through the RCS and a pressurizer, connected to one of the four loops, maintains the pressure within a specified range. Each of the four reactor coolant loops comprises a hot leg from the reactor pressure vessel to a steam generator, a cross-over leg from the steam generator to a reactor coolant pump, and a cold leg from the reactor coolant pump to the reactor pressure vessel. In each of the four loops, the primary water leaving the reactor pressure vessel through an outlet nozzle goes to a steam generator. The primary water flows inside the steam generator tube bundle and transfers heat to the secondary water. The primary water then goes to a reactor coolant pump before returning to the reactor pressure vessel through an inlet nozzle. The feedwater entering the secondary side of the steam generators absorbs the heat transferred from the primary side and evaporates to produce saturated steam. The steam is dried in the steam generators then routed to the turbine to drive it. The steam is then condensed and returns as feedwater to the steam generators. The alternating current, synchronous type generator, driven by the turbine, generates electricity. The generator rotor will be hydrogen cooled and the generator stator will be cooled with water.

The U.S. EPR reactor core consists of 241 fuel assemblies. The fuel assembly structure supports the fuel rod bundles. Inside the assembly, the fuel rods are vertically arranged according to a square lattice with a 17x17 array. There are 265 fuel rods per assembly with the remaining locations used for control rods or instrumentation. The fuel rods are composed of enriched uranium dioxide sintered pellets contained in a cladding tube made of M5 advanced zirconium alloy. Percentage of uranium enrichment and total quantities of uranium for the U.S. EPR core are as follows:

- Cycle 1 (initial) – average batch enrichment is between 2.23 to 3.14 weight percent U-235 and 2.66 weight percent U-235 for core reload with an enriched uranium weight of 285,483 pounds (129,493 kilograms).
- Cycle 2 (transition) – average batch enrichment is between 4.04 to 4.11 weight percent U-235 and 4.07 weight percent U-235 for core reload with an enriched uranium weight of 141,909 pounds (64,369 kilograms).
- Cycle 3 (transition) – average batch enrichment is between 4.22 to 4.62 weight percent U-235 and 4.34 weight percent U-235 for core reload with an enriched uranium weight of 113,395 pounds (51,435 kilograms).
- Cycle 4 (equilibrium) – average batch enrichment is between 4.05 to 4.58 weight percent U-235 and 4.30 weight percent U-235 for core reload with an enriched uranium weight of 113,417 pounds (51,445 kilograms).

Average batch enrichment is the average enrichment for each fuel assembly comprising a batch of fuel. The enrichment for core reload is the average enrichment for all fuel assemblies loaded in the core which is derived from the mass weighted average for the batches of fuel. The above values are 'beginning of life' enrichment values. Discharged enrichment values will be less at the 'end of life' of the assembly. Assembly enrichment reduction is directly proportional to the assembly burnup.

Discharge burnups for equilibrium cores are approximately between 45,000 MWd/MTU to 59,000 MWd/MTU. The batch average discharge burnups for equilibrium cores is about 52,000 MWd/MTU.

Engineered safety features for the U.S. EPR are designed to directly mitigate the consequences of a design basis accident (DBA) and include the following systems and functions:

- Containment - provided to contain radioactivity following a loss of coolant accident (LOCA).

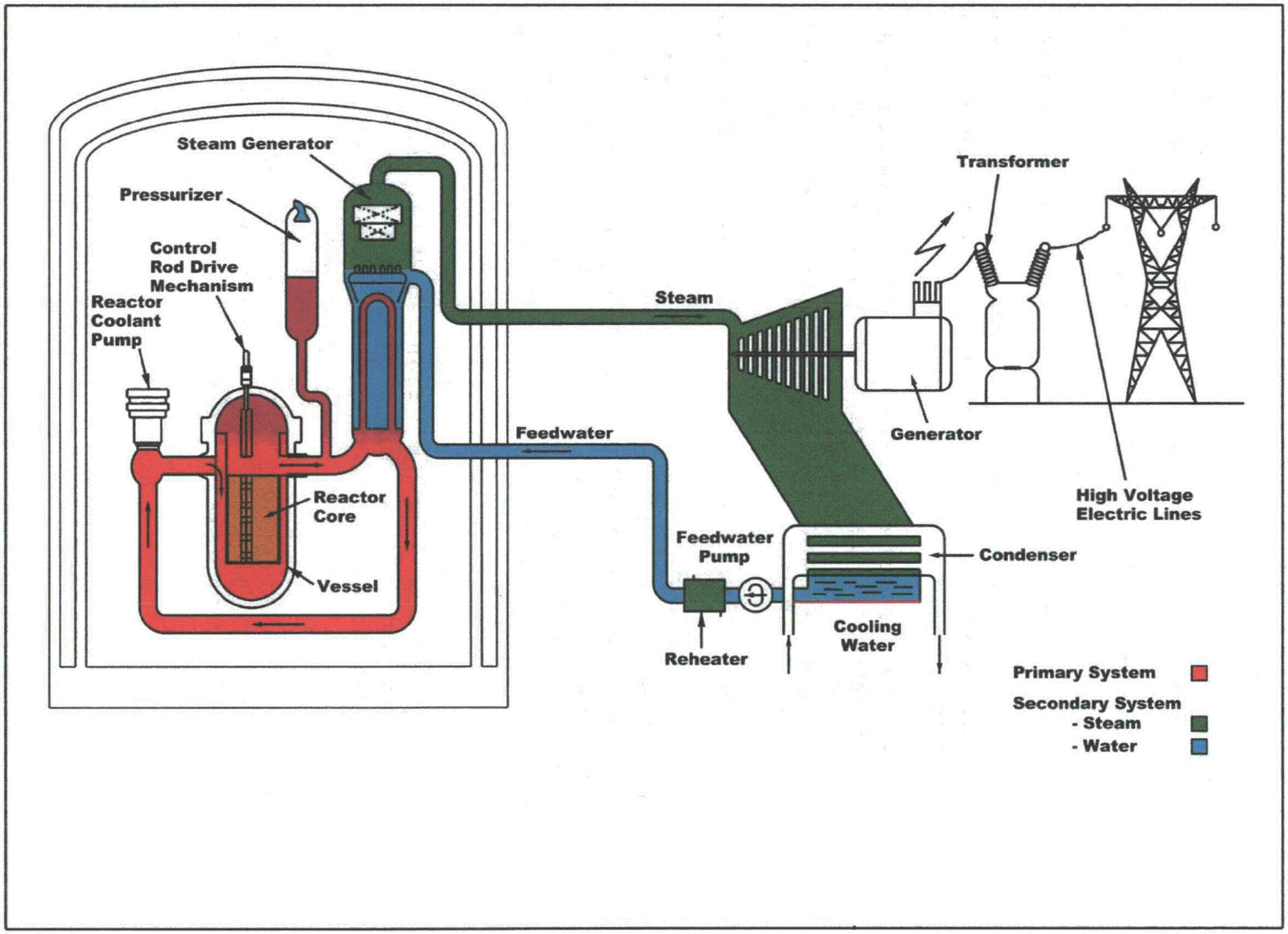
- Containment heat removal - associated with the reduction of energy from the containment after a DBA.
- Containment isolation and leakage testing - provided to minimize leakage from the containment.
- Combustible gas control – configured to reduce hydrogen concentrations in order to maintain containment integrity during and immediately following a DBA LOCA.
- Safety injection – designed to provide the emergency core cooling function.
- Control room habitability - designed so that control room occupants can remain in the control room to operate the plant safely under normal and accident conditions.
- Fission product removal and control systems – configured to reduce or limit the release of fission products following a postulated DBA, severe accident or fuel handling accident.
- Emergency heating, ventilation and air conditioning and filtration – provided to reduce radioiodine released as assumed during design basis events.
- Emergency feedwater – designed to supply water to the steam generators following the loss of normal feedwater supplies.
- Control of pH – associated with the control of pH in the containment following a DBA.

The U.S. EPR utilizes a standard nuclear steam turbine arrangement consisting of a tandem compound, six- flow steam turbine, operating at 1,800 revolutions per minute. The generator is an alternating current, synchronous type, with a hydrogen cooled rotor and water cooled stator. The main condenser condenses the steam exhausted from the three low pressure turbine elements, and is a multipressure, three-shell unit with titanium tubes and tubesheet overlay. The condenser heat transfer area for all three shells is estimated to be approximately 1.6 million ft^2 (149 thousand m^2).

The operational back pressure range at guaranteed performance (100% load) is based on the condenser operating at 3.20 inches HgA (108.36 mbar), 2.44 inches HgA (82.63 mbar) and 1.85 HgA (62.65 mbar) in the high pressure, intermediate pressure and low pressure condenser shells, respectively. For 100% unit load at the average plant back pressure of 2.5 inches HgA (84.7 mbar), the anticipated turbine heat rate is approximately 9,200 BTU/kW-hr.

Circulating water for the U.S. EPR is cooled by a closed-loop, mechanical draft cooling tower. Waste heat rejected to the atmosphere via the cooling tower is 3,238 MWt, resulting in an overall thermal efficiency of approximately 29%.

Figure 3.2-1— Reactor Power Conversion System



3.3 PLANT WATER USE

CCNPP Unit 3 requires water for cooling and operational uses. Sources for water include the Chesapeake Bay and desalinated Chesapeake Bay water (i.e., fresh water supply). Water from the Chesapeake Bay provides makeup water for plant cooling. Desalinated water provided by the CCNPP Unit 3 Desalinization Plant supplies makeup water for power plant operations. Figure 3.3-1 and Table 3.3-1 quantitatively illustrate the average and maximum water flows to and from various plant systems for normal plant operating conditions and normal shutdown/ cooldown conditions, respectively. Flow rates for other plant modes are not applicable since there is no change in demand during startup or refueling operating conditions. The average flows represent continuous plant water usage requirements whereas the maximum flows represent intermittent demands. Water use by non-plant facilities includes potable and sanitary needs for administrative buildings and warehouses, and water required for landscaping maintenance. Potable water demand is based on projected staffing during normal plant operation. Other station water users, as noted above, have not been included in the estimated demand. However, water stored in the raw water storage tanks is expected to meet the needs of non-plant facilities since the tanks were designed for peak load provisions.

3.3.1 Water Consumption

Primary water consumption is for turbine condenser cooling. Cooling water for the turbine condenser and closed cooling heat exchanger for normal plant operating conditions is provided by the Circulating Water Supply System (CWS), which is a non-safety-related interface system. Circulating water for condenser heat dissipation is taken from the Chesapeake Bay and will normally be withdrawn at an average rate of 38,032 gpm (143,968 lpm). A small fraction of the intake water will be used to clean debris from the traveling screens. The CWS discharges the heated water from the condenser to the CWS cooling tower. For the closed-loop CWS cooling tower, approximately half of the water withdrawn from the Chesapeake Bay will be lost to the atmosphere as evaporation and to cooling tower drift. The other half will be released as blowdown. Therefore, the average consumptive use of Chesapeake Bay water during normal operating conditions will be approximately 8.2 E+08 gallons per month (3.1 E+09 liters per month) . Consumptive rates should not fluctuate during droughts as might occur if the source for water were a river or variable lake. Consumptive rates will vary with temperature and humidity. Furthermore, considering that the elevation of pump suction at the CWS Intake Makeup Structure will be lower than the lowest anticipated bay water level and since the pumps and associated electrical equipment will be housed within watertight enclosures, there will be no high water limit due to storm surges. During normal shutdown/cooldown conditions, the maximum flow of water required by the CWS will be 44,320 gpm (167,770 lpm).

Mechanical draft cooling towers with water storage basins (i.e., one basin for each of the four trains) comprise the Ultimate Heat Sink (UHS) which functions to dissipate heat rejected from the Essential Service Water System (ESWS). The ESWS is vital for all phases of plant operation and is designed to provide cooling water during power operation and shutdown of the plant. Under normal operating and normal shutdown/cooldown conditions, the ESWS cooling tower water storage basins will be supplied with non-safety-related makeup water pumped from the Desalinization Plant at an average rate of 629 gpm (2,381 lpm). The Desalination Plant will utilize seawater reverse osmosis technology. A membrane filtration system will pre-treat feed to the reverse osmosis equipment. The makeup water serves to replenish water losses due to cooling tower evaporation and drift at a rate of 566 gpm (2,142 lpm) and 2 gpm (8 lpm) , respectively. The remaining water is released to the Chesapeake Bay as ESWS cooling tower blowdown at an average rate of 61 gpm (231 lpm). For normal operation, desalinated water consumption will average approximately 3.5 E+07 gallons per month (1.3 E+08 liters per month). Consumptive rates should not vary during dry periods. During normal plant shutdown/cooldown, when all four trains of the ESWS are operating , peak water demand will be 1,490 gpm (5,640 lpm). The maximum water flow will be provided by the Desalinization Plant and from water stored in the desalinated water storage tanks. Peak water demand will only be for a short period of time. Any shortfall in demand will be provided by onsite stored water tanks.

The ESWS cooling towers are connected to the remainder of the ESWS through intake and discharge paths. The ESWS takes suction from the ESWS cooling tower basins and cools the Component Cooling Water System (CCWS) heat exchangers. The CCWS is a closed-loop cooling water system that in conjunction with the ESWS provides a means to cool the reactor core, removing heat generated from plant essential and non-essential components connected to the CCWS.

During a design basis accident, Chesapeake Bay water will provide safety-related makeup water for the ESWS cooling tower, for the UHS functions.However, since the consumptive rate for accidents is not associated with normal modes of plant operation, this rate is not shown on the water use diagram, Figure 3.3-1.

Sustained desalinated water demand for power plant makeup is 183 gpm (693 lpm) and includes water supplies for the Demineralized Water Distribution System, the Potable and Sanitary Water Distribution System, the Fire Water Distribution System and floor wash drains. The Demineralized Water Distribution System produces and delivers demineralized water to consumers in the power plant that need high quality, non-safety makeup water. Except for containment isolation, the Demineralized Water Distribution System interfaces are non-safety-related. Under normal system operation, water consumption by the Demineralized Water Distribution System is 80 gpm (303 lpm). During normal shutdown/cooldown conditions, water consumption is also anticipated to be approximately 80 gpm (303 lpm). During normal plant operation, the Potable and Sanitary Water Distribution System supplies consumers with pre-treated water (i.e., Drinking Water Supply) at an average rate of 93 gpm (352 lpm). Due to potential surges in demand, water consumption during normal shutdown/cooldown conditions is anticipated to be 216 gpm (818 lpm). The system provides water for human consumption and sanitary cleaning purposes, and can be used by other systems as a water source. The Potable and Sanitary Water Distribution System is not connected with any radioactive source or other system which may contain substances harmful to the health of personnel. Failures in the Potable and Sanitary Water Distribution System will have no consequences on plant operation or safety functions. Similarly, the Fire Water Distribution System is classified as a non-safety system. It is required to remain functional following a plant accident, to provide water to hose stations in areas containing safe shutdown equipment. Water consumed by the Fire Water Distribution System during normal conditions is required to maintain system availability. The maximum consumptive rate accounts for system actuation. During normal operation, water consumed by the Fire Water Distribution System is due to system leakage and periodic testing. The maximum consumptive rate is based on meeting the National Fire Protection Association (NFPA)'s requirements for replenishing fire protection water storage. The average and maximum flows for powerplant floor wash drains are anticipated to be the same.

Miscellaneous low volume waste and treated radwaste generated by the power plant and sanitary waste treated by the Sanitary Waste Water Treatment Plant are returned to the bay at a combined average rate of 143 gpm (541 lpm). This equates to an average consumptive rate of 40 gpm (151 lpm) for power plant, or 1.7 E+06 gallons per month (6.5 E+06 liters per month). As previously stated, water consumption should not vary during drought conditions since the Chesapeake Bay provides water for the Desalinization Plant. Also, as previously stated, there will be no high water limit due to storm surges. Maximum water flow required for power plant makeup during normal shutdown/cooldown conditions is 926 gpm (3,505 lpm).

In addition to providing makeup water for the ESWS cooling towers and makeup water for the power plant, the average and maximum additional capacity usage rate for the Desalination Plant is anticipated to be 413 gpm (1,563 lpm). Additional capacity is allotted for other potential usage.

Prior to discharge into the Chesapeake Bay, CWS cooling tower and ESWS cooling tower blowdown, and miscellaneous low volume waste are directed to the Waste Water Retention Basin. Wastes resulting from the Desalination Plant's membrane filtration and reverse osmosis equipment will also collect in the Waste Water Retention Basin. The Waste Water Retention Basin serves as an intermediate discharge reservoir. During plant startup, startup flushes and chemical cleaning wastes will first collect in temporary tanks or bladders, and will then be discharged into the Waste Water Retention Basin. Waste Water Retention Basin effluents and treated sanitary waste and liquid radwaste collectinthe seal well. The seal well is a collection point for all effluents prior to their discharge into the Chesapeake Bay.

Total water demand for the Chesapeake Bay during normal operations is 41,095 gpm (155,563 lpm). From this total, 21,019 gpm (79,566 lpm) is returned to the bay from the sealwell . The remaining 20,076 gpm (76,010 lpm) is primarilyattributed to the CWS and ESWS cooling towers evaporation and drift losses.

Section 2.3.2 provides a discussion of permitted activities associated with plant water consumption. Section 4.2 provides a discussion of limitations and restrictions on water consumption during construction activities.

3.3.2 Water Treatment

Water treatment will be required for both influent and effluent water streams. Considering that the cooling water source for CCNPP Unit 3 is the same as that for CCNPP Units 1 and 2, cooling water treatment methodologies for CCNPP Unit 3 will be similar. However, since desalinated water will provide water for CCNPP Unit 3 operations, in lieu of groundwater used by CCNPP Units 1 and 2, fresh water treatment methodologies will differ between the two plants. As previously noted, the source of fresh water for CCNPP Unit 3 will be desalinated bay water. Table 3.3-2 lists the principal water treatment systems and treatment operating cycles. The types, quantities and points of chemical additives to be used for water treatment are also indicated.

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 (i.e., sodium hypochlorite) injected into Chesapeake Bay water influent during spring, summer and fall months to minimize marine growth and control fouling on heat exchanger surfaces. Treatment will improve makeup water quality. Similar to CCNPP Units 1 and 2, an environmental permit to CWS operate this treatment system will be obtained from the State of Maryland. For prevention of legionella, treatment for internal circulating water components (i.e., piping between the CWS Makeup Water Intake Structure and condensers) may utilize existing power industry control techniques consisting of hyperchlorination (chlorine shock) in combination with continuous or intermittent chlorination at lower levels, biocide and scale inhibitor addition. Blowdown treatment will depend on water chemistry, but is anticipated to include application of a biocide (i.e., sodium hypochlorite), dechlorination (i.e., sodium bisulfite) and scale inhibitor (i.e., dispersant) to control bio-growth, reduce residual chlorine, and protect against 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 ESWS Water Treatment System, which is a nonsafety-related system designed to treat desalinated water for normal operating conditions and normal shutdown/cooldown. Treatment of system blowdown will also control the concentration of various chemicals in the ESWS cooling water. During design basis accident conditions, the ESWS Water Treatment System is assumed to be non-operational.

Desalinated water 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 systems. Treatment techniques will meet makeup water treatment requirements set by the Electric Power Research Institute and include the addition of a corrosion inhibitor(s), similar to the Service Water System for CCNPP Units 1 and 2 which 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's potable (drinking) water program and standards by U.S. EPA for drinking water quality under the National Primary Drinking Water Regulation (NPDWA) and National Secondary Drinking Water Regulation (NSDWA). The system will be designed to function during normal operation and outages (i.e., shutdown). However, treatment of desalinated water for the Fire Water Distribution System is not anticipated.

Liquid wastes generated by the plant during all modes of operation will be managed by the Liquid Waste Storage System and the Liquid Waste Processing System. The Liquid Waste Storage System collects and segregates incoming waste streams between radioactive and non-radioactive sources, 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 waste water for both systems include sulfuric acid for reducing pH, sodium hydroxide for raising pH and an anti-foaming agent, complexing agent and/or precipitant for promoting settling of precipitates.

The Waste Water Treatment Plant System will be used to treat sewage for CCNPP Unit 3. 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 (de-chlorination) 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. The solids are shipped offsite to a permitted sanitary treatment facility.

Effluents from water treatment systems discharged to the Chesapeake Bay will meet chemical and water quality limits established in the National Pollutant Discharge Elimination System

(NPDES) permit for CCNPP Unit 3. Section 5.2 provides a discussion on effluent limitations and permit conditions.

Table 3.3-1— Anticipated Water Use
(Page 1 of 2)

Water Streams	Average Flow [a] gpm (lpm)	Maximum Flow [b] gpm (lpm)
Chesapeake Bay Water Demand for Desalinization[c,d]	**3,063 (11,595)**	**3,063 (11,595)**
Membrane Filtration (Backwash)	306 (1,158)	306 (1,158)
Reverse Osmosis	2,757 (10,437)	2,757 (10,437)
Reverse Osmosis Reject [e],	1,532 (5,799)	1,532 (5,799)
Essential Service Water System/Ultimate Heat Sink (UHS) System Makeup [e,f]	629 (2,381)	1,490 (5,640)
UHS Cooling Tower Evaporation[i]	566 (2,142)	1,364 (5,163)
UHS Cooling Tower Drift	2 (8)	4 (16)
UHS Cooling Tower Blowdown	61 (231)	122 (461)
Power Plant Makeup	183 (693)	926 (3,505)
Demineralized Water Distribution System	80 (303)	80 (303)
Potable and Sanitary Water Distribution System [k]	93 (352)	216 (818)
Plant Users[k]	93 (352)	216 (818)
Non-Plant Users[g]	0 (0)	0 (0)
Fire Water Distribution System [h]	5 (19)	625 (2,365)
Floor Wash Drains	5 (19)	5 (19)
Additional Capacity	413 (1,563)	413 (1,563)
Chesapeake Bay Water Demand	**41,095 (155,563)**	**47,383 (179,365)**
Desalinization Plant	3,063 (11,595)	3,063 (11,595)
Circulating Water System	38,032 (143,968)	44,320 (167,770)
Circulating Water System Cooling Tower Evaporation	19,016 (71,984)	22,160 (83,885)
Circulating Water System Cooling Tower Drift [i]	39 (148)	39 (148)
Circulating Water System Cooling Tower Blowdown	18,977 (71,836)	22,121 (83,737)
Effluent Discharge to Chesapeake Bay from Seal Well[m]	**21, 019 (79,566)**	**24,363 (92,224)**
Seal Well	21,019 (79,566)	24,363 (92,224)
Waste Water Retention Basin Discharge	20,915 (79,172)	24,136 (91,364)
Miscellaneous Low Volume Waste	39 (148)	55 (209)
UHS Cooling Tower Blowdown	61 (231)	122 (461)
Circulating Water System Cooling Tower Blowdown	18,977 (71,836)	22,121 (83,737)
Desalinization Plant Waste	1,838 (6,957)	1,838 (6,957)
Membrane Filtration	306 (1,158)	306 (1,158)
Reverse Osmosis Reject [e]	1,532 (5,799)	1,532 (5,799)
Start-up Temporary Storage Discharge [j]	—	—
Trash Screen Cleaning Water Discharge [j]	—	—
Treated Sanitary Waste	93 (352)	216 (818)
Treated Liquid Radwaste	11 (42)	11 (42)

Table 3.3-1— Anticipated Water Use
(Page 2 of 2)

Water Streams	Average Flow [a] gpm (lpm)	Maximum Flow [b] gpm (lpm)

Notes:

a. Average flow represents the expected water consumptive rates and returns for nrmal plant operating conditions.

b. Maximun flow represents water consumptive rates and returns during normal shutdown/cooldown.

c. The source for freshwater is desalinated Chesapeake Bay water.

d. Maximum flow of 3,063 gpm (11,595 lpm) will be provided to the Desalinization Plant, which produces 1,225 gpm (4,637 lpm) of fresh water. Maximum fresh water demand will be met with Desalinization Plant makeup of 1,225 gpm (4,637 lpm) plus water stored in the desalinated water storage tanks.

e. The desalinated water demand of 3,063 gpm (11,595 lpm) is based on 40% recovery for the preliminary design of the Desalinixzation Plant. Influent flow to the reverse osmosis (RO) process equipment is 3, 063 gpm (11,595 lpm). Backwash of the membrane fioltration results in 306 gpm (1,158 lpm) of membrane filter reject flow. Assuming 40% recovery from the Desalinization Plant, the corresponding production rate for the RO process would be approximately 1,532 gpm (5,799 lpm). Referring to the above table, note that a production rate of 1,225 gpm (4,637 lpm) would be less that the makeup demand for the UHS cooling towers. However, the makeup and evaporation demands fo rthe UHS cooling towers in the above table are bounding values that occur under design ambient conditions; actual demands are anticipated to be significantly less. Therefore, the flows will likely change during the detailed design phase. Also, the difference between actual demand and flow anticipated by RO equipment will be accomodated by the desalinated water storage tanks.

f. Two trains will be operating under normal conditions and four trains during shutdown/cooldown.

g. The average flow for potable water demand is based on projected staffing during normal plant operation. Non-plant water users include potable and sanitary needs for administrative buildings and warehouses, and water required for landscaping maintenance. Non-plant water users have not been included in the estimated demand. However, water stored in the raw water storage tank(s) is expected to accomodate other station water users since it will be designed for peak load provisions.

h. During normal operating conditions, water consumed by the Fire Water Distribution System is attributed to system leakage and periodic testing. The maximum consumptive rate is based on meeting the National Fire Protection Association's requirement for replenishing fire protection water storage.

i. The average and maximum cooling tower drift losses are considered equivalent and are less than 0.005% of the CWS flow rate of 785,802 gpm (2,974,584 lpm).

j. Startup effluents occur during plant start-up; the effluents will be stored with in tanks or bladders, which will be removed oce startup is complete. Makeup flows associated with startup and trash screen cleaning are anticipated to be minimal. Similarly, discharges associated with startup effluents and trash screen cleaning effluents, are also anticipated to be minimal.

k. The maximum potatble and sanitary water usage is estimated based on the maximum continuous flow in the Nuclear Island and Conventional Island, and on maximum intermittent flow in either area.

l. The average evaporative rate during normal operation with two trains operating is 283 gpm (1,071 lpm) per train. The maximum evaporation rate during shutdown/cooldown with four trains operating is 341 gpm (1,291 lpm) per train. The blowdown rate is based on 10 cycles of concentration.

m. Consumptive loss in the power plant is 40 gpm (151 lpm). This is derived as follows: [183 gpm - (11 gpm liquid radwaste + 93 gpm sanitary waste + 39 gpm misc. low volume waste)] = 40 gpm. Total water consumed is: (566 gpm + 2 gpm) ESWS cooling tower evaporation and drift + (19,016 gpm + 39 gpm) Circulating Water System cooling tower evaporation and drift + (413 gpm) additional capacity + (40 gpm) power plant consumption = 20,076 gpm (75,996 lpm). Note that this also equates to 41,095 gpm - 21,019 gpm (i.e., bay water flow demand minus effluent discharged into the bay.

Table 3.3-2— Water Treatment Systems
(Page 1 of 2)

System	Point(s) of Addition	Chemical Additives	Estimated Quantity	Operating Cycle(s)
Circulating Water Treatment System [a]	Circulating Water Supply System (CWS) Makeup			Normal Operating Conditions and Normal Shutdown/ Cooldown
	CWS Piping	Sodium Hydroxide (1 - 5 wt%) Sodium Hypochlorite (10 - 20 wt%)	547,500 gal/yr (2,072,513 l/yr)	
	CWS Blowdown	Dispersant	383,000 lb/yr (173,726 kg/yr)	
		Sodium Bisulfite (40 wt%)	191,500 lb/yr (86,863 kg/yr)	
		Antifoam	18,250 gal/yr (69,084 l/yr)	
Essential Service Water System (ESWS) Cooling Tower Water Treatment System [b]	ESWS Cooling Tower Makeup ESWS Cooling Tower Blowdown	Sodium Hydroxide (1 - 5 wt%) Sodium Hypochlorite (10 - 20 wt%) Surfactant	2,000 gal/yr (7,571 l/yr)	Normal Operating Conditions and Normal Shutdown/ Cooldown
Demineralized Water Treatment System [c]	Demineralized Water Distribution System Makeup	Sulfuric Acid (93 wt%)	2,650 gal/yr (10,031 l/yr)	Normal Operating Conditions and Normal Shutdown/ Cooldown
		Sodium Hydroxide (50 wt%)	2,400 gal/yr (9,085 l/yr)	
Drinking Water Treatment System [d]	Potable and Sanitary Distribution System Makeup	Sodium Hydroxide (1- 5 wt%) Sodium Hypochlorite (10 - 20 wt%)	200 gal/yr (757 l/yr)	Normal Operating Conditions and Normal Shutdown/ Cooldown
		Iron-based Sorbent	12 ft^3/yr (0.34 m^3/yr)	
Liquid Waste Storage System and Liquid Waste Processing System [d,e]	Influent Waste Water	Sulfuric Acid (93 wt%)	22,900 gal/yr (86,686 l/yr)	Normal Operating Conditions and Normal Shutdown/ Cooldown
		Sodium Hydroxide (50 wt%)	2,400 gal/yr (9,085 l/yr)	
Waste Water Treatment Plant [d]	Potable and Sanitary Distribution System Effluent	Sodium Hypochlorite (10-20 wt%)	800 gal/yr (3,028 l/yr)	Normal Operating Conditions and Normal Shutdown/ Cooldown
		Sodium Thiosulfate (100 wt%)	1,000 lb/yr (454 kg/yr)	
		Soda Ash	12,000 lb/yr (5,443 kg/yr)	
		Alum / (5 wt%) with Polymer	200 gal/yr (757 l/yr)	

Key:
gal/yr – gallons per year
l/yr – liters per year
ft^3/yr – cubic feet per year
m^3/yr – cubic meters per year
lb/yr – pounds per year
kg/yr – kilograms per year

Table 3.3-2— Water Treatment Systems
(Page 2 of 2)

System	Point(s) of Addition	Chemical Additives	Estimated Quantity	Operating Cycle(s)

Notes:

a. The CWS has no safe shutdown or accident mitigation functions. Sodium hypochlorite will typically be added to makeup water. Sodium hypochlorite and dispersant may be added to piping. Dispersant may contain 10 to 20 weight percent 1-hydroxy-1, 1-diphosphoroethane. Chlorine may also be added to piping for prevention of legionella. All four chemicals listed may be added to blowdown. The sodium bisulfate will be added to the blowdown only. The antifoaming agent will contain between 60 to 100 weight percent petroleum distillate. The estimated quantities of chemical additives are totals used throughout the Circulating Water Treatment System.

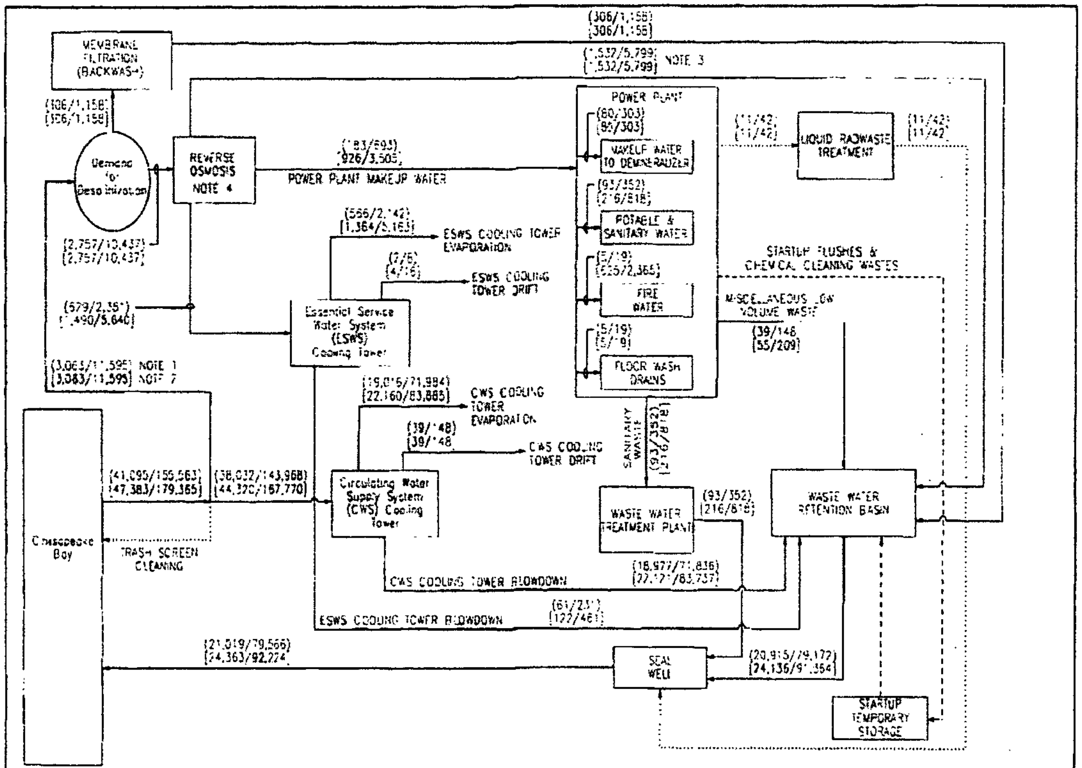
b. During a DBA, the ESWS Cooling Tower Water Treatment System is assumed to be non-operational. The estimated quantity of chemical additives is a combined total for both chemicals listed.

c. The estimated quantities of chemical additives are based on the existing CCNPP Units 1 and 2 Demineralized Water Treatment System which uses the indicated chemicals for the regeneration of condensate demineralizers. The actual quantities of chemical additives will depend on how the demineralizer for CCNPP Unit 3 will be used (i.e., full-flow demineralizers use higher quantities).

d. Types and estimated quantities of chemical additives are based on those used at an existing plant.

e. An anti-foaming agent, complexing agent and/or precipitant may also be used to promote settling of precipitates.

Figure 3.3-1— Anticipated Water Use Diagram



NOTES:

1 MAKEUP WATER TO THE CWS CIRCULATING WATER SYSTEM WILL SUPPLY THE DESALINIZATION PLANT
2 FOR MAXIMUM FLOW, SEE TABLE 3.3-1, NOTE "D"
3 SEE TABLE 3.3-1, NOTE "E"
4 REFER TO TABLE 3.3-1 FOR THE DESALINIZATION PLANT'S ADDITIONAL CAPACITY

LEGEND:

- ------- STARTUP FLOWS
- ——— NORMAL FLOW
- .... FLOW VARIES WITH OPERATING CONDITIONS

KEY:

(AVERAGE FLOWS, GALLONS PER MINUTE/LITERS PER MINUTE)
[MAXIMUM FLOWS, GALLONS PER MINUTE/LITERS PER MINUTE]

3.4 COOLING SYSTEM

The Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 cooling system design, operational modes, and component design parameters are determined from the U.S. EPR design documents, site characteristics, and engineering evaluations. The plant cooling systems and the anticipated cooling system operational modes are described in Section 3.4.1. Design data and performance characteristics for the cooling system components are presented in Section 3.4.2. These characteristics and parameters are used to assess and evaluate the impacts on the environment. The environmental interfaces occur at the intake and discharge structures and the cooling towers. There are two cooling systems that have intakes and cooling towers. These systems are the Circulating Water Supply System (CWS) and the Essential Service Water System (ESWS). Figure 3.4-1 is a general flow diagram of the cooling water systems for CCNPP Unit 3.

3.4.1 Description and operational modes

3.4.1.1 Circulating Water Supply System/Auxiliary Cooling Water Systems

The U.S. EPR uses a Circulating Water Supply System (CWS) to dissipate heat. A closed-cycle, wet cooling system is used for CCNPP Unit 3. This is a different design from the existing CCNPP Units 1 and 2 which have a once-through cooling system. The CCNPP Unit 3 system uses a single plume abated mechanical draft cooling tower for heat dissipation. Under the restrictions imposed by Section 316 of the Federal Clean Water Act, closed-cycle cooling is the only practical alternative for CCNPP Unit 3 that would meet both the Section 316(b) intake requirements at new facilities, as well as the Section 316(a) thermal discharge requirements at this multi-facility site. The CWS at CCNPP Unit 3 dissipates up to 1.108 x 10^{10} BTU/hr (2.792 x 10^9 Kcal/hr) of waste heat rejected from the main condenser and the Closed Cooling Water System (CLCWS) during normal plant operation at full station load. The exhausted steam from the low pressure steam turbine is directed to a surface condenser (i.e., main condenser), where the heat of vaporization is rejected to a loop of CWS cooling water. Cooling water from the CWS is also provided to the auxiliary cooling water system. Two 100% capacity auxiliary cooling water system pumps receive cooling water from the CWS and deliver the water to the CLCWS heat exchangers. Heat from the CLCWS is transferred to the auxiliary cooling water system and heated auxiliary cooling water is returned to the CWS. The heated CWS water is sent to the spray headers of the cooling tower, where the heat content of the water is transferred to the ambient air via evaporative cooling and conduction. After passing through the cooling tower, the cooled water is recirculated back to the main condenser and auxiliary cooling water system to complete the closed cycle cooling water loop. The CWS has nominal flow rate of 785,802 gpm (2,974,584 lpm).

Evaporation in the cooling tower increases the level of solids in the circulating water. To control solids, a portion of the recirculated water must be removed or blown down and replaced with clean water. In addition to the blowdown and evaporative losses, a small percentage of water in the form of droplets (drift) would also be lost from the cooling tower. Peak anticipated evaporative losses are approximately 22,160 gpm (83,885 lpm). Maximum blowdown is approximately 22,121 gpm (83,737 lpm). The drift losses are conservatively 39 gpm (148 lpm) based upon 0.005% of the CWS nominal flow rate for water balance purposes. The actual drift rate will be 0.0005%. Makeup water from the Chesapeake Bay is required to replace the 44,320 gpm (167,770 lpm) losses from evaporation, blowdown and drift.

Makeup water for the CWS will be taken from the Chesapeake Bay by pumps at a maximum rate of approximately 47,383 gpm (179,365 lpm). This is based on maintaining the CWS and supplying the desalination plant with 3,063 gpm (11,595 lpm). The pumps will be installed in a new intake structure located between the existing CCNPP Units 1 and 2 intake structure and the existing barge slip. The makeup water is pumped through a common header directly to the cooling tower basin. Blowdown from the cooling tower discharges to a common retention basin to provide time for settling of suspended solids and to permit further chemical treatment of the wastewater, if required, prior to discharge to the Chesapeake Bay. Figure 3.4-3 shows the location of the CCNPP Unit 3 intake structure, cooling tower, retention basin and discharge.

The CWS water is treated as required to minimize fouling, inhibit scaling on the heat exchange surfaces, to control growth of bacteria, particularly Legionella bacteria, and to inhibit corrosion of piping materials. Water treatment is discussed in Section 3.6.

3.4.1.2 Essential Service Water System/Ultimate Heat Sink

The U.S. EPR design has a safety-related ESWS to provide cooling water to the Component Cooling Water System (CCWS) heat exchangers located in the Safeguards Building and to the cooling jackets of the emergency diesel generators located in the Emergency Power Generating Buildings. The ESWS is used for normal operations, refueling, shutdown/cooldown, anticipated operational events, design basis accidents and severe accidents. The ESWS is a closed-loop system with four safety-related trains and one non-safety-related dedicated (severe accident) train to dissipate design heat loads. The non-safety-related train is associated with one safety-related train.

Safety-related two-cell mechanical draft cooling towers with water storage basins comprise the Ultimate Heat Sink (UHS) which functions to dissipate heat rejected from the ESWS. The two cells of a ESWS cooling tower share a single basin. The ESWS cooling tower basins are sized to provide sufficient water to permit the ESWS to perform its safety-related heat removal function for up to 72 hours post-accident under worst anticipated environmental conditions without replenishment. After 72 hours have elapsed post-accident, if required, the safety-related UHS makeup pumps may be operated to provide brackish water from the Chesapeake Bay to the ESWS cooling tower basins to maintain water inventory for the 30 day post-accident period as stipulated in Regulatory Guide 1.27 (NRC, 1976).

Each of the four ESWS cooling towers has a dedicated CCWS heat exchanger to maintain separation of the safety-related trains. Each ESWS safety-related train uses a dedicated mechanical draft cooling towers to dissipate heat during normal conditions, shutdown/cooldown, or design basis accident conditions. The non-safety-related train uses its associated safety-related train ESWS cooling tower to dissipate heat under severe accident conditions.

Heated ESWS water returns through piping to the spray distribution header of the UHS cooling tower. Water exits the spray distribution header through spray nozzles and falls through the tower fill. Two fans provide upward air flow to remove latent and sensible heat from the water droplets as they fall through the tower fill. The heated air will exit the tower and mix with ambient air, completing the heat rejection process. The cooled water is collected in the tower basin for return to the pump suction for recirculation through the system. Each ESWS cooling tower has a dedicated ESWS pump with an additional pump to supply the severe accident train. Table 3.4-1 provides nominal flow rates and heat loads in different operating modes for the ESWS.

The water loss from the ESWS is expected to be 629 gpm (2,381 lpm) based on 566 gpm (2,142 lpm) from evaporation, 61 gpm (231 lpm) from blowdown, and drift loss of 2 gpm (8 lpm) during normal conditions based on two trains operating. The water loss under shutdown/ cooldown conditions will be approximately 1,490 gpm (5,640 lpm) based on 1,364 gpm (5,163 lpm) from evaporation, 122 gpm (461 lpm), from blowdown and drift loss of 4 gpm (15 lpm) with all four ESWS cooling towers in operation. The blowdown from the four ESWS cooling towers will flow by gravity to the common retention basin.

Makeup water to the ESWS is normally supplied from the plant raw water system. The plant raw water system is supplied from a desalination plant which gets water from the Chesapeake Bay via the CWS. The desalination plant produces approximately 1,225 gpm (4,637 lpm) of raw water (based on 40% recovery). Under post-accident conditions lasting longer than 72 hours, the makeup water will be supplied from the safety-related UHS makeup water system. The safety-related UHS makeup pumps are housed in a safety-related intake structure near the CWS intake structure.

The ESWS makeup water under normal conditions will be provided at a flow rate of approximately 629 gpm (2,381 lpm) to accommodate the evaporation rate (approximately 566 gpm (2,142 lpm)) and drift loss (approximately 2 gpm (7.5 lpm) for the unit) with 61 gpm (231 lpm) blowdown for two ESWS cooling towers. The ESWS blowdown and makeup rates are based on maintaining ten cycles of concentration and evaporation at 82°F wet-bulb and 20% relative humidity.

The ESWS water is treated as required to minimize fouling, inhibit scaling on heat exchange surfaces, to control growth of bacteria (particularly Legionella bacteria) and to inhibit the corrosion of piping materials. Pumps, valves and other system component materials will be designed for use in either a fresh or brackish water application.

Figure 3.4-2 shows the preliminary details for the common retention basin.

3.4.1.3 Common Operational Factors

3.4.1.3.1 Station Load Factor

The U.S. EPR is designed to operate with a capacity factor of 95% (annualized), considering scheduled outages and other plant maintenance. For the site, on a long-term basis, an average heat load of 1.053 x10^{10} BTU/hr (2.652 x 10^9 Kcal/hr) (i.e., 95% of the maximum rated heat load of 1.108 x10^{10} BTU/hr (2.792 x 10^9 Kcal/hr)) will be dissipated to the atmosphere.

3.4.1.3.1.1 Chesapeake Bay Water Temperature

Water temperatures measured from 1984 through 2006 ranged between 36.5°F (2.5°C) and 80.6°F (27°C). Since the existing CCNPP Units 1 and 2 began operation, ice blockage that rendered the intake structure and cooling water system inoperable has not occurred. In 1977 and 1978, solid surface ice formed in the intake channel. The cooling system, however, was able to continue operating without the differential pressure across the traveling screens reaching the High-High setpoint although some pulverized ice and slush were pumped into the system leading to increased blockage of strainers downstream of the pumps. Historical water temperatures in the Chesapeake Bay show that the minimum temperatures near the intake area could produce significant icing of the new intake structure. De-icing controls for the existing CCNPP Units 1 and 2 consist of operational control of the two intake pumps and condenser discharge valve lineups to backwash warmed water from the condenser to the intake channel. Since the design of the new intake and cooling system for the CCNPP Unit 3 does not permit a similar thermal backwash de-icing procedure, de-icing controls, such as heat tracing of the bar racks and/or screens, would be added at the intake structures.

3.4.1.3.1.2 Chesapeake Bay Water Level

CCNPP Units 1 and 2 rely on the Chesapeake Bay for safe shutdown and are designed for a minimum bay low water level of -4.0 ft (-1.2 m) NGVD 29 and can continue to operate at an extreme low water elevation of -6.0 ft (-1.8 m) NGVD 29. CCNPP Unit 3 does not rely on Chesapeake Bay water for safe shutdown since the UHS tower basin contains sufficient storage volume for shutdown loads. The unit is not required to be shutdown based on minimum Chesapeake Bay water level. However, the extreme low water elevation of -6.0 ft (-1.8 m) NGVD 29 is incorporated into the design and operation of the UHS makeup water system.

The maximum flood level at the intake location is Elevation 33.2 ft (10.11 m) NGVD 29 as a result of the surge, wave heights, and wave run-up associated with the probable maximum hurricane (PMH). Thus, the UHS intake structure would experience flooding during a PMH and flood protection measures are required for this building. The UHS makeup water pump room and electrical room are protected by watertight doors. The air-cooled condenser room is protected by having louvers located above the maximum flood level. The non-safety-related traveling screen room is susceptible to flooding but screen rotation is not required for pump operation. All safety-related structures in the power block area have a minimum grade slab or entrance at Elevation 84.6 ft (25.8 m) NGVD 29 or higher.

3.4.1.3.1.3 Anti-Fouling Treatment

Bio-fouling is controlled using chlorination or other treatment methods in the CWS cooling tower basin. The chemical addition to the cooling tower ensures that the fill in the cooling tower remains free of biofilms and other organic deposits. An additional means of treating bio-fouling in the makeup water obtained from the Chesapeake Bay is provided at the CWS makeup water system intake structure to ensure there is no biological fouling of the intake structure or the makeup water supply piping. Additional pre-treatment of the cooling tower makeup is provided, if required, based on periodic water chemistry sampling. Corrosion inhibitors may also be introduced at these injection points, as required, based on the system piping materials and water chemistry.

Bio-fouling is controlled using chlorination or other treatment methods in the UHS cooling tower basins. UHS cooling tower makeup water is normally supplied by fresh water from the desalination plant . Under post accident conditions lasting longer than three days, however, the makeup water may be brackish water from the Chesapeake Bay. In either case, makeup water will be subjected to appropriate filtration and treatment as required, based on periodic water chemistry sampling. Corrosion inhibitors may also be introduced at these injection points, as required, based on the system piping materials and water chemistry.

3.4.2 Component Descriptions

The design data of the cooling system components and their performance characteristics during the anticipated system operation modes are described in this section. Site-specific estimates are used as the basis for discussion.

3.4.2.1 Chesapeake Bay Intake Structure

The Chesapeake Bay intake system consists of the existing CCNPP Units 1 and 2 intake channel, the CCNPP Unit 3 intake channel, the non-safety-related CWS makeup pump intake structure and associated equipment including the non-safety-related CWS makeup pump, the safety-related UHS makeup water system intake structure and associated equipment including the safety-related UHS makeup water pumps, and the makeup water chemical treatment system. The general site location of the new intake system is shown in Figure 3.4-3. Figure 3.4-4 and Figure 3.4-5 show the intake structure in more detail.

The existing intake system consists of the CCNPP Units 1 and 2 dredged channel that extends approximately 4,500 ft (13,80 m) offshore and a 560 ft (171 m) wide, 56 ft (17 m) deep curtain wall that extends the full width of the intake channel creating an embayment in which the intake structures are located (BGE, 1970). The top of the curtain wall is approximately 5 ft (1.5 m) above the water and the bottom is at elevation -28 ft (-8.5 m). Due to siltation, the effective opening is 17 ft (5.2 m), originally the opening was 23 ft (7 m) high. Velocity under the curtain wall at design depth is estimated to be approximately 0.4 ft/sec (0.12 m/sec). Velocities are currently somewhat greater due to siltation (CGG, 2005).

The new CCNPP Unit 3 intake area will be constructed with a sheet pile wall extending approximately 180 linear feet from the existing shoreline to the existing baffle wall and extending approximately 90 feet channelward from the approximate mean high water shoreline creating an approximately 9,000 ft^2 (836.1 m^2) wedge shaped pool. Approximately 50 ft (15.2 m) of existing shoreline armor protection will be removed to install the new sheet pile wall. Once the new sheet pile wall is in place, approximately 60 ft (18.3 m) of armor within the wedge shaped pool will be removed and temporary upland sheet piling will be installed along the makeup water pipe route. This upland sheet piling will extend out into the wedge shaped pool approximately 30 ft (9.1 m) to facilitate dewatering, installation of pipe and the associated security bars. The area within the wedge shaped pool surrounded by the pipe line sheet piling will be dewatered and dredged by mechanical method to create an approximately 30 ft (9.1 m) wide by 30 ft (9.1 m) long by 25 ft (7.6 m) deep area, resulting in approximately 900 yds^3 (688.1 m^3) of sand and gravel which will be deposited at an existing upland, environmentally controlled area at the Lake Davies laydown area onsite. After dredging, two 60 in (152.4 cm) diameter intake pipes will be installed with security bars at the pipe openings, extending approximately 20 ft (6.1m) channelward to a bottom elevation of -25 ft (-7.62 m) mean low water level. After installation of the pipes and associated security bars, shoreline armour protection approximately 80 ft (24.4 m) in length and extending 10 ft (3.1 m) channelward will be restored within the wedge shaped area. In addition, armour protection will be extended out beyond the new sheet pile wall approximately 75 ft (22.9 m) and extend 205 ft (62.5 m) channelward. As a final step, the temporary sheet pile wall around the 60 in (152.4 cm) intake pipes will be removed allowing the area to reflood and submerge the pipes.

The new CCNPP Unit 3 intake piping consists of two runs of 60 inch (152.4 cm) diameter safety related concrete pipes approximately 490 ft (149.4 m) long. These pipes convey water from the CCNPP Unit 3 intake area to a CCNPP Unit 3 common safety related forebay approximately 100 ft (30.5 m) long by 80 ft (24.4 m) wide area with a concrete basemat at Elevation -22.5 ft (-6.9 m) NGVD 29 and vertical concrete walls extending to Elevation 11.5 ft (3.5 m) NGVD 29. The nonsafety related CWS intake structure and the safety related UHS makeup water intake structure are situated at opposite ends of the common forebay.

The new CCNPP Unit 3 intake piping draws water from the Units 1 & 2 intake channel area. The piping is oriented perpendicular to the intake channel flow. This orientation minimizes the potential of fish entering the piping and common forebay as shown on Figure 3.4-3. The flow velocity into the existing intake area from the bay is no more than 0.5 fps (0.15 mps). The flow through the new channel is determined by plant operating conditions. The average flow velocity along the new intake channel would be less than 0.5 fps (0.15 mps), based on the maximum makeup demand of approximately 47,383 gpm (179,365 lpm). The average flow velocities at the circulating water makeup structure and the UHS makeup structure would be less than 0.3 fps (0.09 mps) and less than 0.1 fps (0.03 mps), respectively. Due to circulatory flow in the common forebay, siltation may occur and sediment removal may be required after long term operation to maintain the forebay invert elevation.

The new CCNPP Unit 3 CWS makeup water intake structure will be an approximately 120 ft (36.6 m) long, 60 ft (18.3 m) wide concrete structure with individual pump bays. Three 50% capacity, vertical, wet pit CWS makeup pumps provide up to 44,000 gpm (166,588 lpm) of makeup water.

The CCNPP Unit 3 UHS makeup water intake structure is approximately 90 ft (27.4 m) long, 60 ft (18.3 m) wide concrete structure with individual pump bays. Four 100% capacity, vertical, wet pit UHS water makeup pumps are capable of providing up to 3,000 gpm (11,356 lpm) of makeup water or 750 gpm (2,839 lpm) for each pump.

In the UHS makeup intake structure, one makeup pump is located in an independent pump bay, along with one dedicated traveling screen and trash rack. Each pump bay is furnished with cross bay stop log slots to permit isolation of pumps on an individual bay basis.

For the CWS makeup water intake structure, flow from two traveling screens and trash racks into a common inlet area feeds the three CWS makeup pumps. Each CWS pump is located in its own pump bay with cross bay stop log slots to permit isolation of individual pumps. Debris collected by the trash racks and the traveling screens is collected in a debris basin for cleanout and disposal as solid waste. The through-trash rack and through-screen mesh flow velocities is less than 0.5 fps (0.15 mps). The trash bar spacing is 3.5 in (8.9 cm) from center to center. The dual flow type of traveling screens with a flow pattern of double entry-center exit will be used for both the CWS and UHS intakes. This arrangement prevents debris carry over. The screen panels will be either metallic or plastic mesh with a mesh size of 0.079 to 0.118 in (2 to 3 mm) square. The screen panels are mechanically rotated above the water for cleaning via a screen wash system. The screen wash system for the CWS Makeup Water consists of two screen wash pumps (single shaft) that provide a pressurized spray to remove debris from the water screens. The screen wash system for the UHS Makeup Water System consists of four screen wash pumps that provide a pressurized spray to remove debris from the respective traveling screens. In both intake structures, the flow velocities through the screens are less than 0.5 fps (0.15 mps) in the worst case scenario (minimum bay level with highest makeup demand flow). Nevertheless, a fish return system will be provided on the CWS intake to reduce mortality of aquatic species, consistent with the intent of Clean Water Act Section 316(b) regulations.

The growth of slime, algae and other organic materials will be monitored in the intake structure and their components as well as the accumulation of debris on the trash racks. Cleaning will be performed, as necessary.

The combined pumping flow rate from Chesapeake Bay for CCNPP Unit 3 will be a maximum of approximately 47,383 gpm (179,365 lpm).

3.4.2.1.1 Fish Return System

The existing Units 1 and 2 Fish Return Systems are located to the northeast and southeast sides of the Units 1 and 2 Intake Forebay, respectively. Each unit has its own independent Fish Return System. However, both systems are of the same design and water flows through the Fish Return System where environmental aquatic studies can be performed. Traveling screen wash water leaving the facility then enters the Chesapeake Bay directly though a buried conduit to the shoreline outfall. The Fish Return System contains a holding pit, two isolation gates and flow trough. The main isolation gate is normally open, allowing discharge of screen wash water (containing fish) to the Chesapeake Bay. If needed, the main gate would close, and the side isolation gate opens up allowing diversion of screen wash water to the holding pit to allow environmental studies. Water overflowing the holding pit would lead to the buried conduit and exit to the bay.

A new fish collection/holding system, similar to that of Units 1 and 2, will be constructed for the new Unit 3 Intake Structure. It will be located on the east side (bay side) of the Unit 3 Intake Forebay. Screen wash water and fish collected from the traveling screens of the Unit 3 Circulating Water Makeup Intake Structure will be diverted to the new Fish Return System and will be released to the Chesapeake Bay via a buried pipe to a new shoreline outfall. The outfall will be submerged below low tide level to minimize any drop at the exit to facilitate the fish return to the Chesapeake Bay water. No modification to the existing fish return and holding system for Units 1 and 2 is necessary.

To construct the proposed fish return outfall, an 18 in (45.7 cm) diameter HDPE pipe will be installed in a mechanically excavated trench. The pipe will be installed 4 ft (1.2 m) below the bay bottom and will emerge from the bay bottom 40 ft (12.2 m) channelward. The outfall location will be protected with a 10 ft (3.1 m) by 10 ft (3.1 m) riprap apron extending approximately 48 ft (14.6 m) channelward. To install the pipe, approximately 40 linear ft (12.2 m of the existing shoreline revetment will be removed, and approximately 500 yds^3 (382.3 m^3) of materials will be dredged within the work area. The dredged material will be returned to the trench after the pipe is placed, and the existing shoreline revetment will be restored to its original design after pipe installation. Turbidity curtains are anticipated to be used during the work to contain suspended sediments.

3.4.2.2 Final Plant Discharge

The final discharge consists of cooling tower blowdown from the CWS cooling tower, the ESWS cooling towers and site wastewater streams, including the domestic water treatment and circulation water treatment systems. All biocides or chemical additives in the discharge will be among those approved by the U.S. Environmental Protection Agency and the State of Maryland as safe for humans and the environment, and the volume and concentration of each constituent discharged to the environment will meet requirements established in the National Pollutant Discharge Elimination System (NPDES) permit. The types and quantities of chemicals used are discussed in Section 3.3.

The discharge flow to the Chesapeake Bay through the seal well is mainly from the retention basin. Note that treated liquid radioactive waste and effluent from the sewage treatment plant will discharge directly to the seal well. Discharge from the retention basin occurs through an approximately 30 in (76 cm) diameter discharge pipe to the seal well. From the seal well, the discharge pipe is routed to the offshore diffuser outfall where there are three 16 in (41 cm) diameter nozzles to distribute the discharge flow into the bay. The normal discharge flow will be approximately 21,019 gpm (79,566 lpm) and the maximum discharge flow will be approximately 24,363 gpm (92,224 lpm). This includes the nominal and maximum discharge flow from the CWS cooling tower of approximately 18,977 gpm (71,836 lpm) and 22,121 gpm (83,737 lpm), respectively. Figure 3.4-2 and Figure 3.4-6 show the preliminary details for the retention basin and the seal well, respectively.

The 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 the State of

Maryland regulations for thermal discharges. Figure 3.4-7 shows details of the discharge system. The discharge point is near the southwest bank of the Chesapeake Bay approximately 1,151 ft (351 m) south and 650 ft (198 m) east of the intake piping suction point for CCNPP Unit 3 (relative to plant north) and extends about 550 ft (168 m) into the bay through a buried nominal 30 in (76 cm) discharge pipe with diffuser nozzles at the end of the line. The preliminary centerline elevation of the discharge nozzles of the diffuser is 3 ft (0.9 m) above the Chesapeake Bay bottom elevation. The three 16 in (40.6 cm) diameter nozzles are spaced center-to-center at 9.375 ft (2.86 m) located 3 ft (0.91 m) above the bottom. The angle of discharge is 22.5 degrees to horizontal. Riprap will be placed around the discharge point to resist potential erosion due to discharge jet from the diffuser nozzles. Fish screens are not required on the diffuser nozzles since there will always be flow through the discharge piping, even during outages, to maintain discharge of treated liquid radioactive waste within the concentration limits of the applicable local, state and federal requirements. The length of the diffuser flow after exiting the nozzle is approximately 26 ft (7.9 m).

3.4.2.3 Heat Dissipation System

The CWS cooling tower is used as the normal heat sink. The CWS cooling tower is a mechanical draft cooling tower that has a concrete shell rising to a height of approximately 164 ft (50 m). It is a hybrid design that incorporates dry cooling sections to achieve plume abatement. Internal construction materials include fiberglass-reinforced plastic (FRP) or polyvinyl chloride (PVC) for piping laterals, polypropylene for spray nozzles, and PVC for fill material. Mechanical draft towers use forced air conduction across sprayed water to reject latent and sensible heat from the sprayed water to the atmosphere. The CWS cooling tower will dissipate a maximum waste heat load of up to 1.108 x 10^{10} BTU/hr (2.792 x 10^9 Kcal/hr) from the unit, operate with a 10°F (5.6 °C) approach temperature, and maintain a maximum 90°F (32°C) return temperature at design ambient conditions. Table 3.4-2 provides specifications of the CWS cooling tower. The cooling tower occupies an area of approximately 16 acres (6.5 hectares). The noise levels generated by the CWS cooling tower are approximately 65 dBA or less at the distance of approximately 1,300 feet (396 m) from the cooling tower. The State of Maryland stipulates noise limits based on the classification of the receiving land (55 dBA Ldn for residential land). Ldn is a calculated day-night time average noise level based on an hourly average of the equivalent noise level (Leq) over a 24 hour period. As a rule of thumb for a continuously and invariant operating noise source, the Ldn value is 6.4 dB higher than the average Leq value. The Leq noise limit is therefore 55 dBA to 6.4 dB (or 49.6 dBA). Based on distance losses, the 49.6 dBA (Leq) noise limit will be met within a 7,700 ft (2,347 m) radius from the towers. Figure 3.1-1 shows the location of the CWS cooling tower. Figure 3.1-3 depicts the planned mechanical draft tower, while Figure 3.4-8 provides a sectional view of a typical mechanical draft tower for CCNPP Unit 3.

The ESWS cooling tower is a rectilinear mechanical draft structure. Each of the four ESWS cooling towers are a counterflow, induced draft tower and are divided into two cells. Each cell uses one fan, located in the top portion of the cell, to draw air upward through the fill, counter to the downward flow of water. One operating ESWS pump supplies flow to both cells of an operating ESWS cooling tower during normal plant operation. Table 3.4-1 provides system flow rates and the expected heat duty for various operating modes of the ESWS cooling towers. The ESWS cooling towers are designed to maintain a maximum 92°F (33°C) return temperature to the ESWS heat exchangers during normal operation (95°F (35°C) during both design basis accident and severe accident conditions, and 90°F (32°C) during Shutdown/ Cooldown). Temperature rise through the ESWS heat exchangers will be approximately 17°F (9°C) during normal operation and 19°F (11°C) during cooldown operation based on the heat transfer rates defined in Table 3.4-1. Blowdown from the ESWS cooling towers is mixed with

CWS blowdown. The ESWS cooling towers are located on either side of the power block (two ESWS cooling towers per side), to provide spatial separation, with each ESWS cooling tower occupying an area of approximately 0.19 acres (0.077 hectares). The noise levels generated by the ESWS cooling towers is approximately 65 dBA or less at the distance of approximately 1,300 feet (396 m) from the cooling towers. The State of Maryland stipulates noise limits based on the classification of the receiving land (55 dBA Ldn for residential land). Ldn is a calculated day-night time average noise level based on an hourly average of the equivalent noise level (Leq) over a 24 hour period. As a rule of thumb for a continuously and invariant operating noise source, the Ldn value is 6.4 dB higher than the average Leq value. The Leq noise limit is therefore 55 dBA to 6.4 dB (or 49.6 dBA). Based on distance losses, the 49.6 dBA (Leq) noise limit will be met within a 7,700 ft (2,347 m) radius from the towers. Table 3.4-3 provides specifications of the ESWS cooling towers. Figure 3.1-1 provides a preliminary layout for the ESWS cooling towers.

3.4.3 References

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

CGG, 2005. Proposal for Information Collection with 316(b) Phase II Requirements of the Clean Water Act for Calvert Cliffs Nuclear Power Plant, Constellation Generation Group, 2005.

NRC, 1976. Ultimate Heat Sink for Nuclear Power Plants, Regulatory Guide 1.27, Revision 2, Nuclear Regulatory Commission, January 1976.

Table 3.4-1— Minimal and Nominal Essential Service Water System Flows and Heat Loads at Different Operation Modes Per Train

	Minimum Flow (gpm / lpm)*	Nominal Flow (gpm / lpm)*	Heat Transferred (BTU/ hr / Kcal/hr)	Anticipated Number of Trains Operating
Normal Operation (Full Load)	17,340 / 65,639	19,075 / 72,206	165 E6 / 416 E5	2
Cooldown	17,340 / 65,639	19,075 / 72,206	182 E6 / 459 E5	4
Design Basis Accident	17,340 / 65,639	19,075 / 72,206	313 E6 / 789 E5	2
Severe Accident	2,420 / 9,160	2,665 / 10,088	55 E6 / 139 E5	1

Note:
*Based on a mass flow rate (lbm/hr) converted to gpm using water properties at 14.7 psia (101.4 kPa) and 60°F (15.56 °C)

Table 3.4-2— Circulating Water System Cooling Tower Design Specifications

Design Conditions	Mechanical Draft Cooling Tower
Number of Towers	1
Heat Load	1.108E10 BTU/hr (2.792E09 Kcal/hr)
Circulating Water	785,802 gpm (2,974,584 lpm)
Cycles of Concentration—Normal	2
Approximate Dimensions	Height 164 ft (50 m) Overall diameter 528 ft (161 m) (at the base)
Design Dry Bulb Temperature	91.8°F (33.2°C)(summer)/25°F (-3.9°C)(winter)(1)
Design Wet Bulb Temperature	80°F (26.6°C)(summer)/23.3°F (-4.8°C)(winter)
Design Range	28°F (15.6°C)
Design Approach	10°F (5.6°C)
Air Flow Rate (at ambient design point)	66,454,900 acfm (1,881,794 m^3 per min)
Drift Rate	<0.005%(2)

Note:
(1) Based on tower design at 80% relative humidity.
(2) Conservative value used for water balance purposes. Actual value regarding air modelling is 0.0005%.

Table 3.4-3— Essential Service Water System Cooling Tower Design Specifications

Design Conditions	Mechanical Draft Cooling Tower
Number of Towers	4
Heat Load	See Table 3.4-1
Essential Service Water	See Table 3.4-1
Cycles of Concentration—normal	10
Approximate Dimensions	Height96 ft(29 m) Overall length 60 ft(18.29 m) Overall width 60 ft(18.29 m)
Design Dry Bulb Temperature	98.55°F [37°C](summer)/25°F [-3.9°C](winter)(1)
Design Wet Bulb Temperature	81°F [27.2°C](summer)/24.3°F [-4.3°C](winter)(2)
Design Range	18.4°F (10.2°C)
Design Approach	7°F (3.9°C)
Air Flow Rate (at ambient design point)	1,213,000 cfm (3,438 m^3 per min)
Drift Rate	<0.005%

Notes:
(1) Based on tower design at 50% relative humidity
(2) Includes 1°F (0.56°C) for recirculation

Figure 3.4-1— General Cooling System Flow Diagram for CCNPP Unit 3

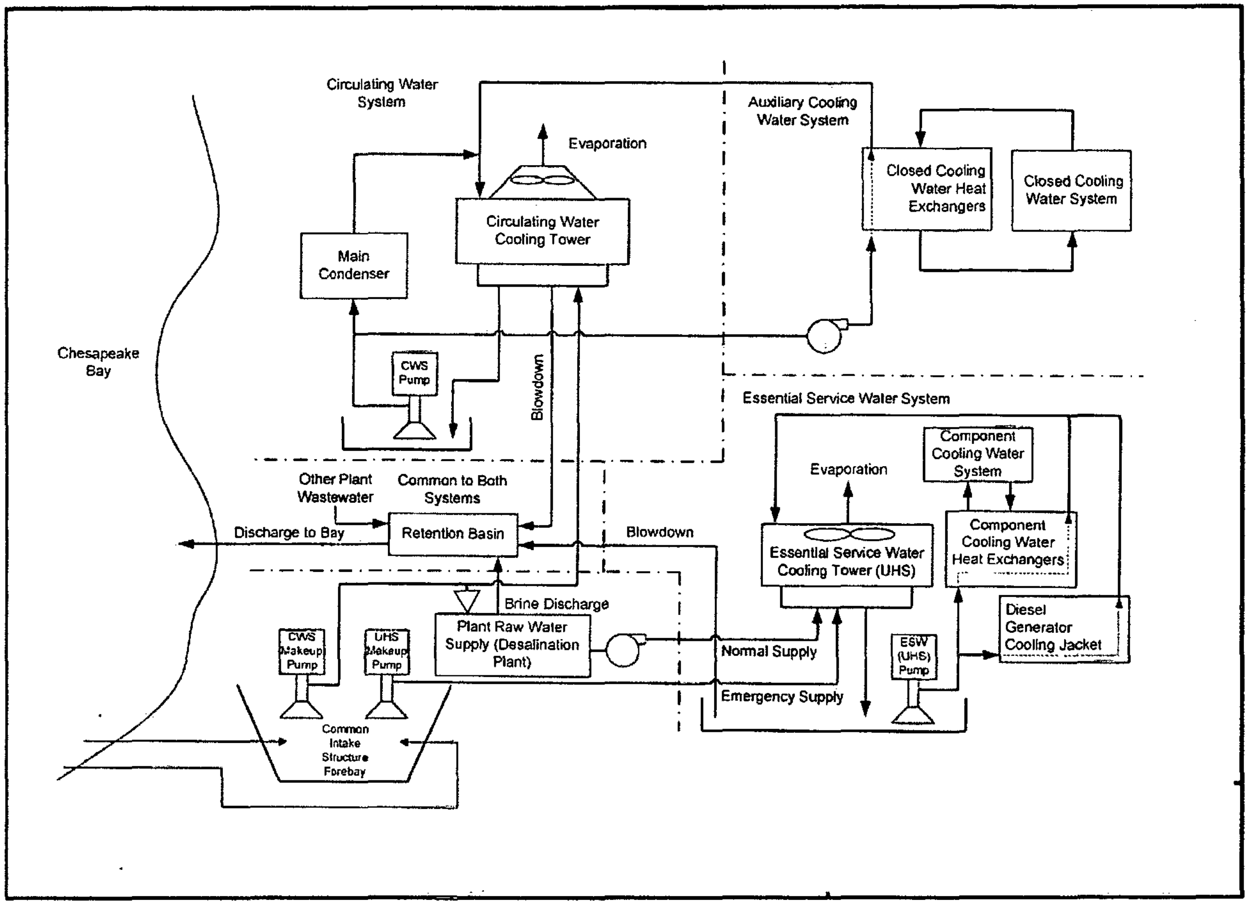


Figure 3.4-2— View of Retention Basin for CCNPP Unit 3

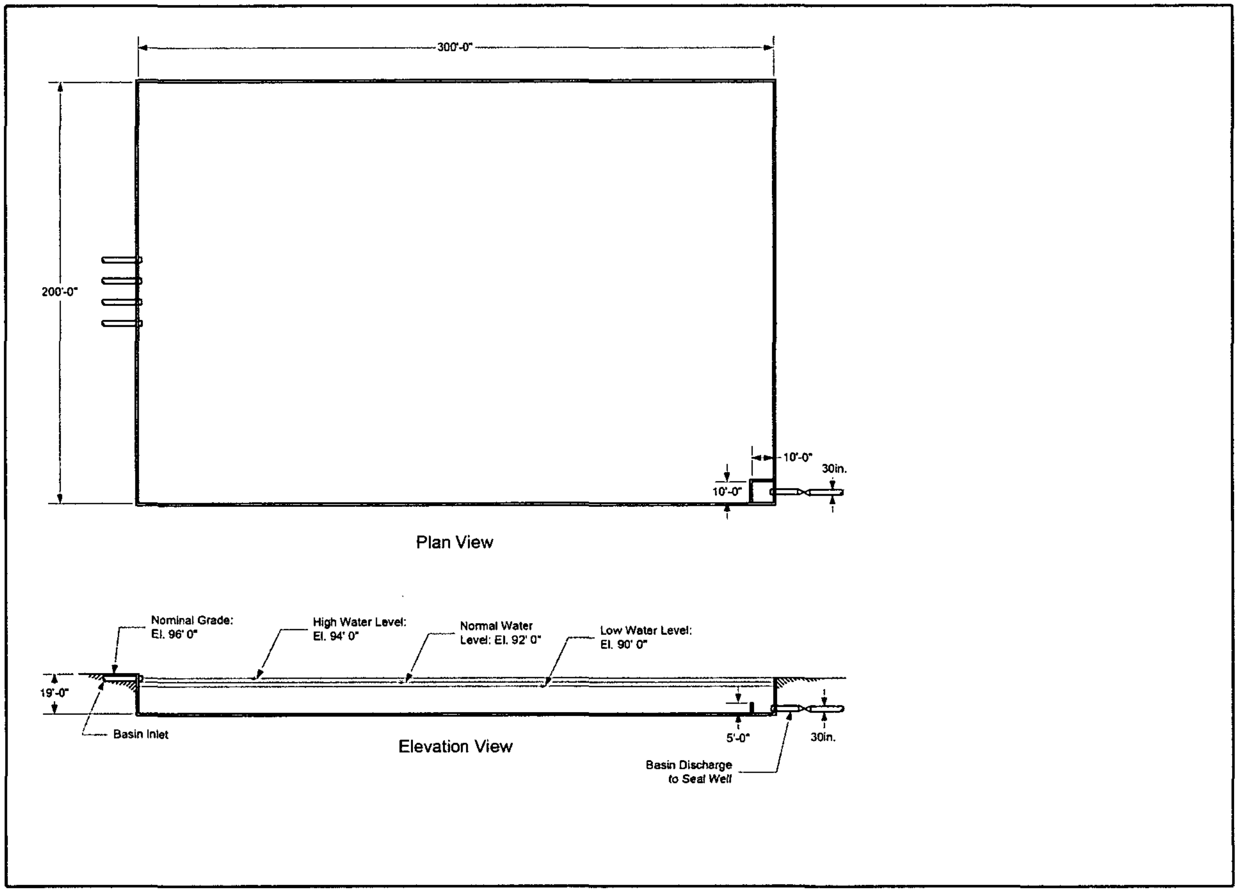


Figure 3.4-3— Circulating Water Intake/Discharge Structure Location Plan for CCNPP Unit 3

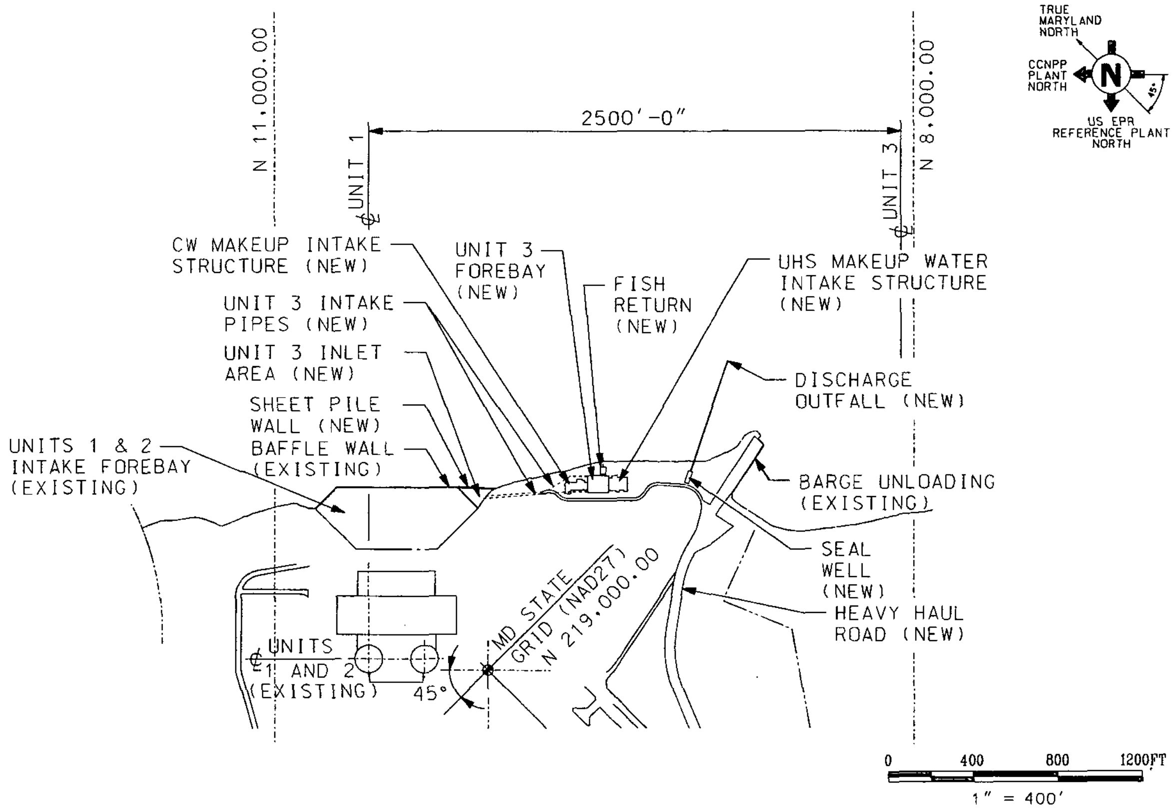


FIGURE 3.4-3
CIRCULATING WATER INTAKE/DISCHARGE
STRUCTURE LOCATION PLAN
08/19/10

Figure 3.4-4— Plan View of Chesapeake Bay Intake System for CCNPP Unit 3

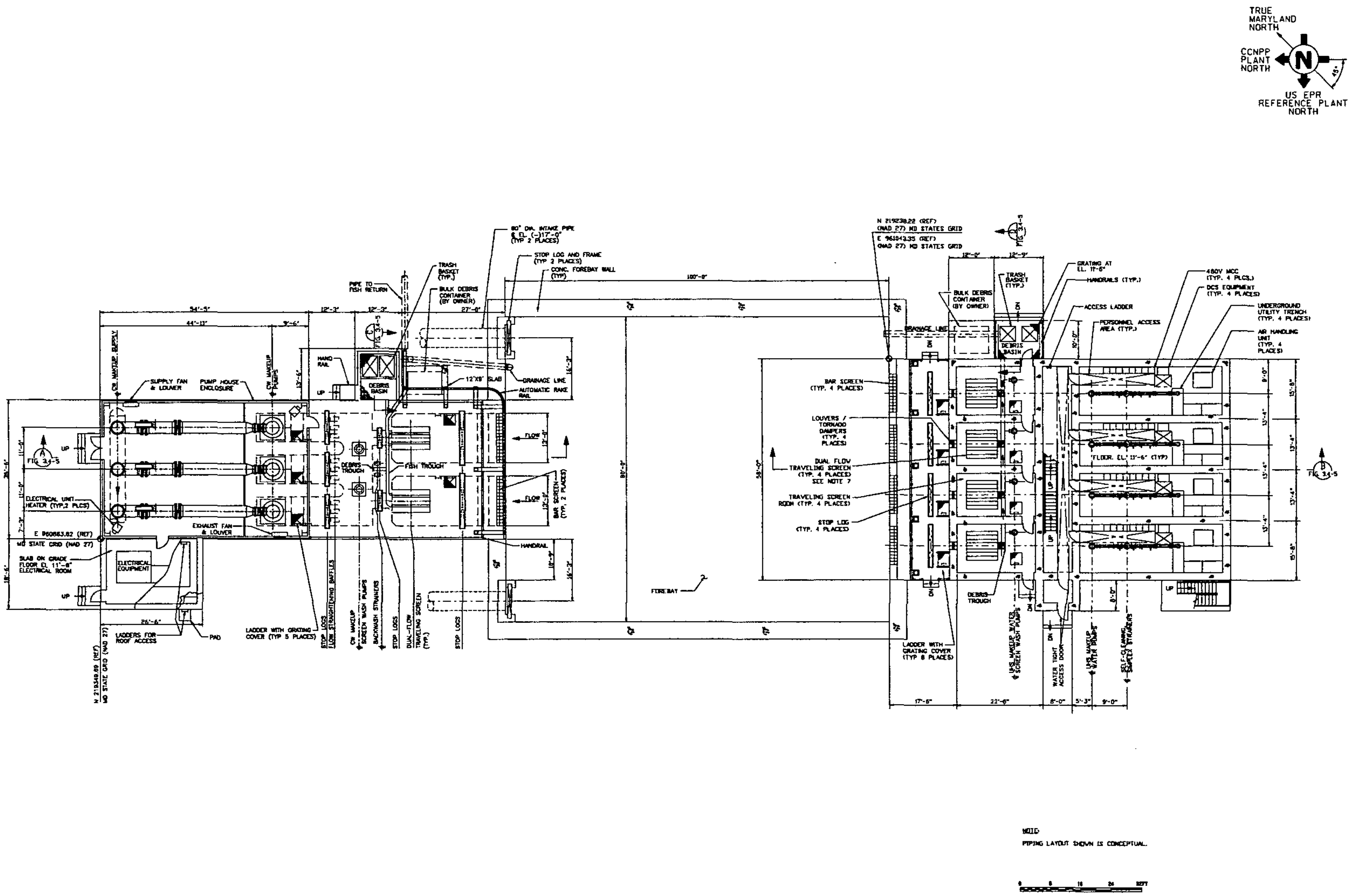


Figure 3.4-5— Section View of Chesapeake Bay Intake System for CCNPP Unit 3

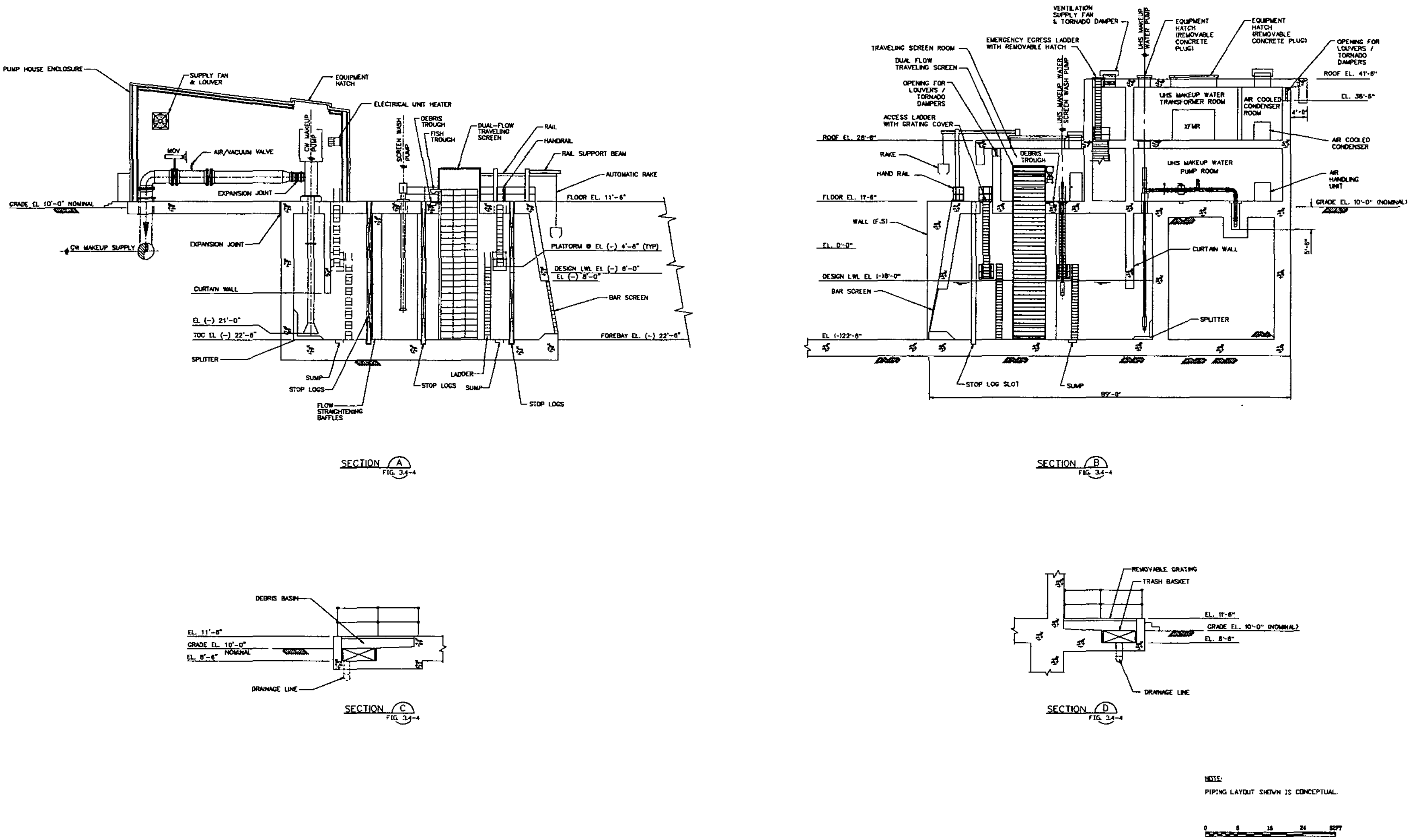


Figure 3.4-6— View of Seal Well for Discharge System for CCNPP Unit 3

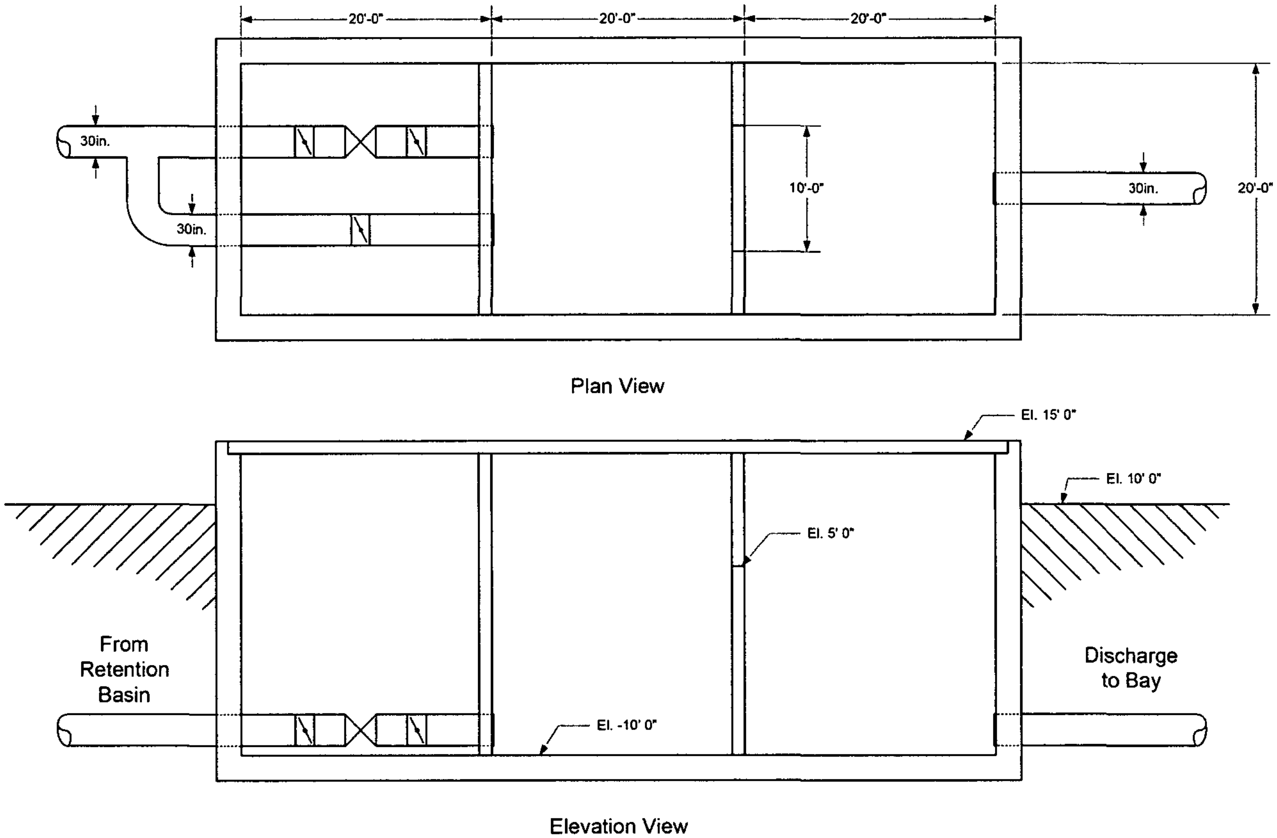


Figure 3.4-7— View of New Discharge Outfall for Discharge System for CCNPP Unit 3

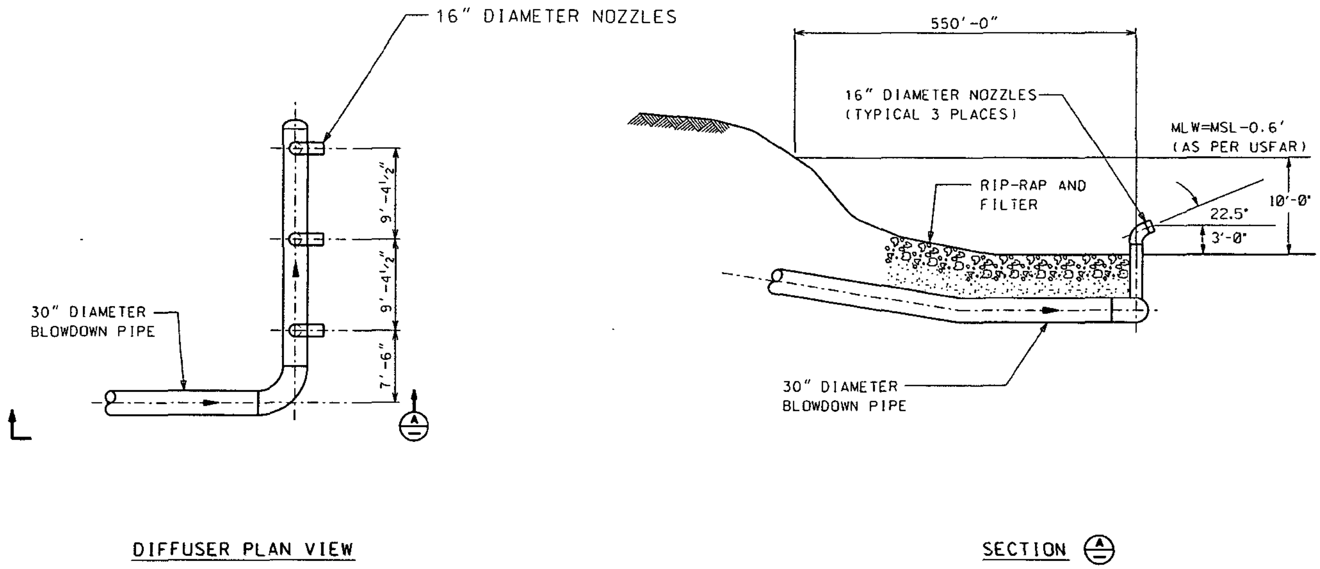
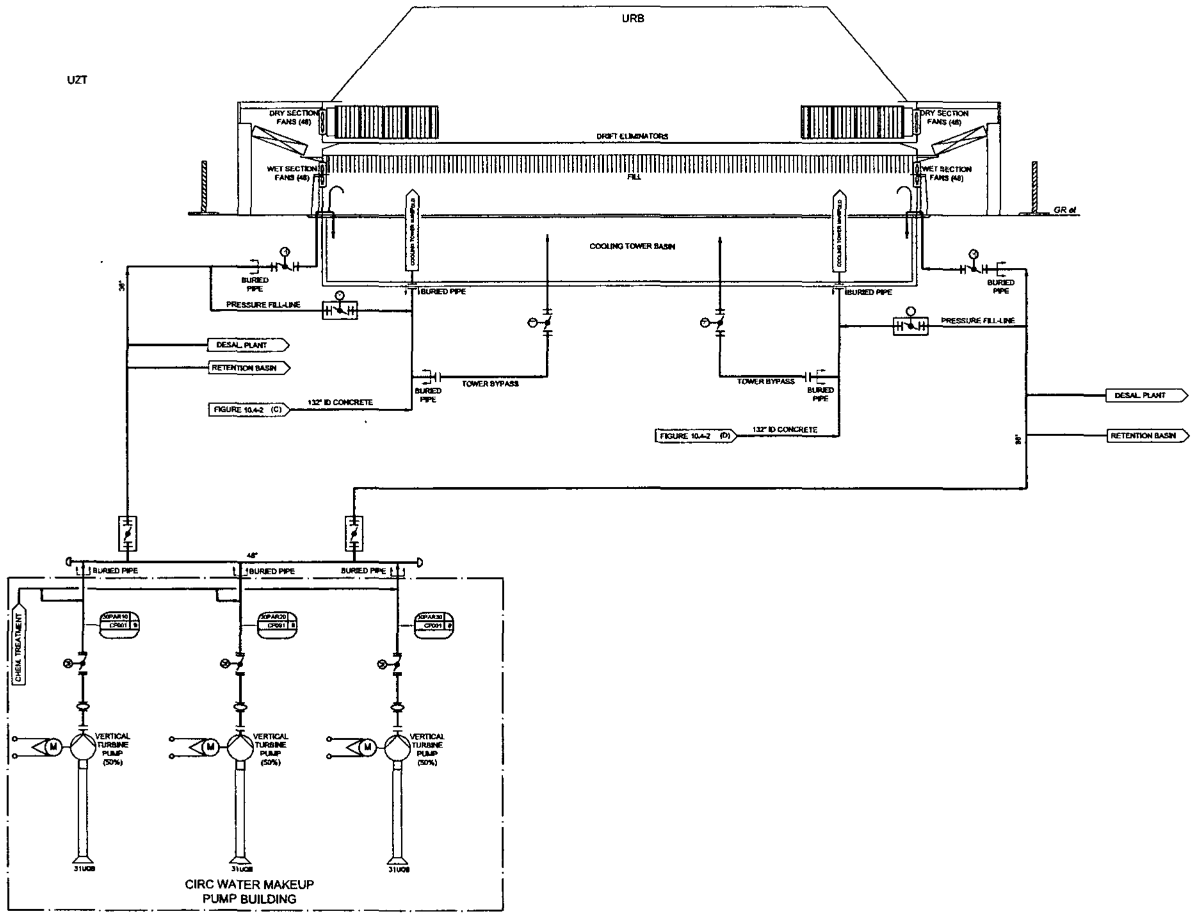


Figure 3.4-8— Typical Mechanical Draft Tower Sectional View



3.5 RADWASTE SYSTEMS AND SOURCE TERM

The generation of power within the reactor results in the presence of radioactive materials in various forms and quantities within the reactor core, reactor coolant system and associated systems and components. The vast majority of the radioactivity produced (fission products) is completely contained within the clad fuel rods and is therefore not available for release to fluid systems or to the environment. However, if imperfections in the cladding are present a small fraction of these fission products escapes from the affected fuel rods to the reactor coolant. The other main source of radioactivity to the reactor coolant is the corrosion of primary system surfaces and irradiation of the corrosion products within the reactor core.

