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3.1 External Appearance and Plant Layout

3.1.1 Site Description

The VCS Units 1 and 2 will be located on a greenfield site, currently used as part of a ranch for cattle pastures. The site is located in Victoria County, approximately 127 miles southwest of Houston, 13.3 miles south of Victoria, Texas, and west of the Guadalupe River. The approximately 11,500-acre site is bounded by Linn Lake to the east, U.S. Highway 77 and Kuy Creek to the west, the Union Pacific railroad (formally called the Missouri Pacific railroad) to the south, and open fields to the north. The site boundary is shown on Figure 3.1-1.

3.1.2 New Unit Description

VCS will consist of two ESBWR units. The ESBWR is a light-water-cooled reactor designed by General Electric-Hitachi.

As shown on Figure 3.1-2, the Units 1 and 2 power block buildings are located within the plant protected area. Principal power block structures include the reactor building, turbine building, electrical building, fuel building, service building, control building, and radwaste building. Figure 3.1-2 also shows structures beyond the principle power block, such as the switchyards, the cooling basin with intake and outfall structures, the plant service water cooling towers including the adjacent pump house, yard fire water pump house, training center, the sewage and water treatment facilities, and storage tanks for fuel oil, station water, and demineralized water.

Figure 3.1-3 provides an artist's conception of the VCS site, with the units superimposed on the site. An architectural rendering of the site, including landscaping and major station features, is shown on Figure 3.1-4. Figures 3.1-5 through 3.1-7 provide an artist's conception of the new units as viewed towards the southwest, southeast, and northeast, respectively.

The VCS units will use closed-cycle cooling for their normal plant cooling system. The circulating water system will use a cooling basin located approximately 600 feet from the protected area. The cooling basin is shown on Figure 3.1-1. The plant service water system will use wet cooling towers. These towers would be located as shown on Figure 3.1-2. Makeup water for the cooling basin will be provided from a newly constructed raw water makeup pump station on the Guadalupe-Blanco River Authority (GBRA) Calhoun Canal in Calhoun County, approximately 18 miles southeast of the property boundary. An intake structure and the aforementioned pump station, as well as the associated pipelines, will be provided and operated by the GBRA and VCS.

3.1.3 Plant Appearance

The power block will be located on the northwest side of the site where the existing grade is at approximate elevation 80 feet (NAVD 88). To the southeast of the power block will be a cooling water basin that is designed to contain a maximum operating water elevation of 91.5 feet (NAVD 88).Most of the embankment around the cooling basin will be at elevation 102 feet (NAVD 88).The grade elevation of the power block will be at approximately 95 feet (NAVD 88). The centers of the reactor buildings are 1000 feet apart.

The height of VCS buildings proper will be less than 167 feetabove finished grade level and constructed of concrete, structural steel with metal siding, or other acceptable material. The height of the plant stack will be 197 feet above finished grade level. The color of the plant will be selected to be aesthetically compatible with the surrounding environment. The landscaping design for the site areas adjacent to the structures, including parking areas, will be compatible with the natural surroundings at the plant location.

Site access is provided from U.S. Highway 77 on the west side of the site. U.S. Highway 77 is an existing four-lane divided highway. An additional off-ramp from U.S. Highway 77 will be constructed as the main entrance for the plant.

3.1.4 Site Development and Improvements

An existing barge offload facility at the Port of Victoria Turning Basin, located east of the site on the Victoria Barge Canal, will be upgraded, as necessary, to support project needs. A heavy haul road will extend from the Port of Victoria Turning Basin via a new road that will require a bridge over the Guadalupe River and adjacent flood plain. The total length of the road from the barge slip area to the power block will be approximately 8 miles. The heavy haul road can be seen on Figure 3.1-1.

An approximately 4938-acre cooling basin will be used as the normal power heat sink for the circulating water system. An adjacent basin of approximately 1295 acres will be used by the GBRA as a storage reservoir. The combined basins will encompass a nominal surface area of approximately 6233 acres. An intake structure and pump station, located on the Calhoun Canal approximately 18 miles southeast of the site boundary, along with the associated pipelines, will be constructed to provide makeup water to both basins. The combined basins will be contained within an earthen embankment. An access/maintenance road will run around the perimeter of the embankment.

The VCS site also requires area for the plant service water cooling towers. The cooling requirements for the plant service water system will be small when compared to the normal heat rejection requirements of the circulating water system and are met through the use of mechanical draft towers. These plant service water cooling towers will be located close to the power block area as shown on Figure 3.1-2.

Services and support structures that are necessary for multiple units (e.g., office facilities, warehouse space, training center, and switchyard) will be located as shown on Figure 3.1-2. Temporary facilities provided during construction of the units are shown on Figure 3.1-8. The total land area to be developed, excluding the makeup water pump house area, can be seen in Figure 3.1-9. After construction is complete, areas used for construction support will be landscaped as appropriate to match the overall site appearance. Previously forested areas beyond applicable setbacks and rights-of-way will be revegetated, as necessary. Additionally, certain topographical features created during construction, including equipment laydown and fabrication areas, areas around completed structures, and construction parking that is not required following the completion of construction, will be contoured to match the surrounding areas.

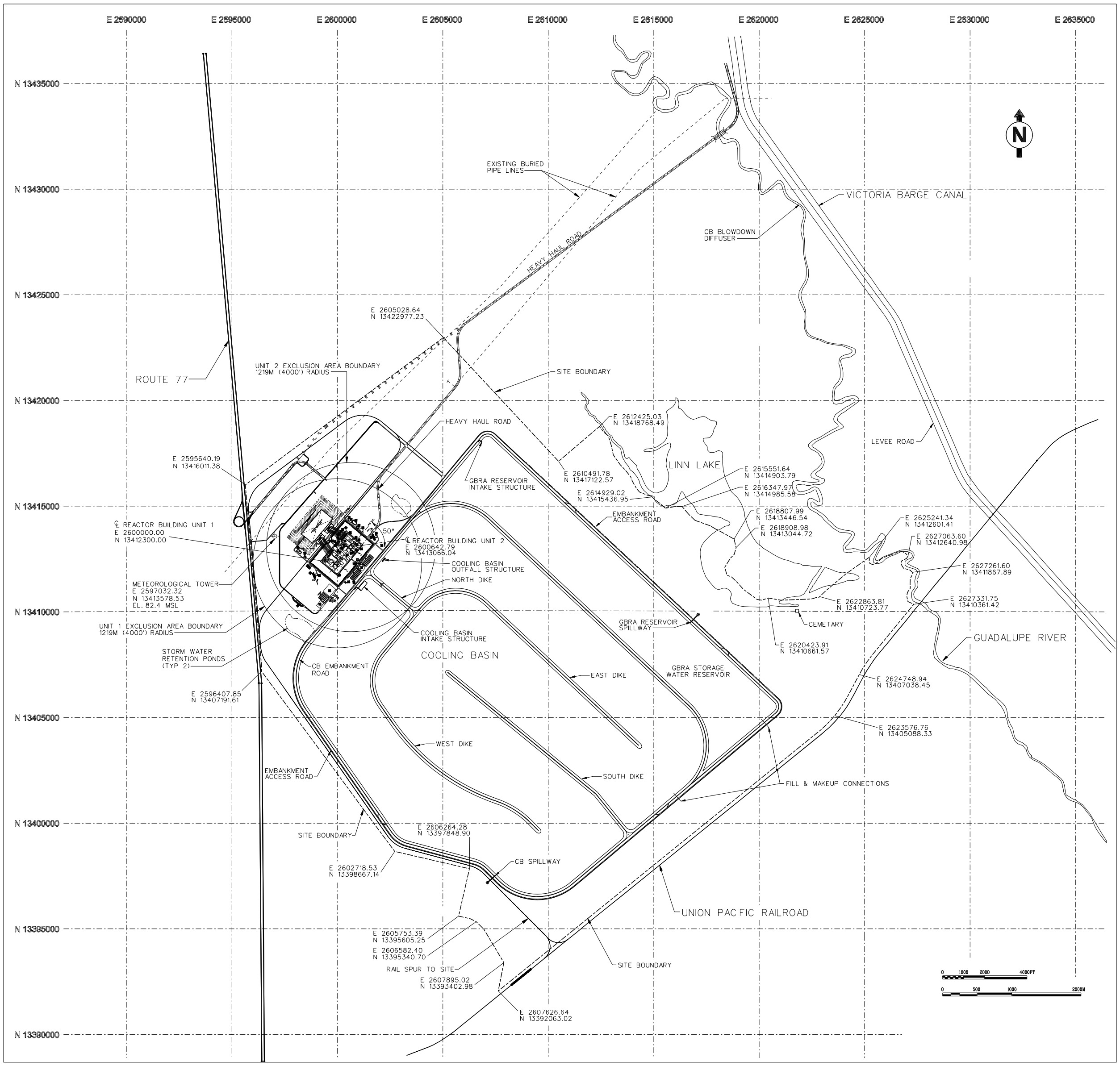

Figure 3.1-1 Site Layout

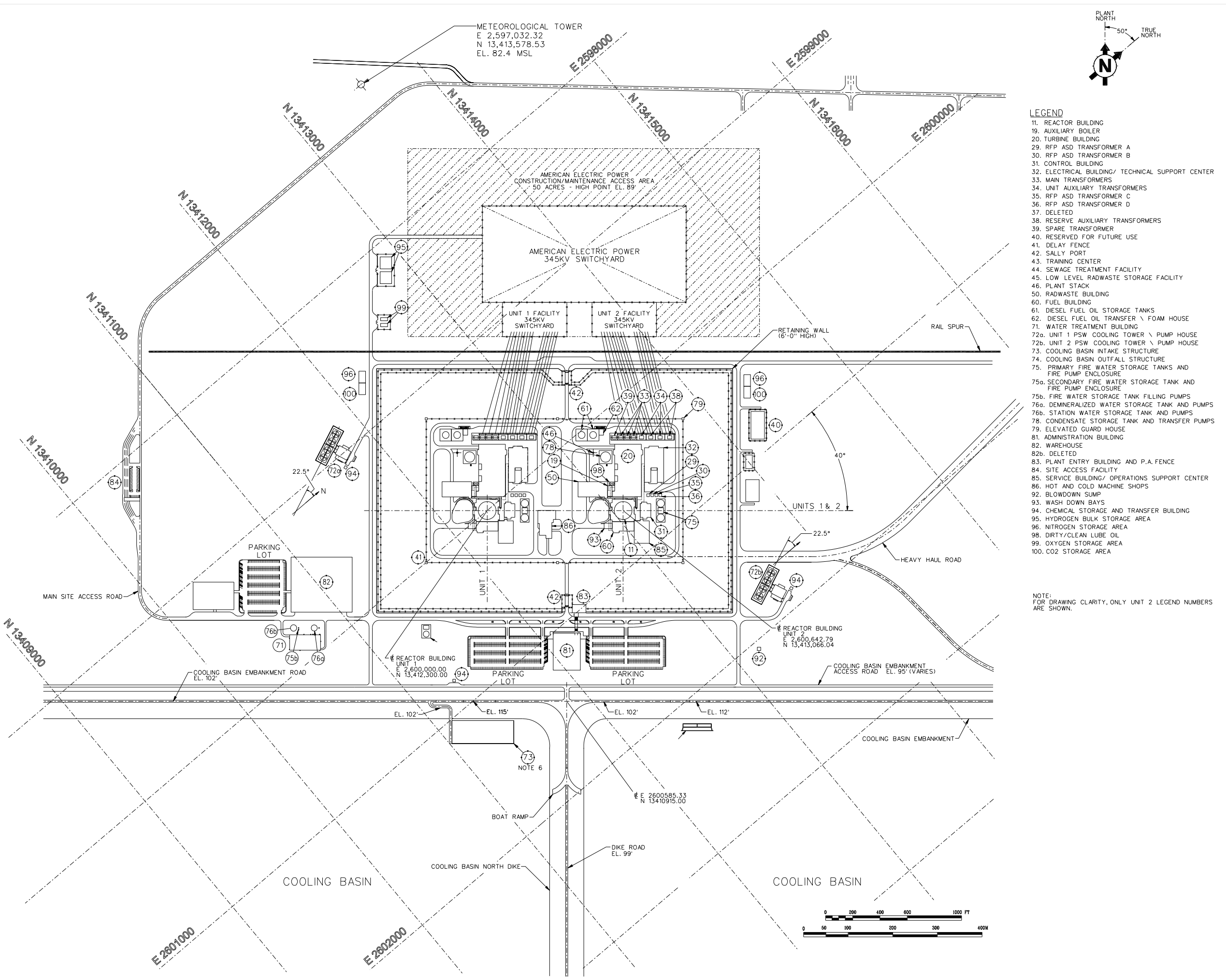

Figure 3.1-2 Major Structure Locations

Figure 3.1-3   Station Superimposed on Site Picture

Figure 3.1-4 Architectural Rendering with Landscaping

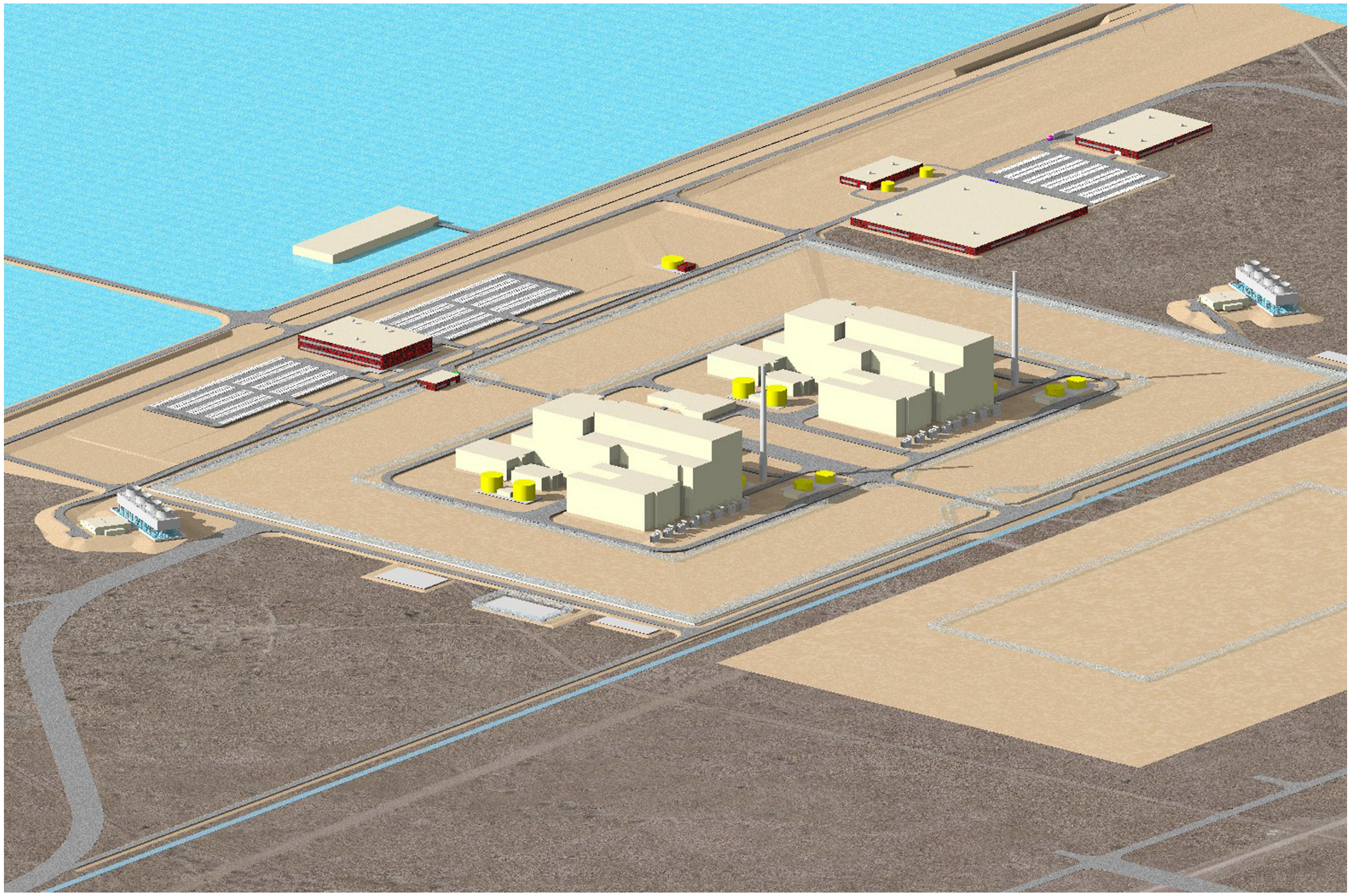

Figure 3.1-5 Station Superimposed on Site Picture Looking Southwest

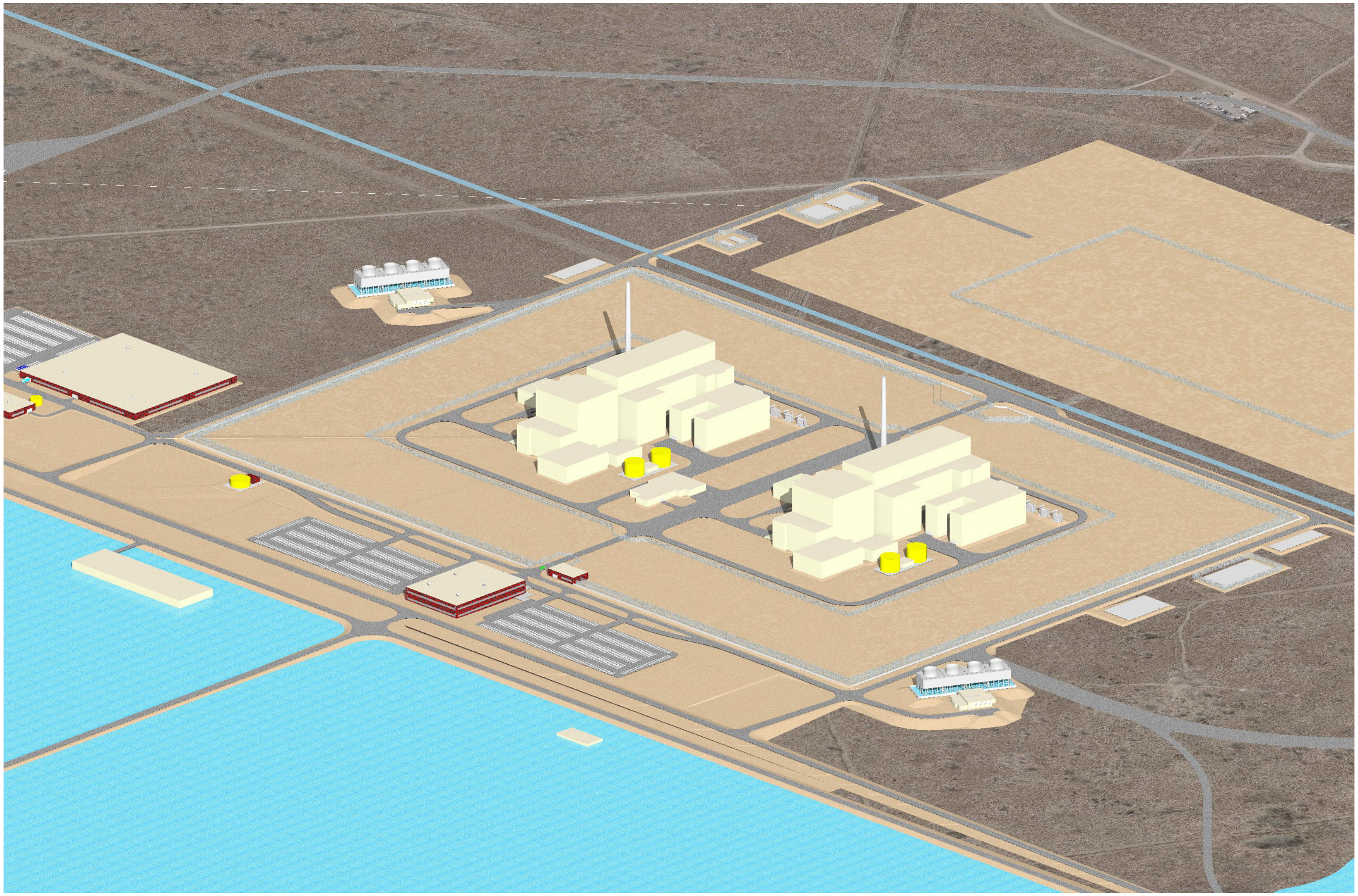

Figure 3.1-6 Station Superimposed on Site Picture Looking Southeast

Figure 3.1-7 Station Superimposed on Site Picture Looking Northeast

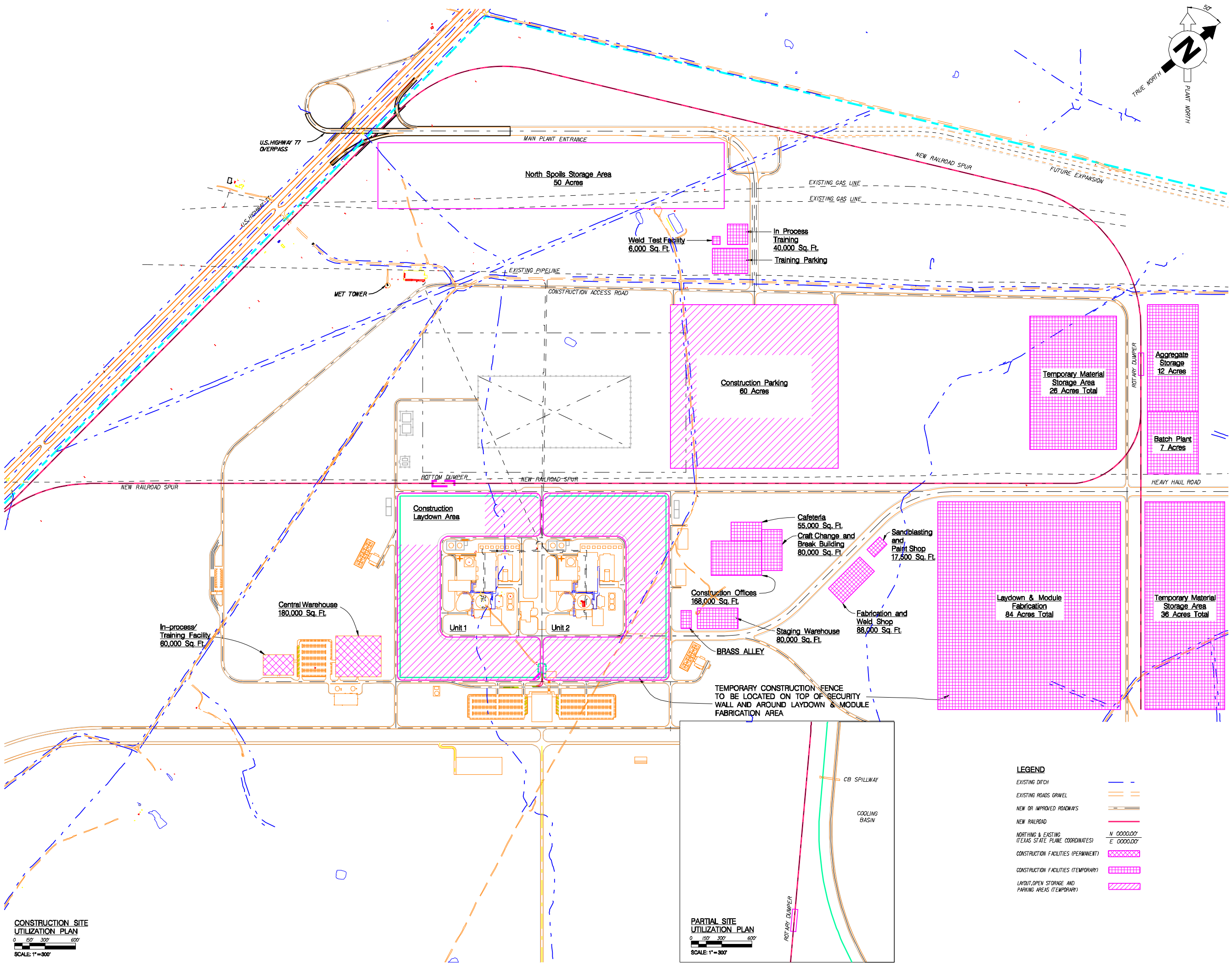

Figure 3.1-8 Temporary Facilities During Construction

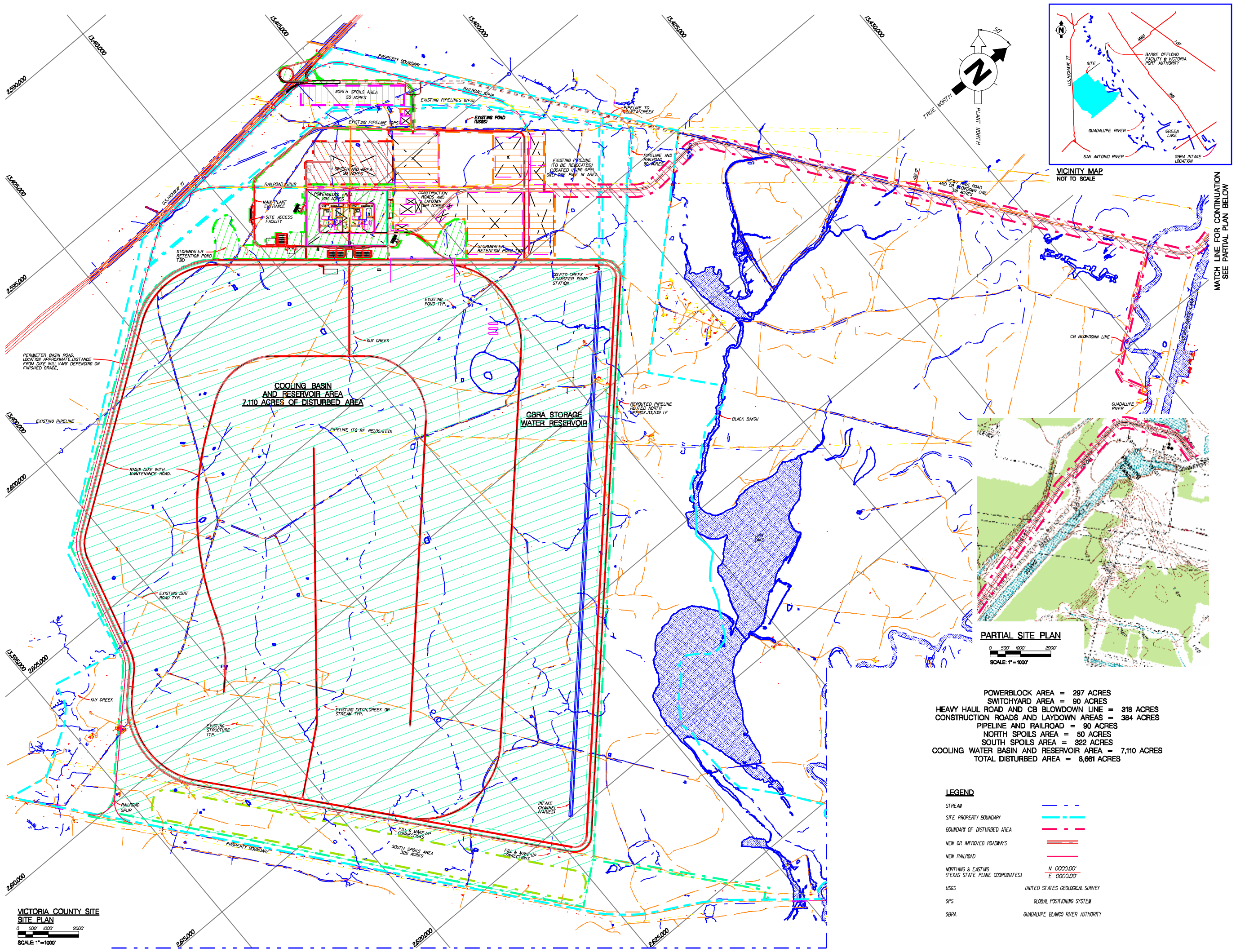

Figure 3.1-9 Total Land to be Developed

3.2 Reactor Power Conversion System

The proposed plant will consist of two units. The thermal power source for each unit is an ESBWR, which will be supplied by General Electric Hitachi Nuclear Energy (GEH). The design life of the proposed ESBWR plant is 60 years in accordance with the DCD. Each unit also includes a turbine-generator set and its auxiliaries. The turbine-generator is manufactured by General Electric Hitachi Nuclear Energy, model number N3R. The architect/engineer is discussed in Section 1.4 of the FSAR, "Identification of Agents and Contractors."

3.2.1 Reactor Description

The ESBWR will have a design and rated core thermal power of 4590 MWt and 4500 MWt, respectively. In the reactor vessel, fuel rods heat the reactor coolant water. The heated water naturally circulates through the reactor core removing additional heat and producing steam. The steam generated in the reactor is supplied to the power conversion systems to generate power. FSAR Chapter 4, "Reactor," provides additional information regarding the reactor, its internals, and the fuel. The nuclear boiler systems are described and illustrated in FSAR Chapter 5, "Reactor Coolant System and Connected Systems."

The ESBWR will use uranium dioxide enriched with U-235 for fissile material. The reactor fuel will consist of individual cylindrical uranium pellets enclosed in a sealed Zircaloy-2 tube to constitute a fuel rod. Each ESBWR fuel assembly will consist of 92 fuel rods grouped in a 10 x 10 array. The ESBWR reactor vessel will contain 1132 fuel assemblies, with a total uranium dioxide fuel weight of 184,867 kg. The average enrichment of the initial reactor core load will be approximately 2.08% U-235. The expected burnup of the discharged fuel in the first core load will be 11,750 MWd/MTU. For additional information on ESBWR fuel design, see Section 4.2 of the FSAR, "Fuel System Design."

3.2.2 Engineered Safety Features

The engineered safety features of the ESBWR plant are those systems provided to mitigate the consequences of postulated accidents. These systems are categorized into three major groups: (1) fission product containment and containment cooling systems; (2) emergency core cooling systems; and (3) control room habitability systems. The systems in the fission product containment and containment cooling systems are containment system and passive containment cooling system. The emergency core cooling system consists of a gravity-driven cooling system, automatic depressurization system, isolation condenser system, and the standby liquid control system. The control room habitability systems would include the control room habitability area HVAC subsystem. For additional information on ESBWR engineered safety features, see Chapter 6 of the FSAR, "Engineered Safety Features."

3.2.3 Power Conversion Systems

The major components of the reactor power conversion system include the reactor pressure vessel, high pressure turbine, moisture separators/reheaters, low-pressure turbines, condenser, generator, feedwater heaters, condensate pumps, and reactor feedwater pumps. Figure 3.2-1 provides a simplified flow diagram of the reactor power conversion system.

Steam from the nuclear boiler system will be supplied to the high-pressure turbine and moisture separator/reheaters. Moisture separator/reheaters enhance the quality of exhaust steam from the high-pressure turbine before it enters the low-pressure turbines. Steam exhausted from the low-pressure turbines will be condensed and deaerated in the condenser. The condenser will be of a multiphase transversal type with a heat transfer area of approximately 1.27 x 10^6 square feet (1.18 x 10^5 square meters). The condenser tube material will be either stainless steel or titanium.

The condensed steam from the condenser will then be returned to the reactor by the feedwater lines. A closed loop circulating water system, using a cooling basin, will supply cooling water to the condenser to condense the exhaust steam. The circulating water system, through the cooling basin, will be designed to reject the main condenser heat duty to the environs. The power conversion system is further described and illustrated in Chapter 10, "Steam and Power Conversion System," of the FSAR.

The rated and maximum turbine generator output values for a multipressure, three-shell condenser will be 1605 MWe and 1657 MWe, respectively, per unit. Station electrical loads will be approximately 70 MWe per unit. The estimated net electrical output, which depends on the site ambient conditions, circulating water temperature, and normal plant heat sink operation, is approximately 1535 MW per unit.

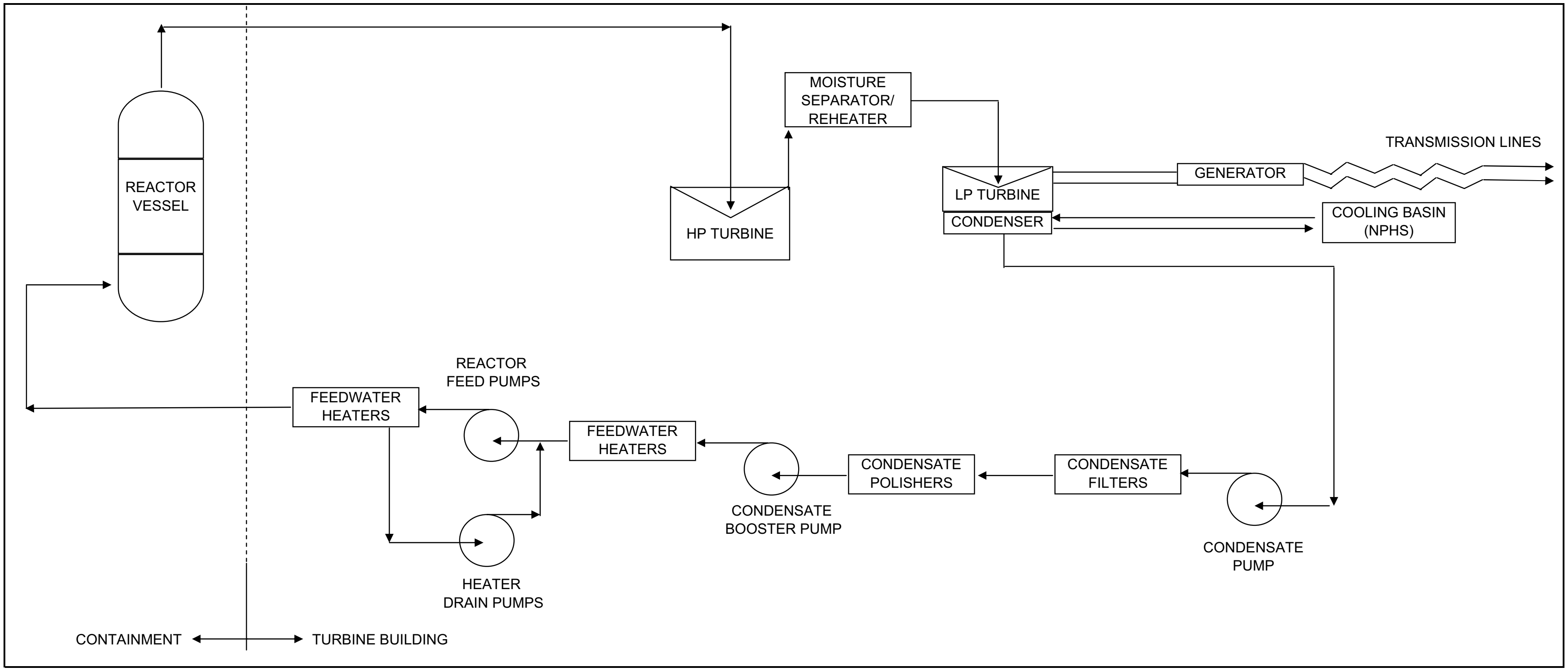

Figure 3.2-1 Simplified Flow Diagram of Power Reactor Conversion

3.3 Plant Water Use

Plant water use considers both plant water consumption and plant water treatment. Plant water used in Unit 1 and Unit 2 of VCS is supplied from two sources: groundwater from local wells and surface water from the Guadalupe River. This section describes the groundwater and surface water usages as well as their final disposition. (There are no other station uses; that is, all uses of plant water are associated with VCS).

3.3.1 Water Consumption

3.3.1.1 Groundwater Use

Groundwater used for VCS is supplied from onsite wells and is used in the following systems:

- Potable water system
- Station water system
- Makeup (demineralized) water system

Figure 3.3-1 provides a groundwater source use diagram for VCS Units 1 and 2. Flow rates to and from the various systems and water users identified in Figure 3.3-1 are shown in Table 3.3-1. The flow rates shown in Table 3.3-1 envelope water consumption during periods of minimum water availability and average plant operation by month. The normal values are the expected flow rates during normal plant operation at full power, and the maximum values are those expected during outages and abnormal conditions.

3.3.1.1.1 Potable Water Use

The VCS potable water system is a common system for both units. Before use as potable water, groundwater supplied from the wells is chemically treated with sodium hypochlorite to prevent biological growth. Treated water is stored in the potable water storage tank (PWST) with a usable volume of 27,000 gallons. In addition to the PWST, the potable water system has transfer pumps, hydropneumatic tanks, piping, and valves. Potable water in the PWST is pumped to the hydropneumatic tanks for pressurization. The pressurized potable water is distributed to the usage points in various buildings at VCS. When both units are in normal power operation, potable water use by the two units is approximately 25 gpm. When one of the units is in normal power operation and the other unit is in a refueling/maintenance outage, potable water use is approximately 60 gpm. Demand for potable water may increase to 225 gpm during the 2-hour shift change periods when one unit is in normal power operation and the other unit is in a refueling/maintenance outage. To meet this peak demand of 225 gpm, the required fill rate of the 27,000 gallon PWST is a minimum of 135 gpm.

3.3.1.1.2 Station Water Use

The VCS station water system is a common system for both units and includes media filters, a station water storage tank, pumps, piping, and valves. Before use as station water, groundwater supplied from the wells is chemically treated, filtered, and stored in the 581,000-gallon storage tank. Water from the storage tank is used for production of makeup (demineralized) water, filling of the fire water storage tanks, backwashing of the station water media filters, and meeting the demands of the miscellaneous station water users.

3.3.1.1.3 **Makeup (Demineralized) Water Use (MWS)**

The VCS makeup (demineralized) water system is a common system for both units. The makeup (demineralized) water system consists of two subsystems: (1) the demineralization subsystem and (2) the storage and transfer subsystem. The makeup water transfer pumps and demineralization subsystem are sized to meet the demineralized water needs for the operational conditions of VCS. During the shutdown/refueling mode, the increase in demineralized water consumption may require the use of a temporary demineralization subsystem and temporary makeup water transfer pumps as a supplemental source.

The demineralization subsystem has three trains. Each train includes a cartridge filter, reverse osmosis (RO) pass 1 modules, RO pass 2 modules, electro-deionization module, and mixed bed demineralizer vessel.

When both units of VCS are in normal power operation, total demand for the demineralized water is approximately 200 gpm, which requires one of the trains to be in operation and 281 gpm of station water to be withdrawn from the station water storage tank and pumped to the water treatment plant. With three trains in operation, the water treatment plant can produce 600 gpm of demineralized water to meet the maximum expected demand of 500 gpm.

The water treatment plant of the makeup (demineralized) water system is designed to remove dissolved minerals, organics, and other impurities in the station water. Demineralized water produced in the water treatment plant is stored in a 396,300-gallon demineralized water storage tank.

Makeup (demineralized) water is pumped from the demineralized water storage tank to the following users:

- Condensate storage tank makeup
- Standby liquid control system makeup
- Liquid waste system chemical addition and line flushing
- Solid waste system for line flushing
- Reactor component cooling water system makeup
- Turbine component cooling water system makeup
- Chilled water system makeup
- Process sampling system process use
- Auxiliary boiler system makeup
- HVAC makeup

- Miscellaneous uses
- Isolation condenser/passive containment cooling pool normal makeup

3.3.1.2 Surface Water Use

The surface water used at VCS as makeup for the 4938-acre VCS cooling basin is supplied from the Guadalupe-Blanco River Authority (GBRA) water system.

The GBRA water system is supplied water immediately upstream of the Guadalupe River saltwater barrier, where a portion of the Guadalupe river flow is diverted into a canal on the west side of Green Lake. This canal connects to Hog Bayou and then connects to a diversion canal that parallels U.S. Highway 35 along the south side of Green Lake. Water is carried in the canal southeast in Goff Bayou to a siphon under the Victoria barge canal. On the east side of the barge canal, two 96-inch underground intake pipelines carry water into the GBRA main pump station via a canal located southeast of the Dow facility. The raw water makeup (RWMU) system intake structure that supplies makeup for VCS is located downstream of the GBRA pump station in Calhoun County, approximately 15 miles southeast of VCS. Locations of the VCS cooling basin and GBRA intake structure are shown in Figures 3.3-3 and 3.3-4.

The RWMU system intake structure, a reinforced concrete design, consists of a pumphouse with trash racks at the intake, through-flow traveling screens in each bay, provisions for stop logs or stop gates, spray wash pumps for the traveling screens, RWMU system pumps, connecting piping, valves, and instrumentation.

The pumphouse at the RWMU system intake structure can provide a total peak makeup flow rate of approximately 267 cfs (120,000 gpm) for both the VCS cooling basin and GBRA reservoir, which is adjacent to the VCS cooling basin (see Figure 3.3-4) and operated by GBRA.

Makeup from the RWMU system pumphouse to the VCS cooling basin is limited to a maximum of 217 cfs (97,500 gpm), supplied via a 90-inch diameter, approximately 19.5 mile-long buried pipeline. A branch line that connects to the 90-inch pipeline on VCS provides makeup for the GBRA reservoir.

The amount of surface water taken from the Guadalupe River for use by VCS is limited to 75,000 acre-feet per year.

The water used in the circulating water systems of Units 1 and 2 and makeup water required for the cooling towers of the plant service water systems (PSWS) of Units 1 and 2 are supplied from the VCS cooling basin.

Figure 3.3-2 provides a surface water source use diagram for the VCS. Flow rates to and from the various systems and water users identified in Figure 3.3-2 are shown in Table 3.3-2. The normal values are the expected flow rates during normal plant operation at full power, and the maximum values are those expected during outages and abnormal conditions.

The rate of surface water consumption is not directly related to the rate of withdrawal and discharge to the Guadalupe River. Withdrawal rate from the Guadalupe River depends on the flow rate of the Guadalupe River, water level in the cooling basin, and quality of water in the cooling basin. Fluctuations in makeup water availability are accommodated by maintaining the cooling basin water level within an acceptable range.

3.3.1.2.1 **Surface Water Use in the Circulating Water Systems of the Units**

The VCS Units 1 and 2 circulating water systems provide cooling water to remove power cycle heat from the main condenser of each unit and transfer this heat to the cooling basin, which is provided as the normal power heat sink. The circulating water system of each unit, which has four circulating water pumps located at the cooling basin intake structure, supplies cooling water at a design flow rate of 1,100,000 gpm from the cooling basin to the main condenser. The cooling water circulated through the main condenser is returned to the cooling basin. The surface water at the cooling basin intake structure is chemically treated (if required) with sodium hypochlorite, scale inhibitor, and bromide-based biocide before it is pumped through the main condensers.

3.3.1.2.2 **Surface Water Use as Makeup for the Plant Service Water System (PSWS) Cooling Towers**

Each unit of the VCS has two independent and 100% redundant PSWS trains that continuously circulate water through the turbine component cooling water system (TCCWS) heat exchangers and reactor component cooling water system (RCCWS) heat exchangers. The plant service water is returned to the mechanical draft PSWS cooling towers to be cooled, collected in the basin of the cooling towers, which is common for both trains, and recirculated through the TCCWS and RCCWS heat exchangers. To make up for the evaporation, drift, and blowdown from the cooling towers, the PSWS makeup pumps located at the cooling basin intake structure supply water to the PSWS cooling tower basins. The water used in the PSWS is chemically treated (if required) with sulfuric acid, sodium hypochlorite, scale inhibitor, dispersant polymer sodium bisulfite, nonoxidizing biocide and dispersant before it is circulated through the TCCWS and RCCWS heat exchangers. Blowdown of the cooling tower basin is necessary to keep the total dissolved solids at an acceptable level.

3.3.2 **Water Treatment**

The following discusses the proposed chemical treatment of groundwater and surface water. The stated flow rates are estimates based on current water analysis.

Groundwater supplied from onsite wells at the VCS and used in the potable water system and station water system is continuously fed 12 trade percent available chlorine as sodium hypochlorite to maintain an approximate 3 ppm chlorine equivalent upstream of the multimedia filters. This treatment is used to prevent biological growth in the potable water, multimedia filters, and the station water storage tank. Since the total suspended solids levels in the groundwater are low, no coagulant chemicals are considered in the treatment. The feeding rate of 12 trade percent available chlorine as sodium hypochlorite is approximately 1.69 gallons per hour for the maximum groundwater flow.

Station water to the demineralization system is treated with the following chemicals:

- Sulfuric acid for pH control, required for maintaining alkalinity of 90 ppm as $CaCO_3$ in the RO pass 1 reject. 93% H_2SO_4 is injected at the RO pass 1 inlet at a dosing rate of 986 ppm. Feeding rate for 93% H_2SO_4 is approximately 2.44 gallons per hour.
- Scale inhibitor for scale control is injected at the RO pass 1 inlet at a dosing rate of 6 ppm. Feeding rate for the scale inhibitor is approximately 0.08 gallons per hour.
- Sodium bisulfite for dechlorination is based on a total residual chlorine of 3 ppm Cl_2 in the RO feed. Dosing rate of $NaHSO_3$ is approximately 4.38 ppm. Feeding rate for 25% $NaHSO_3$ is approximately 0.30 gallons per hour.

The circulating water system is treated with the following chemicals injected into the forebay of the intake structure for the circulating water pumps of the main condensers of the units:

- For primary biofouling control, shock feed chlorination is applied at 1 ppm chlorine equivalent based on feeding 12 trade percent equivalent chlorine as sodium hypochlorite for 30 minutes, four times per day (total of 2 hours per day). Feeding rate for sodium hypochlorite is approximately 551 gallons per hour.
- For secondary biofouling control, shock feed proprietary bromide-based biocide is applied at 1.6 ppm as delivered product up to 2 hours per day. Feeding rate for the proprietary bromide is approximately 88 gallons per hour.
- For scale control, proprietary scale inhibitor is continuously applied at 0.5 ppm as delivered product. Feeding rate for the proprietary scale inhibitor is approximately 27.5 gallons per hour.

Plant service water in the PSWS cooling tower basins of Unit 1 and Unit 2 is treated with the following chemicals:

- Sulfuric acid for pH control, required for maintaining alkalinity of 200 ppm as $CaCO_3$ in the blowdown from the PSWS cooling tower basin. Feeding rate for 93% H_2SO_4 is approximately 88.7 gallons per hour.
- For primary biofouling control, shock feed chlorination is applied at 0.5 ppm chlorine equivalent based on feeding 12 trade percent equivalent chlorine as sodium hypochlorite for 30 minutes, four times per day (total of 2 hours per day). Feeding rate for sodium hypochlorite is approximately 10 gallons per hour.
- For secondary biofouling control, slug feed proprietary nonoxidizing based biocide is applied at 100 ppm as delivered product, injected once per week. Feeding rate for the proprietary nonoxidizing based biocide is approximately 375 gallons per week.
- For scale control, proprietary scale inhibitor is continuously applied at 3 ppm as delivered product. Feeding rate for the proprietary scale inhibitor is approximately 0.69 gallons per hour.

- Sodium bisulfite for dechlorination based on reducing total residual chlorine to 0 ppm and no blowdown flow until total residual chlorine is at 0.5 ppm. Feeding rate for sodium bisulfite is approximately 0.81 gallons per hour.
- Biodispersant for fill fouling, slug feed proprietary cooling water biodispersant, fed at 10 ppm as delivered product, injected once per week. Feeding rate is approximately 37.5 gallons per week.
- For scale control, proprietary dispersant polymer is continuously applied at 3 ppm as delivered product. Feeding rate for the proprietary dispersant polymer is approximately 0.69 gallons per hour.

Table 3.3-1
Groundwater Source Flow Rates (see Figure 3.3-1 for stream numbers)

Stream No.	Stream Description	Normal Flow Rate gpm	Maximum Flow Rate gpm
8	Sanitary Waste to Sanitary Waste Treatment Plant	25	60
9	Treated Sanitary Waste to Blowdown Sump	25	60
10	Potable and Sanitary Water Supply to Hydropneumatic Tank	25	60
11	Treated Chemical Wastes	0.3	0.6
12	Miscellaneous Flows to Liquid/Solid Waste Management System (Treated Radwaste Discharge)	20.4	20.4
13	Effluent from Liquid Waste Management System to Guadalupe River	20.7	21.0
14	Startup Flushes and Chemical Cleaning Waste	0	0
15	Water Treatment Building Wastes	100	242
16	Consumptive Water Use	79.3	329
17	Potable Water Users	25	60
18	Station and Makeup Water System Supply	400	842
19	Filtered Water to Station Water System	400	842
20	Filter Backwash Supply Water	19	40
21	RO Influent	281	702
22	RO Reject	70	175
23	EDI Reject	11	26
24	RO Effluent	211	526
25	EDI Effluent	200	500
26	Mixed Bed Effluent	200	500
27	Demineralized Water to Users	200	500
28	Filter Backwash Waste to Water Treatment Waste Sump	19	40
29	Miscellaneous Clean Water Drains	100	150
30	Water to Fire Water Storage Tank	0	780.3
31	Drains from Fire Water System	0	4256
32	Water to Station Water Users	100	100
33	Equipment Drains/Floor Washdown Water	100	100
34	Service/Control/Electrical Building Drain System	100	100
35	Turbine Building Nonradioactive Drain Wastewater	100	100
36	Oil-Water Separator Effluent	100	100
37	Discharge from Blowdown Sump to Cooling Basin	325	552

Table 3.3-2
Surface Water Source Flow Rates (see Figure 3.3-2 for stream numbers)

Stream No.	Stream Description	Normal (Average) Flow Rate gpm	Maximum Flow Rate gpm
13 (Note 2)	Effluent from Liquid Waste Management System to Guadalupe River	20.7	21.0
37 (Note 2)	Discharge from Blowdown Sump to Cooling Basin	325	552
51	Makeup Water to Cooling Basin from Guadalupe River	42,809 (Note 1)	82,426
53	Cooling Water Supply from Cooling Basin to Condenser of Unit 1	1,100,000	1,100,000
54	Cooling Water Return From Condenser of Unit 1 to Cooling Basin	1,100,000	1,100,000
55	Makeup Water Supply to Unit 1 PSWS Cooling Tower Basin	3,883	5,436
56	Blowdown from Unit 1 PSWS Cooling Tower Basin	3,263	4,586
57	Cooling Water Supply from Cooling Basin to Condenser of Unit 2	1,100,000	1,100,000
58	Cooling Water Return from Condenser of Unit 2 to Cooling Basin	1,100,000	1,100,000
59	Makeup Water Supply to Unit 2 PSWS Cooling Tower Basin	3,883	5,436
60	Blowdown from Unit 2 PSWS Cooling Tower Basin	3,263	4,568
61	Evaporation from Cooling Basin	39,788	60,586
62	Precipitation into Cooling Basin	9,927	9,927
63	Evaporation from Unit 1 PSWS Cooling Tower	620	868
64	Drift from Unit 1 PSWS Cooling Tower	0.4	0.6
65	Evaporation from Unit 2 PSWS Cooling Tower	620	868
66	Drift from Unit 2 PSWS Cooling Tower	0.4	0.6
67	Seepage from Cooling Basin	2,200	2,200
52	Blowdown from Cooling Basin to Guadalupe River	9,833	28,383

Note 1: 42,809 gpm is approx. 92% of 46,497 gpm (75,000 acre-ft/year) withdrawal rate from the Guadalupe River.
Note 2: Groundwater source. See Table 3.3-1.