Fission and activated corrosion product radionuclides within the reactor coolant system constitute the source of radioactivity to associated systems and components. This radioactivity appears in letdown and leakage from these systems and components which, in turn, forms the source of radioactivity in liquid and gaseous discharges from the plant site and in solid waste materials generated within the plant. System effluents are collected, processed, monitored and directed for either reuse or release to the environment by the radioactive waste treatment systems. Solid radioactive wastes are collected and packaged for temporary storage, shipment and offsite disposal.

The design and operational objectives of the CCNPP Unit 3 radioactive waste treatment systems are to maintain, during normal operation, the radioactivity content of liquid and gaseous effluents from the site such that the dose guidelines expressed in Appendix I to 10 CFR Part 50 (10 CFR 50.34a) (CFR, 2007a), 40 CFR Part 190 (CFR, 2007b), and 10 CFR 20.1301(d) (CFR, 2007c) are met. The following descriptions of the design and operation of the radioactive waste treatment systems and presentations of the estimated radioactivity content of plant effluents serve to quantify the magnitudes and characteristics of the releases. These releases are then used as the sources for the radiological environmental impact analyses during normal operation, which are presented in Section 5.4 and demonstrate that the radioactive waste treatment systems are designed to keep doses to the public as low as reasonably achievable (ALARA). The dose to the public from radwaste systems during plant operation will meet the dose limits for individual members of the public as specified in 10 CFR 20.1301 (CFR, 2007c).

3.5.1 Source Terms

Source terms used in the evaluation of radwaste systems and effluent releases are discussed in this section. A power level of 4,612 MW(t) is used to calculate source terms based on the guaranteed core thermal output of 4,590 MW(t) plus a 22 MW(t) (approximately 0.5%) uncertainty allowance for heat balance measurements.

3.5.1.1 Primary Coolant Source Term

Two sets of source terms (reactor coolant radionuclide concentrations) have been determined. The first is a conservative design basis used for waste system performance calculations. This source term is based on the assumption that the primary coolant radionuclide concentrations are made up of a combination of proposed technical specification limits for halogens (1 µCi/gm Dose Equivalent (DE)-I-131 in primary coolant) and noble gases (210 µCi/gm DE-Xe133). Activation products and tritium are derived from the ANSI/ANS 18.1-1999 standard (ANS, 1999). Since the activated corrosion products are independent of failed fuel fraction, design basis and realistic basis concentrations are assumed to be the same. Design basis values for the remaining fission product radionuclides are calculated based on a 1.0% failed fuel fraction. The mathematical model used is described in Section 11.1 of the U.S. EPR Final Safety Analysis Report (FSAR). Table 3.5-1 lists key design basis parameters used in the source term calculation for the primary coolant. Table 3.5-2 summarizes the design basis reactor coolant concentration results. Design basis secondary coolant concentrations are based on an assumed primary to secondary leak rate totaling 600 gpd (2,271 L/d) from all four steam generators. Table 3.5-3 summarizes the secondary coolant liquid and steam phase radioactivity concentrations for design basis conditions.

The second source term is based on a realistic model in which the reactor coolant radionuclide concentrations are based on observed industry experience. The model used is described in Regulatory Guide 1.112 (NRC, 1976a), with the source term calculated using NUREG-0017, Revision 1 (NRC, 1985), which contains the Nuclear Regulatory Commission Pressurized Water Reactor (PWR) Gale Code, revised 1985. Specific parameters used in the calculation are provided in Table 3.5-4.

The resulting radioactivity concentrations in the reactor coolant are listed in Table 3.5-2. The inventories calculated in this manner represent "expected basis" activities and are used for the evaluation of environmental impact during routine operation, including anticipated operational occurrences. The data presented in Table 3.5-2 do not include a shutdown iodine spike. Design basis accident analyses include iodine spikes and are discussed in Section 7.1.

Tritium is produced in the reactor mainly through the interaction of neutrons with soluble boron in the coolant. Additional contributions come from the ternary fissions and from the interaction of neutrons with burnable poison rods, lithium and deuterium. Some of the tritium formed within fuel materials will be present in the reactor coolant due to diffusion and leakage through the fuel cladding. For the U.S. EPR design, the expected tritium production rate in the Reactor Coolant System is 1,840 Ci/yr (6.81E+13 Bq/yr). The concentration of tritium in the reactor coolant is provided in Table 3.5-2.

Radioactivity enters the spent fuel pool due to contamination by reactor coolant during refueling operations and possible fission product releases from spent fuel during the storage period. These radionuclides are continuously removed through the spent fuel pool purification train and the building ventilation filtration system. Therefore, the radioactivity in the spent fuel pool area is not a major source of environmental releases (except for tritium and noble gases). Activity concentrations in the fuel pool and atmosphere are listed in Table 3.5-5.

3.5.1.2 Transported Source Terms

The radioactivity in the reactor is transported to various locations in the plant through plant fluid systems and leakages. A schematic diagram of the radwaste effluent flow paths is provided on Figure 3.5-1.

Normal plant operation is anticipated to result in a certain degree of radioactivity within the secondary coolant systems through primary-to-secondary steam generator tube leakage. With steam generator tube defects present, radioactivity will be released to the environment through steam leakage, condensate leakage, and main condenser off gases. The concentrations of radionuclides in the secondary coolant system are based on ANSI/ANS-18.1-1999 (ANS, 1999) for the reference PWR with U-tube steam generators. The results are shown in Table 3.5-3. The radioactivity present in the reactor coolant and secondary coolant are further transported through various radwaste systems and become source terms for environmental releases.

Liquid Source Terms

The following sources are considered in calculating the release of radioactive materials in liquid effluents from normal operations;

1. Processed water generated from the boron recovery system to maintain plant water balance and for tritium control,
2. Processed liquid waste from the containment building sump, floor drains from the auxiliary building, spent fuel building and radwaste building, laboratory drains, sampling drains, and other controlled area drains, and miscellaneous waste,
3. Unprocessed liquid waste from the turbine building floor drain sumps.

The radioactivity input to the liquid radwaste treatment system is based on the flow rates of the liquid waste streams and their radioactivity levels expressed as a fraction of the primary coolant activity. Table 3.5-6 shows the liquid waste flow rate and activity level. The table indicates radioactivity in each stream as a fraction of primary coolant activity prior to treatment and the decontamination factors applied to waste processing and effective decay time while passing through treatment systems.

Isotopic distribution for various waste streams is shown in Table 3.5-7 for the liquid waste system.

Gaseous Source Terms

The following sources are considered in calculating the releases of radioactive materials (noble gases, iodines and particulates) in gaseous effluents from normal operation:

- Containment purges (continuous)
- Non-condensable gases from the gaseous waste system
- Nuclear auxiliary building(s) ventilation
- Radwaste, Spent Fuel and Safeguard Buildings, Ventilation
- Turbine building ventilation
- Main condenser evacuation exhaust

Any leakage of primary coolant or the process stream either in the containment or in the auxiliary buildings are collected in the buildings and vented through filtration systems to the environment. Any steam/water leakages in the turbine building are directly vented to the environment. The non-condensable gases will be also discharged through the main condenser evacuation system exhaust to the plant stack.

The estimated releases, by isotope, from each source are shown in Table 3.5-8 for normal operation. This table is based on the expected basis source term information presented above, assumptions and parameters in Table 3.5-4.

Solid Source Terms

The following sources are considered in calculating the solid waste generated within the plant. Solidified radioactive waste results from the processing of materials from the following sources:

1. Evaporator concentrates from:
    - Liquid waste evaporator

- Boron recovery evaporator
- Liquid waste centrifuge

2. Spent resin from:
   - Spent fuel pool demineralizer
   - Reactor coolant purification treatment ion exchangers
   - Liquid waste system demineralizers
   - Boron recycle system ion exchanger
3. Liquid from decontamination solutions
4. Spent radioactive filter cartridges from various plant filtering systems and other solid non-compressible radioactive waste.

In addition to solid materials extracted from liquid processing systems, dry active waste (DAW) solids are also generated as the result of collecting low activity compressible waste such as paper, rags (cloth) and polyethylene bags from inside the radiation control area. Non-compressible DAW can include such materials as scrap metal, glass, wood, and soil. Table 3.5-9 summarizes as bounding estimates the annual solid wastes generated.

3.5.2 Radioactive Liquid Processing Systems

The primary design functions of the Liquid Waste Storage System and the Liquid Waste Processing System are to receive radioactive liquid wastes collected from the various systems and buildings in which they were generated, to process those liquid wastes in a manner that reduces the activity present in the aggregate liquid wastes such that discharges to the environment can be controlled to stay below 10 CFR 20, Appendix B, Table 2 concentration limits (CFR, 2007d), and the ALARA design dose objectives of 10 CFR 50, Appendix I (CFR, 2007a) for members of the public. Discharges to the environment must also meet state and federal limits specified in discharge permits.

Normal plant operation also has the potential to result in a certain degree of radioactivity within the secondary coolant systems due to primary-to-secondary steam generator tube leakage. Blowdown and leakage of secondary coolant then constitutes radioactive liquid sources, the radioactivity contents of which are reduced and/ or accounted for by the steam generator blowdown processing system and the condensate leakage collection system.

Figure 3.5-2 provides a simplified drawing of the Liquid Waste Storage System and the Liquid Waste Processing System. The discussions that follow describe the design and operation of each of these systems with greater details found in Section 11.2 of the U.S. EPR FSAR. Figure 3.5-3 provides a simplified drawing of the liquid waste treatment system showing the evaporator and centrifuge. Figure 3.5-4 provides a simplified drawing of the Liquid Waste Treatment System showing the vendor supplied demineralizer system.

3.5.2.1 Liquid Waste System

The U.S. EPR Liquid Waste Storage System and Liquid Waste Processing System are used to manage liquid wastes generated by the plant during all modes of operation. The Liquid Waste Storage System collects and segregates incoming waste streams, provides initial chemical treatment of those wastes and delivers them to one or more of the processing systems. The

Liquid Waste Processing System uses evaporation, centrifugal separation, or demineralization and filtration to separate the waste water from the radioactive and chemical contaminants, and to concentrate those contaminants. The cleaned water is returned to one of two waste monitoring tanks in the liquid waste storage system where it is isolated and recirculated to ensure representative samples can be taken and analyzed prior to release to the environment. Once the monitoring tank contents are deemed suitable to be released, the processed liquid is discharged from the monitoring tank to the Chesapeake Bay via a discharge line with a radiation monitor that will stop the release if unexpected or high radioactivity is detected. The radwaste discharge line for CCNPP Unit 3 connects to the cooling tower retention basin discharge line downstream of the basin for added dilution flow before release in the Chesapeake Bay via an off-shore submerged multi-port (three) discharge nozzle arrangement. The concentrates are also returned to the Liquid Waste Storage System for further concentration and eventual transfer to the radioactive concentrates processing system.

The Liquid Waste Storage System collects liquid wastes from the plant, segregates the wastes based on their expected radioactivity and chemical composition, and stores them in the liquid waste storage tanks accordingly.

Group I wastes are those liquid wastes expected to contain radioactivity and boron, but little or no organic and inorganic substances or solids. Sources of Group I liquid wastes include:

- water from the Fuel Pool Cooling System and Fuel Pool Purification System transferred through the floor drains of the Nuclear Auxiliary Building
- liquid waste from decontamination systems
- waste water from sampling and from process drains and sumps collected in the Nuclear Auxiliary Building
- waste water drained from the evaporator column in the Liquid Waste Processing System
- waste water decanted from the concentrate tanks and waste water returned from the radioactive concentrates processing system
- waste water collected from the floor drains of the radioactive waste processing building

Group I wastes are directed to the Group I liquid waste storage tanks.

Group II wastes are those liquid wastes expected to contain low levels of radioactivity, along with organic and inorganic substances and some solids. Sources of Group II liquid wastes include:

- waste water collected from floor drains and sumps of the Nuclear Auxiliary Building
- waste water from the hot laboratory transferred through the sumps of the Nuclear Auxiliary Building
- waste water from the showers and washrooms in the Nuclear Auxiliary Building
- distillate from the Reactor Coolant Treatment System

- treated water returned from the centrifugal separator in the Liquid Waste Processing System

Provisions exist for collection of Group II wastes from the Steam Generator Blowdown Demineralizing System flushing water. Group II wastes are directed to the Group II liquid waste storage tanks.

Group III wastes are those liquid wastes expected to contain no radioactivity, but some organic or inorganic chemicals, under normal plant operating conditions. Group III waste collection headers are shared with some of the Group II collection headers; the wastes carried in these headers normally are directed to the Group III liquid waste storage tank provided that there are no indications that the waste water contains radioactivity. The "shared" sources are the wastes from the Steam Generator Blowdown Demineralizing System flushing water, and treated water returned from the centrifugal separator in the Liquid Waste Processing System. Provisions also exist for the collection of wastes from some of the floor drains in the radioactive waste processing building.

Since Group III waste liquids normally will have very little or no radioactivity, several of the Group III waste water streams may be routed directly to the monitor tanks in the liquid waste storage system. The Steam Generator Blowdown Demineralizing System flushing water wastes, and the treated water returned from the centrifuge separator in the Liquid Waste Processing System each can be routed directly to the monitor tanks instead of the Group III liquid waste storage tank.

The Liquid Waste Storage System and the Liquid Waste Processing System operate independently of the operating modes of the plant. The systems provide sufficient storage and treatment capacity to process the daily inputs produced during all plant startup, normal operation, plant shutdown, maintenance, and refueling periods. The systems are operated on an as-needed basis throughout the plant operating cycle. From operating experience, the peak volume demand occurs during plant outages, when increased volumes of waste water, in particular the Group II waste water streams, are generated by increased maintenance activities.

The liquid waste storage system includes liquid waste storage tanks, concentrates tanks, and monitoring tanks which temporarily store the liquid wastes at various stages of treatment. It also includes recirculation pumps, a sludge pump, a concentrates pump, and recirculation/ discharge pumps to move the liquid waste between the various tanks. Chemical tanks and chemical proportioning pumps are included to permit the precise mixing and injection of chemicals to treat the liquid waste. Piping and control valves route the liquid wastes between the different tanks and pumps, as well as to several interfaces with the liquid waste processing system.

The liquid waste processing system consists of three separate sections. The evaporator section employs a vapor-compressor type evaporator with a separate evaporator column. The evaporator section also includes evaporator feed pumps, a forced recirculation pump, and a distillate pump to move liquid waste through the evaporation process, several heat exchangers to condition the liquid waste at various stages of the process, and a distillate tank to collect the treated waste water for return to the Liquid Waste Storage System.

The centrifuge section employs both a decanter and a centrifugal separator to separate organic and inorganic contaminants from the waste water. The contaminant 'sludge' is collected in a sludge tank, then pumped to a waste drum for collection and processing as solid waste. The treated water is returned to the Liquid Waste Storage System.

The demineralizer and filtration section includes a demineralizer and an ultra-filtration unit. Piping and control valves allow liquid wastes to be passed through either unit or through both units consecutively; contaminants are retained and the cleaned waste water is returned to the Liquid Waste Storage System.

The capacity of the Liquid Waste Processing System is sufficient to process the average quantity of liquid wastes produced weekly in less than half that period of time. The Liquid Waste Processing System consists of three different subsystems, each of which applies a unique process to concentrate and remove radioactive material from liquid wastes. The processes used are evaporation, centrifugal separation, and demineralization/filtration. Because they contains little or no organics and solids, the Group I wastes are processed by evaporation. The evaporator design provides for a flow that is sufficient to allow processing of 1,050 g/h (3,975 l/hr). This is sufficient capacity to process the entire weekly Group I liquid waste volume in slightly more than 25 hours. Because they contain organics and solids, but little or no activity, the Group II and III waste streams are processed by centrifugal separator. The separator is capable of processing approximately 1,300 g/h (4,921 l/hr). This is sufficient capacity to process the entire weekly Group II and Group III liquid waste volume in 63 hours. The demineralizer is capable of processing approximately 2,400 g/h (9,084 l/hr) of liquid waste. This is sufficient to process the combined weekly volume of the Group I, II, and III waste streams in about 40 hours.

Both the Liquid Waste Storage System and the Liquid Waste Processing System are located entirely within the radioactive waste processing building. Interfacing system piping delivers influent liquid wastes that originate in the plant drains with potential to contain liquid radioactive waste. Table 3.5-10 lists the storage capacity for each of the liquid waste collection and process tanks. Table 3.5-11 provides expected process rates for components in the waste processing system. Table 3.5-12 provides the flow rates and activity for each main grouping of liquid radioactive waste.

Coolant Treatment System

Normal operating modes of the Coolant Treatment System purify and recycle reactor coolant and separate boron for reuse. However, the control of tritium levels in the Reactor Coolant System necessitates the periodic discharge of reactor coolant letdown after processing by the Coolant Treatment System for the removal of boron and the degasification of noble gas activity. The volume of processed reactor coolant to be discharged from the plant is administratively controlled to maintain tritium concentrations in the coolant system within a selected range. This processed liquid is discharged to the Liquid Waste Storage System and the Liquid Waste Processing System before being released to the environment instead of being recycled. This treatment option is performed in order to maintain reactor coolant tritium levels such that personnel exposures during containment entry during both power operation and refueling shutdowns is not unduly limited.

Steam Generator Blowdown Processing System

Control of the steam generator secondary side liquid chemistry is achieved by blowdown and demineralized water makeup. The radioactivity content of this blowdown is dependent on reactor coolant radioactivity levels and the primary-to-secondary leakage rate. The estimated average primary-to-secondary steam generator tube leakage reflected in the GALE source term estimates is 75 lb per day (34 kg per day) (NRC, 1985). The steam generator secondary side blowdown rate associated with this leakage level is 218,400 lbm/hr (99,065 kgm/hr) total for all four steam generators.

The blowdown liquid is routed to the blowdown flash tank. As a result of pressure reduction, approximately 29% of the liquid mass flashes to steam. The steam-water mixture is separated in the flash tank. The overhead steam is directed to the deaerator (also called the feedwater tank). The remaining 71% of the flash tank inlet mass (liquid condensate) is routed through two stages of letdown cooling before being processed by the Steam Generator Blowdown Demineralizer System located in the Nuclear Auxiliary Building for cleanup and return to the turbine condenser.

Secondary System Condensate Leakage Collection and Discharge

With radioactivity present in the secondary sides of the steam generators, moisture carryover brings some radioactivity to the remainder of the secondary coolant system. Consequently, leakage of secondary system condensate forms a potential radioactive liquid release source. The amount of radioactivity reaching condensate leakage points is minimized by the high quality of the steam exiting the steam generators so that no processing of condensate leakage before discharge is required. The estimated average volumetric generation rate of this liquid is 5 gpm (19 lpm) at main steam activity. This liquid is discharged from the plant unprocessed, which results in an estimated annual release of 0.00033 curies/yr (1.2E+7 Bq/yr), not including tritium. A central collection point within turbine building is provided to allow sampling and analysis for radioactivity content. The liquid is released from the plant via a monitored pathway (with alarm and trip function on detected high radioactivity) to a waste water retention basin before release to the Chesapeake Bay.

It is assumed, per the GALE code, that the turbine building floor drains will collect leakage of 7,200 gpd (27,255 lpd) at main steam activity (NRC, 1985). The leakage collected in the floor drain sump is directly discharged to the environment without treatment. Should monitors detect excess radiation in the sump, the sump is isolated for evaluation.

3.5.2.2 Liquid Release to the Environment

The radioactivity inputs to the liquid waste system release calculations are provided in Table 3.5-12. The expected annual liquid release source terms based on the GALE code model of the U.S. EPR are summarized in Table 3.5-7.

Releases from Anticipated Operational Occurrences

Annual average radioactivity releases through liquid effluents are summarized in Table 3.5-15. The additional unplanned liquid release due to anticipated operational occurrences is estimated to be 0.16 Ci/year for the U.S. EPR design based on reactor operating data presented in NUREG 0017 (NRC, 1985). These releases were evaluated to determine the frequency and extent of unplanned liquid release and are assumed to have the same isotopic distributions for the calculated source term of the liquid wastes. The total releases from the anticipated operational occurrences are shown in Table 3.5-16 and are included as part of the "total liquid release source term".

Summary of Radioactive Liquid Release from Normal Operations

Discharge concentrations are listed in Table 3.5-16 and are calculated using a conservative 21,019 gpm (79,566 Lpm) discharge flow rate. The above discharge concentrations are compared with effluent concentration limits given in Table 2, column 2 of 10CFR20, Appendix B (CFR, 2007d).

Due to the impracticality of removing tritium on the scale necessary, some tritium present in the reactor coolant system will be released to the environment during plant life time. From the experiences gained at operating PWRs, the total tritium release is estimated to about 0.4 Curies/MWt/year (NRC, 1985). The quantity of tritium released through the liquid pathway is based on the calculated volume of liquid released, excluding secondary system waste, with a primary coolant tritium concentration of 1 μCi/ml up to a maximum of 0.9 of the total quantity of tritium calculated to be available for release. It is assumed that the remainder of tritium produced is released as a gas from building ventilation exhaust systems. Hence, 1,660 curies (6.14E+13 Bq) of tritium are expected to be released to the environment via liquid effluents from the U.S. EPR each year.

3.5.2.3 Liquid Waste System Cost-Benefit Analysis

In addition to meeting the numerical As Low As Reasonably Achievable (ALARA) design objective dose values for effluents released from a light water reactor as stipulated in 10CFR50, Appendix I (CFR, 2007a), the regulation also requires that plant designs include all items of reasonably demonstrated cleanup technology that when added to the liquid waste processing system sequentially and in order of diminishing cost-benefit return, can, at a favorable cost-benefit ratio, effect reductions in dose to the population reasonably expected to be within 50 mi (80 km) of the reactor. Values of $2,000 per person-rem and $2,000 per person-thyroid-rem are used as a favorable cost benefit threshold based on NUREG-1530 (NRC, 1995). The source term for each equipment configuration option was generated using the same GALE code as described in Section 3.5.1 along with the same plant specific parameters modified only to accommodate the changes in waste stream decontamination factor afforded by the design options simulated.

For the U.S. EPR, the dose reduction effects for the sequential addition of the next logical liquid waste processing component (i.e., waste demineralizer) results in a reduction in the 50 mi (80 km) population total body exposure of 0.06 person-rem (0.0006 person-sievert). Section 5.4 describes the population dose calculation for both the base system case of processing liquid waste with an evaporator and centrifuge for Group I and II waste streams, and the augmented system configuration that adds a vendor supplied waste demineralizer for additional processing of the distillate produced by the evaporator and centrifuge. The effective decontamination factors (DF) for liquid processing for both treatment options are given in Table 3.5-13. These values were used in the execution of the GALE code to determine the change in effluent releases for each processing option. The resulting annual release source terms produced with and without demineralizer processing of evaporator and centrifuge treated liquid waste streams are listed in Table 3.5-14. The cost-benefit population dose calculation evaluated the "unadjusted" GALE releases from the two waste processing options in order to assess the relative difference between the two cases of processing with and without a waste demineralizer. This adjustment factor would otherwise add 0.16 Curies per year to the normal effluent, regardless of treatment applied. The liquid effluent population doses for the cost-benefit analysis use the unadjusted releases so as not to be dominated by the adjustment factor, which is not impacted by either treatment case. Table 3.5-17 illustrates the relative population dose associated with both base equipment configuration and that associated with the addition of the waste demineralizer subsystem. Table 3.5-18 compares the estimated total body dose reduction or savings achieved for the addition of the demineralizer subsystem along with a conservative estimated cost for the purchase, operating and maintenance (O&M) of the equipment. The cost basis for the equipment option is taken from Regulatory Guide 1.110 (NRC, 1976b) and reported in 1975 non-escalated dollars which provides a conservatively low estimate of the equipment cost to today's dollars. A 60 year operating time frame is used since the U.S. EPR is designed for a 60 year operating life. The site area population within 50 mi (80 km) is based a projected population in 2080, over 60 years from the estimated start of plant operations. Using the population at the end of plant life is conservative in that it maximizes the collective dose from plant effluents.

For the total body dose reduction, Table 3.5-18 illustrates that the favorable benefit in reduced dose associated with the addition of waste demineralizer system had a dollar equivalent benefit value of $7,200. However, the estimated cost to purchase, operate and maintain this equipment over its operating life was approximately $446,000, thereby resulting in a total body effective benefit to cost ratio of less than 1.0 (not justified on an ALARA basis of dose savings to the public).

In consideration of the collective thyroid dose reduction, Table 3.5-19 illustrates that the favorable benefit in reduced dose associated with the addition of waste demineralizer system had a dollar equivalent benefit value of $55,200. However, the estimated cost to purchase, operate and maintain this equipment over its operating life is the same as shown for the total body dose assessment above, approximately $446,000. This result in a thyroid effective benefit to cost ratio of also less than 1.0 (not justified on an ALARA basis of dose savings to the public).

In assessing if there are any demonstrated technologies that could be added to the plant design at a favorable cost-benefit ratio, a bounding assessment has also been performed which demonstrates that there is insufficient collective dose available to be saved that would warrant additional equipment cost. For the bounding total body collective dose estimate, if an equipment option could reduce the base case population dose to zero, the maximum potential savings in collective dose would be equivalent to $2,000 per person-rem (reference value for favorable benefit from NUREG-1530 (NRC, 1995)) times the life time integrated total body population dose associated with base condition (i.e., 0.177 person-rem/yr x 60 yrs x $2,000 per person-rem = $21,240). For the thyroid collective dose, the savings would be equivalent to $2,000 per person-rem times the life time integrated thyroid population dose associated with base condition (i.e., 0.682 person-rem/yr x 60 yrs x $2,000 per person-rem = $81,840). The assumption of achieving a zero dose does not take into account that tritium in effluents contribution to the dose and that current available treatment options are ineffective to remove it.

Since the benefit value for both the total body and thyroid to reduce the dose to zero is significantly less than the direct and 60 year O&M cost of the waste demineralizer subsystem option or other options from Regulatory Guide 1.110 (NRC, 1976b) not already incorporated in the plant design, the bounding assessment indicates that there are no likely equipment additions that could be justified on an ALARA basis for liquid waste processing.

It should be noted that even though not warranted on a population dose savings basis, a vendor supplied waste demineralizer subsystem skid has been added to the plant design to provide plant operators greater flexibility to process waste liquids by different processes to best match waste stream characteristics, such as chemical form, with the waste process treatment method that best handles the waste from an economics standpoint.

3.5.3 Radioactive Gaseous Treatment Systems

Radioactive gases (such as xenon, krypton and iodine) created as fission products during reactor operation can be released to the reactor coolant through fuel cladding defects along with hydrogen and oxygen that is generated by radiolytic decomposition of the reactor coolant. Since these gases are dissolved in the reactor coolant, they are transported to various systems in the plant by process fluid interchanges. Subsequent reactor coolant leakage releases a portion of these gases and any entrained particulate radioactivity to the ambient building atmosphere.

Fission product and radiolytic decomposition gases released from reactor coolant within the various process systems are handled by the Gaseous Waste Processing System. Radioactive gases or airborne particulates released to the ambient atmosphere in one of the buildings due to system leakage from the process system piping is managed by the combined operation of the Containment Ventilation System, Safeguards Building Controlled Area Ventilation System, Fuel Building Ventilation System, Nuclear Auxiliary Building Ventilation System, and Sampling Activity Monitoring Systems.

3.5.3.1 System Description and Operations

The Gaseous Waste Processing System and sources are provided in Figure 3.5-5. The Gaseous Waste Processing System combines a quasi-closed loop purge section with a discharge path provided through a carbon bed delay section. The purge section recycles the majority of purge gas after it has been processed. This limits the system demand for makeup purge gas, and also limits the amount of gas that must be discharged through the delay section to the environment.

The purge section includes waste gas compressors, purge gas pre-driers, several purge gas reducing stations, purge gas supply piping to tanks in a number of interfacing systems, purge gas return piping from those tanks, purge gas driers, recombiners, and gas coolers. The purge section also includes a gas supply subsystem, gas measuring subsystems, and compressor sealing subsystems. The purge gas stream consists of nitrogen with small quantities of hydrogen and oxygen, and trace quantities of noble gas fission products.

The carbon bed delay section includes a gel drier, delay beds, a gas filter, and a discharge gas reducing station. The delay section discharges processed gaseous waste to the Nuclear Auxiliary Building Ventilation System for release to the environment via the ventilation exhaust stack.

All the components of the Gaseous Waste Processing System and the majority of the components of connected systems are located in the Nuclear Auxiliary Building. However, there are some connected components that are continually swept by gaseous waste processing purge gas flow that are located in other buildings. The volume control tank and two of seven nuclear island drain and vent systems primary effluent tanks are located in the Fuel Building. Four more nuclear island drain and vent systems primary effluent tanks are located in the four safeguard buildings. The pressurizer relief tank and the reactor coolant drain tank are located in the Reactor Building. Gaseous Waste Processing System piping is routed among the buildings.

The Gaseous Waste Processing System is designed to operate continuously during normal plant operation. For the majority of this time, with the plant operating at full power, the Gaseous Waste Processing System will operate in a steady state mode, with a constant flow rate (0.19 lbm/sec (0.86 kg/sec)) for two compressors running), through the purge section, and a small (0.00015 lbm/sec (0.068 gm/sec)), constant discharge rate from the delay section. Figure 3.5-6 depicts the Gaseous Waste Treatment System. The U.S. EPR DCD Section 11.3 describes the individual components and design details of the Gaseous Waste Management System.

Normal Operation – Purge Section

The circulation of purge gas is maintained by the operation of one or both waste gas compressors. The Gaseous Waste Processing System operates at positive pressures from the waste gas compressors to the reducing stations and the volume control tank, and at sub-atmospheric pressure downstream of the reducing stations through the various connected tanks and the gaseous radwaste processing equipment that returns the purge flow to the suction of the waste gas compressor.

Radioactive fission product gases are collected from the pressurizer relief tank, the reactor coolant drain tank, and the volume control tank. The primary influent source is expected to be the Coolant Degasification System, which extracts both hydrogen and fission product gases from the reactor coolant. The other major source of influent to the Gaseous Waste Processing System is the reactor coolant drain tank.

Gaseous Waste Processing System purge gas drawn from the connected components is routed through the gaseous radwaste processing equipment. First, the gas drier treats the returning purge gas. The gas drier uses a cooling process to reduce the moisture content in the purge gas.

The recombiner uses a catalytic process at elevated temperature to recombine the free hydrogen and oxygen entrained in the purge gas stream.

The gas cooler cools the purge gas stream at the recombiner outlet. A filter assures that no particulates are carried forward to the waste gas compressor.

The waste gas compressor compresses the incoming purge gas flow, and discharges to the sealing liquid tank.

The sealing liquid tank separates the gaseous and liquid phases from each other. The purge gas leaving the sealing liquid tank is routed to the pre-drier. The pre-drier cools the purge gas to reduce its moisture content by condensation.

The Gaseous Waste Processing System piping branches downstream of the pre-drier, dividing the purge gas flow. One branch supplies purge gas to the pressurizer relief tank and the reactor coolant drain tank. A second branch supplies purge gas flow to the volume control tank. The third branch connects to the delay section.

The purge gas flow in the third branch is joined by the purge gas discharged from the volume control tank, and is then distributed to the four parallel branches. These four paths purge radioactive fission product gases from the coolant supply and storage system tanks, the reactor boron and water makeup system, the coolant purification system, the coolant treatment system, the coolant degasification system, the various nuclear island vent and drain system primary effluent tanks (in the Safeguards Buildings, the Fuel Building, and the Nuclear Auxiliary Building), and the Nuclear Sampling System active liquid samples subsystem.

Normal Operation – Delay Section

Only a small quantity of purge flow is sent to the delay beds under normal operating conditions. The remaining quantity is recycled.

The delay beds retain the radioactive fission product gases that enter the delay section. These gases (e.g. xenon and krypton) are dynamically adsorbed by the activated charcoal media in the delay beds, which provides the residence times required for natural decay. For normal operations, the Xenon and Krypton dynamic adsorption coefficient are 70 cm^3/gm (2,000 in^3/lb) for Krypton and 1,160 cm^3/gm (32,110 in^3/lb) for Xenon, respectively. This equates to an estimated holdup time for Xenon and Krypton of 27.7 days for Xenon and 40 hours for Krypton, respectively.

The delay beds consist of three vertical pressure vessels connected in series which are maintained at a constant positive pressure to improve the adsorption of waste gases in the activated charcoal media. Two moisture sensors are configured in parallel upstream of the delay beds to provide warning and protective interlock signals if the moisture content of waste gas entering the delay beds exceeds acceptable levels. A radiation sensor is also located upstream of the delay beds to monitor influent activity levels. Two pressure sensors monitor pressure upstream of the delay beds to provide warning signals for high or low operating pressure conditions, and to provide protective interlock signals.

Surge Gas Operation

Operations that transfer large quantities of primary coolant in the systems purged by the Gaseous Waste Processing System automatically place the system into surge gas operation mode. The Gaseous Waste Processing System operates in surge gas mode primarily during plant startup or shutdown.

Surge Gas Operation – Purge Section

Operation of the Gaseous Waste Processing System purge section is not significantly altered by plant operating mode. Purge flow through the components connected to the Gaseous Waste Processing System continues as in normal operating conditions.

Surge Gas Operation – Delay Section

During conditions of excess gas generation, the flow volume to the delay section automatically increases. This increased flow volume is automatically sensed and shifts the system to surge gas operation mode. Surge gas operation mode automatically stops waste gas releases from the Gaseous Waste Processing System via the Nuclear Auxiliary Building Ventilation System until the system is manually reset.

The capacity of the delay section adapts to the increased flow rate during surge gas operation mode because surge gas mode elevates delay section pressure. Higher pressure increases the storage capacity of the delay section and improves the adsorption capabilities of the activated charcoal.

The delay section maintains the required residence time for natural decay of the fission product gases during surge gas operation mode by virtue of the increased capacity arising from the elevated operating pressure.

Surge gas operation continues for a predetermined period of time sufficient to achieve the required residence times for the fission product gases. When this time period expires, delay section pressure reduction is manually initiated and gradually reduces the pressure in the delay section.

Steam Generator Blowdown Flash Tank Venting

During normal operations, the blowdown liquid is routed to the blowdown flash tank. As a result of pressure reduction, a portion of the liquid mass flashes to steam. The steam-water mixture is separated in the flash tank, with the overhead steam directed to the deaerator (also called the feedwater tank). Non-condensable gases from the deaerator are sent to the main turbine condensers and are removed by the main condenser evacuation system for release to the plant stack.

Radiation sensors on the Steam Generator Blowdown Sampling System continually monitor blowdown activity for indications of a steam generator tube leaks or rupture. If indications of tube rupture are detected, the affected steam generator is automatically isolated from the blowdown flash tank in the Steam Generator Blowdown System. Eventually, after a controlled plant shutdown and cooldown has been completed, the affected steam generator may be drained to the nuclear island vents and drains system, which is one of four normal destinations for steam generator draining (plant drains, clean drains, the condenser and the nuclear island vents and drains).

Main Condenser Evacuation System

The Main Condenser Evacuation System is designed to establish and maintain a vacuum in the condenser during startup, cooldown and normal operation by the use of mechanical vacuum pumps. Vacuum pumps remove air and non-condensable gases from the condenser and connected steam side systems and pass the steam and the air mixture through moisture separators. As a result of compression, the steam component condenses while the extracted air is vented through the vent system into the ventilation system of the Nuclear Auxiliary Building Ventilation System and released to the environment via the plant stack. The activity of the exhausted air is monitored.

Ventilation Filter Systems

Effluent discharged from the delay section of the Gaseous Waste Processing System is directed to the filtration section of the Nuclear Auxiliary Building Ventilation System. Exhaust air from the containment purge "full flow purge" (used only during plant outage periods), along with exhaust air from the Safeguards Building Controlled Area Ventilation, Fuel Pool Building Ventilation, and Nuclear Auxiliary Building Ventilation Systems, is also processed by the filtration section of the Nuclear Auxiliary Building Ventilation System before release from the stack. The ventilation flow paths (including containment "low flow purge" and "full flow purge") continuously exhaust to the Nuclear Auxiliary Building Ventilation System. Each exhaust flow path has a pre-filter and a HEPA filter. The filtered air is sent to the common exhaust plenum and removed via the stack. If radiation sensors in any of the rooms within the Nuclear Auxiliary Building, Reactor Building, Fuel Building, Safeguards Buildings, or the stack detect elevated radioactivity levels in exhaust gases, the associated flow paths are redirected to iodine-adsorbent activated charcoal delay beds and the filtered air is sent to the stack. The charcoal beds each have a downstream HEPA filter to remove potentially radioactive charcoal dust and particulates. The ventilation systems are shown in Figure 3.5-7.

3.5.3.2 Gaseous Release to the Environment

All gaseous effluents are released at the top of the plant stack. The stack height is approximately 197 ft (60 m) above plant grade, or about 6.56 ft (2 m) above the height of the adjacent Reactor Building. The normal stack flow rate is conservatively estimated at 260,000 cfm (7,362 m^3/min) with no credit for thermal buoyancy of the exit gas assumed (ambient temperature) and the low flow purge system assumed to not be operating. The stack diameter is 12.5 ft (3.8 m). The releases of radioactive effluent to the plant stack include contributions from:

- Gaseous Waste Processing System discharges via the carbon delay beds for noble gas holdup and decay.

- Containment purge ventilation discharges.
- Ventilation discharges from (1) the four Safeguards and Access Building controlled areas, (2) the Fuel Pool Building, (3) the Radwaste Building and (4) the Nuclear Auxiliary Building.
- Main Condenser air evacuation exhaust.

The annual average airborne releases of radionuclides from the plant were determined using the PWR GALE code (NRC, 1985). The GALE code models releases using realistic source terms derived from the experiences of many operating reactors, field and laboratory tests, and plant-specific design considerations incorporated to reduce the quantity of radioactive materials that may be released to the environment during normal operation, including anticipated operational occurrences. The code input values used in the analysis are provided in Section 3.5.1. The expected annual releases from the plant are presented in Table 3.5-8 and Table 3.5-20.

3.5.3.3 Gaseous Waste System Cost-Benefit Analysis

As with the liquid waste processing systems, the ALARA design objective dose values for effluents released from a light water reactor as stipulated in 10 CFR 50, Appendix I (CFR, 2007a), the regulation also requires that plant designs include all items of reasonably demonstrated cleanup technology that when added to the gaseous waste processing system sequentially and in order of diminishing cost-benefit return, can, at a favorable cost-benefit ratio, effect reductions in dose to the population reasonably expected to be within 50 mi (80 km) of the reactor. Values of $2,000 per person-rem and $2,000 per person-thyroid-rem are used as a favorable cost benefit threshold based on NRC NUREG-1530 (NRC, 1995). The source term for each equipment configuration option was generated using the same GALE code as described in Section 3.5.1 along with the same plant specific parameters modified only to accommodate the changes in waste stream decontamination factor afforded by the design options simulated.

For the U.S. EPR, the dose reduction effects for the sequential addition of the next logical gaseous waste processing component (i.e., addition of an additional charcoal delay bed to the waste gas holdup subsystem) results in a reduction in the 50 mi (80 km) population total body exposure of 0.03 person-rem (0.0003 person-sievert). Section 5.4 describes the population dose calculation for both the base case augmented charcoal delay bed holdup system for processing gaseous waste. The effective change in holdup time between the base configuration of 3 delay beds and the alternate configuration of 4 delay beds in series is shown in Table 3.5-21. These values were used in the execution of the GALE code to determine the change in effluent releases for both process configurations. The resulting annual release source terms for both purge gas holdup configurations are given in Table 3.5-22. Table 3.5-23 illustrates the relative population dose associated with both base equipment configuration and that associated with the augmented holdup system. Table 3.5-24 compares the estimated total body and thyroid dose reduction or savings achieved for the addition of the extra delay bed along with a conservative estimated cost for the purchase. Operating and maintenance cost associated with this passive subsystem is negligible. The cost basis for the equipment option is taken from Regulatory Guide 1.110 (NRC, 1976a) and reported in 1975 non-escalated dollars which provides a conservatively low estimate of the equipment cost to todays dollars. The site area population within 50 mi (80 km) is based a projected population in 2080, over 60 years from the estimated start of plant operations. Using the population at the end of plant life is conservative in that it maximizes the collective dose from plant effluents.

For both the total body and thyroid dose reduction, Table 3.5-24 illustrates that the favorable benefit in reduced dose associated with the additional charcoal delay bed had a dollar equivalent benefit value of $3,600. However, the estimated cost to purchase this equipment was approximately $67,000, thereby resulting in a total body effective benefit to cost ratio of less than 1.0 (not justified on an ALARA basis of dose savings to the public).

The total gas release from the plant is made up of several sources, of which the charcoal delay bed subsystem provides treatment for the process gas from primary side reactor system components only. As a consequent, assuming that the process gas stream release has a zero value does not result in a zero dose to the population. Ventilation system exhaust from the reactor building and other controlled area buildings, along with any secondary side process gas releases if primary to secondary leaks occur also contribute to the total release. Because these sources are distributed throughout the plant, no single system can be added that effectively reduces all sources of gas releases. However, beyond the waste gas processing that is accomplished by the charcoal delay beds, the existing controlled area ventilation systems already provide for HEPA filtration, and as needed charcoal filtration, to the major sources of gas released to the environment. As a result, no other treatment options not in use are available that could treat a significant fraction of the total release at a favorable cost to that shown for the charcoal delay bed.

3.5.4 Solid Radioactive Waste System

The Solid Waste Management System serves to collect, treat and store the solid radioactive wastes produced throughout the plant. There are several types of wet solid waste produced in the plant. These include spent resins, filter and centrifuge sludge's, sludge from the storage tank bottoms, and evaporator concentrates. There are also dry wastes such as paper, cloth, wood, plastic, rubber, glass and metal components that are contaminated.

The solid system consists of three parts; the radioactive concentrates processing system, the solid waste processing system and the solid waste storage system. Figure 3.5-8 provides a flow diagram of the inputs and processes associated with the solid waste system.

The radioactive concentrates processing system serves to process radioactive concentrates into a monolithic salt block by drying liquid radioactive waste from different systems. The liquid waste treated includes the concentrates left after the liquid waste has been treated in the evaporator of the Liquid Waste Processing System. It also treats the radioactive sludge from the liquid waste storage tanks of the Liquid Waste Storage System. The spent ion exchange resins from the Coolant Purification System or liquid waste processing demineralizer package are also sent to the concentrates processing system, after they have been stored for a period of time, to be processed with the other radioactive concentrates.

The Dry Solid Waste Processing System serves to collect and process the solid or DAW produced throughout the plant. This waste can include materials such as plastics, paper, clothing, glass, rubber, wood and metal. The waste is separated and processed separately depending upon size, activity and physical/chemical conditions. In-plant capability to separate, shred and compact DAW waste materials into disposable containers is provided. Alternately, DAW may be shipped in the "as collected" form to an offsite licensed processor for volume reduction treatment and final packaging and shipment to a disposal facility.

The Solid Waste Storage System serves to store the solid waste mentioned above both before and after processing. The untreated solid waste is stored near its producing area until it is ready to be processed. Wet solid waste shall be stored separately from DAW to avoid cross contamination. Once treated, the solid waste, along with the treated concentrates, is stored in one of two areas. One area is a tubular shaft storage area for the high activity drums and the other is a temporary storage area for low to medium activity drums. Once the activity has reduced to a low enough level, the drums are transported to an offsite repository for final disposal.

3.5.4.1 Radioactive Concentrates Processing System

The Radioactive Concentrates Processing System is used to produce a monolithic salt block inside a disposal drum by drying high solids content liquids from different systems.

Evaporator concentrates from the concentrate tanks and contaminated sludge from the liquid waste storage tanks of the liquid waste storage system are transferred to the concentrate buffer tank. These wastes are mixed, sampled and analyzed for proper pretreatment before leaving the concentrate buffer tank.

Spent resins are stored in the resin waste tanks of the coolant purification system for an extended length of time to allow short lived activity to decay away. When processed, these resins are transferred into the resin proportioning tank. Depending upon activity levels in the resin, a portion of the resins is transferred into the concentrate buffer tank with liquid waste where it is mixed to control the overall waste radioactivity concentration. Spent resin from the Liquid Waste Storage and Processing System demineralizer/ultra filtration skid may be sent directly to high integrity containers (HICs) for in-container dewatering or transferred to the concentrate buffer tank. This demineralizer system produces spent resins as well as a small amount of solid waste from the back flush of the ultra filtration system.

From the concentrate buffer tank, the liquid waste can be transferred into a storage drum in one of three drum drying stations where the water content is evaporated off. Alternately, resin slurries can be transferred to HICs to be dewatered and sent to disposal. In the drum drying station, a seal is established on the drum and a vacuum established. Then the heaters are energized to evaporate the water from the drum. The vacuum in the drum allows a lower required heating temperature to boil off the water. The water vapor is condensed and collected and volume counted before it is drained to the condensate collection tank. The air and non-condensable gases are routed to the Radioactive Waste Building Ventilation System for processing. After most of the liquid has been evaporated out of the drum, it is refilled with more waste from the concentrate buffer tank and the drying process is re-initiated. This filling and evaporation process is repeated until the drum is filled with a solid precipitated dry activity waste product. The solid drum drying process reduces the moisture content of the solid block to the level required for disposal at an offsite repository.

Once the residual moisture has been reached, the shell and bottom heaters are turned off and disengaged from the drum. After a set time, the vacuum unit is shut down and the drum drying station is directly vented to the Radioactive Waste Building Ventilation System. While the drum is still connected to the Radioactive Waste Building Ventilation System, the product is allowed to cool to a less than 212°F (100°C).

The whole drying process is performed automatically which means that the system can operate 24 hours a day and unattended. Only during the drum exchange process does an operator have to be at the control panel to perform the different drum exchange steps. This process is done remotely.

Once the product cools down, the drum is lowered and transferred to the pickup position outside the filling station. In this position the drum is picked up by the drum handling device, lowered to the pickup position conveyor (part of the drum transfer device (DTD)). The DTD transfers the filled uncapped drum to the sampling position for dried waste for taking samples from the content of the drum as far as defined in a semi-automatic mode (the sample is taken automatically while insertion and removal of the shielded drill is performed manually). In the next step the drum is routed to the drum capping device for capping the filled drum.

The drum capping device operates automatically. After the drum reaches the capping position, a start button is pressed and a lid is automatically placed on the drum. The drum is automatically capped and once complete, a release signal allows the further transport of the drum to the drum input/output position. From the input/output position, the drum is moved by the drum store crane to the drum measuring device.

In the drum measuring device, the weight, the dose rate and the main radionuclides of the drum content are measured. A gamma spectroscopy measurement with a Ge-detector is used to determine radionuclides and their activity. The drum is arranged on a turntable which is slowly rotated during the measurement process. The drum measuring device operates automatically. Once the measuring process is complete, the drum is picked up by the drum store crane and moved to the drum store for storage.

3.5.4.2 Solid Waste Processing System

DAW is collected in suitable containers such as plastic bags, drums or bins that are placed in various locations throughout the controlled areas of the plant at such points as step-off pads at exits from contaminated areas. Once full, these collection bags or bins are sent to the solid waste processing area for sorting, compaction if suitable, and final packaging for temporary storage in-plant or shipment to a licensed disposal facility offsite or licensed waste processor for additional processing before final disposal.

The in-plant treatment facilities include a sorting box for sorting waste into compressible and non-compressible fractions, a drying box for drying of wet materials that might have greater than incidental moisture before further treatment, a shredder for treating large bulky combustible and compressible waste before being compacted, and a compactor for in-drum compaction of compressible waste. Filter cartridges are loaded in high integrity containers with other wastes for disposal.

3.5.4.3 Solid Waste Storage System

The different properties, sizes, materials and activity of the solid radioactive waste are considered while collecting the waste in different containers so as to simplify both handling and storage of the waste in the plant and its transport.

Various storage areas are provided in the Radioactive Waste Building for the different types of solid waste and contaminated components.

The system is able to handle and store the waste generated in the different controlled areas of the plant independent from the plant operating conditions. Storage space is provided for collected untreated waste waiting for treatment. Additional space is provided for treated and packaged low activity waste, such as DAW, as well as higher activity waste in a tubular shaft storage arrangement that provides shielding for operating staff. The tubular shaft store is part of the permanent building structure formed in the shape of tubes. The higher activity waste includes items such as the radioactive concentrates treated in the radioactive concentrates processing system and the spent filter cartridges. The drum store is located in the Radioactive Waste Processing Building in an area used for temporary storage of low level radioactive waste treated by the solid waste processing system. The drums can be stacked a maximum of 5 drums high to optimize the available storage space. The drums are stored for a sufficient time to allow the short lived radionuclides to decay thereby reducing the radiation levels to keep radiation exposures ALARA.

The drums containing the spent filter cartridges are placed in a shielded cask and brought to the drum transfer station. Once at the drum transfer station, the vehicle entrance crane lifts the lid off the cask and the drum store crane takes the drum to the tubular shaft store for storage. The lid is then place back on the cask and the cask is returned to the Nuclear Auxiliary Building to the filter changing area.

The drums containing the medium activity waste such as spent filter cartridges, spent resins and the concentrates wastes from the radioactive concentrates processing system are transported to a final repository after being temporarily stored in the tubular shaft storage area. This is done by using the drum storage crane to remove the drums from the tubular shaft and place them in the drum transfer position. They are placed in a shielding cask and lifted to the vehicle entrance area by the vehicle entrance crane. Once in the vehicle entrance area, each drum is removed from the cask and placed into an approved shipping container to be moved to the offsite facility.

3.5.4.4 Expected Volumes

The volume of solid radioactive waste estimated to be generated by the U.S. EPR is approximately 7,933 ft^3(224.6 m^3) per year (including compressible waste). Table 3.5-9 delineates the expected annual volume by waste type. For liquid waste streams, the maximum volume reduction is achieved by converting liquid waste concentrates to dried salt deposits in the waste drum drying subsystem. Final drum drying is expected to achieve a volume reduction (VR) factor of about 5 over the concentrate stream. After dewatering, spent demineralizer resins are assumed to have the same volume as the initial resin volume used (i.e., no VR). Table 3.5-9 presents the final volume of processed concentrates ready for storage or shipment to a disposal facility. For DAW, Table 3.5-9 indicates the "as collected" volumes and assumes that no onsite volume reduction to these waste are applied. These materials are expected to be sent to an off site licensed waste processor for sorting and treatment for volume reduction before shipment to a disposal facility. If onsite compaction of compressible DAW is performed, a VR factor of 5 or more is expected assuming:

1. Each non-regenerable ion-exchanger is changed annually; and
2. Approximately 15 spent filter cartridges from all process systems combined are generated annually with a package volume of approximately 120 ft^3 (3.40 m^3) (one filter element per disposal drum).

Curie content associated with this waste volume is also delineated in Table 3.5-9. The radioactive concentrations vary considerably depending upon plant operating conditions. However, radiation monitoring (and related interlocks) within the solidification system ensure that all shipments will comply with federal and state regulations (i.e., radiation levels and gross weight of shipping vehicle).

3.5.4.5 Solid Release to the Environment

Solid wastes will be shipped from the site for burial at a NRC licensed burial site or to a licensed radioactive waste processing facility. The containers used for solid waste shipments will meet the requirements of 49 CFR Parts 170 through 189 (Department of Transportation Radioactivity Material Regulations) (CFR, 2007e), and 10 CFR Part 71 (Packaging of Radioactive Materials for Transport) (CFR, 2007f). Table 3.5-9 summarizes the annual total solid radioactive waste generated at CCNPP Unit 3.

As of July 1, 2008, the Barnwell LLRW disposal facility in Barnwell, South Carolina no longer accepts Class B and C waste from sources in states outside of the Atlantic Compact. The only other operating disposal site in Richland, Washington, does not currently accept Class B and C wastes from outside the Northwest or Rocky Mountain LLRW Compacts. Maryland is affiliated with the Appalachian Compact.

CCNPP Unit 3 expects to enter into an agreement prior to initial criticality with an NRC-licensed facility that will process or otherwise accept Class B and C LLW. For example, a site in Andrews County, Texas was recently licensed to accept Class B and C waste. For now, however, the site will only accept waste from Texas and Vermont.

In the event that no offsite disposal facility is available to accept Class B and C waste from CCNPP Unit 3 when it commences operation, additional waste minimization measures could be implemented to reduce or eliminate the generation of Class B and C waste. These measures include: reducing the service run length for resin beds; short loading media volumes in ion exchange vessels; and other techniques discussed in the EPRI Class B/C Waste Reduction Guide (Nov. 2007) and EPRI Operational Strategies to Reduce Class B/C Wastes (April 2007). These measures would extend the capacity of the Solid Waste Storage System to store Class B and C waste to over ten years. This would provide additional time for offsite disposal capability to be developed or additional onsite capacity to be added. Continued storage of Class B and C waste in the Solid Waste Storage System would be in accordance with procedures that maintain occupational exposures within permissible limits and result in no additional environmental impacts.

If additional storage capacity for Class B and C were necessary, CCNPP Unit 3 could elect to construct a new temporary storage facility. The facility would meet applicable NRC guidance, including Appendix 11.4-A of the Standard Review Plan, "Design Guidance for Temporary Storage of Low-Level Waste." Such a facility would be located in an appropriate onsite location. The environmental impacts of constructing such a facility would be minimal and would be addressed at the time the facility was announced. The operation of a storage facility meeting the standards in Appendix 11.4-A would provide appropriate protection against releases, maintain exposures to workers and the public below applicable limits, and result in no significant environmental impact.

In lieu of onsite storage, CCNPP Unit 3 could enter into a commercial agreement with a third-party contractor to process, store, own, and ultimately dispose of low-level waste generated as a result of CCNPP Unit 3 operations. Activities associated with the transportation, processing, and ultimate disposal of low level waste by the third-party contractor would necessarily comply with applicable laws and regulations in order to assure public health and safety and protection of the environment. In particular, the third-party contractor would conduct its operations consistent with applicable Agreement State or NRC regulations (e.g., 10 CFR Part 20), which assure that the radiological impacts from these activities would be acceptable. Environmental impacts resulting from management of low-level wastes are expected to be bounded by the NRC findings in 10 CFR 51.51(b) (Table S-3). Table S-3 assumes that solid, low-level waste from reactors will be disposed of through shallow land burial, and concludes that this kind of disposal will not result in the release of any significant effluent to the environment.

3.5.4.6 Independent Spent Fuel Storage Installation

As a result for the need for additional storage capacity for spent fuel being generated by the operations of Calvert Cliffs Nuclear Power Plants (CCNPP) Units 1 and 2, an Independent Spent Fuel Storage Installation (ISFSI) was constructed on the CCNPP site approximately 2,000 ft (610 m) south-southwest of CCNPP Units 1 and 2. The first dry fuel storage canister was loaded into the ISFSI in November of 1993, with additional canisters loaded in subsequent years. The ISFSI is situated approximately 1,600 ft (488 m) west from the CCNPP Unit 3 containment.

3.5.5 Process and Effluent Monitoring

For routine operations, the process and effluent radiological monitoring and sampling systems monitor, record and (for certain subsystems) control the release of radioactive materials that may be generated during normal operation, including anticipated operational occurrences.

The process and effluent radiological monitoring systems consist of radiation detectors connected to local microprocessors. Each microprocessor processes the detector signal in digital form, computes average radioactivity levels, stores data, performs alarm or control functions, and transmits the digital signal to one of the control room information and control systems. Monitoring systems alarm when setpoint limits are exceeded and if the system becomes inoperable. Alarms are indicated both locally and in the control room.

For gaseous waste, all compartment ventilation exhaust air from controlled areas (i.e., Reactor Building, Fuel Building, Safeguard Buildings, Waste Building and Nuclear Auxiliary Building) and the gaseous waste system exhaust air is discharged to and monitored in the plant vent stack. Effluent sampling systems also monitor the Reactor Building, Fuel Building, the Nuclear Auxiliary Building and the mechanical area of the Safeguard Buildings, as well as the vent stack. Samples are also taken and monitored from the exhaust air of the Access Building and the Waste Building. These two buildings are not part of the controlled area and do not vent to the vent stack. Sampling of these two buildings provides assurance that an inadvertent release of radioactivity to the environment will be monitored. Gaseous effluent monitoring systems utilized in the U.S. EPR are discussed in the following sections.

The liquid radioactive waste effluent monitoring system measures the concentration of radioactive materials in liquids released to the environment to ensure that radionuclide concentration limits specified in 10 CFR 20 are complied with. Process line monitors provide operating personnel indication of system performance and the existence of leaks from contaminated systems to clean systems or subsystems of lower expected radioactivity.

The process and effluent monitors are discussed below by the plant system that is being monitored. Table 3.5-25 has been arranged by the radioisotopes monitored to make it more convenient to compare monitors that perform a similar function. The monitors in Table 3.5-25 are grouped by categories for noble gas effluent, gaseous iodine and aerosol (halogen and particulate) effluent, process monitoring (area radiation levels, personnel and equipment contamination, system leakage from the primary side to nuclear island buildings or secondary systems), liquid effluent, and airborne radiation levels.

3.5.5.1 Vent Stack

Vent stack gaseous effluent monitoring is accomplished by the use of continuously operating measurement devices for noble gas, aerosol, and iodine. Samples are also collected that may be utilized for laboratory determination of tritium. Two independent systems provide system redundancy and permits maintenance on one train while continually monitoring effluents with the other train. Each sampling system consists of a sampling nozzle array designed to provide a representative sample, two 100% capacity rotary sampling pumps, and specially designed interconnecting tubing running between a sampling nozzle array, sampling pumps, and radiation monitoring instrumentation. Gaseous samples exiting the monitoring instrumentation are returned to the vent stack. The vent stack effluent monitoring system has the following general characteristics:

- Noble gas activity is monitored with beta-sensitive detectors. The gross output of the monitor is periodically normalized to the radionuclide composition by performing a gamma-spectroscopic analysis on a representative grab sample.
- Aerosol activity is monitored with the use of a particulate filter through which sample flow is continuously maintained. Aerosol particles are removed by the filter, which is continuously monitored by a gamma-sensitive detector.
- Iodine activity is monitored with the use of a dual filter for organic and inorganic iodine. Each filter is continuously monitored by a gamma-sensitive detector.

For both particulate and iodine monitoring, the gross outputs of the monitors are normalized by laboratory analysis of a duplicate set of filters installed in parallel with the primary ones. The vent stack gaseous effluent monitoring system does not perform any automatic actions. The system monitors, records, and alarms in the control room in the event that monitored radiation levels increase beyond specified setpoints. Measurement ranges of noble gas, aerosol, and iodine monitors are shown in Table 3.5-25.

3.5.5.2 Gaseous Waste Carbon Delay Beds

The gaseous waste delay bed process stream is continuously monitored prior to waste flow being directed to the plant vent stack. One gamma-sensitive radiation detector is located up-stream of the delay beds and one beta-sensitive radiation detector downstream of the beds outlet. The upstream detector provides plant personnel with an indication of the amount of radioactivity entering the system. The downstream detector is a beta-sensitive instrument, as Krypton-85 generally forms the main constituent (about 95%) of the normal radioactive noble gas waste stream, and provides personnel a means to compare the reduction in radioactivity afforded by the delay bed system. The gaseous waste monitoring system provides control room and local indication and an alarm in the main control room terminates release to the plant vent stack by closing the discharge valve. Measuring ranges of the gaseous waste disposal radiation monitoring system are shown in Table 3.5-25.

3.5.5.3 Condenser Air Removal Monitor

Non-condensable gases (air and noble gases) in the secondary system are continuously removed during operation by the condenser air removal system. These gases are exhausted to the vent stack. The function of the condenser air removal radiation monitor is to provide local and control room alarm in the event that noble gas radioactivity is detected in the secondary system. This would be an indication of a breach of fuel cladding, primary coolant boundary, or containment leak. Measuring ranges of the condenser air removal radiation monitoring system are shown in Table 3.5-25. No automatic actions are initiated by this system.

3.5.5.4 Main Steam Radiation Monitoring System

Radioactivity releases from the reactor coolant system to the main steam system (nitrogen-16 (N-16), noble gases) can occur as a result of steam generator tube leakage. Radioactivity in the main steam system is monitored over a wide power range by four redundant measuring arrangements per steam line (16 total for the system). The gamma sensitive detectors are mounted adjacent to the monitored main steam lines within the main steam and feedwater valve compartments. At low power levels, radioactivity will be detected in the main steam due to noble gas. At high power levels, the detectors detect the strong gamma from N-16. Shielding of detectors ensures that detectors on other main steam lines do not erroneously respond. The redundant measurement signals are processed, and provide alarm in the control room upon detection of radioactivity. The main steam radiation monitoring system is utilized in conjunction with the condenser air removal and steam generator blowdown radiation monitoring systems to identify a defective steam generator. The main steam radiation monitoring system does not initiate any automatic actions. Isolation of a defective steam generator is performed by manual operator actions. Measuring ranges of the main steam radiation monitoring system are shown in Table 3.5-25.

3.5.5.5 Reactor Coolant Radiation Monitor and Sampling System

The noble gas radioactivity concentration of the primary coolant is monitored by monitoring the noble gas activity concentration in the gaseous volume flow prior to discharge to the Nuclear Sampling System degasifier. Monitoring is accomplished with a beta-sensitive measuring arrangement located immediately adjacent to the sampling line. This measuring point allows early detection of fuel element failures. The measurement range for this radiation monitoring system is shown in Table 3.5-25.

3.5.5.6 Containment Atmosphere Radiation Monitor

The containment atmosphere radiation monitor measures the radioactive gaseous concentrations in the containment atmosphere. The containment atmosphere radiation monitor is a part of a reactor coolant pressure boundary leak detection system. The presence of gaseous radioactivity in the containment atmosphere is an indication of reactor coolant pressure boundary leakage. The measurement range for this radiation monitoring system is shown in Table 3.5-25.

3.5.5.7 Containment Ventilation System Radiation Monitor

The containment ventilation system air filtration exhaust radiation monitor measures the concentration of radioactive materials in the containment purge exhaust air. The monitor provides an alarm in the main control room when the concentration of radioactive gases in the exhaust exceeds a predetermined setpoint.

The containment ventilation system air filtration exhaust radiation monitor is to be an inline monitor that uses a beta-sensitive scintillation detector. The measurement range for this radiation monitoring system is shown in Table 3.5-25.

3.5.5.8 Liquid Waste Tank Monitors

The liquid radioactive waste monitoring system measures the concentration of radioactive materials in liquids released to the environment to ensure that radionuclide concentration limits specified in 10 CFR 20 and dose requirements specified in 10 CFR 50 are complied with. Liquid radioactive waste is discharged in batches. Prior to release of a liquid radioactive waste tank, a representative sample is taken and radiochemically analyzed. Results of this analysis are utilized in conjunction with dilution factor data to determine a release setpoint for the liquid waste monitoring system. Two continuously operating radiation sensors monitor the release line from the tanks. Release is automatically terminated if a set limit is exceeded or if the monitoring system is inoperable. Measurement ranges of the liquid radioactive waste monitoring system are shown in Table 3.5-25.

3.5.5.9 Primary Component Cooling Liquid Monitors

The component cooling water system consists of a closed loop used to transfer heat from nuclear components to service water by the use of coolers (heat exchangers). The closed nature of this system constitutes a barrier against the release of radioactivity to the service water and thus to the environment in the event of leaks in the associated coolers.

The Component Cooling Water Radiation Monitoring System consists of two subsystems. The general component cooling water monitoring system utilizes gamma-sensitive radiation detectors in the four separate safety-related trains of the Component Cooling Water System to monitor the fluid for any escape of radioactivity from the various radioactivity containing systems that make up the nuclear components served by the component cooling circuits. This subsystem provides local and control alarm in the event that component cooling water gamma radiation levels exceed the monitor setpoint. No automatic actions are initiated by this subsystem.

The second subsystem consists of two gamma-sensitive radiation detectors upstream and two gamma-sensitive radiation detectors downstream on the component cooling water lines feeding/exiting the two high-pressure (HP) coolers of the Volume Control System. In the event of a leak in a HP cooler with high-activity primary coolant leaking into the component cooling water system, the radiation detector downstream of the defective cooler indicates the entry of radioactivity from this HP cooler into the component cooling loop that is running at the time. If the radioactivity exceeds a pre-determined limit, the defective HP cooler is automatically isolated, with associated control room alarm, on the primary side. This automatic action is suppressed if the limit value of the radiation detector at the inlet of the cooler has already triggered a high activity signal and during in-service inspection of the measuring points.

The component cooling water radiation monitoring system utilizes lead-shielded gamma-sensitive detectors installed adjacent to the piping. Measuring ranges of the Component Cooling Water Radiation Monitoring System are shown in Table 3.5-25.

3.5.5.10 Steam Generator Blowdown Sample Monitors

The evaporation process within the steam generator results in the concentration of contaminants in the liquid phase. These contaminants include any non-gaseous radioactive substances that have entered the secondary system from the reactor coolant system as a result of tube leakage in a steam generator.

Sampling lines extract blowdown water from the individual blowdown lines for chemical analysis. These lines are located ahead of the primary isolation valve within the reactor containment. Flow is continuously extracted from each of these lines and fed to gamma activity measurement equipment. This allows each steam generator to be monitored separately and continuously for radioactivity carryover to the secondary side. These monitors enable the identification or verification of a steam generator tube leak. Measuring ranges of the Steam Generator Radiation Monitoring System are shown in Table 3.5-25.

3.5.5.11 Turbine Building Drains Effluent Monitor

Turbine Building waste liquid is released from the plant via a monitored pathway to the cooling tower retention basin before release to the Chesapeake Bay. The effluent monitor provides alarm and trip function on the discharge flow if unexpected levels of radioactivity are detected in the release. Measuring ranges of the turbine building drains effluent monitor is shown in Table 3.5-25.

3.5.6 References

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CFR, 2007a. Title 10, Code of Federal Regulations, Part 50.34a, Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents - Nuclear Power Reactors, and Appendix I, Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as is Reasonably Achievable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents, 2007.

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CFR, 2007c. Title 10, Code of Federal Regulations, Part 20.1301, Dose Limits for Individual Members of the Public, Code of Federal Regulations, 2007.

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NRC, 1976a. Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-water Reactors, Regulatory Guide 1.112, Nuclear Regulatory Commission, 1976.

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Table 3.5-1— Parameters Used in the Calculation of Fission Product Activity in Reactor (Design Basis)

	Parameter	Value
1.	Total core thermal power, including measurement uncertainty [MWt]	4,612
2.	Clad defects, as a percent of rated core thermal power being generated by rods with clad defects [%]	1.0
3.	Volume of reactor coolant system [ft^3] (m^3)	15,009 (425)
4.	Reactor coolant full power average temperature [°F](°C)	594 (312.2)
5.	Purification flow rate (normal) [lbm/hr] (kg/hr)	79,400 (36,000)
6.	Effective cation demineralizer flow [gpm]	NA
7.	Fission product escape rate coefficients:	
	a. Noble gas isotopes [sec^{-1}]	6.5E-08
	b. Br, Rb, I and Cs isotopes [sec^{-1}]	1.3E-08
	c. Te isotopes [sec^{-1}]	1.0E-09
	d. Mo isotopes [sec^{-1}]	2.0E-09
	e. Sr and Ba isotopes [sec^{-1}]	1.0E-11
	f. Y, Zr, Nb, Ru, Rh, La, Ce, Pr, Nd and Pm isotopes [sec^{-1}]	1.6E-12
8.	Purification mixed bed demineralizer decontamination factors (fractions removed):	
	a. Noble gases and N-16, H-3	0.0
	b. Cs, Rb	0.5
	c. Anion / others	0.99 / 0.98
9.	Cation bed demineralizer decontamination factor	NA
10.	Degasifier noble gas stripping fractions	NA

Table 3.5-2— Reactor Coolant Radionuclide Concentrations
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	Design Basis		Realistic Source Term (GALE)	
Radionuclide	µCi/gm	Bq/gm	µCi/gm	Bq/gm
		Noble Gases[(a)]		
Kr-83m	1.3E-01	4.7E+03		
Kr-85m*	5.7E-01	2.1E+04	1.8E-02	6.7E+02
Kr-85*	5.3E+00	2.0E+05	5.8E-01	2.1E+04
Kr-87*	3.3E-01	1.2E+04	2.0E-02	7.4E+02
Kr-88*	1.0E+00	3.8E+04	2.1E-02	7.8E+02
Kr-89	2.4E-02	9.0E+02		
Xe-131m*	1.1E+00	4.0E+04	8.8E-01	3.3E+04
Xe-133m*	1.4E+00	5.0E+04	8.2E-02	3.0E+03
Xe-133*	9.5E+01	3.5E+06	3.4E-02	1.3E+03
Xe-135m*	2.0E-01	7.2E+03	1.5E-01	5.6E+03
Xe-135*	3.4E+00	1.3E+05	7.7E-02	2.8E+03
Xe-137	4.6E-02	1.7E+03	3.9E-02	1.4E+03
Xe-138*	1.6E-01	6.1E+03	7.0E-02	2.6E+03
		Halogens[(b)]		
Br-83	3.2E-02	1.2E+03		
Br-84	1.7E-02	6.2E+02	1.8E-02	6.7E+02
Br-85	2.0E-03	7.4E+01		
I-129	4.6E-08	1.7E-03		
I-130	5.0E-02	1.8E+03		
I-131*	7.4E-01	2.7E+04	1.3E-03	4.8E+01
I-132*	3.7E-01	1.4E+04	6.0E-02	2.2E+03
I-133*	1.3E+00	4.6E+04	1.9E-02	7.0E+02
I-134*	2.4E-01	8.9E+03	1.1E-01	4.1E+03
I-135*	7.9E-01	2.9E+04	4.8E-02	1.8E+03
		Rubidium, Cesium[(c)]		
Rb-86m	1.2E-06	4.4E-02		
Rb-86	7.7E-03	2.9E+02		
Rb-88	4.1E+00	1.5E+05	2.2E-01	8.1E+03
Rb-89	1.9E-01	7.0E+03		
Cs-134	6.8E-01	2.5E+04	2.6E-05	9.6E-01
Cs-136	2.1E-01	7.8E+03	6.2E-04	2.3E+01
Cs-137	4.3E-01	1.6E+04	3.7E-05	1.4E+00
Cs-138	8.8E-01	3.3E+04		
		Miscellaneous Nuclides[(c)]		
Sr-89	2.5E-03	9.4E+01	8.9E-05	3.3E+00
Sr-90	1.3E-04	4.8E+00	7.6E-06	2.8E-01
Sr-91	4.1E-03	1.5E+02	8.0E-04	3.0E+01

Table 3.5-2— Reactor Coolant Radionuclide Concentrations

(Page 2 of 3)

	Design Basis		Realistic Source Term (GALE)	
Radionuclide	**µCi/gm**	**Bq/gm**	**µCi/gm**	**Bq/gm**
Sr-92	6.9E-04	2.6E+01		
Y-90	3.1E-05	1.1E+00		
Y-91m	2.1E-03	7.7E+01	5.0E-04	1.9E+01
Y-91	3.2E-04	1.2E+01	3.3E-06	1.2E+01
Y-92	5.6E-04	2.1E+01		
Y-93	2.6E-04	9.6E+00	3.5E-03	1.3E+02
Zr-95	3.7E-04	1.4E+01	2.5E-04	9.3E+00
Zr-97	2.7E-04	9.9E+00		
Nb-95	3.7E-04	1.4E+01	1.8E-04	6.7E+00
Mo-99	4.3E-01	1.6E+04	4.3E-03	1.6E+02
Tc-99m	1.9E-01	E+03	4.2E-03	1.6E+02
Ru-103	3.1E-04	1.1E+01	4.8E-03	1.8E+02
Ru-105	3.8E-04	1.4E+01		
Ru-106	1.1E-04	4.0E+00	5.7E-02	2.1E+03
Rh-103m	2.7E-04	1.0E+01		
Rh-105	1.8E-04	6.5E+00		
Rh-106	1.1E-04	4.0E+00	5.7E-02	2.1E+03
Ag-110m	7.9E-07	2.9E-02	8.2E-04	3.0E+01
Ag-110	4.4E-08	1.6E-03		
Sb-125	3.2E-06	1.2E-01		
Sb-127	2.0E-05	7.4E-01		
Sb-129	2.7E-05	1.0E+00		
Te-127m	1.8E-03	6.5E+01		
Te-127	8.7E-03	3.2E+02		
Te-129m	5.8E-03	2.1E+02	1.2E-04	4.5E+00
Te-129	9.6E-03	3.6E+02	2.6E-02	9.6E+02
Te-131m	1.5E-02	5.5E+02	1.1E-03	4.1E+01
Te-131	1.0E-02	3.8E+02	8.6E-03	3.2E+02
Te-132	1.6E-01	6.0E+03	1.1E-03	4.1E+01
Te-134	2.7E-02	9.9E+02		
Ba-137m	4.0E-01	1.5E+04	3.5E-05	1.3E+00
Ba-139	8.6E-02	3.2E+03		
Ba-140	2.5E-03	9.2E+01	8.4E-03	3.1E+02
La-140	6.4E-04	2.4E+01	1.7E-02	6.3E+02
La-141	2.1E-04	7.8E+00		
La-142	1.3E-04	4.6E+00		
Ce-141	3.5E-04	1.3E+01	9.6E-05	3.6E+00
Ce-143	3.0E-04	1.1E+01	2.0E-03	7.4E+01

Table 3.5-2— Reactor Coolant Radionuclide Concentrations

(Page 3 of 3)

	Design Basis		Realistic Source Term (GALE)	
Radionuclide	**µCi/gm**	**Bq/gm**	**µCi/gm**	**Bq/gm**
Ce-144	2.8E-04	1.0E+01	2.5E-03	9.3E+01
Pr-143	3.5E-04	1.3E+01		
Pr-144	2.8E-04	1.0E+01	2.5E-03	9.3E+01
Nd-147	1.4E-04	5.1E+00		
Np-239	3.5E-03	1.3E+02	1.5E-03	5.6E+01
Pu-238	7.9E-07	2.9E-02		
Pu-239	8.1E-08	3.0E-03		
Pu-240	1.1E-07	4.1E-03		
Pu-241	2.8E-05	1.0E+00		
Am-241	3.1E-08	1.2E-03		
Cm-242	7.5E-06	2.8E-01		
Cm-244	4.1E-07	1.5E-02		
		Activation Products(d)		
Na-24	3.7E-02	1.4E+03	3.7E-02	1.4E+03
Cr-51	2.0E-03	7.4E+01	2.0E-03	7.4E+01
Mn-54	1.0E-03	3.7E+01	1.0E-03	3.7E+01
Fe-55	7.6E-04	2.8E+01	7.6E-04	2.8E+01
Fe-59	1.9E-04	7.0E+00	1.9E-04	7.0E+00
Co-58	2.9E-03	1.1E+02	2.9E-03	1.1E+02
Co-60	3.4E-04	1.3E+01	3.4E-04	1.2E+01
Zn-65	3.2E-04	1.2E+01	3.2E-04	1.2E+01
W-187	1.8E-03	6.7E+01	1.8E-03	6.8E+01
		Tritium		
H-3	4.0	1.5E+05	1.0E+00	3.7E+04
		Nitrogen		
N-16			4.0E+01	1.5E+06

Notes:
For Design Basis concentrations, the following conditions apply;
(a) The noble gas concentrations are at the U.S. EPR Standard Technical Specification limit of 210 µCi/gm DE-Xe-133
(b) The halogen concentrations are at the U.S. EPR proposed Standard Technical Specification limit of 1 µCi/gm DE-I-131
(c) The concentrations for this group are based on 1.0% failed fuel fraction.
(d) The concentration of activation products based on ANSI/ANS-18.1-1999.
* Radionuclide concentration controlled by proposed Technical Specifications

Table 3.5-3— Secondary Coolant Radionuclide Concentrations
(Page 1 of 3)

	Design Basis Liquid		Design Basis Steam		Realistic Source Term-Liquid[e]		Realistic Source Term-Steam[e]	
Radionuclide	µCi/gm	Bq/gm	µCi/gm	Bq/gm	µCi/gm	Bq/gm	µCi/gm	Bq/gm
Noble Gases[a]								
Kr-83m	N/A	N/A	2.1E-05	7.9E-01				
Kr-85m	N/A	N/A	5.8E-06	2.1E-01	0.0E+00	0.0E+00	3.1E-08	1.1E-04
Kr-85	N/A	N/A	5.3E-05	2.0E+00	0.0E+00	0.0E+00	9.5E-08	3.5E-03
Kr-87	N/A	N/A	3.3E-06	1.2E-01	0.0E+00	0.0E+00	9.1E-09	3.4E-04
Kr-88	N/A	N/A	1.0E-05	3.8E-01	0.0E+00	0.0E+00	3.5E-09	1.3E-04
Kr-89	N/A	N/A	2.4E-07	9.0E-03				
Xe-131m	N/A	N/A	1.1E-05	4.0E-01	0.0E+00	0.0E+00	1.4E-07	5.3E-03
Xe-133m	N/A	N/A	1.5E-05	5.6E-01	0.0E+00	0.0E+00	1.4E-08	5.1E-04
Xe-133	N/A	N/A	9.7E-04	3.6E+01	0.0E+00	0.0E+00	5.6E-09	2.1E-04
Xe-135m	N/A	N/A	8.2E-04	3.0E+01	0.0E+00	0.0E+00	2.5E-08	9.1E-04
Xe-135	N/A	N/A	1.6E-04	6.0E+00	0.0E+00	0.0E+00	1.3E-08	4.7E-04
Xe-137	N/A	N/A	4.6E-07	1.7E-02	0.0E+00	0.0E+00	6.5E-09	2.4E-04
Xe-138	N/A	N/A	1.7E-06	6.1E-02	0.0E+00	0.0E+00	1.2E-08	4.4E-04
Halogens[b]								
Br-83	1.6E-03	6.0E+01	1.6E-05	6.0E-01				
Br-84	3.1E-04	1.1E+01	3.1E-06	1.1E-01	5.8E-08	2.2E-03	5.8E-10	2.2E-05
Br-85	3.9E-06	1.5E-01	3.9E-08	1.5E-03				
I-129	4.8E-09	1.8E-04	4.8E-11	1.8E-06				
I-130	4.3E-03	1.6E+02	4.3E-05	1.6E+00				
I-131	7.7E-02	2.8E+03	7.7E-04	2.8E+01	4.1E-08	1.5E-03	4.1E-10	1.5E-05
I-132	2.3E-02	8.4E+02	2.3E-04	8.4E+00	6.5E-07	2.4E-02	6.5E-09	2.4E-04
I-133	1.2E-01	4.3E+03	1.2E-03	4.3E+01	5.2E-07	1.9E-02	5.2E-09	1.9E-04
I-134	6.7E-03	2.5E+02	6.7E-05	2.5E+00	5.5E-07	2.0E-02	5.5E-09	2.0E-04
I-135	6.0E-02	2.2E+03	6.0E-04	2.2E+01	9.2E-07	3.4E-02	9.2E-09	3.4E-04
Rubidium, Cesium[c]								
Rb-86m	9.0E-12	3.3E-07	4.5E-14	1.7E-09				
Rb-86	1.5E-05	5.7E-01	7.7E-08	2.8E-03				
Rb-88	5.0E-04	1.9E+01	2.5E-06	9.3E-02	4.2E-07	1.6E-02	2.1E-09	7.7E-05
Rb-89	2.0E-05	7.4E-01	1.0E-07	3.7E-03				
Cs-134	1.4E-03	5.1E+01	6.9E-06	2.5E-01	9.3E-10	3.4E-05	4.9E-12	1.8E-07
Cs-136	4.2E-04	1.6E+01	2.1E-06	7.8E-02	2.2E-08	8.3E-04	1.1E-10	4.1E-06
Cs-137	8.7E-04	3.2E+01	4.3E-06	1.6E-01	1.4E-09	5.1E-05	6.6E-12	2.4E-07
Cs-138	1.9E-04	6.9E+00	9.4E-07	3.5E-02				
Miscellaneous Nuclides[c]								
Sr-89	2.9E-06	1.1E-01	1.4E-08	5.3E-04	2.9E-09	1.1E-04	1.5E-11	5.4E-07
Sr-90	1.4E-07	5.4E-03	7.2E-10	2.7E-05	2.5E-10	9.1E-06	1.2E-12	4.4E-08
Sr-91	3.6E-06	1.3E-01	1.8E-08	6.7E-04	1.8E-08	6.5E-04	8.8E-11	3.3E-06

Table 3.5-3— Secondary Coolant Radionuclide Concentrations
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	Design Basis Liquid		Design Basis Steam		Realistic Source Term-Liquid[(e)]		Realistic Source Term-Steam[(e)]	
Radionuclide	µCi/gm	Bq/gm	µCi/gm	Bq/gm	µCi/gm	Bq/gm	µCi/gm	Bq/gm
Sr-92	4.0E-07	1.5E-02	2.0E-09	7.4E-05				
Y-90	3.8E-08	1.4E-03	1.9E-10	7.1E-06				
Y-91m	2.2E-06	8.0E-02	1.1E-08	4.0E-04	2.5E-09	9.1E-05	1.2E-11	4.6E-07
Y-91	3.7E-07	1.4E-02	1.8E-09	6.8E-05	1.1E-10	3.9E-06	5.5E-13	2.0E-08
Y-92	5.3E-07	2.0E-02	2.7E-09	9.9E-05				
Y-93	2.3E-07	8.6E-03	1.2E-09	4.3E-05	7.5E-08	2.8E-03	3.8E-10	1.4E-05
Zr-95	4.1E-07	1.5E-02	2.1E-09	7.7E-05	8.0E-09	3.0E-04	4.0E-11	1.5E-06
Zr-97	2.6E-07	9.6E-03	1.3E-09	4.8E-05				
Nb-95	4.2E-07	1.5E-02	2.1E-09	7.7E-05	5.5E-09	2.0E-04	2.9E-11	1.1E-06
Mo-99	4.6E-04	1.7E+01	2.3E-06	8.5E-02	1.3E-07	4.9E-03	6.3E-10	2.3E-05
Tc-99m	2.6E-04	9.8E+00	1.3E-06	4.9E-02	7.3E-08	2.7E-03	3.8E-10	1.4E-05
Ru-103	3.4E-07	1.3E-02	1.7E-09	6.4E-05	1.6E-07	5.8E-03	8.0E-10	3.0E-05
Ru-105	2.8E-07	1.0E-02	1.4E-09	5.2E-05				
Ru-106	1.2E-07	4.4E-03	6.0E-10	2.2E-05	1.9E-06	6.8E-02	9.0E-09	3.3E-04
Rh-103m	3.1E-07	1.1E-02	1.5E-09	5.7E-05				
Rh-105	2.0E-07	7.4E-03	1.0E-09	3.7E-05				
Rh-106	1.2E-07	4.4E-03	6.0E-10	2.2E-05				
Ag-110m	8.8E-10	3.3E-05	4.4E-12	1.6E-07	2.7E-08	9.8E-04	1.4E-10	5.0E-06
Ag-110	1.2E-11	4.4E-07	5.9E-14	2.2E-09				
Sb-125	3.5E-09	1.3E-04	1.8E-11	6.6E-07				
Sb-127	2.2E-08	8.1E-04	1.1E-10	4.0E-06				
Sb-129	1.9E-08	7.1E-04	9.6E-11	3.6E-06				
Te-127m	2.0E-06	7.3E-02	9.8E-09	3.6E-04				
Te-127	8.1E-06	3.0E-01	4.0E-08	1.5E-03				
Te-129m	6.4E-06	2.4E-01	3.2E-08	1.2E-03	3.9E-09	1.5E-04	2.0E-11	7.3E-07
Te-129	6.3E-06	2.3E-01	3.1E-08	1.2E-03	1.7E-07	6.2E-03	8.3E-10	3.1E-05
Te-131m	1.5E-05	5.7E-01	7.7E-08	2.8E-03	3.0E-08	1.1E-03	1.5E-10	5.6E-06
Te-131	4.6E-06	1.7E-01	2.3E-08	8.5E-04	2.3E-08	8.4E-04	1.2E-10	4.3E-06
Te-132	1.8E-04	6.5E+00	8.8E-07	3.3E-02	3.5E-08	1.3E-03	1.7E-10	6.4E-06
Te-134	6.4E-06	2.4E-01	3.2E-08	1.2E-03				
Ba-137m	8.1E-04	3.0E+01	4.1E-06	1.5E-01				
Ba-139	3.9E-05	1.4E+00	1.9E-07	7.2E-03				
Ba-140	2.7E-06	1.0E-01	1.4E-08	5.1E-04	2.6E-07	9.7E-03	1.3E-09	4.9E-05
La-140	8.4E-07	3.1E-02	4.2E-09	1.6E-04	5.1E-07	1.9E-02	2.5E-09	9.3E-05
La-141	1.5E-07	5.5E-03	7.4E-10	2.8E-05				
La-142	5.6E-08	2.1E-03	2.8E-10	1.0E-05				
Ce-141	3.9E-07	1.5E-02	2.0E-09	7.3E-05	3.1E-09	1.1E-04	1.6E-11	5.8E-07
Ce-143	3.1E-07	1.2E-02	1.6E-09	5.8E-05	5.5E-08	2.0E-03	2.8E-10	1.0E-05

Table 3.5-3— Secondary Coolant Radionuclide Concentrations
(Page 3 of 3)

	Design Basis Liquid		Design Basis Steam		Realistic Source Term-Liquid[e]		Realistic Source Term-Steam[e]	
Radionuclide	μCi/gm	Bq/gm	μCi/gm	Bq/gm	μCi/gm	Bq/gm	μCi/gm	Bq/gm
Ce-144	3.1E-07	1.1E-02	1.5E-09	5.7E-05	8.0E-08	3.0E-03	4.1E-10	1.5E-05
Pr-143	3.9E-07	1.4E-02	2.0E-09	7.2E-05				
Pr-144	3.1E-07	1.1E-02	1.5E-09	5.7E-05				
Nd-147	1.5E-07	5.6E-03	7.5E-10	2.8E-05				
Np-239	3.7E-06	1.4E-01	1.9E-08	6.9E-04	4.5E-08	1.7E-03	2.2E-10	8.3E-06
Pu-238	8.9E-10	3.3E-05	4.4E-12	1.6E-07				
Pu-239	9.0E-11	3.3E-06	4.5E-13	1.7E-08				
Pu-240	1.2E-10	4.6E-06	6.2E-13	2.3E-08				
Pu-241	3.1E-08	1.1E-03	1.5E-10	5.7E-06				
Am-241	3.5E-11	1.3E-06	1.7E-13	6.4E-09				
Cm-242	8.3E-09	3.1E-04	4.2E-11	1.5E-06				
Cm-244	4.6E-10	1.7E-05	2.3E-12	8.4E-08				
Activation Products[d]								
Na-24	3.5E-05	1.3E+00	1.8E-07	6.5E-03	8.9E-07	3.3E-02	4.5E-09	1.7E-04
Cr-51	2.2E-06	8.2E-02	1.1E-08	4.1E-04	6.5E-08	2.4E-03	3.2E-10	1.2E-05
Mn-54	1.1E-06	4.1E-02	5.6E-09	2.1E-04	3.3E-08	1.2E-03	1.7E-10	6.1E-06
Fe-55	8.5E-07	3.1E-02	4.2E-09	1.6E-04	2.5E-08	9.1E-04	1.3E-10	4.6E-06
Fe-59	2.1E-07	7.8E-03	1.1E-09	3.9E-05	6.0E-09	2.2E-04	3.1E-11	1.1E-06
Co-58	3.2E-06	1.2E-01	1.6E-08	6.0E-04	9.5E-08	3.5E-03	4.7E-10	1.7E-06
Co-60	3.8E-07	1.4E-02	1.9E-09	7.0E-05	1.1E-08	4.1E-04	5.5E-11	2.0E-06
Zn-65	3.6E-07	1.3E-02	1.8E-09	6.6E-05	1.1E-08	3.9E-04	5.0E-11	1.9E-06
W1-87	1.8E-06	6.7E-02	9.1E-09	3.4E-04	4.9E-08	1.8E-03	2.5E-10	9.3E-06
Nitrogen								
N-16					6.9E-07	2.6E-02	6.9E-08	2.6E-03
Tritium[d]								
H-3	4.0	1.5E-05	4.0E+00	1.5E+05	1.0E-03	3.7E+01	1.0E-03	3.7E+01

Notes:
For design basis concentrations, the following conditions apply:

a. The noble gases are assumed to enter the steam phase instantly.
b. The halogen concentrations are at the US EPR Standard Technical Specification limit of 0.1μCi/gm DE-I131.
c. The concentrations for this group are based on 1.0% failed fuel fraction.
d. The concentration of activation products conservatively assumed to be same concentration as in primary coolant.
e. Normal operation coolant concentrations for the ANSI/ANS-18.1-1999 reference PWR with U-tube steam generators.