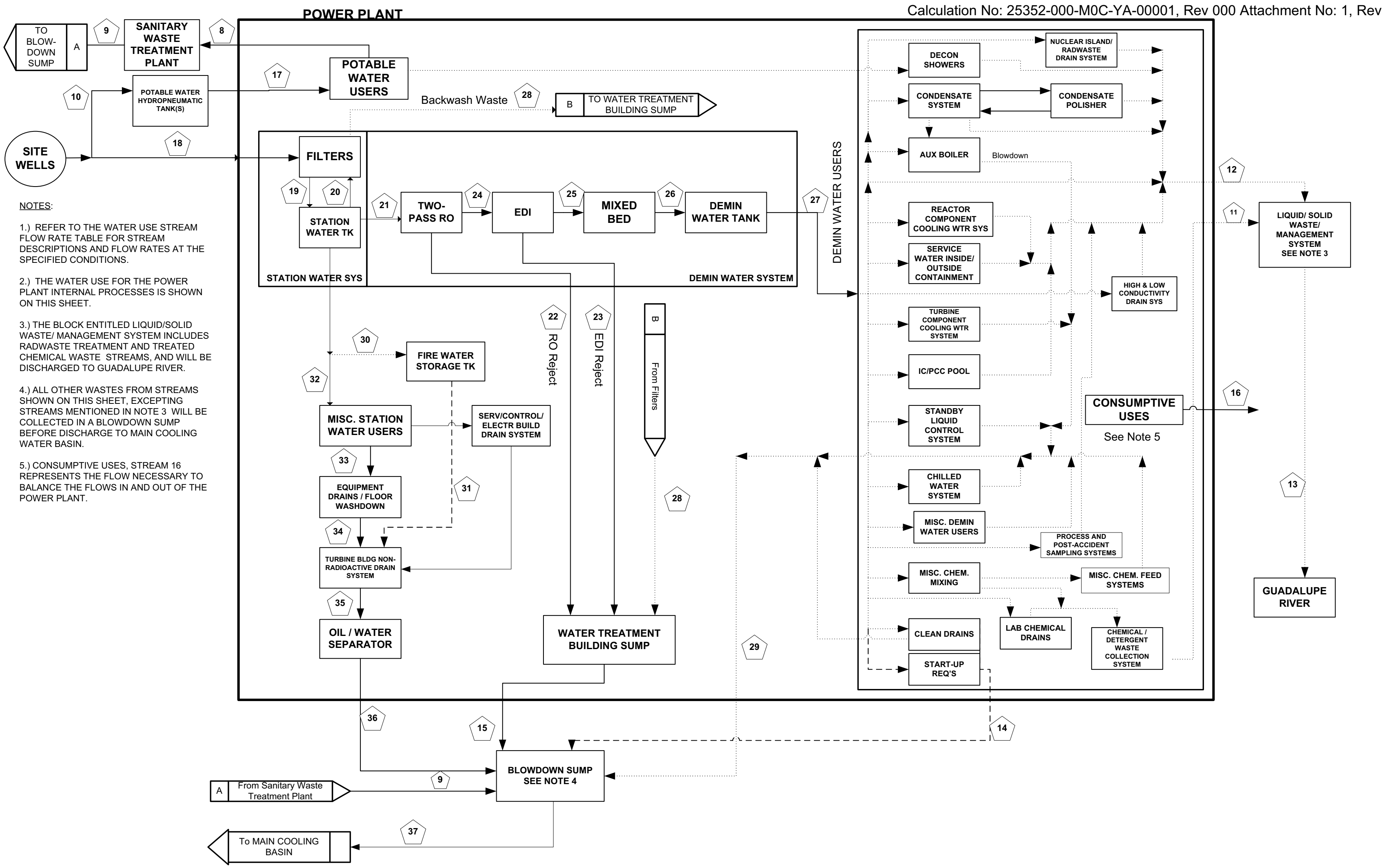

Figure 3.3-1 Groundwater Source Use Diagram

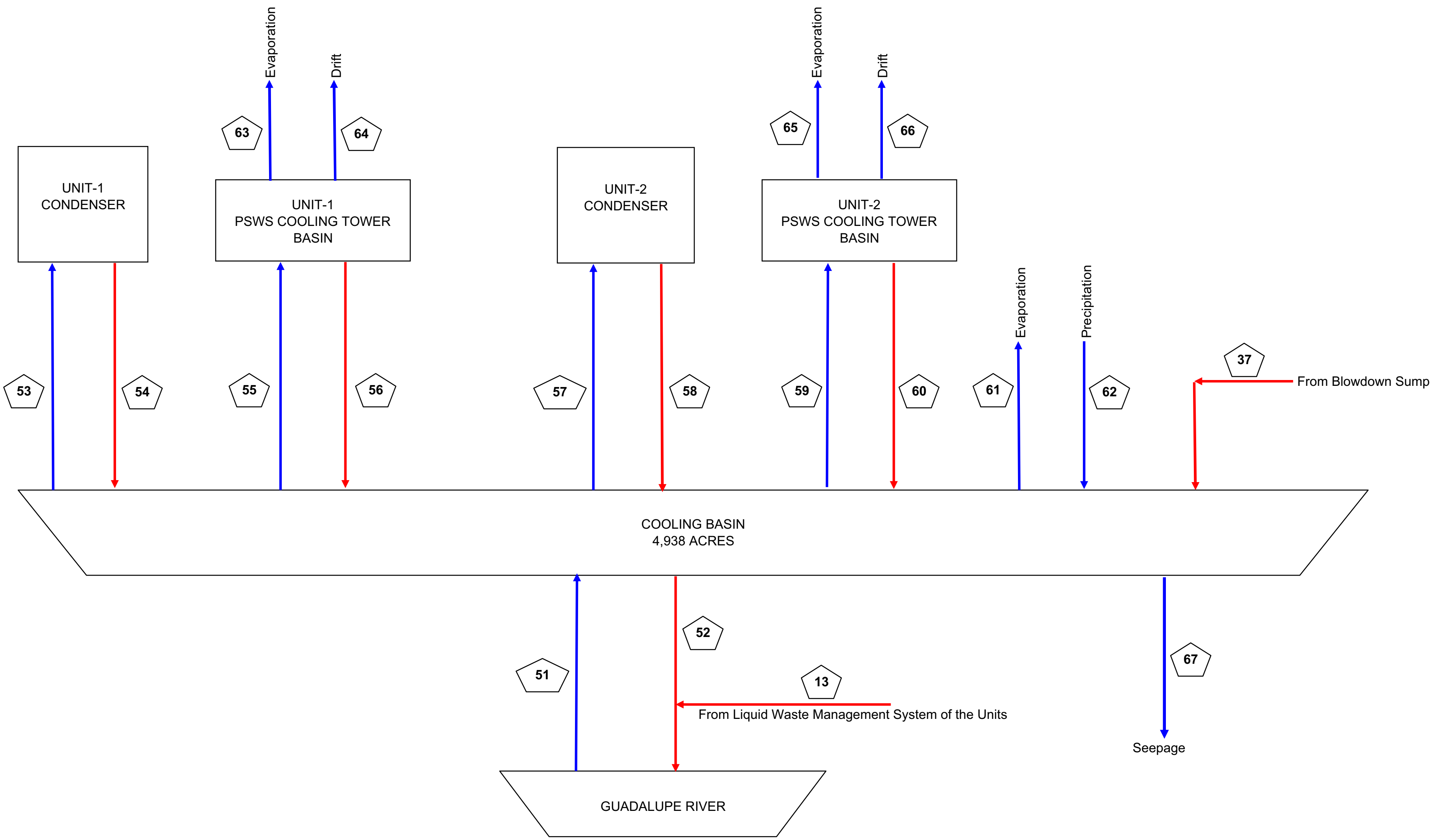

Figure 3.3-2 Surface Water Source Use Diagram

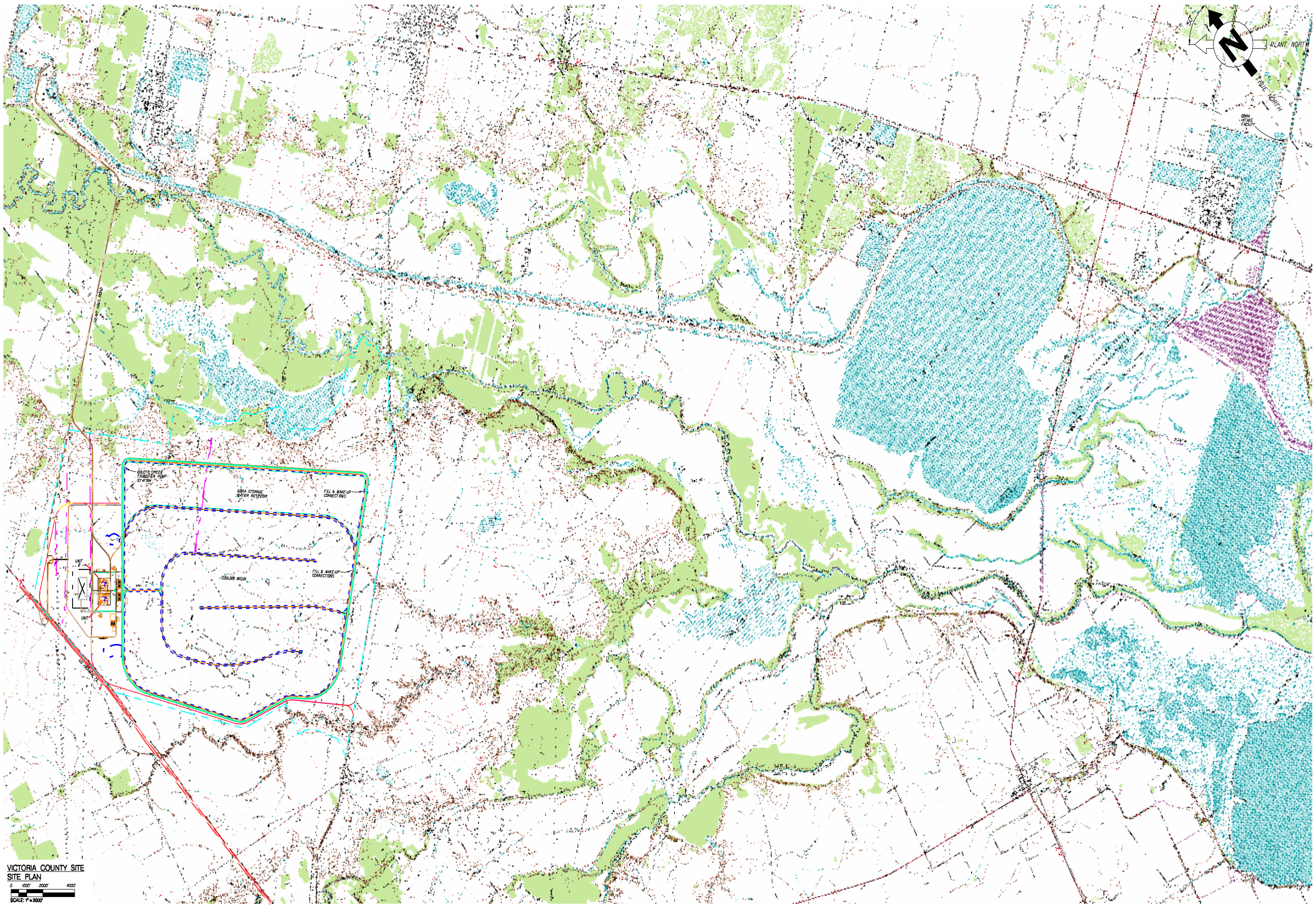

Figure 3.3-3 Site Plan

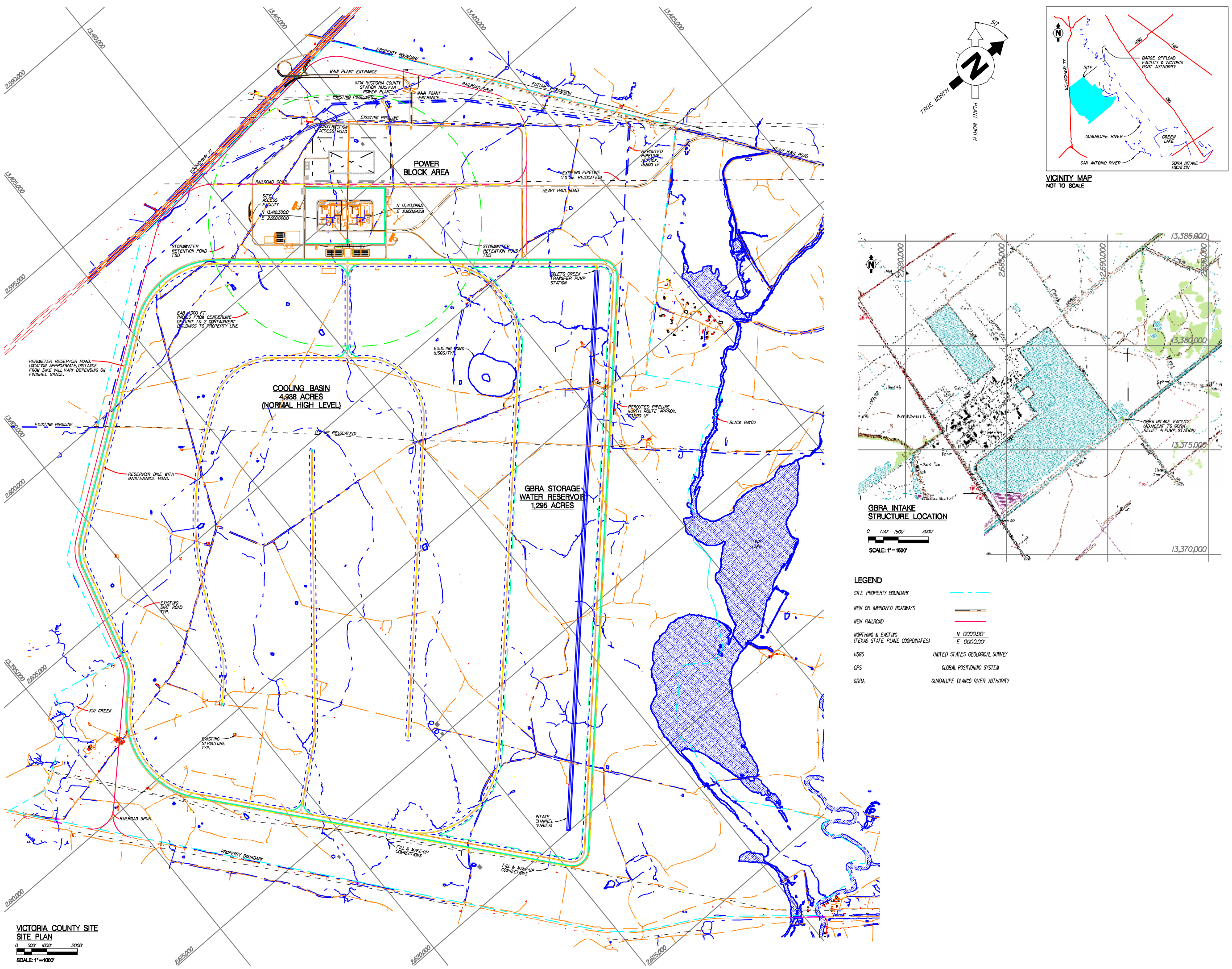

Figure 3.3-4 Power Block, Cooling Basin, and GBRA Intake Structure Location

3.4 Cooling System

VCS Units 1 and 2 cooling systems, operational modes, and component design parameters are determined from the ESBWR DCD (GEH Sep 2007), site characteristics, and engineering evaluations. The plant cooling systems and the anticipated cooling system modes of operation are described in Subsection 3.4.1. Design data and performance characteristics for the cooling system components are presented in Subsection 3.4.2. The parameters provided are used to evaluate the potential impacts to the environment from the cooling system operation. The environmental interfaces occur at the raw water makeup (RWMU) system intake structure on the main canal in the Calhoun Canal System of the Guadalupe-Blanco River Authority (GBRA), the blowdown discharge outfall at the Guadalupe River, the cooling basin, and the plant service water system (PSWS) cooling towers. Figure 3.4-1 is a general flow diagram of the cooling water systems for VCS Units 1 and 2.

The cooling system design for VCS separates the normal cooling and the emergency cooling systems. There is no interconnection or inter-system reliance between normal cooling and emergency cooling systems. The emergency cooling system for VCS is provided by the ultimate heat sink, described in FSAR Subsection 9.2.5, which is not affected by the normal cooling system.

3.4.1 Description and Operational Modes

The cooling system selection for VCS Units 1 and 2 requires consideration of the total amount of heat rejected by the facility and the impacts of the rejected heat on the environment. Site-specific characteristics are used in combination with the ESBWR design parameters to provide an evaluation of the impacts on the VCS site during the operation of the two new units. The construction and operation of the new cooling systems, including the RWMU intake and cooling basin blowdown discharge outfall, will meet the requirements of the Federal Water Pollution Control Act (FWPCA), commonly referred to as the Clean Water Act.

3.4.1.1 Normal Plant Cooling

3.4.1.1.1 Circulating Water System

The circulating water system (CIRC) provides cooling water to remove power cycle heat from the main condenser of each unit and transfers this heat to the cooling basin, which will be the normal power heat sink. The CIRC for VCS will be a closed-cycle system that uses the cooling basin for heat dissipation. Makeup water to the cooling basin will be supplied from the Guadalupe River via the GBRA Calhoun Canal System. The CIRC is not a safety-related system. The CIRC does not interface with any safety-related structures, systems, and components.

The CIRC of each unit will transfer up to approximately 9.878×10^9 Btu/hour (1.976×10^{10} Btu/hour for two units) of rejected heat during normal plant operation at full load. The CIRC will use the cooling basin, with a nominal surface area of approximately 4900 acres, for heat dissipation. The exhaust from VCS Units 1 and 2 steam turbines will be directed to surface condensers (i.e., the main condensers), where rejected heat is transferred to the circulating water. The heated circulating water from the main condensers will be discharged to the cooling basin where the heat content of the circulating water is transferred to the ambient air via evaporative cooling, conduction, and back radiation. After passing through the cooling basin, the cooled water will be pumped to the main condensers from the cooling basin intake structure to complete the closed cycle circulating water loop. Figure 3.4-2 shows the general layout of the cooling basin in relation to VCS Units 1 and 2 power blocks, cooling basin intake structure, and cooling basin discharge structure.

The CIRC for VCS Units 1 and 2 will consist of four pumps per unit that circulate water at a nominal rate of 1,100,000 gpm per unit (2,200,000 gpm for both units). The circulating water pumps, located at the cooling basin intake structure, will take suction from the pump forebay, pump the water through the condensers and then return the heated water to the cooling basin via a discharge structure. Figure 3.4-2 shows the location of the VCS Units 1 and 2 circulating water intake and outfall structures, respectively. The circulating water temperature rise through the condensers will be about 18°F.

The cooling basin will also provide makeup to the PSWS and receive blowdown from it in return. The PSWS makeup pumps will be located inside the cooling basin intake structure.

As shown in Figure 3.4-2, the cooling basin will be completely enclosed by embankment dams consisting of clay or clayey sand fill that will be constructed above ground. Internal earth dikes inside the cooling basin will be used to guide the flow circulation from the cooling basin discharge structure to the cooling basin intake structure. The objective is to optimize the cooling basin's capability to dissipate heat by reducing ineffective surface areas and potential short circuiting in the flow path. The bottom of the cooling basin will be graded to a nominal elevation of 69 feet (NAVD 88) for the most part, with a portion toward the south where the bottom of the cooling basin will follow the existing natural grade that varies between elevation 66–69 feet (NAVD 88). The elevation of the top of the exterior embankment dams will be 102 feet (NAVD 88), except at a few locations that need to be elevated to accommodate crossings over piping and spillways. The top elevation of the internal dike will be at 99 feet (NAVD 88). The exterior embankment dams will be approximately 25 feet wide at the top and be constructed with an exterior slope of 3 horizontal (H) to 1 vertical (V) and an interior slope of 4H to 1V. The internal dikes will have a slope of 3H to 1V on both sides.} At the design pool level of 90.5 feet (NAVD 88), the cooling basin will have a minimum water depth of 21.5 feet at the northern shallower end that will get deeper towards the southern end. The storage volume of the cooling basin at the design pool level is approximately 101,300 acre-feet. The normal maximum operating level of the cooling basin will be 91.5 feet (NAVD 88) that includes an operating range of 1 foot. The storage volume of the cooling basin is approximately 106,200 acre-feet when the basin water level reaches the normal maximum operating level. At the water level of 73.5 feet (NAVD 88), the cooling basin capacity is approximately 19,000 acre-feet, which allows operation of all four CIRC pumps of each unit and meets the plant thermal performance requirements with intake temperature less than 100^{o}F. The minimum cooling basin water level required for the CIRC pump operation, also referred to as the design low water level for the cooling basin, will be 71.5 feet (NAVD 88).

Thermal performance of the cooling basin has been evaluated at the design pool level of 90.5 feet (NAVD 88) and at lower basin water levels down to 73.5 feet (NAVD 88), based on 60 years of historical meteorological conditions representative of the region from 1947 to 2006. The analysis demonstrates that the cooling basin thermal performance meets the plant performance requirements at the design pool level and at reduced basin levels to 73.5 feet (NAVD 88), with both units in full load operation rejecting heat at 1.976 x 10^{10} Btu/hour. The results are further described in Subsection 3.4.2.

The Guadalupe River will be the source of the makeup water to the cooling basin. River water is diverted into the GBRA Calhoun Canal System (GCCS), owned in part by the GBRA, at the river diversion gates located on the Guadalupe River immediately upstream of the Lower Guadalupe diversion dam and saltwater barrier. Makeup water will be pumped into the cooling basin via a new RWMU system intake structure to be constructed on the main canal of the GCCS. The only natural inflow into the cooling basin will be direct rainfall, as the cooling basin is self-contained and has no other contributing drainage area.

In addition to providing makeup water to the cooling basin to compensate for the inventory lost by evaporation, seepage and blowdown, the RWMU system will also supply water to the GBRA storage water reservoir (GSWR) that will be constructed adjacent to the cooling basin on the VCS site. The GSWR will be separated from the cooling basin by an embankment dam, and will be part of the water supply system upgrades that store water for the Coleto Creek Reservoir and other water users.

The RWMU system will include a pump intake structure sized for four main pumps, a 15% capacity pump dedicated for low flow conditions, and a 90-inch diameter makeup water pipeline. The RWMU pumphouse/ forebay structure will be located on the GBRA Main Canal, approximately 18 miles southeast of the VCS site. The RWMU system will be capable of providing approximately 267 cfs (120,000 gpm) to meet the design basis peak makeup flow rate. Makeup water supply will be limited to a maximum of 217 cfs (97,500 gpm) and 50 cfs (22,500 gpm) to the cooling basin and the GSWR, respectively. Under the water reservation agreement between Exelon and the GBRA, the surface water source makeup to cooling basin provided by the GBRA is limited to 75,000 acre-feet per year (46,500 gpm), subject to run-of-river availability, and the instantaneous maximum makeup flow rate is limited to 187 cfs (84,000 gpm). The average pumping flow rate will be approximately 125 cfs (56,200 gpm) with 103.5 cfs (46,500 gpm) supplied to the cooling basin and 22 cfs (9700 gpm) supplied to the GSWR. These normal and maximum flow rates were adjusted as part of the detailed plant water balance presented in Table 3.3-2 and Figure 3.3-2.