Table 3.5-4— Principal Parameters Used in Estimating Realistic Releases of Radioactive Materials in Effluents (GALE Code Input Parameters)
(Page 1 of 5)

GALE Input Parameter	Value
Name and Type of Reactor	U.S. EPR PWR
Thermal Power Level (MWth) (4,590 MWth + 22 MWth measurement uncertainty)	4,612 MWth (4.612E9 J/sec)
Mass of Coolant in Primary System (RCS dry nominal volume - not including the pressurizer) (13,596 ft^3/0.02290 ft^3/lbm)	5.937E5 lbm (2.693E5 kg)
Primary System Letdown Rate (7.94E+04 lbm/h x 0.0229 ft^3/lbm x 7.48 gal/ft^3 x 1 min/60 sec = 226.7 gpm)	226.7 gpm (0.858 m^3/min
Letdown Cation Demineralizer Flow Rate (No purification system cation demineralizer)	0 gpm (0 l/min)
Number of steam generators	4
Total steam flow (Nominal 4 x 5.168E+06 = 20.67E+06 lbm/hr Increase by 1.05 to account for higher thermal power = 21.71E+06 lbm/hr)	2.171E7 lbm/hr (9.845E6 kg/hr)
Mass of liquid in secondary side of each steam generator (SG)	1.6977E5 lbm (7.7006E5 kg)
SG Blowdown rate (Nominal 4 x 0.052E+06 lbm/hr = 208E+03 lbm/hr Adjust by 1.05 to account for higher thermal power 208 x 1.05 = 218.4E+03)	2.184E5 lbm/hr (9.8901E4 kg/hr)
Blowdown Treatment Method (Full blowdown flow processed by Blowdown System and recycled to condensate system.)	0
Condensate Demineralizer Regeneration Time (days) (Regeneration not used)	0
Condensate Demineralizer Flow Fraction	0.33
Shim Bleed Flow Rate (gpd) (Shim bleed is letdown flow for boron control and the liquid is recycled. The nominal flow is: 500 lbm/hr x 0.0229 ft^3/lbm x 7.48 gal/ft^3 x 24 hr/day = 2,056 gpd Adjusting by 1.05 to account for higher thermal power yields 2,158 gpd. The analysis will conservatively assume that 5 percent of the processed shim bleed flow 2,158 x 0.05 = 107.9 rounded to 110 gpd is liquid waste)	110 gpd (416 l/day)
Shim Bleed Fraction of PCA	1.0
Shim Bleed DF for Iodine (With Liquid Waste Storage and Processing System Demineralizer)	1.0E4
Shim Bleed DF for Cesium and Rubidium (With Liquid Waste Storage and Processing System Demineralizer)	1.0E7
Shim Bleed DF for Other Nuclides (With Liquid Waste Storage and Processing System Demineralizer)	1.0E7
Shim Bleed Collection Time (days) $\frac{18500 \text{ gal}}{(\frac{110+1728 \text{ gal}}{\text{day}})} * 0.8 = 8.05 = 8.1 \text{ days}$ (The collection time is for one tank. The collection time includes 1,728 gpd (6,541 lpd) from equipment drains.)	8.1 days

Table 3.5-4— Principal Parameters Used in Estimating Realistic Releases of Radioactive Materials in Effluents (GALE Code Input Parameters)
(Page 2 of 5)

GALE Input Parameter	Value
Shim Bleed Processing and Discharge Times (days) $$\frac{18500\ \text{gal}}{\left(\frac{1.1\ \text{kg}}{\text{sec}}\right)*\left(\frac{1\text{E-3}\ \text{m}^3}{1\ \text{kg}}\right)*\left(\frac{8.64\text{E4}\ \text{sec}}{\text{d}}\right)} * 0.8 = 0.589\ \text{days}$$	0.589 days
Shim Bleed Average Fraction of Waste to be Discharged (There is no recycling of liquid radioactive waste.)	1.0
Equipment Drains Input (gpd) *(Based on U.S. EPR Standard Technical Specification limit on unidentified leakage of 1* gpm (3.79 lpm). Assumes collected by floor drains. Twenty percent added for conservatism.)	1,728 gal/day 6,541 l/day
Equipment Drains Primary Coolant Activity (PCA)	1.0
Equipment Drains DF for Iodine (With Liquid Waste Storage and Processing System Demineralizer)	1.0E4
Equipment Drains DF for Cesium and Rubidium (With Liquid Waste Storage and Processing System Demineralizer)	1.0E7
Equipment Drains DF for Other Nuclides (With Liquid Waste Storage and Processing System Demineralizer)	1.0E7
Equipment Drains Collection Time (days) (Includes 110 gpd (416.4 lpd) from shim bleed.) $$\frac{70\ \text{m}^3}{\left(\frac{110+1728\ \text{gal}}{\text{day}}\right)*\left(\frac{\text{m}^3}{264.17\ \text{gal}}\right)} * 0.8 = 8.1\ \text{days}$$ (Includes 110 gpd (416.4 lpd) from shim bleed.)	8.1 days
Equipment Drains Processing and Discharge Times (days) $$\frac{70\ \text{m}^3}{\left(\frac{1.1\ \text{kg}}{\text{sec}}\right)*\left(\frac{1\text{E-3}\ \text{m}^3}{1\ \text{kg}}\right)*\left(\frac{8.64\text{E4}\ \text{sec}}{\text{d}}\right)} * 0.8 = 0.589\ \text{days}$$	0.589 days
Equipment Drains Average Fraction of Waste to be Discharged (There is no recycling of liquid radioactive waste.)	1.0
Clean Waste Input (gpd) (Clean Waste included as Group II.) (Conservative – 66,000 gal/week / 7 day/week = 9,428 gallons per day)	9,428 gal/day 35,690 l/day
Clean Waste PCA	0.001
Clean Waste DF for Iodine (With Liquid Waste Storage and Processing System Demineralizer)	1.0E2
Clean Waste DF for Cesium and Rubidium (With Liquid Waste Storage and Processing System Demineralizer)	1.0E2
Clean Waste DF for Other Nuclides (With Liquid Waste Storage and Processing System Demineralizer)	1.0E2

Table 3.5-4— Principal Parameters Used in Estimating Realistic Releases of Radioactive Materials in Effluents (GALE Code Input Parameters)
(Page 3 of 5)

GALE Input Parameter	Value
Clean Waste Collection Time (days) $\frac{70\,m^3}{(\frac{250\,m^3}{week})*(\frac{week}{7\,d})} * 0.8 = 1.6\,days$	1.6 days
Clean Waste Processing and Discharge Times (days) $\frac{70\,m^3}{(\frac{1.4\,kg}{sec})*(\frac{1E-3\,m^3}{1\,kg})*(\frac{8.64E4\,sec}{d})} * 0.8 = 0.463\,days$	0.463
Clean Waste Average Fraction of Waste to be Discharged (There is no recycling of liquid radioactive waste.)	1.0
Dirty Waste Input (gpd) (Group III waste is normally not radioactive and it is neglected to maximize concentrations)	0 gal/day (0 l/day)
Dirty Waste PCA (N/A since input is 0 gallons.per day)	0.1
Dirty Waste DF for Iodine (N/A since input is 0 gallons.per day)	1.0E2
Dirty Waste DF for Cesium and Rubidium (N/A since input is 0 gallons.per day)	1.0E3
Dirty Waste DF for Other Nuclides (N/A since input is 0 gallons.per day)	1.0E3
Dirty Waste Collection Time (days) (N/A since input is 0 gallons.per day)	0
Dirty Waste Processing and Discharge Times (days) (N/A since input is 0 gallons.per day)	0
Dirty Waste Average Fraction of Waste to be Discharged (There is no recycling of liquid radioactive waste.)	1.0
Blowdown Fraction Processed	1.0
Blowdown DF for Iodine (1 in the cation bed x 100 in the mixed bed = 100 overall)	1.0E+02
Blowdown DF for Cesium and Rubidium (10 in the cation bed x 10 in the mixed bed = 100 overall)	1.0E+02
Blowdown DF for Other Nuclides (10 in the cation bed x 100 in the mixed bed = 100 overall)	1.0E+03
Blowdown Collection Time (days)	0 days
Blowdown Processing and Discharge Times (days)	0 days
Blowdown Average Fraction of Waste to be Discharged	0.0
Regenerant Flow Rate (gpd) (Regeneration not used)	0.0
Regenerant DF for Iodine	1.0
Regenerant DF for Cesium and Rubidium	1.0
Regenerant DF for Other Nuclides	1.0
Regenerant Collection Time (days)	0.0

Table 3.5-4— Principal Parameters Used in Estimating Realistic Releases of Radioactive Materials in Effluents (GALE Code Input Parameters)
(Page 4 of 5)

GALE Input Parameter	Value
Regenerant Processing and Discharge Times (days)	0.0
Regenerant Average Fraction of Waste to be Discharged	0.0
Is There Continuous Stripping of Full Letdown Flow? (The degasification is normally operated prior to refueling, prior to maintenance of the reactor coolant circuit or if required to decrease the concentration of gaseous reactivity. Value of 'Y' for card 30 is ratio of total amount of noble gases routed to gaseous radwaste from the purification system to total routed from the primary coolant system. Options are 0, 0.25, 1. This is a recycled loop during normal operations, and very little of the flow ends up in delay beds, the value of 0 best represents system.)	No
Flow Rate Through Gas Stripper (gpm)	1.276
Holdup Time for Xenon (days)	27.7 days
Holdup Time for Krypton (days)	1.67 days
Fill Time of Decay Tanks for the Gas Stripper (Days) (Discharged directly to the stack.)	0 days
Primary Coolant Leak to Auxiliary Bldg (lb/day)	160.0
Waste Gas System Particulate Releases HEPA Efficiency (%)	99 %
Fuel Handling Building Releases: Charcoal Efficiency (%) (HEPA and Charcoal efficiencies for non-ESF systems taken to be the same as Gaseous Waste Processing System)	90 %
Fuel Handling Building Releases: HEPA Efficiency (%) (HEPA and Charcoal efficiencies for non-ESF systems taken to be the same as Gaseous Waste Processing System)	99 %
Auxiliary Building Releases: Charcoal Efficiency (%) (HEPA and Charcoal efficiencies for non-ESF systems taken to be the same as Gaseous Waste Processing System)	90 %
Auxiliary Building Releases: HEPA Efficiency (%) (HEPA and Charcoal efficiencies for non-ESF systems taken to be the same as Gaseous Waste Processing System)	99 %
Containment Free Volume.	2.8E+06 ft^3 (7.9E+4 m^3)
Frequency of Primary Coolant Degassing (Times/Year)	2.0
Primary to Secondary Leak Rate (lb/day)	75.0
Containment Internal Cleanup System: Charcoal Efficiency (%) (HEPA and Charcoal efficiencies for non-ESF systems taken to be the same as Gaseous Waste Processing System)	90 %
Containment Internal Cleanup System: HEPA Efficiency (%) (HEPA and Charcoal efficiencies for non-ESF systems taken to be the same as Gaseous Waste Processing System)	99 %
Containment Internal Cleanup System: Flow Rate	4.1 E+03 cfm (1.9 m^3/sec)
Purge Time of Containment (hours)	16.0
Fraction of Iodine Bypassing Condensate Demineralizer	0.67
Iodine Partition Factor (Gas/Liquid) in Steam Generator	0.01

Table 3.5-4— Principal Parameters Used in Estimating Realistic Releases of Radioactive Materials in Effluents (GALE Code Input Parameters)
(Page 5 of 5)

GALE Input Parameter	Value
Containment High Volume Purge: Charcoal Efficiency (%) (HEPA and Charcoal efficiencies for non-ESF systems taken to be the same as Gaseous Waste Processing System)	90 %
Containment High Volume Purge: HEPA Efficiency (%) (HEPA and Charcoal efficiencies for non-ESF systems taken to be the same as Gaseous Waste Processing System)	99 %
Containment High Volume Purge: Purges per Year	2.0
Containment Low Volume Purge: Charcoal Efficiency (%)	90 %
Containment Low Volume Purge: HEPA Efficiency (%)	99 %
Containment Low Volume Purge: Flow Rate (cfm)	2,970 cfm (1.40 m^3/sec)
Steam Leak to Turbine Bldg (lbs/hr)	1700.00
Percent of Iodine Released from Blowdown Tank Vent	0.0 %
Percent of Iodine Removed from Air Ejector Release	0.0 %
Detergent Waste PF (No onsite laundry)	0.0
SG blowdown flash tank gases vented via main condenser air ejector?	No
Condenser air ejector offgas released without treatment?	Yes
Condenser air ejector offgas processed via charcoal adsorbers prior to release?	No
Average flow rate of water used to dilute liquid waste discharged to the environment.	100 cfs (2.83 m^3/sec)
Number of Main Condenser Water Boxes	3
Main Condenser Water Box liquid volume (each) (nominal operating conditions) (ft^3) (m^3)	6,357 ft^3 (180 m^3)
Main Condenser Water Box temperature (nominal operating conditions) (°F) (°C)	69.4 °F (20.8 °C)
Main Condenser Water Box pressure (nominal operating conditions) (millibars)	24.7

Table 3.5-5— Average Radioactivity Concentrations in the Spent Fuel Pool (SFP) Area[1]

(Page 1 of 2)

Nuclide	SFP Water Activity (μCi/cm^3)	SFP Water Activity (MBq/cm^3)	SFP Airborne Activity (μCi/cm^3)	SFP Airborne Activity (MBq/cm^3)
H- 3	5.90	2.18E-02	2.67E-06	9.88E-08
Na-24	1.13E-06	4.18E-08	5.10E-12	1.89E-13
Cr-51	6.01E-06	2.22E-07	2.72E-11	1.01E-12
Mn-54	3.40E-06	1.26E-07	1.54E-11	5.70E-13
Fe-55	2.57E-06	9.51E-08	1.17E-11	4.33E-13
Fe-59	6.06E-07	2.24E-08	2.75E-12	1.02E-13
Co-58	9.50E-06	3.52E-07	4.30E-11	1.59E-12
Co-60	1.14E-06	4.22E-08	5.15E-11	1.91E-13
Zn-65	1.08E-06	4.00E-08	4.91E-12	1.82E-13
Br-83	2.43E-17	8.99E-19	1.07E-22	3.96E-34
Kr-83m	4.87E-16	1.80E-17	2.13E-21	7.88E-23
Kr-85m	1.18E-10	4.37E-12	5.28E-16	1.95E-17
Kr-85	4.33E-03	1.60E+04	1.96E-08	7.25E-10
Kr-87	3.71E-26	1.37E-27	1.60E-31	5.92E-33
Kr-88	6.73E-14	2.49E-15	2.98E-19	1.10E-20
Rb-88	6.79E-14	2.51E-15	3.06E-19	1.13E-20
Sr-89	1.52E-07	5.62E-09	6.89E-13	2.55E-14
Sr-90	1.69E-08	6.25E-10	7.67E-14	2.84E-15
Sr-91	1.42E-10	5.25E-12	6.39E-16	2.36E-17
Sr-92	4.58E-18	1.69E-19	2.02E-23	7.47E-25
Y-90	4.69E-09	1.74E-10	2.13E-14	7.88E-16
Y-91m	7.84E-11	2.90E-12	3.56E-16	1.32E-17
Y-91	3.01E-08	1.11E-09	1.36E-13	5.03E-15
Y-92	8.42E-16	3.12E-17	3.75E-21	1.39E-22
Y-93	3.95E-11	1.46E-12	1.78E-16	6.59E-18
Zr-95	3.50E-08	1.30E-03	1.59E-13	5.88E-15
Nb-95	3.67E-08	1.36E-09	1.66E-13	6.14E-15
Mo-99	1.75E-05	6.48E-07	7.92E-11	2.93E-12
Tc-99m	9.60E-06	3.55E-07	4.38E-10	1.62E-12
Ru-103	3.59E-08	1.33E-09	1.63E-13	6.03E-15
Ru-106	2.27E-08	8.40E-10	1.03E-13	3.81E-15
Rh-103m	3.24E-08	1.20E-09	1.47E-13	5.44E-15
Rh-106	2.27E-08	8.40E-10	1.03E-13	3.81E-15
Ag-110m	3.83E-10	1.42E-11	1.74E-145	6.44E-17
Te-127m	2.41E-07	8.92E-09	1.09E-12	4.03E-14
Te-129m	6.52E-07	2.41E-08	2.95E-11	1.09E-13
Te-129	4.24E-07	1.57E-08	1.92E-12	7.10E-14
Te-131m	1.92E-07	7.10E-09	8.70E-13	3.22E-14

Table 3.5-5— Average Radioactivity Concentrations in the Spent Fuel Pool (SFP) Area[1]

(Page 2 of 2)

	SFP Water Activity		SFP Airborne Activity	
Nuclide	(μCi/cm³)	(MBq/cm³)	(μCi/cm³)	(MBq/cm³)
Te-131	4.33E-08	1.60E-09	1.96E-13	7.26E-15
Te-132	7.92E-06	2.93E-07	3.59E-11	1.33E-12
Te-134	2.09E-45	7.73E-47	8.64E-51	3.20E-52
I-129	1.08E-11	4.00E-13	4.87E-17	1.80E-18
I-130	6.09E-08	2.25E-09	2.74E-13	1.01E-14
I-131	1.26E-04	4.66E+06	5.72E-10	2.12E-11
I-132	2.87E-05	1.06E+06	1.27E-10	4.70E-12
I-133	1.29E-05	4.77E-07	5.83E-11	2.16E-12
I-134	1.67E-35	6.18E-37	7.03E-41	2.60E-42
I-135	1.11E-08	4.11E-10	4.96E-14	1.84E-15
Xe-131m	2.81E-04	1.04E-05	1.27E-09	4.70E-11
Xe-133m	1.39E-04	5.14E+06	6.30E-10	2.33E-11
Xe-133	1.67E-02	6.18E+04	7.54E-08	2.79E-09
Xe-135m	3.39E-09	1.25E-10	1.37E-14	5.07E-16
Xe-135	4.68E-06	1.73E-07	2.11E-10	7.81E-13
Cs-134	1.64E-04	6.07E+06	7.44E-10	2.75E-11
Cs-136	3.16E-05	1.17E+06	1.43E-10	5.29E-12
Cs-137	6.29E-05	2.33E+06	2.85E-10	1.05E-11
Ba-137m	5.92E-05	2.19E+06	2.69E-10	9.95E-12
Ba-140	2.00E-07	7.40E-09	9.04E-13	3.34E-14
La-140	6.93E-08	2.56E-09	3.15E-13	1.17E-14
Ce-141	3.29E-08	1.22E-09	1.49E-13	5.51E-15
Ce-143	4.26E-09	1.58E-10	1.93E-14	7.14E-16
Ce-144	2.70E-08	9.99E-10	1.22E-13	4.51E-15
Pr-143	3.19E-08	1.18E-09	1.44E-13	5.33E-15
Pr-144	2.70E-08	9.99E-10	1.22E-13	4.51E-15
W-187	3.17E-07	1.17E-08	1.43E-12	5.29E-14
Np-239	1.73E-07	6.40E-09	7.81E-13	2.89E-14
Total (Excluding Tritium)	2.20E-02	8.14E+04	9.94E-08	3.68E-09
Iodines	1.68E-04	6.22E+06	7.58E-10	2.80E-11
Particulates	2.58E-05	9.55E-07	1.17E-10	4.33E-12
Noble Gases	2.14E-02	7.92E+04	9.70E-08	3.59E-09

Note:
MBq/cm³ = 1.0E+06 Bq/cm³
μCi/cm³ = 3.7E+04 Bq/cm³
μCi/cm³ = 3.7E-02 MBq/cm³

1. Pool activity based on design basis failed fuel fraction of 0.25 wt. % with a full core off load inventory.

Table 3.5-6— Liquid Waste Release Source Term Inputs

Liquid Waste Inputs								
				Collection	Decay	Decontamination Factors		
Stream	Flow Rate (gal/day) (L/day)	Fraction of PCA	Fraction Discharged	Time (days)	Time (days)	I	Cs	Others
Shim Bleed Rate	1.10E+02 (4.16 E+02)	1.0	1.0	8.1	0.589	1.0E+04	1.0E+07	1.0E+07
Equipment Drains	1.73E+03 (6.55E+03)	1.0	1.0	8.1	0.589	1.0E+04	1.0E+07	1.0E+07
Clean Waste Input	9.43E+03 (3.57E+04)	0.001	1.0	1.6	0.463	1.0E+02	1.0E+02	1.0E+02
Dirty Wastes	0.00E+00 (0.00E+00)	0.1	1.0	0.0	0.0	1.0E+02	1.0E+03	1.0E+03
Blowdown	6.28E+05 (2.38E+06)		0.0	0.0	0.0	1.0E+02	1.0E+02	1.0E+03
Untreated Blowdown	0.00E+00 (0.00E+00)		1.0	0.0	0.0	1.0E+00	1.0E+00	1.0E+00
Regenerant Sols.	0.00E+00 (0.00E+00)		0.0	0.0	0.0	1.0E+00	1.0E+00	1.0E+00

Table 3.5-7— Annual Expected Liquid Waste Releases (English Units)

(Page 1 of 3)

Nuclide	Half-Life (days)	Primary (µCi/ml)	Secondary (µCi/ml)	Boron Recovery System (Ci)	Misc Wastes (Ci)	Secondary (Ci)	Turbine Building (Ci)	Total Liquid Waste Sources (Ci)	Adjusted Total (Ci/yr)	Detergent Wastes (Ci/yr)	Total (Ci/yr)
Corrosion and Activation Products											
Na-24	6.25E-01	2.84E-02	3.40E-07	0.00000	0.00104	0.00000	0.00001	0.00105	0.00613	0.00000	0.00610
Cr-51	2.78E+01	1.39E-03	1.96E-08	0.00000	0.00018	0.00000	0.00000	0.00018	0.00103	0.00000	0.00100
Mn-54	3.03E+02	7.09E-04	9.66E-09	0.00000	0.00009	0.00000	0.00000	0.00009	0.00054	0.00000	0.00054
Fe-55	9.50E+02	5.32E-04	7.28E-09	0.00000	0.00007	0.00000	0.00000	0.00007	0.00041	0.00000	0.00041
Fe-59	4.50E+01	1.34E-04	1.80E-09	0.00000	0.00002	0.00000	0.00000	0.00002	0.00010	0.00000	0.00010
Co-58	7.13E+01	2.04E-03	2.84E-08	0.00000	0.00026	0.00000	0.00000	0.00027	0.00155	0.00000	0.00150
Co-60	1.92E+03	2.35E-04	3.27E-09	0.00000	0.00003	0.00000	0.00000	0.00003	0.00018	0.00000	0.00018
Zn-65	2.45E+02	2.26E-04	3.12E-09	0.00000	0.00003	0.00000	0.00000	0.00003	0.00017	0.00000	0.00017
W-187	9.96E-01	1.38E-03	1.73E-08	0.00000	0.00008	0.00000	0.00000	0.00008	0.00046	0.00000	0.00046
Np-239	2.35E+00	1.08E-03	1.44E-08	0.00000	0.00010	0.00000	0.00000	0.00010	0.00058	0.00000	0.00058
Fission Products											
Sr-89	5.20E+01	6.23E-05	8.52E-10	0.00000	0.00001	0.00000	0.00000	0.00001	0.00005	0.00000	0.00005
Sr-91	4.03E-01	6.41E-04	7.35E-09	0.00000	0.00001	0.00000	0.00000	0.00001	0.00008	0.00000	0.00008
Y-91M	3.47E-02	5.09E-04	2.01E-09	0.00000	0.00001	0.00000	0.00000	0.00001	0.00005	0.00000	0.00005
Y- 93	4.25E-01	2.77E-03	3.09E-08	0.00000	0.00006	0.00000	0.00000	0.00006	0.00036	0.00000	0.00036
Zr-95	6.50E+01	1.73E-04	2.39E-09	0.00000	0.00002	0.00000	0.00000	0.00002	0.00013	0.00000	0.00013
Nb-95	3.50E+01	1.25E-04	1.65E-09	0.00000	0.00002	0.00000	0.00000	0.00002	0.00010	0.00000	0.00010
Mo-99	2.79E+00	3.11E-03	4.19E-08	0.00000	0.00030	0.00000	0.00000	0.00030	0.00175	0.00000	0.00180
Tc-99M	2.50E-01	3.54E-03	3.47E-08	0.00000	0.00029	0.00000	0.00000	0.00029	0.00170	0.00000	0.00170
Ru-103	3.96E+01	3.34E-03	4.65E-08	0.00000	0.00043	0.00000	0.00000	0.00043	0.00251	0.00000	0.00250
Rh-103M	3.96E-02	0.00E+00	0.00E+00	0.00000	0.00043	0.00000	0.00000	0.00043	0.00251	0.00000	0.00250
Ru-106	3.67E+02	3.99E-02	5.50E-07	0.00001	0.00518	0.00000	0.00003	0.00522	0.03050	0.00000	0.03100
Rh-106	3.47E-04	0.00E+00	0.00E+00	0.00001	0.00518	0.00000	0.00003	0.00522	0.03050	0.00000	0.03100

Table 3.5-7— Annual Expected Liquid Waste Releases (English Units)

(Page 2 of 3)

Nuclide	Half-Life (days)	Primary (µCi/ml)	Secondary (µCi/ml)	Boron Recovery System (Ci)	Misc Wastes (Ci)	Secondary (Ci)	Turbine Building (Ci)	Total Liquid Waste Sources (Ci)	Adjusted Total (Ci/yr)	Detergent Wastes (Ci/yr)	Total (Ci/yr)
Ag-110M	2.53E+02	5.76E-04	7.88E-09	0.00000	0.00007	0.00000	0.00000	0.00008	0.00044	0.00000	0.00044
Ag-110	2.82E-04	0.00E+00	0.00E+00	0.00000	0.00001	0.00000	0.00000	0.00001	0.00006	0.00000	0.00006
Te-129M	3.40E+01	8.48E-05	1.17E-09	0.00000	0.00001	0.00000	0.00000	0.00001	0.00006	0.00000	0.00006
Te-129	4.79E-02	2.55E-02	1.28E-07	0.00000	0.00001	0.00000	0.00000	0.00001	0.00004	0.00000	0.00004
Te-131M	1.25E+00	7.98E-04	1.02E-08	0.00000	0.00005	0.00000	0.00000	0.00005	0.00031	0.00000	0.00031
Te-131	1.74E-02	9.04E-03	2.07E-08	0.00000	0.00001	0.00000	0.00000	0.00001	0.00006	0.00000	0.00006
I-131	8.05E+00	2.07E-02	2.49E-07	0.00341	0.00243	0.00000	0.00002	0.00586	0.03424	0.00000	0.03400
Te-132	3.25E+00	8.15E-04	1.09E-08	0.00000	0.00008	0.00000	0.00000	0.00008	0.00048	0.00000	0.00048
I-132	9.58E-02	1.98E-01	1.34E-06	0.00001	0.00016	0.00000	0.00002	0.00020	0.00115	0.00000	0.00120
I-133	8.75E-01	7.92E-02	8.87E-07	0.00185	0.00405	0.00000	0.00007	0.00597	0.03488	0.00000	0.03500
Cs-134	7.49E+02	3.46E-03	4.87E-08	0.00000	0.00045	0.00000	0.00000	0.00045	0.00265	0.00000	0.00260
I-135	2.79E-01	1.90E-01	1.81E-06	0.00052	0.00194	0.00000	0.00010	0.00256	0.01496	0.00000	0.01500
Cs-136	1.30E+01	4.38E-04	6.16E-09	0.00000	0.00005	0.00000	0.00000	0.00005	0.00031	0.00000	0.00031
Cs-137	1.10E+04	4.57E-03	6.49E-08	0.00000	0.00060	0.00000	0.00000	0.00060	0.00351	0.00000	0.00350
Ba-137M	1.77E-03	0.00E+00	0.00E+00	0.00000	0.00056	0.00000	0.00000	0.00056	0.00328	0.00000	0.00330
Ba-140	1.28E+01	5.88E-03	7.94E-08	0.00000	0.00072	0.00000	0.00000	0.00072	0.00421	0.00000	0.00420
La-140	1.67E+00	1.28E-02	1.67E-07	0.00000	0.00130	0.00000	0.00001	0.00131	0.00763	0.00000	0.00760
Ce-141	3.24E+01	6.70E-05	9.16E-10	0.00000	0.00001	0.00000	0.00000	0.00001	0.00005	0.00000	0.00005
Ce-143	1.38E+00	1.47E-03	1.86E-08	0.00000	0.00010	0.00000	0.00000	0.00010	0.00061	0.00000	0.00061
Pr-143	1.37E+01	0.00E+00	0.00E+00	0.00000	0.00001	0.00000	0.00000	0.00001	0.00005	0.00000	0.00005
Ce-144	2.84E+02	1.73E-03	2.38E-08	0.00000	0.00022	0.00000	0.00000	0.00023	0.00132	0.00000	0.00130
Pr-144	1.20E-02	0.00E+00	0.00E+00	0.00000	0.00022	0.00000	0.00000	0.00023	0.00132	0.00000	0.00130
All Others		6.25E-01	1.89E-06	0.00000	0.00000	0.00000	0.00000	0.00000	0.00002	0.00000	0.00002
Total (Except Tritium)		1.27E+00	7.93E-06	0.00582	0.02690	0.00000	0.00033	0.03304	0.19304	0.00000	0.19000
Tritium Release		1.66E+03 Curies per year									

Table 3.5-7— Annual Expected Liquid Waste Releases (English Units)
(Page 3 of 3)

Nuclide	Half-Life (days)	Primary (μCi/ml)	Secondary (μCi/ml)	Boron Recovery System (Ci)	Misc Wastes (Ci)	Secondary (Ci)	Turbine Building (Ci)	Total Liquid Waste Sources (Ci)	Adjusted Total (Ci/yr)	Detergent Wastes (Ci/yr)	Total (Ci/yr)

Note:
0.00000 indicates that the value is less than 1.0E-05.

Table 3.5-7— Annual Expected Liquid Waste Releases (SI Units)

(Page 1 of 3)

Nuclide	Half-Life (days)	Primary (Bq/ml)	Secondary (Bq/ml)	Boron Recovery System (Bq)	Misc Wastes (Bq)	Secondary (Bq)	Turbine Building (Bq)	Total Liquid Waste Sources (Bq)	Adjusted Total (Bq/yr)	Detergent Wastes (Bq/yr)	Total (Bq/yr)
Corrosion and Activation Products											
Na-24	6.25E-01	1.05E+03	1.26E-02	0.00E+00	3.85E+07	0.00E+00	3.70E+05	3.89E+07	2.27E+08	0.00E+00	2.26E+08
Cr-51	2.78E+01	5.14E+01	7.25E-04	0.00E+00	6.66E+06	0.00E+00	0.00E+00	6.66E+06	3.81E+07	0.00E+00	3.70E+07
Mn-54	3.03E+02	2.62E+01	3.57E-04	0.00E+00	3.33E+06	0.00E+00	0.00E+00	3.33E+06	2.00E+07	0.00E+00	2.00E+07
Fe-55	9.50E+02	1.97E+01	2.69E-04	0.00E+00	2.59E+06	0.00E+00	0.00E+00	2.59E+06	1.52E+07	0.00E+00	1.52E+07
Fe-59	4.50E+01	4.96E+00	6.66E-05	0.00E+00	7.40E+05	0.00E+00	0.00E+00	7.40E+05	3.70E+06	0.00E+00	3.70E+06
Co-58	7.13E+01	7.55E+01	1.05E-03	0.00E+00	9.62E+06	0.00E+00	0.00E+00	9.99E+06	5.74E+07	0.00E+00	5.55E+07
Co-60	1.92E+03	8.70E+00	1.21E-04	0.00E+00	1.11E+06	0.00E+00	0.00E+00	1.11E+06	6.66E+06	0.00E+00	6.66E+06
Zn-65	2.45E+02	8.36E+00	1.15E-04	0.00E+00	1.11E+06	0.00E+00	0.00E+00	1.11E+06	6.29E+06	0.00E+00	6.29E+06
W-187	9.96E-01	5.11E+01	6.40E-04	0.00E+00	2.96E+06	0.00E+00	0.00E+00	2.96E+06	1.70E+07	0.00E+00	1.70E+07
Np-239	2.35E+00	4.00E+01	5.33E-04	0.00E+00	3.70E+06	0.00E+00	0.00E+00	3.70E+06	2.15E+07	0.00E+00	2.15E+07
Fission Products											
Sr-89	5.20E+01	2.31E+00	3.15E-05	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	1.85E+06	0.00E+00	1.85E+06
Sr-91	4.03E-01	2.37E+01	2.72E-04	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	2.96E+06	0.00E+00	2.96E+06
Y-91M	3.47E-02	1.88E+01	7.44E-05	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	1.85E+06	0.00E+00	1.85E+06
Y-93	4.25E-01	1.02E+02	1.14E-03	0.00E+00	2.22E+06	0.00E+00	0.00E+00	2.22E+06	1.33E+07	0.00E+00	1.33E+07
Zr-95	6.50E+01	6.40E+00	8.84E-05	0.00E+00	7.40E+05	0.00E+00	0.00E+00	7.40E+05	4.81E+06	0.00E+00	4.81E+06
Nb-95	3.50E+01	4.63E+00	6.11E-05	0.00E+00	7.40E+05	0.00E+00	0.00E+00	7.40E+05	3.70E+06	0.00E+00	3.70E+06
Mo-99	2.79E+00	1.15E+02	1.55E-03	0.00E+00	1.11E+07	0.00E+00	0.00E+00	1.11E+07	6.48E+07	0.00E+00	6.66E+07
Tc-99M	2.50E-01	1.31E+02	1.28E-03	0.00E+00	1.07E+07	0.00E+00	0.00E+00	1.07E+07	6.29E+07	0.00E+00	6.29E+07
Ru-103	3.96E+01	1.24E+02	1.72E-03	0.00E+00	1.59E+07	0.00E+00	0.00E+00	1.59E+07	9.29E+07	0.00E+00	9.25E+07
Rh-103M	3.96E-02	0.00E+00	0.00E+00	0.00E+00	1.59E+07	0.00E+00	0.00E+00	1.59E+07	9.29E+07	0.00E+00	9.25E+07
Ru-106	3.67E+02	1.48E+03	2.04E-02	3.70E+05	1.92E+08	0.00E+00	1.11E+06	1.93E+08	1.13E+09	0.00E+00	1.15E+09
Rh-106	3.47E-04	0.00E+00	0.00E+00	3.70E+05	1.92E+08	0.00E+00	1.11E+06	1.93E+08	1.13E+09	0.00E+00	1.15E+09

Table 3.5-7— Annual Expected Liquid Waste Releases (SI Units)

(Page 2 of 3)

Nuclide	Half-Life (days)	Primary (Bq/ml)	Secondary (Bq/ml)	Boron Recovery System (Bq)	Misc Wastes (Bq)	Secondary (Bq)	Turbine Building (Bq)	Total Liquid Waste Sources (Bq)	Adjusted Total (Bq/yr)	Detergent Wastes (Bq/yr)	Total (Bq/yr)
Ag-110M	2.53E+02	2.13E+01	2.92E-04	0.00E+00	2.59E+06	0.00E+00	0.00E+00	2.96E+06	1.63E+07	0.00E+00	1.63E+07
Ag-110	2.82E-04	0.00E+00	0.00E+00	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	2.22E+06	0.00E+00	2.22E+06
Te-129M	3.40E+01	3.14E+00	4.33E-05	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	2.22E+06	0.00E+00	2.22E+06
Te-129	4.79E-02	9.44E+02	4.74E-03	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	1.48E+06	0.00E+00	1.48E+06
Te-131M	1.25E+00	2.95E+01	3.77E-04	0.00E+00	1.85E+06	0.00E+00	0.00E+00	1.85E+06	1.15E+07	0.00E+00	1.15E+07
Te-131	1.74E-02	3.34E+02	7.66E-04	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	2.22E+06	0.00E+00	2.22E+06
I-131	8.05E+00	7.66E+02	9.21E-03	1.26E+08	8.99E+07	0.00E+00	7.40E+05	2.17E+08	1.27E+09	0.00E+00	1.26E+09
Te-132	3.25E+00	3.02E+01	4.03E-04	0.00E+00	2.96E+06	0.00E+00	0.00E+00	2.96E+06	1.78E+07	0.00E+00	1.78E+07
I-132	9.58E-02	7.33E+03	4.96E-02	3.70E+05	5.92E+06	0.00E+00	7.40E+05	7.40E+06	4.26E+07	0.00E+00	4.44E+07
I-133	8.75E-01	2.93E+03	3.28E-02	6.85E+07	1.50E+08	0.00E+00	2.59E+06	2.21E+08	1.29E+09	0.00E+00	1.30E+09
Cs-134	7.49E+02	1.28E+02	1.80E-03	0.00E+00	1.67E+07	0.00E+00	0.00E+00	1.67E+07	9.81E+07	0.00E+00	9.62E+07
I-135	2.79E-01	7.03E+03	6.70E-02	1.92E+07	7.18E+07	0.00E+00	3.70E+06	9.47E+07	5.54E+08	0.00E+00	5.55E+08
Cs-136	1.30E+01	1.62E+01	2.28E-04	0.00E+00	1.85E+06	0.00E+00	0.00E+00	1.85E+06	1.15E+07	0.00E+00	1.15E+07
Cs-137	1.10E+04	1.69E+02	2.40E-03	0.00E+00	2.22E+07	0.00E+00	0.00E+00	2.22E+07	1.30E+08	0.00E+00	1.30E+08
Ba-137M	1.77E-03	0.00E+00	0.00E+00	0.00E+00	2.07E+07	0.00E+00	0.00E+00	2.07E+07	1.21E+08	0.00E+00	1.22E+08
Ba-140	1.28E+01	2.18E+02	2.94E-03	0.00E+00	2.66E+07	0.00E+00	0.00E+00	2.66E+07	1.56E+08	0.00E+00	1.55E+08
La-140	1.67E+00	4.74E+02	6.18E-03	0.00E+00	4.81E+07	0.00E+00	3.70E+05	4.85E+07	2.82E+08	0.00E+00	2.81E+08
Ce-141	3.24E+01	2.48E+00	3.39E-05	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	1.85E+06	0.00E+00	1.85E+06
Ce-143	1.38E+00	5.44E+01	6.88E-04	0.00E+00	3.70E+06	0.00E+00	0.00E+00	3.70E+06	2.26E+07	0.00E+00	2.26E+07
Pr-143	1.37E+01	0.00E+00	0.00E+00	0.00E+00	3.70E+05	0.00E+00	0.00E+00	3.70E+05	1.85E+06	0.00E+00	1.85E+06
Ce-144	2.84E+02	6.40E+01	8.81E-04	0.00E+00	8.14E+06	0.00E+00	0.00E+00	8.51E+06	4.88E+07	0.00E+00	4.81E+07
Pr-144	1.20E-02	0.00E+00	0.00E+00	0.00E+00	8.14E+06	0.00E+00	0.00E+00	8.51E+06	4.88E+07	0.00E+00	4.81E+07
All Others		2.31E+04	6.99E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.40E+05	0.00E+00	7.40E+05
Total (Except Tritium)		4.70E+04	2.93E-01	2.15E+08	9.95E+08	0.00E+00	1.22E+07	1.22E+09	7.14E+09	0.00E+00	7.03E+09
Tritium Release		6.14E+13 Becquerel per year									

Table 3.5-7— Annual Expected Liquid Waste Releases (SI Units)
(Page 3 of 3)

Nuclide	Half-Life (days)	Primary (Bq/ml)	Secondary (Bq/ml)	Boron Recovery System (Bq)	Misc Wastes (Bq)	Secondary (Bq)	Turbine Building (Bq)	Total Liquid Waste Sources (Bq)	Adjusted Total (Bq/yr)	Detergent Wastes (Bq/yr)	Total (Bq/yr)

Note:
0.00000 indicates that the value is less than 1.0E-05.

Table 3.5-8— Annual Gaseous Effluent Releases (English Units)
(Page 1 of 2)

Nuclide	Primary Coolant (mCi/gm)	Secondary Coolant (mCi/gm)	Building Ventilation				Blowdown Vent Offgas (Ci/yr)	Main Condenser Removal (Ci/yr)	Total (Ci/yr)
			Fuel Handling (Ci/yr)	Reactor (Ci/yr)	Auxiliary (Ci/yr)	Turbine (Ci/yr)			
I-131	2.070E-02	2.510E-07	2.7E-04	1.9E-03	6.6E-03	0.0E+00	0.0E+00	0.0E+00	8.8E-03
I-133	7.917E-02	8.930E-07	1.0E-03	5.8E-03	2.5E-02	0.0E+00	0.0E+00	0.0E+00	3.2E-02

Total H-3 Released via Gaseous Pathway = 180 Ci/yr

C-14 Released via Gaseous Pathway = 7.3 Ci/yr

Ar-41 Released via Gaseous Pathway = 34 Ci/yr

Nuclide	Primary Coolant (mCi/gm)	Secondary Coolant (mCi/gm)	Gas Stripping		Building Ventilation			Blowdown Vent Offgas (Ci/yr)	Main Condenser Removal (Ci/yr)	Total (Ci/yr)
			Shutdown (Ci/yr)	Continuous (Ci/yr)	Reactor (Ci/yr)	Auxiliary (Ci/yr)	Turbine (Ci/yr)			
Kr-85m	2.021E-01	2.968E-08	0.0E+00	0.0E+00	1.4E+02	4.0E+00	0.0E+00	0.0E+00	2.0E+00	1.5E+02
Kr-85	6.836E+00	9.777E-07	3.7E+03	1.4E+04	1.6E+04	1.4E+02	0.0E+00	0.0E+00	6.8E+01	3.4E+04
Kr-87	1.888E-01	2.609E-08	0.0E+00	0.0E+00	4.7E+01	4.0E+00	0.0E+00	0.0E+00	2.0E+00	5.3E+01
Kr-88	3.530E-01	5.140E-08	0.0E+00	0.0E+00	1.7E+02	7.0E+00	0.0E+00	0.0E+00	4.0E+00	1.8E+02
Xe-131m	1.222E+00	1.735E-07	1.3E+02	4.9E+02	2.8E+03	2.6E+01	0.0E+00	0.0E+00	1.2E+01	3.5E+03
Xe-133m	9.368E-02	1.387E-08	0.0E+00	0.0E+00	1.8E+02	2.0E+00	0.0E+00	0.0E+00	0.0E+00	1.8E+02
Xe-133	3.760E+00	5.396E-07	5.3E+01	2.0E+02	8.2E+03	8.0E+01	0.0E+00	0.0E+00	3.7E+01	8.6E+03
Xe-135m	1.634E-01	2.345E-08	0.0E+00	0.0E+00	9.0E+00	3.0E+00	0.0E+00	0.0E+00	2.0E+00	1.4E+01
Xe-135	1.080E+00	1.580E-07	0.0E+00	0.0E+00	1.2E+03	2.3E+01	0.0E+00	0.0E+00	1.1E+01	1.2E+03
Xe-137	4.273E-02	6.165E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xe-138	1.508E-01	2.171E-08	0.0E+00	0.0E+00	8.0E+00	3.0E+00	0.0E+00	0.0E+00	1.0E+00	1.2E+01
Total Noble Gases										4.8E+04

Note:
0.0E+00 appearing in the table indicates release is less than 1.0 Ci/yr for Noble Gases, 0.0001 Ci/yr for I.

Table 3.5-8— Annual Gaseous Effluent Releases (English Units)

(Page 2 of 2)

	Airborne Particulate Release Rate – Ci/yr				
		Building Ventilation			
Nuclide	**Waste Gas System (Ci/yr)**	**Reactor (Ci/yr)**	**Auxiliary (Ci/yr)**	**Fuel Handling (Ci/yr)**	**Total (Ci/yr)**
Cr-51	1.4E-07	9.2E-05	3.2E-06	1.8E-06	9.7E-05
Mn-54	2.1E-08	5.3E-05	7.8E-07	3.0E-06	5.7E-05
Co-57	0.0E+00	8.2E-06	0.0E+00	0.0E+00	8.2E-06
Co-58	8.7E-08	2.5E-04	1.9E-05	2.1E-04	4.8E-04
Co-60	1.4E-07	2.6E-05	5.1E-06	8.2E-05	1.1E-04
Fe-59	1.8E-08	2.7E-05	5.0E-07	0.0E+00	2.8E-05
Sr-89	4.4E-07	1.3E-04	7.5E-06	2.1E-05	1.6E-04
Sr-90	1.7E-07	5.2E-05	2.9E-06	8.0E-06	6.3E-05
Zr-95	4.8E-08	0.0E+00	1.0E-05	3.6E-08	1.0E-05
Nb-95	3.7E-08	1.8E-05	3.0E-07	2.4E-05	4.2E-05
Ru-103	3.2E-08	1.6E-05	2.3E-07	3.8E-07	1.7E-05
Ru-106	2.7E-08	0.0E+00	6.0E-08	6.9E-07	7.8E-07
Sb-125	0.0E+00	0.0E+00	3.9E-08	5.7E-07	6.1E-07
Cs-134	3.3E-07	2.5E-05	5.4E-06	1.7E-05	4.8E-05
Cs-136	5.3E-08	3.2E-05	4.8E-07	0.0E+00	3.3E-05
Cs-137	7.7E-07	5.5E-05	7.2E-06	2.7E-05	9.0E-05
Ba-140	2.3E-07	0.0E+00	4.0E-06	0.0E+00	4.2E-06
Ce-141	2.2E-08	1.3E-05	2.6E-07	4.4E-09	1.3E-05

Table 3.5-8— Annual Gaseous Effluent Releases (SI Units)

Nuclide	Primary Coolant (Bq/gm)	Secondary Coolant (Bq/gm)	Building Ventilation				Blowdown Vent Offgas (Bq/yr)	Main Condenser Removal (Ci/yr)	Total (Bq/yr)	
			Fuel Handling (Bq/yr)	Reactor (Bq/yr)	Auxiliary (Bq/yr)	Turbine (Bq/yr)				
I-131	7.659E+02	9.287E-03	1.0E+07	7.0E+07	2.4E+08	0.0E+00	0.0E+00	0.0E+00	3.3E+08	
I-133	2.929E+03	3.304E-02	3.7E+07	2.1E+08	9.3E+08	0.0E+00	0.0E+00	0.0E+00	1.2E+09	

Total H-3 Released via Gaseous Pathway = 6.7E+12 Bq/yr
C-14 Released via Gaseous Pathway = 2.7E+11 Bq/yr
Ar-41 Released via Gaseous Pathway = 1.3E+12 Bq /yr

Nuclide	Primary Coolant (Bq/gm)	Secondary Coolant (Bq/gm)	Gas Stripping		Building Ventilation			Blowdown Vent Offgas (Bq/yr)	Main Condenser Removal (Ci/yr)	Total (Bq/yr)
			Shutdown (Bq/yr)	Continuous (Bq/yr)	Reactor (Bq/yr)	Auxiliary (Bq/yr)	Turbine (Bq/yr)			
Kr-85m	7.478E+03	1.098E-03	0.0E+00	0.0E+00	5.2E+12	1.5E+11	0.0E+00	0.0E+00	7.4E+10	5.6E+12
Kr-85	2.529E+05	3.617E-02	1.4E+14	5.2E+14	5.9E+14	5.2E+12	0.0E+00	0.0E+00	2.5E+12	1.3E+15
Kr-87	6.986E+03	9.653E-04	0.0E+00	0.0E+00	1.7E+12	1.5E+11	0.0E+00	0.0E+00	7.4E+10	2.0E+12
Kr-88	1.306E+04	1.902E-03	0.0E+00	0.0E+00	6.3E+12	2.6E+11	0.0E+00	0.0E+00	1.5E+11	6.7E+12
Xe-131m	4.521E+04	6.420E-03	4.8E+12	1.8E+13	1.0E+14	9.6E+11	0.0E+00	0.0E+00	4.4E+11	1.3E+14
Xe-133m	3.466E+03	5.132E-04	0.0E+00	0.0E+00	6.7E+12	7.4E+10	0.0E+00	0.0E+00	0.0E+00	6.7E+12
Xe-133	1.391E+05	1.997E-02	2.0E+12	7.4E+12	3.0E+14	3.0E+12	0.0E+00	0.0E+00	1.4E+12	3.2E+14
Xe-135m	6.046E+03	8.677E-04	0.0E+00	0.0E+00	3.3E+11	1.1E+11	0.0E+00	0.0E+00	7.4E+10	5.2E+11
Xe-135	3.996E+04	5.846E-03	0.0E+00	0.0E+00	4.4E+13	8.5E+11	0.0E+00	0.0E+00	4.1E+11	4.4E+13
Xe-137	1.581E+03	2.281E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xe-138	5.580E+03	8.033E-04	0.0E+00	0.0E+00	3.0E+11	1.1E+11	0.0E+00	0.0E+00	3.7E+10	4.4E+11

Total Noble Gases
1.8E+15
Note:
0.0E+00 appearing in the table indicates release is less than 3.7E+10 Bq/yr for Noble Gases, 2.7E+06 Bq/yr for I.

Table 3.5-8— Annual Gaseous Effluent Releases (SI Units)

	Airborne Particulate Release Rate – Bq/yr				
Nuclide	Waste Gas System (Bq/yr)	Building Ventilation			Total (Bq/yr)
		Reactor (Bq/yr)	Auxiliary (Bq/yr)	Handling (Bq/yr)	
Cr-51	5.2E+03	3.4E+06	1.2E+05	6.7E+04	3.6E+06
Mn-54	7.8E+02	2.0E+06	2.9E+04	1.1E+05	2.1E+06
Co-57	0.0E+00	3.0E+05	0.0E+00	0.0E+00	3.0E+05
Co-58	3.2E+03	9.3E+06	7.0E+05	7.8E+06	1.8E+07
Co-60	5.2E+03	9.6E+05	1.9E+05	3.0E+06	4.1E+06
Fe-59	6.7E+02	1.0E+06	1.9E+04	0.0E+00	1.0E+06
Sr-89	1.6E+04	4.8E+06	2.8E+05	7.8E+05	5.9E+06
Sr-90	6.3E+03	1.9E+06	1.1E+05	3.0E+05	2.3E+06
Zr-95	1.8E+03	0.0E+00	3.7E+05	1.3E+03	3.7E+05
Nb-95	1.4E+03	6.7E+05	1.1E+04	8.9E+05	1.6E+06
Ru-103	1.2E+03	5.9E+05	8.5E+03	1.4E+04	6.3E+05
Ru-106	1.0E+03	0.0E+00	2.2E+03	2.6E+04	2.9E+04
Sb-125	0.0E+00	0.0E+00	1.4E+03	2.1E+04	2.3E+04
Cs-134	1.2E+04	9.3E+05	2.0E+05	6.3E+05	1.8E+06
Cs-136	2.0E+03	1.2E+06	1.8E+04	0.0E+00	1.2E+06
Cs-137	2.8E+04	2.0E+06	2.7E+05	1.0E+06	3.3E+06
Ba-140	8.5E+03	0.0E+00	1.5E+05	0.0E+00	1.6E+05
Ce-141	8.1E+02	4.8E+05	9.6E+03	1.6E+02	4.8E+05

Table 3.5-9— Annual Solid Waste Generation Volumes

Waste Type	Quantity (ft³)	Curie Content Expected	Curie Content Maximum	Shipping Volume (ft³) Expected	Shipping Volume (ft³) Maximum	Average Curies per Package Expected	Average Curies per Package Maximum	Maximum Number of Containers
Evaporator Concentrates	710	1.50E+02	9.12E+03	-	140	7.81E+00	4.75E+02	19.2 (a)
Spent Resins (other)	90	1.07E+03	5.23E+04	90	90	1.07E+03	5.23E+04	1.0 (b)
Spent Resins (Rad Waste Demineralizer System)	140	2.96E+01	1.80E+02	140	140	1.85E+01	1.13E+03	1.6 (b)
Wet Waste from Demineralizers	8	1.69E+00	1.03E+02	8	8	1.69E+01	1.03E+03	0.1 (b)
Waste Drum for Solids Collection from Centrifuge System of Liquid Waste Processing System	8	1.69E+00	1.03E+02	-	8	1.54E+00	9.36E+01	1.1 (a)
Filters	120	6.86E+02	6.86E+02	120	120	5.28E+02	5.28E+02	1.3 (b)
Sludge	70	1.48E+01	9.00E+02	-	35	3.70E+01	2.25E+03	0.4 (b)
Total Solid Waste Stored in Drums	1,146	1.95E+03	6.50E+04	358	541			
Mixed Waste	2	0.04	2.43	2	2	1.33E-01	8.10E+00	0.3 (a)
Non-Compressible Dry Active Waste (DAW)	70	2.97E-01	1.81E+01	70	70	2.97E+00	1.81E+02	0.1 (c)
Compressible DAW	1,415	6.01E+00	3.66E+02	707	707	4.29E+00	2.61E+02	1.4 (c)
Combustible DAW	5,300	3.19E+01	1.94E+03	5,300	5,300	6.02E+00	3.66E+02	5.3 (c)
Total DAW	6,785	3.82E+01	2.32E+03	varies	varies	varies	varies	varies
Overall Totals	7,933	1.99E+03	6.73E+04	Varies	varies	varies	varies	varies

Notes:
(a) 55 gal drum
(b) 8-120 HIC
(c) SEALAND

Table 3.5-10— Liquid Waste Management System Tank Capacity

Description	Number of Tanks	Capacity per Tank gallons (liters)	Total Capacity Gallons (liters)
Liquid Waste Storage	2 (Group I waste)	18,500 (70,028)	37,000 (140,056)
	2 (Group II waste)	18,500 (70,028)	37,000 (140,056)
	1 (Group III waste)	18,500 (70,028)	18,500 (70,028)
Concentrate Tanks	3	9,000 (34,068)	27,000 (102,203)
Monitor Tanks	2	18,500 (70,028)	37,000 (140,056)

Table 3.5-11— Liquid Waste Management System Process Parameters

Parameter	Process Value
Design Process Capacity (Nominal) - Evaporator Section	~1,050 gal/hr (3,975 liters/hr)
Design Process Capacity (Nominal) - Centrifuge Section	~ 1,300 gal/hr (4,920 liters/hr)
Design Process Capacity (Nominal) - Demineralizer & Filtration Section	~2,400 gal/hr (9,085 liters/hr)
Maximum Group I Waste Influent Waste Stream	~26,500 gal/wk (100,310 liters/wk)
Maximum Group II Waste Influent Waste Stream	~66,100 gal/wk (250,208 liters/wk)
Maximum Group III Waste Influent Waste Stream	~17,200 gal/wk (65,107 liters/wk)

Table 3.5-12— Radioactivity Input to the Liquid Waste System

Source	Flow Rate	Activity
Shim Bleed	110 gpd (416 liters/day)	Primary Coolant Activity (PCA)
Equipment Drains	1,728 gpd (6,541 liters/day)	PCA
Clean Wastes	9,428 gpd (35,690 liters/day)	0.001 PCA
Dirty Wastes	0.0*	Not Applicable*
Steam Generator Blowdown	218,400 lbm/hr 852,300 gpd (3,226,306 liters/day)	Steam Activity in the Secondary System (Table 3.5-3)
Primary to Secondary Leak Rate	75 lb_m/day (34 kg/day)	Activity in the Secondary System (Table 3.5-3)
Condensate Demineralizer Flow Fraction	0.33	Activity in the Secondary System (Table 3.5-3)

Note:
* Group III waste is not normally radioactive and is being neglected to maximize concentrations.

Table 3.5-13— Liquid Waste Processing Decontamination Factors (DF) For Cost-Benefit Analysis

Nuclide	Effective DF (No Demineralizer)	Effective DF (With Demineralizer)
Group I Waste		
Iodine[1]	2.0E+03	1.0E+04
Cs/Rb	1.0E+05	1.0E+07
Others[2]	1.0E+05	1.0E+07
Group II Waste[3]		
Iodine	2.0E+01	1.0E+02
Cs/Rb	2.0E+01	1.0E+02
Others[2]	2.0E+01	1.0E+02

1. Group I waste includes shim bleed and equipment drains in GALE, and are processed by the waste evaporator in the base case, with the evaporator distillate processed by the demineralizer in the alternate configuration.
2. The DF for Tritium is 1.0 for all cases (i.e., no effective removal by any waste processing configuration).
3. Group II waste includes all clean waste streams as applied by GALE, and are processed by the waste centrifuge in the base case, with the centrifuge clean stream processed by the demineralizer in the alternate configuration.

Table 3.5-14— Liquid Waste Effluent by Process Option[1] Cost-Benefit Analysis
(Page 1 of 2)

Nuclide	Release (Ci/yr) No Demineralizer	Release (GBq/yr) No Demineralizer	Release (Ci/yr) Plus Demineralizer	Release (GBq/yr) Plus Demineralizer
Na-24	0.00523	0.19351	0.00105	0.03885
Cr-51	0.00091	0.03367	0.00018	0.00666
Mn-54	0.00048	0.01776	0.00009	0.00333
Fe-55	0.00036	0.01332	0.00007	0.00259
Fe-59	0.00009	0.00333	0.00002	0.00074
Co-58	0.00136	0.05032	0.00027	0.00999
Co-60	0.00016	0.00592	0.00003	0.00111
Zn-65	0.00015	0.00555	0.00003	0.00111
W-187	0.00040	0.01480	0.00008	0.00296
Np-239	0.00050	0.01850	0.00010	0.00370
Sr-89	0.00004	0.00148	0.00001	0.00037
Sr-91	0.00006	0.00222	0.00001	0.00037
Y-91m	0.00004	0.00148	0.00001	0.00037
Y-93	0.00030	0.01110	0.00006	0.00222
Zr-95	0.00012	0.00444	0.00002	0.00074
Nb-95	0.00009	0.00333	0.00002	0.00074
Mo-99	0.00152	0.05624	0.00030	0.01110
Tc-99m	0.00147	0.05439	0.00029	0.01073
Ru-103	0.00221	0.08177	0.00043	0.01591
Rh-103m	0.00221	0.08177	0.00043	0.01591
Ru-106	0.02689	0.99493	0.00522	0.19314
Rh-106	0.02689	0.99493	0.00522	0.19314
Ag-110m	0.00039	0.01443	0.00008	0.00296
Ag-110	0.00005	0.00185	0.00001	0.00037
Te-129m	0.00006	0.00222	0.00001	0.00037
Te-129	0.00004	0.00148	0.00001	0.00037
Te-131m	0.00027	0.00999	0.00005	0.00185
Te-131	0.00005	0.00185	0.00001	0.00037
I-131	0.02921	1.08077	0.00586	0.21682
Te-132	0.00042	0.01554	0.00008	0.00296
I-132	0.00091	0.03367	0.00020	0.00740
I-133	0.02956	1.09372	0.00597	0.22089
Cs-134	0.00234	0.08658	0.00045	0.01665
I-135	0.01410	0.52170	0.00256	0.09472
Cs-136	0.00028	0.01036	0.00005	0.00185
Cs-137	0.00309	0.11433	0.00060	0.02220
Ba-137m	0.00289	0.10693	0.00056	0.02072
Ba-140	0.00369	0.13653	0.00072	0.02664
La-140	0.00665	0.24605	0.00131	0.04847

Table 3.5-14— Liquid Waste Effluent by Process Option[1] Cost-Benefit Analysis
(Page 2 of 2)

Nuclide	Release (Ci/yr) No Demineralizer	Release (GBq/yr) No Demineralizer	Release (Ci/yr) Plus Demineralizer	Release (GBq/yr) Plus Demineralizer
Ce-141	0.00004	0.00148	0.00001	0.00037
Ce-143	0.00053	0.01961	0.00010	0.00370
Pr-143	0.00004	0.00148	0.00001	0.00037
Ce-144	0.00116	0.04292	0.00023	0.00851
Pr-144	0.00116	0.04292	0.00023	0.00851
H-3	1,660	61,420	1,660	61,420

[1] Does not include contribution from anticipated operation occurrences (0.16 Ci/yr).

Table 3.5-15— Radioactive Liquid Releases Due to Anticipated Operational Occurrences

(Page 1 of 2)

	Adjusted Total	
Nuclide	**(Ci/yr)**	**(Bq/yr)**
Corrosion and Activation Products		
Na-24	0.00610	2.27E+08
Cr-51	0.00100	3.81E+07
Mn-54	0.00054	2.00E+07
Fe-55	0.00041	1.52E+07
Fe-59	0.00010	3.70E+06
Co-58	0.00150	5.74E+07
Co-60	0.00018	6.66E+06
Zn-65	0.00017	6.29E+06
W-187	0.00046	1.70E+07
Np-239	0.00058	2.15E+07
Fission Products		
Sr-89	0.00005	1.85E+06
Sr-91	0.00008	2.96E+06
Y-91m	0.00005	1.85E+06
Y-93	0.00036	1.33E+07
Zr-95	0.00013	4.81E+06
Nb-95	0.00010	3.70E+06
Mo-99	0.00180	6.48E+07
Tc-99m	0.00170	6.29E+07
Ru-103	0.00250	9.29E+07
Rh-103m	0.00250	9.29E+07
Ru-106	0.03100	1.13E+09
Rh-106	0.03100	1.13E+09
Ag-110m	0.00044	1.63E+07
Ag-110	0.00006	2.22E+06
Te-129m	0.00006	2.22E+06
Te-129	0.00004	1.48E+06
Te-131m	0.00031	1.15E+07
Te-131	0.00006	2.22E+06
I-131	0.03400	1.27E+09
TE-132	0.00048	1.78E+07
I-132	0.00120	4.26E+07
I-133	0.03500	1.29E+09
CS-134	0.00260	9.81E+07
I-135	0.01500	5.54E+08
CS-136	0.00031	1.15E+07
CS-137	0.00351	1.30E+08

Table 3.5-15— Radioactive Liquid Releases Due to Anticipated Operational Occurrences
(Page 2 of 2)

	Adjusted Total	
Nuclide	**(Ci/yr)**	**(Bq/yr)**
BA-137m	0.00330	1.21E+08
BA-140	0.00420	1.56E+08
LA-140	0.00760	2.82E+08
CE-141	0.00005	1.85E+06
CE-143	0.00061	2.26E+07
PR-143	0.00005	1.85E+06
CE-144	0.00130	4.88E+07
PR-144	0.00130	4.88E+07
All Others	0.00002	7.40E+05
Total	0.19000	7.14E+09
H-3	1.66E+03	6.1E+13

Table 3.5-16— Summary of Radioactive Liquid Releases Including Anticipated Operational Occurrences
(Page 1 of 2)

Nuclide	Total (Ci/yr)	Total (Bq/yr)	Discharge Concentration (µCi/ml)	Discharge Concentration (Bq/ml)	10CFR20 Appendix B Limits (µCi/ml)	10CFR20 Appendix B Limits (Bq/ml)	Discharge Fraction of Limit
Corrosion and Activation Products							
Na-24	6.1E-03	2.3E+08	1.5E-10	5.4E-06	5.0E-05	1.9E+00	2.9E-06
Cr-51	1.0E-03	3.7E+07	2.4E-11	8.8E-07	5.0E-04	1.9E+01	4.8E-08
Mn-54	5.4E-04	2.0E+07	1.3E-11	4.8E-07	3.0E-05	1.1E+00	4.3E-07
Fe-55	4.1E-04	1.5E+07	9.8E-12	3.6E-07	1.0E-04	3.7E+00	9.8E-08
Fe-59	1.0E-04	3.7E+06	2.4E-12	8.8E-08	1.0E-05	3.7E-01	2.4E-07
Co-58	1.5E-03	5.6E+07	3.6E-11	1.3E-06	2.0E-05	7.4E-01	1.8E-06
Co-60	1.8E-04	6.7E+06	4.3E-12	1.6E-07	3.0E-06	1.1E-01	1.4E-06
Zn-65	1.7E-04	6.3E+06	4.1E-12	1.5E-07	5.0E-06	1.9E-01	8.1E-07
W-187	4.6E-04	1.7E+07	1.1E-11	4.1E-07	3.0E-05	1.1E+00	3.7E-07
Np-239	5.8E-04	2.1E+07	1.4E-11	5.1E-07	2.0E-05	7.4E-01	6.9E-07
Fission Products							
Sr-89	5.0E-05	1.9E+06	1.2E-12	4.4E-08	8.0E-06	3.0E-01	1.5E-07
Sr-91	8.0E-05	3.0E+06	1.9E-12	7.1E-08	2.0E-05	7.4E-01	9.6E-08
Y-91m	5.0E-05	1.9E+06	1.2E-12	4.4E-08	2.0E-03	7.4E+01	6.0E-10
Y-93	3.6E-04	1.3E+07	8.6E-12	3.2E-07	2.0E-05	7.4E-01	4.3E-07
Zr-95	1.3E-04	4.8E+06	3.1E-12	1.2E-07	2.0E-05	7.4E-01	1.6E-07
Nb-95	1.0E-04	3.7E+06	2.4E-12	8.8E-08	3.0E-05	1.1E+00	8.0E-08
Mo-99	1.8E-03	6.7E+07	4.3E-11	1.6E-06	2.0E-05	7.4E-01	2.2E-06
Tc-99m	1.7E-03	6.3E+07	4.1E-11	1.5E-06	1.0E-03	3.7E+01	4.1E-08
Ru-103	2.5E-03	9.3E+07	6.0E-11	2.2E-06	3.0E-05	1.1E+00	2.0E-06
Rh-103m	2.5E-03	9.3E+07	6.0E-11	2.2E-06	6.0E-03	2.2E+02	1.0E-08
Ru-106	3.1E-02	1.1E+09	7.4E-10	2.7E-05	3.0E-06	1.1E-01	2.5E-04
Ag-110m	4.4E-04	1.6E+07	1.1E-11	3.9E-07	6.0E-06	2.2E-01	1.8E-06
Te-129m	6.0E-05	2.2E+06	1.4E-12	5.3E-08	7.0E-06	2.6E-01	2.0E-07
Te-129	4.0E-05	1.5E+06	9.6E-13	3.5E-08	4.0E-04	1.5E+01	2.4E-09
Te-131m	3.1E-04	1.1E+07	7.4E-12	2.7E-07	8.0E-06	3.0E-01	9.3E-07
Te-131	6.0E-05	2.2E+06	1.4E-12	5.3E-08	8.0E-05	3.0E+00	1.8E-08
I-131	3.4E-02	1.3E+09	8.1E-10	3.0E-05	1.0E-06	3.7E-02	8.1E-04
Te-132	4.8E-04	1.8E+07	1.1E-11	4.2E-07	9.0E-06	3.3E-01	1.3E-06
I-132	1.2E-03	4.4E+07	2.9E-11	1.1E-06	1.0E-04	3.7E+00	2.9E-07
I-133	3.5E-02	1.3E+09	8.4E-10	3.1E-05	7.0E-06	2.6E-01	1.2E-04
Cs-134	2.6E-03	9.6E+07	6.2E-11	2.3E-06	9.0E-07	3.3E-02	6.9E-05
I-135	1.5E-02	5.6E+08	3.6E-10	1.3E-05	3.0E-05	1.1E+00	1.2E-05
Cs-136	3.1E-04	1.1E+07	7.4E-12	2.7E-07	6.0E-06	2.2E-01	1.2E-06
Cs-137	3.5E-03	1.3E+08	8.4E-11	3.1E-06	1.0E-06	3.7E-02	8.4E-05
Ba-140	4.2E-03	1.6E+08	1.0E-10	3.7E-06	8.0E-06	3.0E-01	1.3E-05

Table 3.5-16— Summary of Radioactive Liquid Releases Including Anticipated Operational Occurrences

(Page 2 of 2)

	Total		Discharge Concentration		10CFR20 Appendix B Limits		Discharge Fraction of Limit
Nuclide	(Ci/yr)	(Bq/yr)	(μCi/ml)	(Bq/ml)	(μCi/ml)	(Bq/ml)	
La-140	7.6E-03	2.8E+08	1.8E-10	6.7E-06	9.0E-06	3.3E-01	2.0E-05
Ce-141	5.0E-05	1.9E+06	1.2E-12	4.4E-08	3.0E-05	1.1E+00	4.0E-08
Ce-143	6.1E-04	2.3E+07	1.5E-11	5.4E-07	2.0E-05	7.4E-01	7.3E-07
Pr-143	5.0E-05	1.9E+06	1.2E-12	4.4E-08	2.0E-05	7.4E-01	6.0E-08
Ce-144	1.3E-03	4.8E+07	3.1E-11	1.2E-06	3.0E-06	1.1E-01	1.0E-05
Pr-144	1.3E-03	4.8E+07	3.1E-11	1.2E-06	6.0E-04	2.2E+01	5.2E-08
H-3	1.7E+03	6.1E+13	4.0E-05	1.5E+00	1.0E-03	3.7E+01	4.0E-02

Table 3.5-17— Obtainable Dose Benefits for Liquid Waste System Augment

Cases	Population Total Body Dose – Person-Rem (Person-Sievert)[1]	Population Thyroid Dose Person-Rem (Person-Sievert)[1]
Base Case Evaporator/Centrifuge only, no Waste Demineralizer	0.177 (0.00177)	0.682 (0.00682)
Additional Waste Demineralizer	0.121 (0.00121)	0.222 (0.00222)
Obtainable dose benefit	0.06 (0.0006)	0.46 (0.0046)

Note:
[1]Population dose estimates described in Section 5.4.

Table 3.5-18— Liquid Waste System Augment Total-Body Dose Cost-Benefit Analysis

Parameter	Value
Annual Total-body collective dose benefit to the population within 50 miles of the CCNPP site.	0.06 person-rem (0.0006 person-sievert)
Nominal total collective dose over 60 years of operation (0.06 person-rem x 60 yr = 3.6 person-rem)	3.6 person-rem (0.036 person-sievert)
Value for estimating impact based on NUREG-1530	\$2,000 per person-rem (\$20 per person-sievert)
Obtainable benefit from addition of radwaste processing and control option (3.6 person-rem x \$2,000/person-rem = \$7,200)	\$7,200
Cost Options for radwaste processing and control technology upgrade from Regulatory Guide 1.110	400 gpm demineralizer for clean waste processing (1)
Direct cost for option using methodology in Regulatory Guide 1.110, Table A-1 based on 1975 Dollars	\$146,000
Total O&M Annual Cost (From Regulatory Guide 1.110, Table A-2 based on 1975 Dollars)	\$5,000
Total cost over 60 years of operation (direct cost + O&M×60 years)	\$446,000
Benefit/Cost Ratio (Values greater than 1 should be included in plant system design) \$7,200 / \$446,000 = 0.016)	0.016

Note:
(1)The clean waste reflects the nomenclature in GALE and the sizing is based on the EPR GALE input Table 3.5-4.

Table 3.5-19— Liquid Waste System Augment Thyroid Dose Cost-Benefit Analysis

Parameter	Value
Annual thyroid collective dose benefit to the population within 50 miles of the CCNPP site.	0.46 person-rem (0.0046 person-sievert)
Nominal total collective dose over 60 years of operation (0.46 person-rem x 60 yr = 27.6 person-rem)	27.6 person-rem (0.276 person-sievert)
Value for estimating impact based on NUREG-1530 (Note: 10 CFR Part 50, Appendix I has $1,000 per person-rem)	$2,000 per person-rem ($20 per person-sievert)
Obtainable benefit from addition of radwaste processing and control options	$55,200
Cost Options for radwaste processing and control technology upgrade from Regulatory Guide 1.110	400 gpm demineralizer for clean waste processing (1)
Direct cost for option using methodology in Regulatory Guide 1.110 based on 1975 Dollars	$146,000
Total O&M Annual Cost (From Regulatory Guide 1.110, Table A-2 based on 1975 Dollars)	$5,000
Total cost over 60 years of operation (Direct cost + O&M×60 years)	$446,000
Benefit/Cost Ratio (Values greater than 1 should be included in plant system design) $55,200 / $446,000 = 0.12)	0.12

Note:
(1) The clean waste reflects the nomenclature in GALE and the sizing is based on the EPR GALE input Table 3.5-4.

Table 3.5-20— Annual Radioactive Gaseous Releases Due to Anticipated Operational Occurrences

(Page 1 of 2)

Radionuclide	Condition 1: Total Off Normal for 0.5% Failed Fuel (Ci/yr)	Condition 1 (Bq/yr)	Condition 2: Total Off Normal 500 gpd Primary-Secondary Tube Leak for 90 Days (Ci/yr)	Condition 2 (Bq/yr)	Condition 3: Total Off Normal 1 gpm Reactor Coolant Leakage for 10 Days (Ci/yr)	Condition 3 (Bq/yr)	Condition 4: Total Off Normal 200 gpd Reactor Coolant leakage to Aux. Building for 90 days (Ci/yr)	Condition 4 (Bq/yr)
I-131	3.7E-02	1.4E+09	8.8E-03	3.2E+08	1.8E-02	6.5E+08	1.9E-02	7.0E+08
I-133	1.3E-01	4.9E+09	3.2E-02	1.2E+09	5.9E-02	2.2E+09	7.1E-02	2.6E+09
Kr-85m	6.1E+02	2.3E+13	1.6E+02	5.9E+12	8.0E+02	3.0E+13	1.5E+02	5.6E+12
Kr-85	1.4E+05	5.2E+15	3.4E+04	1.3E+15	1.1E+05	4.0E+15	3.4E+04	1.3E+15
Kr-87	2.2E+02	8.2E+12	6.7E+01	2.5E+12	2.7E+02	1.0E+13	5.9E+01	2.2E+12
Kr-88	7.5E+02	2.8E+13	2.1E+02	7.8E+12	9.8E+02	3.6E+13	1.9E+02	7.1E+12
Xe-131m	1.4E+04	5.3E+14	3.5E+03	1.3E+14	1.7E+04	6.2E+14	3.5E+03	1.3E+14
Xe-133m	7.6E+02	2.8E+13	1.8E+02	6.7E+12	1.0E+03	3.8E+13	1.9E+02	6.8E+12
Xe-133	3.6E+04	1.3E+15	8.8E+03	3.3E+14	4.7E+04	1.7E+15	8.7E+03	3.2E+14
Xe-135m	5.8E+01	2.2E+12	2.8E+01	1.0E+12	5.6E+01	2.1E+12	1.9E+01	6.9E+11
Xe-135	5.1E+03	1.9E+14	1.3E+03	4.9E+13	6.9E+03	2.5E+14	1.3E+03	4.7E+13
Xe-137	a	a	a	a	a	a	a	a
Xe-138	5.0E+01	1.9E+12	1.9E+01	7.1E+11	5.0E+01	1.8E+12	1.7E+01	6.2E+11
Cr-51	4.0E-04	1.5E+07	9.7E-05	3.6E+06	5.3E-04	2.0E+07	1.0E-04	3.8E+06
Mn-54	2.4E-04	8.8E+06	5.7E-05	2.1E+06	3.1E-04	1.1E+07	5.8E-05	2.1E+06
Co-57	3.4E-05	1.3E+06	8.2E-06	3.0E+05	4.7E-05	1.7E+06	8.2E-06	3.0E+05
Co-58	2.0E-03	7.4E+07	4.8E-04	1.8E+07	1.7E-03	6.1E+07	5.1E-04	1.9E+07
Co-60	4.7E-04	1.7E+07	1.1E-04	4.2E+06	2.4E-04	8.7E+06	1.2E-04	4.5E+06
Fe-59	1.1E-04	4.2E+06	2.8E-05	1.0E+06	1.5E-04	5.7E+06	2.8E-05	1.0E+06
Sr-89	6.6E-04	2.5E+07	1.6E-04	5.9E+06	7.7E-04	2.8E+07	1.7E-04	6.3E+06
Sr-90	2.6E-04	9.7E+06	6.3E-05	2.3E+06	3.1E-04	1.1E+07	6.8E-05	2.5E+06
Zr-95	4.2E-05	1.6E+06	1.0E-05	3.7E+05	1.0E-05	3.7E+05	2.6E-05	9.5E+05
Nb-95	1.8E-04	6.5E+06	4.2E-05	1.6E+06	1.3E-04	4.7E+06	4.3E-05	1.6E+06
Ru-103	6.9E-05	2.6E+06	1.7E-05	6.2E+05	9.2E-05	3.4E+06	1.7E-05	6.3E+05

Table 3.5-20— Annual Radioactive Gaseous Releases Due to Anticipated Operational Occurrences

(Page 2 of 2)

	Condition 1		Condition 2		Condition 3		Condition 4	
	Total Off Normal for 0.5% Failed Fuel		Total Off Normal 500 gpd Primary-Secondary Tube Leak for 90 Days		Total Off Normal 1 gpm Reactor Coolant Leakage for 10 Days		Total Off Normal 200 gpd Reactor Coolant leakage to Aux. Building for 90 days	
Radionuclide	**(Ci/yr)**	**(Bq/yr)**	**(Ci/yr)**	**(Bq/yr)**	**(Ci/yr)**	**(Bq/yr)**	**(Ci/yr)**	**(Bq/yr)**
Ru-106	3.2E-06	1.2E+05	7.8E-07	2.9E+04	7.8E-07	2.9E+04	8.7E-07	3.2E+04
Sb-125	2.5E-06	9.4E+04	6.1E-07	2.3E+04	6.1E-07	2.3E+04	6.7E-07	2.5E+04
Cs-134	2.0E-04	7.4E+06	4.8E-05	1.8E+06	1.7E-04	6.1E+06	5.6E-05	2.1E+06
Cs-136	1.4E-04	5.0E+06	3.3E-05	1.2E+06	1.8E-04	6.8E+06	3.3E-05	1.2E+06
Cs-137	3.7E-04	1.4E+07	9.0E-05	3.3E+06	3.5E-04	1.3E+07	1.0E-04	3.7E+06
Ba-140	1.8E-05	6.5E+05	4.2E-06	1.6E+05	4.2E-06	1.6E+05	1.0E-05	3.9E+05
Ce-141	5.5E-05	2.0E+06	1.3E-05	4.9E+05	7.4E-05	2.8E+06	1.4E-05	5.1E+05

Note: (a) Less than 1.0 Ci/yr for noble gases

Table 3.5-21— Waste Gas Holdup Times for Xenon and Krypton Cost-Benefit Analysis

Number of Delay Beds	Holdup Time (days)	
	Krypton	Xenon
3 (Base Case)	1.67	27.7
4 (Additional Delay bed)	2.23	36.9

Table 3.5-22— Gaseous Waste Effluent by Process Option[1] Cost-Benefit Analysis

Nuclide	Release (Ci/yr) Base Case	Release (GBq/yr) Base Case	Release (Ci/yr) Additional Delay Bed	Release (GBq/yr) Additional Delay Bed
H-3	1.8E+02	6.7E+03	1.8E+02	6.7E+03
C-14	7.3E+00	2.7E+02	7.3E+00	2.7E+02
Ar-41	3.4E+01	1.3E+03	3.4E+01	1.3E+03
I-131	8.8E-03	3.3E-01	8.8E-03	3.3E-01
I-133	3.2E-02	1.2E+00	3.2E-02	1.2E+00
Kr-85m	1.5E+02	5.6E+03	1.5E+02	5.6E+03
Kr-85	3.4E+04	1.3E+06	3.4E+04	1.3E+06
Kr-87	5.3E+01	2.0E+03	5.3E+01	2.0E+03
Kr-88	1.8E+02	6.7E+03	1.8E+02	6.7E+03
Xe-131m	3.5E+03	1.3E+05	3.2E+03	1.2E+05
Xe-133m	1.8E+02	6.7E+03	1.8E+02	6.7E+03
Xe-133	8.6E+03	3.2E+05	8.4E+03	3.1E+05
Xe-135m	1.4E+01	5.2E+02	1.4E+01	5.2E+02
Xe-135	1.2E+03	4.4E+04	1.2E+03	4.4E+04
Xe-137	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xe-138	1.2E+01	4.4E+02	1.2E+01	4.4E+02
Cr-51	9.7E-05	3.6E-03	9.7E-05	3.6E-03
Mn-54	5.7E-05	2.1E-03	5.7E-05	2.1E-03
Co-57	8.2E-06	3.0E-04	8.2E-06	3.0E-04
Co-58	4.8E-04	1.8E-02	4.8E-04	1.8E-02
Co-60	1.1E-04	4.1E-03	1.1E-04	4.1E-03
Fe-59	2.8E-05	1.0E-03	2.0E-05	1.0E-03
Sr-89	1.6E-04	5.9E-03	1.6E-04	5.9E-03
Sr-90	6.3E-05	2.3E-03	6.3E-05	2.3E-03
Zr-95	1.0E-05	3.7E-04	1.0E-05	3.7E-04
Nb-95	4.2E-05	1.6E-03	4.2E-05	1.6E-03
Ru-103	1.7E-05	6.3E-04	1.7E-05	6.3E-04
Ru-106	7.8E-07	2.9E-05	7.8E-07	2.9E-05
Sb-125	6.1E-07	2.3E-05	6.1E-07	2.3E-05
Cs-134	4.8E-05	1.8E-03	4.8E-05	1.8E-03
Cs-136	3.3E-05	1.2E-03	3.3E-05	1.2E-03
Cs-137	9.0E-05	3.3E-03	9.0E-05	3.3E-03
Ba-140	4.2E-06	1.6E-04	4.2E-06	1.6E-04
Ce-141	1.3E-05	4.8E-04	1.3E-05	4.8E-04

Note 1: Base case design includes 3 charcoal delay beds in the waste gas purge system.

Table 3.5-23— Obtainable Dose Benefits for Gaseous Waste System Augment

Cases	Population Total Body Dose[1]- Person-Rem (Person-Sievert)	Population Thyroid Dose[(1)] Person-Rem (Person-Sievert)
Baseline Configuration	5.52 (0.0552)	5.80 (0.058)
Extra Carbon Delay Bed	5.49 (0.0549)	5.77 (0.0577)
Obtainable dose benefit by augment	0.03 (0.0003)	0.03 (0.0003)

Note:
(1) Population dose estimates described in Section 5.4.

Table 3.5-24— Gaseous Waste System Augment Total-Body / Thyroid Dose Cost Benefit Analysis(1)

Parameter	Value
Annual whole-body / Thyroid collective dose benefit to the population within 50 miles of the CCNPP site.	0.03 person-rem (0.0003 person-sievert)
Nominal total collective dose over 60 years of operation (0.03 person-rem x 60 yr = 1.8 person-rem)	1.8 person-rem (0.018 person-sievert)
Value for estimating impact based on NUREG-1530	$2,000 per person-rem ($20 per person-sievert)
Obtainable benefit from addition of radwaste processing and control option (1.8 person-rem x $2000/person-rem =$3,600)	$3,600
Cost Options for radwaste processing and control technology upgrade from Regulatory Guide 1.110	3-ton charcoal absorber
Direct cost for option (using methodology in Regulatory Guide 1.110, Table A-1 based on 1975 Dollars)	$67,000
Total O&M Annual Cost (From Regulatory Guide 1.110, Table A-2 based on 1975 Dollars)	Negligible
Total cost over 60 years of operation (direct cost + O&M×60 years)	$67,000
Benefit/Cost Ratio (Values greater than 1 should be included in plant system design) $3,600 / $67,000 = 0.053)	0.053

Note:
(1) Since the dose reduction benefit for both the total body and the thyroid give the same collective dose savings, the cost benefit results are directly applicable to both the total body and thyroid evaluations.

Table 3.5-25— Radiation Monitors
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Method	Monitoring Task	Radioisotopes	Range
Noble Gas Effluent Monitors			
Beta-sensitive detector (β)	Primary coolant noble gas activity concentration downstream of the nuclear sampling system degasifier in the Nuclear Auxiliary Building.	Kr-85, Xe-133	3E-4 – 3E+2 µCi/cc 1E+1 – 1E+7 Bq/cc
Gamma-sensitive detector (γ)	Noble gas radioactivity in the exhaust air of cell 1 ventilation systems of the Nuclear Auxiliary Building	Kr-85, Xe-133	3E-7 – 1E-2 µCi/cc 1E-2 – 4E+2 Bq/cc
Gamma-sensitive detector (γ)	Noble gas radioactivity in the exhaust air of cell 2 ventilation systems of the Nuclear Auxiliary Building.	Kr-85, Xe-133	3E-7 – 1E-2 µCi/cc 1E-2 – 4E+2 Bq/cc
Gamma-sensitive detector (γ)	Noble gas radioactivity in the exhaust air of cell 3 ventilation systems of the Nuclear Auxiliary Building.	Kr-85, Xe-133	3E-7 – 1E-2 µCi/cc 1E-2 – 4E+2 Bq/cc
Gamma-sensitive detector (γ)	Noble gas radioactivity in the exhaust air of cell 4 ventilation systems of the Fuel Building.	Kr-85, Xe-133	3E-7 – 1E-2 µCi/cc 1E-2 – 4E+2 Bq/cc
Gamma-sensitive detector (γ)	Noble gas radioactivity in the exhaust air of cell 5 ventilation systems of the Fuel Building.	Kr-85, Xe-133	3E-7 – 1E-2 µCi/cc 1E-2 – 4E+2 Bq/cc
Gamma-sensitive detector (γ)	Noble gas radioactivity in the exhaust air of cell 6 ventilation systems of the Safeguard Building.	Kr-85, Xe-133	3E-7 – 1E-2 µCi/cc 1E-2 – 4E+2 Bq/cc
Beta-sensitive detector (β)	Noble gas radioactivity in the exhaust air of the containment ventilation system that exhausts to the stack.	Kr-85, Xe-133	3E-7 – 1E-2 µCi/cc 1E-2 – 4E+2 Bq/cc
Beta-sensitive detector (β)	Noble gas activity in the region of the refueling machine within the containment while moving fuel assemblies.	Kr-85, Xe-133	1E-6 – 1E-2 µCi/cc 1E-2 – 4E+2 Bq/cc
Beta-sensitive detector (β)	Noble gas activity in the region of the spent fuel mast bridge within the fuel building while moving fuel assemblies.	Kr-85, Xe-133	1E-6 – 1E-2 µCi/cc 1E-2 – 4E+2 Bq/cc
Beta-sensitive detector (β)	Two (2) noble gas activity monitors (redundant) in the vent stack associated with air flow monitors.	Kr-85, Xe-133	1E-6 – 1E+2 µCi/cc 3E+4 – 1E+9 µCi /hr
Calculated	Two (2) noble gas activity release rate calculation modules (redundant) using the measured values from a noble gas monitor and the air flow through the vent stack.	Kr-85, Xe-133	3E-6 – 1E-2 µCi/cc 3E+4 – 1E+9 µCi /hr
Gamma-sensitive multi-channel analyzer (γ)	Noble gas activity in the vent stack.	Xe-133	1 – 50000 cps
Calculated	Noble gas activity release rate is calculated using the measured values from noble gas activity rad. monitor and the air flow through the vent stack.	Kr-85, Xe-133	3E-6 – 1E-2 µCi/cc 1E-1 – 4E+2 Bq/cc, 3E+4 – 1E+9 µCi /hr 1E+9 – 4E+13 Bq/hr
Laboratory evaluation of samples.	Vent stack exhaust air sampler drawn on demand using a mobile high pressure compressor unit. The filtered air sample is filled into a gas bottle. The samples are analyzed in the radiochemical laboratory by gamma spectroscopic evaluation of the nuclide specific composition of the noble gases.	Kr-85, Xe-133	–

Table 3.5-25— Radiation Monitors
(Page 2 of 9)

Method	Monitoring Task	Radioisotopes	Range
Laboratory evaluation of samples.	Two (2) vent stack exhaust air samplers (redundant) for use during and after accidents using a small sample cylinder drawn on demand. The samples are analyzed in the radiochemical laboratory by gamma spectroscopic evaluation of the nuclide specific composition of the noble gases.	Kr-85, Xe-133	–
Gamma-sensitive detectors adjacent to the monitored air duct (γ)	Two (2) air duct monitors (redundant) of the annulus air extraction system downstream of the filters. The instrument is to function also during a sever accident.	Kr-85, Xe-133	3E-7— 1E-2μCi/cc 1E-2 – 4E+2 Bq/cc
Gamma-sensitive detectors adjacent to the monitored air duct (γ)	Two (2) air duct monitors (redundant) of the Safeguard Building controlled-area ventilation system downstream of the filters. The instrument is intended to function also during a severe accident.	Kr-85, Xe-133	3E-7 — 1E-2μCi/cc 1E-2 – 4E+2 Bq/cc
Gamma-sensitive detectors inside the stack (γ)	Two (2) gas activity monitors in the stack (redundant) that detect discharges during accidents. The instrument is intended to finction also during a severe accident.	Kr-85, Xe-133	3E-7 – 1E-2 μCi/cc 1E-2 – 4E+2 Bq/cc
Beta-sensitive detector (β)	Noble gas radioactivity in the exhaust air of the containment recirculation ventilation system.	Kr-85, Xe-133	3E-7 – 1E-2μCi/cc 1E-2 – 4E+2 Bq/cc
Iodine and Aerosol (Halogen and Particulate) Monitoring			
Laboratory evaluation of samples.	Filter cartiridge sampler for aerosol radioactivity in the air of the annulus air extraction system downstream of the filters. The filter cartridge is evaluated in the laboratory.	-	–
Laboratory evaluation of samples.	Filter cartridge sampler for gaseous iodine radioactivity in the air of the annulus air extraction system downstream of the filters. The filter cartridge is evaluated in the laboratory.	-	–
Laboratory evaluation of samples.	Filter cartridge sampler for aerosol radioactivity in the air of the Safeguard Building controlled-area ventilation system down-stream of filters. The filter cartridge is evaluated in the laboratory	–	–
Laboratory evaluation of samples.	Filter cartridge sampler for gaseous iodine radioactivity in the air of the Safeguard Building controlled-area ventilation system down-stream of filters. The filter cartridge is evaluated in the laboratory	-	–
Laboratory evaluation of samples.	Filter cartridge sampler for aerosol radioactivity in the exhaust air of the Access Building. The filter cartridge is evaluated in the laboratory.	I-131	–
Laboratory evaluation of samples.	Filter cartridge sampler for gaseous iodine radioactivity in the exhaust air of the Access Building. The filter cartridge is evaluated in the laboratory.	I-131	–
Laboratory evaluation of samples.	Filter cartridge sampler for aerosol radioactivity down-stream of filters of the laboratory exhaust air in the Nuclear Auxiliary Building. The filter cartridge is evaluated in the laboratory.	I-131	–

Table 3.5-25— Radiation Monitors
(Page 3 of 9)

Method	Monitoring Task	Radioisotopes	Range
Laboratory evaluation of samples.	Filter cartridge sampler for gaseous iodine radioactivity down-stream of filters of the laboratory exhaust air in the Nuclear Auxiliary Building. The filter cartridge is evaluated in the laboratory.	I-131	–
Laboratory evaluation of samples.	Filter cartridge sampler for aerosol radioactivity in the filtered system exhaust air of the Radioactive Waste Processing Building. The filter cartridge is evaluated in the laboratory.	–	–
Laboratory evaluation of samples.	Filter cartridge sampler for gaseous iodine radioactivity in the filtered system exhaust air of the Radioactive Waste Processing Building. The filter cartridge is evaluated in the laboratory.	-	–
Gamma-sensitive detector (γ)	Filter cartridge sampler for aerosol radioisotopes by continuous collection from a sample of the exhaust air on a particulate air filter and on a filter for gaseous iodine during and after accidents. Monitor the entire activity accumulated on the filters, the change of the entire activity accumulated on the filters with time and the change of the entire iodine 131 activity accumulated on the filters with time.	I-131	5E-10 – 3E-2 µCi 2E-5 – 1E+3 Bq (entire activity) 5E-10 – 5E-4 µCi /cc 2E-5 – 2E+1 Bq/cc (I-131) 3E-9 – 5E-3 µCi /cc 1E-4 – 2E+1 Bq/cc (Iodine, less I-131)
Gamma-sensitive detector (γ)	Filter cartridge sampler for radioactive gaseous iodine by continuous collection from a sample of the exhaust air on a particulate air filter and on a filter for gaseous iodine during and after accidents. Monitor the entire activity accumulated on the filters, the change of the entire activity accumulated on the filters with time and the change of the entire iodine 131 activity accumulated on the filters with time.	I-131	5E-10 – 3E-2 µCi 2E-5 – 1E+3 Bq, (entire activity) 5E-10 – 5E-4 µCi/cc 2E-5 – 2E-+1 Bq/cc (I-131) 3E-9 - 5E-3 µCi/cc 1E-4 - 2E+1 Bq/cc (Iodine less I-131)
Laboratory evaluation of samples	Two (2) filter cartridge samplers (redundant) for aerosol radioactivity in the vent stack exhaust air. Each cartridge is to contain a particle filter and a dual element for organic and elemental iodine	I-131	–
Laboratory evaluation of samples	Two (2) filter cartridge samplers (redundant) for gaseous iodine radioactivity in the vent stack exhaust air. Each cartridge is to contain a particle filter and a dual element for organic and elemental iodine.	I-131	–
Laboratory evaluation of samples	Two (2) filter cartridge samplers (redundant) for the vent stack exhaust air including vapor, carbon dioxide and the other carbon compounds continuously. Redundant samples are evaluated in the laboratory for H^3 and C^{14}	I-131	–
Laboratory evaluation of samples	Filter cartridge sampler for aerosol radioactivity in the exhaust air of the containment recirculation ventilation system. The filter cartridge is evaluated in the laboratory.	I-131	–

Table 3.5-25— Radiation Monitors
(Page 4 of 9)

Method	Monitoring Task	Radioisotopes	Range
Laboratory evaluation of samples	Filter cartridge sampler for aerosol radioactivity in the exhaust air of the containment exhaust ventilation system. The filter cartridge which is evaluated in the laboratory.	I-131	–
Laboratory evaluation of samples	Three (3) filter cartridge samplers (one for each cell) for aerosol radioactivity in the exhaust air of the ventilation systems of the Nuclear Auxiliary Building. The filter cartridge is evaluated in the laboratory.	I-131	–
Laboratory evaluation of samples	Filter cartridge sampler for aerosol radioactivity in the exhaust air of the hot workshop in the Nuclear Auxiliary Building. The filter cartridge is evaluated in the laboratory.	I-131	–
Laboratory evaluation of samples	Two (2) filter cartridge samplers (one for each cell) for aerosol radioactivity in the exhaust air of the ventilation systems of the Fuel Building. The filter cartridge is evaluated in the laboratory.	I-131	–
Laboratory evaluation of samples	Filter cartridge sampler for aerosol radioactivity in the exhaust air of the ventilation systems of the Safeguard Building. The filter cartridge is evaluated in the laboratory.	I-131	–
Laboratory evaluation of samples	Filter cartridge sampler for aerosol radioactivity in the exhaust air of the laboratory in the Nuclear Auxiliary Building. The filter cartridge is evaluated in the laboratory.	I-131	–
Laboratory evaluation of samples	Four (4) filter cartridge samplers for aerosol radioactivity in the exhaust air of the ventilation systems of the Radioactive Waste Processing Building. The filter cartridge is evaluated in the laboratory.	I-131	
Process Monitors			
Gamma-sensitive detector (γ)	General area radiation level of the fuel pool floor. Assessing accessibility after abnormal events in the Fuel Building.	–	1E-4 – 1E+4 rem/hr 1E-6 – 1E+2 Sv/hr
Gamma-sensitive detector (γ)	All small items, tools etc. brought out of the controlled area are measured and released by an automatic release box (4 redundant monitors) in the Access Building.	Co-60, Cs-137	
Alpha- and beta-sensitive detectors and gamma-sensitive detectors (a,β,g)	Five (5) exit portal monitors in the Access Building.	Co-60, Cs-137	
Alpha- and beta-sensitive detectors and gamma-sensitive detectors (a,β,g)	Three (3) pre-exit portal monitors in the Access Building.	Co-60, Cs-137	

Table 3.5-25— Radiation Monitors
(Page 5 of 9)

Method	Monitoring Task	Radioisotopes	Range
Gamma-sensitive electronic personnel dosimeter (γ)	At the entrance and exit of the controlled area the personnel dosimeters are read by dosimeter readers (total of 4). The measured dose values together with personal identification codes are evaluated by the dosimetry system of the plant in the Access Building.	–	60 keV - 6 MeV Energy range 1E-4 - 1E+3 rem 1E-6 - 1E+1 Sv Dose range
Gamma-sensitive detector (γ)	Radioactive Waste Processing Building decontamination room radiation monitor.		1E-4 - 1E+1 rem/hr 1E-6 - 1E-1 Sv/hr
Integral gamma-measurement with a gamma-sensitive detector (threshold 100 keV) (γ)	Component cooling loop radiation monitor (4 - one on each component cooling loop) in the Reactor Building.		1E-6 - 1E-3 μCi/ml 4E-2 - 4E+1 Bq/ml
Measurement with gamma-sensitive detectors (γ)	High-pressure coolers of the volume control system radiation monitor (4 - one on each component cooling loop). The detectors are installed at the component cooling water inlet and outlet of each HP cooler in the Reactor Building. The purpose is to detect a leak from the primary side to the component cooling water side.	–	3E-5 - 3E+0 μCi/ml 1E+0 - 1E+5 Bq/ml
Measuring arrangement of gamma detectors (γ)	Dose rate level at the top of the drum (in 10 cm distance) while the drum is rotated slowly in the Radioactive Waste Processing Building.		1E-4 - 1 rem/hr 1E-6 - 1E-2 Sv/hr
Measuring arrangement of gamma detectors (γ)	Dose rate level at the bottom of the drum (in 10 cm distance) while the drum is rotated slowly in the Radioactive Waste Processing Building.		1E-4 - 1 rem/hr 1E-6 - 1E-2 Sv/hr
Measuring arrangement of gamma detectors (γ)	Dose rate level at the shell of the drum (upper area, in 10 cm distance) while the drum is rotated slowly in the Radioactive Waste Processing Building.		1E-4 - 1 rem/hr 1E-6 - 1E-2 Sv/hr
Measuring arrangement of gamma detectors (γ)	Dose rate level at the shell of the drum (middle area, in 10 cm distance) while the drum is rotated slowly in the Radioactive Waste Processing Building.		1E-4 - 1 rem/hr 1E-6 - 1E-2 Sv/hr
Measuring arrangement of gamma detectors (γ)	Dose rate level at the shell of the drum (lower area, in 10 cm distance) while the drum is rotated slowly in the Radioactive Waste Processing Building.		1E-4 - 1 rem/hr 1E-6 - 1E-2 Sv/hr
Measuring arrangement of gamma detectors (γ)	Dose rate level in 1 m distance of the drum while the drum is rotated slowly in the Radioactive Waste Processing Building.		1E-4 - 1 rem/hr 1E-6 - 1E-2 Sv/hr
Measuring arrangement of gamma detectors (γ)	Dose rate in the vicinity of the drum measuring equipment as back ground measurement (in absence of a waste drum) in the Radioactive Waste Processing Building.		1E-4 - 1 rem/hr 1E-6 - 1E-2 Sv/hr

Table 3.5-25— Radiation Monitors
(Page 6 of 9)

Method	Monitoring Task	Radioisotopes	Range
Gamma spectrometer with multi channel analyzer (γ)	Gamma spectroscopy system for 200 liter drums in the Radioactive Waste Processing Building.		
Gamma-sensitive detector (γ)	Upstream activity entering the delay beds of the gaseous waste processing system in the Nuclear Auxiliary Building.	-	1E+0 - 1E+4 cps
Beta-sensitive detector (β)	Activity concentration in the pipe leading from the gas delay line to the vent stack.		1E-6 - 1E+2 µCi/cc 4E-2 - 4E+6 Bq/cc
Gamma sensitive detectors (γ)	N-16 radiation monitor on main steam to detect leakage in the steam generator. This is monitored by four redundant instruments on each main steam line (16 total). The detectors are mounted adjacent to the monitored main steam lines within the main steam and feedwater valve compartments.	N-16	1E-1 - 1E+4 cps
Gamma spectrometer with multi channel analyzer. (γ)	Gamma spectroscopy system for 200 liters drums in the Radioactive Waste Processing Building		
Integral measurement with gamma-sensitive detector (threshold 100 keV) and ring vessel (γ)	Blowdown water line of each individual steam generator (4 - one on each steam generator) in the Nuclear Auxiliary Building.		3E-6 - 1E-2 µCi/ml 1E-1 - 4E+2 Bq/ml
Gamma-sensitive detector (γ)	Containment high-range dose rate monitor (4 independent instruments) in the Reactor Building		1E-1 - 1E+7 rad/hr 1E-3 - 1E+5 Gy/hr
Beta-sensitive detector (β)	Turbine Building Main Condenser monitor		3E-6 - 1E-2 µCi/cc 1E-1 - 4E+2 Bq/cc
Liquid Effluent Monitoring			
Gamma-sensitive detector (threshold 100 keV) (γ)	Liquid radwaste release line from the monitor tanks. Two(2) redundant instruments provide input to a control function in the Radioactive Waste Processing Building.		5E-6 - 1E-3 µCi/ml 2E-1 - 4E+1 Bq/ml
Integral measurement with gamma-sensitive detector (γ)	Liquid effluent from the Plant Drainage System before discharge.	-	3E-6 - 1E-2 µCi/ml 1E-1 - 4E+2 Bq/ml
Integral measurement with gamma-sensitive detector (γ)	Liquid effluent from the Plant Drainage System before discharge.	-	3E-6 - 1E-2 µCi/ml 1E-1 - 4E+2 Bq/ml
Airborne Monitoring			
Gamma-sensitive detector (threshold 350 kev). Alternatively uses a beta-sesitive detector (β,γ)	Aerosol in the exhaust air of containment ventilation.		5E-4 - 3E+0 µCi 2E+1 - 1E+5 Bq, 3E-10 - 1E-6 µCi/cc 1E-5 - 4E-2 Bq

Table 3.5-25— Radiation Monitors
(Page 7 of 9)

Method	Monitoring Task	Radioisotopes	Range
Gamma-sensitive detector (γ)	Gaseous iodine in the exhaust air of containment ventilation.		5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 5E-8 μCi/cc 1E-5 – 2E-2 Bq/cc
Beta-sensitive detector (β)	Tritium in the exhaust air of containment ventilation.	–	3E-9 – 3E-4 μCi/cc 1E-4 – 1E+1 Bq/cc
Gamma-sensitive detector (γ)	Air leaving the containment adjacent to monitored air duct by 2 redundant instruments. These redundant instruments provide input to a control function.	–	1E-5 – 1E+0 rad/hr 1E-7 – 1E-2 Gy/hr
Measurement with gamma-sensitive detectors adjacent to monitored air duct KLA2 (γ)	Air leaving the containment adjacent to a monitored air duct. This redundant instrument provides input to a control function.		1E-5 – 1E+0 rad/hr 1E-7 – 1E-2 Gy/hr
Gamma-sensitive detector (threshold 350 keV). Alternatively uses a beta-sensitive detector (β,γ)	Aerosol in the exhaust air of the cell 1 ventilation system in the Nuclear Auxiliary Building.		5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 1E-6 μCi/cc 1E-5 – 4E-2 Bq/cc
Gamma-sensitive detector (γ)	Gaseous iodine in the exhaust air of thecell 1 ventilation system in the Nuclear Auxiliary Building	I-131	5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 5E-8 μCi/cc 1E-5 – 2E-3 Bq/cc
Gamma-sensitive detector (threshold 350 keV). Alternatively uses abeta-sensitive detector (β,γ)	Aerosol in the exhaust air of the cell 2 ventilation system in the Nuclear Auxiliary Building.		5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 1E-6 μCi/cc 1E-5 – 4E-2 Bq/cc
Gamma-sensitive detector (γ)	Gaseous iodine in the exhaust air of thecell 2 ventilation system in the Nuclear Auxiliary Building.	I-131	5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 5E-8 μCi/cc 1E-5 – 2E-3 Bq/cc
Gamma-sensitive detector (threshold 350 keV). Alternatively uses a beta-sensitive detector (β,γ)	Aerosol in the exhaust air of thecell 3 ventilation system in the Nuclear Auxiliary Building.		5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 1E-6 μCi/cc 1E-5 – 4E-2 Bq/cc
Gamma-sensitive detector (γ)	Gaseous iodine in the exhaust air of the cell 3 ventilation system in the Nuclear Auxiliary Building.	I-131	5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 5E-8 μCi/cc 1E-5 – 2E-3 Bq/cc
Gamma-sensitive detector (threshold 350 keV). Alternativelyuses a beta-sensitive detector (β,γ)	Aerosol in the exhaust air of thecell 4 ventilation system in the Fuel Building.		5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 1E-6 μCi/cc 1E-5 – 4E-2 Bq/cc

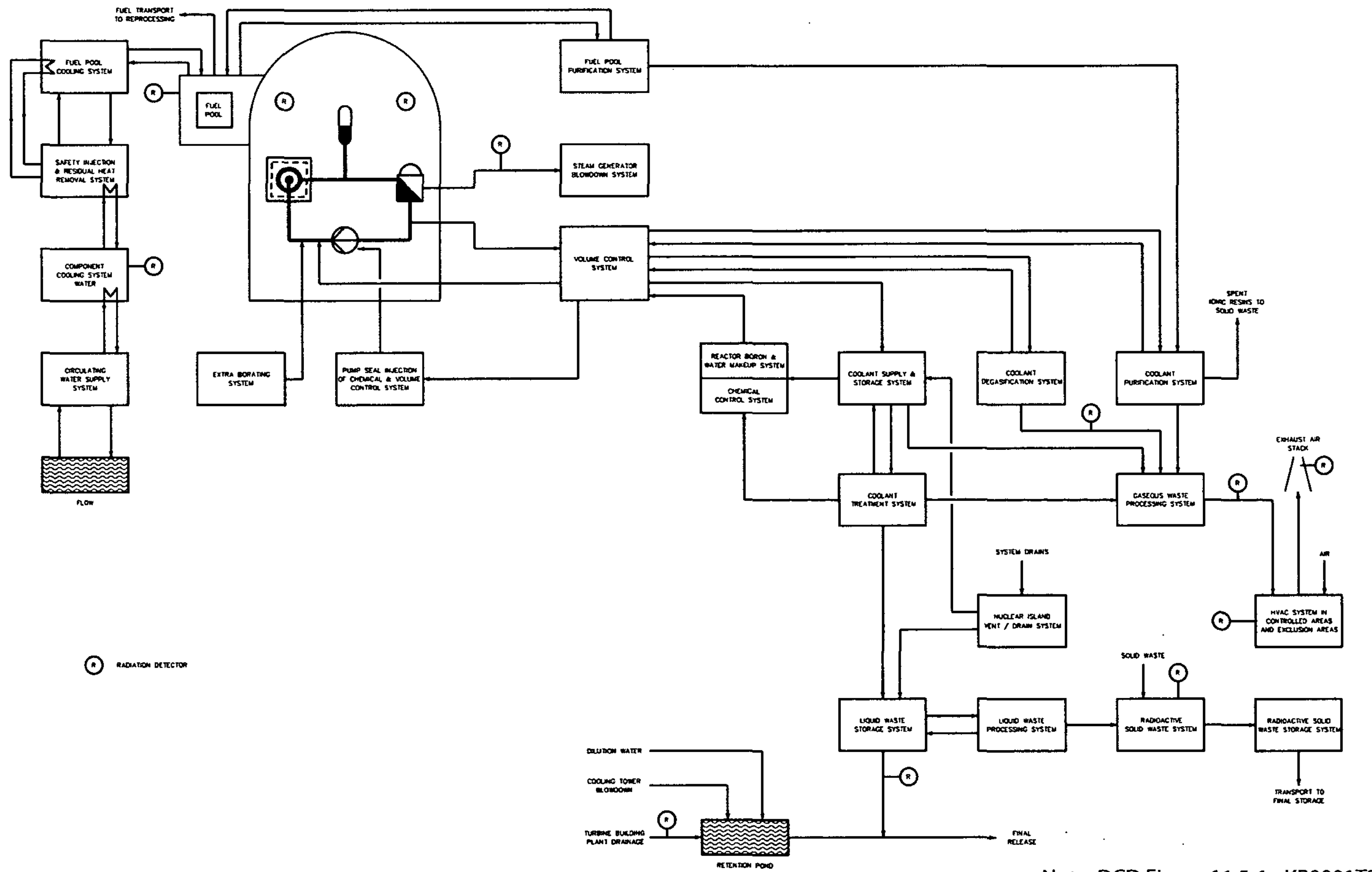
Table 3.5-25— Radiation Monitors
(Page 8 of 9)

Method	Monitoring Task	Radioisotopes	Range
Gamma-sensitive detector (γ)	Gaseous iodine in the exhaust air of the cell 4 ventilation system in the Fuel Building.	I-131	5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 5E-8 μCi/cc 1E-5 – 2E-3 Bq/cc
Gamma-sensitive detector (threshold 350 keV). Alternatively uses a beta-sensitive detector (β,γ)	Aerosol in the exhaust air of the cell 5 ventilation system in the Fuel Building.	–	5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 1E-6 μCi/cc 1E-5 – 4E-2 Bq/cc
Gamma-sensitive detector (γ)	Gaseous iodine in the exhaust air of the cell 5 ventilation system in the Fuel Building.	I-131	5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 5E-8 μCi/cc 1E-5 – 2E-3 Bq/cc
Gamma-sensitive detector (threshold 350 keV). Alternatively uses a beta-sensitive detector (β,γ)	Aerosol in the exhaust air of the cell 6 ventilation system in the Safeguard Building.		5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 1E-6 μCi/cc 1E-5 – 4E-2 Bq/cc
Gamma-sensitive detector (γ)	Gaseous iodine in the exhaust air of the cell 6 ventilation in the Safeguard Building.	I-131	5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 5E-8 μCi/cc 1E-5 – 2E-3 Bq/cc
Gamma-sensitive detector (γ)	Air leaving the fuel handling area adjacent to the monitored air duct by 2 redundant instruments. These redundant instrument provides input to a control function.		1E-5 – 1E+0 rad/hr 1E-7 – 1E-2 Gy/hr. Must be capable of detecting 10 DAC-hours
Gamma-sensitive detector (threshold 350 keV). Alternatively uses a beta-sensitive detector (β,γ)	Aerosol in the laboratory room exhaust air before the filters the Nuclear Auxiliary Building.		1E-5 – 1E+0 rad/hr 1E-7 – 1E-2 Gy/hr Must be capable of detecting 10 DAC-hours
Gamma-sensitive detector (threshold 350 keV). Alternatively uses a beta-sensitive detector (β,γ)	Aerosol in the exhaust air of the hot workshop before the filters Nuclear Auxiliary Building.		5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 1E-6 μCi/cc 1E-5 – 4E-2 Bq/cc Must be capable of detecting 10 DAC-hours
Gamma-sensitive detector (threshold 350 keV). Alternatively uses a beta-sensitive detector (β,γ)	Aerosol in 2 separate locations of the exhaust air of the Radioactive Waste Processing Building.		5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 1E-6 μCi/cc 1E-5 – 4E-2 Bq/cc
Gamma-sensitive detector (γ)	Gaseous iodine in 2 separate locations of the exhaust air of the Radioactive Waste Processing Building.		5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 5E-8 μCi/cc 1E-5 – 2E-3 Bq/cc

Table 3.5-25— Radiation Monitors
(Page 9 of 9)

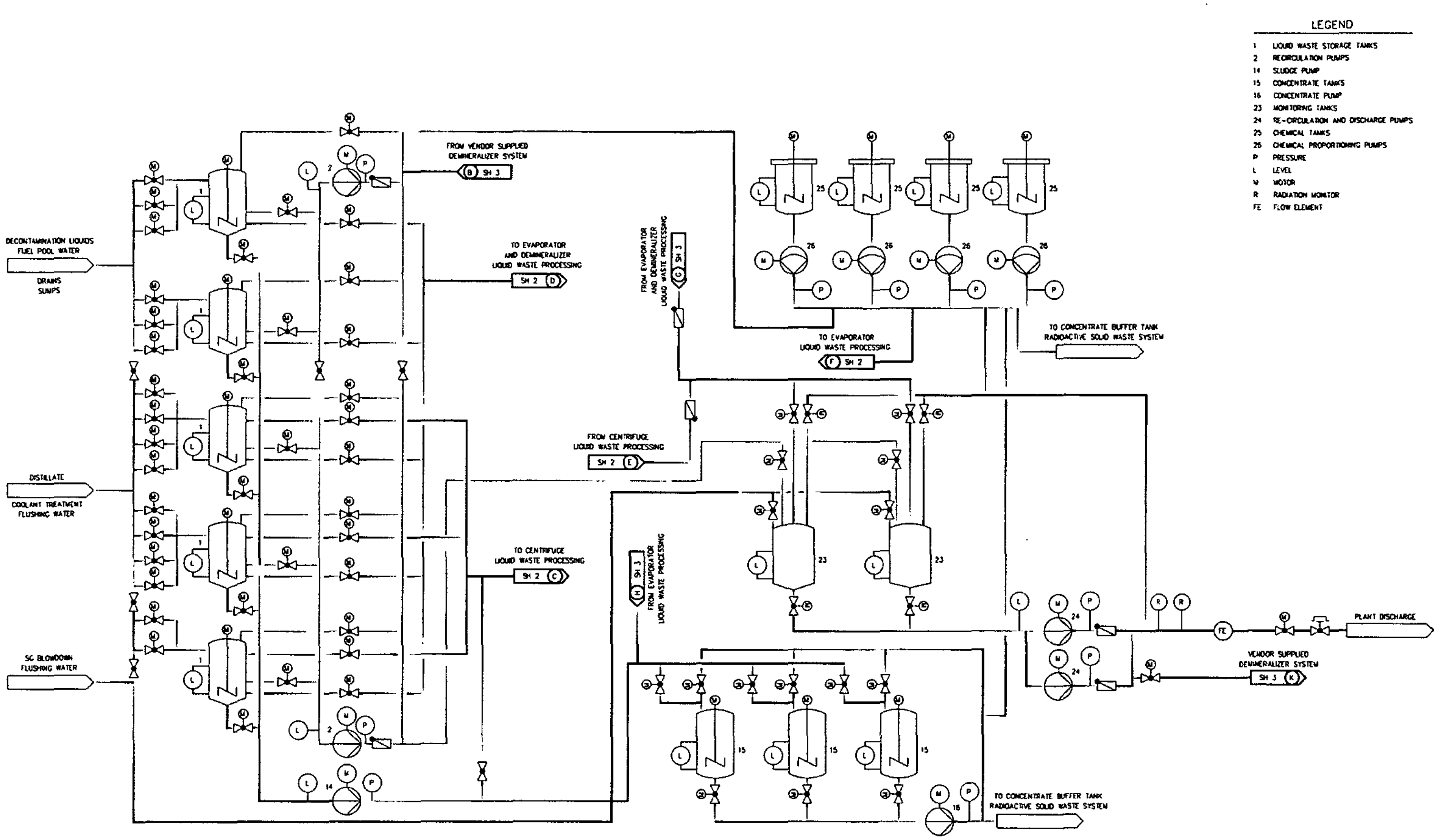
Method	Monitoring Task	Radioisotopes	Range
Gamma-sensitive detector (threshold 350 keV). Alternatively uses a beta-sensitive detector (β,γ)	Aerosol in the exhaust air of the decontamilnation room in the Radioactive Waste Processing Building.		5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 1E-6 μCi/cc 1E-5 – 4E-2 Bq/cc Must be capable of detecting 10 DAC-hours
Gamma-sensitive detector (γ)	Gaseous iodine in the exhaust air of Nuclear Auxiliary Building (cell 1, cell 2 and cell 3), Fuel Building (cell 4 and cell 5), from the Safeguard Building - (cell 6) and from the Radioactive Waste Building – (two cells).	I-131	5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 5E-8 μCi/cc 1E-5 – 2E-3 Bq/cc
Gamma-sensitive detector (threshold 350 keV). Alternatively uses a beta-sensitive detector. (β,γ)	Aerosol in the exhaust air of the mechanical workshop in the Radioactive Waste Processing Building.		5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 1E-6 μCi/cc 1E-5 – 4E-2 Bq/cc Must be capable of detecting 10 DAC-hours
Gamma-sensitive detector (γ)	Intake air of the main control room MCR inside each of the two MCR intake air ventilation ducts.	–	1E-5 – 1E+1 rad/hr 1E-7 – 1E+1 Gy/hr Must be capable of detecting 10 DAC-hours
Gamma-sensitive detector (threshold 350 keV). Alternatively usesa beta-sensitive detector. (β,γ)	Aerosol in the exhaust air of thecontainment ventilation.		5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 1E-6 μCi/cc 1E-5 – 4E-2 Bq/cc Must be capable of detecting 10 DAC-hours
Gamma-sensitive detector (γ)	Gaseous iodine in the exhaust air of containment venthilation.		5E-4 – 3E+0 μCi 2E+1 – 1E+5 Bq, 3E-10 – 5E-8 μCi/cc 1E-5 – 2E-3Bq/cc

Figure 3.5-1— Radwaste Effluent Flow Paths



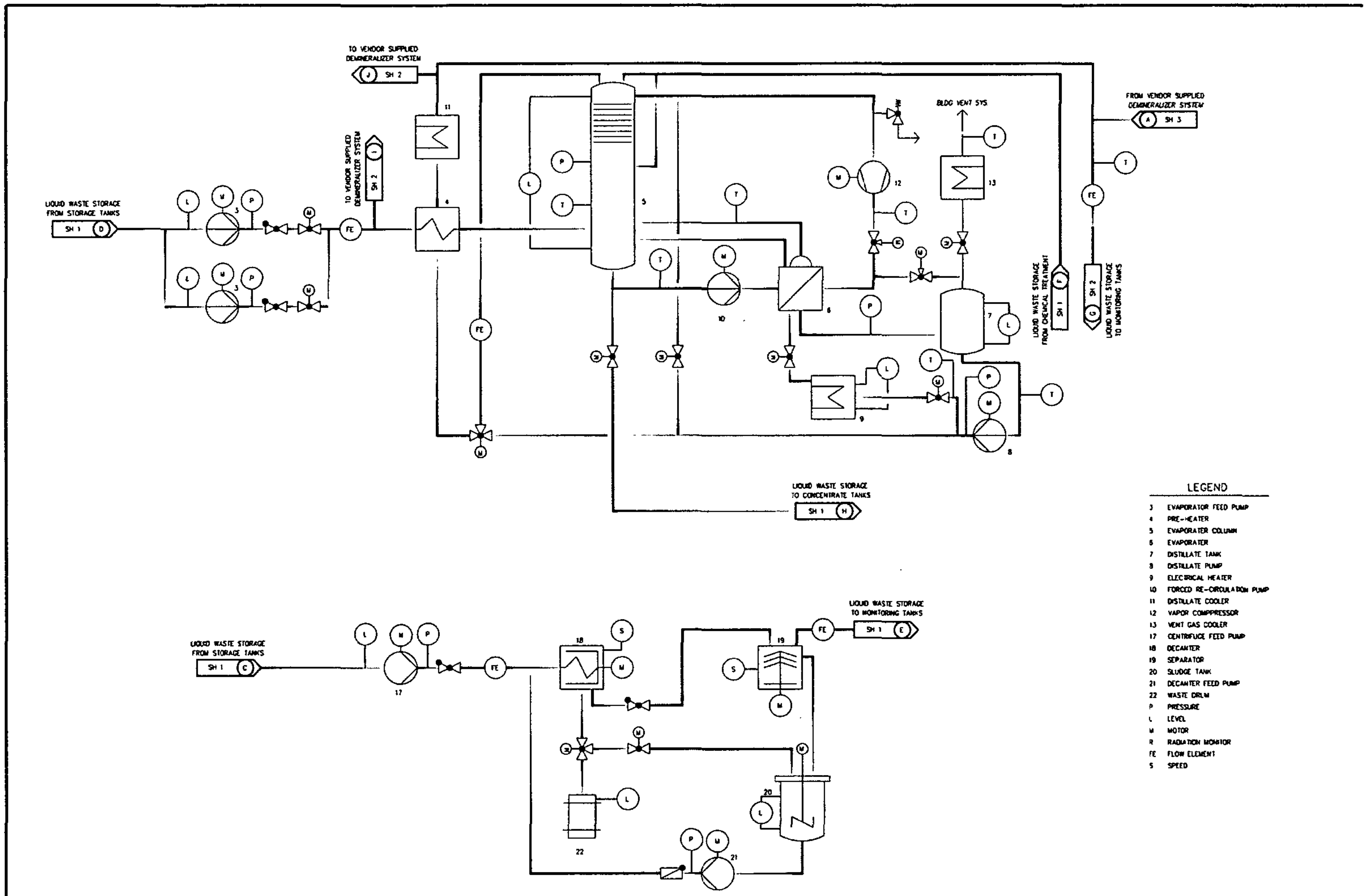
Note: DCD Figure 11.5-1 - KP0001T2

Figure 3.5-2— Liquid Radwaste Storage and Processing



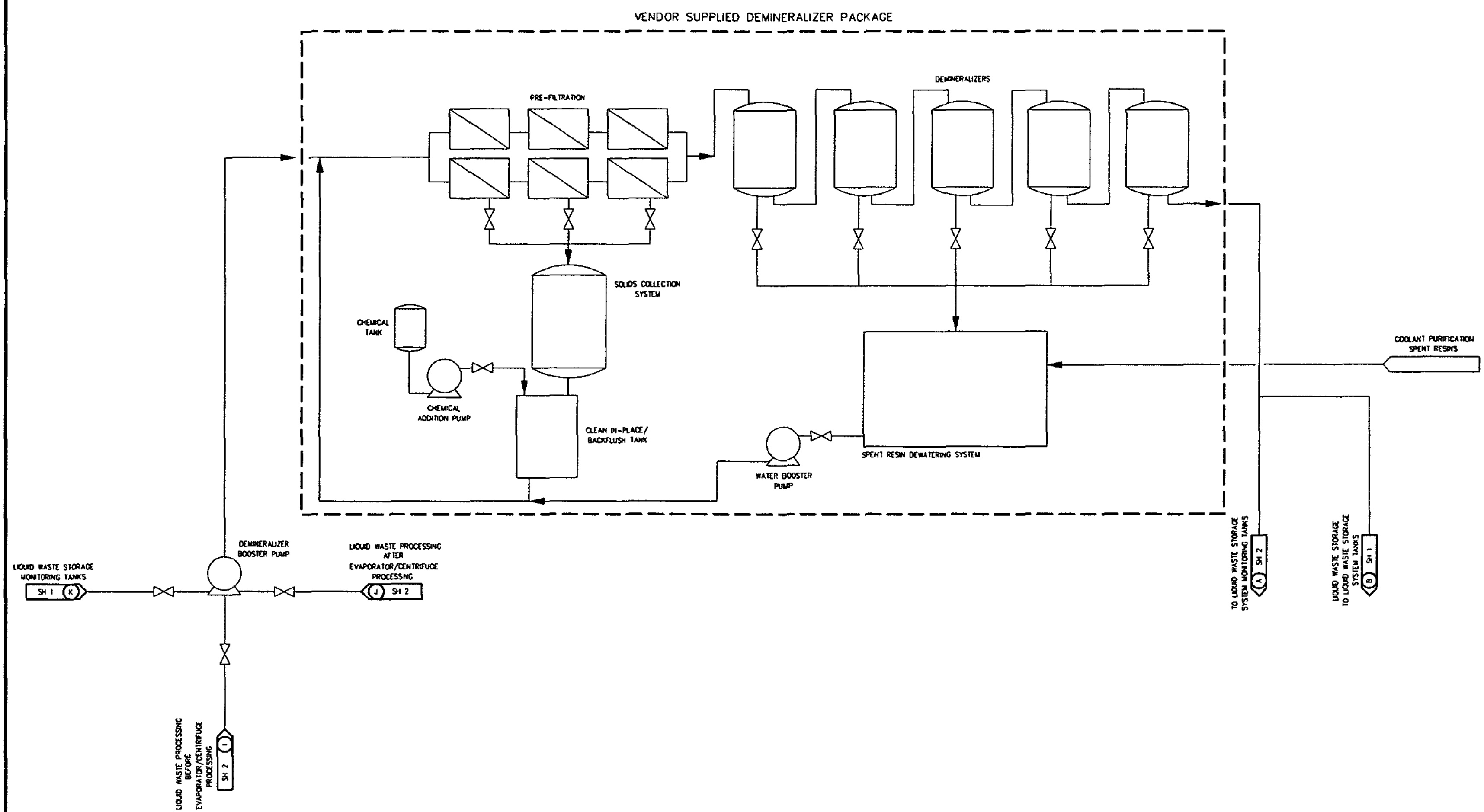
Note: DCD Figure 11.2-1 - KPF01T2

Figure 3.5-3— Liquid Waste Treatment Evaporator and Centrifuge



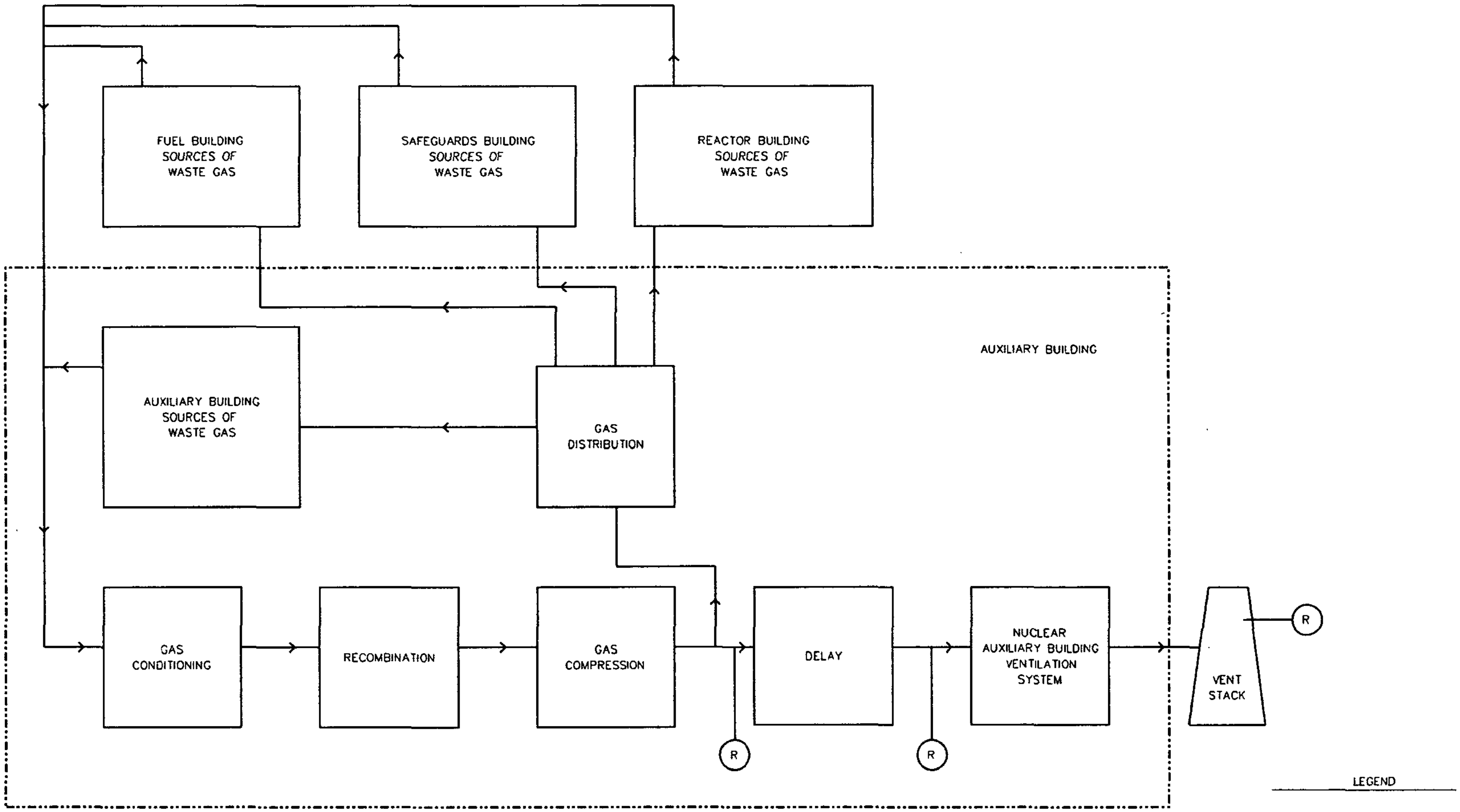
Note: DCD Figure 11.2-2 - KPF02T2

Figure 3.5-4— Liquid Waste Treatment Vendor Supplied Demineralizer System



Note: DCD Figure 11.2-3 - KPF03T2

Figure 3.5-5— Gaseous Waste Processing and Sources



Note: DCD Figure 11.3-2 - KPL07T2

Figure 3.5-6— Gas Waste Treatment

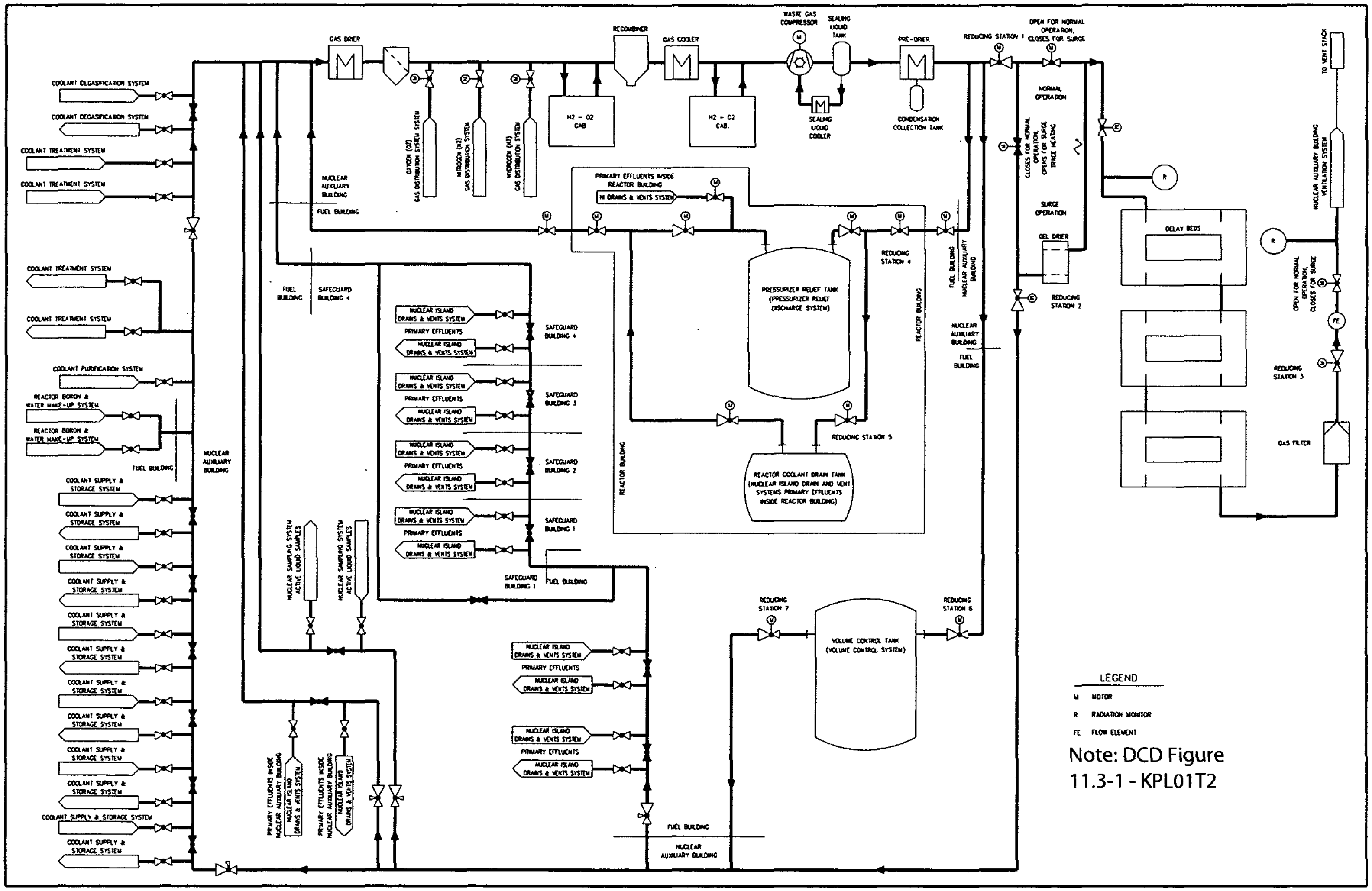
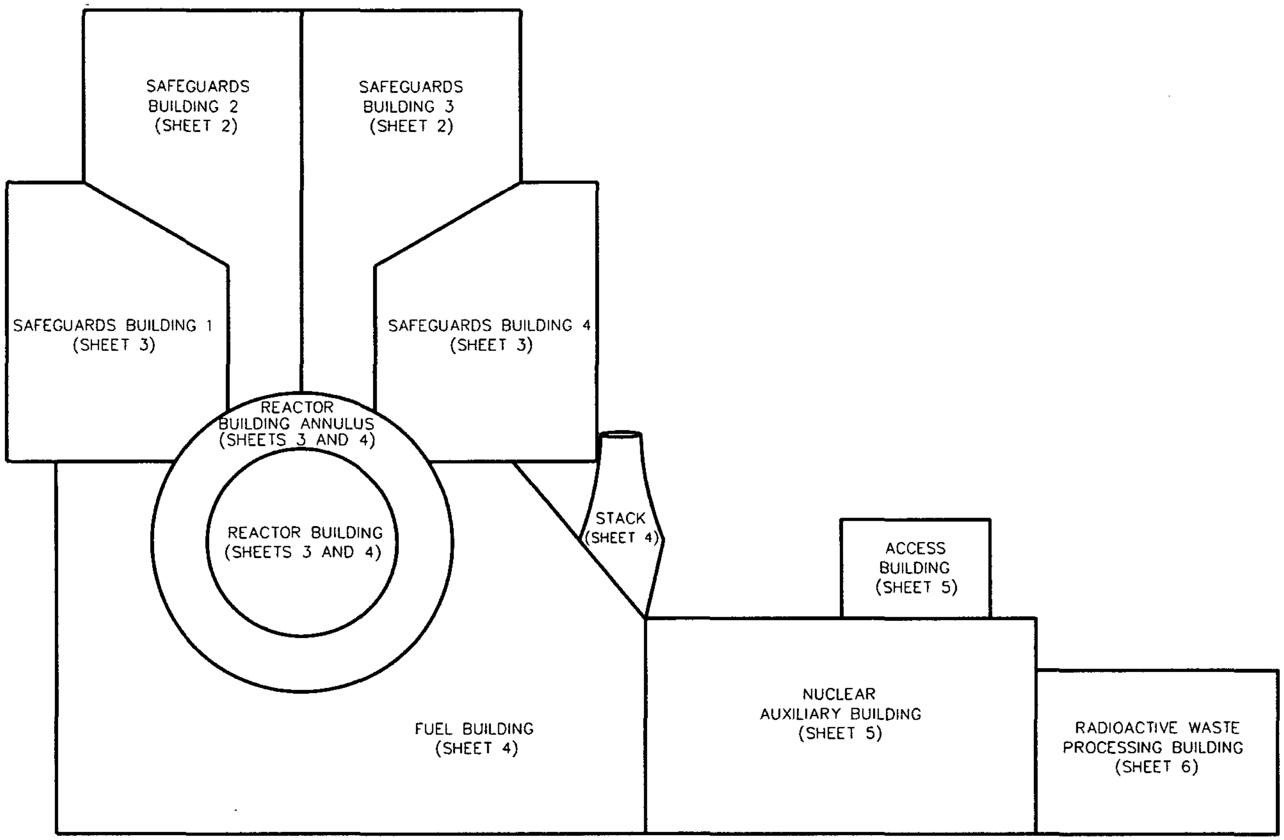
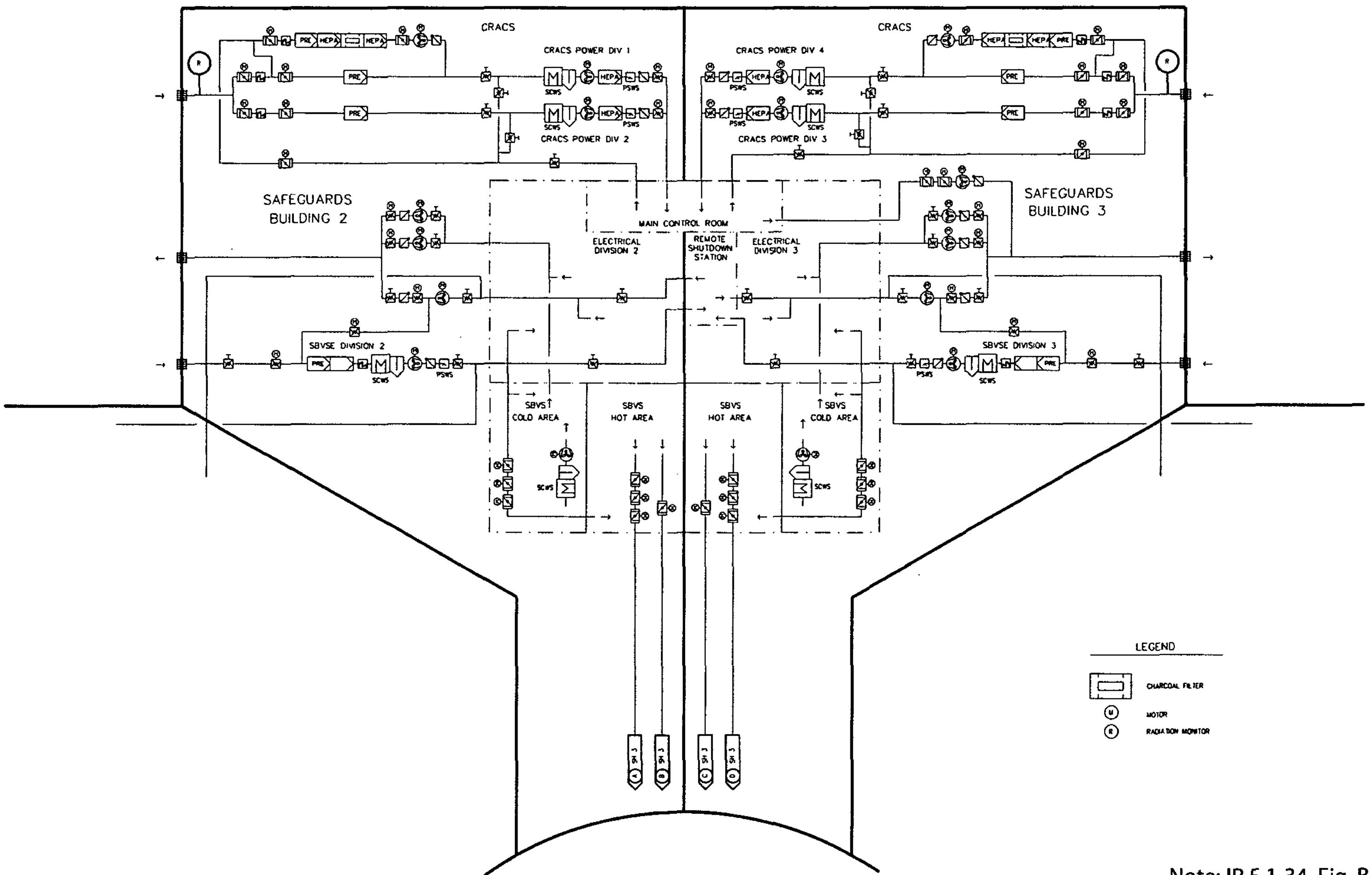


Figure 3.5-7— Controlled Area Ventilation Flow Diagram
(Page 1 of 6)



Note: IR 5.1-34, Fig. B-1

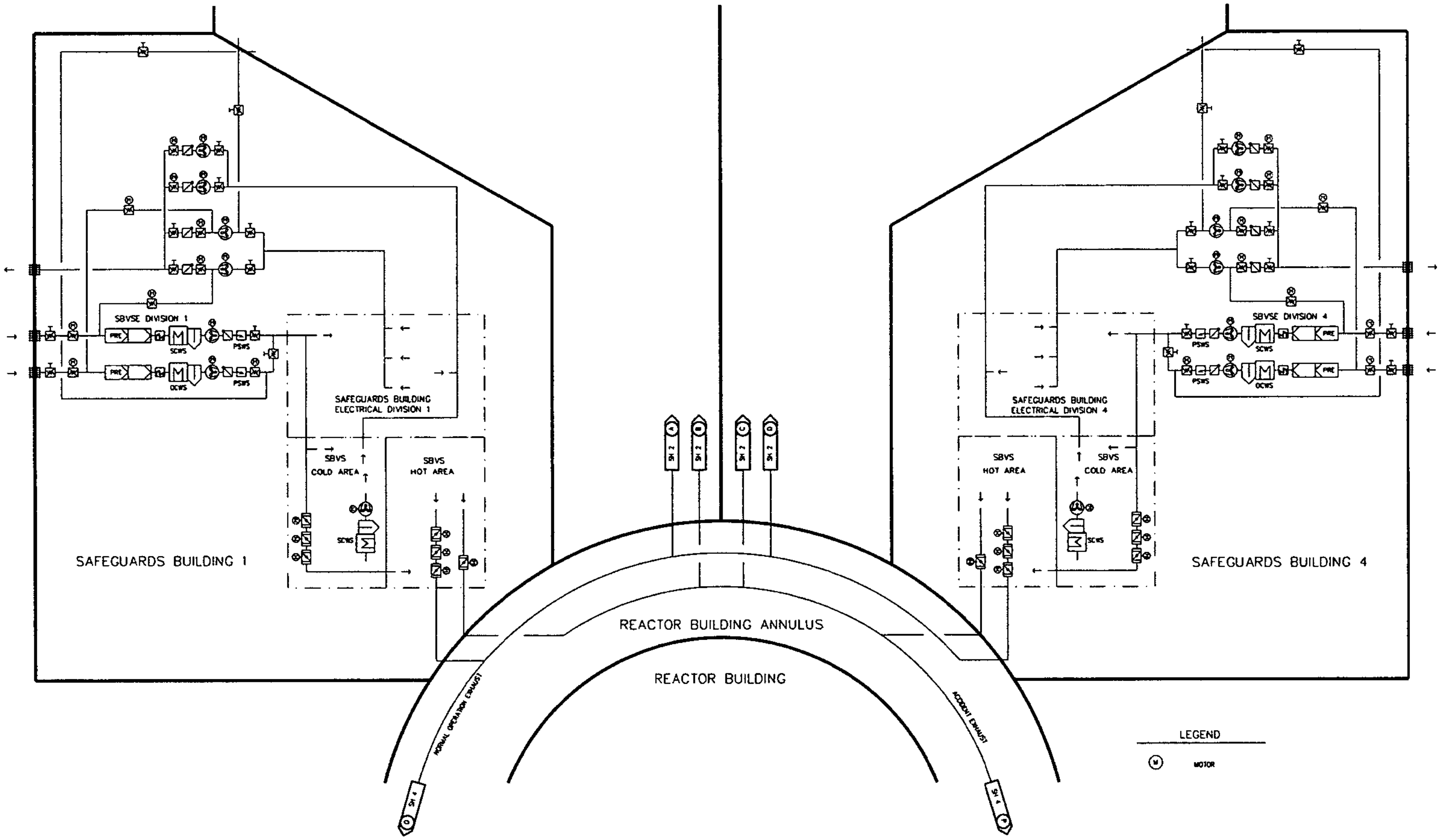
Figure 3.5-7— Controlled Area Ventilation Flow Diagram
(Page 2 of 6)



Note: IR 5.1-34, Fig. B-1

Figure 3.5-7— Controlled Area Ventilation Flow Diagram

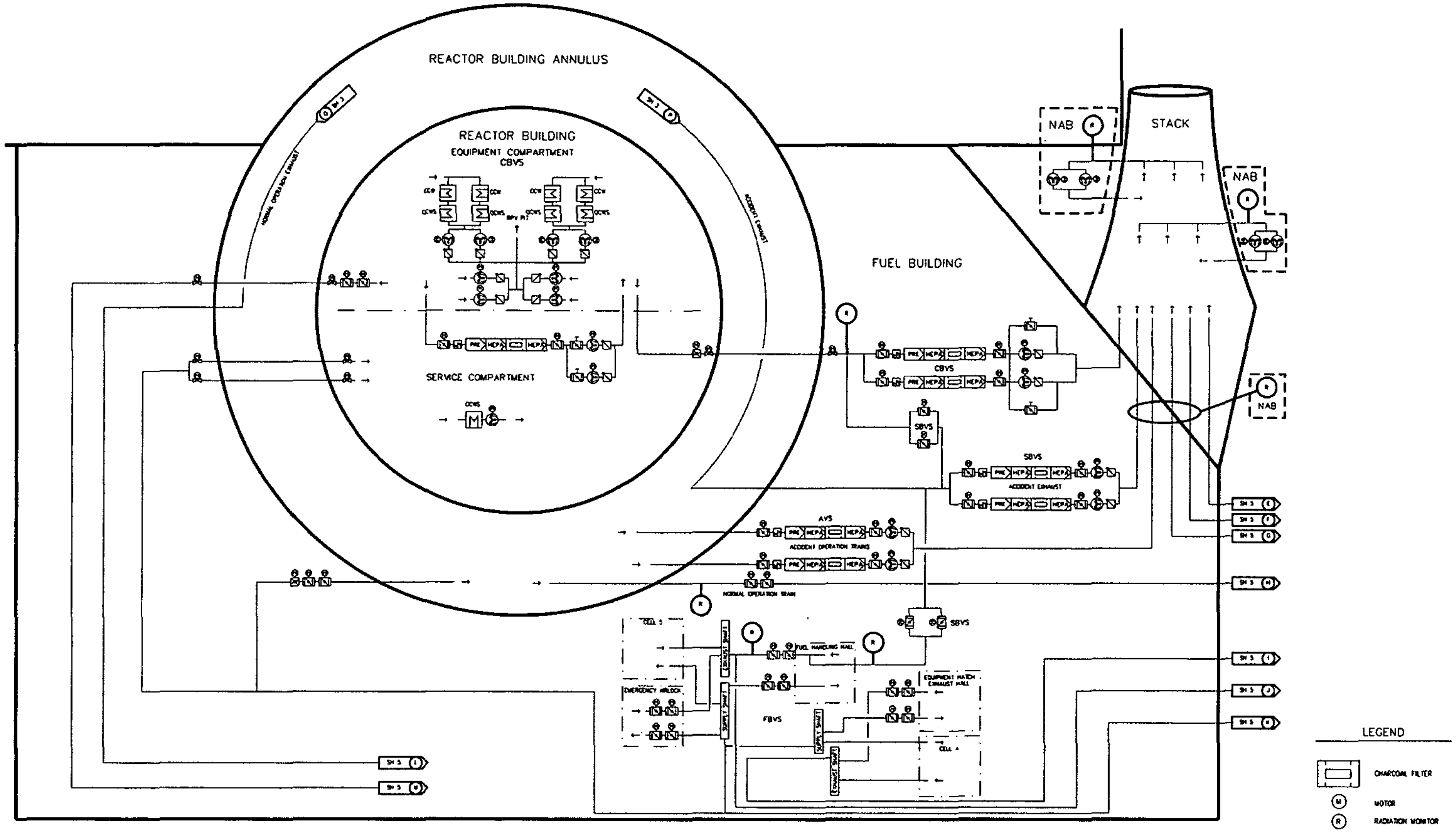
(Page 3 of 6)



Note: IR 5.1-34, Fig. B-1

Figure 3.5-7— Controlled Area Ventilation Flow Diagram

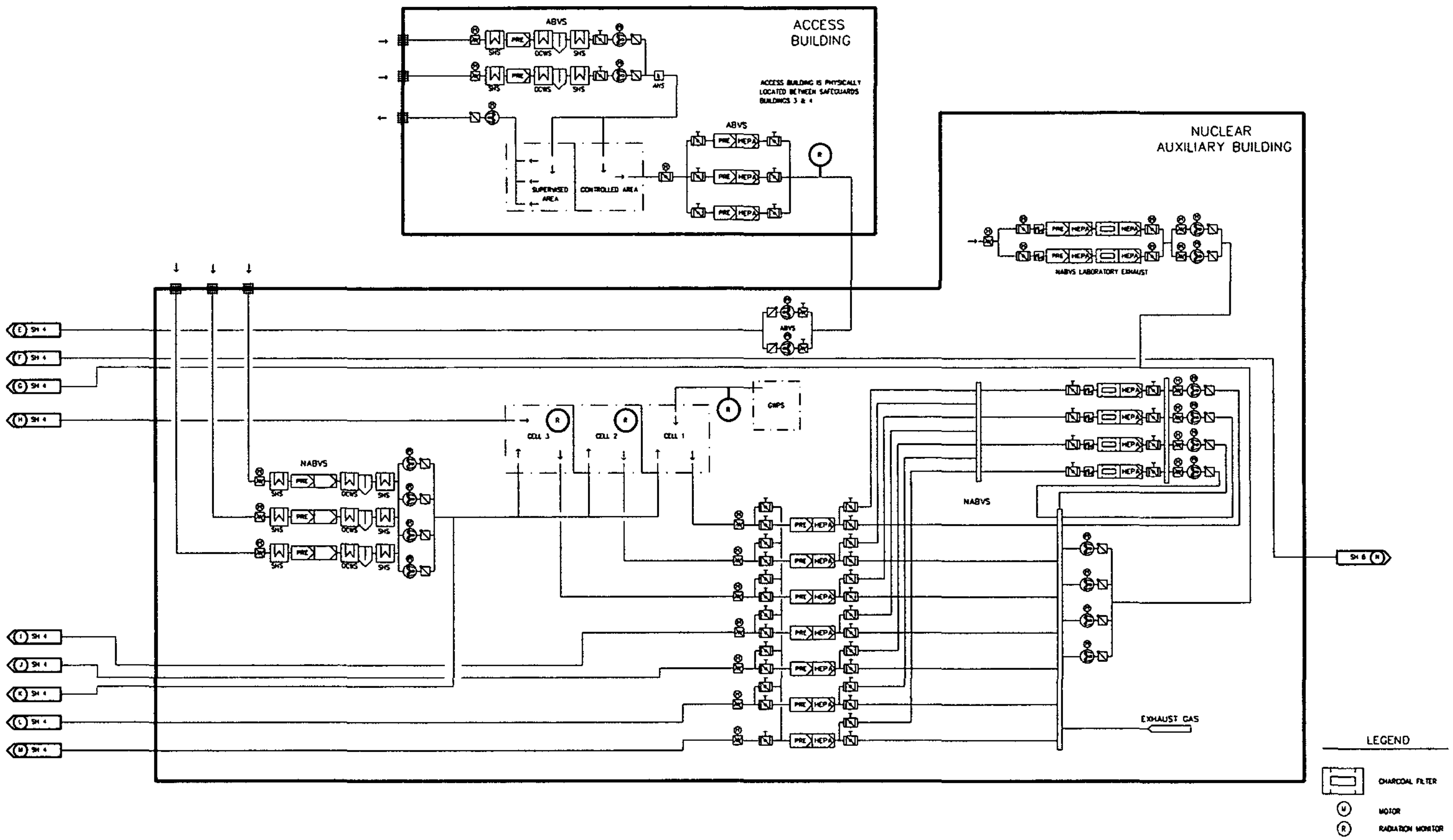
(Page 4 of 6)



Note: IR 5.1-34, Fig. B-1

Figure 3.5-7— Controlled Area Ventilation Flow Diagram

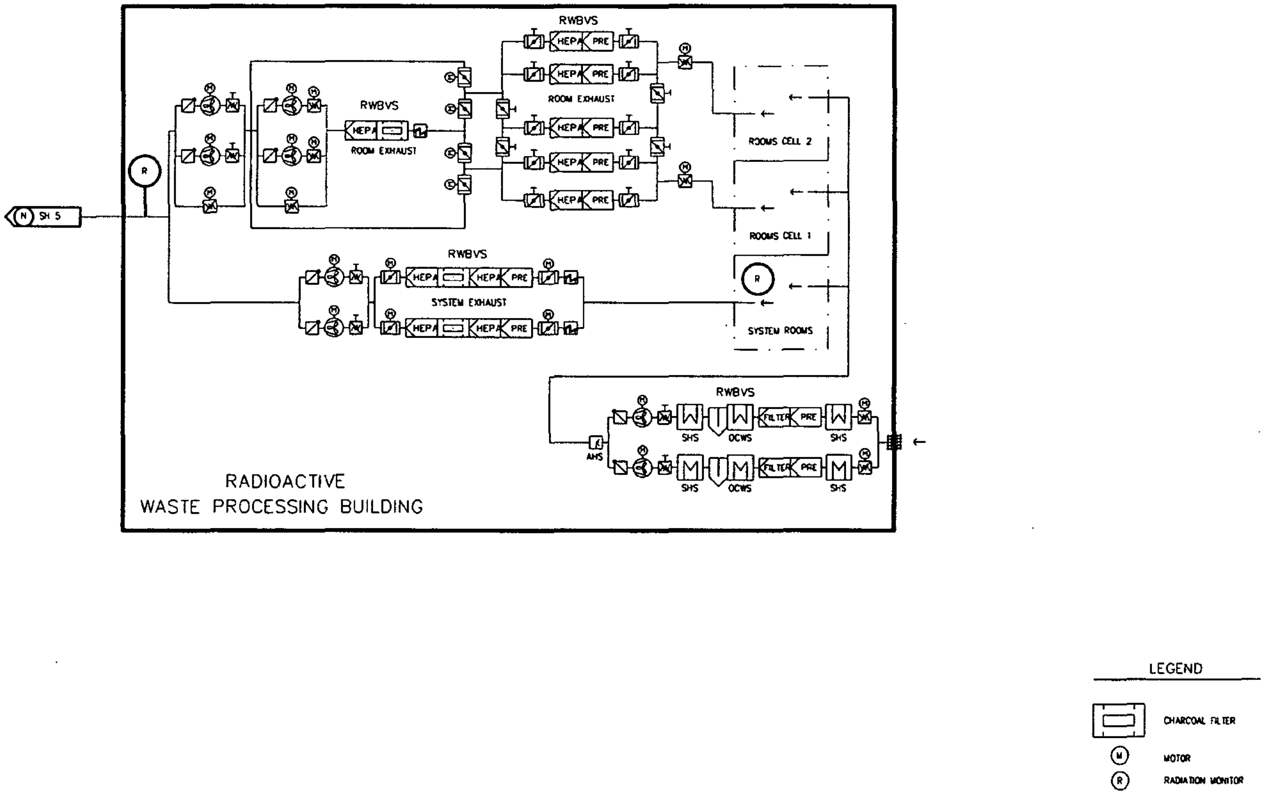
(Page 5 of 6)



Note: IR 5.1-34, Fig. B-1

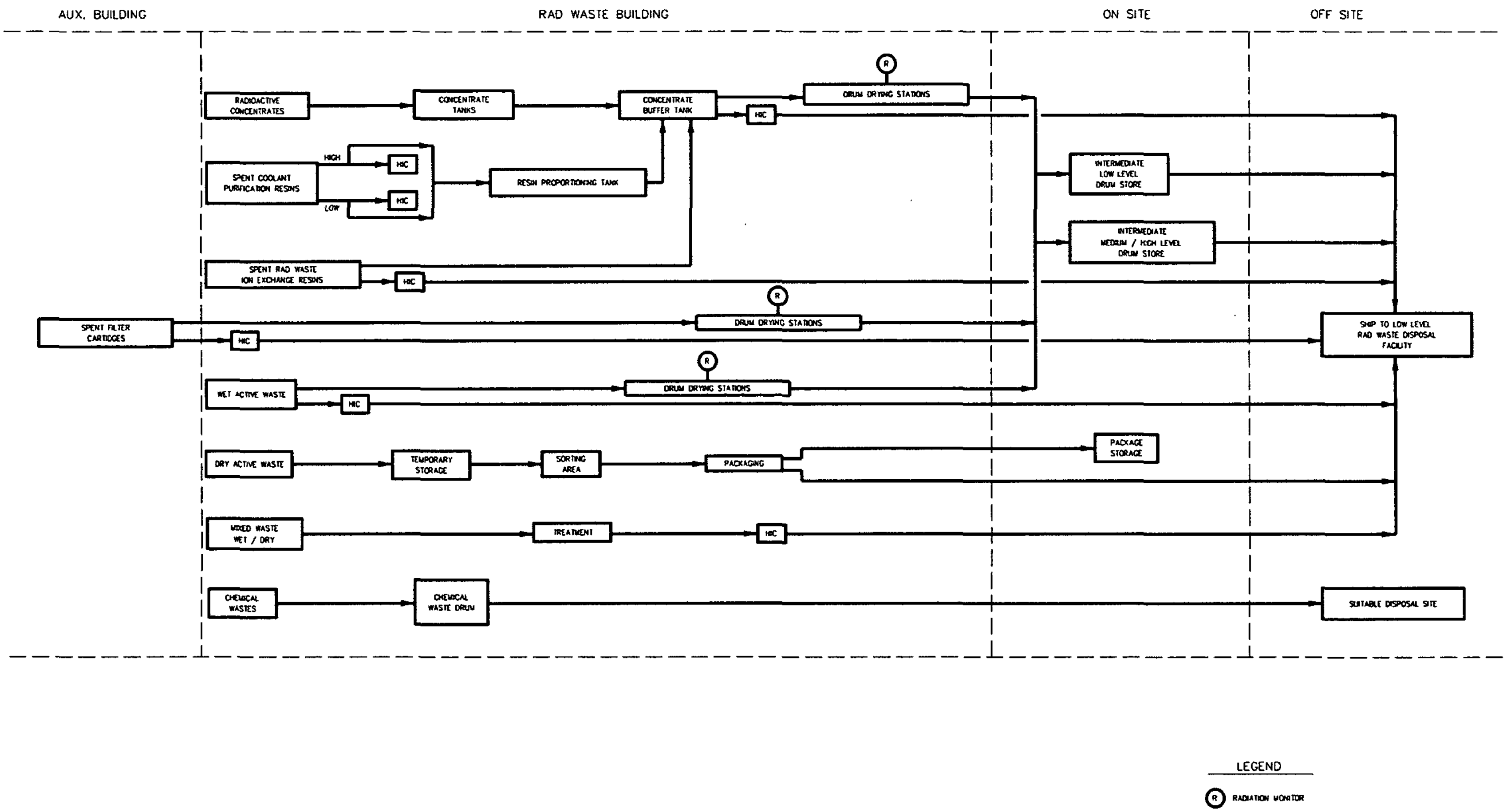
Figure 3.5-7— Controlled Area Ventilation Flow Diagram

(Page 6 of 6)



Note: IR 5.1-34, Fig. B-1

Figure 3.5-8— Solid Waste System Flow Diagram



Note: DCD Figure 11.4-1 - KPC01T2

3.6 NON-RADIOACTIVE WASTE SYSTEMS

This section provides a description of non-radioactive waste systems for CCNPP Unit 3 and the chemical and biocidal characteristics of each non-radioactive waste stream discharged from the unit. The non-radioactive waste streams include: (1) effluents containing chemicals or biocides; (2) sanitary system effluents; and (3) other effluents.

3.6.1 Effluents Containing Chemicals or Biocides

Chemicals are typically used to control water quality, scale, corrosion and biological fouling. Sources of non-radioactive effluents include plant blowdown, sanitary wastes, floor and equipment drains, and storm water runoff.

As described in Section 3.3.2, the treatment of non-radioactive effluents will be performed by the Circulating Water Treatment System, the Essential Service Water (Ultimate Heat Sink)Treatment System, the Liquid Waste Processing System and the Waste Water Treatment Plant. Table 3.6-1 lists the various chemicals processed through these systems. Chemical concentrations within effluent streams from the plant will be controlled through engineering and operational/administrative controls in order to meet NPDES requirements at the time of construction and operation.

Naturally occurring substances (e.g., marine growth) will not be changed in form or concentration by plant operations. These naturally occurring substances that are not sloughed off will removed to a landfill.

The Chesapeake Bay and a desalinization plant will supply cooling water for CCNPP Unit 3. Table 3.6-2 identifies the principal constituents found in the Chesapeake Bay water and desalinization plant output (permeate and reject). Chesapeake Bay water quality is discussed in Section 2.3.3.1.2. Effluent discharge flows into the bay are provided in Table 3.3-1 and Figure 3.3-1.

Evaporative cooling systems include the Circulating Water Supply System and the Essential Service Water System (ESWS) (Ultimate Heat Sink). Some of the cooling water associated with these systems is lost through evaporation via their cooling towers as discussed in Section 3.3. During warm weather, when the difference between the air temperature and the water temperature is relatively small, cooling of the water is almost entirely the result of the extraction of heat through evaporation of water to the air. Under extreme winter conditions (e.g., below zero), when the air is much colder than the water, as much as half of the cooling may be the result of sensible heat transfer from the water to the air with the remainder of the cooling being through evaporation. The Circulating Water System and ESWS cooling towers will be based on two cycles of concentration. No seasonal variations in cycles of concentration are expected.

Section 3.6.3.2 describes the effluent water chemical concentrations from other sources and the water treatment for general plant use and effluents from the resultant waste stream.

3.6.2 Sanitary System Effluents

The purpose of this section is to identify the anticipated volume and type of sanitary waste effluents generated during construction and operation of CCNPP Unit 3. Sanitary waste systems installed during pre-construction and construction activities will likely include portable toilets supplied and serviced by a licensed sanitary waste treatment contractor. Based on an anticipated construction work force of 1000 people in the first year of construction activities and 4000 people in the second through fifth year of constructions activities, the quantity of sanitary waste expected to be generated is 6500 gpd (24,605 lpd) for the first year, and 26,000 gpd (98,420 lpd) for years 2 through 5, or 4.5 gpm (17.0 lpm) and 13.5 gpm (51.1 lpm), respectively. Sanitary waste will be removed offsite during pre-construction and construction activities and will not add to the existing on-site discharge effluents.

During the Operations phase for CCNPP Unit 3, a Waste Water Treatment Plant will collect sanitary wastes. It will be designed for domestic waste only and exclude industrial materials, such as chemical laboratory wastes, and will be sized to accommodate the needs of personnel associated with the unit. The Waste Water Treatment Plant System will be monitored and controlled by trained operators. The CCNPP Unit 3 Waste Water Treatment Plant System will be dedicated to CCNPP Unit 3 and will not process waste from CCNPP Units 1 and 2.

The CCNPP Unit 3 Waste Water Treatment Plant's system capacity and unit loading factors are provided in Table 3.6-7. The CCNPP Unit 3 Waste Water Treatment Plant is expected to treat sanitary waste the same as other Waste Water Treatment Plants in Maryland and meet similar limitations. Therefore, effluent characteristics for the CCNPP Unit 3 Waste Water Treatment Plant are expected to be similar to those for the CCNPP Units 1 and 2 Waste Water Treatment Plant. In addition, similar to the CCNPP Units 1 and 2 Waste Water Treatment Plant, the CCNPP Waste Water Treatment Plant discharge will be processed along with other waste streams, and will not affect storm water runoff.

CCNPP Unit 3 sanitary waste handling will be contracted to a private company whose personnel are licensed by the State of Maryland as Waste Treatment Plant Operators. The Radiation Protection and Chemistry Manager will have oversight of this company to ensure the new plant meets required effluent parameters. The waste sludge will be removed by a private company and transported to a waste processing plant. Sludge will be checked for radiological contaminants prior to release. If any plant related radionuclides are identified, the sludge will be disposed of as low level radioactive waste.

Effluent discharges are regulated under the provisions of the Federal Water Pollution Control Act (USC, 2007) and the conditions of discharge for the units would be specified in the National Pollution Discharge Elimination System (NPDES) permit. It is expected that effluent limits for the CCNPP Unit 3 sanitary system will be similar to those already in effect for the CCNPP Unit 1 and 2 sanitary system. Table 3.6-3 lists anticipated CCNPP Unit 3 liquid and solid effluents associated with the Waste Water Treatment Plant (MD, 2002). It includes flow rates, pollutant concentrations, and the biochemical oxygen demand at the point of release. Sanitary effluents generated during construction of CCNPP Unit 3 are expected to be less than those generated during operation.

The Maryland Department of the Environment (MDE) has authority from the U.S. Environmental Protection Agency (EPA) to issue NPDES permits. Table 1.3-1 lists the environmental-related permits and authorizations for CCNPP Unit 3.

3.6.3 Other Effluents

This section describes miscellaneous non-radioactive gaseous, liquid, or solid effluents not addressed in Sections 3.6.1 or 3.6.2.

3.6.3.1 Gaseous Effluents

Non-radioactive gaseous effluents result from testing and operating the diesel generators and from their related fuel storage tanks, the CWS cooling tower, and the four smaller ESWS cooling towers. These effluents commonly include particulates, sulfur oxides, carbon monoxide, hydrocarbons and nitrogen oxides. Gaseous effluent releases will comply with Federal, State, and local emissions standards and requirements. Table 1.3-1 lists the environmental-related permits and authorizations for CCNPP Unit 3.

CCNPP Unit 3 will have six standby diesel generators (four Emergency Diesel Generators (EDGs), and two Station Blackout (SBO) diesel generators). The auxiliary boilers will use electric heating, and do not contribute directly to air emissions.

It is estimated that each EDG will be tested approximately 4 hours every month, plus an additional 24 to 48 hours once every 2 years. It is estimated that each SBO diesel generator will be tested approximately 4 hours every quarter, plus an additional 12 hours every year for maintenance activities. The SBO diesels will also be tested for an extended period of about 12 hours every 18 months.

The products of diesel fuel combustion exhausted from the EDGs represent emissions to the atmosphere. The exhaust stream emitted from the EDGs contains various pollutants. The emissions commonly include particulates, sulfur oxides, carbon monoxide, hydrocarbons, and nitrogen oxides. Diesel generator emissions will be released from an exhaust stack located on top of the diesel generator buildings at an elevation of 78 ft (23.8 m). Pre-treatment of diesel generator exhaust will depend on future diesel technology that has yet to be determined. Diesel generator exhaust will meet Environmental Protection Agency (EPA) Tier 4 requirements when CCNPP Unit 3 is operational. Maximum expected emissions during plant operation are provided in Table 3.6-4 (MDPSC, 2008).

3.6.3.2 Liquid Effluents

Chesapeake Bay water will serve as the source of cooling water for the Circulating Water Supply System.

Fresh water for CCNPP Unit 3 will be supplied by a desalinization plant that utilizes a sea water reverse osmosis (SWRO) process. The desalinization plant will receive seawater from Chesapeake Bay and will be designed to provide a desalinizated water output of 1.75E+06 gpd (6.62E+06 lpd). The desalinization plant will provide water for the Essential Service Water(Ultimate Heat Sink) System, the Demineralized Water Distribution System, the Potable and Sanitary Water Distribution System and the Fire Protection System as described in Section 3.3.

The SWRO reject stream is brine with a salt concentration of approximately 2 to 1 above normal Chesapeake Bay water levels. The brine is classified as Industrial Waste by the U.S. Environmental Protection Agency. The reject stream water quality for a typical one pass SWRO system is shown in Table 3.6-2. The SWRO effluent (discharge) is directed into the CCNPP Unit 3 Circulating Water System blowdown.

The Circulating Water Supply System takes Chesapeake Bay water into a closed cooling system, which utilizes a cooling tower to cool the water after it has cooled the plant's condensate. A portion of the Circulating Water Supply System water is constantly returned as blowdown to the Chesapeake Bay via a discharge pipe. Accordingly, mixing the discharge of the desalinization plant with the Circulating Water Supply System blowdown will result in a slight dilution of the Circulating Water Supply System discharge. As such, the environmental impact of the desalinization plant discharge will be enveloped by that of the Circulating Water Supply System discharge. During plant shutdown, administrative controls will be used to control the salt concentration discharged to the Chesapeake Bay.

Non-radioactive liquid effluents that could potentially drain to the Chesapeake Bay are limited under the NPDES permit. There are three anticipated outfalls for release of non-radioactive liquid effluents from CCNPP Unit 3:

- one for plant effluents (e.g., effluent from the sewage treatment, desalinization plant, cooling tower blowdown, etc.) via the offshore, submerged diffuser
- one for stormwater via various surface outlets throughout the CCNPP Unit 3 site area
- one for intake screen backwash

These outfalls will be controlled under the CCNPP Unit 3 NPDES permit. Anticipated effluent water chemical concentrations from CCNPP Unit 3 are included in Table 3.6-5.

Other non-radioactive liquid waste effluents generated in the controlled area (i.e., Steam Generator Blowdown Demineralizing System), are managed and processed by the Liquid Waste Storage System and the Liquid Waste Processing System. Non-radioactive liquid waste first collects in a tank where it is pre-treated chemically or biologically. Chemical pre-treatment gives the waste an optimum pH value; biological pre-treatment allows organics to be consumed. If deemed cleaned, it can be routed directly to one of the monitoring tanks; otherwise, once pre-treated, the wastes are forwarded to the Liquid Waste Processing System for treatment. Treatment may consist of evaporation, centrifugation, demineralization/ filtration, chemical precipitation (in connection with centrifugation), or organic decomposition (in connection with centrifugation). After the waste water has been treated, it is received in one of two monitoring tanks, which also receive treated liquid radwaste. Waste water is then sampled and analyzed, and if within the limits for discharge, it can be released. Similar to CCNPP Units 1 and 2, CCNPP Unit 3 non-radioactive liquid waste effluents will not be directly discharged.

3.6.3.3 Hazardous Wastes

Hazardous wastes are materials with properties that make them dangerous or potentially harmful to human health or the environment, or that exhibit at least one of the following characteristics: ignitability, corrosivity, reactivity or toxicity. Federal Resource Conservation and Recovery Act regulations govern the generation, treatment, storage and disposal of hazardous wastes. Hazardous waste is defined as any solid, liquid or gaseous waste that is not mixed waste, is listed as hazardous by any federal or state regulatory agency or meets the criteria of Subpart D of 40 CFR 261 (CFR, 2007) or Code of Maryland Regulation 26.13.02 (COMAR, 2007).

A Hazardous Waste Minimization Plan will be developed and maintained that documents the current and planned efforts to reduce the amount or toxicity of the hazardous waste to be generated at CCNPP Unit 3. Hazardous wastes will be collected and stored in a controlled access temporary storage area (TSA). A Hazardous Material and Oil Spill Response guideline will be maintained that defines HAZMAT team positions and duties. Procedures will be put in place to minimize the impact of any hazardous waste spills in the unlikely event of a spill. Containers of known hazardous waste received at a TSA will be transported offsite within 90 days of the containers accumulation date according to the applicable section/unit procedures. The Radiation Protection and Chemistry Manager will be responsible for coordinating the activities of waste transport disposal vendors or contractors while they are on site, ensuring that the transporter has an EPA identification number.

Table 3.6-6 lists the types and quantities of hazardous waste generated at CCNPP Units 1 and 2. The table is based on the CCNPP biennial hazardous waste reports submitted to the MDE for 2001, 2003, and 2005. The quantity of hazardous wastes generated at CCNPP Unit 3 is expected to be similar to or less than that at CCNPP Units 1 and 2.

3.6.3.4 Mixed Wastes

Mixed waste includes hazardous waste that is intermixed with a low level radioactive source, special nuclear material, or byproduct material. Federal regulations governing generation, management, handling, storage, treatment, disposal, and protection requirements associated with these wastes are contained in 10 CFR (NRC regulations) and 40 CFR (Environmental Protection Agency regulations). Mixed waste is generated during routine maintenance activities, refueling outages, radiation and health protection activities and radiochemical laboratory practices. Section 5.5.2 discusses mixed waste impacts, including quantities of mixed waste generated. The quantity of mixed waste generated at CCNPP Unit 3 is expected to be small, as it is at other nuclear power plants.

The management of mixed waste for CCNPP Unit 3 will comply with the requirements of EPA's Mixed Waste Enforcement Policy and the Memorandum of Understanding with the State of Maryland until an approved, EPA permitted disposal facility becomes available (MDE, 2002). CCNPP Units 1 and 2 currently ship some mixed waste offsite to permitted facilities. This occurs infrequently, and is dependent on the waste matrix. It is expected that CCNPP Unit 3 will also infrequently ship some mixed waste to permitted facilities.

Mixed wastes stored in a TSA will be inventoried and a list will be maintained according to CCNPP Unit 3 procedures, and periodic inspections of mixed waste will be conducted according to these same procedures.

3.6.3.5 Solid Effluents

Operation of an industrial waste facility for private use at the CCNPP site does not require a permit but must comply with the regulations imposed by the State of Maryland for construction, installation and operation of solid waste facilities. Acceptable wastes for a landfill containing land clearing debris generated during construction of the units include earthen material such as clays, sands, gravels and silts; topsoil; tree stumps; root mats; brush and limbs; logs; vegetation; and rock.

Other waste materials such as office paper and aluminum cans will be recycled locally. Putrescible wastes will be disposed in a permitted offsite disposal facility.

The types of solid effluents that would be expected generated by CCNPP Unit 3 include hazardous waste; mixed wastes; and cooling water intake debris, trash, and solid effluents. Hazardous waste generation is discussed in Section 3.6.3.3, and mixed waste generation is discussed in Section 3.6.3.4.

Based on the operating experience at CCNPP Units 1 and 2 , it is expected that CCNPP Unit 3 will have essentially zero solid waste effluent. This is because CCNPP Units 1 and 2 recycles, recovers, or sends offsite for disposal virtually all of its solid waste, and does not release solid waste as an effluent. Disposal, recycling, and recover of solid wastes (e.g., scrap metal, petroleum product waste, etc) is described in Section 5.5.1. In summary:

- Non-radioactive solid wastes (e.g., office wastes, recyclables) are collected temporarily on the CCNPP site and disposed of at offsite, licensed disposal and recycling facilities.

- Debris (e.g., vegetation) collected on trash racks and screens at the water intake structure are disposed of as solid waste.
- Scrap metal, used oil, antifreeze (ethylene or propylene glycol), and universal waste will be collected and stored temporarily on the CCNPP site and recycled or recovered at an offsite permitted recycling or recovery facility, as appropriate. Used oil and antifreeze are not controlled hazardous substances in Maryland unless they have been combined or mixed with characteristic or listed hazardous wastes. Typically, used oil and antifreeze are recycled. If they are not, they will disposed of as solid waste in accordance with the applicable regulations.

3.6.4 References

CFR, 2007. Title 40, Code of Federal Regulations, Part 261, Identification and Listing of Hazardous Waste, 2007.

COMAR, 2007. Code of Maryland Regulation, 28.13.02, Identification and Listing of Hazardous Waste, 2007.

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

MDE, 2002. Letter from H.L. Dye (MDE) to L. Linden (Constellation Nuclear Services), RE: Amended MOU - Mixed Wastes at Calvert Cliffs Nuclear Plant, November 12, 2002.

MDPSC, 2008. Calvert Cliffs 3 Nuclear Project, LLC - UniStar Nuclear Operating Services, LLC - Supplemental Information Regarding Air Modeling, October 13, 2008. Case No. 9127, Maryland Public Service Commission, August 13, 2008, Website: http://webapp.psc.state.md.us/Intranet/CaseNum/CaseAction.cfm?CaseNumber=9127. Date accessed: September 16, 2008.

USC, 2007. Title 33, United States Code, Part 1251, Federal Water Pollution Control Act, 2007.

Table 3.6-1— Treatment System Processing Chemicals

System	Operating Cycle(s)	Chemical Processed	Estimated Total Amount Used per Year	Frequency of Use	Avg./Max. Concentration in Waste Stream (mg/l)
Circulating Water Treatment System (CWS Blowdown)	Normal Operating Conditions and Normal Shutdown/ Cooldown	Sodium Bisulfite	191,500 lbs (86,863 kg)	Continuous	TRC: <0.1 / <0.1
		Sodium Hypochlorite	182,500 gal (690,838 l)	Continuous	TRC: <0.1 / <0.1
		Antifoam	18,250 gal (69,084 l)	Continuous	TOC: 1.4 (MAX)
		Dispersant	191,500 lbs (86,863 kg)	Continuous	TSS: 5.2 (MAX)
ESWS Water Treatment System (UHS System Blowdown)	Normal Operating Conditions and Normal Shutdown/ Cooldown	Sodium Hypochlorite Surfactant	(Combined Volume for Both Chemicals) 1,000 gal (3,786 l)	3 times/week	TRC: <0.1 / <0.1
Liquid Waste Storage and Processing Systems	Normal Operating Conditions and Normal Shutdown/ Cooldown	Sulfuric Acid	22,900 gal (86,686 l)	2 times/week	pH: 6.0 – 9.0
		Sodium Hydroxide	2,400 gal (9,085 l)	1/month	
Waste Water Treatment Plant System	Normal Operating Conditions and Normal Shutdown/ Cooldown	Sodium Hypochlorite	800 gal (3,028 l)	1/month	TRC: <0.1 / <0.1
		Sodium Thiosulfate	1,000 lbs (454 kg)	1/month	TRC: <0.1 / <0.1
		Soda Ash	12,000 lbs (5,443 kg)	1/month	pH: 6.3 – 8.6
		Alum/ Polymer	200 gal (757 l)	1/month	TSS: 3.4 / 45

Key:
gal – gallons
L - liters
kg – kilograms
lbs – pounds
CWS – Circulating Water System
TOC – Total Organic Carbon
TRC – Total Residual Chlorine
TSS – Total Suspended Solids
UHS – Ultimate Heat Sink

Table 3.6-2— Desalination of Plant Water Quality (SWRO Process)

Constituents	Feed Water Values	Permeate Values		Reject Values	
		50% Recovery	40% Recovery	50% Recovery	40% Recovery
Barium, mg/l	0.05	0.0	0.0	0.1	0.08
Calcium, mg/l	350	1.8	1.57	698.31	582.31
Magnesium, mg/l	700	3.64	3.18	1,395.58	1,164.59
Potassium, mg/l	250	6.7	5.92	493.4	412.73
Sodium, mg/l	6,041 *	131.76	116.16	11,951.2	9,990.56
Strontium, mg/l	4	0.02	0.02	7.98	6.65
M Alkalinity, mg/l (as $CaCO_3$)	150	4.02	3.55	287.92	242.46
Ammonia, mg/l	1	0.37	0.34	1.63	1.44
Chlorides, mg/l	11,000	217.98	192.13	18,972.2	18,205.99
Fluorides, mg/l	0.6	0.02	0.01	1.18	0.99
Nitrates, mg/l (as NO_3)	<l 0	2.16	1.98	16.07	15.35
pH, standard units	7.7 - 7.8	6.32	6.31	7.54	7.56
Silica, mg/l (total)	3	0.1	0.09	5.9	4.94
Sulfates, mg/l	1,500	3.01	2.63	2,997.45	2,498.35
Total Dissolved Solids (TDS)	19,973.6	371.56	327.6	39,658.9	33,137.34

Notes:

Recovery values are based on 20,000 mg/l TDS

Values in the table do not include wastes from the membrane filtration equipment, which is essentially Chesapeake Bay water having a total suspended solids (TSS) content ten times that of the feed water. Membrane filtration waste is assumed to be 10% of the influent.

At 50% recovery, the waste will be twice as concentrated as the feed water, which is essentially the same as the blowdown from the Circulating Water Cooling Tower.

Table 3.6-3— Waste Water Treatment Plant System Effluents[(a)]

Parameter[(b)]	Concentrations: Daily Maximum	Concentrations: Monthly Average
Biochemical Oxygen Demand		10.6 mg/l
Chemical Oxygen Demand	26 mg/l	
Total Organic Carbon	5.6 mg/l	
Total Suspended Solids		3.4 mg/l
pH	6.3-8.6	
Ammonia	<1.0 mg/l	
Flow		See Table 3.3-1
Arsenic	0.014 mg/l	
Chromium	0.041 mg/l	
Copper	0.022 mg/l	
Nickel	0.028 mg/l	
Zinc	0.060 mg/l	
Cyanide[(c)]	0.039 mg/l	
Total Residual Chlorine	<0.1 mg/l	
Fecal Coliform	12 mg/l	

Notes:

(a) The indicated parameters and concentrations are based on effluent for the CCNPP Units 1 and 2 Waste Water Treatment Plant. Effluent characteristics for the CCNPP Unit 3 Waste Water Treatment Plant are anticipated to be similar. For the anticipated, treated sanitary waste water flow for the CCNPP Unit 3 Waste Water Treatment Plant, refer to Table 3.3-1

(b) All other parameters were below the detection limit level which was below water quality standards.

(c) As a condition of CCNPP Units 1 and 2 NPDES permit, CCNPP was requested to determine the source of cyanide.

Table 3.6-4— Non-Radioactive Gaseous Effluents

	Maximum Expected Emissions During Plant Operation (tpy)					
Source	**PM**	**PM_{10}**	**NO_X**	**CO**	**VOC**	**SO_2**
CWS Cooling Tower (1 tower)	325.2	260.2	0.0	0.0	0.0	0.0
ESWS Cooling Towers (2 towers)	16.3	16.3	0.0	0.0	0.0	0.0
Diesel Generators (6 units)	1.6	1.6	22.8	29.0	3.8	1.3
Total	343.1	278.1	22.8	29.0	3.8	1.3

Table 3.6-5— Anticipated Effluent Water Chemical Concentrations

Outfall	Parameter(s)	Concentration, mg/l	
		Daily Maximum	Monthly Average
Plant Effluent via Submerged Diffuser	Total Residual Chlorine	0.013	0.0075
Storm Water Runoff	Total Suspended Solids	100	30
	Oil & Grease	20	15
	pH	6.0 to 9.0	NA
Intake Screen Backwash	NA	—	—

Key:
mg/l - milligrams per liters
NA - Not Applicable

Table 3.6-6— Biennial Hazardous Waste Management CCNPP Units 1 and 2

		Year/Quantity (lbs/kg)				
	2001		2003		2005	
Hazardous Waste	(lbs)	(kg)	(lbs)	(kg)	(lbs)	(kg)
Sulfuric Acid	840	381	N/A	N/A	N/A	N/A
Ammonium Hydroxide (lead solution)	80	36	N/A	N/A	N/A	N/A
Epoxy Adhesive/Coatings	10	5	N/A	N/A	522	237
Hydrazine	1	0.5	N/A	N/A	N/A	N/A
Corrosive Liquids	161	73	N/A	N/A	N/A	N/A
Mercury-filled Equipment	5	2	N/A	N/A	15	7
Used Oil (with solvents)	1,200	544	N/A	N/A	N/A	N/A
Paint	4,320	1,960	2,320	1,052	5,115	2,320
PCB Capacitors	4	2	N/A	N/A	N/A	N/A
PCB Light Ballasts	20	9	11	5	N/A	N/A
Flammable Liquid	N/A	N/A	800	363	N/A	N/A
Compressed Gases	N/A	N/A	30	14	N/A	N/A
Lab Pack Chemicals (flammable)	N/A	N/A	200	91	253	115
Lab Pack Chemicals (toxic)	N/A	N/A	80	36	N/A	N/A
Aqueous Ammonia Solution	N/A	N/A	N/A	N/A	6,000	2,722
Activated Carbon	N/A	N/A	N/A	N/A	1	0.5
Lead (debris)	N/A	N/A	N/A	N/A	150	68
Butane	N/A	N/A	N/A	N/A	2	1
Propane	N/A	N/A	N/A	N/A	4	0.9
Total	6,641	3,012.5	3,441	1,561	12,062	5,471.4

Key:
N/A – Not Applicable
(lbs) – pounds
(kg) - kilogram

Table 3.6-7— CCNPP Unit 3 Waste Water Treatment Plant Capacity and Unit Loading

Average Daily Flows	2
Number of people during normal operation	363/day
Flow assumption	15 gpd (56.8 lpd)/person/shift
Shift per day	3
Peak flow during outages (times daily average flow)	3
Mass BOD and TSS per person	0.055 lb (0.25 kg)/day/person
Minimum number of people using shower facilities during normal operation	250/day/shift
Construction phase staffing	2,000/day/shift
Design flow-normal operation	52,500 gpd (1.98 E+5 lpd)
Design flow-outages (peak)	183,000 gpd (6.93 E+5 lpd)
Design flow-construction CCNPP Unit 3	250,000 gpd (9.46 E+5 lpd)
BOD/TSS (estimated)	
Normal plant operations	125 lb (56.7 kg)/day
Outages	375 lb (170 kg)/day
CCNPP Unit 3 construction	400 lb (181.4 kg)/day

3.7 POWER TRANSMISSION SYSTEM

The NRC criteria for review of power transmission systems are presented in Section 3.7 of NUREG-1555 (NRC, 1999). To address these criteria, this section of the Environmental Report describes the transmission system from the CCNPP Unit 3 substation to its connections with the existing CCNPP Units 1 and 2 transmission systems, including lines, corridors, towers, substations, and communication stations. CCNPP Unit 3, with an additional 1,562 MWe net rating, would require the following new facilities and upgrades to connect to the existing transmission system:

- One new 500 kV, 16 breaker, breaker-and-a-half substation to transmit power from CCNPP Unit 3 (PJM, 2006)
- Two new 500 kV, 3,500 MVA (normal rating) circuits connecting the new CCNPP Unit 3 substation to the existing CCNPP Units 1 and 2 substation (PJM, 2006)
- Breaker upgrades and associated modifications at Waugh Chapel, Chalk Point and other affected substations (PJM, 2006).

The existing transmission system, constructed and operated for CCNPP Units 1 and 2, was addressed in the Environmental Report submitted with the original plant license application (BGE, 1970) and re-evaluated in the Environmental Report submitted with the license renewal application (BGE, 1998). The existing transmission system consists of two circuits, the North Circuit which connects the CCNPP site to the Waugh Chapel Substation in Anne Arundel County and the South Circuit that connects the CCNPP site to the Mirant Corporation Chalk Point Generating Station in Prince George's County. The North Circuit is composed of two separate three-phase 500 kV transmission lines run on a single right-of-way from the CCNPP site, while the South Circuit is a single three-phase 500 kV line. The existing transmission system will not be addressed in this section, except where it impacts or is impacted by the transmission facilities of CCNPP Unit 3. The routes for the existing two 500 kV circuits from the CCNPP site to the Waugh Chapel Substation and single 500 kV circuit from the CCNPP site to the Chalk Point Generating Station are presented in Figure 3.7-1.

The new transmission facilities would be developed as required by the Annotated Code of Public General Laws of Maryland, Public Utility Companies Article, Title 7, Subtitle 2, Electric Generation Facility Planning (COMAR, 2007a). The Code outlines the legal and regulatory processes necessary to construct a transmission line in Maryland.

3.7.1 Substation and Connecting Circuits

3.7.1.1 CCNPP Unit 3 Substation

The CCNPP Unit 3 substation would occupy a 700 ft (213 m) by 1,200 ft (366 m) tract of land approximately 1,000 ft (305 m) southeast of CCNPP Unit 3 and 2,000 ft (610 m) east-southeast of the existing switchyard as detailed in Figure 3.7-2. The CCNPP Unit 3 substation would be electrically integrated with the existing CCNPP Units 1 and 2, 500 kV, substation by constructing two approximately 1 mi (1.6 km), 500 kV, 3,500 MVA lines on individual towers. At the existing CCNPP Units 1 and 2 substation, the two line positions previously used for 500 kV circuits 5052 (Calvert Cliffs-Waugh Chapel) and 5072 (Calvert Cliffs-Chalk Point) would be upgraded for use with the two lines to the CCNPP Unit 3 substation. The 5052 and 5072 circuits would be connected to the CCNPP Unit 3 substation, while the 5051 circuit to Waugh Chapel would remain connected to the CCNPP Units 1 and 2 substation (PJM, 2006).

The CCNPP Unit 3 substation and transmission lines would be constructed in areas that, at present, are vegetated, contain delineated wetlands and have steep topography. The CCNPP Unit 3 substation area, as detailed in Figure 3.7-2, would be graded level with removal of any vegetation which might be present. Areas under the transmission lines would be cleared of any vegetation that could pose a safety risk to the transmission system, either through arcing or reducing the structural integrity of towers.

3.7.1.2 Connecting Circuits

The CCNPP Unit 3 substation would be electrically integrated with the existing CCNPP Units 1 and 2, 500 kV, substation by constructing two approximately 1 mi (1.6 km), 500 kV, 3,500 MVA lines on individual towers. A topographic map showing the location of the connecting circuits between the two substations is presented in Figure 3.7-2. Line routing would be conducted to avoid or minimize impact on the existing Independent Spent Fuel Storage Installation, wetlands, or threatened and endangered species identified in the local area. The final design of the new and relocated transmission lines has not been completed, but the layout of the new lines will not have any impact on the existing transmission corridor, and all new line construction will be contained within the CCNPP site property lines. No changes to the offsite corridors are required.

3.7.2 Electrical Design Parameters

3.7.2.1 Circuit Design

The detailed design of the transmission lines has not begun but would include selection of the conductor and conductor configuration and the other design parameters specified by NUREG-1555 (NRC, 1999). Design and construction of transmission lines would be based on the guidance provided by the National Electric Safety Code (NESC) (ANSI/IEEE, applicable version), State and Local regulations , and any requirements of the approved Certificate of Public Convenience and Necessity (CPCN).