A water budget analysis has been performed to demonstrate the capability of the cooling basin to sustain both units in full load operation during historical low flow conditions, including the historical drought of record in the Guadalupe River basin. The required storage volume of the cooling basin was determined based on an annual diversion limit of 75,000 acre-feet, subject to the run-of-river availability, which is in accordance with the water reservation agreement between Exelon and the GBRA. These studies assumed that no water would be pumped to the cooling basin when the cooling basin is filled to the design level, or when no water was available for the plant use because of low flow conditions in the

Guadalupe River basin (see Subsection 5.2.2.1 for more detail). The annual diversion limit of 75,000 acre-feet is based on evaluations of the natural and forced evaporation from the cooling basin and an allowance for seepage and blowdown from the basin. The analysis of the cooling basin water inventory based on these instantaneous and annual flow rates concludes that the allocated cooling basin storage will be adequate to maintain sufficient water for normal operation of VCS Units 1 and 2 during a hypothetical recurrence of the historical drought of record.

3.4.1.1.2 **Plant Service Water System**

The PSWS will provide cooling to the nonsafety-related reactor component cooling water system and turbine component cooling water system heat exchangers, as described in the ESBWR DCD (GEH Sep 2007), Subsection 9.2.1. The PSWS will not perform any safety-related function or interface with any safety-related component. The PSWS has a Regulatory Treatment of Non-Safety Systems (RTNSS) function to provide post-72-hour cooling. The PSWS is required to remove 1.92×10^{10} Btu of heat for a period of 7 days without any active makeup. The plant service water system cooling tower (PSWSCT) basin will be sized to have sufficient storage capacity to meet the above requirement. The PSWS will be a closed-cycle system that uses mechanical draft cooling towers for heat rejection. Makeup water for the PSWS will be supplied from the cooling basin with blowdown returned to the cooling basin.

Each unit will have a PSWS to dissipate up to approximately 3.07×10^8 Btu/hour (6.14×10^8 Btu/hour for two units) of heat from the reactor component cooling water (RCCW) and turbine component cooling water (TCCW) heat exchangers. The TCCW system removes heat from the turbine island auxiliary equipment and transfers the heat to the PSWS via the TCCW heat exchangers. The RCCW system removes heat from the nuclear island auxiliary equipment and dissipates heat to the PSWS via the RCCW heat exchangers. The water from the PSWS cooling tower basin will be pumped through the TCCW and RCCW heat exchangers to the PSWS cooling towers to dissipate heat to the atmosphere.

Each unit of the PSWS will consist of two independent and 100% redundant trains. Four PSWS pumps will be located at the plant service water pumphouse for each unit, and each pump will be sized for 50% of each train flow requirement for plant normal operation. The PSWSCT for each train will be a separate, multicelled, 100% capacity mechanical draft cooling tower. The PSWS heat loads and flow rates during the various operating modes are provided in Table 3.4-1. The table also includes the number of cooling towers and pumps required for various operating conditions such as normal, normal cooldown, single train failure with loss of preferred power and shutdown. Startup and hot standby modes are expected to have the same characteristics of the normal operating condition. The cooling tower internals will be protected from the effects of hurricane-generated missiles. The PSWS supply and return piping between the PSWS pumphouse and the turbine building will be underground. Cold weather bypass lines will be provided for each PSWS return line to allow bypassing the cooling tower fill when the outside temperature is low and cooling tower operation is not required. During cold weather operation, the heated water from the PSWS return line will be discharged directly into the cooling tower basin below the water surface.

PSWS water consumption due to evaporation is estimated to be about 620 gpm per unit during normal conditions and 868 gpm maximum per unit for the loss of preferred power operation with both trains and three PSWS pumps in use. Maximum makeup water flow to the PSWSCT basin from the cooling basin will be 5436 gpm for one unit (10,872 gpm for two units). The blowdown flow from the PSWSCT basin will be discharged to the cooling basin. Maximum blowdown flow will be 4568 gpm for one unit (9136 gpm for two units). Cooling tower drift loss will be about 0.6 gpm for one unit (1.2 gpm for two units). PSWSCT blowdown and makeup rates are based on maintaining 1.19 cycles of concentration in the cooling tower basin water.

3.4.1.2 Post-Accident Cooling

As described in FSAR Subsection 9.2.5, in the event of an accident, the ultimate heat sink will be provided by the isolation condenser/passive containment cooling (IC/PCC) pools, which provide the heat transfer mechanism for the reactor and containment to the atmosphere. To ensure sufficient water inventory for the initial 72 hours of an accident, connections between the dryer/separator pool and IC/PCC pools open passively on low level in the IC/PCC pool. For the post-72-hour cooling, the fire protection system (FPS) provides makeup to the IC/PCC pools and the spent fuel pool through the safety-related portion of the fuel and auxiliary pools cooling system (FAPCS).

The design of the ESBWR separates the safety-related emergency cooling system from the nonsafety-related CIRC and PSWS. As described in ESBWR DCD (GEH Sep 2007) Subsections 5.4.6 and 6.2.2, the IC/PCC pools are located in sub-compartments outside the ESBWR containment and are not affected by atmospheric ice conditions.

3.4.1.3 Other Operational Modes

3.4.1.3.1 Station Load Factor

The ESBWR units are expected to operate with an annualized capacity factor of 96%, taking into consideration scheduled outages and other plant maintenance. For the site, on a long-term basis, an average heat load of approximately 9.483 $x10^9$ Btu/hour (i.e., 96% of the rated heat load of 9.878 $x10^9$ Btu/hour) will be dissipated to the atmosphere per unit.

3.4.1.3.2 River Water Temperature

A review of historical air temperature data indicates that the climate in the vicinity of the site is temperate. Also, there is no record of ice effects. Based on historical data available from representative USGS stations during the period from December 1966 to December 2006, water temperature in the Guadalupe River and San Antonio River in the proximity of the site remained constantly above the freezing point, and the minimum recorded water temperature was about 36.5ºF. Thus, it is concluded that there is no risk of ice formation at the river intake system (the RWMU intake facility), and deicing controls are not necessary.

3.4.1.3.3 Minimum Operating Water Level

The RWMU system and the cooling basin are nonsafety-related facilities and do not perform any safety-related functions. Plant safe shutdown will not depend on minimum water level in the cooling basin or the ability to pump river water to the cooling basin using the RWMU system. The design minimum operating level at the RWMU system intake structure is 24 feet (NGVD 29), which is approximately 23.6 feet (NAVD 88), as shown in Figure 3.4-4.

The design low water level at the cooling basin for CIRC pump operation is established at 71.5 feet (NAVD 88), as shown in Figure 3.4-7. The operating requirements are that the operating units will be shut down if and when the cooling basin water level drops below elevation 71.5 feet (NAVD 88).

3.4.1.3.4 Antifouling Treatment

PSWCT makeup water will be replenished from the cooling basin to compensate for evaporation, blowdown, and drift losses. Water in the PSWSCT basins will be chemically treated to control pH, biofouling, and scale, and also for dechlorination. Dispersants will be added to control fouling of the cooling tower fill material. The chemical type, feed quantity, and duration are described in Section 3.3.

Circulating water will be treated with chemicals injected into the CIRC pumps intake structure forebay to control fouling in the condenser tubes. The treatment will be for biofouling and scale control. The chemical type, feed quantity, and duration are described in Section 3.3. In addition to chemical treatment, a condenser cleaning system will be installed.

Chemical addition of a biocide could be provided at the RWMU system intake structure to prevent biofouling during operation of the RWMU system pumps. The biofouling treatment, if required, would be intermittent as a shock treatment at the pump intake forebay.

3.4.2 Component Descriptions

The design data of the cooling system components and their performance characteristics during anticipated system operation modes is described in FSAR Subsection 9.2.1 and 10.4. Site-specific conditions are used as the basis for design.

PSWS cooling tower design parameters are provided in Table 3.4-2.

3.4.2.1 RWMU System Intake Structure

The RWMU system will provide makeup water for the cooling basin. The RWMU system will withdraw water from the GBRA Calhoun Canal, which is part of the existing GBRA diversion and distribution canal system in Calhoun County, Texas. River water is diverted into the GCCS via the river diversion gates located on the northeast side of the Guadalupe River about 500 feet upstream of the Lower Guadalupe diversion dam and saltwater barrier. As described in Subsection 2.3.1.1, the GBRA Calhoun Canal System consists mainly of man-made and natural canals, siphons, buried pipelines, and a main pump station to lift water from the diversion canal system to the main canal system.

The diversion canal system and the main canal system are both gravity systems and all water supply diversions for Dow, GBRA, and GBRA customers are made from the main canal system. The capacity of the main pump station is about 355 cfs, which provides for 55 cfs to Dow (pursuant to contractual agreement with the GBRA) and about 300 cfs to the GBRA. The impacts due to GBRA system capacity increases are described in Section 5.11.

The RWMU system intake will be located immediately downstream of Relift #1 Pump Station. Makeup water from the RWMU system intake will compensate for the cooling basin water consumed during station operation, including evaporation, blowdown, and seepage. The reinforced concrete construction intake structure of the RWMU system will consist of a four-bay pumphouse with a continuous line of trash racks at the intake, through flow traveling water screens in each pump bay, stop logs, spray wash pumps for the traveling screens, and all necessary support structures.

Design features of the trash racks, traveling screens, trash baskets, and fish return devices, including the maximum and limiting flow velocities at the trash racks and traveling screens, are described in Section 5.3.

The pumping station will be provided with four 33% capacity pumps, each with the capacity of 89 cfs (40,000 gpm) with a total design capacity of 267 cfs (120,000 gpm). In addition, there will be one low capacity pump of 40 cfs (18,000 gpm) capacity installed that will be operated during sustained dry conditions or when the demand to replenish the basins is small. Figures 3.4-3 and 3.4-4 show the plan and section views of the RWMU system intake structure, respectively.

Canal water will be delivered to the cooling basin and the GSWR via a common 90-inch buried pipeline that travels approximately 19.5 miles from the RWMU system intake pumphouse. The makeup water discharge to the cooling basin is through a 90-inch pipe and the makeup water discharge to the GSWR is through a 42-inch pipe.

Operation of the RWMU system would be well-coordinated with the operation of the main pump stations and the river diversion gates. When flow demand to the VCS cooling basin is high, additional pumping will be required from the main pump station to maintain flow and water level in the main canal. When the cooling basin is full and pumping at the RWMU system intake is reduced, the main pump station would be put on reduced capacity before shutting down the RMWU system pumps to prevent overflow in the main canal segment between the two pump stations. The operating procedures of the RWMU system will be finalized and coordinated with the GBRA during detailed design.

3.4.2.2 **Final Plant Discharge**

The cooling basin discharge will be through a new blowdown system to the Guadalupe River. The cooling basin blowdown discharge will be as needed to maintain cooling basin water chemistry by limiting the dissolved solids concentration buildup and also to dilute the radiological concentration within acceptable limits during radioactive liquid waste discharges. The blowdown discharge system will consist of two blowdown pumps, a 48-inch blowdown pipeline, and an outfall at the Guadalupe River with a multi-port diffuser design. The discharge will comply with the Texas Pollutant Discharge

Elimination System (TPDES) permit that will be applied to the outfall at the river. To enhance dilution within a reasonable mixing zone of the discharge outfall, a multi-port diffuser will be used. For the purpose of analysis, the diffuser is assumed to be a 20-foot long end pipe with five 1.75-foot diameter ports. Each of the diffuser ports will be discharging at 3 feet off the river bottom. Riprap protection around the diffuser will be provided to protect the river bed against erosion from the discharge flow. Figure 3.4-5 shows the conceptual design of the diffuser outfall. Subsections 5.3.2.1 and 5.3.2.2.1 provide details of the diffuser thermal performance.

The blowdown facilities will be designed to operate using variable discharge rates up to a design maximum of 40,000 gpm. As described in Section 3.3, a normal blowdown discharge flow of 9833 gpm and a maximum flow of 28,383 gpm were determined from the plant surface water balance. The water balance takes into consideration the allowable makeup rates from the RWMU system along with annual rainfall and the reduction in the cooling basin inventory because of evaporation and seepage. The difference in flow rates between the cooling basin makeup and the inventory loss is available for the cooling basin blowdown to the Guadalupe River.

A cooling basin water budget evaluation, addressed in Subsection 3.4.2.4, was performed to demonstrate the adequacy of the cooling basin water inventory to support operation of VCS 1 and 2 during historical dry conditions, including the historical drought of record. This evaluation assumed that Exelon would implement water conservation programs, including limiting cooling basin blowdown to an average of 2000 gpm. The Exelon water conservation programs are described below.

Restricting blowdown rates during droughts is the best option for managing the cooling basin water inventory when the cooling basin cannot be maintained at normal water levels. VCS would implement water conservation management programs during periods of abnormally low cooling basin water level. The objectives of these programs would be to maximize recycling of liquid radioactive waste and eliminate or minimize the need for discharging radioactive waste and blowing down the cooling basin. The elements of these programs would be:

- Administrative controls (procedural guidance) to terminate blowdown for the cooling basin chemistry control when the basin water level is less than normal operating range.
- Management controls to minimize the storage of radioactive water inside the plant during unit operation.
- Management controls to prevent the introduction of organic compounds in the radwaste systems.
- Chemical and operating controls to maintain optimal performance of the radioactive waste treatment systems.
- Identification and control of water inputs to the liquid radwaste systems. Actions will be taken to minimize the inputs by prioritizing maintenance.

- Planning for additional temporary storage and water treatment systems to supplement permanent radioactive water storage.

These controls are used at Exelon's existing BWR plants and have proven to be effective at conserving water and minimizing or eliminating the need for liquid radwaste discharges.

In addition to water conservation programs, the following mitigation features are available to reduce the amount of water required to be blown down from the cooling basin:

- Condenser Tube Cleaning
- PSWS Chemical Treatment
- CIRC Chemical Treatment

3.4.2.3 CIRC Intake Structure and Discharge Structure in the Cooling Basin

The CIRC intake structure for VCS Units 1 and 2 will be located south of the power block on the northwest side of the cooling basin. Figures 3.4-6 and 3.4-7 show the plan and section view of the CIRC pump intake structure, respectively. The intake structure will accommodate eight concrete volute CIRC pumps,each rated at 275,000 gpm, with a total circulating water capacity for two units of 2,200,000 gpm. There will be three dual flow traveling screens and multiple trash racks serving each pump. The cooling basin pump intake will also accommodate two 20,000 gpm cooling basin blowdown pumps, which are located in a stand-alone bay, and two 5436 gpm PSWS makeup pumps per unit, which share pump bays with the circulating water pumps. Traveling screens will be cleaned of debris via high-pressure spray water jets supplied by the screen wash pumps, also sharing the CIRC pump bays. Trash racks will be cleaned by a set of automatic raking systems per unit. The intake structure will be designed to allow continuous pump operation until the cooling basin water level drops below the design low water level of 71.5 feet (NAVD 88).

The CIRC discharge structure for VCS Units 1 and 2 will be designed to accommodate a total discharge flow of 2,200,000 gpm. There will be four 150-inch diameter circulating water pipes entering the discharge outfall structure. Downstream of the discharge outfall, riprap placement will be provided to prevent erosion. Figures 3.4-8 and 3.4-9 show the design of the discharge structure at the cooling basin.

3.4.2.4 Heat Dissipation System

As stated in Subsection 3.4.1, VCS will use a cooling basin as the normal power heat sink for the CIRC of Units 1 and 2. The heated circulating water from the main condenser of each unit will be discharged to the cooling basin, where the heat content of the circulating water is transferred to the ambient air via evaporative cooling, conduction and back radiation. After passing through the cooling basin, the cooled water will be circulated back to the main condenser through pumping at the cooling basin intake structure, to complete the closed-cycle circulating water loop. The cooling basin will be a nonsafety-related structure.

As shown in Figure 3.4-2, the cooling basin will be completely enclosed by embankment dams consisting of clay or clayey sand fill that will be constructed above ground. Internal earth dikes inside the cooling basin will be used to guide the cooling water circulation from the cooling basin outfall structure to the cooling basin intake structure. The internal dikes will promote surface heat transfer by reducing ineffective surface cooling areas and potential short circuiting in the flow path. For the most part, the bottom of the cooling basin will be graded to a nominal elevation of 69 feet (NAVD 88), with a portion toward the south where the bottom of the cooling basin will follow the existing natural grade that varies between elevation 66 feet to 69 feet (NAVD 88). The elevation of the top of the exterior embankment dams will be 102 feet (NAVD 88), except at a few locations that need to be elevated to accommodate pipe crossings. The top elevation of the interior dike will be at 99 feet (NAVD 88). The exterior embankment dams will be approximately 25 feet wide at the top and be constructed with an exterior slope of 3H to 1V and an interior slope of 4H to 1V. The internal dikes will have a slope of 3H to 1V on both sides. The interior slope of the embankment dams and both sides of the interior dikes will be armored with a layer of soil-cement in a stair-stepped design, to protect against wave-induced erosion. All exterior slopes of all embankments will be covered by vegetation for protection against storm runoff scouring and wind erosion. Other acceptable erosion and slope protection technologies that achieve the same design objectives may be evaluated during detailed design. At the design pool level of 90.5 feet (NAVD 88), the cooling basin will have a minimum water depth of 21.5 feet at the northern, shallower end that will get deeper towards the southern end. The storage volume of the cooling basin at the design pool level is approximately 101,300 acre-feet. The normal maximum operating level of the cooling basin will be 91.5 feet (NAVD 88) that includes an operating range of 1 foot. The storage volume of the cooling basin is about 106,200 acre-feet when the basin water level reaches the normal maximum operating level. The design low water level at the cooling basin for CIRC pump operation is established at 71.5 feet (NAVD 88), as shown in Figure 3.4-7. The operating units will be shut down if the cooling basin water level drops below elevation 71.5 feet (NAVD 88).

The average residence time in the basin is defined as the storage volume divided by the CIRC flowrate, which will be approximately 10 days when the cooling basin is filled to the design pool level. The cooling basin surface area varies slightly with water depth, increasing at a rate of approximately 11 acres for each foot rise in the basin water depth.}

There will be a service road on the top of the embankment dams and interior dikes, and another embankment access road that runs along the outside perimeter of the cooling basin and the GSWR. A drainage ditch between the toe of the embankment and the embankment access road will collect any surface runoff generated on the exterior slope of the embankment dams and the small amount of seepage through the embankments. The ditch will discharge to natural drainage paths through culverts underneath the embankment access road.

The cooling basin will have an emergency spillway to release water during extreme storm events. There will be no normal discharges through this spillway except during storm events that have a return period greater than 100 years. The emergency spillway is designed to pass outflow during a probable maximum precipitation (PMP) event. The emergency spillway will be located near the southern end of the cooling basin embankment dam on the west and will have four slide gates of 6 feet by 7 feet each on top of an ogee weir with a crest elevation at 87 feet (NAVD 88). The spillway gates are designed to open to release flood water only when 1 foot or more of precipitation, which corresponds to a 24-hour storm of 100-year return period or higher, is accumulated in the basin. The maximum water level in the cooling basin during a 72-hour duration probable maximum precipitation (PMP) event is predicted to be about 95.6 feet (NAVD 88), conservatively assuming that all four spillway gates would open fully after the basin water level exceeds 94 feet (NAVD 88). The operating procedure of the spillway gates will be developed during the detailed design phase. The general layout of the cooling basin emergency spillway is shown in Figures 3.4-10 and 3.4-11.

The GSWR will have a similar emergency spillway that is designed with the same hydrologic design criteria of holding at least a 100-year return period storm event and passing the PMP flow. The general layout of the GSWR emergency spillway is shown in Figures 3.4-12 and 3.4-13.

A stilling basin will be installed at the end of each of the spillway channels to dissipate energy in the outflow and to reduce the potential of downstream erosion. The cooling basin spillway flow will discharge to Kuy Creek whereas the spillway flow of the GSWR will discharge to Linn Lake via ravines.

A freeboard analysis to estimate the maximum basin level including the wind wave action, i.e., setup and runup, was conducted to establish the final top elevation of the embankment dams for the cooling basin. The TCEQ publication *Hydrologic and Hydraulic Guidelines for Dams in Texas* (TCEQ Jan 2007) does not provide specific guidelines on the wind condition to use to estimate the maximum wave runup in the determination of the required freeboard of new dams. To evaluate the safety of the cooling basin embankment dams, the following conservative scenarios were considered: (1) a 2-year wind speed in conjunction with the maximum still water level in the basin resulting from the PMP, (2) a probable maximum hurricane (PMH) wind condition with the normal maximum operating water level as the starting basin level, and (3) a 10-year wind speed with the maximum still water level resulting from the PMP. The first two scenarios were conservatively selected based on the combined events criteria in Section 10 of ANSI/ANS-2.8-1992 (ANSI Jul 1992) for safety-related facilities, even though the cooling basin is not a safety-related structure. The last scenario is adopted from the guidelines of the U.S. Department of the Interior, Bureau of Reclamation (USBR 1992) for the design of storage dams. It is further assumed conservatively that the gates of the emergency spillway will not be operable during the PMP resulting in a higher PMP water level of 96.2 feet (NAVD 88) in the cooling basin. Based on the longest fetch distance of about 9000 feet estimated from the physical dimensions of the cooling basin, the worst case maximum water level would be produced by the PMH condition, and was postulated to happen on the north and south embankment dams. Including wind setup and the 2% wave runup, the water level is calculated to be on the order of 0.5 feet or more below the final top elevation of the embankment dams at 102 feet (NAVD 88), which has considered potential construction and post construction settlement. The GSWR will conservatively adopt the same top-of-embankment elevation of 102 feet (NAVD 88) even though it has a lower operating water level (i.e., a lower starting reservoir level than the cooling basin). The wave runup prediction was based on the methodology described in the USACE Coastal Engineering Manual (USACE Oct 2005)

The thermal performance of the cooling basin is evaluated using a one-dimensional multilayer finite difference hydrothermal model that simulates the transient response of a cooling basin or lake to the meteorological conditions and heat load discharge from the plant. The numerical model mathematically simulates the heat transfer and mass balance process that is a result of natural and waste heat inputs, surface cooling and forced circulation induced by the cooling basin intake and discharge systems. Direct precipitation and makeup water inflows to the cooling basin are not simulated, because the inflows are insignificant when compared to the CIRC flow rate. The physical characteristics in terms of surface area and storage volume of the cooling basin, as described above, are represented in the model by a simplified unidirectional flow path in two layers with the CIRC discharge at the upstream end of the model and the CIRC intake at the downstream end of the model.

The cooling basin thermal model predicts the spatial and time variation of water temperature in the cooling basin in response to up to 60 years of historical meteorological conditions and the CIRC system parameters including the design heat duty of 9.878×10^9 Btu/hour per unit (total of 1.976×10^{10} Btu/hour for both units), defined in the model by the CIRC flow rate of 1,100,000 gpm per unit and the condenser temperature rise of 18°F. Water losses from the basin as a result of natural and forced evaporation are predicted as part of the modeling process. The 60 years (from 1947 to 2006) of meteorological data, including dry bulb temperature, wind speed, relative humidity, cloud cover, and solar radiation primarily come from the Victoria Regional Airport meteorological station, supplemented by the data from the Corpus Christi and Galveston stations where there are data gaps. The cooling basin thermal model is calibrated using recent water temperature data measured at a cooling pond in the region.

Thermal performance of the cooling basin is simulated at the design pool level of 90.5 feet (NAVD 88) and at lower basin water levels down to 73.5 feet (NAVD 88), based on the full load conditions for both units. The model results demonstrate that the cooling basin thermal performance meets the plant performance requirements that the intake temperature be less than 100°F, as stated in the ESBWR DCD (GEH Sep 2007) at the design pool level, and at reduced basin levels to 73.5 feet (NAVD 88), with both units in full load operation rejecting heat at a total rate of 1.976×10^{10} Btu/hour. Specifically, the maximum daily average temperature at the intake (i.e., the cold side), with the basin at the design pool level, is predicted to be about 95.8°F. The cooling basin intake water maximum, minimum, and average predicted temperatures with both units in full load operation for each month are presented in Table 3.4-3. This maximum temperature condition occurs in August 2004 in the modeling period. The maximum daily average cold side temperature, with the basin at 73.5 feet (NAVD 88), is 97.4°F in the same month. The annual combined natural and forced evaporation losses from the cooling basin are estimated to vary from a maximum of about 172.5 inches to a long-term average of about 158.0 inches at the design pool level. The evaporation loss varies very slightly with different basin water levels. For instance, the thermal model predicts that at a basin water level of 77.5 feet (NAVD 88), the annual maximum evaporation loss is about 176 inches and the long-term average is about 161.7 inches.

Taking into account the reduced surface area at lower water depths, the total evaporation losses actually decrease by about 1% at the reduced cooling basin water level of 77.5 feet (NAVD 88), comparing to the design pool condition. The predicted cooling basin maximum, minimum, and average evaporation losses with both units in full load operation at the design pool level of 90.5 feet (NAVD 88) for each month are presented in Table 3.4-4.

Blowdown capability will be provided to maintain adequate water chemistry in the cooling basin as described in Subsection 3.4.2.2. During drought conditions, water level in the cooling basin is likely to drop below the design pool level, because of natural evaporative losses, basin seepage, and plant-induced water losses such as forced evaporation and basin blowdown, until the RWMU system intake structure can resume pumping. A water budget analysis for the cooling basin has been performed to evaluate the impacts of potential drought conditions on plant operation, assuming a repeat of the historical hydrometeorological conditions from 1947 to 2006, including the historical drought of record. Inflow to the cooling basin includes direct precipitation and the makeup water flow rate subject to the run-of-river availability, and the annual diversion limit of 75,000 acre-feet to the cooling basin and a maximum instantaneous pumping rate of 187 cfs in accordance with the water reservation agreement between the GBRA and Exelon. The outflow from the cooling basin includes the natural and forced evaporative water losses, seepage through the bottom of the cooling basin and through the embankments, and blowdown discharges. For direct precipitation, the historical rainfall record is available from the Victoria Regional Airport meteorological station. The run-of-river availability at the RWMU system intake location in the GBRA main canal, for the model period of 1947 to 2006, is projected based on an extension to 2006 of the conservative “Full Authorization” simulation, in which all water rights in the river basin use their maximum authorized amounts, of the Guadalupe-San Antonio River Basin Water Availability Model (GSA-WAM) for the region. The period of record for the existing GSA-WAM is 1934 through 1989. The extension of the GSA-WAM to 2006 is based on a simplified hydrologic data extension that relies on gaged stream flow for the 1990 to 2006 period, with limited adjustments for flow naturalization. The extended GSA-WAM streamflow values, in a monthly interval, are disaggregated and redistributed to daily values based on historical daily streamflow patterns and used as input to the water budget model. For the basin outflow, the combined natural and forced evaporative losses are estimated using the cooling basin thermal model described above. A total seepage rate of 2200 gpm, which includes 40 to 400 gpm of seepage through the embankment dikes of the cooling basin, and seepage through the cooling basin bottom as estimated by the groundwater model described in Section 2.3.1.2, is used to represent the total seepage losses from the cooling basin. The blowdown outflow is represented in the model as a continuous discharge of 2000 gpm as explained in Subsection 3.4.2.2. Also included in the inflow is a small effluent flow from the plant’s wastewater treatment system described in Section 3.3. The results of the water budget model indicate that there is sufficient inventory in the cooling basin to support plant cooling water needs during the repeat of the historical regional drought of record. It is predicted that with the operation of the two units at a long-term average station factor of 96%, the water level is not expected to drop below 73.5 feet (NAVD 88), even at the return of the drought of record. The thermal performance analysis of the cooling basin also indicates that the cooling basin will perform adequately for a cooling basin water level as low as 73.5 feet (NAVD 88) with both units in full load conditions. The cooling basin will allow cooling water pump operation until the water level is below the design low water level of 71.5 feet (NAVD 88).

3.4.3 **References**

ANSI Jul 1992. American Nuclear Society, ANSI 2.8-1992, *Determining Design Basis Flooding at Nuclear Power Reactor Sites*, July 1992.

GEH Sep 2007. ESBWR Design Control Document No.: 22A6642AY, Revision 4, September 2007.

Ryan 1973. Ryan, P. J. and D. R. F. Harleman. *An Analytical and Experimental Study of Transient Cooling Pond Behavior,* Report 161, Ralph M. Parsons Laboratory, Massachusetts Institute of Technology, 1973.

TECQ Jan 2007. Texas Commission on Environmental Quality, *Dam Safety Program Hydrologic and Hydraulic Guidelines for Dams in Texas*, January 2007.

USACE Oct 2005. U.S. Army Corps of Engineers, Coastal Hydraulics Laboratory, EM1110-2-1100, Coastal Engineering Manual, October 2005.

USBR 1992. U.S. Department of the Interior, Bureau of Reclamation *Freeboard Criteria and Guidelines for Computing Freeboard Allowance for Storage Dams*, Acer Technical Memorandum No. 2, Revised 1992.

Table 3.4-1
PSWS Heat Loads and Flow Rates per VCS Unit

Mode	Total Flow, gpm	Total Heat Load, BTU/hr (MW)	Number of Trains in Service	Number of Pumps in Service	Train	Number of Pumps in Service Per Train	Flow Rate per Train gpm	Heat Load per Train, BTU/hr (MW)
Normal Operation	40,000	2.98×10^8 (87.2)	2	2	A	1	20,000	1.49×10^8 (43.6)
					B	1	20,000	1.49×10^8 (43.6)
Normal Cooldown	60,000	3.99×10^8 (116.9)	2	3	A	2	40,000	2.66×10^8 (77.9)
					B	1	20,000	1.33×10^8 (39)
Single Train Failure Cooldown	40,000	2.60×10^8 (76.1)	1	2	A or B	2	40,000	2.60×10^8 (76.1)
LOPP Operation Single Train Failure 2 PSWS Pumps	40,000	2.52×10^8 (73.9)	1	2	A or B	2	40,000	2.52×10^8 (73.9)
LOPP Operation Both Trains 3 PSWS Pumps	60,000	4.09×10^8 (120)	2	3	A	2	40,000	2.73×10^8 (80)
					B	1	20,000	1.36×10^8 (40)
Shutdown	20,000	2.89×10^8 (84.8)	1	1	A or B	1	20,000	2.89×10^8 (84.8)

Note: LOPP – Loss of Preferred Power

Table 3.4-2
PSWS Cooling Tower Design Parameters

Parameter	Value
Cooling tower type	Industrial concrete counter flow, mechanical draft
Total number of cooling towers at VCS	4
Number of PSWS cooling towers per unit	2
Width of PSWS cooling tower	63 feet
Length of PSWS cooling tower	129 feet
Diameter of individual fan outlet	32.8 feet
Number of fans per PSWS cooling tower	2
PSWS cooling tower height	56 feet
Heat Load (per unit)	90 MW (3.7 x 108 Btu/hr)
Maximum drift	0.6 gallons per minute
PSWS flow rate during normal operation (per unit)	40,000 gallons per minute
Cooling range	15.4°F
Design wet bulb temperature	81.3°F
Design cold leg temperature	88.0°F
Air flow rate per fan	1,628,300 cubic feet per minute
Sound Level (total tower contribution)	52 dBA at 400 feet

Table 3.4-3
Predicted Cooling Basin Intake Temperatures
(Based on 100% load condition for both VCS Units 1 and 2)

Temperature(°F)			
Month	**Maximum**	**Minimum**	**Average**
January	75.9	47.4	64.0
February	77.2	50.0	65.7
March	80.8	56.8	70.2
April	85.9	65.8	76.0
May	90.1	72.7	82.3
June	93.9	78.0	87.9
July	95.4	83.4	90.1
August	95.8	83.8	90.3
September	94.6	77.6	87.5
October	94.5	66.9	81.2
November	84.3	58.9	72.8
December	79.4	47.8	65.9

Note: Based on Daily Average Temperatures, at Design Pool Level of 90.5 feet (NAVD 88)

Table 3.4-4
Predicted Cooling Basin Evaporation Losses
(Based on 100% load condition for both VCS Units 1 and 2)

Evaporation (inches)			
Month	**Maximum**	**Minimum**	**Average**
January	11.5	6.4	9.3
February	11.1	5.1	8.8
March	13.0	8.1	10.9
April	14.4	9.7	12.0
May	17.4	11.5	14.2
June	18.3	12.8	16.0
July	20.2	14.3	17.5
August	19.2	14.7	17.3
September	18.8	14.1	16.0
October	18.6	11.5	14.6
November	14.1	9.4	11.9
December	11.6	7.5	9.6

Note: Based at Design Pool Level of 90.5 feet (NAVD 88), includes both natural and forced evaporation

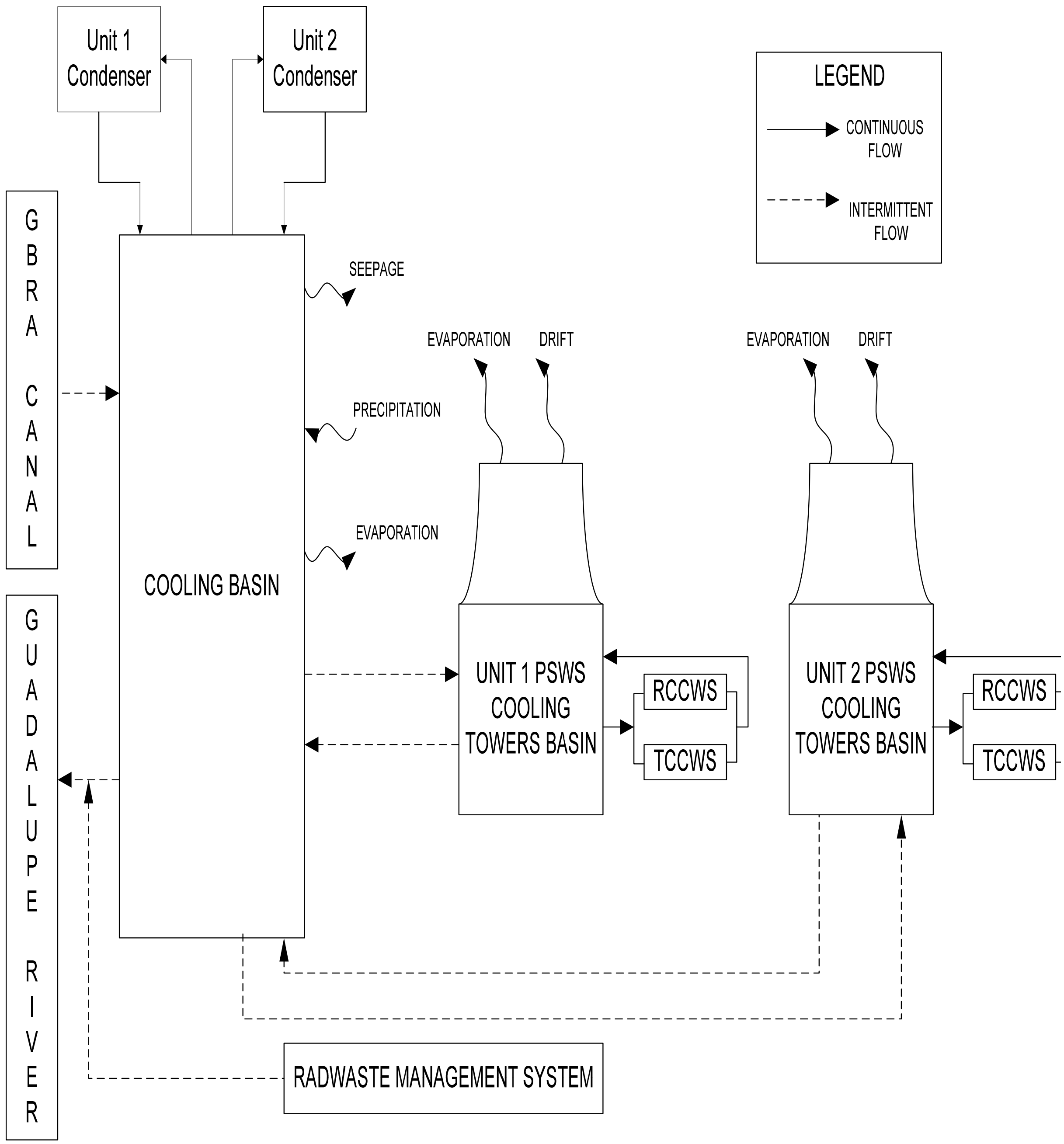

Figure 3.4-1 VCS Cooling Water Flow Diagram

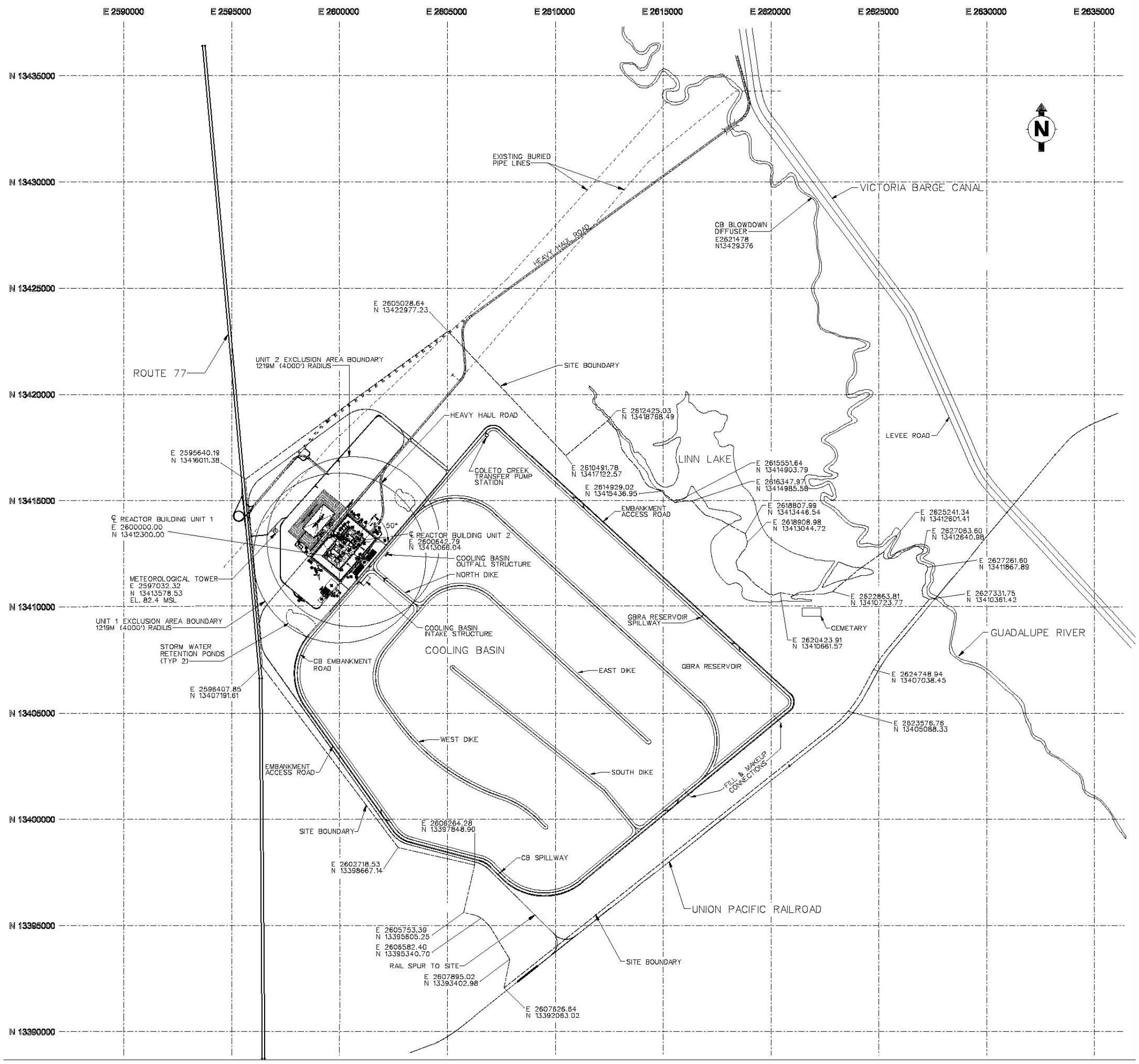

Figure 3.4-2 VCS Cooling Basin

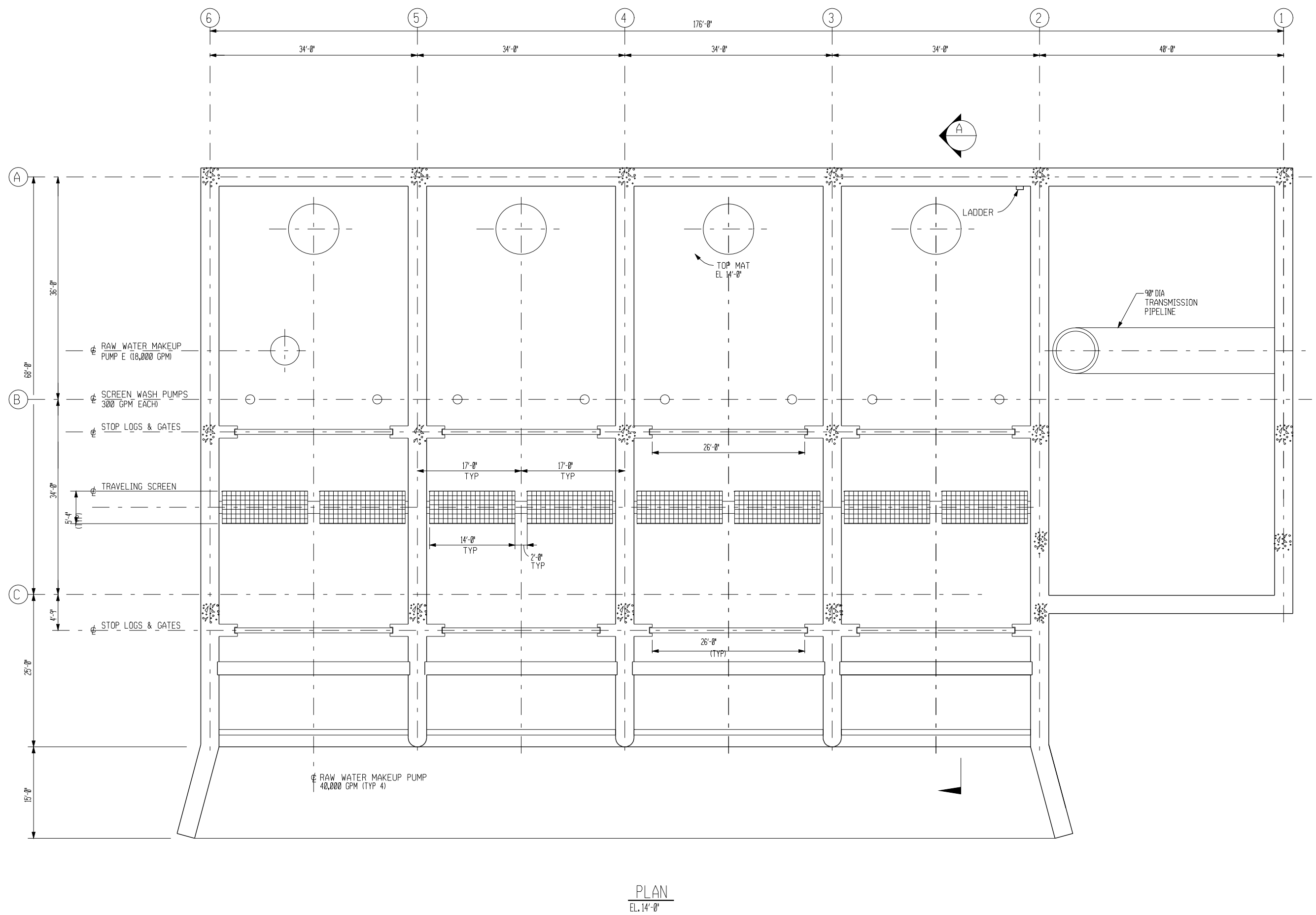

Figure 3.4-3 VCS Units 1 and 2 RWMU Intake Structure (Plan View)

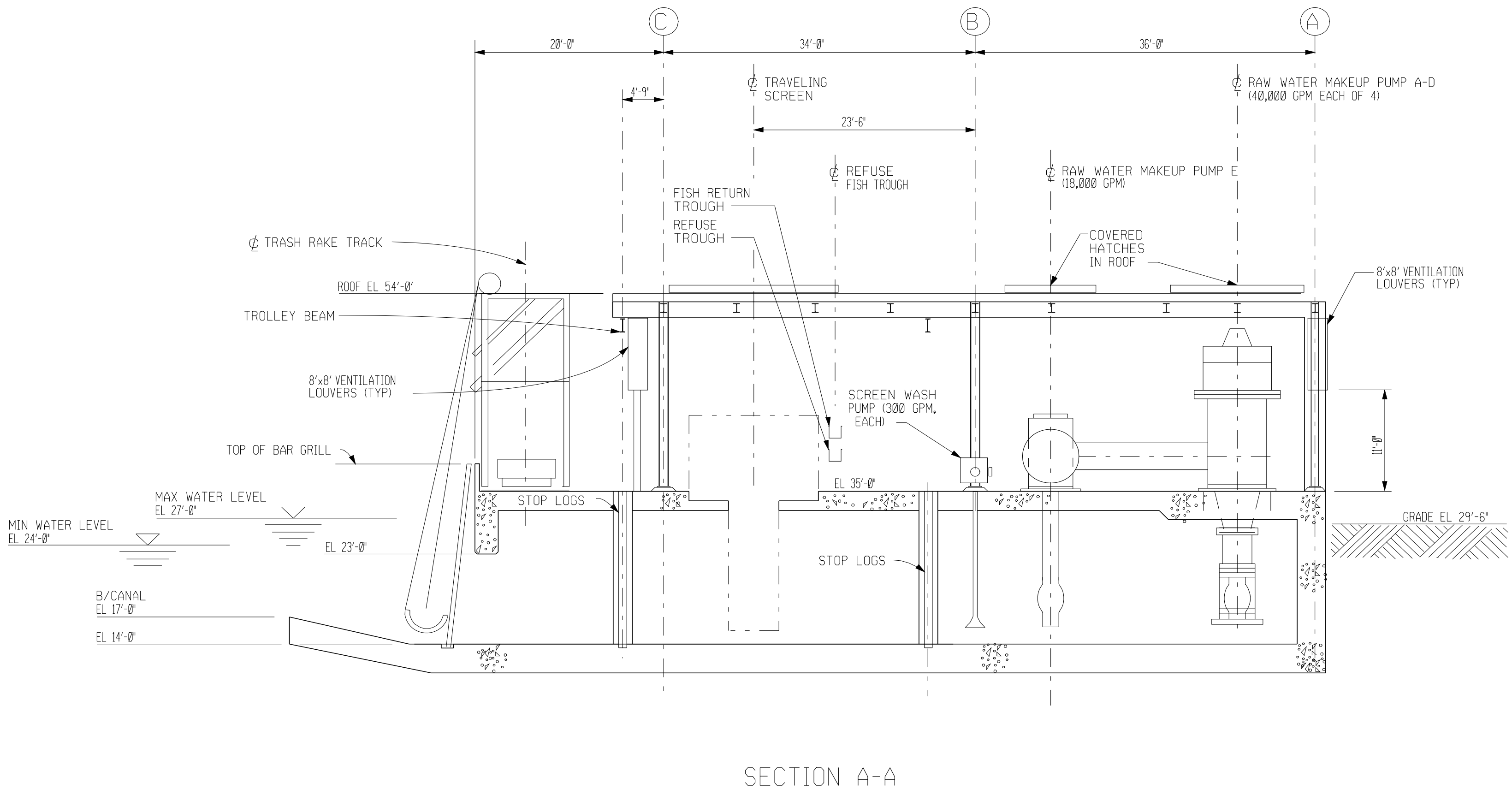

Figure 3.4-4 VCS Units 1 and 2 RWMU Intake Structure (Section View)
(Elevations in this figure are given in NGVD 29)