While the detailed design of the transmission circuits has not begun, the conductors would be selected to meet the power delivery requirements of CCNPP Unit 3. The two 500 kV lines connecting the existing CCNPP Units 1 and 2 substation and the proposed CCNPP Unit 3 substation would be rated at 3,500 MVA (normal rating) (PJM, 2006). Each phase would use the same three sub-conductor bundles comprised of three 1,590 circular mills, 45/7 aluminum conductor, steel reinforced conductors with 18 in (0.5 m) separation. There would typically be two overhead ground wires of 19#9 Alumoweld® or 7#8 Alumoweld®, but the final design could specify optical ground wire fiber optic cable in place of the Alumoweld® ground wire. The new lines would be designed to preclude crossing of lines wherever possible.

3.7.2.2 Induced Current Analysis

The design of the new transmission circuits would consider the potential for induced current as a design criterion. The NESC has a provision that describes how to establish minimum vertical clearances to the ground for electric lines having voltages exceeding 98 kV alternating current to ground. The clearance must limit the induced current due to electrostatic effects to 5 mA if the largest anticipated truck, vehicle, or equipment were short-circuited to ground. For this determination, the NESC specifies that the lines be evaluated assuming a final unloaded sag at 120°F (49°C). The calculation is a two step process in which the analyst first calculates the average field strength at 1.0 m (3.3 ft) above the ground beneath the minimum line clearance, and second calculates the steady-state current value. The design and construction of the CCNPP Unit 3 substation and transmission circuits would comply with this NESC provision. At a minimum, conductor clearances over the ground would equal or exceed 29 ft

(8.8 m) phase-to-ground over surfaces that could support a large truck or farm machinery, while clearance over railroad lines would equal or exceed 37 ft (11.3 m) phase-to-ground.

3.7.3 Noise Levels

The noise impacts associated with the transmission system would be from three major sources: (1) corona from the transmission lines (a crackling or hissing noise); (2) operation of the substation transformers; and (3) maintenance work and vehicles.

3.7.3.1 Corona

Corona discharge is the electrical breakdown of air into charged particles caused by the electrical field at the surface of the conductors, and is increased by ambient weather conditions such as humidity, air density, wind, and precipitation and by irregularities on the energized surfaces. During wet conditions audible noise from the corona effect can exceed 50 dBA for a 500 kV line may range between 59 and 64 dBA. Corona noise for a 500 kV line has been estimated to be 59.3 dBA during a worst-case rain with heavy electrical loads (SCE, 2006). For reference, normal speech has a sound level of approximately 60 dB and a bulldozer idles at approximately 85 dB. The State of Maryland Environmental Noise Standard for industrial zoning districts is 75 dBA (MD, 2007).

As shown in Figure 3.7-2, the proposed CCNPP Unit 3 substation and transmission lines connecting the CCNPP Unit 3 substation and the existing CCNPP Units 1 and 2 substation would be constructed entirely on the CCNPP site. The new transmission lines would be approximately 1 mi (1.6 km) in length and located more than 3,500 ft (1,060 m) from the site boundary. The corona noise would be significantly reduced at the site boundary from approximately 60 dBA near the conductors.

3.7.3.2 Substation Noise

Substations include transformer banks and circuit breakers that create "hum," normally around 60 dBA, and occasional instantaneous sounds in the range of 70 to 90 dBA during activation of circuit breakers (SCE, 2006). The proposed CCNPP Unit 3 substation would introduce these new noise sources (transformers and circuit breakers) to its location. The noise levels surrounding the substation would likely be close to 60 dBA near the substation fence, but would be significantly reduced near the site boundary, approximately 2,800 ft (850 m) to the south.

3.7.3.3 Maintenance Noise

Regular inspections and maintenance of the transmission system and right-of-ways are performed. A patrol is performed twice annually of all transmission corridors, while more comprehensive inspections are performed on a rotating 5 year schedule Maintenance is performed on an as-needed basis as dictated by the results of the line inspections and are generally performed on a 5 year rotating schedule for tree trimming. The noise levels for maintenance activities would typically be those associated with tree trimming, spraying, mowing and vehicle driving. Noise levels for maintenance in the new onsite corridor are expected to be similar to those currently generated by maintenance activities.

3.7.4 Structure Design

The existing 500 kV transmission towers are designed and constructed to National Electric Safety Code and current CCNPP site standards. New towers added to support CCNPP Unit 3 will also conform to these criteria. The new towers will be steel tubular or lattice designs, and will provide minimum clearances in accordance with the aforementioned standards. The two circuits connecting the existing CCNPP Units 1 and 2 substation and the CCNPP Unit 3 substation would be carried on separate towers. All structures would be grounded with a combination of ground rods and a ring counterpoise system. None of the transmission structures would exceed a height of 200 ft (61 m) above ground surface; thus, Federal Aviation Administration permits would not be required.

3.7.5 Inspection and Maintenance

Regular inspections and maintenance of the transmission system and right-of-ways will be performed. These inspections and maintenance include patrols and maintenance of transmission line hardware on a periodic and as-needed basis. Vegetation maintenance may include tree trimming and application of herbicide. Maintenance of the proposed onsite corridors including vegetation management will be implemented under the Baltimore Gas and Electric Forestry Program in accordance with ANSI A300 (ANSI, 2001a) (ANSI, 2006b) standards to promote safety, reliability, and environmental benefit.

3.7.6 References

ANSI/IEEE, applicable version. National Electric Safety Code, ANSI/IEEE C2, version in effect at time of design, American National Standards Institute/Institute of Electrical and Electronics Engineers.

ANSI, 2001a. Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices (Pruning), ANSI-A300 (Part 1), American National Standards Institute, 2001.

ANSI, 2001b. Integrated Vegetation Management, ANSI-A300 (Part 7), American National Standards Institute, 2001.

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

BGE, 1998. Applicant's Environmental Report – Operating License Renewal Stage, Calvert Cliffs Nuclear Power Plant Units 1 and 2, Baltimore Gas and Electric Company, April 1998.

COMAR, 2007a. Annotated Code of Public General Laws of Maryland, Public Utility Company Article, Title 7, Subtitle 2, Electric Generation Planning, 2007.

COMAR, 2007b. Code of Maryland Regulation, Title 26, Subtitle 2, Chapter 3, Control of Noise Pollution, 2007.

MD, 2007. Code of Maryland Regulations, COMAR 26.02.03, Control of Noise Pollution, 2007.

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

PJM, 2006. PJM Generator Interconnection Q48 Calvert Cliffs 1640 MW Feasibility Study, DMS #390187, PJM Interconnection LLC, October 2006.

SCE, 2006. Devers-Palo Verde 500 kV No. Project (Application No. A.05-04-015), Final Environmental Impact Report/ Environmental Impact Statement, State of California Public Utilities Commission, Southern California Edison, October 2006.

Figure 3.7-1— CCNPP Site 500 kV Circuit Corridors

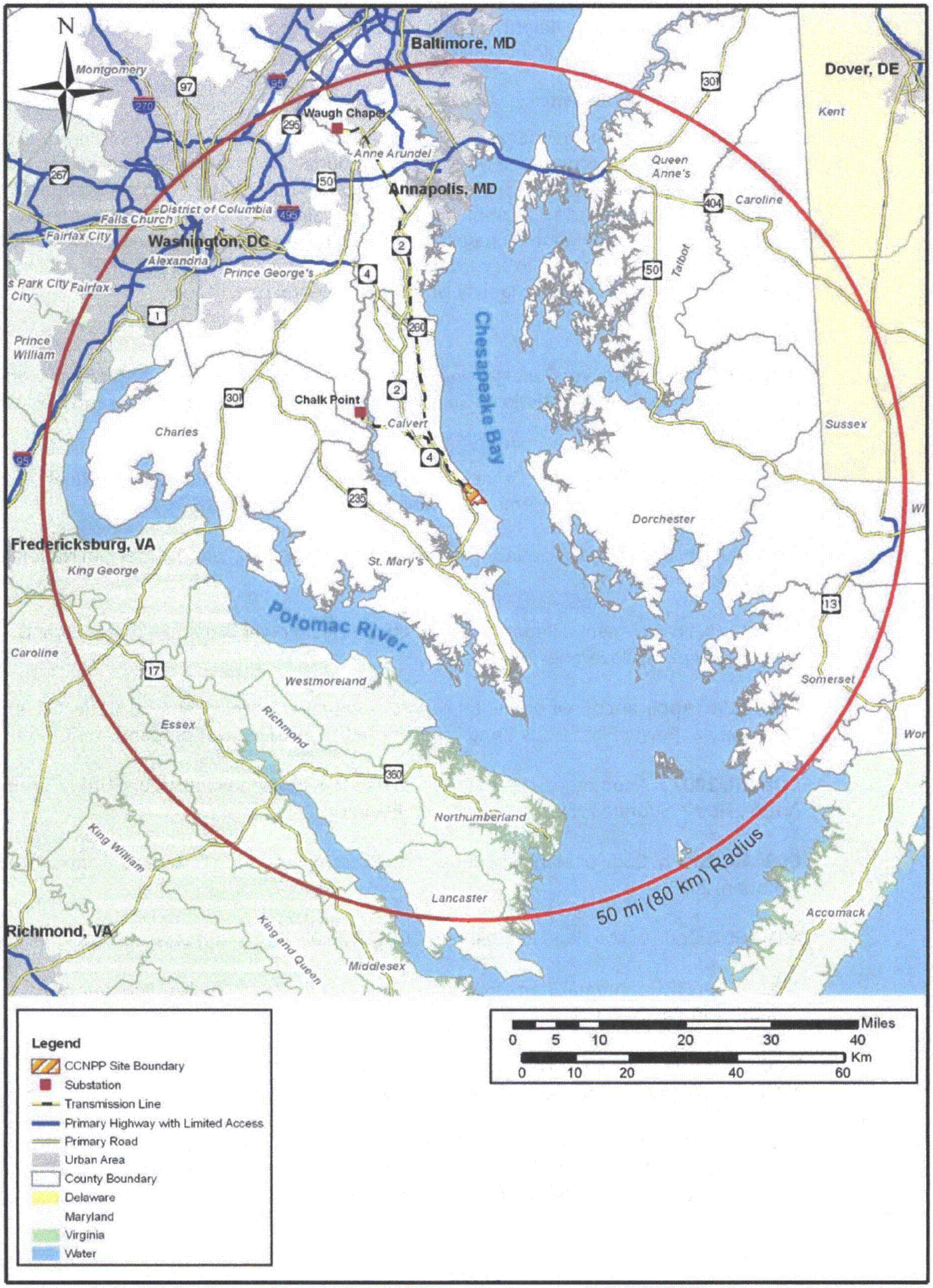
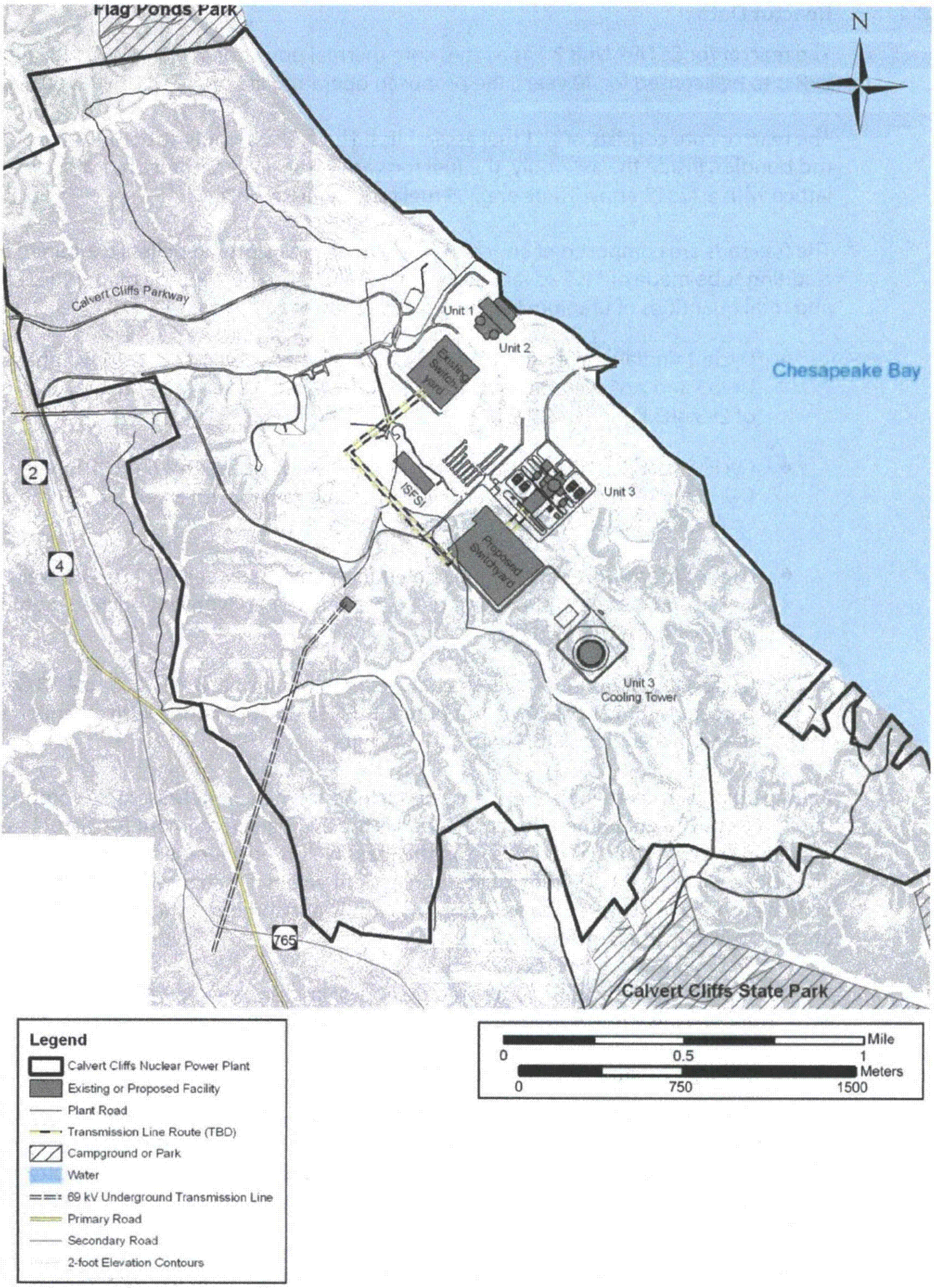


Figure 3.7-2— CCNPP Site Topography and Generalized Transmission Line Corridor



See Figure 2.1-1 and Figure 3.1-2 for Site and Powerblock layout

3.8 TRANSPORTATION OF RADIOACTIVE MATERIALS

3.8.1 Reactor Data

The reactor for CCNPP Unit 3 has a rated core thermal power of 4,590 (MWt). Although the U.S. EPR is to be licensed for 40 years, the proposed operating life of the U.S. EPR is 60 years.

The reactor core consists of 241 fuel assemblies. The fuel assembly structure supports the fuel rod bundles. Inside the assembly, the fuel rods are vertically arranged according to a square lattice with a 17x17 array. There are 265 fuel rods per assembly.

The fuel rods are composed of enriched uranium dioxide sintered pellets contained in a cladding tube made of M5® advanced zirconium alloy. The percentage of uranium enrichment and total quantities of uranium for the reactor core is as follows:

- Cycle 1 (initial) - average batch enrichment is between 2.23 to 3.14 weight percent U-235 and 2.66 weight percent U-235 for core reload with an enriched uranium weight of 285,483 lbs (129,493 kg).
- Cycle 2 (transition) - average batch enrichment is between 4.04 to 4.11 weight percent U-235 and 4.07 weight percent U-235 for core reload with an enriched uranium weight of 141,909 lbs (64,369 kg).
- Cycle 3 (transition) - average batch enrichment is between 4.22 to 4.62 weight percent U-235 and 4.34 weight percent U-235 for core reload with an enriched uranium weight of 113,395 lbs (51,435 kg).
- Cycle 4 (equilibrium) - average batch enrichment is between 4.05 to 4.58 weight percent U-235 and 4.30 weight percent U-235 for core reload with an enriched uranium weight of 113,417 lbs (51,445 kg).

Average batch enrichment is the average enrichment for each fuel assembly comprising a batch of fuel. The enrichment for core reload is the average enrichment for all fuel assemblies loaded in the core which is derived from the mass weighted average for the batches of fuel. The above values are 'beginning of life' enrichment values. Discharged enrichment values will be less at the 'end of life' of the assembly. Assembly enrichment reduction is directly proportional to the assembly burnup.

Discharge burnups for equilibrium cores are approximately between 45,000 and 59,000 MWd/MTU. The batch average discharge burnup for equilibrium cores is about 52,000 MWd/MTU.

3.8.2 Onsite Storage Facilities for Irradiated Fuel

As discussed in Section 3.5.3, the spent fuel pool will be sized to accommodate at least 10 calendar years of wet storage, plus a full core offload. CCNPP Unit 3 will utilize a 5 year minimum decay period between removal from the reactor and transportation offsite, as required by the Department of Energy (DOE) and as prescribed under 10 CFR 961, Appendix E, (CFR, 2007c).

3.8.3 Treatment and Packaging of Radioactive Materials other than Irradiated Fuel

Solid low level waste (LLW) shipped offsite for processing and disposal include dry activated wastes (DAW), aqueous cartridge type filters, solidified evaporator concentrates, resin beads, irradiated hardware, and small amounts of mixed wastes. The waste streams, annual generated volumes, and shipments are summarized in Table 3.8-1.

The CCNPP Unit 3 waste-streams identified in Table 3.8-1 will be packaged in solid form in accordance with the requirements of 10 CFR 51.52(a)(4), 10 CFR 71, 49 CFR 173, and 49 CFR 178, (CFR 2007a, 2007b, 2007d, and 2007e), and as required for acceptance by the processor and disposal site's waste acceptance criteria.

3.8.4 Transportation System for Fuel and Other Radioactive Wastes

Unirradiated fuel will be shipped to CCNPP Unit 3 by truck.

The DOE is responsible for irradiated fuel shipments from CCNPP Unit 3 to the repository. The DOE will make the decision regarding the mode of transport. It is anticipated that irradiated fuel will be shipped by truck, rail, or barge.

Radioactive waste from CCNPP Unit 3 will be shipped by truck or rail.

CCNPP Unit 3 will operate in accordance with carrier procedures and policies that comply with the requirements of 10 CFR 51.52(a)(4), 10 CFR 71, 49 CFR 173, and 49 CFR 178, (CFR 2007a, 2007b, 2007d, and 2007e). The procedures will be similar to those established for CCNPP Units 1 and 2.

3.8.5 Transportation Distance from the Plant to the Storage Facility

The detailed analysis of the transportation of fuel and wastes to and from the facility is provided in Sections 5.11 and 7.4. The discussion of the analysis includes the assumptions regarding the transportation distances to the appropriate storage facilities.

3.8.6 Conclusions

Table 3.8-2 compares the conditions in 10 CFR 51.52(a) (CFR, 2007a) with the design parameters for CCNPP Unit 3. As noted in Table 3.8-2, the design for CCNPP Unit 3 will not meet all of the conditions of 10 CFR 51.52(a) (CFR, 2007a). Therefore, the environmental impact from the transportation of fuel and wastes to and from the facility require detailed analyses as required in 10 CFR 51.52(b) (CFR, 2007a). Detailed analyses are presented in Sections 5.11 and 7.4.

3.8.7 References

CFR, 2007a. Code of Federal Regulations, Title 10, 51.52, Environmental Effects of Transportation of Fuel and Waste - Table S-4, 2007.

CFR, 2007b. Code of Federal Regulations, Title 10, Part 71, Packaging and Transportation of Radioactive Material, 2007.

CFR, 2007c. Code of Federal Regulations, Title 10, Part 961, Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste, Appendix E, 2007.

CFR, 2007d. Code of Federal Regulations, Title 49, Part 173, Shippers - General Requirements for Shipments and Packagings, 2007.

CFR, 2007e. Code of Federal Regulations, Title 49, Part 178, Specifications for Packagings, 2007.

Table 3.8-1— Annual Solid Radioactive Wastes

Waste Type	Quantity ft^3 (m^3)	Activity Content (Ci) Expected	Activity Content (Ci) Maximum	Shipping Volume ft^3 (m^3) Expected	Shipping Volume ft^3 (m^3) Maximum
Solid Waste Stored in Drums					
Evaporator Concentrates	710 (20.1)	1.50E+02 5.5E+12	9.12E+03 3.37E+14	Varies	140 (3.96)
Spent Resins (Other)	90 (2.55)	1.07E+03 3.96E+13	5.23E+04 1.93E+15	90 (2.55)	
Spent Resins (Radwaste Demineralizer System)	140 (3.96)	1.50E+02 5.5E+12	9.12E+03 3.37E+14	140 (3.96)	
Wet Waste from Demineralizer	8 (0.23)	1.50E+02 5.5E+12	9.12E+03 3.37E+14	8 (0.23)	
Waste Drum for Solids Collection from Centrifuge System of Liquid Waste Storage & Processing	8 (0.23)	1.50E+02 5.5E+12	9.12E+03 3.37E+14	Varies	8 (0.23)
Filters (quantity)	120	6.86E+02 2.54E+13		120 (3.40)	
Sludge	70 (1.98)	1.50E+02 5.5E+12	9.12E+03 3.37E+14	Varies	35 (0.99)
Total Solid Waste Stored in Drums	1,146 (32.5)	2.51E+03 9.29E+13	9.86E+04 3.65E+15	358 (10.1)	541 (15.3)
Mixed Waste					
Mixed Waste	2 (0.057)	0.04 1.48E+09	2.43 8.99E+10	2 (0.057)	
Dry Active Waste (DAW)					
Non-Compressible DAW	70 (1.98)	2.97E-01 1.09E+10	1.81E+01 6.97E+11	70 (1.98)	
Compressible DAW	1,415 (40.1)	6.01E+00 2.22E+13	3.66E+02 1.35E+13	707 (20.0)	
Combustible DAW	5,300 (150.1)	3.19E+01 1.18E+12	1.94E+03 7.18E+13	5,300 (150.1)	
Total Dry Active Waste	6,785 (192.1)	3.82E+01 1.43E+12	2.32E+03 8.58E+13	Varies	
Overall Totals	7,933 (224.6)	2.55E+03 9.43E+13	1.01E+05 3.74E+15	Varies	

Notes:
1. Activity contents represent waste activity after a defined period (i.e., 6 months) that covers onsite storage before shipping.
2. The volume of evaporator concentrates and sludge, and the number of waste drums will be determined by the method of treatment.

Table 3.8-2— Transportation Environmental Impact Comparison

10 CFR 51.52(a) Parameter	10 CFR 51.52(a) Condition	CCNPP Unit 3
(1) Reactor Power Level, MWt	3,800	4,590
(2) Fuel Form and U235 Enrichment, weight percent	Zircaloy encapsulated sintered uranium dioxide pellets at 4.0	M5® advanced zirconium alloy encapsulated sintered uranium dioxide pellets at 4.58
(3) Average Irradiation Level and Minimum Decay, MWd/MTU	33,000 at 90 days decay	52,000 at 5 years decay
(4) Radioactive Waste Physical Form	Packaged as Solid	Packaged as Solid
(5) Transport Mode	New Fuel: Truck Irradiated Fuel: Truck, Rail, Barge LLW: Truck, Rail	New Fuel: Truck Irradiated Fuel: Truck, Rail, Barge LLW: Truck, Rail
(6) Environmental Impacts	Table S-4 of 10 CFR 51.52	Refer to Sections 5.11 and 7.4

Note:
LLW – Low Level Waste

ENVIRONMENTAL REPORT

CHAPTER 4

IMPACTS OF CONSTRUCTION

4.0 IMPACTS OF CONSTRUCTION

4.1 LAND USE IMPACTS

This section describes the impacts of site preparation and construction to the CCNPP site and the surrounding area. Section 4.1.1 describes impacts to the site and vicinity. Section 4.1.2 describes impacts that could occur along transmission lines. Section 4.1.3 describes impacts to historic and cultural resources at the site.

4.1.1 The Site and Vicinity

The CCNPP site land use is presented in Table 2.2-1 and shown on Figure 2.2-1. The land use categories are consistent with USGS land use/cover categories. Land use/cover within the 8 mi (13 km) site vicinity is presented in Table 2.2-2 and shown on Figure 2.2-2. Highways and utility right-of-ways that cross the site and vicinity are shown on Figure 2.2-4 and Figure 2.2-5.

4.1.1.1 The Site

CCNPP Unit 3 and supporting facilities would be located on the 2,070 acre (838 hectares) CCNPP site, to the southeast of and adjacent to CCNPP Units 1 and 2. The CCNPP site use activities will not change as the result of the proposed action. The CCNPP site acreage were purchased for and used by Constellation Energy for the purpose of generating electricity. The proposed action of the construction and operation of an additional power unit does not alter the site's current use. The CCNPP site will conform to all applicable local, state, and Federal land use requirements and restrictions as they pertain to the proposed action. Figure 4.1-1 shows the current Calvert County zoning categories for the CCNPP site.

The State of Maryland and Calvert County have land use plans that attempt to limit sprawl and encourage smart growth primarily through zoning ordinances. Through regulation, the Federal, State, and County governments attempt to limit potential environmental impacts to coastal areas including the Chesapeake Bay. The CCNPP site would follow all local, state, and federal requirements that pertain to the Coastal Zone Management Program (MDE, 2004) regulations and those regulations pertaining to the Chesapeake Bay Critical Area (CALCO, 2006) (CAC, 2006). During construction, site activities are required to be authorized by the agencies and programs listed in Table 1.3-1. There are no recognized Native American Tribal Land use plan that would have jurisdiction over the CCNPP site or within the vicinity of the CCNPP site that could impact the CCNPP site.

Table 4.1-1 provides an estimate of the land areas that would be disturbed during construction of CCNPP Unit 3 and supporting facilities, including temporary features such as laydown areas, stormwater retention ponds, and borrow areas. The CoApplicants currently estimate that a total of approximately 460 acres (186 hectares) of the CCNPP site will be disturbed during the construction of CCNPP Unit 3. Of that total, approximately 320 acres (129 hectares) would be permanently dedicated to CCNPP Unit 3 and its supporting facilities. Approximately 36.4 acres (14.7 hectares) of existing open field area to the north of the proposed construction access road will be used to permanently store excavated material from the power block, CWS Cooling Tower and other construction areas that are not suitable for construction backfill. This area will be stabilized with vegetative cover after final grading. Approximately 15 acres (6 hectares) may have to have vegetation removed to accommodate large construction equipment, but it will not be necessary to disturb soil. Acreage not containing permanent structures would be reclaimed to the maximum extent possible.

From Figure 4.1-1, an estimate was made regarding the amount of land currently zoned as Forest and Farm District within the CCNPP site boundary that would be affected by the proposed construction activities. Approximately 147 acres (59 hectares) of land currently zoned Forest and Farm District will be permanently (134 acres (54 hectares)) or temporarily (13 acres (5.2 hectares)) impacted by the construction activities. Approximately 19.7 acres (8 hectares within the Intensely Developed Area (IDA) will be impacted.

As discussed in Section 4.3.1.1, an estimated 193 acres (78 hectares) of mixed deciduous forest would be lost during construction activities, approximately 28 acres (11 hectares) of which would be temporary. Additional information is provided on Table 4.3-1.

Section 2.2.1 describes the land areas that are devoted to major uses within the CCNPP site boundary and the CCNPP site vicinity. These areas are depicted on Figure 2.2-1 and Figure 2.2-2, respectively. In addition, Section 2.2.1 describes the highways and utility right-of-way that cross the CCNPP site and vicinity. The footprint for the proposed unit and supporting facilities will be partially located on land and facilities associated with Camp Conoy, a recreational facility formerly used by CCNPP employees. This area is not open to the public; thus, there would be no impact to public recreation areas as the result of the proposed action. CalvertCliffs 3 Nuclear Project and UniStar Nuclear Operating Services are not aware of any Federal action in the area that would have cumulatively significant land use impacts.

Heavy equipment and reactor components would be barged up the Chesapeake Bay to the existing barge slip. The slip area would be dredged and the existing heavy haul road from the barge slip would be modified and extended to the new construction site and lay down areas. A new access road, approximately 2 mi (3.2 km) long, would be constructed from Maryland State Road 2/4 to the construction site providing access to the construction areas without impeding traffic to the existing units. A site perimeter road system and access road around the cooling tower area to the power block would be built. Another road would be constructed to the proposed water intake structure.

The new intake, discharge, and barge facilities would be located in the 100 year coastal floodplain. With those exceptions, construction activities would be outside the 500 year floodplain in areas designated as areas of minimal flooding (FEMA, 1977).

The proposed location of CCNPP Unit 3 and supporting facilities is not farmland, and does not possess any prime farmland soils. The CCNPP site itself is predominantly forested with areas categorized as "Urban" or "Built-up" in the vicinity of the areas of current CCNPP operational facilities. In addition, the only known mineral deposits currently being extracted in Calvert Country are sand and gravel as described in Section 2.2.1.2. There are no known economic mineral deposits on the CCNPP site.

The proposed construction activities would result in the permanent loss, through filling, of approximately 11.72 acres (4.7 hectares) of non-tidal wetland habitat and approximately 30.69 acres (12.48 hectares) of non-tidal wetland buffer. Section 4.3.1.3 provides a detailed discussion of construction impacts to wetlands.

Construction would also impact 33.4 acres (13.5 hectares) within the Chesapeake Bay Critical Area including approximately 14.35 acres (5.8 hectares) within the Chesapeake Bay Critical Area Buffer area that extends 100 ft (30.5 m) landward of mean high tide. This occurs in the vicinity of the proposed intake and discharge pipelines, the heavy haul road, stormwater retention basins, sand filters, and security fencing. The intrusion into the Chesapeake Bay Critical Area (CBCA) buffer also includes the regrading of a parcel near the intake structure to accommodate construction equipment. These intrusions are within the areas designated IDA. Section 4.3.1 provides a detailed discussion of construction impacts within the Chesapeake Bay Critical Area.

In the event the construction of CCNPP Unit 3 is not completed, a Site Redress Plan describing the return of the site to preconstruction conditions willbe provided.

It is concluded that the land use impacts to the CCNPP site and vicinity of the CCNPP site from construction of the new unit would be MODERATE, primarily due to the loss of wetlands and wetland buffers, and would require mitigation. The mitigation measures associated with the wetlands and wetland buffers are described in Section 4.3.1.4.

4.1.1.2 The Vicinity

Land in the vicinity of the CCNPP site is rural with development generally occurring in town centers per current Calvert County zoning and planning requirements. Land use within 8 miles (13 km) of the site is predominantly forest as described in Figure 2.2-2.

The construction activities that would degrade the visual aesthetics of the land would be limited to those activities potentially seen from the new construction access road. Because of the forested nature of the area surrounding the proposed site, it is unlikely that construction activities for the proposed facilities could be seen directly from the adjacent highway, with the exception of the activities to build or upgrade the CCNPP site access road. Once the proposed facility construction extends above the tree line, some construction could be seen from roadways or other areas in the vicinity of the site depending on the area's topography and the immediate land cover. Construction of the new water intake and discharge structure and the upgrade to the barge pier, barge pier crane, and related roadways will be visible from the Chesapeake Bay. However, because a portion of the CCNPP site is currently zoned as industrial and already contains CCNPP Units 1 and 2, visual impacts from the proposed project would be similar to existing site conditions.

Section 4.4.2.4 provides the details on potential population impacts due to construction activities. The majority of the temporary construction workforce would probably live outside of Calvert County and St. Mary's County. These workers would commute or find temporary housing in Calvert County or St. Mary's County. No other land use changes in the vicinity would likely occur as a result of construction workforce related population changes.

Thus, it is concluded that impacts to land use in the vicinity of CCNPP Unit 3 would be SMALL, and not require mitigation.

4.1.2 Transmission Corridors and Offsite Areas

The additional electricity generated from CCNPP Unit 3 will not require the addition of new offsite right-of-way. As discussed in Section 2.2.2.2, the proposed CCNPP Unit 3 construction activities on the CCNPP site would include the following transmission system changes:

- One new 500 kV substation to transmit power from CCNPP Unit 3
- Two new 500 kV, 3,500 MVA circuits connecting the new CCNPP Unit 3 substation to the existing CCNPP Units 1 and 2 substation
- Two existing 500 kV, 3,500 MVA circuits that are currently connected to the existing CCNPP Units 1 and 2 substation will be disconnected from the substation and extended 1.0 mi (1.6 km) to the CCNPP Unit 3 substation.

Numerous breaker upgrades and associated modifications would also be required at Waugh Chapel substation, Chalk Point Generating Station, and other existing substations.

The North and South Circuits of the CCNPP power transmission system are located in corridors totaling approximately 65 miles (105 km) of 350 to 400 ft (100 to 125 m) wide corridors owned by Baltimore Gas and Electric. The lines cross mostly secondary-growth hardwood and pine forests, pasture, and farmland. The existing CCNPP Units 1 and 2 are also connected to the Southern Maryland Electric Cooperative's Bertha substation via a 69 kV underground transmission line.

The transmission line work being considered to support this project would require new towers and transmission lines to connect the CCNPP Unit 3 switchyard to the existing switchyard for CCNPP Units 1 and 2. Line routing would be conducted to avoid or minimize impact on the existing Independent Spent Fuel Storage Installation (ISFSI), wetlands, and threatened and endangered species identified in the local area. No new offsite corridors or widening of existing corridors are required. The proposed onsite connector corridor would be located on land already in use to generate electric power. Some of the proposed facility locations associated with the project are located on land currently zoned and used as light industrial. The remainder is zoned as Farm and Forest District. CCNPP Unit 3 will be exempt from the Calvert County Zoning Ordinance once the CPCN for CCNPP Unit 3 is issued. However, all federal, state, and local regulations and requirements including those that deal with construction impacts, and those regulations pertaining to the Coastal Zone Management Program, the Chesapeake Bay Critical Area, and the Maryland Public Service Commission would be complied with.

There are no Federal actions that would have cumulatively significant land use impacts within the vicinity and region of the CCNPP site activity and offsite areas as described in Section 2.8.

Because there are no new offsite transmission corridors, it is concluded that there will be no additional impacts to the offsite transmission corridor lands associated with the proposed construction of CCNPP Unit 3. The proposed onsite transmission line connector corridor would be located on land already in use to generate electric power. No new access roads of modifications to existing roads are currently anticipated.

4.1.3 Historic Properties

Table 2.5-40 and Table 2.5-41 list resources within the proposed project's Area of Potential Effect (APE) that are eligible for listing on the National Register of Historic Places (NRHP) as well as resources that have been evaluated as neglible based on Phase II testing. These tables reflect the comments received from the Maryland State Historic Preservation Office (SHPO) (MHT, 2007 and MHT, 2009). As described in Section 2.5.3, the cultural resource survey of the CCNPP site identified seventeen archaeological sites, one of which is considered eligible for inclusion in the NRHP. The survey also identified five architectural resources, four of which are considered eligible for the NRHP.

The assessment of effects to the five NRHP-eligible resources from project construction activities is as follows. It is likely that archaeological site (18Cv474) would be heavily damaged by construction activities and use, thereby resulting in an adverse effect to those resources. Of the four architectural resources, two would be adversely affected. These two architectural resources are the Baltimore and Drum Point Railroad roadbed and Camp Conoy. These two architectural and historical resources are located within the 727 acre (294 hectares) APE and would be heavily damaged by construction activities and use, resulting in an adverse effect to these resources. Consultation with the SHPO and interested parties is ongoing concerning measures to avoid or mitigate adverse effects to these resources. The assessment of effects conducted for the Preston's Cliffs property, located in the northeast corner of the 727-acre

(294-hectare) project APE, concluded that proposed project impacts, consisting of tree planting within the limits of its NRHP boundary, will result in no effect to this resource. The Parran's Park property will be impacted by at-grade road construction within the resource's NRHP boundary. However, an assessment of effects concluded that because an existing roadway is located in closer proximity to the resource, because the proposed new roadway construction will not cause destruction or damage to any significant elements of the historic resource, and because the proposed construction of the Unit 3 facilities will be obscured from view by vegetation, the proposed project impacts will result in no adverse effect to the Parran's Park property.

One NRHP-eligible archaeological site has been identified within the project APE. In the event that this site cannot be avoided by project construction, a Phase III Data Recovery Plan for the site will be prepared in consultation with the SHPO. If avoidance is not feasible, Phase III Data Recovery investigations of the site will be conducted to mitigate adverse effects, per Section 106 of the National Historic Preservation Act (USC, 2007).

Consultation on the Phase I and II cultural resources investigations with Native American tribes is pending. This consultation could result in changes to the recommended National Register of Historic Places eligibility of the 22 identified resources. Phase III data recovery investigations and subsequent SHPO consultation will be conducted on NRHP-eligible archaeological resources that are located within the proposed project area and cannot be avoided, to minimize, or mitigate any adverse effects, per Section 106 of the National Historic Preservation Act (USC, 2007). A Memorandum of Agreement (MOA) will be prepared for the three NRHP-eligible resources that will be adversely affected by the proposed project.

Some areas in the Chesapeake Bay have been previously dredged for the existing discharge conduit and channel, cooling water intake channel, the barge slip and channel, and the shore protection revetment. Construction of the new intake channel and portions of the discharge conduit would occur within areas previously dredged or disturbed by construction. Cultural resource surveys were conducted in the areas of the discharge piping (PANAM, 2008). This survey identified areas to ideally avoid in piping routing. Thus, in routing the piping with consideration of this survey result, there would be no impacts to underwater historic properties from construction of these facilities.

With construction activities, there is always the possibility for inadvertent discovery of previously unknown cultural resources or human remains. Prior to initiation of land disturbing activities, procedures will be developed which include actions to protect cultural, historic, or paleontological resources or human remains in the event of discovery. These procedures will comply with applicable Federal and State laws. These laws include the National Historic Preservation Act (USC, 2007), and Code of Maryland, Criminal Law, Title 10, Subtitle 4, Sections 10-401 through 10-404 (MD, 2004a) and the Code of Maryland, Title 4, Subtitle 2, Section 4-215 (MD, 2004b).

It is concluded that there will be adverse impacts to cultural resources from construction. An assessments of effects on the National Register-eligible resources located in the APEs has been conducted and consultation has been initiated with the SHPO to identify measures for avoidance, minimization, or mitigation of any adverse effects, per Section 106 of the National Historic Preservation Act. Any identified measures would be delineated in a Memorandum of Agreement between U.S. Army Corps of Engineers, the SHPO, CalvertCliffs 3 Nuclear Project, UniStar Nuclear Operating Services, and potentially the Advisory Council on Historic Preservation.

The magnitude of the impacts and requirements for mitigation are determined to be moderate.

4.1.4 References

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Table 4.1-1— Construction Areas Acreage and Operations Acreage, Land Use and Zoning

Construction Area	Construction Acreage (hectares)	Current Land Use	Current Zoning
Power Block	50 (20 ha)	Forest and Urban or Built Up	I-1 and FFD
Cooling tower	15 (6 ha)	Forest	FFD
UHS Intake Structure	5 (2 ha)	Urban or Built Up	I-1
500kV AIS Switchyard	25(10 ha)	Forest and Urban or Built Up	I-1 and FFD
Transmission Corridor	30(12 ha)	Forest and Urban or Built Up	I-1 and FFD
Desalination Plant	5 (2 ha)	Forest	FFD
Other Permanently Disturbed Area	190 (77 ha)	Forest and Urban or Built Up	I-1 and FFD
Total Acreage of Disturbed Area for Permanent Construction Features	**320 (128 ha)**	—	—
Total Acreage of Disturbed Area for Temporary Construction Features	**140 (57 ha)**	Forest and Urban or Built Up	I-1 and FFD
Total Disturbed Area (2)	**460 (186 ha)**	—	—

Notes:

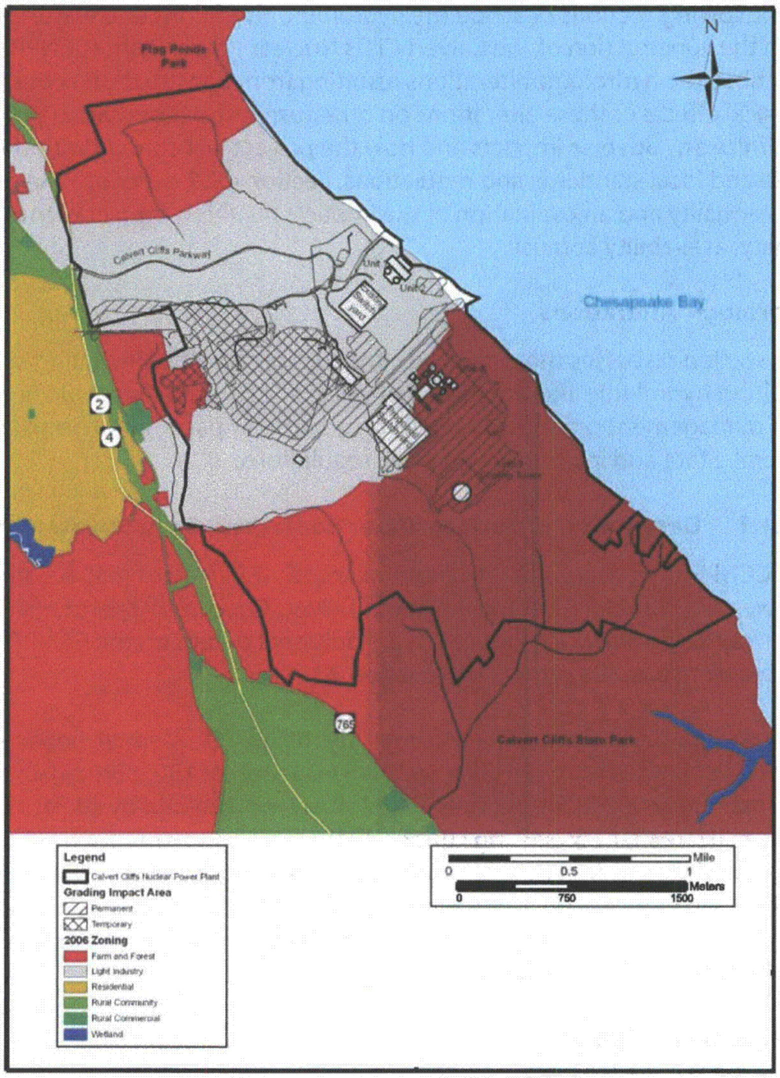
I-1 = Light Industrial

FFD = Farm and Forest District

a. Of the 280.95 acres (113.7 hectares) disturbed, 134 acres (54.2 hectares) are zoned FFD.

b. Of the 139.1 acres (56.3 hectares) temporarily disturbed by construction activities, 13 acres (5.7 hectares) are zoned FFD.

Figure 4.1-1— CCNPP Site Zoning and Grading Layout



4.2 WATER-RELATED IMPACTS

The following sections describe the hydrologic alterations and water use impacts that result from the construction of the Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3. Section 4.2.1 describes the hydrologic alterations resulting from construction activities including the physical effects of these alterations on other users, the best management practices to minimize any adverse impacts and how the project will comply with the applicable Federal, State and local standards and regulations. Section 4.2.2 describes the potential changes in water quality and an evaluation of the impacts resulting from construction activities on water quality, availability and use.

4.2.1 Hydrologic Alterations

This section discusses the proposed construction activities including site preparation, the resulting hydrologic alterations and physical effects of these activities on other water users, best management practices to minimize adverse impacts, and compliance with applicable Federal, State and local environmental regulations.

4.2.1.1 Description of Surface Water Bodies and Groundwater Aquifiers

The CCNPP site covers an area of approximately 2.070 acres (838 hectares) and is located on the western shore of Chesapeake Bay in Calvert County, Maryland near Maryland State Highway 2/4 as shown in Figure 2.1-2. Additional details on the CCNPP site location and surrounding area are provided in Section 2.1.

The topography at the CCNPP site is gently rolling with steeper slopes along stream courses. Local relief ranges from sea level up to an elevation of 130 ft (40 m) with an average relief of approximately 100 ft (30 m). The CCNPP site is well drained by short, intermittent, and perennial streams. Six existing surface water impoundments are present on the site. A drainage divide (ridge) runs approximately from southeast to northwest across the CCNPP site as shown in Figure 2.3-4. Approximately 20% of the existing CCNPP site surface runoff is directed to drainages discharging into Chesapeake Bay. The remaining 80% of the runoff flows into tributaries of Johns Creek.

Surface Water Bodies

The surface water bodies (Fig 2.3-4) within the hydrologic system at CCNPP that may be affected by the construction and operation of Unit 3 are:

- Two unnamed streams designated (Branch 1 and 2) on the eastern side of the drainage divide, Branch 1 being downstream of the Camp Conoy Fishing Pond
- Johns Creek, Branch 3 and Branch 4, and the unnamed headwater tributaries
- Goldstein Branch
- Laveel Branch
- Camp Conoy Fishing Pond and two downstream impoundments
- Lake Davies and two unnamed impoundments within the Lake Davies dredge spoils disposal area
- Chesapeake Bay and Patuxent River

The streams listed above are perennial and are typically fed by springs and seeps.

The Camp Conoy fishing pond is a man-made impoundment with an earthen dam on the northeast side. Water depth increases slowly away from the shoreline, with a depth of less than 1 ft (0.3 m) over most of the lake and may exceed 3 ft (1 m) near the center. An outlet pipe conveys water from the fishing pond to a single stream channel which continues northeast toward Chesapeake Bay. Two smaller impoundments were created along this channel, and water depth in these two impoundments does not appear to exceed 1 to 2 ft (0.3 to 0.6 m) in most locations. These two impoundments are within the Chesapeake Bay Critical Area boundary.

A series of three man-made impoundments are present south of the existing dredge spoils disposal area near the center of the CCNPP site. These sequentially connected basins convey stormwater runoff from the dredge spoils disposal area to Johns Creek. Water levels in Johns Creek appear to be heavily influenced by surface runoff from the dredge spoils disposal area. The upper, pond closest to the spoils pile (Lake Davies) appears to extend to a depth below the water table and has open water of unmeasured depth at its center. The downstream impoundments do not typically contain surface water but persist as wetlands.

USGS gauging stations exist for downstream areas of the Patuxent River and these records are presented in Section 2.3.1. Additional details on the surface water drainage and hydrology are also presented in Section 2.3.1 and the Final Wetland Delineation Report (TTNUS, 2007).

Groundwater Aquifers

The local aquifer systems that could be impacted by project construction activities at the CCNPP site are, from shallow to deep, the: Surficial aquifer, Piney Point - Nanjemoy aquifer, and the Aquia aquifer. The hydrostratigraphic column for the CCNPP site and surrounding area, identifying geologic units, confining units, and aquifers is shown in Figure2.3-31. A schematic cross-section of the southern Maryland hydrostratigraphic units is shown in Figure 2.3-32. The physical characteristics of the groundwater aquifers are provided in Sections 2.3.1 and 2.3.2.

The Surficial aquifer is primarily tapped by irrigation wells, and some old farm and domestic wells. It is not widely used as a potable water supply because of its vulnerability to contamination and unreliability during droughts. The Piney Point - Nanjemoy aquifer and underlying Aquia aquifer are the chief sources of groundwater in Calvert County and St. Mary's County. The Piney Point - Nanjemoy aquifer is primarily used for domestic water supply. The Aquia aquifer is the primary source of groundwater for major groundwater appropriation in southern Maryland.

4.2.1.2 Construction Activities

The following construction activities will take place that may alter site hydrology:

Clearing, Grubbing, and Grading

Spoils, backfill borrow, and topsoil storage areas will be established on parts of the CCNPP property. Clearing and grubbing of the site begins with harvesting trees, vegetation removal, and disposal of tree stumps. Topsoil will be moved to a storage area (for later use) in preparation for excavation. The general plant area including the switchyard and cooling tower area will be brought to plant grade in preparation for foundation excavation and installation. As described in Section 4.1, approximately 460 acres (186 hectares) of land will be cleared for road, facility construction, laydown and parking uses.

Road Construction

A new and upgraded intersection at Nursery Road on Maryland State Highway (MD) 2/4, south of the existing Calvert Cliffs Parkway to CCNPP Units 1 and 2, will be built and utilized as a construction access route into the CCNPP Unit 3 construction area. Approximately 2 mi (3 km) of road will be upgraded and built to accommodate the traffic into the construction area. The existing barge slip heavy haul road will also be upgraded and extended to the Unit 3 site area and construction laydown areas. The maximum slope for the existing and extended haul road is 4% grade. A CCNPP Unit 3 site perimeter road system will be installed including an access road from the cooling tower area to the power block area.

Temporary Utilities

Temporary utilities include above-ground and underground infrastructure for power, communications, potable water, wastewater and waste treatment facilities, fire protection, and for construction gas and air systems.

Temporary Construction Facilities

Temporary construction facilities include offices, warehouses, sanitary toilets, a changing area, a training area, and personnel access facilities. The site of the concrete batch plant includes the cement storage silos, the batch plant and areas for aggregate unloading and storage.

Parking, Laydown, Fabrication, and Shop Preparation Areas

The parking, laydown, fabrication and shop areas include preparation of the parking and laydown areas by grading and stabilizing the surface with gravel. The shop and fabrication areas include the concrete slabs for formwork, laydown, module assembly, equipment parking and maintenance, and fuel and lubricant storage. Concrete pads for cranes and crane assembly will be installed.

Underground Installations

Concurrent with the power block earthworks, the initial non-safety-related underground fire protection, water supply, sanitary and hydrogen gas piping, and electrical power and lighting duct banks will be installed and backfilled. These installations will continue as construction progresses.

Unloading Facilities Installation

The existing barge slip will be upgraded. New sheet pile will be installed and the existing crane foundations removed from the water. The slip will be widened by dredging to receive larger barge shipments that have roll-on, roll-off capability. Concurrently, crane foundations will be placed to erect a heavy lift crane.

Intake/Pumphouse Cofferdams

A sheet pile cofferdam and dewatering system will be installed on the south side of the CCNPP Units 1 and 2 intake structure to facilitate the construction of the CCNPP Unit 3 makeup water intake structures and pump houses. Pilings may also be driven to facilitate construction of new discharge system piping.

Excavation and dredging of the intake structures, erection of pump houses, and installation of mechanical, piping, and electrical systems follow the piling operations and continue through site preparation into plant construction. Excavated and dredged material will be transported to an onsite spoils area located outside the boundaries of designated wetlands.

Power Block Earthwork (Excavation)

The deepest excavations in the power block area are for the CCNPP Unit 3 reactor and auxiliary building foundations that extend to approximately 40 ft (12 m) below plant grade. The next deepest excavations are for the turbine building foundation area which will be excavated approximately 21 ft (6.4 m) below plant grade with the circulating water piping excavation areas extending down to 33 ft (10 m) below plant grade.

The excavations will take place concurrent with the installation of any required dewatering systems, slope protection and retaining wall systems. At a minimum, drainage sumps will be installed at the bottom of the excavations from which surface drainage and groundwater infiltration will be pumped to a stormwater discharge point. Monitoring of construction effluents and stormwater runoff would be performed as required in the stormwater pollution prevention plan, the National Pollutant Discharge Elimination System (NPDES) permit, and other applicable permits obtained for construction. Excavated material will be transferred to the spoils and backfill borrow storage areas. Acceptable material from the excavations will be stored and reused as structural backfill.

Power Block Earthwork (Backfill)

The installation of suitable backfill to support structures or systems occurs as part of the site preparation activities. Backfill material will come from the concrete batch plant, onsite borrow pit and storage areas, or offsite sources. Excavated areas will be backfilled to reach the initial level of the building foundation grade. Backfill will continue to be placed around the foundation as the building rises from the excavation until final plant grade is reached.

Nuclear Island Base Mat Foundations

The deepest foundations in the power block are installed early in the construction sequence. Detailed steps include: installation of the grounding grid, mud-mat concrete work surface, reinforcing steel and civil, electrical, mechanical/piping embedded items, forming, and concrete placement and curing.

Transmission Corridors

A new transmission substation/switchyard will be installed adjacent to the power block area for CCNPP Unit 3. A new onsite transmission corridor will be installed from the CCNPP Unit 3 switchyard to the existing CCNPP Units 1 and 2 switchyard. Tower foundations will be installed as well as an access road running along the corridor.

Offsite Areas

No offsite areas will be impacted by the construction activities for CCNPP Unit 3. The existing offsite transmission corridor and towers will be utilized for the high voltage lines for CCNPP Unit 3.

4.2.1.3 Water Sources and Amounts Needed for Construction

The amounts of water needed during construction of CCNPP Unit 3 are summarized in Table 4.2-1. Amounts required are categorized as that needed for Construction Personnel, Concrete Mixing Curing and Washdown, and Dust Control/Hydrostatic Testing. Quantities are listed by construction year, one through six. The basis for these estimated requirements are also noted in Table 4.2-1.

An application for a groundwater appropriation from the Aquia aquifer has been filed with the Maryland Department of the Environment (MDE) based upon the requirements included in

Table 4.2-1. The pending permit allows withdrawals of 100,000 gpd (3.79E+5 lpd) on a yearly basis and 180,000 gpd (6.81E+5 lpd) for the month of maximum use. The source is to be new production wells to be drilled on the CCNPP site. The permit will be for a period of eight years with provision for extension.

Water requirements in excess of those authorized by MDE are expected to be satisfied by trucking water from State authorized sources to on-site storage tanks.

When completed, product water from the proposed desalinization plant will replace groundwater from the on-site construction wells. The desalinization plant will produce 1,750,000 gpd (6.62E+6 lpd) of product water from Chesapeake Bay water using the seawater reverse osmosis process.

The plant will have three portions consisting of a centralized pump center, an energy recovery center, and a reverse osmosis center. The plant will contain a pretreatment filtration system and chemical conditioning equipment to prevent fouling and mitigate corrosion in pipes and equipment. The desalinization plant is expected to reduce the salinity of the water to a level of approximately 1.67E-3 lbs/gal (200 to 300 mg/l), with the general characteristics of softened well water.

4.2.1.4 Surface Water Bodies Receiving Construction Effluents that Could Affect Water Quality

The surface water bodies as shown in Figure 2.3-4 within the hydrologic system at the CCNPP site that could receive effluents during CCNPP Unit 3 construction include:

- Two unnamed streams (Branch 1 and Branch 2) on the eastern side of the drainage divide, Branch 1 being downstream of the Camp Conoy Fishing Pond;
- Camp Conoy Fishing Pond and two downstream impoundments;
- Johns Creek, Branch 3 and Branch 4, and the unnamed headwater tributaries;
- Goldstein and Laveel Branches of Johns Creek;
- Lake Davies and two unnamed impoundments within the Lake Davies dredge spoils disposal area; and
- Chesapeake Bay and Patuxent River.

Several impoundments are planned to catch stormwater and sediment runoff from the various construction areas. Modeling of the runoff from the probable maximum flood (PMF) during plant operation bounds the possible runoff amounts, characteristics, and impacts that might occur during construction due to unpaved surfaces allowing for greater stormwater infiltration into the ground. The impoundments will be sized so as to prevent fast flowing, sediment laden stormwater from reaching the creeks or Chesapeake Bay prior to allowing the sediments to settle out. The flow velocities will be minimized to prevent erosion of creek and stream banks. The allowable flow rates and physical characteristics of stormwater runoff will be specified in the State discharge permits.

Maximum runoff for the entire western basin during the PMF is estimated at 21,790 cfs. The maximum high water level elevation in Johns Creek is 65 ft (19.8 m) NGVD 29, which is below the approximate 84.6 ft (25.8 m) NGVD 29 elevation of the final site grade in the power block, switchyard, and cooling tower area.

4.2.1.5 Construction Impacts

Construction of CCNPP Unit 3 with its associated cooling tower will impact several of the current drainages and impoundments at the CCNPP site. Runoff from the finished grade of the CCNPP Unit 3 power block, switchyard, cooling tower, parking areas and laydown areas will be directed by sloping towards a series of sand filters around most of the periphery of these permanent features. Any excess runoff from the filters will in turn flow into stormwater impoundments. However, for large storms the infiltration capacity of the base materials will be exceeded and overflow pipes will direct the excess runoff to the stormwater impoundments. The final site grading plan is shown in Figure 4.2-1.

Grading of the dredge spoils pile for a laydown area, concrete batch plant, access road, and construction parking areas could increase runoff into the existing impoundments downstream of the dredge spoils pile and into temporary impoundments along the southern edge of the new access road as shown in Figure 4.2-1.

Construction impacts to the existing surface water bodies are summarized as follows:

- Increasing runoff from the approximately 130 acres (53 hectares) of impervious surfaces (including the power block, switchyard, cooling tower, laydown areas, critical areas, and roads).
- Infilling and eliminating the Camp Conoy Fishing Pond under the southeast portion of the laydown area south of the CCNPP Unit 3 power block foundation
- Infilling and eliminating the upper reaches of Branch 2 and Branch 3, and an unnamed tributary to Johns Creek
- Isolating portions of the upper reach of Branch 1 by construction of the laydown areas south of the CCNPP Unit 3 power block foundation
- Disruption of the drainage in the Lake Davies dredge spoils disposal area with possible impacts on the two downstream impoundments
- Wetlands removal and disruptions
- Possibly increasing the sediment loads into the proposed impoundments and downstream reaches

The overall site drainage basin areas are not directly affected by the proposed site grading plan. The 80% / 20% drainage proportion to the west and east respectively, will stay the same during and after construction. Approximately 15 to 20 acres (6 to 8 hectares) will be added to the east drainage basin and removed from the west drainage basin.

These impacts to surface water bodies are MODERATE, primarily due to the loss of wetlands and wetland buffers, and require mitigation. The mitigation measures associated with the wetlands and wetland buffers are described in Section 4.3.1.4.

4.2.1.6 Identification of Surface Water and Groundwater Users

There are no users of onsite surface water. Johns Creek flows into the Patuxent River where there is recreational boating and fishing. Branch 1 and Branch 2 flow into Chesapeake Bay where there are also recreational boaters in addition to public beaches to the north and south of the CCNPP site. Commercial fisheries and recreational fishing also exist in Chesapeake Bay as discussed in Section 2.3.2.

Groundwater users in the vicinity of the CCNPP site are identified in Section 2.3.2. As described in Section 2.3.2, the nearest permitted Maryland Department of the Environment (MDE) groundwater well (beyond the boundary of the CCNPP property boundary and downgradient from the site), is conservatively presumed to lie adjacent to the southeastern boundary of the CCNPP site. At this location, the distance between the boundary and the center of CCNPP Unit 3 is approximately 1.1 mi (1.8 km) as shown in Figure 2.3-67. The flow direction was based on the regional direction of flow within the Aquia aquifer as shown in Figure 2.3-62.

4.2.1.7 Proposed Practices to Limit or Minimize Hydrologic Alterations

The following actions will be used to limit or minimize expected hydrologic alterations:

- Implementation of best management practices (BMPs) such as;
    - Maintaining clean working areas;
    - Removing excess debris and trash from construction areas;
    - Properly containing and cleaning up all fuel and chemical spills;
    - Installing erosion prevention devices in areas with exposed soils;
    - Installing sediment control devices at the edges of construction areas; and
    - Retaining and controlling stormwater and wash-down water onsite.
- Implementation of a Storm Water Pollution Prevention Plan (SWPPP)

The sand filter trenches are designed to allow runoff to infiltrate. They will shift, slightly, the recharge areas for the Surficial aquifer. The amount of recharge may increase since there is less opportunity for evaporation and evapotranspiration. Monitoring of construction effluents and stormwater runoff will be performed as required in the stormwater pollution prevention plan, NPDES permit, and other applicable permits obtained for the construction.

4.2.1.8 Compliance with Applicable Hydrological Standards and Regulations

The regulations guiding the implementation of Best Management Practices (BMPs) are provided by the Maryland Department of the Environment (MDE, 1994). These regulations contain BMP installation instructions and typical construction activities which require BMPs. Monitoring of construction effluents and stormwater runoff will be performed as required in the stormwater pollution prevention plan, NPDES permit, and other applicable permits obtained for the construction.

4.2.1.9 Best Management Practices

The following BMPs will be implemented:

- Implementation of a SWPPP;
- Controlling site runoff;
- Monitoring runoff, groundwater, and surface water bodies for contaminants;

- Implementing controls, such as a spill prevention program, to protect against accidental discharge of contaminants (fuel spills, other fluids and solids that could degrade groundwater.

The amount of recharge may increase since there is less opportunity for evaporation and evapotranspiration. Monitoring of construction effluents and stormwater runoff would be performed as required in the stormwater management plan, NPDES permit, and other applicable permits obtained for the construction.

In addition, CCNPP Unit 3 will comply with the requirements and conditions of the various permits issued to support construction. Environmental compliance personnel will monitor construction activities and provide direction to add, modify or replace site practices to ensure compliance with hydrological standards and regulations.

In summary, the impact to hydrology is SMALL due to design of the surface water retention systems and use of best management practices to control surface water runoff.

4.2.2 Water Use Impacts

This section discusses the proposed construction activities and resulting hydrologic alterations that could impact water use, an evaluation of potential changes in water quality resulting from construction activities and hydrologic changes, an evaluation of proposed practices to minimize adverse impacts, and compliance with applicable Federal, State and local environmental regulations.

4.2.2.1 Description of the Site and Vicinity Water Bodies

The CCNPP site covers an area of approximately 2,070 acres (8838 hectares) and is located on the western shore of Chesapeake Bay in Calvert County, Maryland near (MD) 2/4 as shown in Figure 2.1-2. Additional details on the CCNPP site location and surrounding area are provided in Section 2.1.

The surface water bodies, as shown in Figure 2.3-4, within the hydrologic system at the CCNPP site that may be affected by the construction and operation of CCNPP Unit 3 are discussed in Section 4.2.1.1.

Additional details on the surface water drainage and hydrology are presented in Section 2.3.1 and the Final Wetland Delineation Report (TTNUS, 2007).

The aquifers that could be impacted by project construction activities at the CCNPP site are the Surficial aquifer, the Chesapeake aquifer/confining unit, and the Castle Hayne-Aquia aquifer. These, and the other aquifers in the regional groundwater system, are described in Section 2.3.1 and Section 2.3.2. Site-specific hydrogeologic cross-sections are provided in Figure 2.3-60 and Figure 2.3-61.

4.2.2.2 Hydrologic Alterations and Related Construction Activities

Construction impacts to the existing surface water bodies are summarized as follows:

- Increasing runoff from the approximately 130 acres (53 hectares) of impervious surfaces (including the power block, switchyard, cooling tower, laydown areas, critical areas, and roads);
- Infilling and eliminating the Camp Conoy Fishing Pond under the southeast portion of the laydown area south of the CCNPP Unit 3 power block foundation;

- Infilling and eliminating the upper reaches of Branch 2 and Branch 3, and an unnamed tributary to Johns Creek;
- Isolating portions of the upper reach of Branch 1 by construction of the laydown areas south of the CCNPP Unit 3 power block foundation;
- Disruption of the drainage in the Lake Davies dredge spoils disposal area with possible impacts on the two downstream impoundments;
- Wetlands removal and disruptions; and
- Possibly increasing the sediment loads into the proposed impoundments and downstream reaches.

The hydrologic alterations to groundwater that could result from the project related construction activities are:

- Creation of a local and temporary depression in the Surficial aquifer potentiometric surface due to dewatering for foundation excavations
- Disruption of current Surficial aquifer recharge and discharge areas by plant construction. Hilly, vegetated areas would be cleared and graded; some streams and the Camp Conoy Fishing Pond (impoundment) would be backfilled and construction areas would be covered by less permeable materials and graded to increase runoff into sand filter trenches. The locations of, or quantity of, water produced at springs and seeps could change downgradient of the construction areas
- Stormwater runoff from the flat, non-vegetated foundation pads, switchyard and laydown areas would be directed and concentrated into sand filter trenches and new impoundments that could affect recharge to the Surficial aquifer. Since the sand filter trenches and impoundments are unlined, they could act as smaller, focused recharge areas and might increase the amount of water recharging the surficial aquifer
- Additional drawdown in the Aquia aquifer when the water needed for CCNPP Unit 3 construction is supplied by onsite wells
- Minor shifting of the Surficial aquifer recharge area(s) to the underlying Chesapeake aquifer/confining unit

A further discussion of related construction activities is provided in Section 4.2.1.2.

4.2.2.3 Physical Effects of Hydrologic Alterations

Impacts from the construction of CCNPP Unit 3 are similar to those associated with any large construction project. The construction activities that could produce hydrologic alterations to surface water bodies and groundwater aquifers are presented in Section 4.2.1.2. The potentially affected surface water bodies and groundwater aquifers are described in Section 4.2.1.4. The potential construction effects on surface water bodies and groundwater aquifers are presented in Section 4.2.1.5.

Surface Water Impacts

Because of the potential for impacting surface water resources, a number of environmental permits are needed prior to initiating construction. Table 1.3-1 in Chapter 1 provides a list of construction-related consultations and permits that have to be obtained prior to initiating construction activities.

The construction activities expected to produce the greatest impacts on the surface water bodies occur from:

- Reducing the available infiltration area
- Grading and the subsequent covering of the 46 acre (19 hectare) CCNPP Unit 3 power block foundation
- Grading and covering of the 18 acre (7 hectare) CCNPP Unit 3 cooling tower pad
- Grading and covering of the 59 acre (24 hectare) CCNPP Unit 3 switchyard/substation
- Vegetation removal and grading of 151 acres (61 hectares) for laydown areas, concrete batch plant, offices, parking, warehouses, and shop preparation areas
- Creation of impoundments
- Elimination of an existing impoundment (i.e., Camp Conoy Fishing Pond)
- Elimination of existing branches of Johns Creek

Site grading and new building foundations will cover and reduce existing infiltration and recharge areas. Possible increases in runoff volume and velocity in the downstream creeks may cause erosion and adversely affect riparian habitat if not controlled.

Dewatering for the proposed foundation excavations could also impact surface water bodies. Effluent from the dewatering system, and any stormwater accumulating during the excavation, would be pumped to a stormwater discharge point or into onsite impoundments. If pollutants (e.g., oil, hydraulic fluid, concrete slurry) exist in these effluents from construction activities, they could enter the impoundments, downstream channel sections, or other surface water bodies. Monitoring of construction effluents and stormwater runoff would be performed as required in the stormwater management plan, NPDES permit, and other applicable permits obtained for the construction. Depending on the design of the stormwater impoundments and discharge systems, outflow rates into the surface streams could be altered.

All water bodies within the CCNPP site boundary could have the potential to indirectly receive untreated construction effluents. The water bodies listed in Section 4.2.1.1 are potentially subject to receiving untreated construction effluents directly. It will be necessary to implement proper BMPs under state regulations such as a: General NPDES Permit for Stormwater associated with Construction Activity, Erosion and Sediment Control Plan, and a stormwater pollution prevention plan. Table 1.3-1 lists and presents additional information on the Federal, State and Local Authorizations associated with this project.

If proper BMPs are implemented under these permits, treated construction effluents could be released to the site water bodies without adverse impacts. Flow rates for untreated construction effluents will depend upon the usage of water during site construction activities and the amount of precipitation contacting construction debris during construction activities. Flow rates and physical characteristics of the construction effluents are discussed in Section 4.2.1.4. A quantitative calculation and evaluation of the construction effluents and runoff will be done as part of the state construction permit process. BMPs would be implemented to control runoff, soil erosion, and sediment transport. Good housekeeping practices and engineering controls will be implemented to prevent and contain accidental spills of fuels, lubricants, oily wastes, sanitary wastes, etc.

BMPs are implemented under a Spill Prevention Plan, a SWPPP, and an Erosion Control Plan, as described in Section 4.2.1.7 and Section 4.2.2.10. Environmental control systems installed to minimize impacts related to construction activities will comply with all Federal, state and local environmental regulations and requirements. Once the initial controls are in place, they are maintained through the completion of construction and during plant operation, as needed.

Surface water use impacts are MODERATE, primarily due to the loss of wetlands and wetland buffers,.and will require mitigation. The mitigation measures associated with the wetlands and wetland buffers are described in Section 4.3.1.4.

Groundwater Impacts

Depending on the design of the stormwater impoundments and discharge systems, outflow velocity and volume in the surface streams could change, and change the volume of water available to infiltrate and recharge the Surficial aquifer.

Increasing groundwater withdrawals for construction needs from the onsite Aquia aquifer production wells, could produce a local depression of the potentiometric surface in that aquifer. These increased withdrawals could potentially induce salt water intrusion or produce land subsidence, but as discussed earlier, neither had been reported as a significant problem in Calvert County or St. Mary's County.

The hydrologic alterations that could be produced in the groundwater aquifers are expected to be localized and possibly temporary. Most of the effects are expected to occur in the uppermost or Surficial aquifer. Any effects in the deeper aquifers are expected to be minor, due to remaining within the existing permit withdrawal limits, and dependent to a large extent on groundwater travel time, thickness and physical properties of the intervening stratigraphic units, and the nature of the hydraulic connection between aquifers.

The construction activities listed in Section 4.2.1.2 that are expected to produce the greatest impacts on the Surficial aquifer are related to:

- Changing the existing recharge and discharge areas
- Possibly changing the amount of runoff available for infiltration
- Dewatering of foundation excavations during construction

Site grading and leveling for the building foundations and laydown areas will cover and possibly eliminate existing recharge areas. Runoff from the graded areas will be directed into sand filters and several proposed impoundments, possibly creating new "focused" recharge areas. Runoff velocity may be increased in the channels downstream of the impoundments, which could decrease the amount of runoff available for infiltration and recharge. Fine-grained sediments could settle out in the impoundments and channels and create less-permeable areas for infiltration and recharge. These changes affect local recharge to the Surficial aquifer. Impacts on the deeper Aquia aquifer are likely to be SMALL.

Dewatering foundation excavations also produce localized impacts on the Surficial aquifer. The deepest excavations anticipated are for the proposed reactor and auxiliary building foundations, and extend approximately 40 ft (12 m) below plant grade and approximately 60 ft (18.3 m) below pre-construction grade. The dewatering system and activities are not expected to have any significant impact on the deeper Aquia aquifer due to the main recharge area of the Aquia aquifer is to the north. Hence, it is insensitive to perturbances of the Surficial aquifer. Effluent from the dewatering system will be pumped to a stormwater discharge point. Monitoring of construction effluents and stormwater runoff will be performed as required in the stormwater pollution prevention plan, NPDES permit, and other applicable permits obtained for the construction.

The locally lowered Surficial aquifer water level would be expected to eventually recover after the dewatering and other subsurface construction activities are complete. Although it would be altered by buildings and paved areas, rainwater is still allowed to infiltrate in other plant areas to recharge the aquifer.

- **Effects of Surficial aquifer changes on recharge to and users of the Piney Point-Nanjemoy aquifer**

As a result of the low vertical hydraulic conductivity, large thickness and continuity of the confining beds between the Surficial aquifer and principal aquifers in the vicinity of the CCNPP (the Piney Point-Nanjemoy and Aquia aquifers) changes at the surface that may locally affect the recharge, to discharge from or water table elevation in the Surficial aquifer are not expected to alter the groundwater potentiometric surface or water availability of these deeper aquifers. While the Surficial aquifer may provide recharge to the deeper aquifers as either leakage through the intervening confining layers or as direct infiltration where it directly contacts an underlying aquifer this recharge occurs over the entire areal extent of the Surficial aquifer where it overlies the deeper aquifers. The portion that is attributable to local recharge immediately above the Piney Point-Nanjemoy and Aquia aquifers at CCNPP is a small fraction of their total recharge.

The planned construction activities may lead to a slight reduction in recharge of the Surficial aquifer in some areas (due to construction of impermeable surfaces or temporary dewatering effects) or an increase in other areas (such as stormwater retention basins). Therefore it is difficult to determine the ultimate impact of Unit 3 to the underlying aquifers. However, it is possible to make some reasonable bounding assumptions. Considering the 2006 water table elevation of about 80 ft msl in the Surficial aquifer (Figure 2.3.1-42) and a potentiometric head in the Piney Point-Nanjemoy aquifer of about 0 ft msl, a vertical thickness of about 250 ft and a vertical hydraulic conductivity of .001 ft/day for the intervening Upper Confining Bed (MGS 1997) implies a vertical flux of about 3.2×10^{-5} ft^3/ft^2 day (about 0.14 in/yr) between the Surficial aquifer and the Piney Point-Nanjemoy aquifer. This flux is analogous to the value modeled by MGS 2007 which has a simulated flux rate north of CCNPP of 0.1 in/yr.

If one considers a 10^6 ft^2 area approximately the size of the Unit 3 power block (e.g., a square with sides 1,000 ft long) over which groundwater recharge is totally eliminated, recharge to the Piney Point-Nanjemoy aquifer would be reduced by about 40 ft^3/day or about 300 gpd. In reality the volume of recharge would be reduced less that 300 gpd because surface runoff within the power block will be directed to sand filter trenches and basins where infiltration is enhanced.

Three hundred gpd is not significant in comparison to the overall recharge to the deeper aquifers in southern Maryland. This value is also not significant in comparison to one of the major users of the Piney Point-Nanjemoy aquifer in the vicinity of the CCNPP. The White Sands subdivision, with a Groundwater Appropriation Permit average withdrawal rate of 8,000 gpd (Table 2.3-23). Therefore, even assuming a reduced recharge from the Surficial aquifer to the Piney Point-Nanjemoy aquifer of 300 gpd the effect on the Piney Point-Nanjemoy aquifer is negligible and users of groundwater from that unit are not expected to see any effect of the reduced recharge on water level in the vicinity of the CCNPP

- **Effects of changes to the Surficial aquifer on the level of the water table and discharge to John's Creek**

A numerical model has been developed of the Surficial aquifer at CCNPP Unit 3 (see Section 2.3.2.2.11). The model encompasses all areas affected by construction of Unit 3 and contributing discharge to John's Creek. Simulation of post-construction conditions indicates that maximum groundwater levels around the power block area will be approximately 55 ft msl. The depth to the water table in this area is estimated to be 30 ft below grade level. Groundwater levels in this area are dependent on many factors including the hydraulic conductivity of the fill material and the rate of groundwater recharge over the graded areas of the site.

The impact of the construction of Unit 3 on groundwater discharge to John's Creek will be negligible.

- **Effects of withdrawals from the Aquia aquifer on the users of the Aquia and Piney Point-Nanjemoy aquifers**

Increasing withdrawal from the Aquia aquifer from the average values withdrawn over the past 5 years by CCNPP Unit 1 & 2 (an average of about 387,000 gpd from July 2001 to June 2006) (Table 2.3-27) to the value permitted in CA69G-010 (05) of 450,000 gpd (Table 2.3-23), is expected to cause increased drawdowns in the vicinity of the CCNPP Unit 2 production wells. The effects of the increased withdrawal, even though limited to about 68 months for the duration of Unit 3 construction, may extend several thousand feet from the pumping wells. For example considering an infinite confined aquifer with no leakage (to maximize the potential drawdown), a transmissivity of about 1,000 ft^2/day a storativity of about 10^{-4} (MGS 1997) and discharge of 63,000 gpd from one well for 2,040 days would yield drawdown in the Aquia aquifer of about 4 ft at a distance of about 10,000 ft and drawdown of about 7 ft at a distance of about 1,000 ft from the pump well. This drawdown would be insignificant to other users of the Aquia aquifer in the vicinity of CCNPP Unit 2 and would have an insignificant effect on increasing leakage from the overlying Piney Point-Nanjemoy aquifer to the Aquia aquifer.

The impact to groundwater is SMALL and localized.

4.2.2.4 Water Quantities Available to Other Users

As described in Section 2.3.2.1.2, at present no surface water withdrawals are made in Calvert County for public potable water supply. Water use projection in Maryland for 2030 does not include surface water as a source for public water supply in southern Maryland counties including Calvert Country.

Groundwater use and trends in southern Maryland and at the CCNPP site are presented in Section 2.3.2.2 and in Section 2.4.12 of the Final Safety Analysis Report.

The Surficial aquifer is not used as a potable water source in the vicinity of the CCNPP site. The impacts expected from foundation dewatering or other construction activities will not impact any local users. The Camp Conoy facilities include four wells authorized under an MDE water appropriation permit. These wells draw from the Piney Point aquifer and have an appropriation limit of 500 gpd (1,900 lpd). These wells are expected to be abandoned. The impact on the local water supply resulting from any abandonment of these wells will be minor.

4.2.2.5 Water Bodies Receiving Construction Effluents

The surface water bodies directly downstream of the proposed construction activities could be impacted during clearing, grubbing, and grading. Locations of surface water and its users that could be impacted by construction activities are provided in Section 4.2.1.4.

Since most of the water for construction would be used for consumptive uses such as grading, soil compaction, dust control, and concrete mixing, little infiltration would be expected. Any effluents that might infiltrate would recharge the Surficial aquifer, and, potentially, the underlying Chesapeake aquifer/ confining unit, and the Castle Hayne-Aquia aquifer.

If contaminants enter the surface water bodies unchecked, there would be a potential for infiltration and subsequent groundwater contamination. If contaminants do enter groundwater, they may impact the quality of water withdrawn for industrial and commercial applications.

Any construction effluents infiltrating into the subsurface could potentially reach the Surficial aquifer if they are of sufficient volume and concentration. The plume migration would be downgradient and, depending on location, flow either eastward toward Chesapeake Bay or westward toward the Patuxent River. As described in Section 2.3.2, the horizontal groundwater flow in the Surficial aquifer is generally bi-directional. A northwest trending groundwater divide roughly follows a line extending through the southwestern boundary of the proposed power block area. Northeast of this divide, horizontal groundwater flow is northeast toward the Chesapeake Bay to small seeps and springs or onsite streams. Groundwater southwest of this divide flows to the southwest.

It is also possible that this groundwater could discharge locally at seeps or springs. Any possible impacts on deeper aquifers would also depend on the infiltrating volume and the hydrologic connection with the Surficial aquifer.

The composition of possible construction effluents that could infiltrate into the Surficial aquifer would depend on several factors related to the physical nature of the effluent material, i.e., solids versus liquids, solubility, vapor pressure, mobility, compound stability, reactivity in the surface and subsurface environments, dilution, and migration distance to groundwater. It is expected that proper housekeeping and spill management practices would minimize potential releases and volumes and physically contain any releases. Pesticides and herbicides are expected to be applied in limited site areas for insect and weed/brush control.

Several impoundments are planned to catch stormwater and sediment runoff from the various construction areas. Sand filter trenches are planned to drain the proposed CCNPP Unit 3 power block, cooling tower pad, switchyard, and laydown areas. Modeling of the runoff from the probable maximum flood (PMF) during plant operation bounds the possible runoff amounts, characteristics, and impacts that might occur during construction due to unpaved surfaces during construction allowing for greater stormwater infiltration to ground. The storm water conveyance system will discharge excess runoff into impoundments. The impoundments will be sized so as to prevent fast flowing, sediment laden stormwater from reaching the creeks or Chesapeake Bay prior to allowing the sediments to settle out. The flow velocities will be minimized to prevent erosion of creek and stream banks. The allowable flow rates and physical characteristics of stormwater runoff will be specified in State discharge permits.

Maximum runoff for the entire basin during the PMF is estimated at 21,790 cfs (617 cms). The maximum high water level elevation in Johns Creek is 65 ft (19.8 m) NGVD 29, which is below the approximate 84.6 ft (25.8 m) NGVD 29 elevation of the final site grade in the power block, switchyard, and cooling tower area.

4.2.2.6 Baseline Water Quality Data

Baseline water quality data for surface water bodies is provided and discussed in Section 2.3.3. A summary of the water quality data for the onsite surface water bodies is presented in Table 2.3-29. Baseline water quality data for groundwater is provided in Section 2.3.3.

4.2.2.7 Potential Changes to Surface Water and Groundwater Quality

The following section describes the potential water quality impacts resulting from the construction of CCNPP Unit 3.

The CCNPP site is a private facility and does not have any municipal water supplies. All water currently used onsite is drawn from Chesapeake Bay or subsurface aquifers. There are 13 groundwater supply wells onsite. The wells are listed in Table 2.3-26. Figure 2.3-68 shows the locations of the onsite supply wells. Four wells supply fresh water for CCNPP Units 1 and 2 operations; eight wells supply ancillary site facilities such as the rifle range and Camp Conoy. The Old Bay Farm well, identified in Table 2.3-26, is no longer in use.

Potential Changes to Surface Water Quality

Any potential surface water quality impacts are associated with the site clearing and grading activities.

The addition of sediment and organic debris to the local streams resulting from clearing, grubbing, and grading could decrease water quality. Organic debris could dam or clog existing streams, increase sediment deposition, and increase potential for future flooding. Organic debris decomposing in streams can cause dissolved oxygen and pH imbalances and subsequent releases of other organic and inorganic compounds from the stream sediments. Sediment laden waters are prone to reduced oxygen levels, algal growth, and increases in pathogens. If heavy metals or chemical compounds spill and/or wash into surface waters, there could be a direct toxicity to aquatic organisms. These potential pollutant releases could impact aquatic species and in turn affect the recreational aspects associated with fishing, canoeing, or kayaking.

The water bodies downstream of the proposed construction areas could be directly and indirectly affected by construction activities onsite. Construction debris residing on the pads and temporary staging areas could mix with construction wash-down water or stormwater, exit the site via untreated runoff and produce chemical reactions adverse to downstream ecology. Possible contaminants include: sediment, alkaline byproducts from concrete production, concrete sealants, acidic byproducts, heavy metals, nutrients, solvents, and hydrocarbons (fuels, oils, and greases). There could be a high potential for contaminants to mix with site wash-down water or rainwater/precipitation runoff and be washed downstream into surface water bodies existing on the CCNPP site due to the persistent nature of local precipitation. There could also be the potential for spills within the construction areas consisting of fuels, solvents, sealants, paints, or glues. Construction dusts not suppressed could drift outside of the construction zones and contaminate nearby water supplies. If these contaminants enter the surface water bodies unchecked there could be a potential for infiltration and subsequent groundwater contamination.

The proposed removal of onsite wetlands could reduce the ability of microbiotic organisms and fauna to naturally attenuate contaminants and pollutants produced onsite.

The impacts to surface water quality downstream of the construction site are SMALL due to the use of BMPs to control dust, runoff, and spills.

Potential Changes to Groundwater Quality

The spoils for CCNPP Units 1 and 2 were deposited in the dredge spoils disposal area of the site known as the Lake Davies area. Dredge spoils generated during the dredging of the barge slip area and construction of the intake/discharge structures may contain elevated levels of metals and salts. Runoff containing saline residue from the spoils could enter the impoundment just southeast of the spoils disposal pile, which is likely in direct hydraulic contact with the Surficial aquifer. Any impact on groundwater quality would probably be minor due to dilution. Little, if any, water quality impacts would be expected if this diluted water were to reach the deeper aquifers.

Dewatering for the foundation excavations may increase the oxidation of some sedimentary constituents by placing them in direct contact with the atmosphere. The oxides might have an increased solubility and could migrate down gradient when the potentiometric head is reestablished following construction completion. Possible impacts to the Surficial aquifer water quality would be SMALL and decrease with migration and dilution.

4.2.2.8 Surface Water and Groundwater Users

Surface water users downstream of the site may experience impacts from potential water quality changes if construction effluent concentrations and volumes are large enough and the release enters directly into a surface water body bypassing the overflow catch basins and retention ponds. The surface water users that could be impacted in the event of a release are those downstream of the CCNPP site along the tributaries flowing to the Patuxent River and Chesapeake Bay. Any impacts to the larger surface water bodies receiving the discharge are expected to be minor.

Groundwater users in vicinity of the CCNPP site are identified in Section 2.3.2.

4.2.2.9 Predicted Impacts on Water Users

The impact of potential increased sediment loads in site runoff during construction would result in SMALL or no impacts to surface water users and affected areas.

Because groundwater from CCNPP Units 1 and 2 onsite wells will be used for construction, there might be impacts on local users that also make withdrawals from the Aquia aquifer.

Potential construction effluent impacts on aquifer groundwater quality would first be manifested in the Surficial aquifer. Construction activities are only expected to produce limited and temporary impacts in the Surficial aquifer. As described in Section 2.3.1, the Surficial aquifer is not used as a potable water source in the vicinity of the CCNPP site. Therefore, potential groundwater quality changes would not be expected to have any impact on possible users. Potential impacts to the deeper aquifers are dependant on the nature of the hydraulic connection between aquifers described in Section 4.2.1.1. Groundwater quality impacts on users of the deeper aquifer users are SMALL due to dilution and other contaminant attenuation effects that could occur along any effluent plume migration path.

The CCNPP site is located in U.S. EPA Region 3 (the District of Columbia, Delaware, Maryland, Pennsylvania, Virginia, and West Virginia). Six sole-source aquifers are identified in U.S. EPA Region 3 as shown in Figure 2.3-66. These are not located in southern Maryland. Thus, the addition of CCNPP Unit 3 is a SMALL impact to any sole source aquifer.

4.2.2.10 Measures to Control Construction Related Impacts

The following measures will be taken to avoid runoff from the construction areas entering and potentially impacting downstream surface water bodies and groundwater, as applicable:

- Implementation of a SWPPP
- Controlling runoff and potential spills using dikes, earthen berms, seeded ditches, and impoundments
- Monitoring for contaminants within construction area impoundments and impoundments downstream of disturbed areas
- Implementation of BMPs to protect against accidental discharge of contaminants (fuel spills, other fluids and solids that could degrade groundwater and surface water resources)
- Performing additional onsite surface and groundwater monitoring compared to established water quality benchmarks and historical site data

Sand filter trenches are planned for the periphery of the power block, laydown, cooling tower and switchyard areas. The sand filter trenches are constructed of base materials that promote infiltration of runoff from low intensity rainfall events. However, for large storms the infiltration capacity of the base materials would be exceeded and the overflow pipes are provided to direct the runoff to the stormwater basins. The stormwater basins are unlined impoundments with simple earth-fill closure on the down stream end and include discharge piping to the adjacent watercourses.

Following the acquisition of the required permits and authorizations, site preparation activities include the installation or establishment of environmental controls to assist in controlling construction impacts to groundwater. These environmental controls include:

- Coffer Dams
- Stormwater management systems
- Spill containment controls
- Silt screens

- Settling basins
- Dust suppression systems

These controls assist in protecting the Surficial aquifer by minimizing the potential for construction effluents to infiltrate directly into the subsurface or to carry possible contaminants to aquifer recharge areas.

Mitigation measures for barge slip dredging and construction activities in the area of the new intake structure and discharge outfall include:

- Restricting dredging only during certain times of the year to minimize impacts to aquatic species
- Restricting dredging to only the areas identified for dredging
- Installing a silt curtain around each dredge or active dredge area to minimize sediment release, as far as practicable, at the seabed/silt curtain interface and at the surface water level/silt curtain interface
- Ensuring clam-shell dredges are fully closed and hoisted slowly to limit the amount of spillage
- Not filling spoils barges to levels which will cause overflowing of materials during loading and moving
- Not allowing vessel decks to be washed in such a way that allows material to be released overboard
- Installing a sheet pile cofferdam and dewatering system to facilitate construction of the CCNPP Unit 3 intake structure
- Carrying out water-quality monitoring in accordance with any permit requirements

Additional measures to minimize or contain accidental releases of contaminants will be the establishment, maintenance, and monitoring of:

- Solid waste storage areas;
- Backfill borrow, spoils, and topsoil storage areas; and
- Site drainage patterns.

Groundwater monitor wells will be installed to assess gradient changes toward the excavation dewatering areas and potential groundwater quantity and quality changes.

Construction groundwater use impacts might be expected in the Aquia aquifer and the groundwater withdrawals and potentiometric surface depression will be monitored. As mentioned in Section 4.2.1.1, salt water intrusion has not been identified as a problem in this area of Maryland.

As explained in Section 4.2.2.7, any contamination that might be introduced into the Surficial aquifer would be attenuated by the time it might reach deeper aquifers.

4.2.2.11 Consultation with Federal, State and Local Environmental Organizations

The regulations guiding the implementation of Best Management Practices (BMPs) are provided by the Maryland Department of the Environment (MDE, 1994). These regulations contain BMP installation instructions and typical construction activities which require BMPs. Monitoring of construction effluents and stormwater runoff would be performed as required in the stormwater management plan, NPDES permit, and other applicable permits obtained for the construction. The integrated permitting process for the applicable environmental permits will proceed concurrently with NRC review of the combined license application.

4.2.2.12 Compliance with Water Quality and Water Use Standards and Regulations

The regulations guiding the implementation of water quality and water use standards and regulations are provided by the Maryland Department of the Environment (MDE, 1994). These regulations contain water quality and water use standards that must be adhered to during construction. In addition, site specific permits for various construction activities will contain conditions that must be complied with for the duration of the permitted activity.

4.2.2.13 Water Quality Requirements for Aquatic Ecosystems and Domestic Users

Section 4.3.2 discusses information pertaining to water quality requirements for aquatic ecosystems. The USEPA declared Chesapeake Bay an impaired water body in 1998 based on the Federal Water Pollution Control Act (USC, 2007) due to excess nutrients and sediments. The Chesapeake Bay water is required to meet federal regulatory water quality standards by 2010 (USC, 2007).

Domestic users of groundwater need to meet the State water quality standards for potable water systems.

4.2.2.14 References

MDE, 1994. Standards and Specifications for Soil Erosion and Sediment Control, Website: http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/erosionsedimentcontrol/standards.asp, Date accessed: March 14, 2007.

MGS, 1997. Hydrogeology, Model Simulations, and Water-Supply Potential of the Aquia and Piney Point-Nanjemoy Aquifers in Calvert and St. Mary's Counties Maryland, Maryland Geological Survey Report of Investigations No. 64, Maryland Geological Survey, G. Achmad and H. Hansen, 1997.

MGS, 2007. Water Supply Potential of the Coastal Plain Aquifers in Calvert, Charles and St. Mary's Counties, Maryland, with Emphasis on the Upper Patapsco and Lower Patapsco Aquifers, Maryland Geological Survey Report of Investigations No. 76, Maryland Geological Survey, D. Drummond, August 2007.

TTNUS, 2007. Final Wetland Delineation Report, for Proposed UniStar Nuclear Project Area, Calvert Cliffs Nuclear Power Plant Site, Calvert County, Maryland, TetraTech NUS, May 2007

USC, 2007. Title 33, United States Code, Part 1251, Federal Water Pollution Control Act, 2007.

USGS, 2007. Hydrogeology of the Piney Point-Nanjemoy, Aquia, and Upper Patapsco aquifers, Naval Air Station Patuxent River and Webster Outlying Field, St. Mary's County, Maryland, 2000-06, USGS Scientific Investigations Report 2006-5266, 26p, U.S. Geological Survey, C. Klohe and R. Kay, 2007.

Table 4.2-1— Estimated Annual Amounts of Fresh Water by Construction Year Needed for CCNPP Unit 3[f]

Construction Year	1	2	3	4	5	6
People	4,275,000[a] gal (16,183,000 L)	17,100,000[b] gal (64,730,000 L)	17,100,000[b] gal (64,730,000 L)	17,100,000[b] gal (64,730,000 L)	17,100,000 [b] gal (64,730,000 L)	
Concrete Mixing, Curing and Washdown[c]	4,700,000 gal (17,792,000 L)	4,700,000 gal (17,792,000 L)	4,700,000 gal (17,792,000 L)	4,700,000 gal (17,792,000 L)	4,700,000 gal (17,792,000 L)	
Dust Control/ Hydrostatic Testing[d]	11,400,000 gal (43,154,000 L)	11,400,000 gal (43,154,000 L)	11,400,000 gal (43,154,000 L)	11,400,000 gal (43,154,000 L)	11,400,000 gal (43,154,000 L)	
Subtotal	20,375,000 gal (77,128,000 L)	33,200,000 gal (125,675,000 L)	33,200,000 gal (125,675,000 L)	33,200,000 gal (125,675,000 L)	33,200,000 gal (125,675,000 L)	22,133,000 gal[e] gal (83,774,000 L)

Notes:

a. Estimated at 1,000 persons using 15 gal (56.8 L) per day for 285 days per year.

b. Estimated at 4,000 persons using 15 gal (56.8 L) per day for 285 days per year.