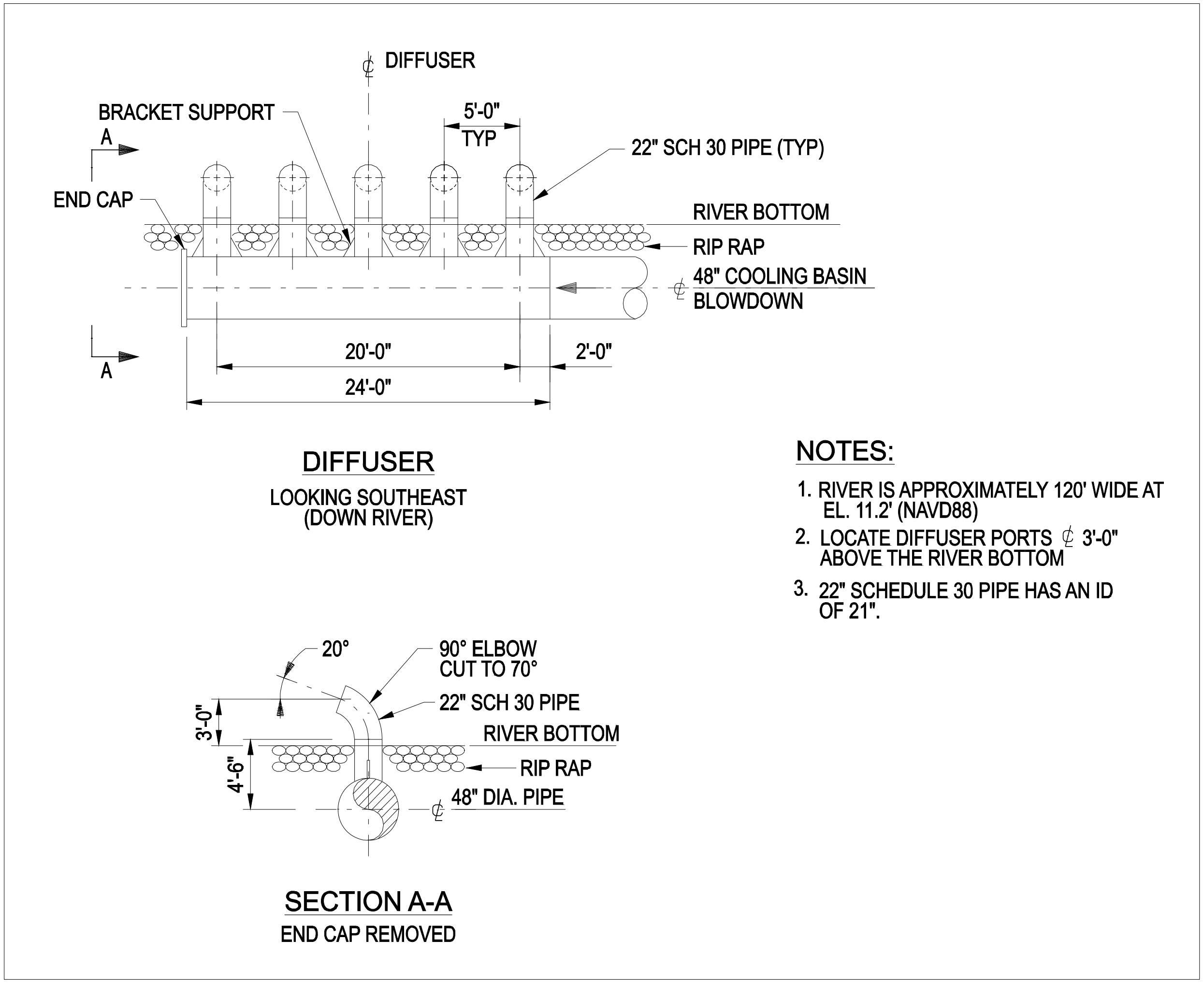

Figure 3.4-5 VCS Units 1 and 2 Blowdown Discharge Outfall

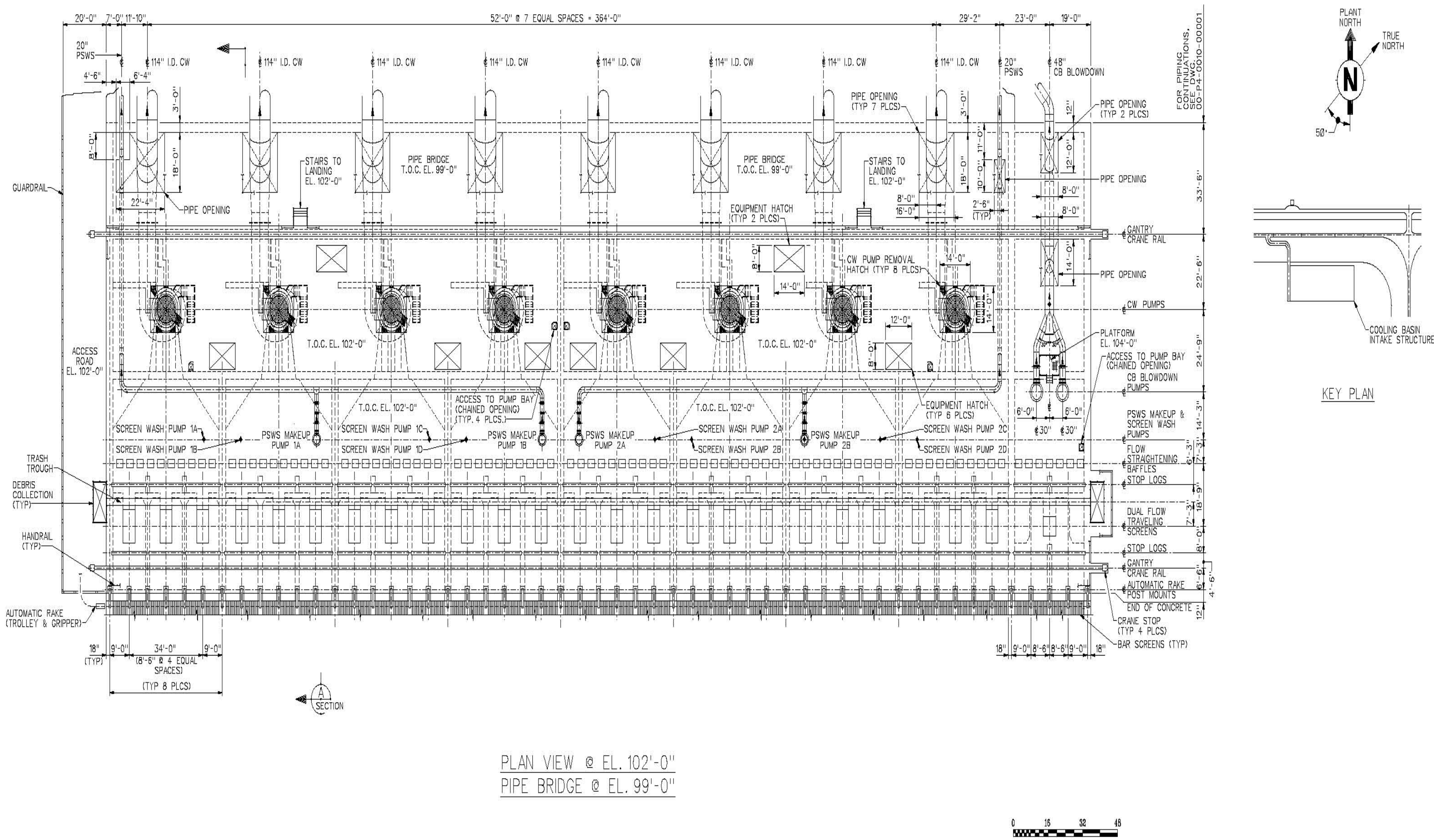

Figure 3.4-6 VCS Units 1 and 2 Cooling Basin Intake Structure (Plan View)

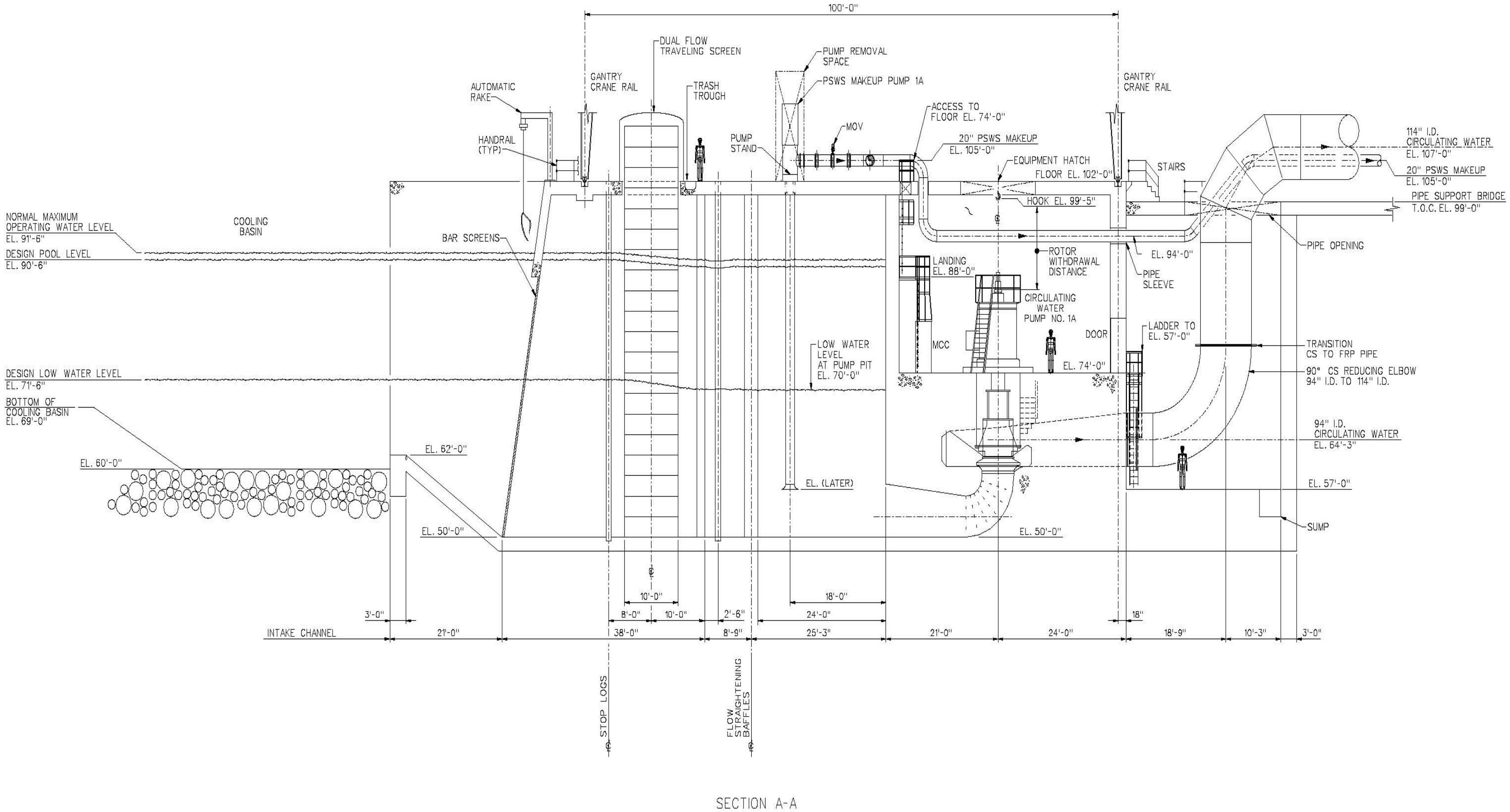

Figure 3.4-7 VCS Units 1 and 2 Cooling Basin Intake Structure (Section View)

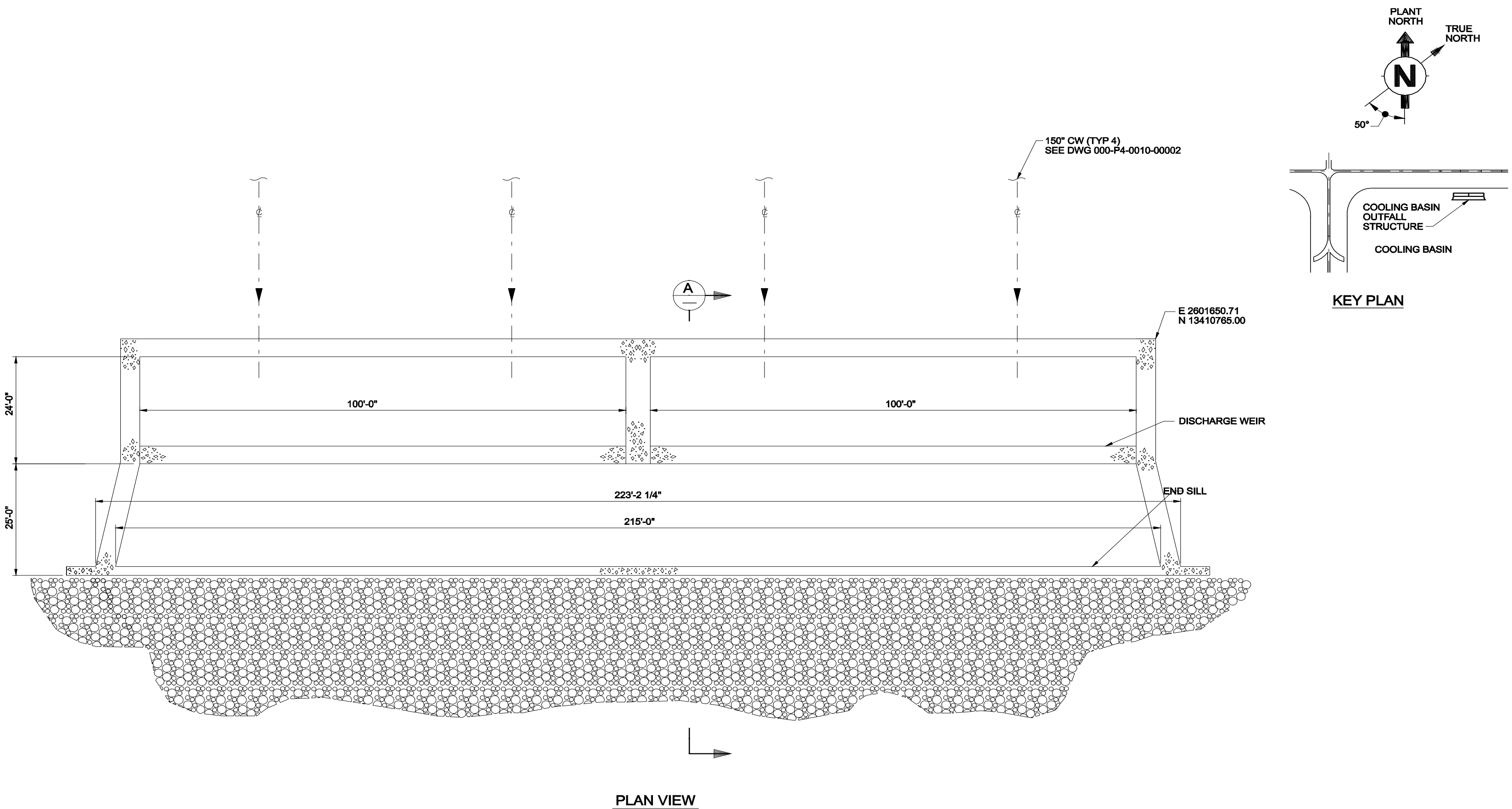

Figure 3.4-8 VCS Units 1 and 2 Cooling Basin Discharge Structure (Plan View)

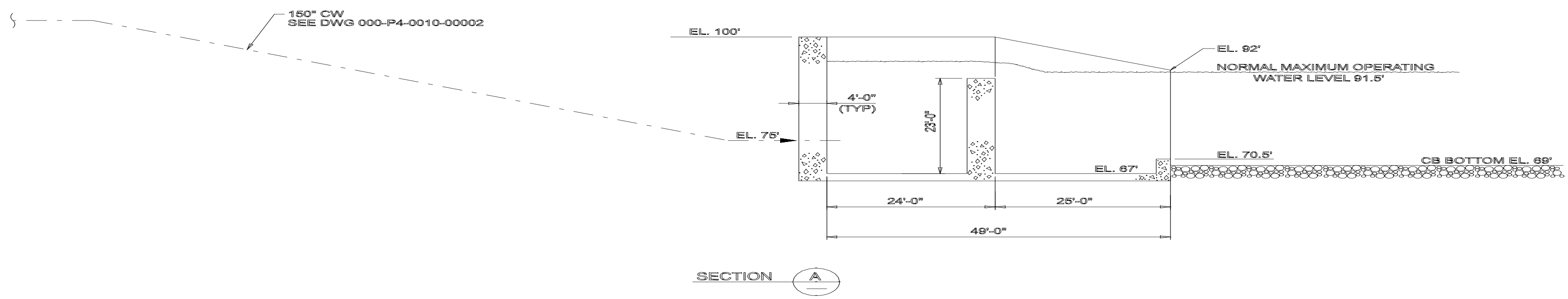

Figure 3.4-9 VCS Units 1 and 2 Cooling Basin Discharge Structure (Section View)

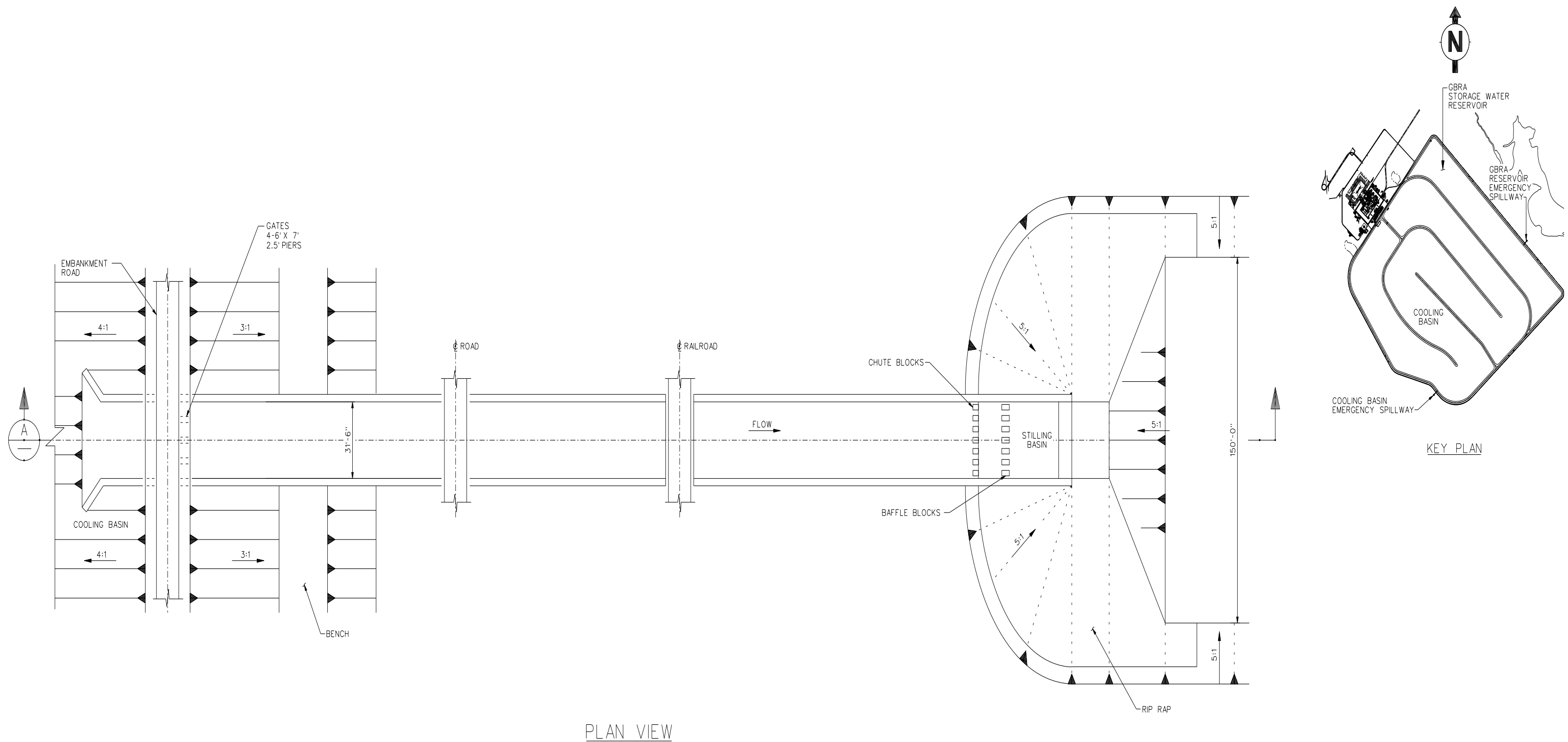

Figure 3.4-10 VCS Units 1 and 2 Cooling Basin Emergency Spillway General Layout (Plan View)

Figure 3.4-11 VCS Units 1 and 2 Cooling Basin Emergency Spillway General Layout (Section View)

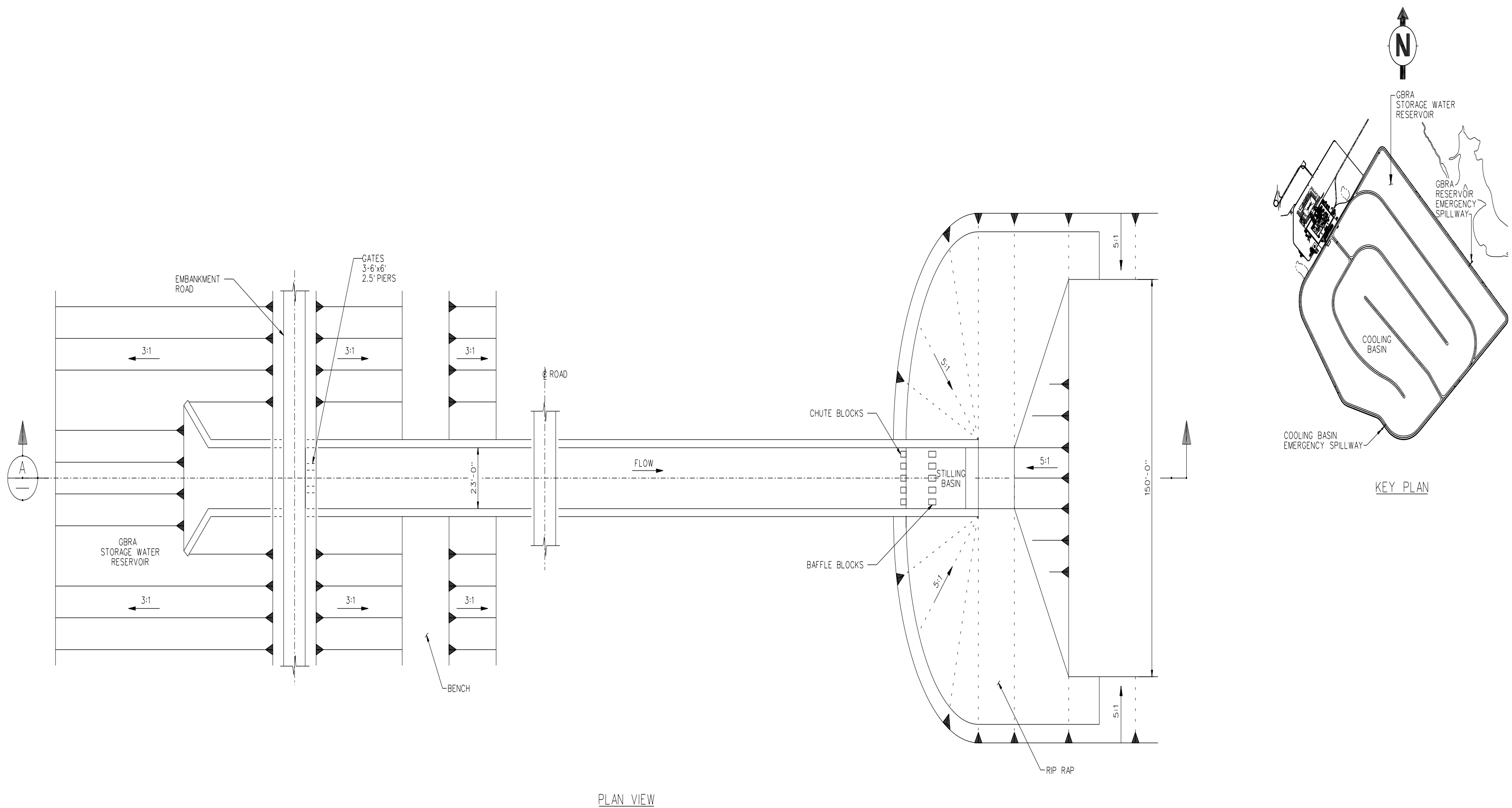

Figure 3.4-12 GSWR Emergency Spillway General Layout (Plan View)

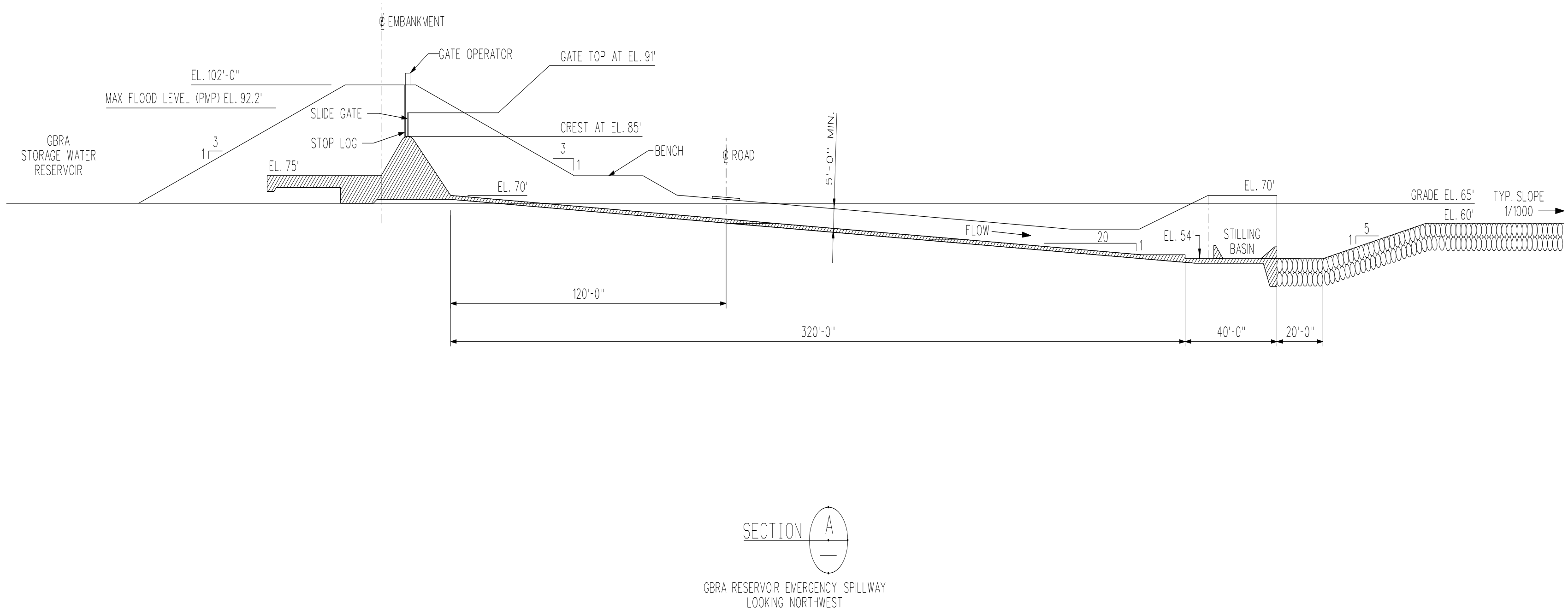

Figure 3.4-13 GSWR Emergency Spillway General Layout (Section View)

3.5 Radioactive Waste Management System

This section describes the liquid, gaseous, and solid radioactive waste management systems proposed to be used at VCS Units 1 and 2. The following sections include the purpose of each system along with the radioisotopic sources, the system influents, a brief system description, and the final disposition of the processed waste streams.