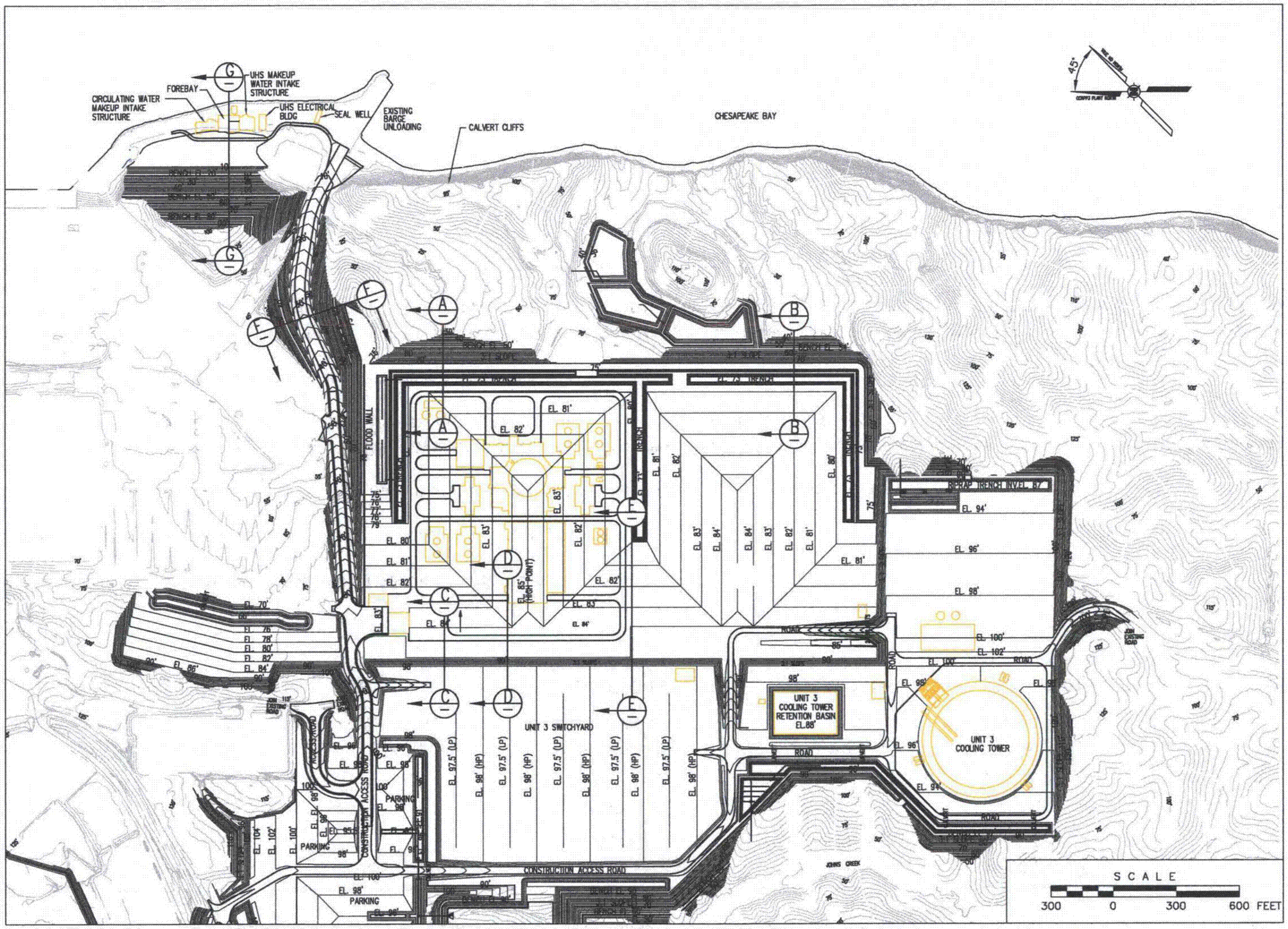
c. Estimated at 7,833 cubic yards (5,988.8 m^3) per month using 50 gal (189.3 L) per cubic yard and 12 months per year.

d. Estimated at 40,000 gal (151,400 L) per day for 285 days per year. During year 1, an estimated 40,000 gpd is expected to be utilized for dust control. Between years 2 and 6, an estimated 40,000 gpd is expected to be utilized for dust control and/or system hydrostatic testing purposes.

e. Estimated at two-thirds of the amount used in any year 2 through 5.

f. Water for construction would largely come from the existing onsite groundwater production wells. For construction years 1-4, the construction water would be supplied by a combination of onsite well water, trucked in supply, and storage tanks. The desalination plant is anticipated to be operational to meet freshwater supply needs during construction years five and six.

Figure 4.2-1— Final Site Grading Plan CCNPP Unit 3



4.3 ECOLOGICAL IMPACT

4.3.1 Terrestrial Ecosystems

This section describes the impacts of construction on the terrestrial ecosystem. Construction would require the permanent or temporary disturbance of approximately 460 acres (186 hectares) of terrestrial habitat on the CCNPP site as shown in Figure 4.3-1. This area is assumed to be the maximum area of soil to be exposed at any time. Approximately 320 acres (129 hectares) of the affected terrestrial habitat would be permanently converted to structures, pavement, or other intensively-maintained exterior grounds to accommodate the proposed power block, cooling tower, switchyard, roadways, permanent construction laydown area, borrow area, retention basins, intake, forebay, and water supply structures and permanent parking lots. The remaining disturbed area of approximately 140 acres (57 hectares) would be only temporarily disturbed to accommodate the batch plant, temporary construction laydown areas, temporary construction offices and warehouses, and temporary construction parking. The temporarily disturbed habitats would be restored to a naturally vegetated condition once construction activities are complete. The permanent loss of affected terrestrial habitat of 320 acres (129 hectares) is small compared to the 1,796,718 acres (724,242 hectares) in the region as shown in Table 2.2-4. Approximately 11.72 acres (4.7 hectares) of the lost terrestrial habitat is wetlands compared to 240,288 acres (97,245 hectares) of wetlands in the region as shown in Table 2.2-4. Figure 2.2-1 shows the CCNPP site boundary and the major buildings to be constructed. Figure 4.3-2 shows the land to be cleared, the waste disposal area and the construction zone.

The construction footprint was designed to minimize impacts to terrestrial ecosystems, specifically lands within the Chesapeake Bay Critical Area (CBCA), which encompasses lands within 1,000 ft (305 m) of the mean high tide level on the shoreline; locations of federally-designated or state-designated threatened or endangered species; wetlands; wetland buffers designated by Calvert County; and forest cover, especially riparian forests, forested slopes, and large blocks of contiguous forest that provide habitat for forest dwelling species forest interior dwelling species (FIDS).

The proposed footprint of construction within the CBCA would be limited to approximately 33.39 acres (13.5 hectares), including approximately 14.35 acres (5.8 hectares) in the CBCA buffer areas, and approximately 19.04 acres (7.7 hectares) in the remainder of the CBCA. The CBCA impact is due primarily to the water intake structures and pipelines, the discharge pipelines, the heavy haul road from the barge slip, security fencing, and the security perimeter gravel path. Certain areas within the CBCA will be regraded for proposed wetland mitigation and the area to accomodate construction equipment for the intake structures. Certain of the affected land within the CBCA buffer is designated as an Intensely Developed Area (IDA) due to the presence of the existing barge slip serving CCNPP Units 1 and 2. None of the sandy cliff or beach areas on the CCNPP site that provide habitat for the puritan tiger beetle or northeastern beach tiger beetle will be disturbed because their habitat is north, south, and east of the construction footprint.

None of the sandy cliff or beach areas on the CCNPP site that provide suitable habitat for the puritan tiger beetle or northeastern beach tiger beetle will be disturbed because their habitat is primarily southeast of the construction footprint. No construction will take place within 1,500 ft of three bald eagle nests known to occur on the CCNPP site. However, a new bald eagle nest first observed within the construction footprint in 2007 may have to be mitigated after consultations and in agreement with the appropriate agencies.

It is not possible to construct the proposed facilities without adversely impacting terrestrial ecosystems, including wetlands, wetland buffers designated by Calvert County, and FIDS habitat. Construction activities will start after the State of Maryland issues the appropriate permits to start clearing and grading of the site. Activities to construct nonsafety-related systems and structures are expected to begin December 2009. Construction is expected to be complete by July 2015.

4.3.1.1 Vegetation

Plant Communities, Forest and Habitats: Clearing and grubbing would result in the vegetation losses shown in Figure 4.3-1 and summarized in Table 4.3-1. The losses would include approximately 238 acres of forest stands. This figure represents a decrease from the Co-Applicants' previous estimate that 252 acres of forest would be cleared. The decrease is the result of efforts to avoid and minimize forest clearing detailed in the Forest Conservation Plan (FCP).

Of the 238 acres of forest stands (within both the Critical Area and outside of the Critical Area), approximately 193 acres (78 hectares) are mature forest cover consisting of well developed tree canopy and understory strata and dominant trees over 12 in. (30 cm) in diameter at breast height (DBH), including:

- Approximately 183 acres (74 hectares) of mixed deciduous forest,
- Approximately 10 acres (4 hectares) of bottomland deciduous forest

The losses would also include approximately 45 acres (18 hectares) of younger, fast growing forest cover, including:

- Approximately 40 acres (16 hectares) of mixed deciduous regeneration forest, and
- Approximately 5 acres (2 hectares) of successional hardwood forest.

Of the approximately 238 acres of forest clearing proposed at this time, approximately 22 acres are in the CBCA, where forest clearing is regulated under the Maryland Chesapeake Bay Critical Areas Act.

As indicated in Table 4.3-1, each of the affected types of vegetation is common throughout the CCNPP Site.

The boundaries of vegetated areas subject to clearing and grubbing will be prominently marked prior to site preparation. Merchantable timber within marked areas may be harvested prior to site preparation. Merchantable timber occurs only in areas of mixed deciduous forest, well-drained bottomland deciduous forest, and poorly drained bottomland deciduous forest. Remaining trees will then be felled. Stumps, shrubs, and saplings will be grubbed, and groundcover and leaf litter will be cleared to prepare the land surface for grading. Felled trees, stumps, and other woody material would be disposed of by burning, chipping and spreading the wood chips, and/or sent to an offsite landfill. Opportunities to recycle woody material for use elsewhere on the CCNPP site or for sale to the public may be considered. Recycling opportunities could include cutting logs into firewood, using wood chips to mulch landscaped areas, using logs to line pathways, piling logs and brush in open fields to improve terrestrial wildlife habitat, and placing stumps (root wads) in stream channels to prevent bank erosion and enhance aquatic habitat.

Because of the need for grading broad contiguous areas of land to construct the power block, switchyard, and cooling tower, there will be no practicable opportunities to preserve individual trees within those areas. However, a biologist would examine forested areas subject to clearing for the temporary construction parking areas, construction office and warehouse area, and construction laydown areas for aesthetically outstanding trees or clusters of trees that might be capable of preservation without interfering with construction activities. Only trees where a minimum of 70% of the critical root zone can be left ungraded without interfering with construction activities would be identified for preservation. The critical root zone is defined by the Maryland Department of Natural Resources (MDNR) as a circular zone surrounding a tree trunk with a radius of 1 ft (0.3 meter) for each inch DBH (and a minimum radius of 8 ft (2.4 m) (MDNR, 1997). The critical root zone would be marked consistent with the State Forest Conservation Technical Manual (MDNR, 1997).

Sediment and erosion control BMPs including earth berms, and silt basins, will be erected around the perimeter of the construction footprint to reduce the potential for sedimentation of adjoining vegetated areas. Detailed specifications for the BMPs and vegetative stabilization will be presented in a soil erosion and sediment control plan approved by the MDE prior to site disturbance. Soil piles will be covered with plastic or bermed until removed during backfill and final grading activities. Monitoring of construction effluents and storm water runoff will be performed as required by the Storm Water Management Plan, the NPDES permit, and other applicable permits obtained for construction.

Important Habitats: The construction footprint was designed to minimize encroachment into habitats identified in Section 2.4.1 as important. Three habitats on the CCNPP Site were identified as important. Poorly drained bottomland deciduous forest and herbaceous marsh vegetation meet the definition of wetlands protected under federal and state regulations. Well-drained bottomland deciduous forest is important because of its occurrence in riparian settings. Site preparation will result in the permanent loss (filling) of approximately 11.72 acres (4.7 hectares) of wetland habitats.

Important Plant Species: The chestnut oak, tulip poplar, mountain laurel, and New York fern were identified in Section 2.4.1 as important because they are key contributors to the overall structure and ecological function of forested plant communities on the CCNPP site. Chestnut oak, which is dominant or codominant in the canopy throughout most of the mixed deciduous forest on the CCNPP site, is a slow growing tree species that is difficult to grow and transplant (Hightshoe, 1988). Similarly hard to grow species common in the mixed deciduous forest on the CCNPP site includes white oak, bitternut hickory, and pignut hickory (TTNUS, 2007a). Mountain laurel, which forms a dense understory over much of the mixed deciduous forest (TTNUS, 2007b), is also a slow growing species and is difficult to transplant (Hightshoe, 1988). Even though mixed deciduous forest can be replanted, several hundred years could be necessary to restore the oaks, hickories, and mountain laurel to their present sizes in the restored forest cover. Any losses of cover by these species, even in areas of only temporary disturbance where forest vegetation can be replanted, must therefore be considered effectively permanent.

The showy goldenrod, Shumard's oak, and spurred butterfly pea were identified in Section 2.4.1 as important because they are listed by the State of Maryland as threatened or rare. Spurred butterfly pea was observed during a rare plant survey conducted in 2006 only in areas outside of the proposed construction footprint (TTNUS, 2007b) and therefore will not be adversely affected. Shumard's oak was observed outside of but very close to within 50 ft (15 m) the western edge of the proposed construction area for the cooling tower. The observed specimens of Shumard's oak do not have to be cut down to allow site preparation, but portions of their root systems could experience compaction or other physical disturbances. Careful protection of trees at the edge of the cooling tower construction area will be necessary to prevent mortality of the observed Shumard's oak specimens. Clusters of showy goldenrod (listed as threatened by Maryland) were observed in the 2006 surveys within the proposed construction footprint for the power block, at the edges of forested areas within Camp Conoy (TTNUS, 2007d). The clusters of Showy Goldenrod in Camp Conoy will be adversely impacted by construction of the power block.

In the State of Maryland, threatened and endangered plants are the property of the landowner and there are no statutory requirements for mitigation of impacts. Maryland Department of Natural Resources Natural Heritage Services (MDNR) was consulted and provided with a sample of the plant for verification. Information was also provided on the goldenrod's occurrence both within the project footprint and on the Baltimore Gas and Electric (BGE) transmission right-of-ways adjacent to the project area. MDNR advised that transplanting the goldenrod in Camp Conoy was of limited conservation value. MDNR concurred that efforts were made to minimize the impacts to the Showy Goldenrod population in Camp Conoy during facility layout and design. MDNR also acknowledged that maintenance practices on the BGE right-of-ways would likely continue to provide the early successional habitat required by the goldenrod.

4.3.1.2 Fauna

The vegetation losses will reduce the habitat available to mammals, birds, and other fauna that inhabit the CCNPP Site and surrounding region. Some smaller, less mobile fauna such as mice, shrews, and voles could be killed by heavy equipment used in clearing, grubbing, and grading. Larger, more mobile fauna will be displaced to adjoining terrestrial habitats, which could experience temporary increases in population density of certain species. If the increases exceed the carrying capacity of those habitats, the habitats could experience degradation and the displaced fauna could compete with other fauna for food and cover, resulting in a die-off of individuals until populations decline to below the carrying capacity. Potential impacts to specific fauna species identified in Section 2.4.1 as important are discussed below.

White-tail Deer: White-tail deer, which are identified in Section 2.4.1 as important because of their recreational value to hunters, are abundant throughout the CCNPP site (TTNUS, 2007c) and throughout Maryland. Deer populations have generally increased rather than decreased as Maryland and Virginia have become more densely developed (Fergus, 2003). When deer populations exceed the carrying capacity of forested habitats, as is common in Maryland and Virginia, shrubs and saplings can be killed or stunted by over-browsing (Fergus, 2003). Although some CCNPP personnel have noticed browse damage to understory forest vegetation on the CCNPP site, the damage is not yet severe (TTNUS, 2007c). Displaced deer can be expected to cause greater browsing and trampling of the understory of forested areas surrounding the proposed construction. The effects from increased browsing by displaced deer could be at least partially offset by increased hunting in public lands to the north and south.

Scarlet Tanager and Other Forest Interior Dwelling Species (FIDS): The scarlet tanager was identified as important because it represents one of several MDNR-designated FIDS (listed in "A Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area" (CAC, 2000)) observed on the CCNPP Site in 2006 (TTNUS, 2007c). The construction footprint was designed to minimize fragmentation of forest cover to the extent possible. The proposed power block will be situated in an area where the forest cover has already been fragmented by the lawns and playing fields of Camp Conoy. The proposed batch plant, construction laydown areas, construction office and warehouse area, and construction parking area will be situated in areas where the forest cover has already been fragmented by former agricultural fields, dredge spoil disposal, and existing roadways. Construction of CCNPP facilities will not substantially contribute to increased fragmentation of forest cover or loss of habitat for the scarlet tanager or other FIDS.

Construction of the proposed switchyard, cooling tower, and construction offices and warehouses would encroach into areas of unfragmented forest north and east of the headwaters to Johns Creek and south of Camp Conoy. The only alternative to siting the facilities in the forested areas west and south of the proposed power block location would be to site them to the east, which would encroach into the CBCA. Construction of the facilities would therefore reduce the availability of suitable habitat in the region to the scarlet tanager and other FIDS. However, the reduction would be minimized because the forest clearing would take place in blocks beginning at the edge of the forested landscapes rather than as clearings or strips that encroach deeper into the forest interior.

Bald Eagle: The bald eagle was identified as important because of its previous status as a federal protected species and state listed threatened species. Three known bald eagle nesting sites were present on the CCNPP site in 2006, although one nest was determined in 2007 to no longer be active (TTNUS, 2007c). The proposed construction footprint does not encroach within a 1,500 ft (457 meter) circular setback surrounding each of the three nesting sites. However, bald eagles established a new nest after the 2006 breeding season in a tree adjoining a ball field in Camp Conoy (Figure 2.4-2). The new nest was first observed in April 2007. Two adult bald eagles were observed circling the nest, suggesting that it was active. Because the nest is located within an area that will be impacted by construction, the Maryland Department of Natural Resources and U.S. Fish and Wildlife Service will be consulted regarding avoidance and appropriate mitigation measures.

Puritan Tiger Beetle and Northeastern Beach Tiger Beetle: The proposed construction activities would have little potential to affect the puritan tiger beetle or northeastern beach tiger beetle, which were identified as important because of their federal threatened status. Both species have highly specific habitat requirements that limit their potential occurrence on the CCNPP site to the sandy cliffs adjoining undeveloped shoreline stretches of the Chesapeake Bay (USFWS, 1993; USFWS, 1994). No major construction activities would take place on or within 500 ft (152 m) of any cliff or beach habitats which are all located south of the existing barge slip. The proposed CCNPP Unit 3 intake inlet area, associated structures, and discharge pipeline have been located, and the heavy haul road has been routed, to impact the Chesapeake Bay shoreline between the existing CCNPP Units 1 and 2 intake structure and the barge slip where the shoreline consists of armored fill soil, a habitat unsuitable for either tiger beetle species.

The results of the 2006 survey (Knisley, 2006) indicated that the work proposed at the CCNPP site will not have any effect on the puritan or northeastern beach tiger beetles or their habitats. However, since the beach south of the barge slip is favorable habitat for the puritan tiger beetle, mitigation measures will consist of administrative controls such as posting signage or fencing off the beach south of the barge slip area, to restrict personnel access.

Bird Collisions: The tallest structure constructed as part of CCNPP Unit 3 is the vent stack at 211 ft (64 m), followed by the reactor building at 204 ft (62.2 m), and the cooling tower, with a height of 164 ft (50 m). The vent stack will be the tallest structure in the vicinity, which is predominantly rural. Assuming a tree canopy height of approximately 80 ft (24 m), the vent stack would protrude 131 ft (40 m) over the surrounding tree canopy. Because the vent stack would be constructed at a location with a ground surface elevation of 85 ft (26 m) above mean sea level (USGS, 1987), its top would be approximately 296 ft (90.2 m) above mean sea level, and hence 296 ft (90.2 m) above the water surface of the Chesapeake Bay.

Some bird mortality would likely result from collisions with the vent stack, reactor building, and cooling tower, but the expected mortality would be low and unlikely to significantly affect populations of migratory bird species. There are few published data regarding bird collision mortality with vent stacks, reactor buildings, or cooling towers. However, research was conducted in the early 1970s on the potential for bird collisions with cooling towers at the Davis-Besse Nuclear Power Station. Over 80 bird mortalities were reported in 1973 due to collisions with a 495 ft (150.8 m) tall cooling tower constructed on the southeast shore of Lake Erie as part of the Davis-Besse Nuclear Power Station (Rybak, 1973). However, the Davis-Besse tower is 495 ft (150.8 m) in height, more than 284 ft (86.5 m) taller than the proposed vent stack, the tallest proposed structure for CCNPP Unit 3, and more than 330 ft (100.5 m) taller than the CCNPP cooling tower.

Monitoring conducted at the Davis-Besse Nuclear Power Station between Fall 1972 and Fall 1979 revealed a total of 1,561 bird carcasses, of which 78.7% (approximately 1,229 carcasses) were attributed to collisions with the cooling tower. Most of the carcasses were species that migrate at night such as warblers (Family *Parulidae*), vireos (Family *Vironidae*), and kinglets (Family *Sylvidae*) (Temme, 1979). Many warbler and vireo species are suffering substantial population declines due at least in part to forest fragmentation (Askins, 2000) and have been identified as FIDS by the MDNR (CAC, 2000). Substantial numbers of warblers, vireos, and kinglets likely migrate through the extensive forested lands on and around the CCNPP site, and warblers of multiple species as well as the red-eyed vireo (*Vireo olivaceus*) were observed on the CCNPP site in 2006 (TTNUS, 2007c). Some individual warbler and vireo mortality events due to collisions with the vent stack, reactor building, and must therefore be expected. Due to the relatively low height of the proposed cooling tower, the mortality should not have an adverse effect on populations of any bird species. Measures such as reducing the lighting on the cooling tower to the minimum required by the Federal Aviation Administration and using flashing lights instead of floodlights have been shown to be effective in reducing the incidence of bird collisions (Ogden, 1996).

The construction of the onsite transmission lines could injure birds if they collide with the new conductors or towers or by electrocution if birds with large wingspans contact more than one conductor (i.e., cross phases). However, the transmission line connections will be constructed in, and adjoining other developed areas, and would not fragment natural bird habitats. Regularly occurring noise from human activity will also discourage frequent visitation by birds. The new towers would not be higher that the existing towers on the CCNPP site, and thus would be no more likely to increase bird collisions than the existing towers.

No new offsite transmission corridors and no offsite areas are impacted since no changes are required to the existing transmission lines or towers.

4.3.1.3 Wetlands

The construction footprint for the proposed facilities has been designed to minimize encroachment into areas delineated as wetlands or other waters of the U.S. However, except to the extent that any opportunities to further reduce wetland impacts are identified during the detailed engineering process, the construction of the proposed facilities would not be possible without permanently filling approximately 8,350 linear feet (2,545 m) of intermittent and upper perennial stream channels and approximately 11.72 acres (4.7 hectares) of the delineated wetland areas. The project would therefore require an individual permit under Section 404 of the Federal Water Pollution Act (USC, 2007) from the Baltimore District of the U.S. Army Corps of Engineers (USACE). The project does not qualify for approval under the Maryland Programmatic General Permit because of the extent of the affected regulated areas and because constructing the intake and discharge pipelines, fish return pipe and dredging to allow larger vessels to access the existing CCNPP barge slip requires work within the traditionally navigable waters of the Chesapeake Bay.

The project would also require a permit from the Maryland Department of the Environment (MDE) under the Maryland Non-tidal Wetlands Protection Act (COMAR, 2005). The project would also disturb approximately 30.69 acres (12.48 hectares) of land defined as non-tidal wetland buffer by Calvert County under the Maryland Non-tidal Wetlands Protection Act (COMAR, 2005). Non-tidal wetland buffer is defined by Calvert County as lands within 50 ft (15 m) of the landward (up-gradient) edge of non-tidal wetlands, as delineated using the federal methodology. The act also regulates expanded non-tidal wetland buffers extending as far as 100 ft (30.5 m) from the landward edge of Wetlands of Special State Concern. However, no Wetlands of Special State Concern have been identified for the CCNPP site. The permits and authorizations required for the project are presented in Section 1.3.

Most of the wetland fill would take place in Wetland Assessment Areas II, IV, and IX. Minor wetland impacts are proposed for Wetland Assessment Areas I and VII. None of the wetlands directly adjacent to Johns Creek (in Wetland Assessment Area V) or Goldstein Branch (in Wetland Assessment Area VII) would be filled, although some wetlands adjacent to headwaters to those streams would be filled. No wetlands or nontidal wetland buffers would be disturbed in Wetland Assessment Area III, Wetland Assessment Area V, Wetland Assessment Area VI or Wetland Assessment Area VIII.

In sum, the major components of the project will have the following wetland impacts:

- Construction of the power block (reactor, turbine and safety-related structures) will impact 0.03 acres (0.01 hectares) of wetlands all of which is in Wetlands Assessment Area I.
- Construction of Laydown Area I will impact 4.90 acres (1.98 hectares) of wetlands in Wetlands Assessment Area II and 0.09 acres (0.04 hectares) of wetlands in Wetlands Assessment Area IV.
- Construction of the cooling tower will impact 0.75 acres (0.30 hectares) of wetlands in Wetlands Assessment Area IV.
- Construction of the switchyard will impact 4.13 acres (1.67 hectares) of wetlands in Wetlands Assessment Area IV.
- The Unit 3 access road will impact 0.72 acres (0.29 hectares) of wetlands in Wetlands Assessment Area VII.
- Construction of Laydown Area 2, followed by a parking lot, will impact 1.10 acres (0.45 hectares) of wetlands in Wetland Assessment Area IX.

These wetland impacts are summarized herein.

Wetland Assessment Area I: Grading to construct the power block will fill 0.03 acres (0.01 hectares) of Wetland Assessment Area I. Most of the fill would encompass approximately 729 linear feet (222 m) of intermittent and upper perennial stream channels and adjacent forested wetlands. The affected stream channels have been deeply scoured by surface runoff and are adjoined by very narrow strips of forested wetlands that are less than 5 ft (1.5 m) in width and bounded by steep, eroding banks (TTNUS, 2007d). Construction of the heavy haul road will impact approximately 111 lf (33.8 m) of perennial stream channel. Construction activities will disturb 2.09 acres (0.85 hectares) of uplands within 50 ft (15 m) of Wetland Assessment Area I designated as non-tidal wetland buffer by Calvert County. Because the structural components of the power block must be closely spaced over an evenly graded surface for effective operation, it is not possible to fragment the pad to allow preservation of the stream or wetlands.

Together, the nuclear island and turbine island requires a square of approximately 28 acres (11.33 hectares). For security reasons, the protected area boundary around the nuclear and turbine islands encompasses approximately 48 acres (19.43 hectares). All the facilities within this square have a distinct function and all are necessary to function together. These facilities could not be economically or functionally separated to avoid impacted wetlands. The power block is located to limit the impact to the critical area and take advantage of Units 1 and 2 supporting facilities, such as shops, office space and parking.

Grading to construct the power block will fill approximately 0.03 acres (0.01 hectares) of an isolated wetlands within the CBCA in Wetland Assessment Area I. However, no wetland impacts will occur within 100 ft (30.5 m) of mean high tide of the Chesapeake Bay shoreline, the CBCA buffer. Approximately 1.84 acres (0.78 hectares) of uplands in the CBCA designated by Calvert County as nontidal wetland buffer would also be impacted. Construction within the CBCA, including the eastern (down-gradient) portions of Wetland Assessment Area I, is necessary to connect the proposed power block via a heavy haul road to an existing barge dock that presently serves CCNPP Units 1 and 2.

The losses of the wetland features in Wetland Assessment Area I would not represent a substantial loss in terms of wetland functions or values. Wetland functions are physical, chemical, and biological processes or attributes of wetlands that are vital to the integrity of a wetland system, independent of how those benefits are perceived by society. Wetland values are attributes that are not necessarily important to the integrity of a wetland system but which are perceived as valuable to society (Adamus, 1991). A functional assessment included in the wetland delineation report (TTNUS, 2007d) identified only two functions (and no values) present in Wetland Assessment Area I: groundwater recharge/discharge and wildlife habitat. Neither was identified as principal, i.e., of high importance to regional ecosystems or society at a local, regional, or national level. The low number of functions and values identified for Wetland Assessment Area I generally reflects the severely eroded and scoured condition of the stream channels and banks, the narrowness of the adjacent vegetated wetlands, and proximity to existing developed areas associated with CCNPP Units 1 and 2 (TTNUS, 2007d).

Wetland Assessment Area II: Preparation of the proposed permanent construction laydown area south of the power block will fill 4.90 acres (1.98 hectares) of Wetland Assessment Area II. Filled areas will include the Camp Conoy fishing pond which includes 2.63 acres (1.06 hectares) of open water as well as approximately 0.75 acres (0.32 hectares) of emergent wetlands and 1.47 acres (0.60 hectares) of forested wetlands fringing the pond. Stormwater Retention Basin 5 construction will total 1.74 acres (0.70 hectares). Also included are 0.05 acres of an isolated wetland. Currently, a total of 4.90 acres (1.98 hectares) of wetlands are proposed for impact in Wetland Assessment Area II. Construction of Laydown Area 1 would also disturb 7.18 acres (2.91 hectares) of uplands within 50 ft (15 m) of Wetland Assessment Area II designated as non-tidal wetland buffer by Calvert County. The affected buffer consists mostly of undeveloped forested land. Construction of Laydown Area 1 would also impact 384 lf (117 m) of intermittent and perennial stream channel.

Impacts to Wetland Assessment Area II would be within the CBCA, but will be 0.35 acres (0.14 hectares) limited to the most landward (westernmost) 200 ft (61 m) of the CBCA. The wetland impacts will be necessary for laydown and the construction of the retention basin. Approximately 0.86 acre (0.35 hectares) of uplands, all undeveloped forest land, in the CBCA designated by Calvert County as non-tidal wetland buffer would be impacted. No areas of Wetland Assessment Area II within 800 ft (244 m) of the Chesapeake Bay will be impacted, including the two small impoundments on the wetlands complex flowing northeast from the Camp Conoy Fishing Pond to the Bay.

In the construction of a nuclear power station various facilities are necessary to perform safety-related construction and maintain the security of the site. Space allocation for construction activities, laydown, parking , and office space south of CCNPP Unit 3 is necessary for its proximity to the power block and turbine block construction site. This impacts the Camp Canoy fishing pond because this area would be filled to an elevation of 85 ft msl. The power block and turbine block construction site has limited accessibility on two sides. The critical area to the east and the heavy haul road and existing parking lots for CCNPP Units 1 and 2 limit access to the north. Construction congestion will be further compounded because the western perimeter will be closed off two to three years into the schedule for construction of the switchyard. Consequently, it is crucially important for mainta ining construction flow that the entire south side be available for construction activities .

A climate controlled warehouse for storage of safety-related components and sensitive electrical and electronic equipment would be located in this laydown area on the south side of the power block/turbine block construction site. A test laboratory would also be located within this area. This laboratory would contain, for example, non-destructive examination and radiograph equipment and a calibration lab. Items tested include concrete, rebar, etc. Several different fabrication shops would be located within this area. Some of these shops would construct safety-related components and would require controlled processes to achieve the required level of quality. In addition, the construction of certain large components, such as the bottom shell of the containment liner, will require precise fabrication in an area adjacent to the power block and will then be lifted in place by large construction cranes. The containment liner is safety-related and is approximately 175 ft in diameter. Other facilities that are planned for location on the south side include security, badging, first aid, safety, training, change facility, and lunch room. Location of these facilities near the work site is important as they support a controlled, secure, and safe work environment. Maintaining a controlled construction site is especially important because of the proximity to Units 1 and 2 and the requirement to maintain security for these facilities.

The evaluation of wetland functions and values included in the wetland delineation report (TTNUS, 2007d) identified seven functions (groundwater recharge/discharge, fish and shellfish habitat, sediment/toxicant retention, nutrient removal, production export, sediment/shoreline stabilization and wildlife habitat) and three values (recreation, educational/scientific value, and uniqueness/heritage) present in Wetland Assessment Area II. Of these, wildlife habitat and recreation have been identified as principal. Wildlife habitat was identified as a principal function because of the diversity of vegetative cover in the wetlands and adjoining uplands.

Recreation was identified as a principal value because of the trails, dock, and other facilities at the Camp Conoy fishing pond. The loss of the wetlands and wetland buffer in Wetland Assessment Area II therefore represents a substantial reduction in the local availability of quality wildlife habitat. The loss of the Camp Conoy Fishing Pond would not, however constitutethe loss of an outdoor recreational facility because the property has been closed to recreational use as a result of heightened security space concerns related to CCNPP Unit 1 and 2.

Wetland Assessment Area III: No part of Wetland Assessment Area III or its associated non-tidal wetland buffer designated by Calvert County would be filled.

Wetland Assessment Area IV: Construction of the proposed switchyard will require permanently filling 4.13 acres (1.67 hectares) of wetlands and other waters of the state and U.S. in Wetland Assessment Area IV, including 4,178 lf of intermittent and perennial stream channels, forested wetlands, and forested springs associated with a generally southwest-flowing headwater of Johns Creek. Construction will also disturb 15.84 acres (6.42 hectares) of uplands within 50 ft (15 m) of Wetland Assessment Area IV designated as nontidal wetland buffer by Calvert County. The wetland and wetland buffer impacts are unavoidable because of the need to construct the switchyard adjacent to the power block. Construction of the heavy haul road will also impact 530 lf (161.5 m) of perennial stream channels.

The switchyard contains the electrical equipment necessary to connect the generator output to the high voltage transmission system. The switchyard provides the interface point between the power plant and the 500kV electric transmission system. As such, it has been located so as to provide the most advantageous location with respect to the power plant, and to the existing transmission system. The various electrical switches, breakers and transformers need to be located on an area of land adjacent to the turbine building where the transformers are located. Transmission lines connect the transformers with the switchyard and the planned configuration provides for the least intrusive transmission line routing, avoiding the use of large expanses of land to accommodate transmission towers and the transmission line routing and bending radius transition. The further west the switchyard is located, the greater the impact to Johns Creek. Its current location at the headwaters of Johns Creek causes the least impact to wetlands.

The switchyard is an electrically interconnected set of breakers and take-off towers. The interconnection of all the components in the switchyard provides the functionality and reliability that the connection to the grid requires to support safe plant operation. Splitting the switchyard into separate areas would decrease the reliability and flexibility of the installation. Therefore, the switchyard is designed as a continuous block of approximately 24 acres.

The size of the switchyard is dictated by the transmission system voltage, 500kV, and the number and the configuration of the breakers, and the number of lines leaving the switchyard. The Unit 3 switchyard provides the optimum combination of operational and economic considerations and is widely employed in switchyard layouts. The design dictates that the switchyard must be deep enough to accommodate three 500kV breakers in each bay, in addition to the buses and take-off towers. The width of the switchyard is dictated by the number of bays required to service the connections to the switchyard. A total of six bays are required to connect four transmission lines, six transformers, and provide an allowance for two additional future connections.

The power block of Unit 3 is laid out with all the power transformers located on the west end of the power block. Consequently, in order to facilitate overhead EI-IV line connections, the switchyard should be arranged closest to the west side of the power block area.

The three existing transmission lines enter the area from the north, and two of the three will be rerouted to the new Unit 3 switchyard. In order to avoid crossing lines, the two lines closest to Unit 3 will be extended along their existing trajectory on the Calvert Cliffs property, and angled into the new switchyard. Placing the new switchyard at an angle to reduce the route length would only provide a small benefit, and would require a larger overall switchyard footprint if the switchyard is expanded in the future.

New transmission lines are planned to connect the existing Units 1 and 2 switchyard to the new Unit 3 yard. This is required in order to avoid disruption to the existing offsite power supply connections to Units 1 and 2. This provides the additional benefit of allowing Unit 3 the option to receive or transmit power through these lines. These new connecting lines are routed along the same right of way area as the rerouted transmission lines mentioned above. This prevents creation of a second 500kV corridor and minimizes the overall acreage that is required to route the power lines.

The switchyard cannot be moved to the north to shorten the new lines due to existing structures and improvements in this area. Moving the switchyard to the south or west would increase the area required to install the new transmission lines and towers.

The switchyard area is used initially as a construction laydown area to lessen the impact to land use and to stage equipment/materials near the construction site. As construction progresses, this area would transition to switchyard construction. If the switchyard were not located in this area, a large portion would still be required to be disturbed.

Conversion of the area from a construction lay down/production/access area is expected to take place approximately two to three years into the plant construction process.

Lands east of the power block are in the CBCA, lands south are needed for the cooling tower and laydown area, and lands north contain existing facilities. Hence, the only practicable location for the switchyard is west or the power block. The need for closely clustering the switchyard facilities over a contiguous, evenly graded area would prevent preserving the subject stream channels, springs, and wetlands.

Construction of the proposed CWS cooling tower will require permanently filling 0.75 acres (. 304 hectares) of wetlands and approximately 1,445 lf (440.4 m) of intermittent and perennial stream channel other waters of the state and U.S. in Wetland Assessment Area IV. The cooling tower should be located as close as practicable to the turbine island. Locating the cooling tower further from the turbine island increases the construction and operating cost. Additional piping lengths increase the material, excavation, and labor costs during construction. Operating costs increase due to greater auxiliary loads from larger pumps and motors to move the cooling water greater distances.

The Unit 3 cooling tower will be located to minimize salt deposition in forested areas and in the CBCA. The location of the cooling tower also minimizes drift over the substation structures to avoid safety and engineering concerns. Finally, locating the Unit 3 cooling tower in this area will allow for potential site expansion. This location permits use of the area to the east for cooling tower expansion. Construction of a second cooling tower would be accomplished without having the 4 large (11' diameter) circulating water pipes crossing over each other which presents significant engineering concerns.

Preparation of the proposed laydown area south of the power block (Laydown Area 1) will fill 0.09 acres (0.04 hectares) of Wetland Assessment Area IV. Filled areas will include upstream intermittent stream reaches of an unnamed tributary to Johns Creek.

Construction of Laydown Area 1 would also disturb 1.47 acres (0.59 hectares) of uplands within 50 feet (15 m) of Wetland Assessment Area IV designated nontidal wetland buffer. The affected buffer consists mostly of undeveloped forested land.

The evaluation of wetland functions and values included in the wetland delineation report (TTNUS, 2007d) identified five functions (groundwater recharge/discharge, sediment/toxicant retention, nutrient removal, production export, and wildlife habitat) and three values (recreation, educational/scientific value, and uniqueness/heritage) present in Wetland Assessment Area IV. Of these, wildlife habitat and uniqueness/heritage were identified as principal. Wildlife habitat was identified as principal because of the presence of the wetlands within a large block of contiguous forest that provides habitat for FIDS. Uniqueness/heritage was identified as principal because of the fact that Johns Creek and its headwaters east of (MD) 2/4 represent one of the few stream systems in southern Calvert County that still remains largely free of development. The loss of the wetlands and wetland buffer in Assessment Area IV therefore represents a reduction in the local availability of quality wildlife habitat, including FIDS habitat, and a reduction in the availability of outdoor passive recreation facilities in the region.

<u>Wetland Assessment Area V: No jurisdictional USACE or MDE wetlands or associated nontidal wetland buffer will be filled. The functional assessment included in the wetland delineation report identified more principal functions and values for Wetland Assessment Area V than for any other Wetland Assessment Area.</u> The principal functions included wildlife habitat, fish and shellfish habitat, sediment/toxicant retention, nutrient removal, and production export. Uniqueness/heritage was identified as a principal value. Some key properties of Wetland Assessment Area V contributing to its functional superiority include the juxtaposition of forest and emergent wetland vegetation, the meandering and braided course of Johns Creek through the wetlands, and the extensive coverage by mature forest cover in the adjoining uplands. Avoiding encroachment into Wetland Assessment Area V and its associated nontidal wetland buffers was therefore a key objective when selecting a route for the construction access road.

<u>Wetland Assessment Area VI:</u> No jurisdictional USACE or MDE wetlands or associated nontidal wetland buffers within Wetland Assessment Area VI will be impacted by the construction of the CCNPP Unit 3. Areas resembling wetlands were determined to be non-jurisdictional by the USACE because these areas encompass former sediment basins which are man-made rather than natural features associated with the Lake Davies dredged material disposal area. In addition, these sediment basins are infested throughout by dense growth of the non-native invasive grass phragmites, which is of generally low value as food or cover by wildlife. The phragmites cover extends over most of the emergent wetlands and under the tree canopy in most of the forested wetlands, as well as most of the abutting uplands.

<u>Wetland Assessment Area VII:</u> Construction of the construction access road, will require filling 0.72 acres (0.29 hectares) of wetlands and other waters of the state and U.S. in Wetlands Assessment Area VII, including 1,084 linear feet (760 m) of headwaters to Goldstein Branch and

adjacent forested wetlands. The affected area includes intermittent and perennial stream channels, forested wetlands, and forested springs associated with headwaters to Goldstein Branch, but construction will not involve disturbing the main channel of Goldstein Branch or its directlv adjoining wetlands. It is proposed to use bridges and culverts to minimize disruption of these streams. Construction will also disturb 3.41 acres (1.38 hectares) of uplands within 50 feet (15 m) of Wetland Assessment Area VII designated as nontidal wetland buffer by Calvert County. A portion of the laydown area north of Lake Davies consists of a 0.62 acre (0.25 hectare) emergent marsh that is a former storm water detention structure and is non-jurisdictional. The original locations of the construction road and concrete batch plant were relocated to minimize impacts on the wetlands associated with John Creek and the Goldstein Branch, and the preserve the maximum amount of wetlands and wetland buffer in Assessment Area VII.

The evaluation of wetland functions and values included in the wetland delineation report (TTNUS, 2007d) identified six functions (groundwater recharge/discharge,fish and shellfish habitat, sediment/toxicant retention, nutrient removal, production export, and wildlife habitat) and one value (recreation) present in Wetland Assessment Area VII. Of these, nutrient removal and wildlife habitat have been identified as principal. Nutrient removal was identified as principal because it contains emergent vegetation in places and receives runoff from lawns on private property close to MD 2/4. Wildlife habitat was identified as principal because it is a largely intact natural system largely free of urban or agricultural development. This area was considered important based on the quality of its wildlife habitat and on its contribution to nutrient removal in the local region.

Wetland Assessment Area VIII: No part of Wetland Assessment Area VII or its associated nontidal wetland buffer designated by Calvert County would be filled.

Wetland Assessment Area IX: Construction of Laydown Area 2, to be followed by use as a parking lot will require filling the entirety of Wetland Assessment Area IX (1.10 acres (0.45 hectares)), including 0.64 acres (0.26 hectares) of forested wetlands and 0.46 acres (0.19 hectares) of emergent wetlands. Wetland Assessment Area IX consists of 1,200 linear feet (366 m) of multiple springs and small fragments of intermittent stream channels and ditches within a small remnant area of forest land surrounded by existing roadways and parking lots. Construction will also disturb 2.56 acres (1.04 hectares) of uplands within 50 ft (15 m) of Wetland Assessment Area IX designated as non-tidal wetland buffer by Calvert County. The affected buffer consists of undeveloped forested land and mowed grassland adjoining existing roadways.

The affected wetlands and associated buffers are of low functional quality. The evaluation of wetland functions and values included in the wetland delineation report (TTNUS, 2007d) identified only one function (wildlife habitat) and one value (visual quality/aesthetics). Neither was identified as principal. While the isolated forest area, including its wetlands, might have some value as an "oasis" for wildlife traversing the existing developed areas west of CCNPP Units 1 and 2, its small size and proximity to areas of heavy human and vehicular use make it generally unattractive to most terrestrial wildlife. Surface flow in the wetlands is all directed into existing storm sewers rather than into natural streams, hence the opportunity for the wetlands to perform water quality functions or production export to aquatic food chains is minimal. The loss of Wetland Assessment Area IX therefore represents a minimal loss of wetland functions and values.

Summary: The losses of the wetland features in Wetland Assessment Area I would not represent a substantial loss in terms of wetland functions or values. Only two wetland functions (i.e., groundwater recharge/discharge and wildlife habitat) would be affected as a result of the proposed development (impacts) with in Wetland Assessment Area I. Neither was identified as principal, i.e. of high importance to regional ecosystems or society at a local, regional, or national level. No wetland values would be affected by the proposed development within this assessment area. Space of construction activities, lavdown, and fabrication space is needed during construction in close proximity to the CCNPP Unit 3 power block. However, lands east of the power block are in the CBCA, lands to the west are needed for the switchyard, and lands north contain existing CCNPP Units 1 and 2 facilities. As a result. it is necessary to use the area immediately to the south during construction, thus permanently impacting the former Camp Conoy fishing pond in Wetland Assessment Area II. No wetlands with in Wetland Assessment Area III would be impacted through the proposed development activities. Five wetland functions (groundwater recharge/discharge, sedimen/toxicant retention, nutrient removal, production export, and wildlife habitat) and three values (recreation, educational/scientific value , and uniqueness/heritage) would be affected from proposed impacts to wetlands within Wetland Assessment Area IV. The proposed wetland impacts in this assessment area are unavoidable, however. No wetlands within Wetland Assessment Area V would be impacted through the proposed development activities. No wetland values would be affected by the proposed development within this assessment area. Six wetland functions (groundwater recharge/discharge, fish and shellfish habitat, sediment/ toxicant retention, nutrient removal, production export, and wildlife habitat) and one value (recreation) would be affected from proposed impacts to wetlands within Wetland Assessment Area VII. Of these, nutrient removal and wildlife habitat were reported to be principal. The proposed wetland impacts in this assessment area are unavoidable. No wetlands within Wetland Assessment Area VIII would be impacted through the proposed development activities. Only one wetland function (wildlife habitat) and one value (visual quality/aesthetics) would be affected as a resu lt of the proposed development (impacts) with in Wetland Assessment Area IX. Neither was identified as principal.

In general, the CCNPP Unit 3 construction facilities, including the batch plant, access road, parking, and laydown areas, have been designed to lessen the impact on wetlands. Large existing wetlands/surface waters have been avoided to the extent practicable by the planned location of construction parking and laydown areas. The power block, switchyard. and cooling tower areas require large blocks of land where little design modification can be done to avoid wetlands. The power block will be physically located to lessen the impact to the critical areas. As a result, the location will minimize the impacts to the Johns Creek watershed. Relocating the power block and the switchyard further west of the currently designed locat ion would cause a greater impact to this watershed.

4.3.1.4 Other Projects Within the Area with Potential Impacts

Although not a project, Calvert County is redirecting future residential and commercial development into existing clusters of urban development termed "town centers" away from the CBCA, including the cliffs and beaches that provide potential habitat for the two tiger beetle species and bald eagles (CCPC, 2004).

The EIS for the other large energy facility development project planned for Calvert County, the Cove Point Liquefied Natural Gas (LNG) expansion project indicates that no cliff or other naturally vegetated Chesapeake Bay habitat would be impacted by the project (FERC, 2005). The EIS also indicates that the one bald eagle nest near a proposed pipeline crossing of the Patuxent River in western Calvert County could be impacted by the construction. The developer of the project, Dominion Cove Point LNG, LP, has committed to the U.S. Fish and Wildlife Service (USFWS) to implement appropriate mitigation measures.

Calvert County has experienced extensive fragmentation of forest cover and loss of FIDS habitat due to agricultural and suburban development. The Cove Point LNG expansion project would limit forest clearing in the county to lands directly adjacent to the LNG and ancillary facilities and areas to the side of existing pipeline right-of-way (FERC 2005) and is unlikely to diminish FIDS habitat.

4.3.1.5 Consultation

Affected Federal, State and Regional agencies will be contacted regarding the potential impacts to the terrestrial ecosystem resulting from plant construction. The Maryland Natural Heritage Program, operated by the Maryland Department of Natural Resources, was consulted for information on known occurrences of Federally-listed and State-listed threatened, endangered, or special status species and critical habitats (Byrne, 2006). Identification of the important species discussed above was based in part on information provided by that consultation. The U.S Fish and Wildlife Service was consulted via letter dated April 12, 2007 and responded on May 22, 2007 stating that no federally protected, threatened, or endangered species are known to exist with the proposed project area except for the occasional transient species, but qualified the response by stating that "if additional information on the distribution of listed or proposed species becomes available, this determination maybe reconsidered (Ratnaswamy, 2007), The consultation occurred prior identification of the eagle in the project vicinity (Section 4.3.1.2) and additional consultation is planned as stated in Section 4.3.1.2. USFWS and the Maryland Department of Natural Resources will be provided an opportunity to review the Environmental Report.

4.3.1.6 Mitigation Measures

Opportunities for mitigating unavoidable impacts to terrestrial ecosystems involve restoration of natural habitats temporarily disturbed by construction creation of new habitat types in formerly disturbed areas, as well as enhancement of undisturbed natural habitats. Mitigation plans will be developed in consultation with the applicable State and local resource agencies and will be implemented on the CCNPP site to the extent practicable. The description of mitigation measures is addressed below for upland areas (flora and fauna) and wetland areas.

<u>Flora and Fauna:</u> Mitigation to replace temporary and permanent impacts to upland areas (Table 4.3-1) will consist of reforestation as well as development of other appropriate naturally vegetated areas (e.g., meadows, shrub/scrub communities). Some areas on the CCNPP site may be available for mitigation, including lawns and old agricultural fields. Consideration will be given to mitigation within the CBCA as well as areas further inland. Because the areas of projected forest losses in the CBCA are already fragmented by roads and lawns in Camp Conoy and the roadways and open areas adjoining the barge dock, reforestation within the CBCA will contribute to the State of Maryland's goal of increased FIDS habitat in the CBCA (CAC, 2000). In addition, UniStar will keep the remaining unforested upland, not impacted by the construction of CCNPP Unit 3, as old field habitat to maintain site biodiversity.

The reforestation process is designed to ultimately generate a mixed deciduous forest. Mixed deciduous forest is the climax vegetation, i.e., the permanently-sustaining vegetation that would result following an extended period without disturbance, for uplands in central Maryland, including Calvert County. The process by which unvegetated land reverts to climax vegetation is termed natural succession. Left undisturbed, abandoned agricultural land in central Maryland typically passes through a series of intermediate forest stages termed seres.

The initial series consist of vegetation dominated by grasses and other herbaceous plants; then vegetation dominated by shrubs and tree saplings; then forest vegetation dominated by Virginia pines and hardwoods such as black locust and black cherry that grow rapidly in conditions of full sunlight; and finally forest dominated by oaks, tulip poplars, and other hardwoods that can regenerate under their own shade. The initial two series correspond to the old field vegetation on the CCNPP site, the intermediate series corresponds to the successional hardwood forest, and the final (climax) series corresponds to the mixed deciduous forest. The mixed deciduous regeneration forest is the result of logging mixed deciduous forest without killing the stumps and associated root systems; it therefore consists of a mixture of stump sprouts of climax tree species and fast-growing successional tree species and is intermediate in character between mixed deciduous forest and successional hardwood forest.

An optimal mix of tree species for planting includes tulip poplar, sweet gum, green ash, black locust, Virginia pine, and loblolly pine. All are relatively fast growing when properly planted, are easily transplanted and widely available as nursery stock (Hightshoe, 1988), and are components of the existing successional hardwood forest and/or mixed deciduous forest on the CCNPP site (TTNUS, 2007b). Based on reported growth rates (Hightshoe, 1988), a stand planted with bare-root or 1-gallon container-grown nursery stock of the above species would form a closed canopy forest resembling the existing successional hardwood forest or mixed deciduous regeneration forest within 20 to 30 years. At that point, the stand will provide habitat for FIDS. The Matapeake soils mapped in the subject area have a reported site index of 75 to 85 for loblolly pine (USSCS, 1971).The site index indicates the expected height for planted loblolly pine after 50 years. Site index data are not available for the other species, but the data for loblolly pine provides a general idea of growth rate for relatively fast growing tree species.

Oaks, beeches, and other shade-tolerant climax species would be expected to voluntarily establish in the shade of the stand as their nuts are dispersed naturally by squirrels and other wildlife. Mountain laurel and other understory and groundcover vegetation typical of mixed deciduous forests would also be expected to gradually become established under the shade of the closed canopy. The floristic composition of the stand will gradually approach that of the existing mixed deciduous forest on the CCNPP site, a process that could require more than 100 years.

Portions of the power plant and rights-of-way disturbed during construction will be stabilized after the cessation of construction activities within that portion of the footprint and right-of-way, followed by seed application, except in actively cultivated lands, in accordance with the best management practices presented in Maryland Standards and Specifications for Soil Erosion and Sediment Control. In wetlands and wetland buffers, seed application shall consist of the following species: annual ryegrass *(Lolium multiflorum)*, millet *(Setaria italica)*, barley *(Horedum spp.)*, oats *(Uniola spp.)*, and/or rye *(Secale cereale)*. Other non-persistent vegetation may be acceptable with appropriate approval. To minimize forest losses, cleared areas that are no longer in use and not anticipated to be in use following project construction will be replanted with tree species appropriate for the area.

<u>Wetlands:</u> Wetland mitigation in Maryland is driven primarily by conditions established by the USACE and MDE in permits issued under Section 404 of the Federal Water Pollution Control Act (USC, 2007) and the Maryland Nontidal Wetlands Protection Act (COMAR, 2005). Wetland mitigation follows a sequencing process beginning with avoidance of wetland impacts, then minimization of wetland impacts, and lastly compensatory mitigation to offset impacts. The

proposed facilities have been sited, and the proposed construction has been configured, to avoid encroaching into wetlands (and a surrounding 50 ft (15 meter) wide buffer) to the extent possible. Other factors such as minimizing encroachment into the CBCA, keeping NRC-required buffers within the CCNPP site boundaries, and situating the power block close to the existing CCNPP units were considered; hence the wetland impacts detailed above must be considered unavoidable.

Several measures will be taken to minimize the unavoidable adverse effects to wetlands. The use of berms, temporary and permanent vegetative stabilization, and other soil erosion and sediment control practices would reduce the risk of sediment runoff into intact wetlands adjoining the areas of fill. Sand filter trenches will be constructed around the periphery of the power block, construction laydown area, cooling tower and switchyard areas to help catch surface runoff and prevent degradation of adjoining terrestrial and aquatic habitats. The sand filter trenches would be constructed of base materials that promote infiltration of runoff from low intensity rainfall events. However, for large storms the infiltration capacity of the base materials would be exceeded and the overflow pipes would direct the runoff to the stormwater retention basins. The stormwater retention basins would be unlined impoundments, vegetated with regionally indigenous wetland grasses and herbs, with simple earth-fill closure on the down stream end and could include discharge piping to the adjacent watercourses.

Wetland mitigation will be required by conditions established in an individual permit to be issued by the USACE and under Section 404 of the Federal Water Pollution Control Act and in the CPCN in accordance with the requirements of the Maryland Nontidal Wetlands Protection Act. Wetland mitigation follows a sequencing process beginning with avoidance of wetland impacts, then minimization of wetland impacts, and lastly compensatory mitigation to offset impacts. The proposed facilities have been sited, and the proposed construction has been configured to avoid encroaching into wetlands(and surrounding 50 ft (15 m) wide buffer) to the extent practicable. Other factors such as minimizing encroachment into the CBCA, keeping NRC-required buffers within the CCNPP site boundaries, and situating the power block close to the existing CCNPP units were considered; hence, the wetland impacts detailed above are considered unavoidable.

The mitigation plan is divided into four categories: (1) on-site forested wetland in-kind creation; (2) onsite herbaceous wetland enhancement; (3) on-site stream restoration and (4) off-site forested wetland restoration. The details of each mitigation plan component are presented below.

The proposed compensatory "in kind" mitigation for the scheduled impacts to wetlands and surface waters of the CCNPP Unit 3 project is intended to meet the mitigation requirements of the USACE Baltimore District and includes the creation and enhancement of wetlands to conditions more suitable for use by wildlife species native to the region. Four general mitigation strategies were initially identified: 1) on site and in kind; 2) on site and not in kind; 3) off site and in kind; and 4) off site and not in kind. The mitigation strategy chosen for the CCNPP Unit 3 project was on-site and in-kind mitigation, as this strategy, or mitigation action, would replace nontidal wetland acreage, nontidal stream channel, and functional losses more effectively than the other three strategies. The project is designed to adhere to the Code of Maryland Regulations (COMAR), Subsection 26.23.04.03 (COMAR, 2005).

Forested Wetland In-Kind Creation

The wetland mitigation component of the compensatory mitigation plan includes the following proposed activities:

- The creation of forested wetland habitat within the Camp Conoy area that lies within the CBCA (Mitigation Site WC-1), the creation of forested and herbaceous wetland habitat within the middle manmade, abandoned, sediment basin of the Lake Davies Disposal Area (Mitigation Site WC-2);
- The enhancement of a smaller manmade, abandoned, sediment basin within the Lake Davies Disposal Area (Mitigation Site WE-1) and the enhancement of a portion of Johns Creek and a linear drainageway extension occurring to the south of the Lake Davies Disposal Area (Mitigation Site WE-2)
- The eradication of phragmites through herbicide application (Mitigation Sites WC-2, WE-1, and WE-2)
- The use of soil material from impacted on-site wetland areas that do not contain phragmites to create mitigations sites as a supplemental growth medium (Mitigation Site WC-1 and WC-2).

Wetland Creation Mitigation Sites

Mitigation Site WC-1

Mitigation Site WC-1 is next to the northern boundary of the CCNPP Unit 3 project area within the Camp Canoy area, which lies within the CBCA. The WC-1 site is the only mitigation area of the four proposed wetland mitigation sites that occurs within the CBCA. The selection of the WC-1 site resulted from an opportunity to route stormwater from the Unit 3 facility to the proposed forested wetland creation site, thereby providing a source of hydrology for this mitigation site.

For the WC-1 site, stormwater from the proposed power block and adjacent laydown area will be used to drive the hydrology of the created wetlands. Three wetland cells in series are proposed. Discharge from the site will enter into the cell at the highest elevation. A catch basin with an overflow elevation set approximately one foot above the ground elevation and equipped with a small outlet pipe will drain water from this cell through the berm into the middle cell in approximately 24 hours. Likewise, water from the middle cell will flow into the lower cell through a catch basin set about 1 foot above base elevation. Water in the lowest cell will discharge slowly into an existing channel leading down to the Chesapeake Bay. The uppermost wetland cell will also be equipped with an overflow spillway to handle discharges up to the 25-year storm. These peaks will be reduced through temporary storage in the wetland and then released into the channel below Camp Conoy. The 24-hour drawdown time in the wetland cells was determined to reduce inundation of tree roots for excessive periods of time. Micropools and other microtopography features will be added to the wetland cells to diversify habitat for wetland flora and fauna. Finally, the WC-1 site will receive treated stormwater to drive the hydrology of the site. The WC-1 site has not been designed to provide attenuation (water quality treatment) for stormwater being routed from the constructed CCNPP Unit 3 facility.

The WC-1 site will be planted with seedlings of native hydrophytic tree species to create a wetland hardwood forest community. Approximately 4.6 acres of forested wetlands will be created in this location. At a mitigation credit ratio of 2:1, this mitigation site will yield approximately 2.3 acres of credit. Wetland function will be increased by creating wildlife habitat for wetland dependent and wetland independent species. These created wetlands will provide waterfowl habitat; i.e., winter flooded conditions for resident and migratory species, with drawdown in the spring to maintain the vitality of the planted tree species and provide a suitable substrate for plant regeneration.

Mitigation Site WC-2

Mitigation Site WC-2 is located within the Lake Davies Disposal Area, near the western boundary of the CCNPP Unit 3 project area. The Lake Davies Disposal Area was created during the construction of CCNPP Units 1 and 2 as a disposal area for dredged material from the project area. The WC-2 site occurs as the middle of three sediment basins (i.e., upper, middle, and lower basins) that are separated from each other by elevated berms. The middle and lower basins are man-made, but appear to support hydrophytes within areas of hydric soils and exhibit wetland hydrology. The existing site conditions of the basins provide an opportunity for the implementation of nontidal wetland mitigation strategies.

Within the Lake Davies Disposal Area, wetland creation will be provided for the middle abandoned sediment basin through the establishment of the following vegetative zones:

- An interior open water (pond) area will be planted with floating aquatic species;
- A surrounding freshwater marsh fringe will be planted with herbaceous plant species; and
- An outer zone will be planted with woody bottomland hardwood species.

Wetland fill material will be deposited within the sediment basin to raise the ground elevation across the central portion of the basin. Soil material from impacted on-site wetland areas will be used for the WC-2 mitigation site; however, only impacted wetlands that do not contain phragmites will be considered for a source of hydric soil material. The undesirable, exotic, plant species phragmites, which is currently infesting the sediment basin, will be eradicated through the application of chemical herbicide before the filling and planting activities. The hydroperiod of this created wetland area will be manipulated through the establishment of a water control structure. Through these mitigation activities, approximately 0.9 acre of open water (pond) habitat and 1.3 acres of freshwater marsh habitat will be created. At a mitigation credit ratio of 1:1, this mitigation site will yield approximately 1.3 acres of credit for emergent marsh. The planting of approximately 7.2 acres of bottomland hardwood forest will provide forested wetland creation. At a mitigation credit ratio of 2:1, this mitigation site will yield approximately 3.6 acres of credit for forested wetlands. The creation of zones of open water, marsh, and bottomland hardwood forest will greatly increase wetland habitat diversity (wetland function) and wetland value within this basin and be an improvement over the existing habitat condition; i.e., a monoculture of phragmites.

Wetland Enhancement Mitigation Sites

Mitigation Site WE-1

Mitigation Site WE-1 is located within the aforementioned Lake Davies Disposal Area. The WE-1 site occurs as the lower sediment basin within the disposal area. Berms physically separate this basin from the middle sediment basin (WC-2) and a linear drainageway extension to the south (WE-2). The mitigation site is presently dominated by phragmites. Field observations indicate the presence of hydric soils and wetland hydrology within this proposed wetland enhancement mitigation site. Culverts hydrologically connect this basin to the middle sediment basin (WC-2) and the linear drainageway extension to the south (WE-2).

The lower sediment basin within the Lake Davies Disposal Area will be enhanced through the eradication of phragmites, by application of chemical herbicide, and the planting of woody bottomland hardwood species (trees and shrubs). These mitigation activities will provide approximately 2.4 acres of wetland enhancement. At a mitigation credit ratio of 3:1, this mitigation site will yeild approximately 0.8 acre of credit for forested wetlands.

The planting of desirable woody species within the enhancement area, along with phragmites eradication, will provide suitable wildlife habitat (wetland function) and wetland values within this phragmites-infested basin. The benefits of eradicating phragmites would be the replacement of a somewhat sterile environment with a more diverse community through the planting of desirable plant species.

Mitigation Site WE-2

Mitigation Site WE-2 is generally located within Johns Creek. This mitigation site includes a linear drainageway extension to the south of the aforementioned lower sediment basin (WE-1), i.e., next to the southern end of the Lake Davies Disposal Area. The downstream portion of Johns Creek that is proposed for enhancement includes the portion of the reach that extends from a point approximately 1,000 feet upstream of the MD 2/4 bridge to a point near the western end of stream mitigation site SR-4. The WE-2 site lies outside the CCNPP Unit 3 boundary but within the CCNPP property boundary. Therefore, as with the other three previously described wetland mitigation sites, all mitigation activities will be implemented on site. The portions of the Johns Creek reach that are not infested with phragmites (i.e., as occurring downstream and upstream of the mitigation site) are not included within the WE-2 mitigation area.

Wetland enhancement will be provided within a significant portion of the Johns Creek system through the eradication of phragmites, by application of chemical herbicide and the planting of woody bottomland hardwood species. The target areas encompass:

- The eastern (upstream) and western (downstream) portions of Johns Creek near the confluence of Johns Creek and the linear drainageway extension occurring to the south of the Lake Davies Disposal Area; and
- The portion of Johns Creek that is proposed for enhancement includes the portion of the reach, which extends from a point located approximately 1,000 feet upstream of the MD 2/4 bridge to a point located near the western end of stream mitigation site SR-4. The linear drainageway extension appears as a remnant stream system that is presumed to have historically extended northward into the area that is now known as the Lake Davies Disposal Area.

The planting of desirable woody species (trees and shrubs) within the enhancement areas of Johns Creck, along with phragmites control, will provide wildlife habitat within this poorly drained bottomland hardwood forest community. The phragmites-infested portions of Johns Creek have been significantly degraded over time as a result of recruitment of this invasive species. Therefore, the proposed mitigation activities will replace the loss of one or more functions within the targeted wetland community. The mitigation activities associated with the WE-2 site will provide approximately 15.7 acres of wetland enhancement. At a mitigation credit ratio of 3:1, this mitigation site will yield approximately 5.23 acres of credit for forested wetlands.

Wetland Mitigation Planting Plan

Creation Sites

After excavation and the establishment of bottom elevations and the installation of water control structures, the WC-1 site will be planted with native hydrophytic trees species. The tree species will be planted at a density of 680 stems per acre (8-foot centers) to allow for anticipated mortality from wildlife depredation by white-tailed deer *(Odocoileus virginianus)* or other browsers and defoliation by insects during early seedling establishment. It is expected that recruited, desirable, woody species will add to the overstory stem density in the mitigation site. The plant material will be representative of the species composition of the adjacent bottomland hardwood forested wetlands within the CCNPP property and native to the region. In addition, the plant material will include species that have been identified as suitable for installation on wetland mitigation projects by the Calvert County Soil and Water Conservation District (CCSWCD) and the CAC. The final selection of plant stock may be determined to some extent by availability. The selected tree species will consist of containerized and/or bare root stock protected by tree shelters (i.e., TUBEX® or Miracle Tube tree shelters). The tree shelters will provide protection from wildlife depredation, wind, or other influences. The tree material for installation will include, but is not limited to willow oak *(Quercus phellos)*, water oak *(Quercus nigra)*, black gum, red maple, tulip tree *(Liriodendron tulipifera)*, river birch *(Betula nigra)*, and/or American sycamore *(Platanus occidentalis)*. The palette of tree species will be finalized before installation. Additional species may be added if they are determined to be highly suitable for installation in the WC-1 mitigation site.

Three planting zones are proposed for the WC-2 mitigation site; i.e., open water freshwater marsh fringe, and bottomland hardwood forest. The open water (pond) habitat will be planted with pondweed *(Potamogeton sp.)*, water lily *(Nymphaea sp.)*, or other suitable floating aquatic species. The marsh fringe will be planted with native hydrophytic herbaceous species. The herbaceous species will be planted at a density of 4,800 stems per acre (3-foot centers). The plant material will be representative of the species composition of adjacent herbaceous wetlands within the CCNPP property and native to the region. The herbaceous material for installation will include arrow arum *(Peltandra virginica)*, duck potato *(Sagittaria latifolia)*, water plantain *(Alisma subcordatum)*, and/or pickerelweed *(Pontederia cordata)*. The palette of herbaceous species will be finalized before installation. Additional species may be added if they are determined to be highly suitable for installation in the WC-2 mitigation site. The tree species for installation within the outer zone (bottomland hardwood forest) of the mitigation site will include, but is not limited to, willow oak, water oak, black gum, red maple, tulip tree, river birch, and/or American sycamore. Additional species may be added if they are determined to be highly suitable for installation in the WC-2 mitigation site. The tree species will be planted at a density of 680 stems per acre (8-foot centers). The installation of all plant material within the WC-2 mitigation site will be conducted following the deposition of fill material and contour shaping within the basin.

Enhancement Sites

The enhancement of the WE-1 mitigation site will entail the planting of native hydrophytic trees to establish a bottomland hardwood forest community within this basin. The tree species for installation will include, but is not limited to, willow oak, water oak, black gum, red maple, tulip tree, river birch, and/or American sycamore. The palette of tree species will be finalized before installation and may include the addition of other desirable tree species. The plant material will be representative of the species composition of the adjacent bottomland hardwood forested wetlands within the CCNPP property and native to the region. The tree species will be planted at a density of 680 stems per acre (8-foot centers).

The enhancement of the WE-2 mitigation site will entail the planting of native hydrophytic trees and shrubs to establish a bottomland hardwood forest community within the mitigation site. The proposed mitigation site includes the bottomland hardwood forest component of the eastern (upstream) and the western (downstream) portions of Johns Creek (near the confluence of Johns Creek and linear drainageway extension) and the linear drainageway extension. The tree species for installation will include, but is not limited to, willow oak, water oak, black gum, red maple, tulip tree, river birch, and/or American sycamore. The shrub species for installation will include silky dogwood *(Cornus amomum)*, inkberry *(Ilex glabra)*, shadbush *(Amelanchier canadensis)*, highbush blueberry *(Vaccinium corymbosum)*, possum-haw *(Viburnum nudum)*, elderberry (*Sambucus canadensis*), and Virginia willow *(Itea virginica)*. The palette of tree and shrub species will be finalized before installation and may include the addition of other desirable tree or shrub species. The plant material will be representative of the species composition within Johns Creek and native to the region. The tree and shrub species will be planted at a density of 680 stem streams per acre (8-foot centers).

Stream Mitigation

The CCNPP Unit 3 site contains five potential stream restoration reaches and five potential stream enhancement reaches (perennial and intermittent) on site. The stream reaches proposed for mitigation activities are primarily contained within the Woodland Branch and Johns Creek watershed and secondarily in the Camp Conoy area that lies within the CBCA.

The stream mitigation component of the compensatory mitigation plan includes the following proposed activities:

- The restoration of stream channel within the on-site portion of upper and lower Woodland Branch;
- The enhancement of stream channel within two un-named tributaries to and the middle reach of Woodland Branch;
- The restoration of stream channel within an un-named tributary to and a portion of the mainstem of Johns Creek;
- The enhancement of stream channel within an un-named tributary to Johns Creek; and
- The restoration and enhancement of stream channel within un-named western Bay tributaries of the Camp Conoy area.

The proposed stream restoration and stream enhancement are intended to compensate for the unavoidable, direct loss of physical, biological and/or riparian function of impacted streams. Stream restoration will take advantage of opportunities to reconnect channels to their historic flow paths and restore active access to wooded floodplains. Areas where degraded channels are abandoned will be designed to function as pockets of seasonal wetlands, ephemeral ponds, and oxbow lakes in the riparian zone. Stream enhancement activities, intended to improve existing stream physical and ecological functions within the channel's current flow path include bank grading operations and floodplain creation at lower elevations, bank treatments, and native plantings.

The stream restoration and enhancement mitigation opportunities, combined with the proposed stormwater management plan, will offset losses to watershed functions by increasing the ability to provide flood storage, naturally recharge local aquifers, improve water quality, and maintain stream and riparian functions that support corresponding ecology.

Woodland Branch

Five proposed mitigation reaches within Woodland Branch have been identified as stream restoration or enhancement sites: SR-1 (Lower Woodland Branch), SE-1 (unnamed tributary to Lower Woodland Branch), SR-2 (Upper Woodland Branch), SE-2 (Middle Woodland Branch), and SE-3 (unnamed tributary to Upper Woodland Branch). Although the Woodland Branch watershed drains to a tributary stream of the Patuxent River, stream restoration efforts will be completed in consideration with CBCA requirements.

Channel Restoration Reaches

Priority 1 restoration of SR-1 and SR-2 would include relocating the main channel alignment away from the existing "F" type channels toward more stable "C" and "E" type channels, beginning at headcuts and continuing downstream to an area where floodplain access is more available. As is typical for proposed relocation, the abandoned reach of channel will be plugged throughout to prevent bypass, however it will still retain depressional qualities allowing it to serve as an ephemeral pond.

Functional lift that can be achieved by creation of complex bed features including riffles and pools to provide habitat for aquatic species, and woody planting to provide bank protection, shade, nutrient uptake, and food supply.

Channel Enhancement Reaches

The entrenchment of SE-1, SE-2, and SE-3 stream reaches have not escalated to unmanageable proportions, therefore allowing corrective measures to be addressed through minor changes to existing channel dimension. Maintaining the existing channel alignment, slight adjustments to the profile and channel cross section will allow the stream to transform from an existing "F" type channel toward a more stable "C" or "E" type channel through bank sloping and/or creating inner berm features.

Functional lift that can be achieved using this approach includes creating a small floodplain at a lower elevation, creation of complex bed features including riffles and pools to provide habitat for aquatic species, and woody planting to provide bank protection, shade, nutrient uptake, and food supply. One advantage of modifying channels in place is that the hyporheic zone maintains its integrity and the benthos living in this zone experience less disruption.

Western Bay Tributaries

Two proposed mitigation reaches consist of low order streams that discharge directly into the western Chesapeake Bay, SR-3 (Branch 1), and SE-4 (Branch 2).

Channel Restoration Reach

The extreme nature of the over widening and incision of SR-3 allows for Priority 2 restoration in the form of establishing a "new" active floodplain within the existing "F" type channel. However, this can only be accomplished through bank (future valley wall) grading and substantial adjustment of the existing alignment and profile. This restoration activity will begin immediately below the proposed fill zone and continue downstream until reconnection with the adjacent floodplain becomes practical, near an existing culvert. This construction effort would minimize the loss of healthy trees by stabilizing steep valley slopes using bioengineering applications.

Channel Enhancement Reach

The primary element of enhancement at this site involves providing a channel stabilization grade control feature at the confluence with the Bay. By preventing upstream migration of a single seven-foot headcut, this feature will preserve the upstream sequence of wetlands and stream channels. Additional enhancement throughout this reach includes riparian re-vegetation and minor bank grading where knickpoints have initiated. Minor bank grading plus other enhancements will be performed in preparation for bioengineering application and native plant landscaping.

Johns Creek

Channel Restoration Reaches

Priority 1 restoration is proposed for SR-4 and SR-5 whereby the existing channels will be abandoned and relocated toward the center of the valley, allowing for restored stream function. This treatment will continue for 950 lf for SR-4 and 450 lf for SR-5 until acceptable access to the active floodplain is achieved.

Channel Enhancement Reaches

Enhancement activity in the stream segment would include the grading of streambanks to an angle more representative of natural stream slopes. The reduced streambank slope angle would allow the stream to better access its floodplain and improve ecological connectivity. Success of this enhancement reach could be contingent, in part, to effective re-establishment of grade controls in the downstream, SR-5.

Approximately 5 acres (2 hectares) of emergent freshwater herbaceous wetlands communities within the existing sediment ponds southwest of the Lake Davies Area will be enhanced through the eradication of phragmites and planting of native emergent species. The final selection of plant stock may be determ ined to some extent by availability. The selected trees and shrubs will consist of two gallon containerized stock protected by tree shelters (i.e.: TIJBEX® or Miracle Tube tree shelters). The tree shelters will provide protection from wildlife depredation, wind, or other influences. The tree materia l for installation will include bald cypress *(Taxodiwn distichum)*; willow oak *(Quercus phellos)*, water oak *(Quercus nigra)*, black gum *(Nyssa sy/vatica)*, green ash *(Fraxinus pennsy/vanica)*, red maple *(Acer rubrum)*, sweetgum *(Liquidambar styraciflua)*, and/or tulip tree *(Liriodendron tulipifera)*. The shrub material will include silky dogwood *(Comus amomum)*, inkbeny *(Ilex glabra)*, shadbush *(Amelanchier canadensis)*, highbush blueberry *(Vaccinium corymbasum)*; possum-haw *(Viburnum nudum)*, elderbeny *(Sambucus canadensis)*, and Virginia willow *(Itea virginica)*. The palette of tree and shrub species will be finalized before installation. Additional species may be added if they are determined to be highly suitable for installation in the target wetland in-kind creation areas.

Herbaceous Wetland Enhancement

The second component in the proposed compensatory wetland mitigation plan is on-site enhancement of herbaceous wetlands. The emergent freshwater marsh communities within the existing sediment basins (ponds) that occur to the south of the proposed temporary construction laydown area (Assessment Area VI) and Johns Creek (Assessment Area V) will be enhanced through the eradication of common reed (*Phragmites austra lis*) and the planting of native emergent plant species. Approximately 20 acres of herbaceous wetland enhancement will be achieved through this activity.

The 5-acre marsh area will be planted with native hydrophytic herbaceous species. The herbaceous species will be planted at a density of 2,720 stems per acre (four-foot centers). The plant material will be representative of the species composition of adjacent herbaceous wetlands and native to the region. The final selection of plant stock may be determined to some extent by availability. The herbaceous material for installation will include arrow arum *(Pelrandra virginica),* duck potato *(Saqittaria latifolia)*, water plantain *(Alisma subcordatum)*, and/or pickerelweed *(Ponrederia cordara)*. The palette of herbaceous species will be finalized before installation. Additional species may be added if they are determined to be highly suitable for installation in the target wetland enhancement areas. The eradication of common reed will be conducted through the application of approved herbicide. The eradication of common reed will be completed before the installation of plant material.

Stream Enhancement

Until refined values of existing stream lengths are developed using best available information, we can now only estimate the proposed lengths of each treatment type.

Restoration, intended to establish function where it once existed but has since been lost, will include adjustment of horizontal/vertical channel alignment and channel cross section, and will be performed on approximately 6,850 linear feet (2,082 m) as follows: Conoy Creek 250 linear feet (76 m); Lone Creek - 1,100 linear feet (334 m); Johns Creek (mainstem) - 550 linear feet (167 m); Johns Creek (unnamed tributary) - 1,200 linear feet (365 m); Woodland Branch upstream and downstream (mainstem, two locations) - 2,000 linear feet (608 m); and 1,750 linear feet (532 m), respectively. Additional restoration treatments include: instream habitat structures (cover logs, lateral/longitudinal diversity, root wads), bank stabilization (vegetative and bioengineering treatments) and riparian wetland enhancements (hydraulic and vegetative).

Stream enhancement activities intended to increase existing functions will include less intense grading operations, such as minor adjustments of horizontal alignment and channel cross section only at isolated features, and include: 1) improvements to aquatic habitat, 2) bank stabilization, and 3) native riparian planting. Enhancement activities will be performed on approximately 4,550 linear feet (1,383 m) as follows: Conoy Creek - 2,000 linear feet (608 m); Johns Creek (mainstem) - 500 linear feet (152 m); Woodland Branch (main stem 500 linear feet (152 m); Woodland Branch (unnamed tributaries, two total) 500 linear feet (152 m) and 1,050 linear feet (319 m). Additional opportunities for stream mitigation may exist at the lower end of Lake Davies.

The banks of the aforementioned stream reaches will be planted with native woody species, at a planting density of 10,890 stems per acre (two-foot centers). The plant material will be representative of the species composition of adjacent stream reaches and native to the region.

The final selection of plant stock may be determined to some extent by availability. The woody material for installation will include silky dogwood, elderberry, Carolina willow *(Salix caroliniana),* and/or wax myrtle *(Myrica cerifera)*. The palette of woody species will be finalized before installation. Additional species may be added if they are determined to be highly suitable for installation in the target stream bank areas.

Offsite Forested Wetland Restoration

Up to 5 acres (2 hectares) of offsite forested wetland restoration will be provided if mitigation acreage requirements are not met through the proposed implementation of the aforementioned three mitigation plan components; i.e., onsite forested wetland in-kind creation, herbaceous wetland enhancement. And stream enhancement.

Mitigation Monitoring Program

Following the completion of the on-site wetland creation, wetland enhancement, stream restoration, and stream enhancement activities, a five-year annual monitoring plan will be implemented pursuant to the MDE, Water Management Administration (WMA) mitigation monitoring guidelines and protocols. This effort will entail the establishment of permanent cross-sections for stream restoration and enhancement reaches as well as sample plots within mitigation areas to obtain data on survivorship, growth, and vitality of planted vegetables. Additional data to be reported at the mitigation areas will include: (1) species composition of recruited, desirable plant species: (2) species composition and area cover of nuisance/exotic plant species; (3) wildlife utilization and depredation; (4) hydrologic conditions (surface inundation or depth to groundwater); and (5) current site conditions at fixed photographic points. Annual monitoring reports will be submitted to both MDE and the USACE within 60 days of data collection.

The monitoring program will include an initial baseline (time-zero) monitoring event, to be conducted immediately following the planting of the mitigation areas. After the baseline event is completed, a five-year monitoring schedule will be initiated, to include annual sample events during September-October of each year. A baseline report and five annual monitoring reports will be prepared for review by regulatory staff of USACE and the WMA. The reports will include the vegetative sampling results, current hydrologic conditions, photo-documentation, descriptions of problems encountered, and discussion of maintenance actions taken. Monitoring reports will be submitted within 90 days of each monitoring event. Monitoring reports will be submitted to the USACE and the WMA. Following agency review and coordination, remedial/contingency measures will be implemented, if required.

The targets for the in-kind creation and enhancement efforts will be divided into two specific areas: (1) in-kind creation and enhancement of wetland communities and enhancement of stream reaches and (2) in kind creation or sustainment of adequate hydrology. The specific success criteria for the monitoring program will be identified prior to the implementation of planting and monitoring activities, but will include, at a minimum, the success of the planted vegetation, as measured through survivorship counts and observations of vitality and growth, and the existence of adequate hydrology. If success criteria have been satisfied at the completion of the five-year monitoring program, a request for release from monitoring will be made to the U.S. ACE and/or WMA.

4.3.2 Aquatic Ecosystems

This section provides an assessment of the potential impact construction activities will have on aquatic ecosystems to impoundments and streams onsite and to the Chesapeake Bay offsite. New transmission lines and access corridors are limited to the CCNPP site. The existing transmission corridor will be used offsite.

As shown in Table 4.3-2, 2.69 acres (1.09 hectares), of the affected aquatic habitat, will be permanently converted to structures, pavement, or other intensively-maintained exterior grounds to accommodate the proposed power block, cooling tower, switchyard, roadways, permanent construction laydown area, borrow area, retention basins, and permanent parking lots. The permanent loss of affected aquatic habitat of 2.69 acres (1.09 hectares) is small compared to the 1,548,769 acres (626,787 hectares) in the region as shown in Table 2.2-4. Figure 2.1-1 shows the CCNPP site boundary and the major buildings to be constructed. Figure 4.3-2 shows the land to be cleared, the waste disposal area and the construction zone. A topographic map is provided as Figure 2.3-4, showing the important aquatic habitats. A similar analysis is discussed for wetlands in Section 4.3.1.

Section 4.2 includes a footprint of the construction area and a description of construction methods. Construction activities will start after the State of Maryland issues the appropriate permits to start clearing and grading of the CCNPP site. Activities to construct non-safety-related systems and structures will begin after that. The NRC combined license is expected by March 2011 which will allow construction of safety-related systems and structures. Construction is expected to be complete by July 2015 as discussed in Section 1.2.7.

4.3.2.1 Impacts to Impoundments and Streams

The construction footprint of CCNPP Unit 3 covers 460 acres (186 hectares) including many separate wetland and surface water areas. Construction effects to aquatic habitats in the immediate area range from temporary disturbance to complete destruction. The following surface water bodies are potentially affected by construction activities:

- Two unnamed streams (Branch 1 and Branch 2) on the eastern side of the drainage divide, Branch 1 being downstream of the Camp Conoy Fishing Pond
- Johns Creek, Branch 3 and Branch 4, and the unnamed headwater tributaries
- Goldstein Branch
- Laveel Branch
- Camp Conoy Fishing Pond and two downstream impoundments
- Lake Davies and two unnamed impoundments within the Lake Davies dredge spoils disposal area
- Chesapeake Bay and Patuxent River

As described in Section 4.2.2.2, construction of CCNPP Unit 3 will permanently destroy some of the existing surface water bodies. Construction impacts to the existing surface water bodies are summarized as follows:

- Increasing runoff from the approximately 130 acres (53 hectares) of impervious surfaces (including the power block, switchyard, cooling tower, laydown areas, critical areas, and roads)

- Infilling and eliminating the Camp Conoy Fishing Pond under the southeast portion of the laydown area south of the CCNPP Unit 3 power block foundation
- Infilling and eliminating the upper reaches of Branch 2 and Branch 3, and an unnamed tributary to Johns Creek
- Isolating portions of the upper reach of Branch 1 by construction of the laydown areas south of the CCNPP Unit 3 power block foundation
- Disruption of the drainage in the Lake Davies dredge spoils disposal area with possible impacts on the two downstream impoundments
- Wetlands removal and disruptions
- Possibly increasing the sediment loads into the proposed impoundments and downstream reaches

The overall site drainage basin areas are not directly affected by the site grading plan. The 80%/20% drainage proportion to the west and east respectively, would stay the same during and after construction. Approximately 15 to 20 acres (6 to 8 hectares) would be added to the east drainage basin and removed from the west drainage basin.

Dredging will take place at the barge slip area to accommodate delivery of large components. Dredging will also be performed for construction of the discharge line from the circulating water system. Dredged material will be disposed of in the previously used disposal area known as Lake Davies.

When a surface water body is filled by construction activities, impacts to aquatic life are expected. If the water body has an outlet, and the disturbance is gradual rather than abrupt, some fish may relocate. Oftentimes, however, construction impacts to small impoundments or stream reaches result in loss of the fish and invertebrates.

As discussed in Section 2.4.2 extensive surveys of the onsite streams and impoundments documented that no rare or unique aquatic species occur in the construction zone. 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. The most important aquatic invertebrate species in the impoundments and streams are the juvenile stages of flying insects; these species readily recolonize available surface waters, and so would not be lost to the area. No important aquatic habitats were identified in the freshwater systems in the project vicinity. The fish in the Camp Conoy pond are most likely to perish during construction activities as the overflow from the pond flows down to the Chesapeake Bay via two small impoundments. The fish in the tributaries of John's Creek would most likely swim away from the affected areas to other parts of the creek outside the construction footprint.

Table 2.4-6 provides a list of important species and habitats found in the Chesapeake Bay. Figure 2.4-1 is a map of important species and habitats. 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. As discussed in Section 2.4.2, the American eel is abundant year round in all tributaries to the Chesapeake Bay.

Onsite streams and ponds were described in terms of the typical surface water habitats in the area. Headwater streams in general are considered important; however, there is nothing of regional significance about these particular streams. All of the onsite aquatic species mentioned in this section are common in the area. No loss of critical habitat is anticipated.

Although the wetland areas themselves are considered a sensitive and valuable resource, the particular wetlands that will be impacted onsite are not substantively distinguishable from other wetland acreage in the vicinity. Additional details of the specific plants that will be lost in each area are presented in the final Wetland Delineation Report (TTNUS, 2007e).

Several other drainages and impoundments at the CCNPP site will be moderately to severely impacted. It is possible, and even likely, that some sediment will be deposited in wetlands, including impoundments and stream channels, with rainfall runoff during and immediately following construction. Best construction management practices will reduce the amount of erosion and sedimentation associated with construction, however, and would limit impacts to aquatic communities in down-gradient water bodies. Although unlikely, it is also possible that excavated soil placed in the proposed spoils and overflow storage area will be disturbed and move with runoff into streams onsite. Details are summarized herein:

- Increased runoff from 130 acres (53 hectares) of impervious surfaces (including the power block, switchyard, laydown areas, critical areas, cooling tower, and roads).
- Creation of a large impoundment east of the power block pad by construction of a dam, discharge structure and piping that will discharge to the impoundment down stream of the Camp Conoy fishing pond
- Creation of sand filters on the periphery of the power block, laydown, cooling tower and switchyard areas. The ditches are constructed of base materials that promote infiltration of runoff from low intensity rainfall events. However, for large storms the infiltration capacity of the base materials will be exceeded and the overflow pipes are provided to direct the runoff to the stormwater basins. The stormwater basins are unlined impoundments with simple earth-fill closure on the down stream end and may include discharge piping to the adjacent watercourses
- Creation of new impoundments southwest of the proposed switchyard and cooling tower pads for stormwater detention with associated discharge structures and outlet piping to the unnamed tributary of Johns Creek
- Disruption of the drainage in the Lake Davies dredge spoils disposal area with possible impacts on the two downstream impoundments
- Wetlands removal and associated impacts
- Increased sediment loads into the proposed impoundments and downstream reaches of Johns Creek and its associated tributaries, Branch 1 and Branch 2

Proposed construction activities that will potentially affect onsite water bodies are described in Section 4.2. During construction, effects to aquatic ecosystems may result from sedimentation (due to erosion of surface soil) and, to a lesser extent, spills of petroleum products. A report on human impacts to stream water quality listed siltation as the primary cause of stream degradation by a wide margin (Waters, 1995). In a 1982 nationwide survey by the U.S. Fish and Wildlife Service on impacts to stream fisheries, sedimentation was named the most important factor (Waters, 1995).

Three major groups of aquatic organisms are typically affected by the deposition of sediment in streams: (1) aquatic plants, (2) benthic macro invertebrates, and (3) fish. The effects of excess sediment in streams, including sediment generated by construction activities, are influenced by particle size. Finer particles may remain suspended, blocking the light needed for primary producers photosynthesis, and initiating a cascade of subsequent effects (Waters, 1995) (MDE, 2007a). Turbidity associated with suspended sediments may reduce photosynthetic activity in both periphyton and rooted aquatic plants. Suspended particles may also interfere with respiration in invertebrates and newly hatched fish, or reduce their feeding efficiency by lowering visibility. Slightly larger particles fall out of suspension to the stream bed, where they can smother eggs and developing fry, fill interstitial gaps, or degrade the quality of spawning grounds. As the gaps in the substrate are filled, habitat quality is decreased for desirable invertebrates such as Ephemeroptera, Plecoptera, and Trichoptera, and less desirable oligochaetes and chironomids become dominant (Waters, 1995). Such changes in the benthic community assemblage result in a loss of fish forage, and a subsequent reduction in fish populations.

Construction sites contribute to erosion, which can lead to sedimentation in streams. Construction-related activities such as excavation, grading for drainage during and after construction, temporary storage of soil piles, and use of heavy machinery all disturb vegetation and expose soil to erosive forces. Reducing the length of time that disturbed soil is exposed to the weather is an effective way of controlling excess erosion and sedimentation.

Preventing onsite erosion by covering disturbed areas with straw or matting is also a preferred method of controlling sedimentation. When erosion cannot be prevented entirely, intercepting and retaining sediment before it reaches a stream is a high priority.

Several measures will be taken to minimize the unavoidable adverse effects to the aquatic ecology. The use of berms, temporary and permanent vegetative stabilization, and other soil erosion and sediment control practices will reduce the risk of sediment runoff into intact wetlands adjoining the areas of fill. Sand filters will be constructed around the periphery of the power block, construction laydown area, cooling tower and switchyard areas to help catch surface runoff and prevent degradation of adjoining terrestrial and aquatic habitats. The sand filters will be constructed of base materials that promote infiltration of runoff from low intensity rainfall events. However, for large storms the infiltration capacity of the base materials will be exceeded and the overflow pipes will direct the runoff to the stormwater retention basins. The stormwater retention basins will be unlined impoundments, vegetated with regionally indigenous wetland grasses and herbs, with simple earth-fill closure on the down stream end and will include discharge piping to the adjacent watercourses.

Construction impacts to water resources will be avoided or minimized through best management practices and good construction engineering practices such as stormwater retention basins and silt screens (MDE, 2007b). The Stormwater Pollution Prevention Plan, which provides explicit specifications to control soil erosion and sediment intrusion into wetlands, streams and waterways will be followed. The Spill Prevention, Control and Countermeasure Program will also be used to clean up and contain oil spills from construction equipment to avoid or minimize the impact to wetlands and waterways.

4.3.2.2 Impacts to Chesapeake Bay

As discussed in Section 2.4.2, the Chesapeake Bay is considered important estuarine habitat to most, if not all, of the estuarine species identified in the area. However, none of the important species in the vicinity of the CCNPP site are endemic to Chesapeake Bay. All of them range widely throughout the mid-Atlantic coast, and most occur in the Gulf of Mexico, as well.

The portion of the Chesapeake Bay nearest the CCNPP site is of lower relative importance compared to other areas of the Chesapeake Bay. Estuarine species that use the Chesapeake Bay as nursery grounds need the submerged aquatic vegetation (SAV) and tidal marshes for nutrient-rich forage for the larvae and young-of-the-year, as well as for protective cover from predators. The area near the CCNPP site has no SAV, and does not provide critical habitat for any species.

The National Marine Fisheries Service designated Essential Fish Habitat (EFH) for each life stage of federally managed marine fish species in the Chesapeake Bay area; the bluefish is the only important species in the CCNPP site area that is federally managed, and for which EFH has been designated. Bluefish eggs and larvae are found only offshore, so no EFH occurs in Chesapeake Bay. For juvenile bluefish, all major estuaries between Penobscot Bay (Maine) and St. Johns River (Florida) are EFH. Generally juvenile bluefish occur in North Atlantic estuaries from June through October, Mid-Atlantic estuaries from May through October, and South Atlantic estuaries March through December, within the "mixing" and "seawater" zones. Adult bluefish are found in North Atlantic estuaries from June through October, Mid-Atlantic estuaries from April through October, and in South Atlantic estuaries from May through January in the "mixing" and "seawater" zones. Bluefish adults are highly migratory and distribution varies seasonally and according to the size of the individuals comprising the schools. Bluefish are generally found in waters with normal shelf salinities (greater than 25 parts-per-thousand).

The threatened and endangered species known to occur in the area are two species of sturgeon and two of sea turtles. No sturgeon is known to have spawned in the Chesapeake in decades. The sea turtles that occasionally use the Chesapeake Bay spawn much further south, outside the Chesapeake Bay watershed.

Relatively minimum effects of sedimentation or runoff into the Chesapeake Bay are expected. However, construction of the CWS intake inlet area and discharge pipeline, and enlargement of the barge slip, will cause some disturbance in the Chesapeake Bay. As described in Section 4.2.1, a sheet pile cofferdam and dewatering system may be installed on the south side of the CCNPP Units 1 and 2 intake structure to facilitate the construction of the CCNPP Unit 3 CWS intake piping and trash rack structure. Pilings may also be driven into the seabed to facilitate construction of new discharge system piping. Enlargement of the barge slip is estimated to require removal of about 15,000 cubic yards (11,500 cubic meters) of sediment. Dredging of the barge slip would result in increased suspended sediment in the immediate area for a limited period. Excavation and dredging of the CWS intake piping area would have similar effects. All dredging will conform to guidance provided by the Maryland Port Authority and dredging permit conditions including mitigation measures to minimize suspended sediment and other impacts.