All of the radioactive waste management systems will be designed to keep the radiation exposure of plant personnel ALARA and to ensure offsite radiation exposures are within the limits of 10 CFR 20 and 10 CFR 50, Appendix I.

The components and parameters considered in the benefit-cost balance are provided in FSAR Chapter 11.

3.5.1 **Source Terms**

The information provided in this section defines the radioactive source terms in the reactor water and steam that serve as design bases for the gaseous, liquid, and solid radioactive waste management systems (GEH Sep 2007).

Radioactive source term data for boiling water reactors has been incorporated in ANSI/American Nuclear Society (ANS) 18.1 (ANSI/ANS 1999). This standard provides bases for estimating typical concentrations of the principal radionuclides that may be anticipated over the lifetime of a BWR plant. The source term data is based on the cumulative industry experience at operating BWR plants, including measurements at several stations.

The various radionuclides included in the design basis have been categorized as fission products (noble gas, radioiodine, and other) or activation products (coolant, non-coolant, tritium and Argon-41).

Typical concentrations of the 13 principle noble gas fission products as observed in steam flowing from the reactor vessel are provided in the Source Term Standard ANSI/ANS-18.1. Concentrations in the reactor water are considered negligible under normal power operation because all of the gases released to the coolant are assumed to be rapidly transported out of the vessel with the steam and removed from the system with the other noncondensables in the main condenser. As a result of the rapid removal of the gases, the expected relative mix of gases does not depend on the reactor design (GEH Sep 2007). The design basis principle noble radiogas source terms are presented in the GEH ESBWR DCD Table 11.1-2a, and the normal operation source terms reside in DCD Table 11.1-2b.

The design basis reactor water radioiodine fission concentrations are based on the relative mix of radioiodines in reactor water predicted by the data of Source Term Standard ANSI/ANS-18.1 with magnitudes increased such that the I-131 concentration is consistent with the DCD Table 11.1-1 release rate from the fuel. This provides a margin relative to the expected I-131 release rate shown in DCD Table 11.1-1. Source Term Standard ANSI/ANS-18.1 specifies expected concentrations of the five principal radioiodines in reactor water for a reference BWR design and provides the bases for adjusting the concentrations for plants with relevant plant parameters that do not match those of the reference plant. The concentration adjustment factor calculations are described in DCD Subsection 11.1.3 using the plant parameters in DCD Table 11.1-3. The scale factor required to increase the concentration of I-131 from the concentration calculated using Source Term Standard ANSI/ANS-18.1 to the design basis value is shown in DCD Table 11.1-1. The design basis concentrations are presented in DCD Table 11.1-4a, and the normal operation concentrations are in DCD Table 11.1-4b.

Other fission products include fission products other than noble gases and iodines and also include transuranic nuclides. Some of the fission products are noble gas daughter products that are produced in the steam and condensate system. The only transuranic that is detectable in significant concentrations is Np-239. (GEH Sep 2007) The design basis reactor water concentrations are presented in DCD Table 11.1-5a, and the normal operation concentrations reside in DCD Table 11.1-5b.

Additional information such as release rates and decay times, for noble gas, radioiodine, and other fission products can be found in DCD Subsection 11.1.1.

The coolant activation product of primary importance in BWRs is N-16. ANSI/ANS-18.1 specifies a concentration of N-16 for plants with hydrogen water chemistry. The hydrogen water chemistry concentration is used as the design basis N-16 concentration in steam for the ESBWR shielding design. This is treated as essentially independent of reactor design because both the production rate of N-16 and the steam flow rate from the vessel are assumed to vary in direct proportion to reactor thermal power. The design basis N-16 concentrations in steam and reactor water are shown in DCD Table 11.1-6.

Non-coolant activation products are radionuclides produced in the coolant by neutron activation of circulating impurities and by corrosion of irradiated system materials. Typical reactor water concentrations for the principal activation products are contained in Source Term Standard ANSI/ANS-18.1. The values from Source Term Standard ANSI/ANS-18.1 were adjusted to ESBWR conditions by using the procedure described in DCD Subsection 11.1.3 and appropriate data from DCD Table 11.1-3. These results were increased by the same factor used for the design basis radioiodine concentrations to obtain the conservative design basis reactor water concentrations shown in DCD Table 11.1-7a, with the normal operation concentrations provided in DCD Table 11.1-7b.

Tritium is produced by activation of naturally occurring deuterium in the primary coolant and, to a lesser extent, as a fission product in the fuel. The tritium is primarily present as tritiated oxide. Because tritium has a long half-life (12 years) and is not affected by cleanup processes in the system, the concentration is controlled by the rate of loss of water from the system by evaporation or leakage. The typical concentration of tritium can be found in DCD Subsection 11.1.2.

Ar-41 is produced in the reactor coolant as a consequence of neutron activation of naturally occurring Ar-40 in air that is entrained in the feedwater. The Ar-41 gas is carried out of the vessel with the steam and stripped from the system with the noncondensables in the main condenser. Observed Ar-41 levels are highly variable due to the variability in air in-leakage rates into the system. The design basis for the Ar-41 release rate is specified in DCD Table 11.1-1.

Additional information on activation products can be found in DCD Subsection 11.1.2.

The fuel and auxiliary pools cooling system provides continuous cooling and cleaning of the spent fuel storage pool during normal plant operation. The fuel and auxiliary pools cooling system schematic diagram is found in DCD Figure 9.1-1. A diagram of the HVAC system servicing the fuel pool area is found in DCD Figures 9.4-5 and 9.4-6. Sources of makeup water for the isolation condenser/passive containment cooling system will be the makeup water system during normal operation and the fire protection system for 72 hours to 7 days after an accident. In addition, a connection is available for an outside water source to be used (post-LOCA fill).

The design basis parameter source terms have been provided in DCD Tables 11.1-1, 11.1-2a, 11.1-4a, 11.1-5a, 11.1-6, and 11.1-7a. DCD Table 12.2-15 contains values used in calculating the annual airborne release (leakage rates) source term provided in DCD Table 12.2-16.

The assumptions and parameters (i.e., leakage flow rate and contaminated volume) used to determine the airborne activity levels are tabulated in DCD Table 12.2-23a, and the airborne concentrations in the radwaste building are provided in DCD Table 12.2-23e. The spent fuel pool and equipment areas airborne radioactivity concentrations are tabulated in DCD Table 12.2-23c.

All radioactive release points/paths within the plant are identified and monitored by the process radiation monitoring system. Refer to Subsection 3.5.5 for more information on pathways and estimates of radioactive releases. Doses to the public from the operation of VCS are provided in Subsection 5.4.2.

3.5.2 Liquid Radioactive Waste Management System

The ESBWR liquid waste management system (LWMS) will be designed to control, collect, process, handle, store, and dispose of liquid radioactive waste generated as a result of normal operation, including anticipated operational occurrences. The LWMS is designed so that no potentially radioactive liquids can be discharged to the environment unless they have first been monitored and diluted, as required. Offsite radiation exposures on an annual average basis would be within the limits of 10 CFR 20 and 10 CFR 50. (GEH Sep 2007) This system is not shared between Units 1 and 2.

The primary source of radioactive isotopes in the LWMS will be from non-coolant activation products (i.e., impurities and corrosion products activated by neutron radiation in the reactor vessel). Another source of radioactive materials in the LWMS will be radioiodine fission products and other daughter products produced in the steam and condensate system or other fission products diffusing through fuel cladding, leaching from the fuel itself, or escaping through a fuel cladding leak, should they occur.

The liquid sources of input to the LWMS will be controlled and uncontrolled leakage from the reactor coolant system, reactor coolant and condensate cleanup and purification systems, control rod drive systems, and various cooling systems that may contain radioactive materials. Other possible inputs will be liquids resulting from the decontamination of plant areas and components. Liquid influents will be segregated by activity and water quality in order to ensure selection of the optimum processing technique.

The VCS LWMS design will include the use of both permanently installed tanks and pumps used for collection, transfers, sampling, and recycling or disposal in conjunction with mobile/portable systems used for processing. Depending on the waste stream being processed, the mobile/portable systems will consist of processing techniques such as filtration, activated charcoal adsorption, reverse osmosis, and demineralization. Also, depending on the waste stream being processed, certain pretreatment may be required. This pretreatment could include chemical addition, mixing, settling, and decanting.

Mobile/portable systems will be used so that the processing techniques provide operation flexibility and maintainability to support plant operation. All mobile/portable systems will be fully contained within the radwaste building. Additional information on the mobile/portable systems is provided in DCD Subsection 11.2.2.3, *Detailed System Component Description*. Furthermore, in addition to standard leakage control measures used, the radwaste building tank cubicles will be lined with stainless steel, sufficient to contain the maximum liquid inventory in the unlikely event of a tank failure.

The intent of the LWMS will be to recycle, to the extent practical, processed water back to the plant for reuse. Discharges to the environment will only occur when the plant's water quality, dilution stream availability, or water inventory does not permit recycling. Once all of the requirements are met for discharge to the environment, the LWMS will discharge to the cooling basin blowdown line before the stream is discharged to the Guadalupe River. The blowdown discharge location for the main cooling basin can be seen in Figure 3.1-1. The LWMS will be designed such that no liquids can be discharged unless they have first been monitored and processed, as necessary. The average annual liquid release activities from each ESBWR unit are given in Table 3.5-1.

Additional information on the LWMS is provided in DCD Section 11.2, and a process flow diagram on the LWMS for one unit can be found in DCD Figure 11.2-1. The LWMS interconnections with other systems can be seen in Figure 2.6.2-1, Tier 1 of the ESBWR DCD.

Diagrams of the liquid radioactive waste management system for one unit can be seen in DCD Figures 11.2-1a, 11.2-1b, 11.2-3, and 11.2-4. Tank capacity for the LWMS for one unit can be found in DCD Table 11.2-2a. Design capacity for the permanent components of the LWMS for one unit can be found in DCD Table 11.2-2b and for the mobile systems can be seen in DCD Table 11.2-2c. The probable system inputs for normal and maximum flows and time needed to process the maximum flows for one unit can be found in DCD Table 11.2-4. Decontamination factors for the LWMS can be found in DCD Table 11.2-3.

3.5.3 **Gaseous Radioactive Waste Management System**

The gaseous radioactive waste management system (GWMS) will be designed to process and control the release of gaseous radioactive effluents to the site environs so as to maintain the exposure of persons in unrestricted areas to radioactive gaseous effluents ALARA. This system is not shared between Units 1 and 2.

The two main sources of gaseous radioactive effluents will be the radioactive particulate in the exhaust from the building ventilation systems and the noncondensable gases generated as fission products and disassociation by radiolysis in the reactor and removed from the main condenser via the steam jet air ejectors and sent to the offgas system.

Exhaust ventilation of the radwaste building general areas and reactor building contaminated areas will be filtered through HEPA, carbon filters, or charcoal absorbers and monitored for radioactivity before release from the plant's main stack. Radioactive filters and absorbers will be disposed of in the solid radioactive waste management system.

The offgas system receives the waste stream from the steam jet air ejectors and passes it through a hydrogen recombiner to recombine the radiolytic hydrogen and oxygen. The offgas stream will then pass through a series of coolers, condensers, and dryers to remove essentially all of the moisture. The offgas stream will then be sent through activated charcoal absorber beds, which provide adequate decay time before discharge from the plant. Finally, the waste stream will be sent through radiation monitors before being released to the environs through the plant main stack. The plant main stack location can be seen in Figure 3.1-1. Table 3.5-2 lists the expected gaseous isotopic releases (source terms) from each VCS unit.

Information on the GWMS is provided in DCD Section 11.3 and a top-level diagram for the GWMS for one unit can be found in DCD Figure 11.3-1. The figure shows the release point for the GWMS. Design parameters per unit for the GWMS can be found in DCD Table 11.3-1. The major component design parameters for one unit can be found in DCD Table 11.3-2. The calculations for the gas holdup system per unit can be found in DCD Subsection 11.3.2.1. The estimated quantities and flow rates of gaseous releases per unit are found in DCD Table 11.3-6.

3.5.4 **Solid Radioactive Waste Management System**

The solid waste management system (SWMS) will be designed to control, collect, handle, process, package, and temporarily store wet and dry solid radioactive waste before shipment. This waste will be generated as a result of normal operation and anticipated operational occurrences. This system is not shared between Units 1 and 2.

The SWMS will process the filter backwash sludges, concentrates from reverse osmosis, and bead resins generated by the LWMS, the reactor water cleanup/shutdown cooling system, fuel and auxiliary pools cooling system, and the condensate purification system.In addition, contaminated solids such as HEPA and cartridge filters, rags, plastic, paper, clothing, tools, and equipment will also be collected, sorted and disposed of in the SWMS.

The VCS SWMS design will include the use of both permanently installed tanks and pumps used for collection, mixing, decanting, and transfers of wet solid waste in conjunction with mobile systems used for dewatering the wet solid waste in high-integrity containers (HIC). Separate mobile dewatering stations will be provided for the high and low activity wet solid waste streams. Water removed during the dewatering process will ultimately be sent back to the appropriate collection tank in the LWMS for further processing and recycle or release.

Once the HICs are adequately dewatered, they will be closed for shipment. The HICs will be temporarily stored in a shielded area within the radwaste building before shipment to a burial site for final disposal.

Concentrated liquid waste (i.e., the reject stream from the reverse osmosis membranes in the mobile/portable liquid processing system) will also be collected in the SWMS and may be processed in one of three ways: (1) it may be packaged for shipment to an offsite processor where it will be dried to a granular consistency and then repackaged by the offsite processor for shipment to a burial site for final disposal; (2) a thermal drying system may be purchased or leased, which performs the same processing described in the previous item on site; or (3) using the remaining capacity of the waste resin in either a spent resin holdup tank or in an HIC, the concentrated liquid waste may be demineralized and returned to the LWMS for further processing. The resin will then be dewatered, packaged, and disposed of as described above.

Most dry solid waste is expected to be sufficiently low in activity to permit temporary storage in unshielded, cordoned-off areas. These wastes will be collected in containers located in appropriate areas throughout the plant. The filled containers will be sealed and moved to controlled access areas for sorting, packaging, and temporary storage. The solid waste will be separated into three categories: non-contaminated wastes (i.e., clean waste that can be disposed of as free-release normal trash), contaminated metal waste, and all other waste (i.e., clothing, plastics, paper, HEPA filters, rags, etc.). The radioactive solid waste will be packaged in suitably sized containers that meet DOT requirements for shipment to either an offsite processor for further processing (e.g., recovery or incineration) or for ultimate disposal at a burial site.

In the event that sewage sludge becomes radioactively contaminated (as determined by sampling) above the anticipated background levels and regulations prohibit discharge, the contents of the sludge tank can be pumped to a drying bed. The sludge will be allowed to dry. Once dry, health physics technicians will survey the bed and collect all contaminated sludge for offsite processing and disposal. The contaminated sludge will be packaged in an appropriately sized DOT approved shipping container for disposal at a licensed burial facility. Alternatively, the packaged sludge may be shipped to a third-party vendor for further processing (e.g., volume reduction by incineration), repackaging and final disposal.

Onsite storage space for a 6-month volume of packaged waste is provided in the radwaste building. A license application for near-surface disposal of low-level radioactive waste (LLW) was submitted by Waste Control Specialists, LLC to the Texas Commission on Environmental Quality (TCEQ) in August 2004. In August 2008, the TCEQ issued a draft license (No. R04100) for the proposed disposal site in Andrews County, Texas. Even with the closure of the Barnwell, South Carolina LLW disposal facility to states outside the Atlantic Interstate Low-Level Radioactive Waste Compact, development of the Andrews County LLW disposal facility would provide a permanent disposal facility for Class A, B and C wastes generated by operation of VCS Units 1 and 2 and for other wastes generated by member states of the Texas Low-Level Radioactive Waste Disposal Compact.

In the event that the timing of the development of the Andrews County disposal facility, or a similar facility, does not support disposal of LLW from VCS Units 1 and 2, the following options are available for managing the generated LLW:

- A LLW disposal facility in Clive, Utah could be used for disposal of Class A LLW. Class A LLW generally constitutes approximately 99% by volume of the total LLW for a nuclear power station like VCS (NRC Jan 2007). The 6-month onsite storage space per unit at VCS would provide storage space for significantly longer than six months with prompt disposal of Class A LLW in Clive, Utah.
- A temporary storage facility could be constructed in accordance with the requirements discussed in FSAR Subsection 11.4.1.

The environmental impacts of LLW, including shipment of LLW to offsite disposal facilities, are considered in this Environmental Report. Additionally, the NRC considered the environmental impact of long-term interim storage of LLW generated by nuclear power plants in its *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NRC May 1996) and concluded the impacts would be small. Therefore, if longer-term storage of Class B and C LLW through prompt disposal of Class A LLW or construction of a temporary storage facility at VCS are necessary, the conclusions of the impact analyses presented in this Environmental Report would remain the same. Both wet and dry wastes will be packaged for offsite shipment and burial in accordance with the requirements of applicable NRC and DOT regulations, including 10 CFR 61, 10 CFR 71, and 49 CFR 171 through 180, as applicable. The total predicted yearly activity and yearly generated volume of solid radwaste per unit is listed in the DCD Table 11.4-2.

Additional information on the SWMS is provided in DCD Section 11.4. A process flow diagram and the container storage schemes per unit for the SWMS can be found in DCD Figure 11.4-1, and figures showing the conceptual design for a dewatering system can be found in DCD Figures 11.4-2 and 11.4-3. The SWMS component capacity is found in DCD Table 11.4-1.

3.5.5 **Process and Effluent Monitoring System**

The process and effluent monitoring system allows for determining the content of radioactive material in various gaseous and liquid process and effluent streams (GEH Sep 2007). All radioactive release points/paths within the plant are identified and monitored by this system. All other release points/paths of the plant are located in clean areas where radiological monitoring is not required.

The main purpose for radiation monitoring is to initiate appropriate protective action to limit the potential release of radioactive materials to the environment if predetermined radiation levels are exceeded in major process/effluent streams. Another objective is to provide plant personnel with indication and alarm of the radiation levels in the major process/effluent streams.

The detector locations are selected to monitor the major and potentially significant paths for release of radioactive material during normal reactor operation including anticipated operational occurrences. Monitoring of each major path provides measurements that are representative of releases.

The types of instrumentation, together with pertinent parameters for each subsystem, are presented in DCD Tables 11.5-1, 11.5-2, and 11.5-4. DCD Figure 11.5-1 in conjunction with DCD Table 11.5-3 provides radiation detector locations. DCD Figure 11.5-2 shows the block diagram of a safety-related process and effluent monitoring channel. Signal conditioning units are located in the proximity of the radiation detectors when practical or in the main control room back panel area. Displays for alarm and radiation level are provided at the signal conditioning unit, and also at the main control room console video display units. The safety-related distributed control and information system receives signals from the signal conditioning units, performs control functions and also feeds the signals to the nonsafety-related distributed control and information system for display, alarm, and data recording functions.

For more details on the process radiation monitoring system, refer to DCD Section 11.5. The provisions for sampling liquid streams can be found in DCD Table 11.5-5, and the radiological analysis summary of liquid effluent samples can be found in DCD Table 11.5-7. The provisions for sampling gaseous streams can be found in DCD Table 11.5-6 and the radiological analysis of gaseous effluent samples can be found in DCD Table 11.5-8.

3.5.6 **References**

ANSI/ANS 1999. ANSI/ ANS, 18.1, *Radioactive Source Term for Normal Operation of Light Water Reactors*, 1999.

GEH Sep 2007. GE-Hitachi Nuclear, *ESBWR Design Control Document, Tier 2*, Document 26A6642, Revision 4, September 2007.

NRC May 2006. U.S. Nuclear Regulatory Commission, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, May 2006.

NRC Jan 2007. U.S. Nuclear Regulatory Commission, *History and Framework of Commercial Low-Level Radioactive Waste Management in the United States*, NUREG-1853, January 2007.