Dredging inevitably causes an increase in suspended sediment in the immediate area, and may result in a plume of suspended sediment some distance from the site. In a study of the effects of hopper dredging in Chesapeake Bay, near-field concentrations of suspended sediment, < 980 ft (< 300 m) from the dredge, reached 840 to 7,200 mg/L or 50 to 400 times the normal background level. Far-field concentrations (> 980 ft (> 300 m)) were enriched 5 to 8 times background concentrations and persisted 34% to 50% of the time during a dredging cycle (1.5 to 2.0 hr) (Nichols, 1990).

The ecological effect of the suspended sediment depends on a variety of factors, including the type of dredge used, the timing and duration of the dredging, the particle size of the suspended sediment, the presence of toxins in the sediment, the success of environmental controls to contain suspended sediment, and the life stage of the species present. Both short term direct behavioral effects (such as entrainment, turbidity, fish injury, and noise) and long term cumulative effects (such as possible contaminant release and habitat alteration) on marine organisms can result from dredging (Nightingale, 2001). Although effects may be similar, concern is often greater at the disposal site than at the dredge site; controversy over the effects of disposal of dredge spoils in the Chesapeake Bay has been ongoing since the 1970s (MSG, 2000). A thorough independent scientific investigation of the effects of disposing of large volumes of sediment in a deep channel of the Chesapeake Bay concluded that, apart from possibly affecting migrating sturgeon, no significant biological effects resulted from the deposition of sediment in the channel. Although this study is not directly applicable to the small-scale dredging proposed for CCNPP Unit 3, it serves as reassurance that the Chesapeake Bay is so large, and has such an enormous volume of water flowing through it, that even extremely large disturbances, such as the deposition of dredged material from Baltimore Harbor, have a negligible long term effect on the Chesapeake Bay ecosystem (MSG, 2000).

Small-scale dredging like that required to construct CCNPP Unit 3 is not considered a significant impact to the Chesapeake Bay. A report by the NOAA Chesapeake Bay Office, developed by a Technical Advisory Panel comprised of top fisheries scientists from area universities and senior government fisheries scientists, presented a Fisheries Ecosystem Plan for the Chesapeake Bay; it is notable that the only mention of the effects of dredging in the 450 page report were the following two general statements: "Dredging and the displacement of dredge spoil to other parts of the Chesapeake Bay can affect fish and shellfish by removing or inundating slow-moving or sessile species and their prey. Dredge spoil can also reintroduce sedimentary inventories of nutrients and contaminants into the water" (Chesapeake Bay Fisheries Ecosystem Advisory Panel (NOAA, 2006)). The report also acknowledged that the effects of even widely-used methods of harvest that disturb bottom sediments, such as trawling and crab dredging, remain unknown.

Excavation and dredging of the intake structure, discharge pipe, and barge slip will continue through CCNPP site preparation into plant construction. Excavated and dredged material will be transported to the onsite Lake Davies dredge spoils area as shown in Figure 4.3-1. Figure 3.4-3 shows the show location of the intake and outfall structures areas and the barge slip.

Important species in the project area that may be temporarily affected by dredging include eggs, larvae, and adults of invertebrates and fishes. Based on the monitoring of the baffle wall and intake screens for CCNPP Units 1 and 2, Bay anchovy and Atlantic menhaden are the most common mid-water fish species in the immediate area (EA, 2006). These species may be temporarily affected by high levels of suspended sediment, which can interfere with foraging and respiration, as well as cause dermal abrasion to delicate fishes. No invertebrate sampling data are available in the intake area. In a study of dredging in Chesapeake Bay, benthic communities survived the deposition of suspended sediment despite the exceedance of certain water quality standards (Nichols, 1990).

Relatively no threatened or endangered species are expected to be affected by the proposed dredging. During the license renewal review process in 1999 for CCNPP Units 1 and 2, the National Marine Fisheries Service concluded that CCNPP license renewal would not adversely affect either the shortnose sturgeon or the loggerhead turtles because the CCNPP Units 1 and 2 discharge/intake do not lie within the areas normally used by either species (NRC, 1999).

Neither the shortnose sturgeon nor the loggerhead turtle has been found impinged on the CCNPP Unit 1 and 2 intake screens during the 21 years of monitoring data (NRC, 1999).

The assemblage of aquatic species present near the CCNPP site varies throughout the year, due to spawning and migration patterns of individual fish and invertebrate species, as described in Section 2.4.2. The season of the year in which dredging and construction occur would determine to a large extent the impact on specific aquatic resources within the Chesapeake Bay. However, because the area to be dredged is small and in a protected near shore area that is in close priximity to an area already dedicated to intake and other industrial functions, the overall impact on eggs and larvae is expected to be SMALL and TEMPORARY.

4.3.2.3 Impacts on the Transmission Corridor and Offsite Areas

The new transmission lines do not cross over any onsite water bodies. At one point, the transmission corridor right-of-way is near Johns Creek. No important aquatic species and their habitat will be impacted by the transmission corridor.

Transmission line construction will be limited to onsite construction of short connections from the new switchyard to the existing 500 kV transmission line that runs from near the center of the CCNPP site northward. Construction of a 500 kV transmission line from the CCNPP Unit 3 switchyard to the existing 500 kV transmission line on the CCNPP site will require clearing trees in 0.31 acres (0.13 hectares) of additional forested wetlands in Wetland Assessment Area IV (adjoining 520 linear feet (158 m) of intermittent stream channel), as well as in 1.85 acres (0.75 hectares) of additional forested uplands designated as non-tidal wetland buffer by Calvert County. No grading will be conducted in the subject wetlands or wetland buffer; disturbance will be limited to tree and shrub removal only. Surface soils within the affected wetlands and buffer will remain undisturbed, as will the pattern of surface runoff. The vegetation impacts to the affected wetlands and buffer are necessary because trees growing close to a 500 kV electric conductor must be removed to prevent possible outages. The transmission line is needed to convey electric power generated by the CCNPP Unit 3 power block to existing transmission lines that connect to the regional power grid.

The onsite transmission corridor for CCNPP Unit 3 is within the construction area. The information provided above pertaining to control of erosion and sedimentation applies to streams and wetlands within the transmission corridor.

No incremental effect on aquatic resources beyond what currently occurs within the transmission corridor is expected for the construction of CCNPP Unit 3.

The existing offsite transmission corridor will be used for CCNPP Unit 3. No new transmission corridors and no offsite areas are impacted since no changes are required.

4.3.2.4 Summary

Construction activities that may cause erosion that could lead to harmful deposition in aquatic water bodies would be (1) of relatively short duration, (2) permitted and overseen by state and federal regulators, and (3) guided by an approved Stormwater Pollution Prevention Plan. Any small spills of construction-related hazardous fluids, such as petroleum products, would be mitigated according to a Spill Prevention, Control, and Countermeasure Plan. Some sensitive habitats occur within the area expected to be affected by construction activities; however, no important aquatic species are expected to be affected. Impacts to aquatic communities from construction would be SMALL and temporary, and would not warrant mitigation.

No incremental effect on aquatic resources beyond what currently occurs within the transmission corridor is expected.

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Table 4.3-1— Vegetation (Plant Community) Impacts in Acres (Hectares) Construction of Proposed CCNPP Unit 3

(Page 1 of 2)

			Permanent Losses					Temporary Losses					
Habitat (Plant Community Type)	Forest (MDNR Definition)	Wetland (Federal and MDE Definition)	CBCA IDA 0-100' (0-30 meters)	CBCA IDA 100-1,000' (30 -305 meters)	CBCA RCA 0-100' (0-30 meters)	CBCA RCA 100-1,000' (30 -305 meters)	Rest of Site	CBCA IDA 0-100' (0-30 meters)	CBCA IDA 100-1,000' (30 -305 meters)	CBCA RCA 0-100' (0-30 meters)	CBCA RCA 100-1,000' (30 -305 meters)	Rest of Site	Total
Lawns/Developed Areas	No	No	1.33 (0.54)	1.76 (0.71)	-	5.21 (2.11)	19.33 (7.82)	-	-	-	-	24.30 (9.80)	51.93 (21.01)
Old Field Vegetation	No	No	0.09 (0.04)	1.13 (0.46)	-	0.23 (0.09)	27.35 (11.07)	-	-	-	-	96.00 (38.80)	124.80 (50.50)
Mixed Deciduous Forest	Yes	No	0.01 (0.004)	14.75 (5.9)	-	5.20 (2.10)	133.81 (54.15)	-	-	-	-	26.44 (10.70)	180.21 (72.92)
Mixed Deciduous Regeneration Forest	Yes	No	-	-	-	-	36.28 (14.68)	-	-	-	-	12.00 (4.90)	48.28 (19.54)
Well-Drained Bottomland Deciduous Forest	Yes	No	-	-	-	-	1.37 (0.55)	-	-	-	-	0.05 (0.02)	1.42 (0.57)
Poorly Drained Bottomland Deciduous Forest	Yes	Yes	-	0.15 (0.06)	-	0.50 (0.20)	8.87 (3.59)	-	-	-	-	0.31 (0.13)	9.83 (3.98)
Herbaceous Marsh Vegetation	No	Yes	-	0.05 (0.02)	-	0.02 (0.01)	1.74 (0.70)	-	-	-	-	1.63 ()	1.81 (0.73)
Successional Hardwood Forest	Yes	No	-	-	-	1.71 (0.69)	3.50 (1.40)	-	-	-	-	7.82 (3.16)	13.03 (5.27)
Open Water	No	Yes	-	0.02 (0.01)	-	0.01-(0.01)-	2.66 (1.08)	-	-	-	-	-	2.69 (1.09)
Total			1.43 (0.57)	17.86 (7.22)	-	12.86 (5.20)	233.58 (94.53)	-	-	-	-	166.61 (67.35)	436.5 (176.64)
			Total Permanent: 265.73 (108.10)					Total Temporary: 170.77 (69.11)					

Table 4.3-1— Vegetation (Plant Community) Impacts in Acres (Hectares) Construction of Proposed CCNPP Unit 3
(Page 2 of 2)

Habitat (Plant Community Type)	Forest (MDNR Definition)	Wetland (Federal and MDE Definition)	Permanent Losses: CBCA IDA 0-100′ (0-30 meters)	CBCA IDA 100-1,000′ (30-305 meters)	CBCA RCA 0-100′ (0-30 meters)	CBCA RCA 100-1,000′ (30-305 meters)	Rest of Site	Temporary Losses: CBCA IDA 0-100′ (0-30 meters)	CBCA IDA 100-1,000′ (30-305 meters)	CBCA RCA 0-100′ (0-30 meters)	CBCA RCA 100-1,000′ (30-305 meters)	Rest of Site	Total

Notes:
MDNR: Maryland Department of Natural Resources
MDE: Maryland Department of the Environment
CBCA: Chesapeake Bay Critical Area
IDA: Intensive Developed Area (within CBCA)
RCA: Resource Conservation Area (within CBCA)

Table 4.3-2— Non-Tidal Wetland and Non-Tidal Wetland Buffer Losses in Acres (Hectares) Construction of Proposed CCNPP Unit 3
(Page 1 of 2)

	Permanent Grading Losses				Temporary Grading Losses				Permanent Non-Grading Losses (Forest Clearing for Transmission Line)				Total Losses	
Wetland Assessment Area	**PFO**	**PEM**	**Open Water**	**Buffer**	**PFO**	**PEM**	**Open Water**	**Buffer**	**PFO**	**PEM**	**Open Water**	**Buffer**	**Wetland**	**Buffer**
I- Total	**0.03 (0.01)**	-	-	**2.09 (0.85)**	-	-	-	-	-	-	-	-	**0.03 (0.01)**	**2.09 (0.85)**
I-Outside CBCA	-	-	-	0.37 (0.15)	-	-	-	-	-	-	-	-	-	0.37 (0.15)
I-Inside CBCA-IDA	-	-	-	0.85 (0.34)	-	-	-	-	-	-	-	-	-	0.85 (0.34)
I-Inside CBCA-RCA	0.03 (0.01)	-	-	0.87 (0.35)	-	-	-	-	-	-	-	-	0.03 (0.01)	0.87 (0.35)
II- Total	**1.52 (0.68)**	**0.75 (0.30)**	**2.63 (1.06)**	**6.79 (2.75)**	-	-	-	-	-	-	-	-	**4.90 (1.98)**	**6.79 (2.75)**
II-Outside CBCA	0.94 (0.38)	0.75 (0.30)	2.49 (1.01g)	5.87 (2.38)	-	-	-	-	-	-	-	-	4.18 (1.69)	5.87 (2.38)
II-Inside CBCA-RCA	0.58 (0.24)	-	0.14 (0.06)	0.92 (0.37)	-	-	-	-	-	-	-	-	0.72 (0.29)	0.92 (0.37)
III-Total						No Impacts to Wetland Assessment Area III								
IV-Total	**4.97 (2.01)**	-	-	**15.84 (6.41)**	-	-	-	-	-	-	-	-	**4.97 (2.01)**	**15.84 (6.41)**
V-Total						No Impacts to Wetland Assessment Area V								
VI-Total						No Impacts to Wetland Assessment Area VI								
VII-Total	**0.72 (0.30)**	-	-	**3.41 (1.38)**	-	-	-	-	-	-	-	-	**0.72 (0.30)**	**3.41 (1.38)**
VIII-Total						No Impacts to Wetland Assessment Area VIII								
IX-Total	**0.64 (0.26)**	**0.46 (0.19)**	-	**2.56 (1.04)**	-	-	-	-	-	-	-	-	**1.10 (0.45)**	**2.56 (1.04)**
Total	7.88 (3.19)	1.21 (0.47)	2.63 (1.06)	30.69 (12.42)	-	-	-	-	-	-	-	-	11.72 (4.74)	30.69 (12.42)

Table 4.3-2— Non-Tidal Wetland and Non-Tidal Wetland Buffer Losses in Acres (Hectares) Construction of Proposed CCNPP Unit 3

(Page 2 of 2)

	Permanent Grading Losses				Temporary Grading Losses				Permanent Non-Grading Losses (Forest Clearing for Transmission Line)				Total Losses	
Wetland Assessment Area	**PFO**	**PEM**	**Open Water**	**Buffer**	**PFO**	**PEM**	**Open Water**	**Buffer**	**PFO**	**PEM**	**Open Water**	**Buffer**	**Wetland**	**Buffer**

Notes:

PFO:	Palustrine Forested	CBCA:	Chesapeake Bay Critical Area	RCA:	Resource Conservation Area
PEM:	Palustrine Emergent	IDA:	Intensively Developed Area		

Figure 4.3-1— CCNPP Vegetation Impacts July 2008

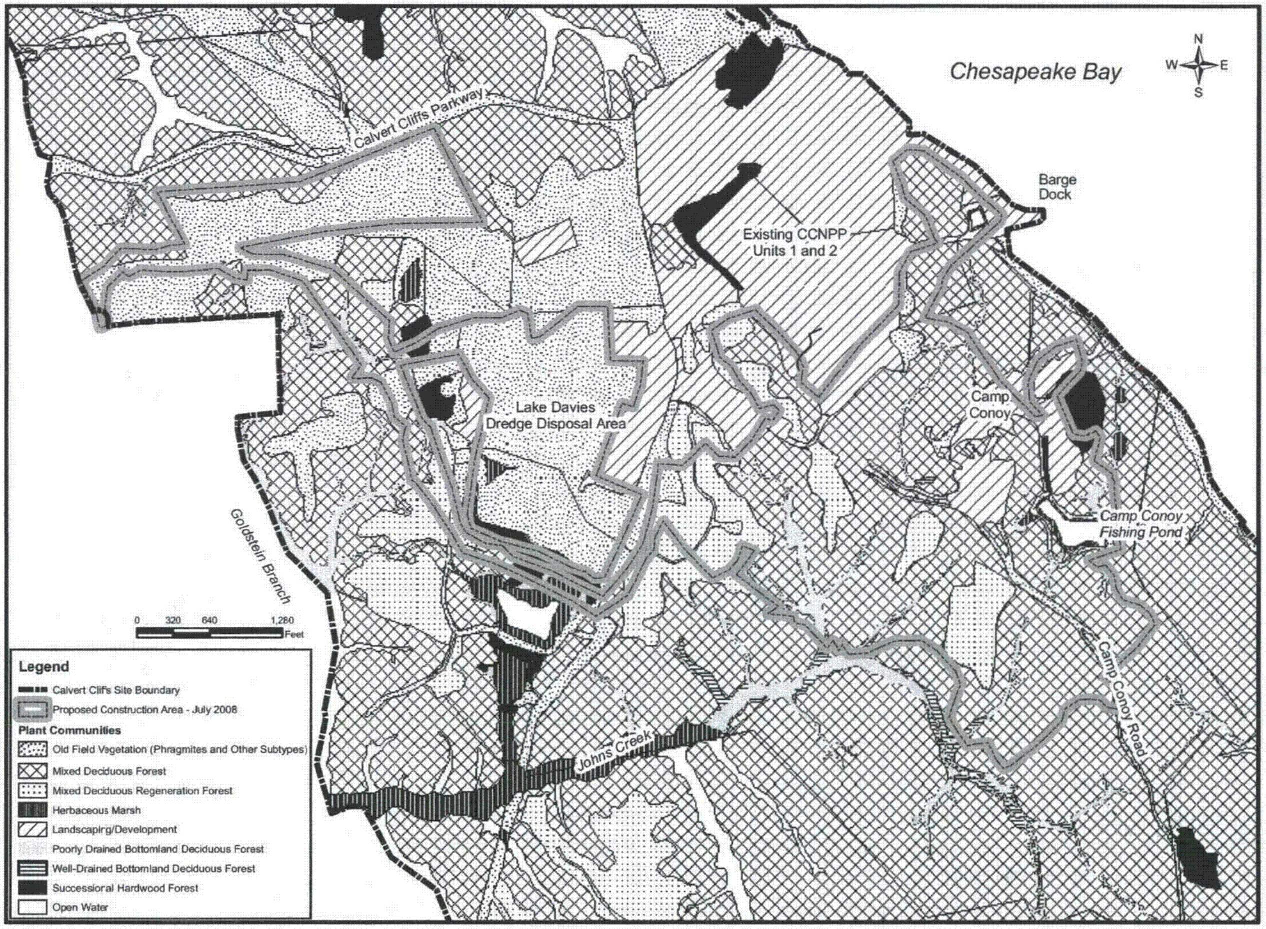
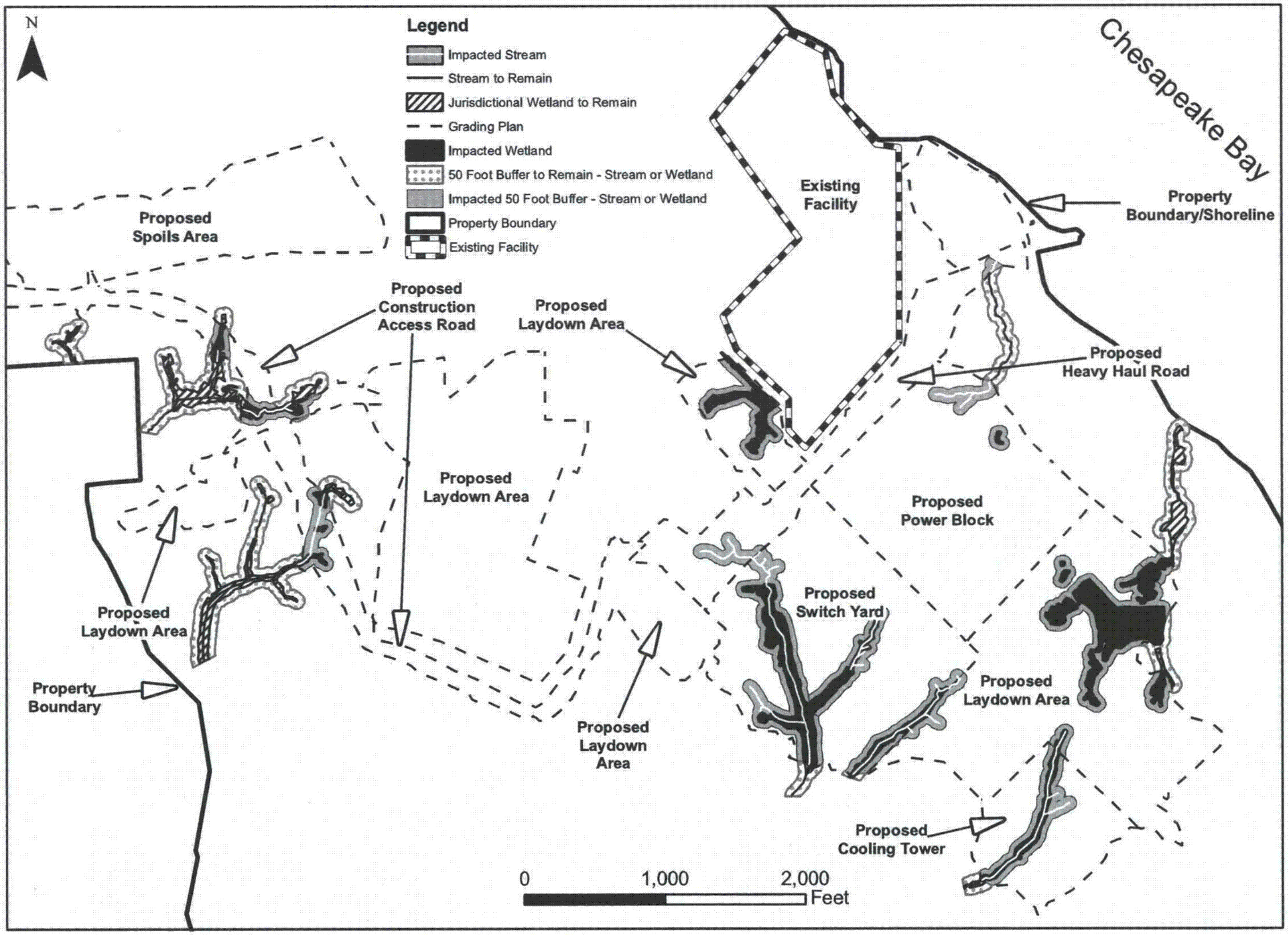


Figure 4.3-2— CCNPP Unit 3 Wetland Impacts



4.4 SOCIOECONOMIC IMPACTS

4.4.1 Physical Impacts

Construction activities at the CCNPP site will cause temporary and generally localized physical impacts such as increased noise, vehicle exhaust, and dust. This section addresses these potential impacts as they might affect people (the local public and workers), buildings, transportation routes, and the aesthetics of areas located near the plant site.

A description of the CCNPP site, location and surrounding community characteristics is provided in Sections 2.1, 2.2, and 2.5. Chapter 3 describes the proposed facility including its external appearance.

As discussed below, the potential for direct physical impacts to the surrounding communities from plant construction is expected to be SMALL.

4.4.1.1 The Public and Workers

People who work at or live near the CCNPP site will be subject to physical impacts resulting from construction activities. Onsite construction workers will be impacted the most, with workers at the existing adjacent operating units subject to slightly reduced, similar impacts. People living or working adjacent to the site will be impacted significantly less due to site access controls and distance from the construction site where most activities will occur. Transient populations and recreational visitors will be impacted the least for similar reasons and the limited exposure to any impacts of construction.

4.4.1.2 Noise

Section 2.7 provides information and data related to the background noise levels that exist at the construction site.

Noise levels in the site area will increase during construction primarily due to the operation of vehicles; earth moving, materials-handling, and impact equipment; and other tools.

Typical noise levels from equipment that is likely to be used during construction are provided in Table 4.4-1 (Beranek, 1971). Onsite noise levels that workers will be exposed to are controlled through appropriate training, personnel protective equipment, periodic health and safety monitoring, and industry good practices. Good practices such as maintenance of noise limiting devices on vehicles and equipment, and controlling access to high noise areas, duration of emission, or shielding high noise sources near their origin will limit the adverse effects of noise on workers. Non-routine activities with potential to adversely impact noise levels such as blasting will be conducted during weekday business hours and utilize good industry practices that further limit adverse effects.

The exposure of the public to adverse effects of noise from construction activities will be reduced at the source by many of the same measures described above and the additional distance, interposing terrain, and vegetation which provide noise attenuation. The noise levels at the nearest residential and other surrounding property boundary areas will be controlled to remain at or below state limits. Pile driving will occur during some construction activities. State regulations define those periods during which these activities may occur to minimize the impact of the associated noise (COMAR, 2007). The state regulations also set standards that limit the intensity of vibration that may be transmitted beyond the construction site property boundaries and that will be complied with during construction.

Traffic noise in the local area will increase as additional workers commute, and materials and waste are transported to and from the construction site. Noise impacts will occur primarily during shift changes and will not be extraordinary given the source and nature of vehicle noise and the normally varying nature of transient vehicle noise levels. Additionally, localized impacts will be reduced as distance from the construction site increases and traffic diverges outward.

In summary, good noise control practices on the construction site, and the additional attenuation provided by the distance between the public and the site, will limit noise effects to the public and workers during construction so that its impact will be small and temporary. Construction noise generation is directly linked with the conduct of construction activities which will be end as the facility enters operation.

4.4.1.3 Dust and Other Air Emissions

Construction activities will result in increased air emissions. Fugitive dust and fine particulate matter will be generated during earth moving and material handling activities. Vehicles and engine-driven equipment (e.g., generators and compressors) will generate combustion product emissions such as carbon monoxide, oxides of nitrogen, and to a lesser extent, sulfur dioxides. Painting, coating and similar operations will also generate emissions from the use of volatile organic compounds (VOCs).

To limit and mitigate releases, emission-specific strategies, plans and measures will be developed and implemented to ensure compliance within the applicable regulatory limits defined by the primary and secondary National Ambient Air Quality Standards in 40 CFR 50 (CFR, 2007c) and the National Emission Standards for Hazardous Air Pollutants in 40 CFR 61 (CFR, 2007d). Air quality and release permits and operating certificates will be secured where required.

For example, a dust control program will be incorporated into the Storm Water Pollution Prevention Plan. A routine vehicle and equipment inspection and maintenance program will be established to minimize air pollution emissions. Emissions will be monitored in locations where air emissions could exceed limits (e.g. the concrete batch plant).

The State of Maryland, Department of Labor, Licensing and Regulation, implements occupational health and safety regulations that set limits to protect workers from adverse conditions including air emissions. If localized emissions result in limits being exceeded, corrective and protective measures will be implemented to reduce emissions (or otherwise protect workers in some cases) in accordance with the applicable regulations.

Implementation of controls and limits at the source of emissions on the construction site will result in reduction of impacts offsite. For example, the dust control program will limit dust due to construction activities to the extent that it is not expected to reach site boundaries.

Transportation and other offsite activities will result in emissions due largely to use of vehicles. Activities will generally be conducted on improved surfaces and any related fugitive dust emissions will be minimized. As with noise, impacts will be reduced as distance from the site increases.

In summary, air emission impacts from construction are expected to be SMALL because emissions will be controlled at the sources where practicable, maintained within established regulatory limits that were designed to minimize impacts, and distance between the construction site and the public will limit offsite exposures. Construction air emissions impacts are temporary because they will only occur during the actual use of the specific construction equipment or conduct of specific construction activities, and surfaces will be stabilized upon completion of construction activities.

4.4.1.4 Buildings

The primary buildings in the immediate area with potential for impact from construction are those associated with CCNPP Units 1 and 2. Some peripheral onsite buildings will be removed during construction. Related information about historic properties and the impacts of construction on them is provided in Sections 2.5.3 and 4.1.3.

Many existing onsite buildings related to safety of the existing facility were constructed to meet seismic qualification criteria which make them resistant to the effects of vibration and shock similar to that which could occur during construction. Other onsite facilities were constructed to the appropriate building codes and standards which include consideration of seismic loads. Regardless of the applicable design standard, construction activities will be planned, reviewed, and conducted in a manner that ensures no adverse effect on the operating nuclear units and that buildings are adequately protected from adverse impact.

Construction activities are not expected to affect offsite buildings due to their distance from the construction site. For example, the nearest residence is located approximately 3,000 ft (900 m) from the construction site footprint. As described above in 4.4.1.1, offsite vibrations are limited by state regulations and compliance with those regulations will further prevent mechanical interaction with offsite facilities.

The impact of construction activities on nearby buildings will be SMALL and temporary because of the design of onsite building and the administrative programs that will ensure no adverse interaction with the operating units, while offsite buildings are located at greater distances that isolate them from potential interaction.

4.4.1.5 Transportation Routes

The major transportation routes in the area are described in Section 2.5.1.

Traffic will increase substantially on Maryland State Route (MD) 2/4 during peak construction periods and will be at its highest during shift changes. Construction workers will use the public highways in the area around the site to commute to work. Additionally, public roadways will be used to transport most construction materials and equipment to the site. Impact on area transportation resources will generally decrease with increased distance from the site as varied routes are taken by individual vehicles.

As a result of the expected increase in traffic around the site, a Traffic Impact Analysis (TIA) of the area during construction and operation of the additional unit planned at the CCNPP (KLD, 2007) was conducted. The TIA study area was based on input from the state of Maryland and Calvert County. The area extended 4 miles (6.4 km) from the site access road in the north and south direction (Figure 4.4-1) and included the following intersections along Maryland State Route 2/4:

- Calvert Beach Road (intersection with signal control)
- Calvert Cliffs Parkway (intersection with signal control)
- Pardoe Road (intersection without signal control)

- Cove Point Road (intersection without signal control)

The TIA based its conclusions on the ability of the Maryland State Route 2/4 roadway network to accommodate projected construction traffic volumes generated utilizing techniques to measure capacity in the form of Critical Lane Volume (CLV) at intersections with signals (e.g., stop lights) and level of service (LOS) at intersections without signals (e.g., use of signage only such as stop or yield signs). Any signal-controlled intersection with a CLV of 1450 vehicles/ hour (vph) or less was considered acceptable, based on the state and county guidelines. LOS, on the other hand, is an ordinal scale that is defined from A to F, with "A" being the best level of service. Typically, the LOS is determined for the peak hour during the identified periods as it represents "worst case" conditions. A LOS with scale of "E" or better (delays of less than 50 seconds) at an intersection without signal control was considered acceptable.

As expected, the major concern identified in the TIA was the traffic related to the construction staff and the daily peak travel period and patterns in and around the start and end of the day shift. Since there are no major highway development or improvement projects planned within the area to influence the capacity of the roadway system (KLD, 2007), a new site access road connecting directly to Maryland State Route 2/4 at Nursery Road south of the plant will be built to reduce traffic impacts related to construction activities.

Nonetheless, the TIA concluded that the existing roadway system has insufficient capacity to handle this peak demand. Refer to Table 4.4-2. The intersections of Calvert Beach Road and Nursery Road are the most affected during the morning and afternoon peak traffic hour. The critical element in the increased traffic levels is the construction crew and not traffic delivering materials arriving to the site.

As a result, additional mitigation during the construction period is needed. For example, the TIA noted that the anticipated area future growth rate of 2.5% per year will require that signals be placed at Pardoe Road and Cove Point Road, the two intersections along Maryland State Route 2/4 without signals. Additionally, a Phase 2 TIA will be performed to determine the mitigation necessary to achieve the target value CLV of 1450 vph at intersections with signals. Examples of the type of mitigation that will be considered include both physical improvements such as traffic control signals, turning and merging lanes. Additionally, management measures, such as staggered shift changes and increasing average vehicle capacity will be considered. Thus, the potential impacts to the surrounding communities from construction traffic, although expected to be moderate, will be temporary and manageable.

Large components / equipment will be transported by barge to the site and delivered to the existing site barge unloading facility. The barge unloading facility will be refurbished and upgraded to meet the equipment delivery needs as well as to comply applicable regulatory requirements. The refurbishment will include new sheet pile, widening of the slip to receive large barge shipments, upgrading the existing onsite, heavy-haul road, and extending it to the construction area. Neither the unloading facility refurbishment nor the heavy-haul road extension is expected to have an impact to the public as each activity is confined to an access-restricted area.

4.4.1.6 Aesthetics

Construction activities generally will not be visible from points outside the CCNPP site boundary due to the heavily wooded area surrounding the site. Section 3.1 provides a detailed description of the site and figures that illustrate the appearance of the facility after completion. Construction activities will be visible on those portions of the facility visible in the illustrations, for example construction equipment such as cranes will be visible during use. Federal regulations require that any temporary or permanent structure, including all appurtenances, that exceeds an overall height of 200 ft (61 m) above ground level be appropriately marked with FAA lighting requirements, additionally temporary cranes will be used to construct structures that are likely to require lighting during their use.

Recreational users of Chesapeake Bay to the north and east will generally be unable to view the construction site due to its elevation above the water and setback distance from the shoreline. Portions of the construction may be visible from certain locations on the Bay (see Section 3.1), including elevated activities and those conducted along the shoreline such as the barge unloading facility, and installation of intake and discharge equipment. Construction of the heavy haul road, related heavy equipment staging area, and new water intake structure requires removal of a portion of the hill area near CCNPP Units 1 and 2 causing those facilities to be exposed to a wider field of view from the Chesapeake Bay. Construction of the intake structure and pump house and associated discharge piping at the shoreline for the CCNPP Unit 3 should have minimal visual impact considering their proposed location between the CCNPP Units 1 and 2 intake structure and barge slip facility, respectively. No other visual impacts will be visible from nearby ground level vantage points.

The existing transmission line corridor will be used to provide power to the grid. No new transmission line towers are needed offsite.

Water turbidity may be present during construction and dredging activities. Measures to control water turbidity or other related activity impacts include implementation of the Storm Water Pollution Prevention Plan (SWPPP), transportation of excavated and dredged material to an onsite spoils area, and compliance with the required federal and state regulations and permit conditions (see Section 1.3).

Aesthetic impacts are expected to be small and temporary because the CCNPP Unit 3 site is set back from, and only limited portions of the construction will be visible from, publicly accessible areas. Most construction activities will be shielded from public view and construction activities are by nature temporary.

4.4.1.7 References

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COMAR, 2007. Code of Maryland Regulations, COMAR 26.02.03, Control of Noise Pollution, 2007.

KLD, 2007. KLD Associates, Inc., Traffic Impact Study at the Calvert Cliffs Nuclear Power Plant – Phase 1, TR-405, May 30, 2007.

4.4.2 Social and Economic Impacts

This analysis presents information about the potential impacts to key social and economic characteristics that could arise from the construction of the power plant at the CCNPP site. The analysis was conducted for the 50 mi (80 km) comparative geographic area and for the region of influence (ROI, Calvert County and St. Mary's County, Maryland), where appropriate and as described in Section 2.5.2. The discussion focuses on potential impacts to population settlement patterns, housing, employment and income, tax revenue generation, and public services and facilities.

4.4.2.1 Study Methods

Changes in regional employment can result in impacts to the region's social and economic systems. An estimate of direct full-time equivalent (FTE) personnel that would be needed to construct the new unit was determined and is provided in Table 4.4-3. "Direct" jobs are those new construction employment positions that would be located on the CCNPP site. "Indirect jobs" are positions created off of the CCNPP site as a result of the purchases of construction materials and equipment, and the new direct workers' spending patterns in the ROI. Examples of indirect jobs that could be generated include carpenters and other construction jobs, barbers, restaurant personnel, gas station and auto repairs jobs, convenience store cashiers, drying cleaning and laundry jobs, and so forth.

To estimate indirect employment that would be generated by construction of the power plant, a regional multiplier was generated by the RIMS II software provided by the Regional Economic Analysis Division of the U. S. Bureau of Economic Analysis (BEA, 1997). This model, based upon the construction industry in the ROI, generated a multiplier of 0.6855 indirect jobs created for each direct job. This multiplier was then applied to the estimated peak number of new direct FTE workers to estimate the peak number of indirect jobs that will be created in the ROI.

This analysis evaluates two potential in-migration impact scenarios for the construction workforce, an assumed 20% of the peak construction workforce moving into the ROI with their families for the duration of construction and a second scenario with 35% moving into the ROI. These scenarios were selected because they are representative of the range of in-migration levels that the NRC found in studies they conducted in 1981 of nuclear power plant construction workforces. The NRC (NRC, 1981b) conducted a study of 28 surveys of construction workforce characteristics for 13 nuclear power plants. They found that 17% to 34% of the total construction workforces at most of these nuclear power plants (the 75th percentile) had moved their families into the study areas for each power plant.

They then conducted a more detailed analysis of in-migrants and found that the most common in-migration levels (again for the 75th percentile) for the construction/labor portion of the workforce ranged from 11% to 29%. Additionally, an analysis of the craft labor portion of the workforce showed that pipefitters, electricians, iron workers, boilermakers, and operating engineers were most likely non-managerial staff to in-migrate into an area, and general laborers, carpenters, and other types of construction workers were the least likely to in-migrate (NRC, 1981b).

For managerial and clerical staff the in-migration levels ranged from 40% to 58%. Of the managerial staff alone (i.e., excluding clerical staff), most sites had in-migration rates of 58% to 76% (NRC, 1981b).

The potential demographic, housing, and public services and facilities impacts are only discussed for the two-county region of influence because those impacts are an integral part of and derive from the impacts of the in-migrating construction workforce. Impacts to employment and tax revenues are discussed for the 50 mi (80 km) comparative geographic area and the ROI because of the construction labor pool that would be drawn from and the collection and distribution of income and sales tax revenues throughout the state.

4.4.2.2 Construction Labor Force Needs, Composition and Estimates

4.4.2.2.1 Labor Force Availability and Potential Composition

There will be an estimated maximum 3,950 FTE person workforce constructing the CCNPP Unit 3 power plant between 2011 and 2015, representing a significant increase in the overall employment opportunities for construction workers. In comparison, Calvert County had 2,231 construction jobs in 2006 and St. Mary's County had 1,716 construction jobs (MDDLLR, 2007). As shown in Table 4.4-3, this peak is estimated to last for about 12 months, from about the third quarter of the fourth year of construction through about the second quarter of the fifth year. Over the course of the entire construction period, staffing needs are estimated to increase relatively steadily from the third quarter of the first year until the peak is reached. Once the peak has passed, the staff levels again will drop steadily, until the last 5 months of construction when employment levels will drop significantly.

Relatively recent studies have shown that the availability of qualified workers to construct the power plant might be an issue, particularly if several nuclear power plants are built concurrently nationwide. Competition for this labor could increase the size of the geographic area, beyond the middle eastern seaboard, from which the direct construction labor force would have to be drawn for CCNPP Unit 3. In its study of the construction labor pool for nuclear power plants, the U.S. Department of Energy (DOE, 2004) stated that, "A shortage of qualified labor appears to be a looming problem...The availability of labor for new nuclear power plant construction in the U.S. is a significant concern."

These workforce restrictions are most likely to occur with "managers, who tend to be older and close to retirement, and skilled workers in high-demand, high-tech jobs." The DOE (2005) anticipates that qualified boilermakers, pipefitters, electricians, and ironworkers might be in short supply in some local labor markets. Labor force restrictions can be exacerbated by the fact that portions of the labor force might have to have special certifications for the type of work that they are doing, and because they might have to pass NRC background checks. (DOE, 2004) DOE also found that, "recruiting for some nuclear specialists (e.g., health physicists, radiation protection technicians, nuclear QA engineers/technicians, welders with nuclear certification, etc.) may be more difficult due to the limited number of qualified people within these fields" (DOE, 2004b). However, meeting these needs can be accomplished by hiring traveling crafts workers from other jurisdictions or regions of the country, which is a typical practice in the construction industry.

Estimates about the composition of the CCNPP Unit 3 construction workforce (i.e., types of personnel needed) have not been developed for the power plant. However, existing studies of other nuclear power plant construction sites provide an indication about the potential composition of the CCNPP Unit 3 construction workforce. As shown in Table 4.4-4 (DOE, 2005), during the peak construction period an estimated 67% (2,635) of the construction workforce could be craft labor. Other less prevalent construction personnel could include about 8% (330) of UniStar's operation and maintenance staff, 7% (265) site indirect labor, and 6% (230) Nuclear Steam Supply System vendor and subcontractor personnel.

In more specifically reviewing only the potential craft labor force component of the entire construction workforce (see Table 4.4-5, DOE, 2005), the greatest levels of employment during the peak of construction could be about 18% (475) electricians and instrument fitters, 18% (475) iron workers, 17% (450) pipefitters, 10% (265) carpenters, and 10% (265) of general laborers. Table 4.4-6 shows the percentage of each of these craft labor categories that would be needed during seven phases of construction. Carpenters, general laborers, and iron workers would comprise the greatest proportions of the workforce during the concrete formwork, rebar installation, and concrete pouring phase of construction. Iron workers would continue to be the greatest portion of the workforce during the installation of structural steel and miscellaneous iron work. General laborers and operating engineers would be most needed during the earthwork and clearing of the site, including excavation and backfilling. The installation of mechanical equipment would primarily require pipefitters and millwrights. Pipefitters would also be the primary craft labor category working during installation of piping. Electricians would be the most prevalent during installation of the power plant instrumentation and the electrical systems (GIF, 2005).

4.4.2.3 Demography

As stated above, it is estimated that a peak of 3,950 FTE employees would be required to construct CCNPP Unit 3. As shown in Table 4.4-8A, the total maximum potential number of workers on site at any one time is approximately 5,783 personnel. This total represents the sum of the CCNPP Unit 3 construction workforce. Units 1 and 2 operations staff (833), and CCNPP Units 1 or 2 outage personnel (1,000), assuming only one unit is in outage at a time. The total influx of workers to the area would include approximately 562 indirect workers assuming a 35% emigration of construction workers to Calvert and St. Mary's Counties.

The number of workers potentially entering and leaving the site on a daily basis would be mitigated by shift rotation of the operations, outage and construction staff. In addition, the construction workforce is expected to ramp up gradually to its peak and then diminish as construction nears completion.

The number of construction and indirect workers potentially residing in the ROI is shown in Tables 4.4-7 and 4.4-8. Under the 20% in-migration scenario an estimated peak of 720 construction workers would migrate into the ROI along with about 1,160 family members, for a total of 1,880. Of these, the total estimated direct in-migration would be about 1,400 people (68%) into Calvert County and 475 people (23%) into St. Mary's County. Under the 35% in-migration scenario an estimated peak of 1,260 direct workers would migrate into the ROI along with about 2,025 family members, for a total of 3,285 people. Of these, the total estimated peak in-migration would be about 2,455 people (68%) into Calvert County and 830 people (23%) into St. Mary's County.

In addition, it is estimated that a maximum of 493 indirect jobs would be created within the ROI under the 20% scenario and 860 indirect workforce jobs would be created under the 35% scenario (multiplying 3,595 ROI peak direct workers by the BEA indirect employment/ economic multiplier of 0.6855 (BEA, 1997)). Under both scenarios, all of these indirect jobs located within the ROI could be filled by the spouses of the direct workforce, because the number of in-migrating family members would exceed the number of indirect jobs created by the in-migrating direct workforce.

An in-migration of up to 1,880 people into the ROI under the 20% scenario or up to 3,285 people under the 35% scenario would only represent a 1.2% to 2.0% increase in the total ROI population of 160,774 people. Because these percentage changes are small, it is concluded that the impacts to population levels in the ROI would be small, and would not require mitigation.

Figure 4.4-2, shows the overlapping 50 mile (80 km) zones for four nuclear power plant sites surrounding the CCNPP site. The other power plants include Salem Units 1 & 2 and Hope Creek Unit 1 to the northeast, Peach Bottom Units 2 and 3 to the north, North Anna Units 1 and 2 to the southwest, and Surry Units 1 and 2 to the south/southwest. As can be seen in the figure, the CCNPP site's 50 mi (80 km) radius overlaps slightly with the 50 mi (80 km) zones of each of these facilities. The cumulative effect of a portion of the construction workforce originating from within 50 mi (80 km) of Calvert Cliffs and potentially drawing employees from these other four power plants, or significantly adding to the total employment levels for these types of facilities in these areas, would be SMALL because of the distances and intervening political and geographical features, and would not require mitigation.

4.4.2.4 Housing

The in-migrating construction workforce would likely either rent or purchase existing homes, or would rent apartments and townhouses. Non-migrating (i.e., weekly or monthly) workers would likely stay in area hotels, motels, bed and breakfasts (B&Bs), or at area campgrounds and recreational vehicle (RV) parks. Of the estimated 720 households migrating into the ROI to construct CCNPP Unit 3 under the 20% scenario and the 1,260 households in the 35% scenario, it is estimated that 535 to 940 households (75 percent) would reside in Calvert County and 180 to 320 (25 percent) would reside in St. Mary's County. This would represent a maximum of 12.9% to 22.6% of the 5,568 total housing units vacant in the ROI in 2000 (see Section 2.5.2). Thus, the ROI and each county within it have enough housing units available to meet the needs of the workforce, based upon 2000 housing information.

However, since 2000, discussions with the Calvert County Department of Economic Development indicated that the housing market in Calvert County might be tight. Despite this indication, as shown in Section 2.5.2 the county issued a low of 488 authorizations for construction of single family and multifamily units in 2005 to a high of 928 permits in 2002 (MDDP, 2006). Unlike Calvert County, discussions with the St. Mary's County Government indicated that the housing market might still remain open in St. Mary's County (see Section 2.5.2 for more details). Thus, the housing market is not likely to be quite as open as indicated by the 2000 data, but there still appears to be adequate housing available based upon the fact that less than 25% of the 2000 levels of vacant units would be used.

Also, the Calvert County Department of Economic development has indicated that because housing prices have increased significantly in Calvert County over the past few years, particularly in the northern part of the county, some of the units that might be available for purchase or rent in that location might be outside of the construction workers' budget. This might result in a greater percentage of the in-migrating construction workforce seeking housing in St. Mary's County than is estimated in these projections.

In addition to the above housing units, there are a total of 33 apartments and townhouse complexes providing one to three bedroom rental units in the ROI. Most of these facilities are located in St. Mary's County, including 28 apartment and townhouse complexes. These rental complexes could be used to house part of the in-migrating workforce and might be a viable option to purchasing more costly single-family homes. In addition, the St. Mary's County

Government has indicated that some apartment units currently used by a major employer in the county to house staff in training, might become available in the future because of potential relocation of training activities to areas outside of Maryland. These units could provide an additional housing option for the in-migrating construction workforce.

Weekly or monthly commuters might elect to stay at one of the 28 hotels/motels/B&Bs facilities, providing about 1,950 rooms for rent, in the ROI. Most of the 28 hotels/motels/B&Bs facilities are located in St. Mary's County, with 16 hotel/motel facilities having 737 rooms. Because the hotels and motels are operating at or near capacity during the summer vacation season, from about April through August (see Section .2.5.2), the portions of the workforce that might want to stay on a weekly or monthly basis and then commute home might compete with existing users. During the remainder of the year, enough units would likely be available to meet the needs of the weekly or monthly commuters.

Because significantly more housing units are available than would be needed, the in-migrating workforce alone should not result in an increase in the demand for housing, or in increases in housing prices or rental rates. Also, construction is not scheduled to begin until 2011, providing adequate time for private developers to construct additional new homes and apartment complexes if the economy in the ROI expands, in general, and demand warrants it. In addition, for about seven months out of the year there are noticeable quantities of vacant motel and hotel units that could be used by weekly and monthly commuters. Thus, because of the available housing, it is concluded that the impacts to area housing would be SMALL, and would not require mitigation.

4.4.2.5 Employment and Income

4.4.2.5.1 50 mi (80 km) Comparative Geographic Area

As stated above, it is estimated that a peak of 3,950 direct construction employees would build CCNPP Unit 3. Under the 20% peak in-migration scenario described above, it is implicit that the remaining 80% (3,160) either would be commuting from a reasonable distance on a daily basis or would stay at area hotels/motels and would be weekly/monthly commuters to the job site. Under the 35% in-migration scenario, an estimated 65% (2,570) of the peak direct construction workers would be daily or weekly/monthly commuters. The greatest proportion of these workers would likely commute from within or near the Washington DC; Alexandria, Virginia; Annapolis, Maryland; and the Baltimore, Maryland, metropolitan areas. However, a portion of these workers also would likely originate from outside of this 50 mi (80 km) radius, from throughout the middle eastern seaboard and the remainder of the U.S. The greater the distance that they would commute and the longer that they are employed on the construction site, the more likely they would be to commute from home on a weekly or monthly basis and stay in area motels, or to become in-migrants into the ROI, as described in the housing section above. Because the employment opportunities and income would be spread over the 50 mi (80 km) radius, and an even larger geographic area and basis of comparison outside of the region, the beneficial impacts would be SMALL and would not require mitigation.

4.4.2.5.2 Two-County Region of Influence

Direct construction workforce employment is already discussed in the demography section above. In addition to the 3,950 direct workforce, a peak of 495 indirect workforce jobs would be created in the ROI under the 20% scenario and 860 indirect jobs would be created under the 35% scenario (see Tables 4.4-7 and 4.4-8). This would result in a peak increase of 1,212 to 2,120 employed people in the ROI, depending upon the scenario selected. The peak increase in employment would range from 905 to 1,585 people in Calvert County and 310 to 535 people in St. Mary's County. Unemployed or underemployed members of the labor force could benefit from these increased employment opportunities, to the extent that they have the craft skills required (e.g., laborers, carpenters, electricians, plumbers, welders) and are hired as part of the construction workforce. These increases would result in a noticeable but small impact to the area economy, representing a maximum 4.0% increase in the 39,341 total labor force in Calvert County in 2000 and 1.2% in the 46,032 total labor force in St. Mary's County (USCB, 2000).

It is estimated that the direct construction workforce will receive average salaries of $34.00/hour/worker (two-thirds of the estimated $50 per hour, including benefits), or about $70,720 annually. This would result in an annual salary expenditure, for the peak construction workforce of 3,950 people, of $279.3 million. The average annual salary for the direct workforce would be moderately less than the $84,388 median income for an entire household in Calvert County in 2005, but larger than $62,939 median household income in St. Mary's County. Based upon the peak 35% scenario in-migration levels, Calvert County would experience an estimated $66.5 million increase in annual income during peak construction and St. Mary's County would receive an estimated $22.5 million annually. In addition, the working spouses of the direct construction workers, who filled indirect jobs created by the power plant, would contribute substantially to individual household incomes. The additional direct and indirect workforce income would result in additional expenditures and economic activity in the ROI. However, it would represent a small percentage of overall total income and economic activity in the ROI. It is concluded that the beneficial impacts to employment and income would be SMALL, relative to the overall labor force and ROI-wide income, and would not require mitigation.

4.4.2.6 Tax Revenue Generation

4.4.2.6.1 50 mi (80 km) Comparative Geographic Area

State income taxes would be generated by the in-migrating residents, although the amount cannot be estimated because of the variability of investment income, retirement contributions, tax deductions taken, applicable tax brackets, and other factors. It is estimated that the 50 mi (80 km) radius and the state, excluding the two-county ROI, would experience a $223.5 million increase in annual wages from the direct workforce under the 20% scenario (i.e., 80% of the construction workforce in the 50 mi (80 km) area) and $181.6 million under the 35% scenario (i.e., 65% of the construction workforce in the 50 mi (80 km) area). Relative to the existing total wages for the region and the 50 mi (80 km) radius, it is concluded that the potential increase in state income taxes represent a small economic benefit.

Additional sales taxes also would be generated by the power plant and the in-migrating residents. CalvertCliffs 3 Nuclear Project and UniStar Nuclear Operating Services would directly purchase materials, equipment, and outside services, which would generate additional state sales taxes. Also, in-migrating residents would generate additional sales tax revenues form their daily purchases. The amount of increased sales tax revenues generated by the in-migrating residents would depend upon their retail purchasing patterns, but would only represent a small benefit to this revenue stream for the region and the 50 mi (80 km) radius.

Overall, although all tax revenues generated by the CCNPP Unit 3 and the related workforce would be substantial in absolute dollars, as described above, they would be relatively small compared to the overall tax base in the region and the state of Maryland. Thus, it is concluded that the overall beneficial impacts to state tax revenues would be SMALL.

4.4.2.6.2 Two-County Region of Influence

In 2006, Constellation Energy paid about $15.8 million in Calvert County property taxes (including $10.3 million in personal property and $5.5 million in operating real property taxes) for Units 1 and 2, and in 2007 it paid about $16.2 million in property taxes (including $10.6 million in personal property and $5.6 million in operating real property taxes),

The total project capital cost estimated for CCNPP Unit 3 is [Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application] billion (in 2007 dollars). In 2007, the CCNPP Unit 3 site is estimated to generate [Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application] million in total property taxes in its current, substantially undeveloped state. Investments in planning, engineering, and an assumed limited work authorization from 2008 through 2010 would result in UniStar paying increased county total property taxes, from about [Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application] million in 2008, to [Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application] million in 2009, to [Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application] in 2010. Even more substantial increases in total property tax payments would occur in subsequent years once major construction activities commence, including [Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application] million in 2011, [Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application] million in 2012, [Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application] million in 2013, [Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application] million in 2014, and [ ] million in 2015. The maximum of [Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application] million would represent a significant [Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application] percent increase in Calvert County's $78.8 million in annual property (real and personal) tax revenues for fiscal year 2005, and a [Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application] percent increase in total county revenues of $174.1 million (see Section 2.5.2).

These increased property tax revenues would either provide additional revenues for existing public facility and service needs or for new needs generated by the power plant and associated workforce. The increased revenues could also help to maintain or reduce future taxes paid by existing non-project related businesses and residents, to the extent that project-related payments provide tax revenues that exceed the public facility and service needs created by CCNPP Unit 3. However, the payment of those taxes often lags behind the actual impacts to public facilities and services, or the time needed to plan for and provide the additional facilities or services. Thus, it is concluded that these increased power plant property tax revenues would be a LARGE economic benefit to Calvert County.

Additional county income taxes would be generated by the in-migrating residents, although the amount cannot be estimated because of the variability of investment income, retirement contributions, tax deductions taken, applicable tax brackets, and other factors. It is estimated that Calvert County would experience a $66.5 million increase in annual wages from the direct workforce. St. Mary's County would experience an estimated annual increase of $22.5 million from the direct workforce. Relative to the existing total wages for the ROI, it is concluded that the potential increase in county income taxes represent a small economic benefit to the jurisdictions.

As with the 50 mi (80 km) comparative geographic area, additional sales taxes also would be generated within the ROI by the power plant and the in-migrating residents. However, these purchases would be much smaller within the ROI. The amount of increased sales tax revenues generated by the in-migrating residents would depend upon their retail purchasing patterns, but would only represent a small benefit to this revenue stream for Calvert and St. Mary's Counties.

Overall, although all tax revenues generated by the CCNPP Unit 3 and the related workforce would be substantial, as described above, they would be relatively small compared to the overall tax base in the ROI. Thus, it is concluded that the overall beneficial impacts to tax revenues would be SMALL.

4.4.2.7 Land Values

The Maryland Department of Natural Resources evaluated three industrial facilities to determine how their presence might affect area property values. The three industrial facilities included CCNPP Units 1 and 2, the Alcoa Eastalco Works in Frederick County, and the Dickerson Generating Plant in Montgomery County. The study showed that residential property values were not adversely affected by their proximity to the CCNPP site. Overall, Maryland power plants have not been observed to have negative impacts on surrounding property values. This

lack of impact is partially attributed to impact mitigation fees imposed in Maryland Power Plant Research Program (PPRP) conditions stipulated in Certificates of Public Convenience and Necessity (CPCNs). It is concluded that the impacts to land values would be SMALL, and would not require mitigation.

4.4.2.8 Public Services

Although an increase in population levels from the CCNPP operational workforces would likely place additional demands on area doctors and hospitals, as indicated in Section 2.5.2 discussions with Calvert Memorial Hospital have indicated that these services have enough capacity to accommodate the increased demand and impacts would likely be small. However, the increased population levels could place some additional daily demands on constrained police services, fire suppression and EMS services, and schools. Impacts to these services are provided below.

<u>Police</u>

The Calvert County Sheriffs Department previously has expressed concern about whether they have sufficient staff levels to simultaneously respond to a potential emergency and offsite evacuation in the event of an emergency. The department has identified ongoing current needs for additional funding, staff, facilities, and equipment. However, the department does not feel that construction of CCNPP Unit 3 and the potential additional in-migrating construction workforce, daily commuters, and weekly/monthly commuters would not create additional needs beyond the existing ones.

Similarly, representatives from St. Mary's County Government have stated that the Sheriff's Department currently has the typical ongoing need for additional staff. They felt that the peak in-migrating workforce and their families into the county would minimally increase their needs from their current levels, but not enough to warrant taking action.

EMS and Fire Suppression Services

The Calvert County and St. Mary's County have large volunteer fire departments that appear to be doing an excellent job of meeting the needs of their residents. The Calvert County Public Safety office has indicated that they have ongoing needs for some staff, renovation or construction of facilities for three departments, new vehicles, and new equipment. However, representatives of both departments felt that construction of the power plant generally would not create additional needs beyond those that already exist. Calvert County did state that the Emergency Management office staff would be affected by having to conduct emergency planning activities for the new power plant.

The incremental number of emergency calls due to in-migrating direct and indirect workers can be estimated by comparing the existing inventory of calls to the relative percentage increase in population that may occur. Table 2.5-3 provides the 2010 population estimates for Calvert County (94,450) and St. Mary's County (107,700). The percentage increase in population attributed to the influx of construction workers and operators in these counties was estimated to be approximately 2,466 people in Calvert County and 834 people in St. Mary's County for the 20% immigation scenario. The relative increase is approximately 3% for Calvert County and less than 1% for St. Mary's.

Table 2.5-35 provides a listing of the fire/EMS calls that were experienced in Calvert County during 2005. There were a total of 16, 797 calls during that period or about 0.2/person. Applying an increase in population size on the order of 3%, and assuming that the rate of calling is proportionate to population size, number of calls would increase by approximately 500 annually. Comparable data were not available for St. Mary's County.

These fire and emergency response departments are supplemented by the CCNPP's onsite emergency response team, which includes a fire brigade. The CCNPP Unit 3 staff will include an onsite emergency response team staff, a fire brigade and emergency medical technician (EMT) responders. A new emergency management plan will be developed for CCNPP Unit 3, similar to that already existing for CCNPP Units 1 and 2, that would address CalvertCliffs 3 Nuclear Project and UniStar Nuclear Operating Services and agency responsibilities, reporting procedures, actions to be taken, and other items should an emergency occur at CCNPP Unit 3.

Existing fire and law enforcement services in Calvert County and St. Mary's County appear to be adequate to meet current daily needs within their jurisdictions. As described in Section 4.4.2.6 above, the significant new tax revenues generated in Calvert County by operation of CCNPP Unit 3 would provide additional funding to expand or improve services and equipment to meet the additional daily demands created by the plant. St. Mary's County would also experience increased revenues from operation of the power plant, but to a much lesser extent. However, some departments still might not have enough staff and equipment to respond to an emergency situation, including offsite evacuation. Because the relevant departments did not feel that the new power plant would increase the needs on their services to the point of having to take action, it is concluded that there would be a SMALL impact on the fire and law enforcement departments and no mitigation would be required.

Educational System

There were 17,431 students enrolled in Calvert County public schools in 2006. St. Mary's had 16,552 students enrolled (ER Section 2.5.2.5.1) (Table 2.5-22). The number of students in Calverty County represents about 20% of the county population and in St. Mary's, about 17%. If we apply these percentages to the estimated increase in population due to construction worker in-migration, approximately 490 new students would enroll in Calvert County (an increase of 2.8%) and about 140 in St. Mary's (an increase about about 0.8%).

Assuming that of the 2.6 household members, 0.6 are students and a 20% in-migration during CCNPP Unit 3 construction, there would be a total of about 720 new households in the ROI (ER Section 4.4.2.4). This results in approximately 432 new students in the ROI. Approximately 68% of these, or 294, would reside in Calvert County and 23% in St. Mary's, or about 99 students.

The estimated $[Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application] to $[Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application] million in increased annual property taxes that would be paid to Calvert County by UniStar during construction of CCNPP Unit 3, which include levies for the Calvert County Public School System, would provide additional funds to meet the educational needs of children for the in-migrating operational workforce. Calvert County Public Schools indicated that some of these current needs include providing additional special services (i.e., special education) for its students. If enrollment levels were to increase as a result of constructing the power plant, the district might seek assistance in recruiting additional teachers and would install modular classrooms. However, in general, the district did not feel that the in-migrating workforce would have an impact on the system. Thus, it is concluded that the impacts to the Calvert County Public School System would be SMALL, and would not require mitigation.

The St. Mary's County Government stated that the educational facilities in St. Mary's County Public School System already are operating about at capacity. However, representatives of the county stated that school enrollment has been relatively stable for the last few years, they are completing construction of a new elementary school, and don't anticipate building a new high school until about 2012. Because they are generally able to meet existing needs, they are now focused more on improving students' performance. The in-migration of an estimated 182 to 318 new households into the county from construction of the CCNPP Unit 3 could place greater demands on the system. Although the school district could receive some additional funding from property taxes generated by these new households (likely to be minimal because adequate housing units are already available in the county and those units are already being taxed), it would not receive additional funding directly from the power plant because CCNPP Unit 3 does not pay property taxes to St. Mary's County. Because the St. Mary's County Public School System is at capacity and would not receive additional funding, the impacts of the power plant would be SMALL and no mitigation would be required.

4.4.2.9 Public Facilities

As discussed above, there is a sufficient quantity of vacant housing units in Calvert and St. Mary's Counties to meet the housing needs of the in-migrating direct construction workforce for CCNPP Unit 3, so no new housing units would likely be required. The excess capacity in the water and sewage services and the lack of new construction resulting from the power plant would result in no effects to those services. Although an increase in the population would likely place additional demands on area transportation and recreational facilities, the facilities appear to have enough capacity to accommodate the increased demand and impacts would likely be small. Area highways and roads would have increased traffic levels, particularly during shift changes at the CCNPP, resulting in a SMALL traffic impact. These impacts are described in Section 4.4.1.

4.4.2.10 References

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4.4.3 Environmental Justice Impacts

This section describes the potential disproportionate adverse socioeconomic, cultural, environmental, and other impacts that construction of CCNPP Unit 3 could have on low income and minority populations within two geographic areas. The first geographic areas is a 50 mi (80 km) radius of the CCNPP Unit 3 power plant, where there is a potential for disproportionate employment, income, and radiological impacts, compared to the general population (NRC, 1999). This analysis also evaluates potential impacts within the region of influence (ROI), most of which is encompassed within a 20 mi (32 km) radius of the power plant site, where more localized potential additional impacts could occur to transportation/

traffic, aesthetics, recreation, and other resources, compared to the general population. It also highlights the degree to which each of these populations would disproportionately benefit from construction of the proposed power plant, again compared to the entire population is also discussed.

Section 2.5.1 provides details about the general population characteristics of the study area. Section 2.5.4 provides details about the number and locations of minority and low income populations within a 50 mi (80 km) radius of the CCNPP site, and their related reliance on subsistence sources. Calvert County contains 41 census blocks, among which there are no minority census blocks. St. Mary's County contains 55 identified census blocks, two of which are minority census blocks. Maryland has a total of 1,116 census blocks with 463 of these classified as minority census blocks.

In Maryland, 27 census blocks are classified as low income. Calvert County has no low income census blocks and St. Mary's County has one. The incidence of low income households within the 50 mi zone is also low, being 4.11% in Calvert County and 6.75% in St. Mary's County compared to 8.32% in Maryland as a whole.

4.4.3.1 Minority and Low Income Populations and Activities

As discussed in Section 2.5, about 90% of the residential population that lives within a 50 mi (80 km) radius lives farther than 30 mi (48 km) from the site. Calvert County and St. Mary's County have been defined as the ROI because 91% of the current CCNPP Units 1 and 2 operational workforce resides there, and it is assumed that the in-migrating construction workforce for CCNPP Unit 3 would also primarily reside in and impact this geographic area.

Because the power plant site is already developed and access is restricted, no minority or low income residences would be removed or relocated within the ROI. Additionally, the distance of the plant from area residents, in general, is great enough that none of these populations would be directly affected by construction of the power plant (i.e., noise, air quality, and other disturbances from the footprint of the facility). Construction and operation of CCNPP Unit 3 are expected to have no disproportionate effect on minority and low income populations.

4.4.3.1.1 50 Mile (80 km) Comparative Geographic Area

Employment and Income

There would be an estimated maximum 3,950-person workforce constructing the CCNPP Unit 3 power plant from 2011 to 2015, representing a significant increase in the overall employment opportunities for construction workers. Unemployed or underemployed members of minority and low income groups could benefit from increased employment opportunities, to the extent that they have the craft skills required (e.g., laborers, carpenters, electricians, plumbers, welders), are hired as part of the construction workforce, and have adequate transportation to access the construction site. These low income and minority populations primarily reside in the Washington/Arlington/Alexandria Metropolitan Statistical Area (MSA) and Prince Georges County, Maryland, and in Fairfax County, Virginia. The beneficial impacts of these potential new employment opportunities likely would be SMALL.

In addition, because of the demand for such skills, the proportion of low income and minority construction workers from the comparative geographic area that are currently employed could realize increased income levels, to the extent that they leave lower paying jobs to work on CCNPP Unit 3. The beneficial impacts of these increased income levels for low income and minority populations likely would be SMALL.

There are no unique minority or low income populations within the comparative geographic area that would likely be disproportionately adversely impacted by construction of the proposed power plant because they are located more than 30 mi (48 km, or outside of the ROI) from the CCNPP Unit 3 site where no environmental impacts (e.g., noise, air quality, water quality, changes in habitat, aesthetic, etc.) would likely occur.

4.4.3.1.2 Two-County Region of Influence

Employment and Income

Unemployed or underemployed members of minority and low income groups within the ROI also could benefit from increased employment opportunities, to the extent that they have the craft skills required (e.g., laborers, carpenters, electricians, plumbers, welders) and are hired as part of the construction workforce. The beneficial impacts of increased employment opportunities are likely to be more noticeable for minority and low-income populations within the 20 mi (32 km) radius that includes most of the ROI because of the potential hiring levels relative to the smaller existing workforce base. As shown in Table 4.4-9, minority and low income populations within a 20 mi (32 km) radius that comprises the ROI are located at least 11 mi (18 km) to the south in St. Mary's County and over 19 mi (30.6 km) away in Dorchester County. Because of their limited geographic extent and the level of impacts, the beneficial impacts of these potential new employment opportunities likely would be SMALL.

In addition, impacts on area businesses, and potentially related increased opportunities to obtain higher paying indirect jobs, could be realized from increased economic activity resulting from CCNPPs purchase of materials from businesses within the ROI. The beneficial impacts of these potential new employment opportunities likely would be SMALL.

In addition, because of the demand for such skills, the proportion of low income and minority construction workers from the ROI that are currently employed could realize increased income levels, to the extent that they leave lower paying jobs to work on CCNPP Unit 3. These benefits might be even greater for the low income populations within the 20 mi (32 km) radius of the ROI, relative to the benefits realized in the 50 mi (80 km) comparative geographic area, if construction related income currently is lower within the ROI. The beneficial impacts of these increased income levels for low income and minority populations likely would be SMALL.

4.4.3.2 Subsistence Activities

The types and levels of subsistence activities occurring in the two-county region of influence (i.e., Calvert and St. Mary's Counties) are described in Section 2.5.4. As discussed there, fish and shellfish harvesting are important parts of the food gathering activities for minority and low income residents. Chesapeake Bay sediments would be disturbed and turbidity would likely increase during construction of the water intakes and outfall for the CCNPP Unit 3. These activities could disturb current subsistence catch rates of shellfish and finfish, to the extent that they are occurring near the CCNPP site. Construction of the CCNPP Unit 3 intakes within the existing intake embayment should limit siltation effects outside of the curtain wall and are not likely to alter fishing habits or harvest. Construction of the discharge multi-port diffuser would result in temporary disturbance of the substrate and a localized increase in turbidity during the work activities, thus resulting in a small impact. Although these activities could disturb traditional subsistence catch rates of shellfish and finfish, to the extent that they are occurring near the CCNPP site, the impacts likely be SMALL for all members of the general public and, thus, would not represent a disproportionate impact to minority or low income populations.

As stated in ER Section 2.4.1, white-tail deer and waterfowl populations are abundant throughout Maryland and on or near the CCNPP site. These populations represent a valuable resource for hunters.

In addition, it is assumed that collection of plants for ceremonial purposes and as a food source (i.e., culturally significant plants, berries, or other vegetation) could be occurring in the two-county region of influence. Again, minority and low-income populations might be conducting these collection activities, off of the CCNPP site, more often than the general population. In addition, when conducting their collection activities, they also could be harvesting greater quantities of plants, than the general population. For safety and security reasons the general public is not allowed uncontrolled access to the CCNPP site. Thus, no ceremonial or subsistence gathering of culturally significant plants, berries, or other vegetation occurs on the site and no impacts will occur.

Table 4.4-1— Typical Noise Levels of Construction Equipment

Equipment Type	Noise Level, db(A)		
	Peak	at 50 ft (15.2 m)	at 3000 ft (914.4 m)
Earthmoving			
Loaders	104	73-86	38-51
Dozer	107	87-102	52-67
Scraper	93	80-89	45-54
Graders	108	88-91	53-56
Dump trucks	108	88	53
Heavy trucks	95	84-89	49-54
Materials Handling			
Concrete mixer	105	85	50
Crane	104	75-88	40-53
Forklift	100	95	60
Stationary			
Generator	96	76	41
Impact			
Pile driver	105	95	60
Jack hammer	108	88	53

Table 4.4-2— Projected Traffic Conditions During Construction

	Morning Peak 6:30-7:30 AM		Afternoon Peak 4:00-5:00 PM	
Intersection at MD 2/4	**LOS[1]**	**CLV (vph)**	**LOS**	**CLV (vph)**
Calvert Beach Road	F	1796	F	1986
Calvert Cliffs Parkway	B	1005	E	1558
Pardoe Road	C	1293	E	1471
Cove Point Road	D	1371	E	1577
Nursery Road	F	2303	F	2525

LOS: Level of Service
CLV: Critical Lane Volume

1. Note:
LOS Ratings
A: Best Serivce
F: Worst Service
E or better indicates a wait of <50 seconds at an intersection without signal control.

Table 4.4-3— Estimated Average FTE Construction Workers, by Construction Year/Quarter at the CCNPP

Year / Quarter of Construction		Average FTE Construction Workforce
Year 1:		
	1	350
	2	800
	3	1,250
	4	1,600
Year 2:		
	1	1,900
	2	2,200
	3	2,500
	4	2,800
Year 3:		
	1	3,050
	2	3,200
	3	3,350
	4	3,500
Year 4:		
	1	3,683
	2	3,867
	3	3,950
	4	3,950
Year 5:		
	1	3,950
	2	3,917
	3	3,700
	4	3,400
Year 6:		
	1	3,050
	2	1,967
	3*	768*

Note: The third "quarter" of construction year 6 has only two months; the length of the total construction period is estimated to be 68 months.

Table 4.4-4— Total Peak On-Site Nuclear Power Plant Construction Labor Force Requirements (based on an average of single power plants)

Personnel Description	DOE Percent of Total Peak Personnel, Average Single Unit	DOE Peak Total Personnel, Average Single Unit	Estimated CCNPP Unit 3 Total Peak Workforce Composition
Craft Labor	66.7%	1,600	2,635
Craft Supervision	3.3	80	130
Site Indirect Labor	6.7	160	265
Quality Control Inspectors	1.7	40	67
NSSS Vendor and Subcontractor Staffs	5.8	140	229
EPC Contractor's Managers, Engineers, and Schedulers	4.2	100	166
Owner's O&M Staff	8.3	200	328
Start-Up Personnel	2.5	60	99
NRC Inspectors	0.8	20	32
Total Peak Construction Labor Force	100.0 %	2,400	3,950

Notes:
EPC = Engineering, Procurement, and Construction
O&M = operation and maintenance
NRC = Nuclear Regulatory Commission
NSSS = Nuclear Steam Supply System
Percentages and numbers may total slightly more or less than the total due to rounding.

Table 4.4-5— Peak On-Site Nuclear Power Plant Construction Craft Labor Force Requirement (based on an average of single power plants)

Craft Personnel Description	DOE Percent of Peak Craft Labor Personnel, Average Single Unit	DOE Peak Craft Labor Personnel, Average Single Unit	Estimated CCNPP Unit 3 Peak Craft Workforce Composition
Boilermakers	4.0 %	60	105
Carpenters	10.0	160	264
Electricians/Instrument Fitters	18.0	290	474
Iron Workers	18.0	290	474
Insulators	2.0	30	53
Laborers	10.0	160	264
Masons	2.0	30	53
Millwrights	3.0	50	79
Operating Engineers	8.0	130	211
Painters	2.0	30	53
Pipefitters	17.0	270	448
Sheetmetal Workers	3.0	50	79
Teamsters	3.0	50	79
Total Craft Labor Force	100.0 %	1,600	2,635

Notes: Percentages and numbers may total slightly more or less than the total due to rounding.

Table 4.4-6— Nuclear Power Plant Craft Labor Force Composition by Phases of Construction (in percent)

	Percentage of Craft Labor Force by Construction Phase						
Craft Labor	**Concrete Formwork, Rebar, Embeds, Concrete**	**Structural Strength Steel, Misc. Iron & Architectural**	**Earthwork Clearing, Excavation, Backfill**	**Mechanical Equipment Installation**	**Piping Installation**	**Instrument Installation**	**Electrical Installation**
Boilermakers				15			
Carpenters	40	5					2
Electricians/ Instrument Fitters						70	96
Iron Workers	20	75		10			
Laborers	30	5	60				1
Millwrights				25			
Operating Engineers	5	15	35	12	15	2	1
Pipefitters				35	80	28	
Teamsters			5	3	5		
Others	5						
Total Percentage of Craft Labor Force	100	100	100	100	100	100	100

Table 4.4-7— Estimates of In-Migrating Construction Workforce in Calvert County and St. Mary's County, 20% In-Migration Scenario, 2011-2015

In-migration Characteristics	Calvert County	St. Mary's County	Total ROI
Direct Workforce:			
Maximum Direct Workforce			3,950
Percent of Current CCNPP Units 1 & 2 Workforce Distribution	68%	23%	
Estimated In-migrating Direct Workforce (@20% assumption)	537	182	719
In-migrating Direct Workforce Population (@2.61 people/household)	1,402	474	1,876
Indirect Workforce:			
Estimated Distribution of Peak Direct Workforce	2,686	909	3,595
Peak Indirect Workforce (@0.6855, BEA multiplier)	368	125	493
Indirect Workforce Needs That Could Met by Direct Workforce Spouses (@59.5% working spouses)	515	175	689
Remaining, Unmet Indirect Workforce Need*	-148	-50	-196

Notes:

It is assumed that 100% of the construction workforce in-migrating into the ROI will move their families with them.

U.S. Census Bureau 2000 census data indicates that the state of Maryland had 2.61 people per household.

U.S. Census Bureau 2000 census data indicates that, within the state of Maryland, 59.5% of households had a working spouse.

* - A negative value for the remaining, unmet indirect workforce needs means that working spouses of the in-migrating direct workforce will exceed the estimated number of indirect workforce jobs generated by the power plant.

Table 4.4-8— Estimates of In-Migrating Construction Workforce in Calvert County and St. Mary's County, 35% In-Migration Scenario, 2011-2015

In-migration Characteristics	Calvert County	St. Mary's County	Total ROI
Direct Workforce:			
Maximum Direct Workforce			3,950
Percent of Current CCNPP Units 1 & 2 Workforce Distribution	68%	23%	
Estimated In-migrating Direct Workforce (@35% assumption)	940	318	1,258
In-migrating Direct Workforce Population (@2.61 people/household)	2,454	830	3,284
Indirect Workforce:			
Estimated Distribution of Peak Direct Workforce	2,686	909	3,595
Peak Indirect Workforce (@0.6855, BEA multiplier)	644	218	862
Indirect Workforce Needs Met by Direct Workforce Spouses (@59.5% working spouses)	901	305	1.205
Remaining, Unmet Indirect Workforce Need*	-256	-87	-434

Notes:

It is assumed that 100% of the construction workforce in-migrating into the ROI will move their families with them.

U.S. Census Bureau 2000 census data indicates that the state of Maryland had 2.61 people per household.

U.S. Census Bureau 2000 census data indicates that, within the state of Maryland, 59.5% of households had a working spouse.

* - A negative value for the remaining, unmet indirect workforce needs means that working spouses of the in-migrating direct workforce will exceed the estimated number of indirect workforce jobs generated by the power plant.

Table 4.4-8A— Total Work Force Potential During CCNPP Unit 3, Units 1 and 2 Operations (and outage) and Buildup of Unit 3 Operations Staff

Workforce Groups	Workforce Potential	Total
Units 1 and 2 Operations and Outage		
Units 1 & 2 Operations	833[1]	
Units 1 & 2 Outage Workers	1,000[2]	
Maximum Existing Operational Workforce		1,833
Unit 3 *Construction*		
Peak Unit 3 Direct Construction Workforce	3.950[3]	
Cumulative Units 1 & 2, Outage plus Peak Direct Construction Workforce		5,783
Indirect In-Migration	862	
Cumulative Peak Operations, Construction & Outage Workforce		6,645
Unit 3 Operations		
Peak Unit 3 Direct Operations Workforce	363[4]	
Cumulative Units 1 & 2 with Outage and Peak Direct Workforce	1,833	
Unit 3 Operations and Unit 1 & 2 with Outage		2,196
Indirect In-Migrations Workforce	562	
Cumulative Peak Operation & Outage		2,758

Notes:
1. ER Table 2.5-1
2. ER Section 5.8.2.1.2
3. ER Section 4.4.2.3
4. ER Section 5.8. 2.3.

Table 4.4-9— Minority and Low Income Populations Within About 20 Linear Miles (32 km) of the CCNPP Site

County	Type of Population	Number of Census Block Groups	Estimated Linear Distance from CCNPP mi (km)	Direction from CCNPP
Region of Influence:				
Calvert	Minority	0	n/a	n/a
	Low Income	0	n/a	n/a
St. Mary's	Minority	2	11 (17.7)	South
	Low Income	1	11 (17.7)	South
Other Counties:				
Dorchester	Minority	4	>19 (30.6)	northeast
	Low Income	2	21 (33.8)	northeast
Charles	Minority	0	n/a	n/a
	Low Income	0	n/a	n/a
Prince George's	Minority	0	n/a	n/a
	Low Income	0	n/a	n/a
TOTAL	Minority	6		
	Low Income	3		

Notes:

n/a = not applicable

A 20-mi (32 km) radius was selected because it includes most of Calvert County and St. Mary's County, the ROI, but also includes portions of other counties

Figure 4.4-1— CCNPP Traffic Impact Assessment Study Area

Figure 4.4-2— Cumulative Overlapping 50 mi (80 km) Zones for Nuclear Power Plants Surrounding CCNPP Unit 3

4.5 RADIATION EXPOSURE TO CONSTRUCTION WORKERS

This section discusses the exposure of construction workers building Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 to radiation from the normal operation of CCNPP Units 1 and 2.

4.5.1 Site Layout

The physical location of CCNPP Unit 3 relative to the existing CCNPP Units 1 and 2 on the CCNPP site is presented on Figure 4.5-1. As shown, except for the CCNPP Unit 3 Intake Structure, CCNPP Unit 3 would be located southeast of the protected area from CCNPP Units 1 and 2. Hence, the majority of construction activity would take place outside the protected area for the existing units, but inside the Owner Controlled Area for the CCNPP site.

4.5.2 Radiation Sources at CCNPP Units

During the construction of CCNPP Unit 3, the construction workers will be exposed to radiation sources from the routine operation of CCNPP Units 1 and 2. Sources that have the potential to expose CCNPP Unit 3 workers are listed in Table 4.5-1. They are characterized as to location, inventory, shielding, and typical local dose rates. Interior, shielded sources are not included. Figure 4.5-2 and Figure 4.5-3 show the locations of these sources. These sources are discussed in the Offsite Dose Calculation Manual (ODCM) (CCNPP, 2005), the annual Radiological Effluent Release Report (CCNPP, 2007a), and the Radiological Environmental Operating Report (CCNPP, 2007b) for CCNPP Units 1 and 2. The four main sources of radiation to CCNPP Unit 3 workers are gaseous effluents, liquid effluents, the Independent Spent Fuel Storage Installation (ISFSI) and the Interim Resin Storage Area. These are discussed below.

All gaseous effluents flow out the CCNPP Units 1 and 2 plant stacks. The releases are reported annually to the NRC. For example, the annual gaseous releases from CCNPP Units 1 and 2 for 2006 were reported as 876 Ci (3.24E+13 Bq) of fission and activation gases, 3.28E-2 Ci (1.21E +9 Bq) of I-131, 1.62E-5 Ci (6E+5 Bq) of particulates with half-lives greater than eight days, and 4.79 Ci (1.77E+ 11 Bq) of tritium (CCNPP, 2007a). Doses to the general population are also reported annually.

Effluents from the liquid waste disposal system produce small amounts of radioactivity in the discharge to the Chesapeake Bay. The annual liquid radioactivity releases for 2006 were reported as 4.87E-2 Ci (1.80E+09 Bq) of fission and activation products, 1560 Ci (5.75E+13 Bq) of tritium, and 1.71 Ci (6.31E+10 Bq) of dissolved and entrained gases (CCNPP, 2007a).

There are two main direct radiation sources, the ISFSI and the Interim Resin Storage Area. This is because they are closer to CCNPP Unit 3 than all the other direct sources. There are radiation monitors at the perimeter of each. Radiation from minor direct sources from CCNPP Units 1 and 2 would be picked up by the ISFSI and Resin Storage Area monitoring programs, and thus, would be included in the dose estimates below.

4.5.3 Historical Dose Rates

The historical measured and calculated dose rates that were used to estimate worker dose are presented below.

4.5.3.1 Gaseous and Liquid Effluent Historical Measurements

The doses listed in Table 4.5-2 are to the maximally exposed member of the public due to the release of gaseous and liquid effluents from CCNPP Units 1 and 2 and are calculated in accordance with the existing units' ODCM (CCNPP, 2005). The maximum individual doses are from historical CCNPP Units 1 and 2 Annual Radiological Environmental Operating Reports and, prior to that, the Radiological Environmental Monitoring Program Annual Reports. While these off-site doses provide perspective on the variation of effluent releases through the history of the operation of Units 1 and 2, on-site workers will be exposed to fewer pathways. For example, construction workers will not ingest food (edible plants or fish) grown in effluent streams as part of their work activity. Therefore, only inhalation and external pathways will be considered in the calculation of dose to workers.

4.5.3.2 ISFSI Historical Measurements

Figure 4.5-4 provides thermoluminescent dosimeter (TLD) measurements made adjacent to the ISFSI in 2005 as well as a conservative extrapolation of dose over distance. Table 4.5-3 contains the average monthly ISFSI TLD dose and the average monthly control location dose from 1990 to 2005. The locations used to determine the background are locations DR 1, 7, 8, 20, 21, 22, and 23 as described in the 2005 Radiological Environmental Monitoring Program (REMP) report (CCNPP, 2006b). Table 4.5-4 provides the time trend for the ISFSI net annual dose since spent fuel was initially placed into storage at the ISFSI in 1993.

4.5.3.3 Resin Storage Area Historical Measurements

Table 4.5-5 provides historical Resin Storage Area TLD readings from 2001 through 2005.

Figure 4.5-5 provides the ISFSI and Resin Storage Area TLD readings, averaged over all detectors and over each year of data. Figure 4.5-6 extrapolates the 2005 dose rate over distance from the center of the Resin Area.

4.5.4 Projected Dose Rates at CCNPP Unit 3

Dose rates from all sources combined were calculated for each 100 x 100 foot square on the plant grid. These dose rates were in terms of mrem/year. For purposes of dose rate calculations a 100% occupancy is assumed. (For purposes of collective dose calculations the occupancy for construction workers is 2,200 hours per year.) The dose rates were the sum of the dose rate from the four main sources; gases, liquids (only on the shoreline), ISFSI, and Resin Storage Area. They are shown in Figure 4.5-7 for the year 2015, the last year of construction. It is this year that the dose rate will be greatest, primarily because the ISFSI will have the largest number of spent fuel storage casks. In the calculations, no credit is taken for any additional shielding other than that presented in measured doses.

The collective dose is the sum of all doses received by all workers. It is a measure of population risk. The number of workers (in terms of Full Time Equivalents) and their location by zone are given in Table 4.5-13. The zone locations are shown by 100 x 100 foot squares in Figure 4.5-7. The details of the collective dose calculations are given in the following discussion.

The equation for dose rate during year t at location x,y on the plant grid is:

$$\dot{D}_{x,y} = \dot{D}_{gas} + \dot{D}_{liq} + \dot{D}_{N,2005} + \dot{D}_{S,t} + \dot{D}_{resin}$$

where the terms are explained in the ER subsections.

The equation for the average dose rate in a zone is:

$$\bar{\dot{D}}_z = \frac{1}{N_z} \sum_{(\text{all } x,y \text{ in } Z)} \dot{D}_{x,y}$$

where N_Z is the number of squares in the zone.

The equation for collective dose for the construction period is:

$$D = \frac{2200}{8760} \sum_t \sum_z \bar{\dot{D}}_z FTE_{z,t}$$

where

$$\frac{2200}{8760} = \text{fraction of work hours per year}$$

$$\bar{\dot{D}}_z = \text{average dose rate in zone, Z.}$$

$FTE_{Z,t}$ = Full Time Equivalents in zone Z during year t.

The equation for FTE is:

$$FTE_{Z,t} = P_Z \, Census_t$$

where P_Z = probability of worker in zone, Z

$Census_t$ = FTE of workers on site in year t.

The probability of a worker in each zone, P_Z, reflects the average construction worker and is based on a rough idea of how much time the average worker spends in each zone. For example, the time in the parking lot and road is low, in the construction area is high, in the offices is less. These are best estimates based on construction experience.

The spatial distribution of zones on the site is shown (red letters indicating a zone code in each square) in Figure 4.5-7. There are many locations where construction workers are not expected to be, so they are not marked in the Figure. Those squares that are marked were chosen because of planned activities at those locations, for example, the parking lots are marked on site drawings, as are roads, and most importantly, the construction area.

4.5.4.1 Gaseous Dose Rates

The annual TEDE (Total Effective Dose Equivalent) dose rate from gaseous effluents to construction workers on the CCNPP Unit 3 site is bounded by the following equation:

$$\dot{D}_{gas} = 220256 \, r^{-1.8} \text{ (mrem/year)}$$

where r = distance from stack to worker location in feet

The skin dose rate equation bounds organ doses from iodines and particulates.

$$\dot{D}_{skin} = 1066039 \, r^{-1.8} \text{ (mrem/year)}$$

where r = distance from stack to worker location in feet

This parametric equation is based on annual average, undepleted, ground level χ/Qs that are based on CCNPP site specific meteorology for the years 2000 to 2006. Note that only those wind directions which could carry gaseous effluents from the stacks to the CCNPP Unit 3 workers were included in the present analysis. Thus, the ENE through W sectors (clockwise) are included. The χ/Q data used are provided in Table 4.5-6. A bounding curve was then fitted to a power equation as shown in Figure 4.5-8.

The equation is:

$$\frac{\chi}{Q}(r) = 60r^{-1.8}$$

where r is the stack to target distance in feet.

The dose rates were calculated for an onsite location with a known χ/Q for the years 2001 through 2006 according to the Regulatory Guide 1.109 (NRC, 1977) method with Total Effective Dose Equivalent (TEDE) calculations according to Federal Guidance Reports 11 (EPA, 1988) and 12 (EPA, 1993). The gaseous releases are shown in Table 4.5-7. The 2006 releases gave the highest dose rates. This data was then used to establish the dose rate to χ/Q ratio which was used to derive a parametric equation to bound the dose rate from the 2006 releases. These equations generate "TEDE" doses suitable for 10 CFR 20.1301 calculations.

4.5.4.2 Liquid Dose Rates

The dose from liquid effluents is conservatively calculated assuming all the exposure is from deposition on the shoreline. The historical liquid effluents and dilution rates for the years 2001 through 2006 are given in Table 4.5-8. The maximum calculated dose at the shoreline during this interval is 0.32 mrem/yr (3.2 μSv/yr). Thus,

$$\begin{aligned}\dot{D}_{liq} &= 0.32 \text{ (mrem/year) on shoreline}\\ &= 0 \text{ not near the water}\end{aligned}$$

The actual discharge from CCNPP Units 1 and 2 is 850 ft (259 m) away from shore. The dilution factor at the shore would provide a significant reduction but is conservatively ignored. The LADTAPII computer code (NRC, 1986) was used to make these calculations. LADTAPII assumes a 12 hours/year occupancy rate which had to be scaled up to by the factor 8760/12 for annual dose rate calculations.

4.5.4.3 ISFSI Dose Rates

The dose rate had to be calculated at various distances and directions from the ISFSI. The dose rate also had to be projected into the future as more spent fuel was loaded into storage canisters and stored at the ISFSI from CCNPP Units 1 and 2. TLD readings around the ISFSI as shown in Figure 4.5-4 were used to develop the following equation for 2005 dose rate as a function of location:

$$\dot{D}_{N,2005} = 76\,\omega\, e^{-0.00195r} \text{ (mrem/year)}$$

The equation for solid angle is derived empirically from dosimetry and distance measurements at the ISFSI site. The height, H, and radius, R, are effective values derived from the fit. They are 400 and 124 feet respectively. The equation is:

$$\omega = 2\arcsin\left(\left(\frac{H}{\sqrt{H^2 + r^2}}\right)\left(\frac{R}{\sqrt{R^2 + r^2}}\right)\right)$$

This is a reasonable approximation for the North end, i.e., ISFSI-N, which was about 72% loaded with spent fuel at the end of 2005. The exterior perimeter distance, x, to ISFSI-N is calculated assuming a source center at N9703, E7936. Then, it was assumed that all post-2005 spent fuel loading went into ISFSI-S whose source center was N9403, E7936. The source term for ISFSI-S was an extrapolation of the historic dose rate increase from ISFSI-N as shown in Figure 4.5-10. The dose rate from ISFSI-S as a function of calendar year after 2005 is:

$$\dot{D}_{s,t} = (-170.8456 + 0.08521\,t)\,\dot{D}_{N,2005}$$

where t is the absolute year (such as 2010).

Note that these provide annual average dose rates. There are significant temporal variations, for example, during ISFSI loading operations the dose rate will go up. These variations are included in the annual average.

4.5.4.4 Resin Area Dose Rates

The resin dose rate equation is given below where, r, the distance in feet from the effective center of the Resin Area, i.e., N 10100 E 7600 on the plant grid is given in feet

$$\dot{D}_{resin} = \frac{2.23E6\, e^{-0.000951r}}{r^2} \text{ (mrem/year)}$$

This is independent of direction. The Cobalt-60 photon energy spectrum is assumed because it typically dominates or bounds the exterior distance dose rate from resin beds. In reality there is expected to be significant variation in the sources and their strengths from quarter to quarter. There is also expected to be some azimuthal variation in dose rate. However, this is a best estimate, which is suitable for the purpose of ALARA calculations.

This equation was fitted to TLDs located as shown in Figure 4.5-11. The data for 2005 was used. All the data for the years 2001 through 2005 are in Table 4.5-5. There has been one year in which the dose rate was higher than is predicted by this equation. For this reason, future TLD dose rates will be monitored to assure that this equation and associated results remain valid.

4.5.4.5 Example Dose Rate Calculation

As an example the dose rate to the location N8050, E9150 is calculated. This location is at the center of the square that is nearest to the center of the containment of the new plant. The ISFSI will be at its maximum load for the construction period, i.e. as projected in 2015. The distances between the sources and the receptor are shown in the following table. Note that the first grid coordinate on the map is shown as N8050, but, mathematically is -8050. The distance between the gas stack and the receptor is

$$r = \sqrt{(-10474 - -8050)^2 + (9996 - 9150)^2} = 2567$$

The other distances are similarly calculated

Location	N	E	r (ft)
Receptor	-8050	9150	
Gas Stack	-10474	9996	2567
ISFSI North Half	-9703	7936	1927
ISFSI South Half	-9403	7936	1694
Resin Area	-10100	7600	2570

The dose rate from gases released from the stack are

$$\dot{D}_{gas} = 220256 \cdot 2567^{-1.8} = 0.16064$$

The dose rate from liquids is zero because the receptor is not near the shoreline nor any effluent liquids. The dose rate from the ISFSI is calculated assuming the 2005 load at both the North and South halves. Both dose calculations depend upon the solid angles in streradians (sr) which are calculated as follows:

$$\omega_N = 2\arcsin\left(\left(\frac{400}{\sqrt{400^2 + 1927^2}}\right)\left(\frac{124}{\sqrt{124^2 + 1927^2}}\right)\right) = 0.02611\,\text{sr}$$

Similarly for the south half:

$$\omega_S = 2\arcsin(\left(\frac{400}{\sqrt{400^2 + 1694^2}}\right)\left(\frac{124}{\sqrt{124^2 + 1694^2}}\right)) = 0.03356\text{sr}$$

Note, that arcsin() calculates planar angle in degrees or radians. Units of degrees are converted by θ(radians) = θ(degrees) 180/π(radians). The dose rate from the North half of the ISFSI is

$$\dot{D}_{N,2005} = 76 \cdot 0.02611 \cdot e^{-0.00195 \times 1927} = 0.04$$

From the south half the dose rate is calculated assuming it is loaded like the north half in 2005:

$$\dot{D}_{S,2005} = 76 \cdot 0.03356 \cdot e^{-0.00195 \times 1694} = 0.09381$$

Correcting for ISFSI loading out to the year 2015:

$$\dot{D}_{S,2015} = (-170.8456 + 0.08521 \cdot 2015)\, 0.09381 = 0.07998$$

The dose rate from resins is:

$$\dot{D}_{resin} = \frac{2.23E6\, e^{-0.000951 \times 2570}}{2570^2} = 0.02931$$

Thus, the dose rate near the center of the containment in 2015 is:

$$\dot{D} = 0.16064 + 0 + 0.04631 + 0.07998 + 0.02931 = 0.316(\text{mrem/y})$$

4.5.5 Compliance with Dose Rate Regulations

CCNPP Unit 3 construction workers are, for the purposes of radiation protection, members of the general public. The construction workers (with the exception of certain specialty contractors loading fuel or using industrial radiation sources for radiography) do not deal with radiation sources.

Dose limits to members of the public are provided in 10 CFR 20.1301 (CFR, 2007a) and 10 CFR 20.1302 (CFR, 2007b). Note that 10 CFR 20.1201 through 20.1204 do not apply to the construction workers as they are considered members of the public and not radiation workers.

4.5.5.1 10 CFR 20.1301

10 CFR 20.1301 (CFR, 2007a) limits annual doses from licensed operations to individual members of the public to 0.1 rem (1 mSv) TEDE (total effective dose equivalent.) In addition, the dose from external sources to unrestricted areas must be less than 0.002 rem (0.02 mSv) in any one hour. This applies to the public both outside of and within controlled areas. The maximum dose rates by zone are given in Table 4.5-9. For an occupational year, i.e., 2,200 hours onsite, the maximum dose would be on the road by the ISFSI or the Resin Storage Area where the dose would be 0.0389 rem (0.389 mSv) and less than 0.002 rem (0.02 mSv) in any one hour. This assumes the worker stood on the road for all working hours in one year. This value is less than the limits specified above for members of the public.

4.5.5.2 10 CFR 10.1302

10 CFR 20.1302 (CFR, 2007b) requires surveys of radiation levels in unrestricted and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public in 10 CFR 20.1301 (CFR, 2007a). The Technical Specifications for Calvert Cliffs Units 1 and 2 limit radioactivity release rates to values that ensure the requirements of Appendix I to 10 CFR 50 are met and therefore ensure compliance with 10 CFR 20.1301 (CFR, 2007a). Furthermore, the Radiological Environmental Monitoring Program for Units 1 and 2 will place dosimetry devices on the fence of the construction area for Unit 3; these devices will also verify the dose is below the 10 CFR 20.1301 (CFR, 2007a) limits.

4.5.5.3 10 CFR 50, Appendix I

The 10 CFR 50, Appendix I criteria (CFR, 2007c) apply only to effluents. The purpose of the criteria are to assure adequate design of effluent controls. The annual limits for liquid effluents are 3 mrems (30 μSv) to the total body and 10 mrems (100 μSv) to any organ. For gaseous effluents, the pertinent limits are 5 mrems (50 μSv) to the total body and 15 mrems (150 μSv) to organs including skin. Table 4.5-10 shows that there is no dose rate to workers in a construction zone from effluents that exceeds these limits. Therefore, the criteria have been met.

4.5.6 Collective Doses to CCNPP Unit 3 Workers

The collective dose is the sum of all doses received by all workers. It is a measure of population risk. The total worker collective dose for the combined years of construction is 4.6 person-rem (0.046 person-Sieverts). This is a best estimate and is based upon the worker census and occupancy projections shown in Table 4.5-11 and Table 4.5-12. The breakdown of FTE, average dose and collective dose by construction year and occupancy zone is given in Tables 4.5-13, 4.5-14 and Table 4.5-15. These assume 2,200 hours per year occupancy for each worker and are based on effluent release and meteorological data through 2006.

4.5.7 References

CFR, 2007a. Title 10, Code of Federal Regulations, Part 20.1301, Dose Limits for Individual Members of the Public, 2007.

CFR, 2007b. Title 10, Code of Federal Regulations, Part 20.1302, Compliance with Dose Limits for Individual Members of the Public, 2007.

CFR, 2007c. Code of Federal Regulations, Title 10 CFR 50, Appendix I, Numerical Guides for Design Objectives and Limiting Condition for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light Water Cooled Nuclear Power Reactor Effluents, 2007.

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EPA, 1988. Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion, Federal Guidance Report No. 11, Document Number EPA-52011-88-020, U.S. Environmental Protection Agency, September 1988.

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NRC, 1978. Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations will be as Low As is Reasonably Achievable, Regulatory Guide 8.8, Revision 3, Nuclear Regulatory Commission, June 1978.

NRC, 1977. Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR Part 50, Appendix I, Regulatory Guide 1.109, Revision 1, Nuclear Regulatory Commission, October 1977.

NRC, 1986. LADTAP II – Technical Reference and User Guide, NUREG/CR-4013, Nuclear Regulatory Commission, April 1986.

Table 4.5-1— Source List for CCNPP Units 1 and 2

Source	Location	Radioactive Inventory	Shielding	Typical Dose Rates
CCNPP Unit 1 Stack	Side of CCNPP Unit 1 containment	There are two elevated vents, one for each of CCNPP Units 1 and 2. Their joint effluents are characterized in the annual RETS/ REMP reports[(a)]	N.A., airborne effluent	Offsite doses generally less than mrem/year (few hundredths msievert/year)
CCNPP Unit 2 Stack	Side of CCNPP Unit 2 containment		N.A., airborne effluent	Offsite doses generally less than mrem/year (few hundredths msievert/year)
Circulating Water System Discharge	850 ft (259.1 m) from shore	Liquid effluents discharged to bay are characterized in annual RETS/ REMP reports[(b)]	N.A., waterborne effluent	Offsite doses generally less than mrem/year (few hundredths msievert/year)
ISFSI	ISFSI Pad	Spent fuel characterized by TLD measurements listed in annual ISFSI REMP report	Vented concrete bunkers	Contact dose rates <20 mrem/hr (<0.2 msievert/ hr)
Auxiliary Building	West of Turbine Building	Radwaste tanks and storage	Shielded building walls	Exterior contact <2.5 mrem/hr (<0.025 msievert/hr)
Refueling Water Tanks (RWT)	Adjacent to Auxiliary Building on 45 ft (13.7 m) elevation	Maximum inventory occurs when tanks have reactor water	None	<5.0 mrem/hr (<0.05 msievert/hr) at 15 ft (4.6 m) distance
Interim Resin Storage Area, Lake Davies	300 ft (91.4 m) west of ISFSI	Interim storage of spent resin and filters	None	<0.5 mrem/hr (<0.005 msievert/hr) at the storage area fence
Materials Processing Facility (MPF)	South of Turbine Building	Interim storage of dry active waste, and liquids being processed for shipment	Variety of shields built into structure	Exterior contact <0.5 mrem/hr (<0.005 msievert/hr)
Original Steam Generator Storage Facility	*100 ft (30.5 m) north of north end of ISFSI*	*Lower assemblies of four original steam generators*	*Heavily shielded building*	*Exterior contact <0.5 mrem/hr (<0.005 msievert/hr)*
West Road Cage	On 45 ft (13.7 m) Elevation ~120 ft (~36.6 m) Auxiliary Building rollup doors	Interim storage of spent resins and filters	None	< 5.0 mrem/hr (<0.05 msievert/hr) at the cage fence

Notes:

a. The gaseous releases reported for 2006 were 876 Ci (3.24E13 Bq) of fission and activation gases, 3.28E-2 Ci (1.21E9 Bq) of I-131, 1.62E-5 Ci (6E5 Bq) of particulates with half-lives greater than eight days, and 4.79 Ci (1.77E11 Bq) of tritium. These are typical compared to recent years.

b. Liquid effluents from the liquid waste disposal produce small amounts of radioactivity in the discharge to the Chesapeake Bay. The annual liquid radioactivity releases for 2006 were reported as 4.87E-2 Ci (1.80E+09 Bq) of fission and activation *products, 1560 Ci (5.75E13 Bq)of tritium, and 1.71 Ci (6.31E10 Bq) of dissolved and entrained gases. These are typical* compared to recent years.

Table 4.5-2— Historical All-Source Compliance for Offsite General Public

(Historically the receptors have been offsite; therefore the dose is dominated by gaseous and liquid effluents.)

	Historical Site Boundary Doses Reported to NRC (mrem/ year)/(msievert/year)		
Limits	**75**	**25**	**25**
Year	**Thyroid**	**WB**	**Other Organs**
2006	0.052/0.00052	0.004/0.00004	0.010/0.00010
2005	0.006/0.00006	0.005/0.00005	0.095/0.00095
2004	0.007/0.00007	0.002/0.00002	0.006/0.00006
2003	0.006/0.00006	0.004/0.00004	0.023/0.00023
2002	0.003/0.00003	0.007/0.00007	0.174/0.00174
2001	0.005/0.00005	0.010/0.0001	0.351/0.00351
2000	0.018/0.00018	0.018/0.00018	0.211/0.00211
1999	0.011/0.00011	0.013/0.00013	0.686/0.00686
1998	0.005/0.00005	0.005/0.00005	0.302/0.00302
1997	0.005/0.00005	0.009/0.00009	0.235/0.00235
1996	0.005/0.00005	0.012/0.00012	0.245/0.00245
1995	0.007/0.00007	0.017/0.00017	0.132/0.00132
1994	0.024/0.00024	0.039/0.00039	0.473/0.00473
1993	0.099/0.00099	0.125/0.00125	0.466/0.00466
1992	0.125/0.00125	0.114/0.00114	0.420/0.00420
1991	0.167/0.00167	0.045/0.00045	0.292/0.00292
1990	0.070/0.00070	0.070/0.00070	0.370/0.00370
1989	0.526/0.00526	0.113/0.00113	0.674/0.00674
1988	1.130/0.01130	0.120/0.00120	0.500/0.00500
1987	0.381/0.00381	0.250/0.00250	1.360/0.01360
1986	0.685/0.00685	0.093/0.00093	0.643/0.00643
1985	0.800/0.00800	0.010/0.00010	0.030/0.00030
1984	0.710/0.00710	0.110/0.00110	0.020/0.00020
1983	0.150/0.00150	0.060/0.00060	0.030/0.00030
1982	0.220/0.00220	0.034/0.00034	0.080/0.00080
1981	0.100/0.00100	0.002/0.00002	0.080/0.00080
1980	0.170/0.00170	0.009/0.00009	N/A/N/A

Table 4.5-3— Historical ISFSI Exposures by Year

Average TLD Exposures by Year Digitized from Figure 7 of 2005 REMP Report (mRoentgen/30 days) (These are historical values and are listed as reported, in English units)		
Year	**ISFSI**	**Control**
1990	3.96	N/A
1991	3.95	4.11
1992	4.28	4.40
1993	3.99	4.19
1994	4.73	4.63
1995	5.14	4.69
1996	5.01	4.20
1997	5.56	4.31
1998	6.20	4.56
1999	6.07	4.47
2000	5.72	3.88
2001	6.88	4.15
2002	7.23	4.48
2003	8.46	4.60
2004	8.27	4.51
2005	8.14	4.02

Note:

1990 through 1992 provide baseline data before spent fuel stored at ISFSI in 1993.

Table 4.5-4— Historical ISFSI Net Trend

Annual Gamma Dose Rate based on ISFSI TLDs							
Year	ISFSI	Control[(a)]	Net ISFSI	ISFSI	Control[(a)]	Net ISFSI
	mrem/y	mrem/y	mrem/y	μSv/y	μSv/y	μSv/y
1991	48.06	47.54	(b)	480.6	475.4	(b)
1992	52.10	51.11	(b)	521.0	511.1	(b)
1993	48.53	48.54	0.00	485.3	485.4	0.0
1994	57.55	53.93	3.62	575.5	539.3	36.2
1995	62.59	54.67	7.92	625.9	546.7	79.2
1996	61.00	48.61	12.39	610.0	486.1	123.9
1997	67.69	50.02	17.68	676.9	500.2	176.8
1998	75.38	53.08	22.30	753.8	530.8	223.0
1999	73.80	52.00	21.79	738.0	520.0	217.9
2000	69.56	44.78	24.77	695.6	447.8	247.7
2001	83.71	48.02	35.69	837.1	480.2	356.9
2002	87.92	52.08	35.84	879.2	520.8	358.4
2003	102.90	53.49	49.41	1029.0	534.9	494.1
2004	100.65	52.41	48.24	1006.5	524.1	482.4
2005	99.07	46.52	52.55	990.7	465.2	525.5

Notes:

a. Slightly adjusted such that 1993 net TLD dose is zero.

b. 1991 and 1992 provide baseline before first spent fuel stored at ISFSI in 1993.

Table 4.5-5— Historical Resin Area TLD Readings for 2001 through 2005

Quarter	RPDR05	RPDR06	RPDR07	RPDR08	RPDR09	RPDR10	RPDR11	RPDR12
1st Qtr 2001	16.07	16.88	27.94	16.66	32.02	29.56	11.82	21.36
2nd Qtr 2001	51.86	129.45	166.45	124.63	113.28	48.70	17.39	29.98
3rd Qtr 2001	38.54	50.32	154.74	146.91	122.34	52.91	16.91	32.08
4th Qtr 2001	17.54	20.19	23.16	19.72	19.62	21.49	12.68	21.98
1st Qtr 2002	20.91	23.04	38.04	37.08	28.29	28.45	13.96	24.30
2nd Qtr 2002	19.07	18.71	15.78	17.54	19.28	20.96	13.43	21.78
3rd Qtr 2002	15.83	16.20	19.20	18.68	21.08	23.75	16.27	27.98
4th Qtr 2002	16.87	17.04	23.38	18.94	18.91	21.48	17.89	29.63
1st Qtr 2003	16.48	17.21	23.87	18.31	18.11	22.52	18.06	19.73
2nd Qtr 2003	17.75	17.74	31.33	18.73	16.34	25.52	21.06	21.49
3rd Qtr 2003	15.44	15.87	20.96	20.52	16.98	19.31	17.58	24.81
4th Qtr 2003	18.01	16.93	18.63	17.39	19.97	21.78	17.29	26.26
1st Qtr 2004	16.32	16.75	17.88	17.64	18.75	20.89	17.38	25.82
2nd Qtr 2004	36.25	33.89	18.85	36.51	24.17	22.40	16.14	23.34
3rd Qtr 2004	30.26	30.32	24.27	50.34	28.67	30.49	14.84	32.10
4th Qtr 2004	59.47	72.37	74.41	77.07	43.09	46.48	21.50	48.46
1st Qtr 2005	33.37	42.40	34.46	37.28	31.26	33.52	17.03	52.83
2nd Qtr 2005	57.76	53.64	35.03	44.53	45.42	33.16	18.67	60.40
3rd Qtr 2005	30.16	33.09	23.84	42.11	25.38	24.47	15.03	46.03
4th Qtr 2005	17.97	16.71	20.91	38.71	20.81	18.56	14.62	39.27

Note:
(Exposure Rates to TLDs are expressed in mRoentgen/90 days. Note that for photons, a Roentgen is approximately equal to a rem.)

Table 4.5-6— Historical Annual Average χ/Q (sec/m³) In CCNPP Unit 3 Directions

Normal Effluent Annual Average, Undecayed, Undepleted χ/Q Values for Ground Level Release Without Building Wake Using CCNPP Meteorological Data for Directions that Could Affect CCNPP Unit 3 Workers

	Distance from Stacks to CCNPP Unit 3 Location							
Downwind Direction	**328 ft (100 m)**	**656 ft (200 m)**	**1640 ft (0.5 km)**	**0.5 mi (0.8 km)**	**0.62 mi (1.0 km)**	**0.75 mi (1.2 km)**	**0.93 mi (1.5 km)**	**1.24 mi (2.0 km)**
ENE	1.43E-03	4.03E-04	7.76E-05	3.32E-05	2.24E-05	1.62E-05	9.19E-06	4.48E-06
E	1.08E-03	3.04E-04	5.86E-05	2.51E-05	1.69E-05	1.23E-05	6.95E-06	3.39E-06
ESE	9.72E-04	2.73E-04	5.26E-05	2.26E-05	1.53E-05	1.11E-05	6.27E-06	3.05E-06
SE	7.12E-04	1.96E-04	3.77E-05	1.63E-05	1.11E-05	8.07E-06	4.56E-06	2.21E-06
SSE	4.63E-04	1.27E-04	2.43E-05	1.05E-05	7.17E-06	5.21E-06	2.94E-06	1.42E-06
S	5.27E-04	1.43E-04	2.70E-05	1.16E-05	7.87E-06	5.71E-06	3.22E-06	1.55E-06
SSW	4.80E-04	1.30E-04	2.45E-05	1.05E-05	7.13E-06	5.17E-06	2.92E-06	1.40E-06
SW	4.63E-04	1.26E-04	2.38E-05	1.02E-05	6.92E-06	5.03E-06	2.84E-06	1.37E-06
WSW	4.03E-04	1.10E-04	2.08E-05	8.90E-06	6.06E-06	4.40E-06	2.49E-06	1.20E-06
W	3.64E-04	9.90E-05	1.88E-05	8.09E-06	5.52E-06	4.01E-06	2.27E-06	1.09E-06

	Distance from Stacks to CCNPP Unit 3 Location						
Downwind Direction	**1.5 mi (2.4 km)**	**1.55 mi (2.5 km)**	**1.86 mi (3.0 km)**	**2.49 mi (4.00 km)**	**2.50 mi (4.02 km)**	**3.5 mi (5.6 km)**	**4.5 mi (7.2 km)**
ENE	2.85E-06	2.61E-06	1.74E-06	9.29E-07	9.19E-07	4.85E-07	3.11E-07
E	2.15E-06	1.97E-06	1.32E-06	7.02E-07	6.94E-07	3.67E-07	2.35E-07
ESE	1.94E-06	1.78E-06	1.18E-06	6.29E-07	6.22E-07	3.27E-07	2.09E-07
SE	1.39E-06	1.28E-06	8.44E-07	4.44E-07	4.39E-07	2.28E-07	1.44E-07
SSE	8.96E-07	8.20E-07	5.41E-07	2.83E-07	2.80E-07	1.44E-07	9.07E-08
S	9.75E-07	8.93E-07	5.87E-07	3.06E-07	3.03E-07	1.55E-07	9.71E-08
SSW	8.81E-07	8.06E-07	5.30E-07	2.76E-07	2.72E-07	1.39E-07	8.70E-08
SW	8.60E-07	7.87E-07	5.17E-07	2.70E-07	2.67E-07	1.37E-07	8.55E-08
WSW	7.53E-07	6.89E-07	4.53E-07	2.36E-07	2.33E-07	1.19E-07	7.46E-08
W	6.86E-07	6.28E-07	4.13E-07	2.15E-07	2.13E-07	1.09E-07	6.82E-08

Table 4.5-7— Historical Gaseous Releases for 2002 through 2006

Nuclide	2002 Release Ci (Bq)	2003 Release Ci (Bq)	2004 Release Ci (Bq)	2005 Release Ci (Bq)	2006 Release Ci (Bq)
1 H-3	7.33E+00 (2.71E+11)	1.20E+01 (4.44E+11)	5.86E+00 (2.17E+11)	6.48E+00 (2.40E+11)	4.79E+00 (1.77E+11)
18 Ar-41	1.06E-02 (3.92E+08)	1.68E-02 (6.21E+08)	4.32E-01 (1.60E+10)	2.87E-03 (1.06E+08)	2.72E-03 (1.01E+08)
26 Fe-55	None Detected	None Detected	2.52E-04 (9.33E+06)	None Detected	None Detected
27 Co-58	None Detected	None Detected	1.24E-05 (4.59E+05)	7.09E-06 (2.62E+05)	8.99E-06 (3.33E+05)
27 Co-60	None Detected	None Detected	None Detected	None Detected	7.19E-06 (2.66E+05)
35 Br-82	None Detected	None Detected	1.10E-05 (4.07E+05)	None Detected	None Detected
36 Kr-85 m	1.78E-02 (6.60E+08)	6.67E-02 (2.47E+09)	5.48E-02 (2.03E+09)	2.18E-02 (8.06E+08)	8.60E-02 (3.18E+09)
36 Kr-85	3.33E+01 (1.23E+12)	2.99E+01 (1.11E+12)	2.31E+01 (8.54E+11)	2.22E+01 (8.23E+11)	1.88E+02 (6.94E+12)
36 Kr-87	3.09E-04 (1.14E+07)	2.87E-03 (1.06E+08)	7.08E-05 (2.62E+06)	None Detected	None Detected
36 Kr-88	6.65E-04 (2.46E+07)	9.07E-03 (3.36E+08)	4.90E-03 (1.81E+08)	9.06E-03 (3.35E+08)	2.33E-02 (8.61E+08)
38 Sr-89	None Detected	None Detected	None Detected	1.24E-07 (4.59E+03)	9.08E-09 (3.36E+02)
38 Sr-90	None Detected	None Detected	4.48E-10 (1.66E+01)	9.43E-07 (3.49E+04)	None Detected
53 I-131	5.75E-04 (2.13E+07)	1.82E-03 (6.72E+07)	1.54E-03 (5.71E+07)	1.36E-03 (5.03E+07)	3.28E-02 (1.21E+09)
52 I-132	None Detected	None Detected	None Detected	None Detected	4.28E-03 (1.58E+08)
53 I-133	2.96E-03 (1.10E+08)	3.80E-03 (1.41E+08)	1.42E-03 (5.25E+07)	3.06E-03 (1.13E+08)	2.32E-02 (8.57E+08)
53 I-135	None Detected	None Detected	None Detected	None Detected	3.87E-03 (1.43E+08)
54 Xe-131 m	1.00E-01 (3.71E+09)	9.53E-01 (3.53E+10)	8.35E-01 (3.09E+10)	6.57E-01 (2.43E+10)	1.51E+01 (5.60E+11)
54 Xe-133 m	2.84E-01 (1.05E+10)	1.83E+00 (6.78E+10)	1.75E+00 (6.49E+10)	6.11E-01 (2.26E+10)	6.49E+00 (2.40E+11)
54 Xe-133	6.03E+01 (2.23E+12)	1.12E+02 (4.15E+12)	1.22E+02 (4.52E+12)	1.55E+02 (5.72E+12)	2.58E+02 (9.53E+12)
54 Xe-135 m	6.12E-04 (2.26E+07)	5.29E-03 (1.96E+08)	1.29E-04 (4.77E+06)	None Detected	None Detected
54 Xe-135	2.75E+00 (1.02E+11)	5.77E+00 (2.13E+11)	9.23E+00 (3.41E+11)	1.29E+01 (4.77E+11)	2.67E+01 (9.87E+11)
54 Xe-138	1.34E-04 (4.96E+06)	3.71E-04 (1.37E+07)	7.15E-09 (2.64E+02)	None Detected	None Detected

Table 4.5-8— Historical Liquid Releases 2001 through 2006

(Page 1 of 2)

Isotope	2001 Release Ci (Bq)	2002 Release Ci (Bq)	2003 Release Ci (Bq)	2004 Release Ci (Bq)	2005 Release Ci (Bq)	2006 Release Ci (Bq)
Ag-110M	3.45E-02 (1.28E+09)	2.03E-02 (7.49E+08)	2.22E-03 (8.22E+07)	2.65E-04 (9.81E+06)	9.78E-06 (3.62E+05)	1.77E-04 (6.55e+06)
Ba-140	None Detected	2.88E-05 (1.07E+06)	None Detected	None Detected	None Detected	None Detected
Be-7	None Detected	3.94E-04 (1.46E+07)	None Detected	None Detected	None Detected	None Detected
Ce-144	1.19E-03 (4.40E+07)	None Detected	2.25E-04 (8.33E+06)	None Detected	None Detected	None Detected
Co-57	1.19E-03 (4.39E+07)	3.50E-04 (1.30E+07)	7.61E-05 (2.82E+06)	1.62E-05 (5.99E+05)	1.39E-06 (5.14E+04)	1.79E-05 (6.64E+05)
Co-58	3.04E-01 (1.13E+10)	4.29E-02 (1.59E+09)	1.44E-02 (5.33E+08)	5.90E-03 (2.18E+08)	2.39E-03 (8.85E+07)	3.23E-03 (1.19E+08)
Co-60	1.95E-02 (7.22E+08)	1.94E-02 (7.19E+08)	3.64E-03 (1.34E+08)	1.77E-03 (6.53E+07)	5.94E-04 (2.20E+07)	1.43E-03 (5.31E+07)
Cr-51	5.64E-02 (2.09E+09)	1.09E-02 (4.03E+08)	1.54E-03 (5.71E+07)	6.88E-04 (2.55E+07)	3.89E-04 (1.44E+07)	5.01E-04 (1.85E+07)
Cs-134	3.30E-03 (1.22E+08)	2.35E-04 (8.68E+06)	7.95E-05 (2.94E+06)	2.78E-04 (1.03E+07)	7.55E-05 (2.79E+06)	4.48E-04 (1.66E+07)
CS-136	None Detected	None Detected	None Detected	None Detected	None Detected	1.09E-05 (4.03E+05)
Cs-137	9.39E-03 (3.48E+08)	4.44E-04 (1.64E+07)	3.17E-04 (1.17E+07)	7.34E-04 (2.71E+07)	1.32E-04 (4.89E+06)	5.60E-04 (2.07E+07)
Eu-154	6.99E-04 (2.59E+07)	3.32E-04 (1.23E+07)	2.03E-04 (7.51E+06)	None Detected	None Detected	None Detected
Eu-155	2.23E-04 (8.25E+06)	3.63E-04 (1.34E+07)	1.47E-04 (5.44E+06)	None Detected	None Detected	None Detected
Fe-55	1.07E-01 (3.96E+09)	1.19E-01 (4.41E+09)	2.71E-02 (1.00E+09)	1.51E-02 (5.59E+08)	8.67E-02 (3.21E+09)	2.27E-02 (8.39E+08)
Fe-59	5.02E-03 (1.86E+08)	2.25E-03 (8.33E+07)	5.80E-05 (2.14E+06)	5.35E-06 (1.98E+05)	1.66E-05 (6.13E+05)	5.15E-05 (1.90E+06)
I-131	1.42E-03 (5.26E+07)	3.51E-04 (1.30E+07)	6.04E-04 (2.24E+07)	2.93E-04 (1.08E+07)	1.58E-04 (5.86E+06)	4.10E-03 (1.52E+08)
I-132	None Detected	2.40E-04 (8.88E+06)	None Detected	None Detected	None Detected	None Detected
I-133	8.97E-05 (3.32E+06)	4.95E-05 (1.83E+06)	1.57E-05 (5.80E+05)	3.55E-05 (1.31E+06)	1.59E-05 (5.86E+05)	8.91E-05 (3.30E+06)
La-140	None Detected	9.69E-05 (3.59E+06)	None Detected	None Detected	None Detected	None Detected
Mn-54	5.75E-03 (2.13E+08)	4.66E-03 (1.72E+08)	7.45E-04 (2.76E+07)	1.81E-04 (6.68E+06)	4.11E-05 (1.52E+06)	2.21E-04 (8.18E+06)
Na-24	4.66E-03 (1.72E+08)	None Detected	2.49E-06 (9.21E+04)	None Detected	None Detected	None Detected
Nb-95	5.96E-02 (2.20E+09)	2.16E-02 (7.98E+08)	2.65E-03 (9.82E+07)	3.06E-04 (1.13E+07)	1.60E-04 (5.93E+06)	2.89E-04 (1.07E+07)
Nb-97	3.54E-05 (1.31E+06)	None Detected	None Detected	None Detected	None Detected	None Detected
Ni-63	None Detected	None Detected	None Detected	2.17E-03 (8.03E+07)	6.16E-03 (2.28E+08)	7.47E-04 (2.76E+07)
Ru-103	5.42E-04 (2.01E+07)	7.10E-05 (2.63E+06)	None Detected	None Detected	None Detected	None Detected
Sb-124	3.42E-03 (1.26E+08)	6.43E-05 (2.38E+06)	5.50E-04 (2.04E+07)	None Detected	None Detected	None Detected

Table 4.5-8— Historical Liquid Releases 2001 through 2006

(Page 2 of 2)

Isotope	2001 Release Ci (Bq)	2002 Release Ci (Bq)	2003 Release Ci (Bq)	2004 Release Ci (Bq)	2005 Release Ci (Bq)	2006 Release Ci (Bq)
Sb-125	2.15E-02 (7.96E+08)	1.70E-02 (6.30E+08)	8.85E-03 (3.27E+08)	1.44E-04 (5.33E+06)	8.57E-06 (3.17E+05)	6.83E-05 (2.53E+06)
Sn-113	5.45E-03 (2.02E+08)	2.18E-03 (8.06E+07)	5.27E-05 (1.95E+06)	None Detected	None Detected	None Detected
Sn-117M	3.77E-04 (1.40E+07)	3.86E-04 (1.43E+07)	1.08E-03 (3.98E+07)	3.20E-05 (1.18E+06)	1.28E-04 (4.74E+06)	None Detected
Sr-89	7.63E-04 (2.82E+07)	9.51E-06 (3.52E+05)	4.84E-04 (1.79E+07)	None Detected	3.83E-04 (1.42E+07)	None Detected
Sr-90	2.12E-05 (7.84E+05)	None Detected	1.89E-06 (7.00E+04)	None Detected	None Detected	None Detected
Te-125M	None Detected	None Detected	None Detected	None Detected	1.27E-02 (4.70E+08)	1.38E-02 (5.11E+08)
Te-132	None Detected	1.44E-04 (5.33E+06)	None Detected	None Detected	None Detected	None Detected
W-187	None Detected	7.15E-06 (2.65E+05)	None Detected	None Detected	None Detected	None Detected
Zn-65	1.54E-06 (5.70E+04)	None Detected	None Detected	None Detected	None Detected	None Detected
Zr-95	3.59E-02 (1.33E+09)	1.12E-02 (4.15E+08)	1.46E-03 (5.41E+07)	1.59E-04 (5.88E+06)	1.17E-04 (4.34E+06)	1.58E-04 (5.84E+06)
Zr-97	5.61E-05 (2.08E+06)	None Detected	None Detected	None Detected	None Detected	None Detected
Total	6.82E-01 (2.52E+10)	2.75E-01 (1.02E+10)	6.65E-02 (2.46E+09)	2.81E-02 (1.04E+09)	1.10E-01 (4.08E+09)	4.86E-02 (1.80E+09)
Dilution Flow ft^3/sec (L/sec)	3705.3 (104922)	2738.4 (77543)	4924.0 (139431)	5147.8 (145769)	5147.8 (145769)	5003.4 (141681)

Table 4.5-9— Projected Dose Rates from all Sources by Construction Zone

Maximum Construction Zone Dose Rates (mrem/year) Assuming 2,200 Hours per Year Occupancy			
Zone	**Zone Description**	**Dose Rate mrem/2,200 hours (mSv/2,200 hours)**	**Effluents Only mrem/2200 hours (mSv/2200 hours)**
B	Batch Plant	0.02 (0.0002)	0.01 (0.0001)
C	Construction on main structures	1.35 (0.0135)	0.08 (0.0008)
L	Laydown	21.67 (0.2167)	0.12 (0.0012)
O	Office/Trailer	2.42 (0.0242)	0.03 (0.0003)
P	Parking	19.65 (0.1965)	0.04 (0.0004)
R	Roads	38.89 (0.3889)	0.13 (0.0013)
S	Shoreline, tunnel, barge, in/out flow	0.47 (0.0047)	0.47 (0.0047)
T	Tower/Basin/Desalinization	0.02 (0.0002)	0.01 (0.0001)
W	Warehouse	0.65 (0.0065)	0.03 (0.0003)
	Maximum, not roads	21.67 (0.2167)	0.47 (0.0047)
	Maximum, all zones	38.89 (0.3889)	0.47 (0.0047)

Note: The 39 mrem assumes worker occupancy of 2200 hours per year on the highest dose location on the road, converted assuming 8760 hours per year. The ALARA program will prevent this. In fact, workers will spend very little time at that location. Occupancy is expected to be 2%, or 44 hours per year at any road location. Taking credit for 2% occupancy the road dose drops to 0.78 mrem. This and all other doses meet the criterion.

Table 4.5-10— Projected Dose Rates from Effluents by Construction Zone

	Maximum Dose Rate Assuming Full Time Occupancy mrem/year (mSievert/year)					
Zone	**Zone Description**	**Gaseous Effluents TEDE**	**Bounding App. I Total Body (Noble Gas)**	**Bounding App. I Skin (Noble Gas)**	**Bounding App I Organ (Iodines & Particulates)**	**Liquid Effluents TEDE**
B	Batch Plant	0.06 (0.0006)	0.12 (0.0012)	0.23 (0.0023)	0.29 (0.0029)	0.00 (0.0000)
C	Construction on main structures	0.32 (0.0032)	0.63 (0.0063)	1.27 (0.0127)	1.59 (0.0159)	0.00 (0.0000)
L	Laydown/Spoils	0.48 (0.0048)	0.97 (0.0097)	1.93 (0.0193)	2.41 (0.0241)	0.00 (0.0000)
O	Office/Trailer	0.12 (0.0012)	0.24 (0.0024)	0.48 (0.0048)	0.60 (0.0060)	0.00 (0.0000)
P	Parking	0.17 (0.0017)	0.33 (0.0033)	0.66 (0.0066)	0.83 (0.0083)	0.00 (0.0000)
R	Roads	0.53 (0.0053)	1.06 (0.0106)	2.11 (0.0211)	2.64 (0.0264)	0.00 (0.0000)
S	Shoreline, tunnel, barge, in/out flow	1.55 (0.0155)	3.09 (0.0309)	6.18 (0.0618)	7.73 (0.0773)	0.32 (0.0032)
T	Tower/Basin/Desalinization	0.06 (0.0006)	0.12 (0.0012)	0.24 (0.0024)	0.30 (0.0030)	0.00 (0.0000)
W	Warehouse	0.10 (0.0010)	0.20 (0.0020)	0.41 (0.0041)	0.51 (0.0051)	0.00 (0.0000)
	Maximum	1.55 (0.0155)	3.09 (0.0309)	6.18 (0.0618)	7.73 (0.0773)	0.32 (0.0032)
	10CFR50 Appendix I Limit		5 (0.05)	15 (0.15)	15 (0.15)	3 (0.03)

Table 4.5-11— Projected Construction Worker Census 2010 to 2015

Year	Construction Workers on Site
2010	531
2011	2,281
2012	4,000
2013	4,000
2014	4,000
2015	3,215

Table 4.5-12— Projected Construction Worker Occupancy by Zone

Zone Description	Zone Code	Occupancy Fraction
Batch Plant	B	0.001
Construction on Main Structures	C	0.665
Laydown/Spoils	L	0.020
Office/Trailer	O	0.160
Parking	P	0.020
Roads	R	0.020
Shoreline, Tunnel, Barge, In/Out Flow	S	0.066
Tower/Basin/Desalinization	T	0.066
Warehouse	W	0.003
	Total	1.021

Note: Total of occupancy fractions is greater than 1 because the "Laydown/Spoils" zone fraction was conservatively increased to match the occupancy fraction for parking and roads.

Table 4.5-13— FTE for CCNPP Unit 3 Construction Workers

		FTE (Number of Workers by Zone)					
Zone	**Count**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
B	41	0.5	2.3	4.0	4.0	4.0	3.2
C	232	353.1	1516.9	2660.0	2660.0	2660.0	2138.0
L	451	10.6	45.6	80.0	80.0	80.0	64.3
O	87	85.0	365.0	640.0	640.0	640.0	514.4
P	172	10.6	45.6	80.0	80.0	80.0	64.3
R	170	10.6	45.6	80.0	80.0	80.0	64.3
S	69	35.0	150.5	264.0	264.0	264.0	212.2
T	65	35.0	150.5	264.0	264.0	264.0	212.2
W	38	1.6	6.8	12.0	12.0	12.0	9.6
	By YEAR	542.2	2328.9	4084.0	4084.0	4084.0	3282.5

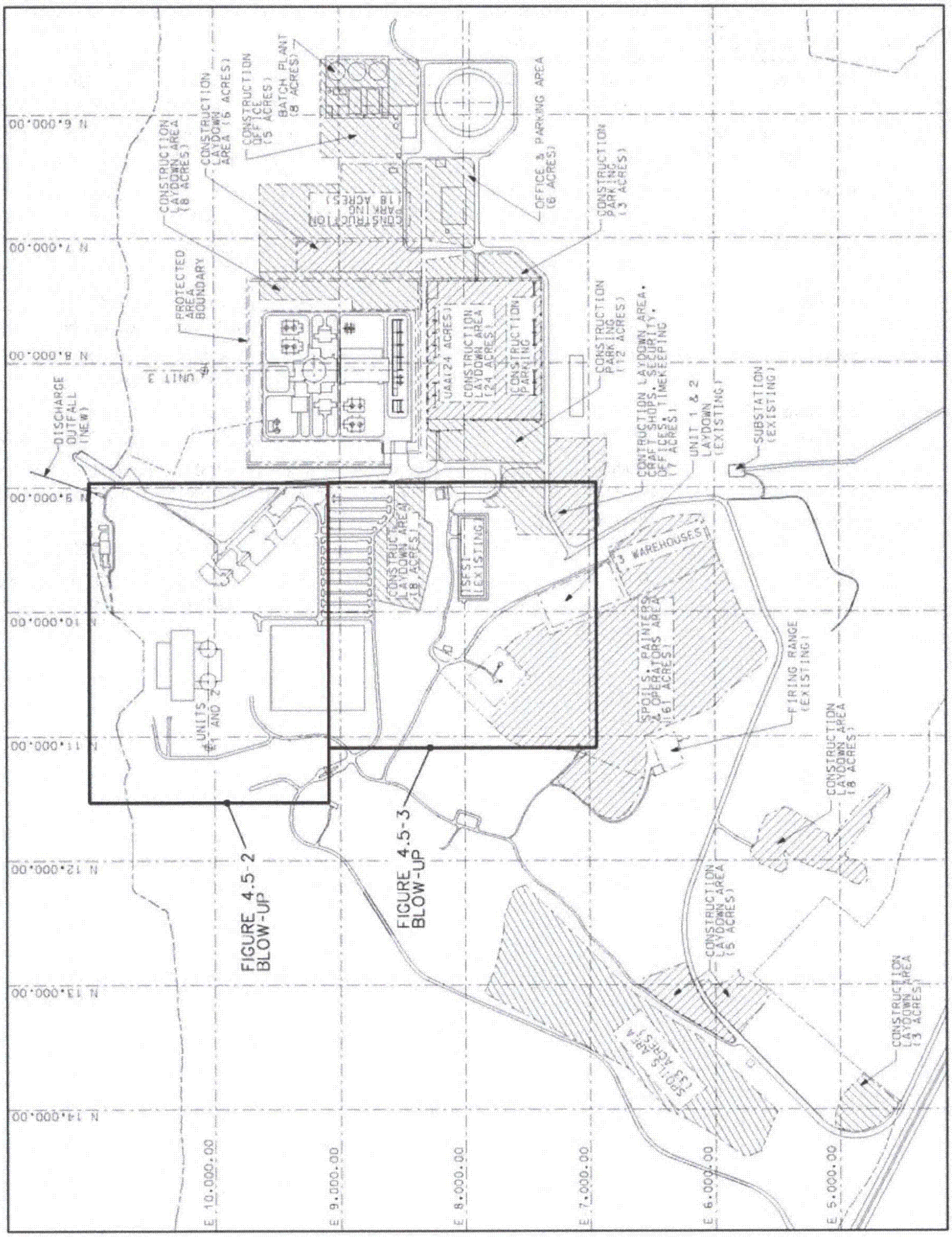
Table 4.5-14— Average Dose Rates to CCNPP Unit 3 Construction Workers

		Average Dose Rate (mrem/year (mSv/year)) by Zone					
Zone	Count	2010	2011	2012	2013	2014	2015
B	41	0.054 (0.00054)	0.054 (0.00054)	0.054 (0.00054)	0.054 (0.00054)	0.054 (0.00054)	.054 (0.00054)
C	232	0.493 (0.00493)	0.523 (0.00523)	0.553 (0.00553)	0.582 (0.00582)	0.612 (0.00612)	0.642 (0.00642)
L	451	3.218 (0.03218)	3.311 (0.03311)	3.404 (0.03404)	3.496 (0.03496)	3.589 (0.03589)	3.682 (0.03682)
O	87	1.059 (0.01059)	1.128 (0.01128)	1.196 (0.01196)	1.264 (0.01264)	1.332 (0.01332)	1.400 (0.01400)
P	172	2.383 (0.02383)	2.632 (0.02632)	2.881 (0.02881)	3.130 (0.03130)	3.379 (0.03379)	3.628 (0.03628)
R	170	10.757 (0.10757)	11.262 (0.11262)	11.767 (0.11767)	12.273 (0.12273)	12.778 (0.12778)	13.283 (0.13283)
S	69	0.731 (0.00731)	0.732 (0.00732)	0.732 (0.00732)	0.732 (0.00732)	0.732 (0.00732)	0.733 (0.00733)
T	65	0.054 (0.00054)	0.054 (0.00054)	0.054 (0.00054)	0.054 (0.00054)	0.055 (0.00055)	0.055 (0.00055)
W	38	0.929 (0.00929)	0.952 (0.00952)	0.975 (0.00975)	0.999 (0.00999)	1.022 (0.01022)	1.045 (0.01045)

Table 4.5-15— CCNPP Unit 3 Collective Dose to Construction Workers

		Collective Dose (person-rem) (person-sievert) by Zone						
Zone	**Zone Description**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**By Zone**
B	Batch Plant	0.0000 (0.0000)	0.0000 (0.0000)	0.0001 (0.000001)	0.0001 (0.000001)	0.0001 (0.000001)	0.0000 (0.0000)	0.0002 (0.000002)
C	Construction on Main Structures	0.0437 (0.000437)	0.1992 (0.001992)	0.3691 (0.003691)	0.3889 (0.003889)	0.4087 (0.004087)	0.3445 (0.003445)	1.7541 (0.017541)
L	Laydown	0.0086 (0.000086)	0.0379 (0.000379)	0.0684 (0.000684)	0.0702 (0.000702)	0.0721 (0.000721)	0.0595 (0.000595)	0.3167 (0.003167)
O	Office/Trailer	0.0226 (0.000226)	0.1033 (0.001033)	0.1922 (0.001922)	0.2031 (0.002031)	0.2141 (0.002141)	0.1809 (0.001809)	0.9162 (0.009162)
P	Parking	0.0064 (0.000064)	0.0302 (0.000302)	0.0579 (0.000579)	0.0629 (0.000629)	0.0679 (0.000679)	0.0586 (0.000586)	0.2837 (0.002837)
R	Roads	0.0287 (0.000287)	0.1290 (0.001290)	0.2364 (0.002364)	0.2466 (0.002466)	0.2567 (0.002567)	0.2145 (0.002145)	1.1119 (0.011119)
S	Shoreline, Tunnel, barge, In/Out Flow	0.0064 (0.000064)	0.0277 (0.000277)	0.0485 (0.000485)	0.0485 (0.000485)	0.0486 (0.000486)	0.0390 (0.000390)	0.2188 (0.002188)
T	Tower/Basin/ Desalinization	0.0005 (0.000005)	0.0021 (0.000021)	0.0036 (0.000036)	0.0036 (0.000036)	0.0036 (0.000036)	0.0029 (0.000029)	0.0163 (0.000163)
W	Warehouse	0.0004 (0.000004)	0.0016 (0.000016)	0.0029 (0.000029)	0.0030 (0.000030)	0.0031 (0.000031)	0.0025 (0.000025)	0.0136 (0.000136)
	By YEAR	0.1173 (0.001173)	0.5310 (0.005310)	0.9791 (0.009791)	1.0270 (0.010270)	1.0749 (0.010749)	0.9024 (0.009024)	**4.6316** (0.046316)

Figure 4.5-1— Site Layout of CCNPP Units 1, 2, and 3



See Figure 2.1-1 and Figure 3.1-2 for Site and Powerblock layout

Figure 4.5-2— Sources on CCNPP Units 1 and 2 (Part 1 and 2)

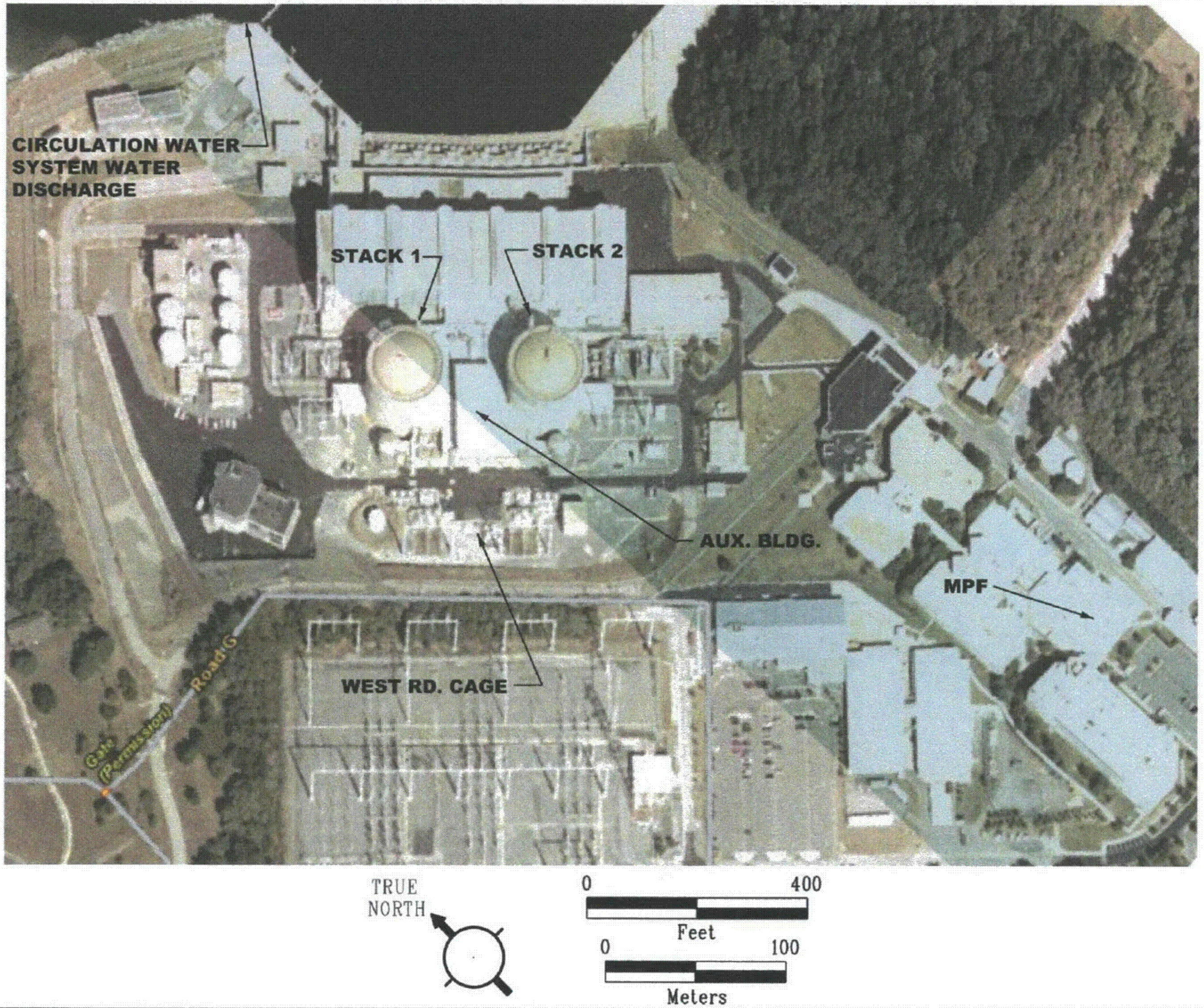


Figure 4.5-3— Sources on CCNPP Units 1 and 2 (Part 2 of 2)

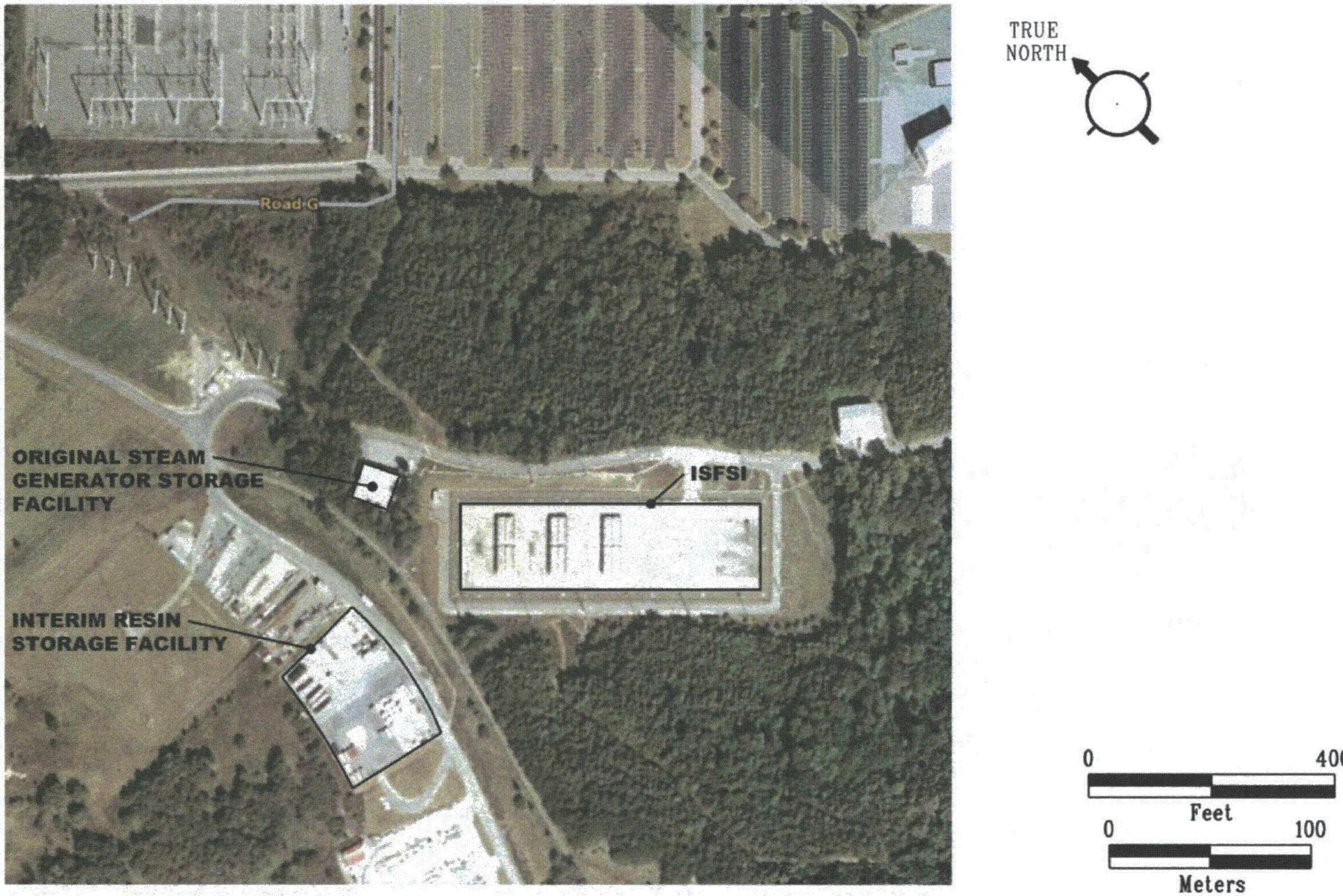


Figure 4.5-4— Historical ISFSI 2005 TLD Doses Versus Distance

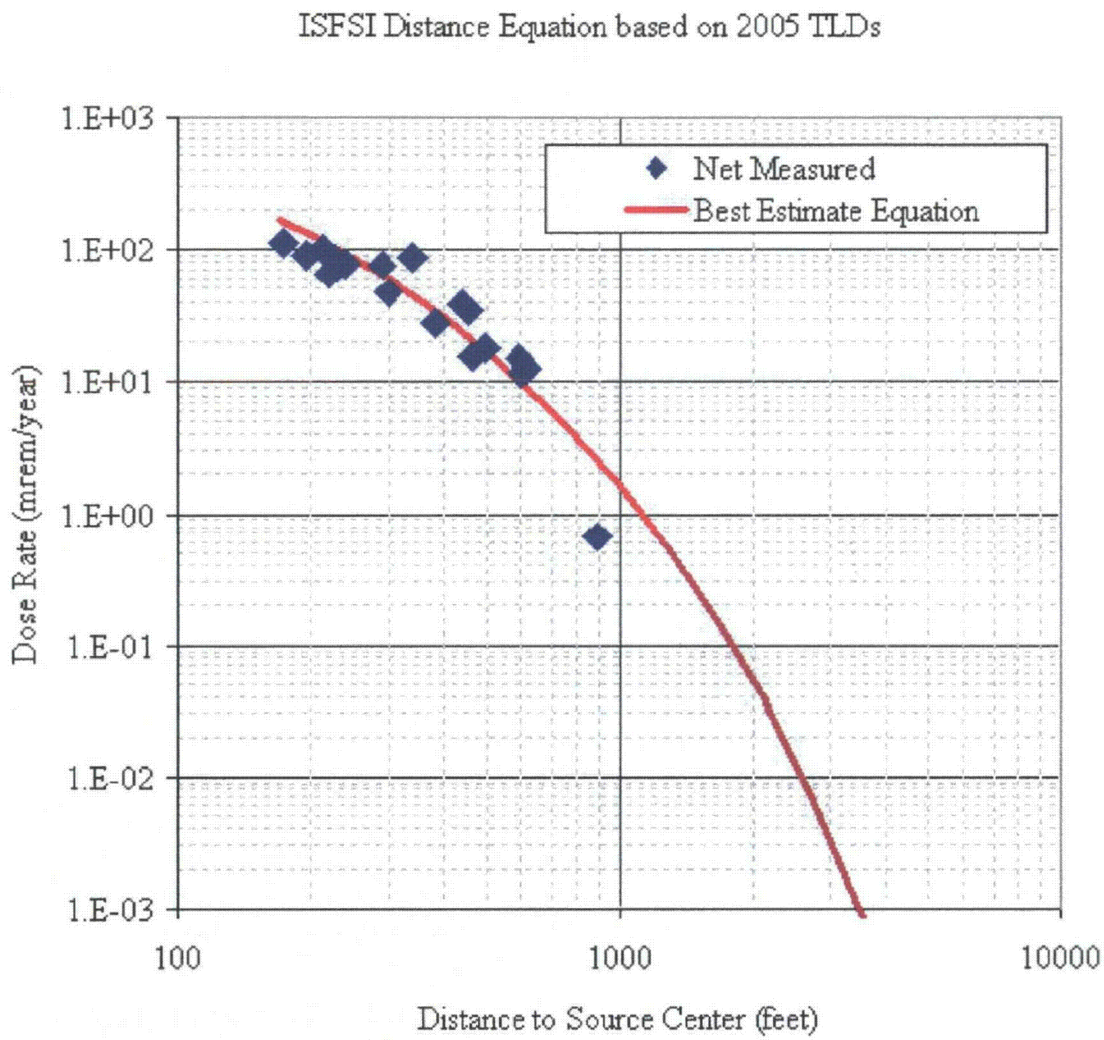


Figure 4.5-5— Resin Area and ISFSI Historical TLD Readings

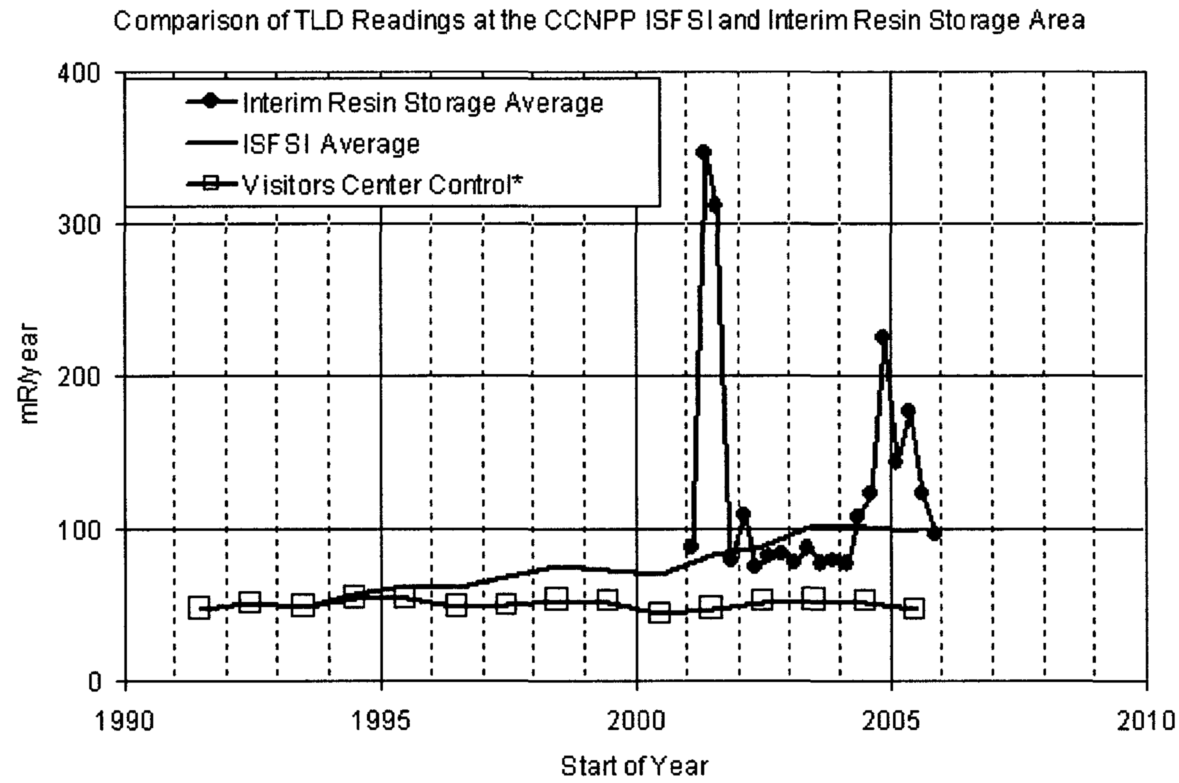


Figure 4.5-6— Resin Area Dose Rate for 2005

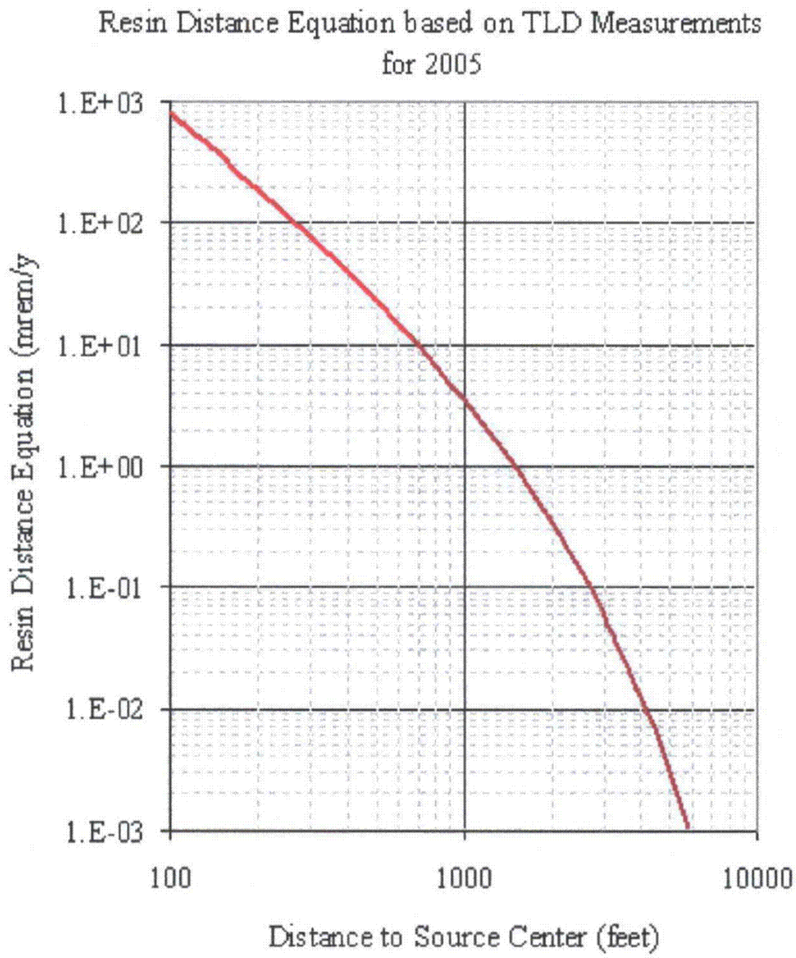
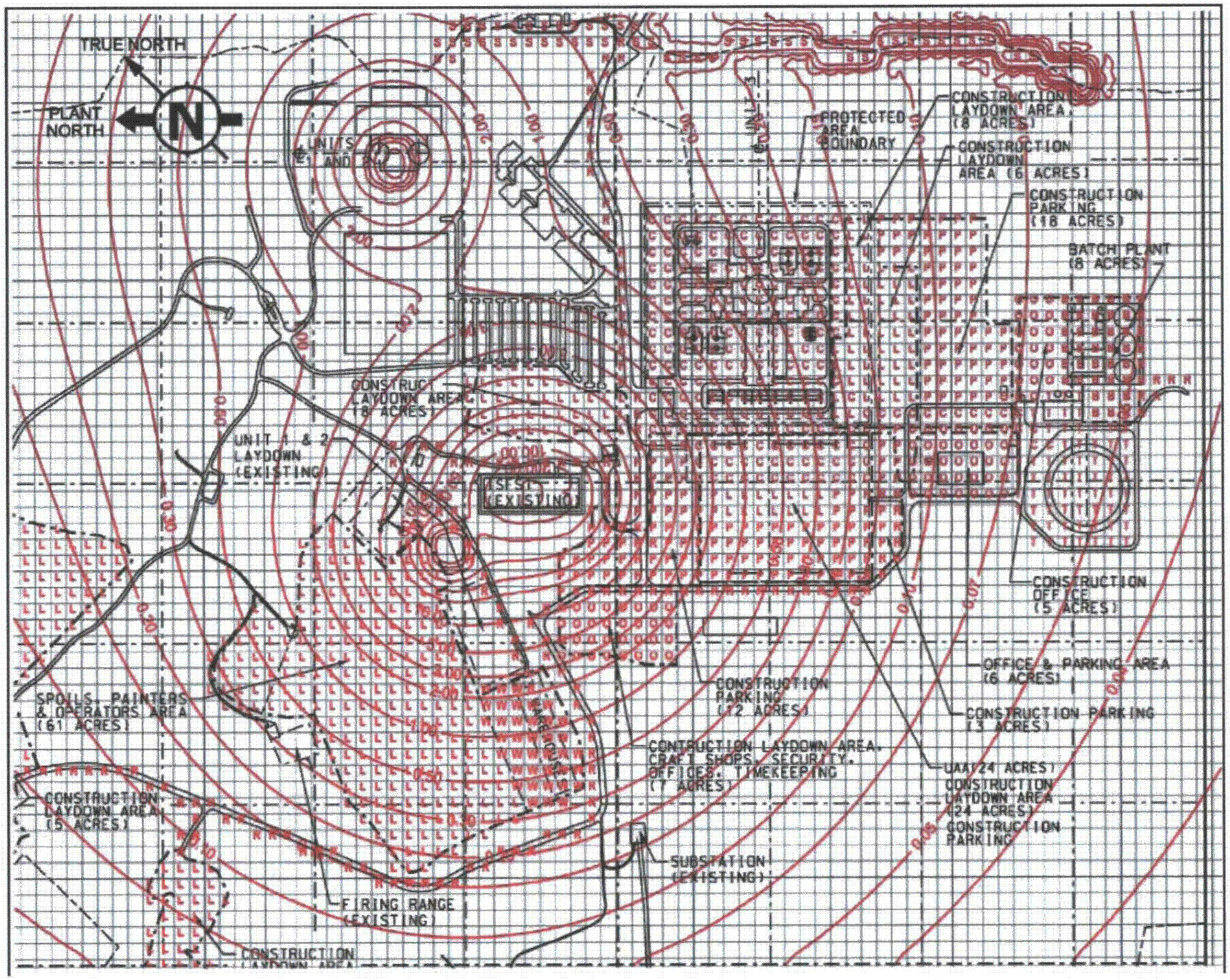


Figure 4.5-7— Dose Rate Estimated in 2015 in Units of mrem per 8760 Hours



Note 1 — the plant grid on this figure is shown in 100-foot by 100-foot squares.

Note 2 — the following provides a key to the zones indicated in the figure.

Zone	Description
B	Batch Plant
C	Construction on main structures
L	Laydown/Spoils
O	Office/Trailer
P	Parking
R	Roads
S	Shoreline, tunnel, barge, in/out flow
T	Tower/Basin/Desalinization
W	Warehouse

Note 3 — See Figure 2.1-1 and Figure 3.1-2 for Site and Powerblock layout

Figure 4.5-8— Bounding Annual Average X/Q in CCNPP Unit 3 Direction

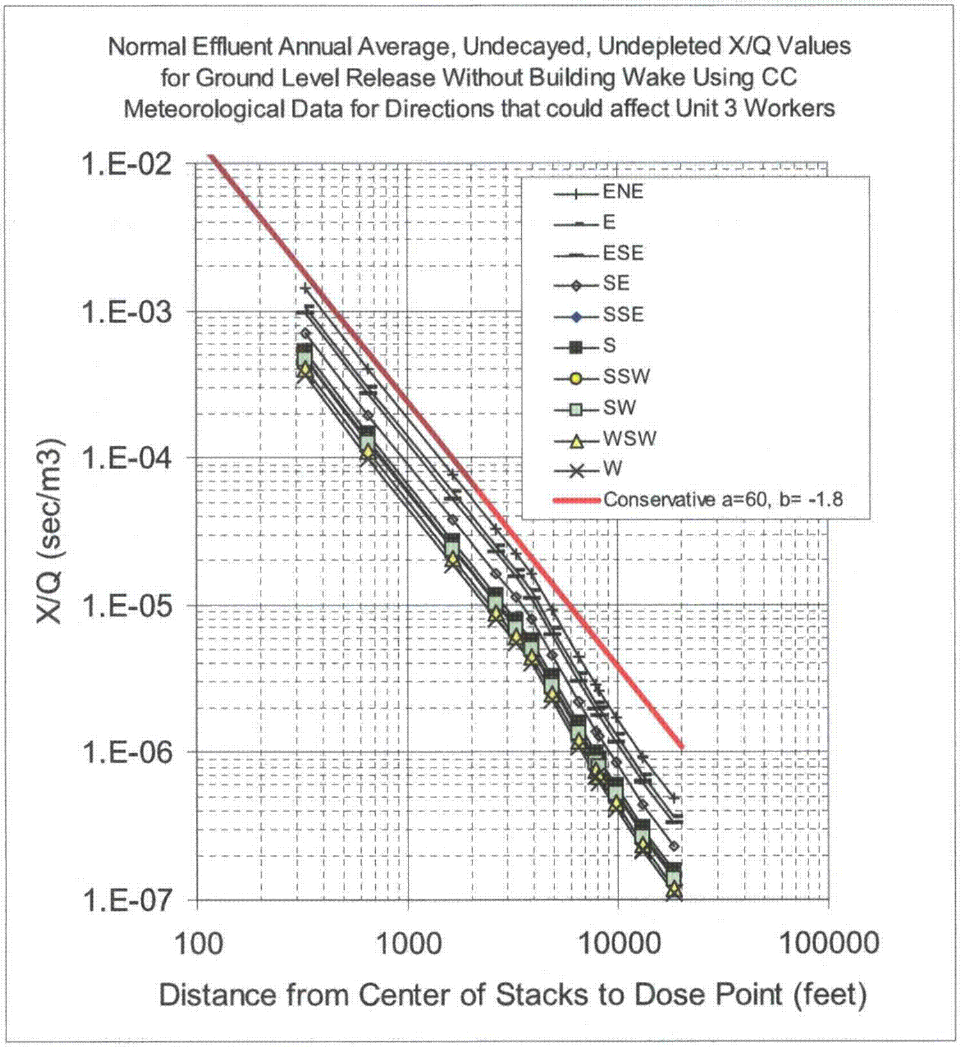


Figure 4.5-9— ISFSI TLD Locations

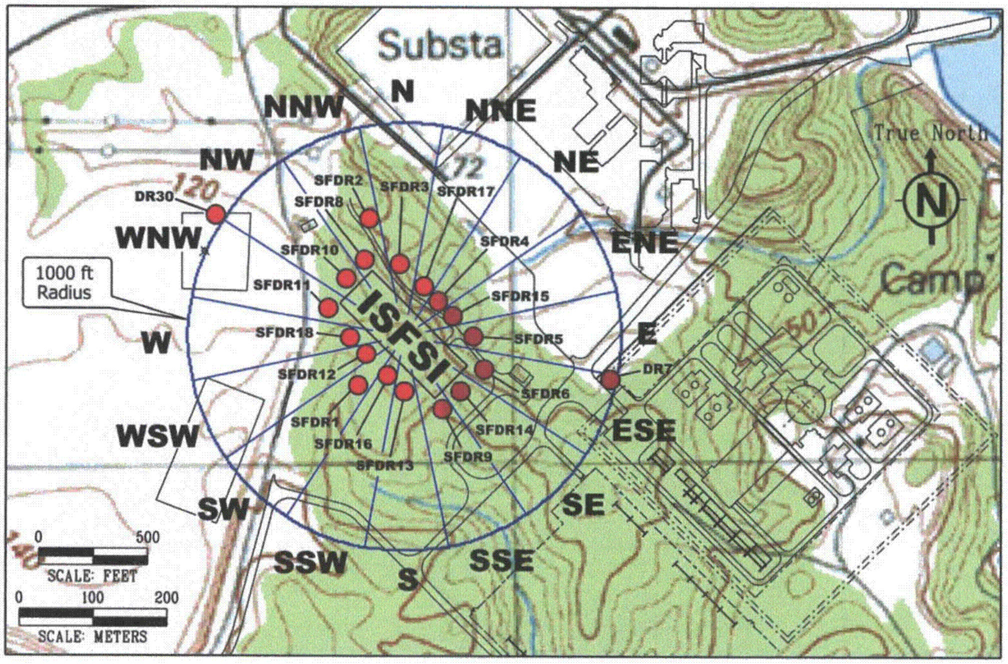


Figure 4.5-10— Annual Gamma Net ISFSI Dose Rate

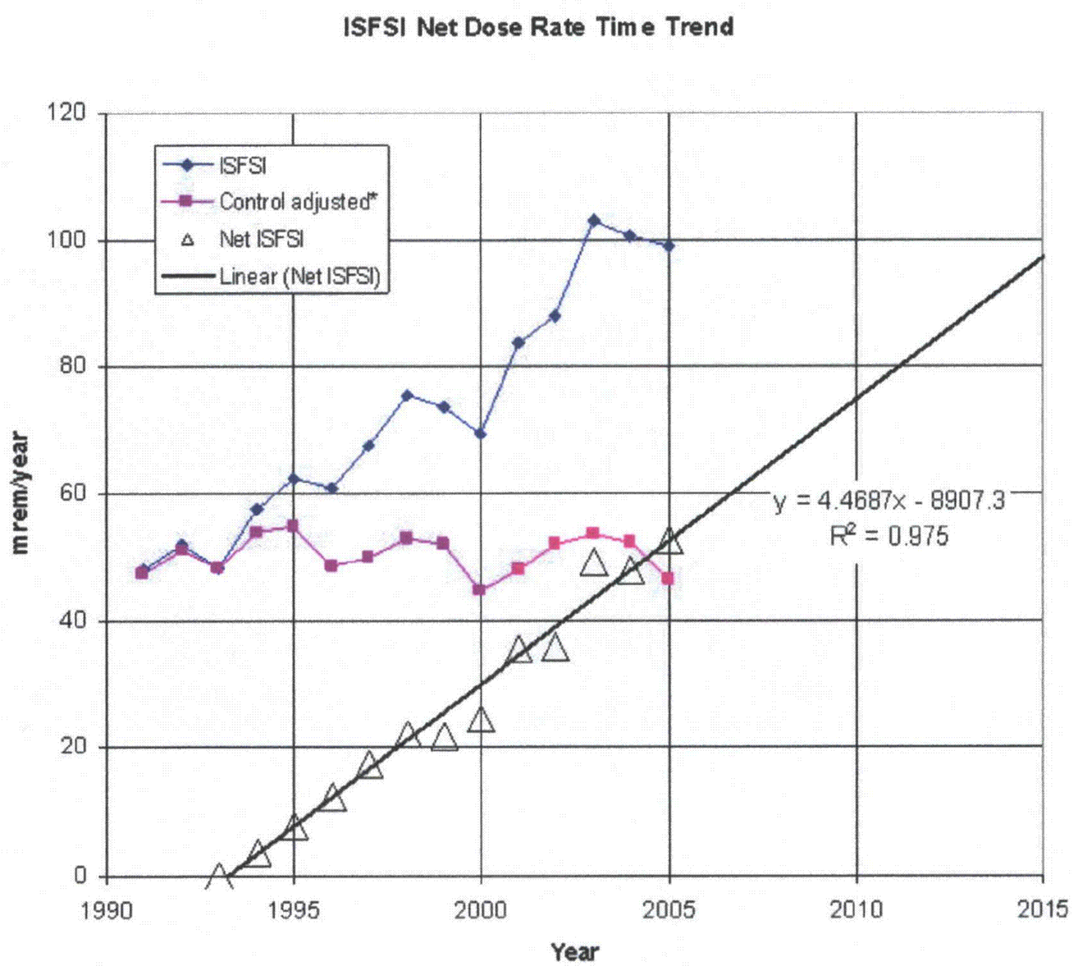
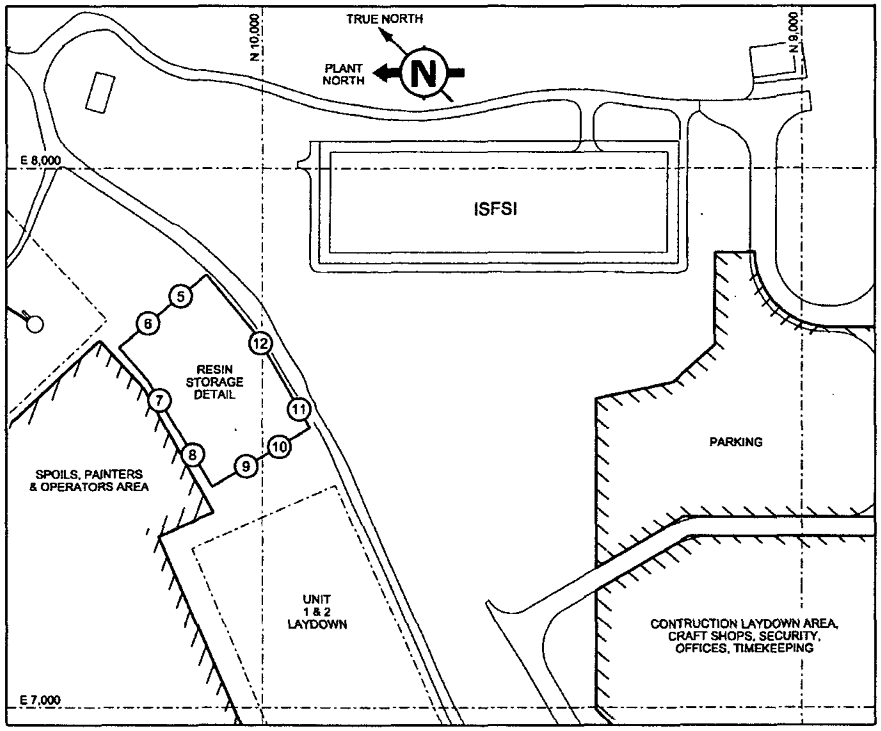


Figure 4.5-11— Resin Area TLD Locations



4.6 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING CONSTRUCTION

In general, potential impacts will be minimized through compliance with applicable Federal, Maryland, and local laws and regulations enacted to prevent or minimize adverse environmental impacts that may be encountered such as air emissions, noise, storm water pollutants, and spills. Principal among these will be the National Pollutant Discharge Elimination System (NPDES) Construction General Permit and the Corps of Engineers 404 Permit to minimize sediment erosion and protect water quality. The Site Resource Management Plan will address affected site lands and waters. Also included will be required plans such as a Storm Water Pollution Prevention Plan (SWPPP) and associated Best Management Practices (BMPs) as well as administrative actions such as a Traffic Management Plan.

Table 4.6-1 lists the potential impacts associated with the construction activities described in Sections 4.1 through 4.5 and 4.7. The table identifies, from the categories listed below, which adverse impact may occur as a result of construction activities and its relative significance rating (i.e., [S]mall, [M]oderate, or [L]arge) following implementation of associated measures and controls. Table 4.6-1 also includes a brief description, by ER Section, of each potential impact and the measures and controls to minimize the impact, if needed.

- Erosion and Sedimentation
- Air Quality (dust, air pollutants)
- Wastes (effluents, spills, material handling)
- Surface Water
- Groundwater
- Land Use
- Water Use and Quality
- Terrestrial Ecosystems
- Aquatic Ecosystems
- Socioeconomic
- Aesthetics
- Noise
- Traffic
- Radiation Exposure
- Other (site specific (i.e., non-radiological health impacts))

Based on existing site conditions, in-place CCNPP Units 1 and 2 programs and procedures, as well as the measures and controls proposed, the potential adverse impacts identified from the construction of CCNPP Unit 3 are anticipated to be SMALL, if any, for all categories evaluated except: (1) surface waters, which is expected to be MODERATE and require mitigation due to the impact of wetlands and wetland buffers; (2) traffic, which is expected to be MODERATE but manageable with the implementation of a Traffic Management Plan.

Table 4.6-2 provides estimates of the percentage of impacts attributable to "construction" and to "preconstruction" as well as a summary of the basis for the estimates. The estimated construction related impacts presented in the table were based primarily on two factors, namely the area associated with the construction of safety-related structures, systems, or components (SSCs) and the labor hours associated with the construction of SSCs. Information related to these two factors is provided as follows:

- Construction Area - The area that will be developed for CCNPP Unit 3 is estimated to be approximately 460 ac (186 ha). Of this developed area, approximately 130 ac (53 ha) will be occupied by SSCs. This includes 5 ac (2 ha) for the UHS Intake Structure, 25 ac (10 ha) for the 500 kV AIS Switchyard, 30 ac (12 ha) for the Transmission Corridor, 50 ac (20 ha) for the Power Block, 15 ac (6 ha) for the Cooling Tower and 5 ac (2 ha) for the Desalination Plant. It is assumed that preconstruction activities of clearing, grubbing and site preparation will impact land area to be occupied by both SSCs and non SSCs structures/activities. All site development will be done concurrently.

- Labor Hours - Based on construction estimates for all phases of development of the CCNPP Unit 3, the estimated labor hours associated with the construction of SSCs is approximately 90% of the total labor hours associated with the development of the entire CCNPP Unit 3 plant site.

"Other factors that were considered where applicable include the following:

- Construction Duration - Estimates of impacts generally associated with construction activities were estimated to be related to construction of SSCs 77% of the time and to preconstruction activities 23% of the time.

- Water Usage - The quantity of water to be used for preconstruction is estimated to be 10% of the total water requirements in Table 4.2-1. Preconstruction activities were assumed to begin at the start of Year 1 and extend eight months into Year 2 to align with the assumption that preconstruction activities comprise 23% of time of construction. The water usage predicted for the first 20 months of the 86 month CCNPP Unit 3 construction period is allocated to preconstruction activities. That usage totals 10% of the total volume in Table 4.2-1.

Table 4.6-1— Summary of Measures and Controls to Limit Adverse Impacts During Construction

(Page 1 of 7)

ER Reference Section	Erosion/Sediment (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Groundwater (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomic (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	Other (site specific) (O)	Erosion/Sediment (ES)
4.1Land Use Impacts	S	S	S	M	-	S	-	S	S	-	-	-	-	-	-	S

ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
4.1.1The Site and Vicinity	Clearing, grading, excavation, and re-contouring. (ES)(AQ)(L)(TE)	Comply with NPDES Construction General Permit, including EPA effluent limitations.
	Disturbance (temporary and permanent) of wetlands and streams in vicinity. (SW)(AE)	Use site Resource Management Plan and BMPs to protect resources such as wetlands and streams in vicinity.
		Comply with individual Corps of Engineers 404 Permit.
		Comply with Maryland Non-Tidal Wetlands Protection Act permit.
		Restore wetlands and wetland buffers temporarily disturbed during construction.
		Construct new wetlands.
	Soil stockpiling and disturbance to natural drainage channels. (L)(ES)	Implement Storm Water Pollution Prevention Plan (SWPPP), including sediment and erosion control.
	Removal of existing trees and vegetation. (WS)(TE)	Use site Resource Management Plan and comply with BMP requirements; on-site land is not used for farmland nor is it considered prime or unique.
		Unmerchantable trees and slash will be chipped and spread as wood chips, or disposed of at an offsite landfill.
		Acreage will be restored following construction to the extent possible.
	Construction of temporary and permanent structures. (AQ)(L)(TE)	Construction footprint would be wholly contained on an existing dedicated nuclear power plant site.
	Release of fuels, oils, or other chemicals. (WS)(TE)(AE)	Implement Spill Prevention Control and Countermeasures (SPCC) Plan.
4.1.2Transmission Corridors and Off-site Areas	The existing transmission lines have sufficient capacity to carry the total output of existing CCNPP Units 1 and 2, as well as CCNPP Unit 3; as a result, there will be no new off-site transmission lines or rights-of-way disturbance. (L)(TE)	Use existing transmission corridor maintenance policies and practices to protect terrestrial and aquatic ecosystems.

Table 4.6-1— Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Page 2 of 7)

ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
4.1.3Historic Properties (and Cultural Resources)	Disturbance of archaeological resources. (L)	Perform Phase II Cultural Resource Survey. In consultation with the SHPO, develop plan and procedures to manage identified/ unidentified historic/cultural resource. Take appropriate actions (e.g., stop work) following discovery of potential historic/cultural resource.

ER Reference Section	Erosion/Sediment (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Groundwater (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomic (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	Other (site specific) (O)	Erosion/Sediment (ES)
4.2Water-Related Impacts	S	-	S	M	S	S	S	-	S	-	-	-	-	-	-	S

ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
4.2.1Hydrologic Alterations	Erosion, sediment, and storm water runoff (from on-site building, utilities, and road construction activities). (ES)(SW)(GW)(W)	Implement Storm Water Pollution Prevention Plan (SWPPP), including sediment and erosion control, as part of the NPDES Construction General Permit requirements.
	Chesapeake Bay turbidity/sediment effects (from dredging, refurbishment of the shoreline unloading facility, and installation of the Intake and Discharge Structures). (WS)(SW)(W)(AE)	Comply with Corps of Engineers 404 Permit requirements.
	Temporary increase in groundwater withdrawal. (GW)(W)	Comply with existing Groundwater Water Appropriations and Use Permit Withdrawal Limit. Use off-site water supply. Install Desalinization Plant.

Table 4.6-1— Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Page 3 of 7)

ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
4.2.1Hydrologic Alterations (Cont.)	Temporary dewatering activities. (GW)(W)	Comply with COMAR 26.17.06 for dewatering activities or obtain Water Appropriation and Use Permit, as needed.
		Comply with individual Corps of Engineers 404 Permit.
		Comply with BMP requirements.
		Monitor perched water levels.
	Disturbance of wetlands and streams in vicinity. (SW)(AE)	Use site Resource Management Plan and BMPs to protect resources such as wetlands and streams in vicinity.
		Comply with Maryland Non-Tidal Wetlands Protection Act permit.
		Comply with individual Corps of Engineers 404 Permit.
		Restore wetlands and wetland buffers temporarily disturbed during construction.
		Construct new wetlands.
	Shift of the Surficial aquifer recharge area(s). (GW)	Monitor perched water levels.
4.2.2Water Use Impacts	Temporary increase in groundwater withdrawal. (GW)(W)	Comply with existing Groundwater Water Appropriations and Use Permit Withdrawal Limit.
		Use off-site water supply.
		Install Desalinization Plant.
	Reduction in available pervious (infiltration) areas. (GW)(W)	Install sand filter trenches to allow runoff to infiltrate.

Table 4.6-1— Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Page 4 of 7)

ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
4.2.2Water Use Impacts (Cont.)	Temporary dewatering activities. (GW)	Comply with COMAR 26.17.06 for dewatering activities or obtain Water Appropriation and Use Permit, as needed.
		Comply with individual Corps of Engineers 404 Permit.
		Comply with BMP requirements.
	Disturbance of wetlands and streams in vicinity. (SW)(AE)	Use site Resource Management Plan and BMPs to protect resources such as wetlands and streams in vicinity.
		Comply with Maryland Non-Tidal Wetlands Protection Act permit.
		Comply with individual Corps of Engineers 404 Permit.
		Comply with BMP requirements
		Restore wetlands and wetland buffers temporarily disturbed during construction.
		Construct new wetlands.
	Construction of new impoundments and modification of existing impoundments. (L)(AE)	Use site Resource Management Plan and BMPs to protect resources such as wetlands and streams in vicinity.
	Release of fuel, oils, or other chemicals. (WS)(AE)	Implement Spill Prevention, Control, and Countermeasures (SPCC) Plan.
	Temporary increase in sediment and silt. (ES)(W)	Implement Storm Water Pollution Prevention Plan (SWPPP), including sediment and erosion control, as part of the NPDES Construction General Permit requirements.
	Temporary increase in turbidity. (ES)(W)	Comply with Corps of Engineers 404 Permit requirements.
4.3Ecological Impacts		

Erosion/Sediment (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Groundwater (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomic (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	Other (site specific) (O)	Erosion/Sediment (ES)
S	-	-	-	-	-	S	S	S	-	S	-	-	-	-	S

Table 4.6-1— Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Page 5 of 7)

ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
4.3.1Terrestrial Ecosystems	Loss of vegetation (i.e., oaks, hickories, mountain laurel and showy goldenrod) and existing habitat for important fauna (i.e., white-tailed deer and scarlet tanager and other forest-interior dwelling species (FIDS)), as well as forest cover. (TE)	Use site Resource Management Plan and BMPs to protect resources. To the extent practicable, design construction footprint to account for CBCA and other important habitat, including bald eagles nests. If any bald eagles' nest is located within the construction area, the Maryland Department of Natural Resources and U.S. Fish and Wildlife service will be contacted to obtainapproval of the required mitigating actions. Minimize cooling tower lighting, as practicable and allowed by regulation. Create new habitats (i.e., unforested uplands to ultimately generate a mixed deciduous forest). Maintain remaining unforested upland as old field habitat. Acreage will be restored following construction to the maximum extent possible.
	Disturbance (temporary and permanent) of wetlands and streams in vicinity. (ES)(AE)(A)	Use site Resource Management Plan and BMPs to protect resources such as wetlands and streams in vicinity. Comply with Maryland Non-Tidal Wetlands Protection Act Permit. Comply with BMP requirements. Comply with individual Corps of Engineers 404 Permit.
	Temporary disturbance of Chesapeake Bay Critical Area (CBCA). (AE)(A)	Preserve aesthetically outstanding tree clusters, as practical; harvest merchantable timber; use or recycle other woody material, as appropriate; develop reforestation plan.
	Limited mortality of wildlife (e.g., avian collisions with man-made structures.) (TE)(AE)	Use site Resource Management Plan and BMPs to protect resources.

Table 4.6-1— Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Page 6 of 7)

ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
4.3.2Aquatic Ecosystems	Disturbance (temporary and permanent) of wetlands and streams in vicinity; however, on-site wetlands are not substantively distinguishable from other wetlands in the site vicinity and streams within the construction zone contain no rare or unique aquatic species. (SW)(ES)(AE)(A)	Use site Resource Management Plan and BMPs to protect resources. Implement Spill Prevention, Control, and Countermeasures (SPCC) Plan. Comply with Maryland Non-Tidal Wetlands Protection Act Permit. Comply with individual Corps of Engineers 404 Permit. Comply with BMP requirements. Restore wetlands and wetland buffers temporarily disturbed during construction. Construct new wetlands.
	Temporary sediment and silt buildup. (ES)(AE)	Implement Storm Water Pollution Prevention Plan (SWPPP), including sediment and erosion control and the construction of new impoundments, as appropriate.
	Temporary turbidity increase. (ES)(AE)(W)	Comply with Corps of Engineers 404 Permit requirements.
	Limited mortality of fish (i.e., resulting from sedimentation). (AE)	Comply with BMPs, including intercepting and retaining sediment before it reaches streams.
4.4Socioeconomic Impacts	Erosion/Sediment (ES), Air Quality (AQ), Wastes (WS), Surface Water (SW), Groundwater (GW), Land Use (L), Water Use & Quality (W), Terrestrial Ecosystems (TE), Aquatic Ecosystems (AE), Socioeconomic (S), Aesthetics (A), Noise (N), Traffic (T), Radiation Exposure (R), Other (site specific) (O), Air Quality (AQ) S S - - - - - - S S S M - - S	
4.4.1Physical Impacts	Equipment and non-routine noise. (N)	Comply with applicable MDE noise limits. Comply with applicable OSHA noise-exposure limits.
	Air emissions (fugitive emissions and exhaust emissions) increase. (AQ)(WS)	Comply with applicable EPA and MDE air quality regulations. Implement routine vehicle/equipment inspection and maintenance program.
	Local and regional traffic increase. (AQ)(T)	Install new site perimeter and access road. Conduct Phase 2 Traffic Impact Analysis (TIA). Develop Traffic Management Plan using Phase 2 TIA results.
	The site is aesthetically altered due to CCNPP Units 1 and 2. Additional temporary impacts due to the visibility of construction activities. (A)	No mitigating measures required, because local residences and road traffic have limited visibility of site due to heavily wooded area.

Table 4.6-1— Summary of Measures and Controls to Limit Adverse Impacts During Construction
(Page 7 of 7)

ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
4.4.2Social and Economic Impacts	Influx of large construction work force. (S)	Small aggregate socioeconomic impacts anticipated, mitigation not required.
	Public services need (housing, schools, land use) increase. (S)	Small aggregate socioeconomic impacts anticipated; mitigation not required.
	Spending and tax revenue increase. (S)	Large beneficial impact to county property tax revenues; small beneficial impact for other types of tax revenues. No mitigating measures or controls required.
4.4.3 Environmental Justice Impacts	No disproportionate adverse impacts to minority or low-income populations. (S)	No mitigating measures or controls required
4.5Radiation Exposure to Construction Workers	Erosion/Sediment (ES): -; Air Quality (AQ): -; Wastes (WS): -; Surface Water (SW): -; Groundwater (GW): -; Land Use (L): -; Water Use & Quality (W): -; Terrestrial Ecosystems (TE): -; Aquatic Ecosystems (AE): -; Socioeconomic (S): -; Aesthetics (A): -; Noise (N): -; Traffic (T): -; Radiation Exposure (R): S; Other (site specific) (O): -; Erosion/Sediment (ES): -	
	ISFSI and Interim Resin Storage Area direct radiation exposure. (R)	Total Effective Dose Equivalent (TEDE) from all exposures has been determined to be below limits set in 10 CFR 20.1301. Implement ALARA practices at construction site.
	CCNPP Units 1 and 2 gaseous effluents exposure. (R)	Implement ALARA practices at construction site.
	CCNPP Units 1 and 2 liquid effluents exposure. (R)	Implement ALARA practices at construction site.
4.7Non-Radiological Health Impacts	Erosion/Sediment (ES): -; Air Quality (AQ): -; Wastes (WS): -; Surface Water (SW): -; Groundwater (GW): -; Land Use (L): -; Water Use & Quality (W): -; Terrestrial Ecosystems (TE): -; Aquatic Ecosystems (AE): -; Socioeconomic (S): -; Aesthetics (A): -; Noise (N): -; Traffic (T): -; Radiation Exposure (R): -; Other (site specific) (O): S; Erosion/Sediment (ES): -	
	Risk to workers from accidents and occupational illnesses. (O)	Implement site-wide Safety and Medical Program, including safety policies, safe work practices, as well as general and topic-specific training.