Table 3.5-1 (Sheet 1 of 2)
Release Activities in Liquid Effluent (Ci/yr) Per VCS Unit

Isotope	Release Activity Per Unit
I-131	4.19×10^{-3}
I-132	8.19×10^{-4}
I-133	2.10×10^{-2}
I-134	4.00×10^{-5}
I-135	5.41×10^{-3}
H-3	1.40×10^{1}
Na-24	5.11×10^{-3}
P-32	4.19×10^{-4}
Cr-51	1.30×10^{-2}
Mn-54	1.60×10^{-4}
Mn-56	1.30×10^{-3}
Fe-55	2.30×10^{-3}
Fe-59	7.00×10^{-5}
Co-58	4.41×10^{-4}
Co-60	9.00×10^{-4}
Cu-64	1.30×10^{-2}
Zn-65	4.51×10^{-4}
Zn-69m	9.19×10^{-4}
Br-83	9.00×10^{-5}
Sr-89	2.20×10^{-4}
Sr-90	2.00×10^{-5}
Sr-91	1.20×10^{-3}
Y-91	1.40×10^{-4}
Sr-92	2.89×10^{-4}
Y-92	1.10×10^{-3}
Y-93	1.20×10^{-3}
Zr-95	2.00×10^{-5}
Nb-95	2.00×10^{-5}
Mo-99	3.00×10^{-3}
Tc-99m	5.51×10^{-3}
Ru-103	4.00×10^{-5}
Ru-105	1.70×10^{-4}

Table 3.5-1 (Sheet 2 of 2)
Release Activities in Liquid Effluent (Ci/yr) Per VCS Unit

Isotope	Release Activity Per Unit
Te-129m	9.00×10^{-5}
Te-131m	1.00×10^{-4}
Te-132	2.00×10^{-5}
Cs-134	6.81×10^{-4}
Cs-136	4.11×10^{-4}
Cs-137	1.80×10^{-3}
Ba-139	4.00×10^{-5}
Ba-140	8.19×10^{-4}
Ce-141	7.00×10^{-5}
La-142	3.00×10^{-5}
Ce-143	3.00×10^{-5}
Pr-143	9.00×10^{-5}
W-187	2.40×10^{-4}
Np-239	1.10×10^{-2}
Total w/o H-3	9.79×10^{-2}
Total w/ H-3	1.41×10^{1}

Table 3.5-2 (Sheet 1 of 3)
Release Activities in Gaseous Effluent (Ci/yr) for Each VCS Unit

Isotope	Release Activity Per Unit
Kr-83m	1.01×10^{-3}
Kr-85m	1.76×10^{1}
Kr-85	1.16×10^{2}
Kr-87	3.92×10^{1}
Kr-88	5.89×10^{1}
Kr-89	3.78×10^{2}
Kr-90	3.38×10^{-4}
Xe-131m	2.97
Xe-133m	2.32×10^{-3}
Xe-133	8.41×10^{2}
Xe-135m	6.14×10^{2}
Xe-135	6.57×10^{2}
Xe-137	7.84×10^{2}
Xe-138	6.27×10^{2}
Xe-139	4.24×10^{-4}
I-131	4.08×10^{-1}
I-132	1.59
I-133	1.32
I-134	2.86
I-135	1.66
H-3	7.57×10^{1}
C-14	9.57
Na-24	1.46×10^{-5}
P-32	3.62×10^{-6}
Ar-41	7.70×10^{-3}
Cr-51	2.09×10^{-3}
Mn-54	3.97×10^{-3}
Mn-56	2.89×10^{-5}
Fe-55	1.28×10^{-4}
Fe-59	5.24×10^{-4}
Co-58	1.00×10^{-3}
Co-60	8.59×10^{-3}

Table 3.5-2 (Sheet 2 of 3) Release Activities in Gaseous Effluent (Ci/yr) for Each VCS Unit

Isotope	Release Activity Per Unit
Ni-63	1.28×10^{-7}
Cu-64	1.87×10^{-5}
Zn-65	7.57×10^{-3}
Rb-89	5.43×10^{-7}
Sr-89	4.00×10^{-3}
Sr-90	2.07×10^{-5}
Y-90	8.84×10^{-7}
Sr-91	1.82×10^{-5}
Sr-92	1.25×10^{-5}
Y-91	4.70×10^{-6}
Y-92	9.95×10^{-6}
Y-93	1.95×10^{-5}
Zr-95	1.21×10^{-3}
Nb-95	6.59×10^{-3}
Mo-99	4.49×10^{-2}
Tc-99m	6.03×10^{-6}
Ru-103	2.81×10^{-3}
Rh-103m	2.23×10^{-6}
Ru-106	3.65×10^{-7}
Rh-106	3.65×10^{-7}
Ag-110m	1.58×10^{-6}
Sb-124	1.45×10^{-4}
Te-129m	4.41×10^{-6}
Te-131m	1.49×10^{-6}
Te-132	3.81×10^{-7}
Cs-134	4.81×10^{-3}
Cs-136	3.97×10^{-4}
Cs-137	7.27×10^{-3}
Cs-138	2.30×10^{-6}
Ba-140	2.11×10^{-2}
La-140	3.49×10^{-5}
Ce-141	7.19×10^{-3}
Ce-144	3.65×10^{-7}

Table 3.5-2 (Sheet 3 of 3)
Release Activities in Gaseous Effluent (Ci/yr) for Each VCS Unit

Isotope	Release Activity Per Unit
Pr-144	3.65×10^{-7}
W-187	3.49×10^{-6}
Np-239	2.24×10^{-4}
Total w/o H-3	4.15×10^{3}
Total w/ H-3	4.23×10^{3}

3.6 Nonradioactive Waste Systems

The following section provides descriptions of nonradioactive waste systems for VCS. Typical nonradioactive waste systems need to address: 1) effluents containing chemical or biocides, 2) sanitary effluents, 3) other effluents (gaseous, liquid, and solid effluents), and 4) hazardous wastes.

3.6.1 Effluents Containing Chemicals or Biocides

The maintenance of proper water chemistry for plant operation requires the treatment of well water and river water to be used in various plant systems such as circulating water, station water, potable water, and demineralized water. A discussion of chemicals, concentrations, feed injection points, and dose information for potential use at VCS is located in Subsection 3.3.2. The water from the onsite wells will be sampled to determine if water treatment is necessary.

Waste effluents from station water system filter backwash, demineralized water system reverse osmosis and electrodeionization rejects, sanitary waste treatment plant, and nonradioactive drains throughout the station will be collected in the blowdown sump and subsequently pumped to the cooling basin. Blowdown from the plant service water system will be discharged directly to the cooling basin. Cooling basin blowdown, required to maintain acceptable water quality in the basin, will be discharged to the Guadalupe River.

Biocides and chemical additives used in plant systems will be those approved by the EPA or the state of Texas. The effluents associated with these nonradioactive systems may contain low concentrations of some chemicals and/or biocides. The concentrations of chemicals, including the 126 Priority Pollutants from 40 CFR 423, Appendix A, are discussed in Subsection 2.3.3. The cooling basin water will also contain low concentrations of chemicals and/or biocides in the discharge from the plant systems, in addition to those chemicals contained originally in the Guadalupe-Blanco River Authority canal water. The concentration of chemicals in the cooling basin will be monitored by laboratory testing and the water will be treated, if necessary, to ensure that the limits established in the Texas Pollution Discharge Elimination System (TPDES) permit to be issued by the Texas Commission on Environmental Quality (TCEQ) are met, before the cooling basin blowdown is released to the Guadalupe River.

The systems that require a means of control and treatment are described in Subsection 3.3.2. The concentration factor on a seasonal basis for evaporative cooling systems is discussed in Section 3.4. The average and maximum concentrations of natural material in the makeup and well water is discussed in Section 2.3.

The projected chemicals to be added to each system for water treatment and the estimated amount used per year are identified in Table 3.6-6. The constituents and concentrations in the river water makeup to the cooling basin have been derived from the water quality data for the Guadalupe-Blanco River Authority Calhoun Canal and the Guadalupe-Blanco River Authority Salt Water Barrier provided in Subsection 2.3.3. The constituents and concentrations for the groundwater makeup are located in

Table 2.3.3-3, column TWBD. The constituents and concentrations in the cooling basin blowdown effluent to the Guadalupe River are shown in Table 3.6-1.

3.6.2 Sanitary System Effluents

A sanitary waste system will be maintained on site during the construction and operation of VCS with effluents in compliance with acceptable industry design standards, the Clean Water Act, and the TPDES permit.

Portable sanitary facilities will be used until a permanent sanitary waste treatment facility is functional, and as needed during peak construction or outage activities to augment the permanent system. These temporary facilities will include centralized restroom and hand-wash trailer(s) in addition to single restroom units located throughout the site, as necessary. The waste collected in these temporary facilities will be disposed of by a licensed sanitary waste disposal contractor.

The permanent sanitary waste discharge system for VCS will be designed to collect and transfer sanitary water/waste from the potable water and sanitary waste system to the sewage treatment facility. The sewage treatment facility will be a standard industry design for processing the sanitary water/waste to meet local and state regulations for the effluent quality. Operation of the permanent sewage treatment system will be independent of plant operational mode (full power operation, shutdown/refueling, and startup).

A permanent sanitary treatment facility will be constructed onsite and designed to provide capacity for the two-unit site. The characteristics of the treated effluent are tabulated in Table 3.6-2. Treated water will be routed to the blowdown sump which, in turn, will be pumped to the cooling basin. Waste sludge generated at the water treatment plant and sanitary wastewater treatment plant will be disposed of offsite via contract with a licensed waste transportation and disposal company. Offsite sludge disposal methods could include landfilling, incineration, land application, and/or further treatment at licensed facilities. This sludge will be regularly monitored for radioactivity before discharge. In the event that sewage sludge becomes radioactively contaminated above the anticipated background level and regulations prohibit discharge, the sludge will be processed by the solid waste management system. For information on the solid waste management system, see Subsection 3.5.4.

Technology for processing wastes could include laboratory testing of effluents to ensure proper treatment.

3.6.3 Other Effluents

This section describes gaseous, liquid, and solid effluents not addressed in Subsections 3.6.1 and 3.6.2.

3.6.3.1 Gaseous Effluents

Plant operation at VCS will result in small amounts of nonradioactive gaseous emissions (including airborne solids) to the environment from equipment associated with plant auxiliary systems (e.g., standby diesel generators, auxiliary boiler, diesel-driven fire pumps). The auxiliary boiler will run only during startup/shutdown of the unit. The diesel generators, diesel-driven fire pumps, and other auxiliary diesel-driven equipment will operate periodically for testing or during an event that will require their designed use, and the related emissions will be intermittent. Projected emissions from the diesel-fueled equipment are provided in Table 3.6-4, and the locations and approximate release elevations are provided in Table 3.6-5. To mitigate the impacts of exhaust emissions, the diesel engine design will employ an engine control system.

3.6.3.2 **Liquid Effluents**

Nonradioactive liquid effluents (excluding laboratory wastes) will be discharged to the cooling basin. A process diagram of the liquid effluents (use and discharge) can be seen in Figures 3.3-1 and 3.3-2. Concentrations of applicable constituents in nonradioactive liquid effluents that will be discharged (via cooling basin blowdown) to the Guadalupe River will be limited under the TPDES permit. The permit will also limit mass loading to the river by specifying allowable discharge quantities. Laboratory testing of liquid effluents will be performed to ensure proper treatment. The pollutants listed in 40 CFR 423, Appendix A, *EPA Steam Electric Power Generating Point Source Category, 126 Priority Pollutants*, if present on site, will be tracked and monitored.

The liquid lab wastes generated by sampling systems will be tested and disposed of in the radioactive liquid waste management system. The liquid waste management system discharge concentrations are shown in Table 3.6-3. See Subsection 3.5.2 for further information on the system.

The storm water that collects in the protected area will be drained to one of two storm water detention ponds. Storm water in detention ponds will not be treated and will drain via gravity to the creek, river, and flood plain of the surrounding environment.

Information on the flow rates to and from systems for the groundwater and station water use are shown in ER Tables 3.3-1 and 3.3-2.

3.6.3.3 **Solid Effluents**

Nonradioactive solid wastes typically include industrial wastes such as metal, wood, and paper, as well as process wastes like resins and sludges. To the extent practicable, scrap metal, lead acid batteries, and paper collected at VCS will be recycled offsite at an approved recycling facility. Laboratory testing may be completed to ensure proper treatment of the solid waste effluent.

Debris (e.g., vegetation) collected on trash screens at the water intake structure(s) will be disposed of either on site or offsite as solid waste in accordance with TCEQ regulations.

Nonradioactive hazardous wastes will be collected and stored temporarily on site until disposed of at offsite licensed commercial waste disposal facilities or recovered at an offsite permitted recycling or recovery facility.

3.6.3.4 Hazardous Wastes

Hazardous wastes are wastes 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.

Based on Exelon's fleet operating experience, VCS would be expected to be registered as a Small Quantity Generator for hazardous waste and would typically generate no more than 2200 pounds (between 220 and 2200 pounds) of hazardous waste per month. VCS would implement a waste minimization plan, as described in Subsection 5.5.2.3.

Wastes will be stored temporarily on site, packaged in an approved U.S. Department of Transportation container, and periodically disposed of at a permitted disposal facility. All hazardous waste activities will be performed in compliance with federal regulations. Treatment, storage, and disposal of wastes generated by construction and operations of VCS will be governed by local and federal regulations.

Table 3.6-1
Constituents and Concentrations for the Cooling Basin Blowdown[a]

Constituent Name	Cooling Basin Blowdown (mg/l)
Alkalinity, total as $CaCO_3$	496
Aluminum	17.3
Ammonia as N	0.364
Biochemical Oxygen Demand	7.00
Boron	0.46
Bromide	0.135
Calcium	273
Chloride	287
Chemical Oxygen Demand	101
Conductivity (μmhos/cm)	2515
Dissolved Silica as SiO_2	46.8
Fluoride	1.11
Iron	6.08
Lead	0.01
Magnesium	53.5
Manganese	0.223
Nitrate as N	6.22
Nitrite as N	0.08
Oil and Grease	0.04
pH (standard units)	5.9
Phosphorous	0.692
Potassium	17.6
Silica as SiO_2	53.4
Sodium	215
Strontium	2.10
Sulfate	472
Sulfide	7.13
Total Dissolved Solids	2030
Titanium	0.159
Total Organic Compounds	32.6
Total Kjeldahl Nitrogen	3.16
Total Suspended Solids	166
Zinc	0.405

a. All liquid effluents from the plant, except for the discharge from the liquid waste management system and stormwater, are discharged to the cooling basin. The cooling basin blowdown constituent concentrations reflect this design.

Table 3.6-2
Treated Sanitary Waste Effluent[a]

Maximum Average Flowrate (GPM)	60
Constituent Name	Concentration (mg/l) unless otherwise noted
Alkalinity, total as $CaCO_3$	274
Ammonia as N	3
Biochemical Oxygen Demand	30
Calcium	11
Chloride	2
Chemical Oxygen Demand	12.5
Conductivity (µmhos/cm)	1820
Dissolved Silica as SiO_2	4.3
Fluoride	0.34
Iron	0.74
Magnesium	6.5
Manganese	0.018
pH (standard units)	8.8
Phosphorous	8
Potassium	2.8
Silica as SiO_2	18.7
Sodium	386
Strontium	1.16
Sulfate	4.1
Sulfide	2
Total Dissolved Solids	1120
Total Kjeldahl Nitrogen	40
Total Suspended Solids	30
Zinc	0.01
Boron	0.408
Bromide	3
Total Organic Compound	49.5
Aluminum	1
Total Residual Chlorine	2

a. Treated water from the sanitary waste system will be routed to the blowdown sump and pumped to the cooling basin. The cooling basin blowdown constituent concentrations reflect this design.

Table 3.6-3
Concentration from the Liquid Waste Management System[a]

Maximum Average Flowrate (GPM)	21
Constituent Name	**Concentration (mg/l)**
Alkalinity, total as $CaCO_3$	0.002
Chloride	0.006
Conductivity (µmhos/cm)	0.06
Fluoride	2×10^{-6}
pH (standard units)	7
Phosphorous	3×10^{-6}
Silica as SiO_2	0.0001
Sodium	0.002
Sulfate	0.001
Sulfide	1×10^{-5}
Total Dissolved Solids	0.006

a. The liquid waste management system effluent is mixed in the blowdown stream from the cooling basin before the water is discharged to the Guadalupe River.

Table 3.6-4
Estimated Annual Emissions of Gaseous Effluents

Source	Pollutant Discharge (per source) (lb/year)					Hours of Run per Year (per source)	Quantity of Sources (per site)
	PM	SO_x	CO	Hydrocarbons	NO_x		
Auxiliary Boiler	1438	515	3267	180	14374	720	2
Standby Diesel Generators	876	17820	1188	1782	23760	36	4
Primary Fire Protection Diesel Fire Pump	3.48	[a]	7.60	2.06	67.16	36	2
Regulatory Treatment of Non-Safety Systems Generator Diesel Driver	0.17	[a]	0.38	0.10	3.36	36	4
Reactor Pressure Vessel Makeup Diesel Pump	10.89	[a]	23.76	6.44	209.8	36	2
Yard Fire Protection Diesel Fire Pump	3.48	[a]	7.60	2.06	67.16	36	1

a. Air permits will specify allowable quantities for SO_x discharges.

Table 3.6-5
Locations and Approximate Elevations of Gaseous Effluent Sources (per unit)

Source of Effluent	Approximate Exhaust Discharge Elevation (feet above grade)	Location
Auxiliary Boiler	75	Roof of Radwaste Building
Standby Diesel Generators	128	Adjacent to Electrical Building, stack elevation ends above roof of Electrical Building
Primary Fire Protection Diesel Fire Pump	17	Roof of Fire Pump Enclosure
Regulatory Treatment of Nonsafety Systems Generator Diesel Driver	16	Roof of Control Building
Reactor Pressure Vessel Makeup Diesel Pump	17	Roof of Fire Pump Enclosure
Yard Fire Protection Diesel Fire Pump	17	Roof of Yard Fire Pump Enclosure

Table 3.6-6
Projected Chemicals Usage for Water Treatment (for VCS)

System	Chemical	Amount Used per Year (gallons)	Frequency of use	Concentration (ppm)
PSWS	93% Sulfuric Acid	1,110,600	Continuous	551
PSWS	12% Sodium Hypochlorite	14,600	Shock	0.5
PSWS	Scale Inhibitor	8,600	Continuous	3
PSWS	25% Sodium Bisulfite	10,200	Continuous	0.876
PSWS	Dispersant	8,600	Continuous	3
PSWS	Non-Oxidizing Biocide	39,000	Week Slug	100
PSWS	Proprietary BioDispersant	4,000	Week Slug	10
CIRC	12% Sodium Hypochlorite	737,800	Shock	1
CIRC	Scale Inhibitor	442,000	Continuous	0.5
CIRC	Proprietary Bromide	118,400	Shock	1.6
GW	12% Sodium Hypochlorite	17,600	Continuous	3
DWS	Scale Inhibitor	800	Continuous	6
DWS	Sodium Bisulfite	3,100	Continuous	5.25
DWS	Sulfuric Acid	24,900	Continuous	986

Legend:
CIRC circulating water system
DWS demineralized water system
GW groundwater
PSWS plant service water system

3.7 Power Transmission System

This section identifies the interconnection components and activities necessary to complete the interface between VCS Units 1 and 2 and associated switchyards, VCS AEP Why Substation and the interconnections to the regional power grid, for offsite power supply to VCS and for VCS-generated power export. These components include:

- A new onsite AEP 345 kV Why Substation for VCS Units 1 and 2.
- Onsite 345 kV tie-lines from VCS Units 1 and 2 switchyards to the new AEP 345 kV Why Substation. The 345 kV switchyards interconnect the VCS generator main, unit auxiliary, and reserve auxiliary transformer terminals with the AEP Why Substation.
- Six new or rerouted AEP 345 kV transmission lines (eight total circuits) that interconnect VCS with various existing 345 kV substations and a new Cholla substation of the regional AEP transmission system.
- In addition, six new or rerouted 345 kV transmission lines (eight total circuits) remote from the VCS site are provided to fully integrate the VCS generation into the regional transmission grid.

Switchyard and substation activities will involve construction on the Exelon VCS site property.

Transmission facilities are constructed within designated overhead transmission line corridors to remote transmission provider interconnection substation locations.

3.7.1 Switchyard and Substation Interfaces

The VCS Unit 1 and 2 generator main, unit auxiliary, and reserve auxiliary transformers connect via onsite tie-lines to the AEP Why Substation via the Unit 1 and 2 switchyards.

The AEP 345 kV Why Substation will be provided to accommodate the output of the new VCS units. The location of this new substation will be on the VCS site, approximately 1000 feet north of VCS Units 1 and 2. The design of the substation will be a standard air-insulated breaker-and-a-half scheme and will be comprised of eight high-voltage equipment bays in the configuration, two of which are reserved for future transmission lines.

The dimensions, material, color, and finish of the substation structures will be in accordance with AEP design practices.

3.7.2 Transmission System

The following describes the power transmission system line components, the corridor locations for the lines, and prospective ownerships.

Six new regional 345 kV overhead transmission lines (two double-circuit and four single-circuit) connect to the new AEP Why Substation on the VCS site. Figure 3.7-1 provides the overall transmission system interconnection configuration and transmission corridors' general locations for the VCS site and outlying region.

The transmission line corridors are as follows:

Why Substation to Existing Coleto Creek Substation

- Construction: double-circuit, overhead, lattice, or tubular steel structures
- Length: Approximately 20 miles
- Conductors/Rating: 1590 kcmil ACSR, 1852/2740 MVA (normal/emergency)
- Route: The lines between Why and Coleto Creek will require a new corridor that takes a generally northwest-southeast path between the substations. An alternate corridor based on colocation with existing 138 kV lines is possible. Final route selection will be based on considerations of least impact to the community and lowest cost.
- Counties traversed: Victoria, Goliad
- Owner: AEP[1]

Why Substation to Existing Hillje Substation

- Construction: double-circuit, overhead, lattice, or tubular steel structures
- Length: Approximately 60 miles
- Conductors/Rating: 1590 kcmil ACSR, 1852/2740 MVA (normal/emergency)
- Route: A candidate "northern" route corridor follows an existing 138 kV line northeast to the existing STP-White Point 345 kV line. The candidate "southern" route corridor follows a rail line to the existing STP-White Point 345 kV line. The corridor then heads northeast where the existing 345 KV line turns southeast to STP. From that point to Hillje, the new lines would generally parallel existing 138 kV lines into Hillje substation.
- Counties traversed: Victoria, Calhoun, Jackson, Wharton
- Owner: AEP[1]

Why Substation to Existing Blessing Substation

- Construction: single-circuit, overhead, lattice, or tubular steel structures
- Length: Approximately 60 miles
- Conductors/Rating: 1590 kcmil ACSR, 1852/2740 MVA (normal/emergency)
- Route: This line will parallel the new line to Hillje described above, up to a point near the existing Lolita Substation. At this point, the new line will head east to Blessing Substation, generally paralleling existing 138 kV lines.
- Counties traversed: Victoria, Calhoun, Jackson, Wharton, Matagorda
- Owner: AEP[1]

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1. Indicates ownerships are tentative. ERCOT planning process establishes final ownership.

The following lines consist primarily of reuse of existing operating 345 kV line infrastructure from STP to White Point Substation:

Why Substation to Existing STP Substation

There is an existing 345 kV line between STP and Whitepoint Substation that passes nearby the Why Substation. This line will be "looped in" to the Why Substation from the intersection point.

- Construction: single-circuit, overhead, lattice, or tubular steel structures
- Length: 6-20 miles to existing line intersection point.
- Line Rating: 1011/1011MVA (normal/emergency)
- Route: The line will leave Why Substation and head east to the existing right-of-way and connect into the existing line to STP. This is an existing line, so no new right-of-way is required beyond the intersection point.
- Counties traversed: Victoria, Calhoun, Jackson, Wharton, Matagorda
- Owner: AEP[1]

Why Substation to Existing Whitepoint Substation

- There is an existing 345 kV line between STP and Whitepoint Substation that passes nearby the Why Substation. This line will be "looped in" to the Why Substation from the intersection point.
- Construction: single-circuit, overhead, lattice, or tubular steel structures
- Length: 6-20 miles to existing line intersection point.
- Line Rating: 1011/1011MVA (normal/emergency)
- Route: The line will leave Why Substation and head east to the existing right-of-way and there connect into the existing line to White Point. This is an existing line, so no new right-of-way is required beyond the intersection point.
- Counties traversed: Victoria, Calhoun, Jackson, Wharton, Matagorda
- Owner: AEP[1]

Why Substation to New Cholla Substation

The need for this transmission line was identified by the final AEP Interconnection Study. This study was completed after the macro-corridor analysis described in Subsection 3.7.3.1. The Cholla Substation is expected to be built before the planned Exelon VCS site completion, to accommodate other generation interconnections. This new substation is expected to be located in the vicinity of the existing 138 kV and 345 kV transmission lines between STP and Elm Creek Substation (San Antonio region). This would place the new substation approximately 40 miles northwest of Why Substation, in DeWitt County.

1. Indicates ownerships are tentative. ERCOT planning process establishes final ownership.

- Construction: single-circuit, overhead, lattice, or tubular steel structures
- Length: Approximately 20 miles
- Conductors/Rating: 1590 kcmil ACSR, 1852/2740 MVA (normal/emergency)
- Route: The new 345 kV line would generally follow a northwest-southeast route corridor and would colocate with existing transmission lines where practical. Additional right-of-way width would be required.
- Counties traversed: Victoria, Goliad, DeWitt.
- Owner: AEP[1]

The following transmission lines beyond the VCS-direct interconnections are necessary to fully deliver VCS-generated power to the regional transmission grid under the range of system operating and line outage scenarios:

Cholla Substation to Zorn Substation

A new double-circuit 345 kV line will be connected from Cholla Substation to the existing Zorn Substation. The Zorn Substation is part of the existing 345 kV transmission system that includes the STP-Elm Creek line. It would be expected that the new line could use (or widen) the existing right-of-way used by the STP-Elm Creek lines. Zorn is in Guadalupe County, east of San Antonio.

- Length: Approximately 75 miles
- Counties traversed: DeWitt, Gonzales, Guadalupe
- Owner: AEP[1]

Cholla Substation to Coleto Creek Substation

A new single-circuit 345 kV line would be connected between Cholla and the existing Coleto Creek substation in Goliad County. There is an existing 138 kV system that exists between Victoria Substation and Coleto Creek Substation. This new line may be able to colocate with the existing transmission lines where practical. Additional right-of-way width would be required.

- Length: Approximately 40 miles
- Counties traversed: Goliad, DeWitt
- Owner: AEP[1]

Cholla Substation to Elm Creek Substation and to STP Substation

The existing Elm Creek to STP 345 kV circuit, in the vicinity of the new Cholla Substation would be "looped in" to the Cholla Substation to facilitate these two new line terminations. Therefore, no new transmission line construction is necessary.

- Counties traversed (by existing line): DeWitt, Gonzales, Wilson, Guadalupe

1. Indicates ownerships are tentative. ERCOT planning process establishes final ownership.

Hillje Substation to O'Brien Substation

A new double-circuit 345 kV line will be required between the existing Hillje Substation and the existing O'Brien substation in Fort Bend County, southwest of Houston. This line will support the output of the STP and VCS units to the Houston area. There are existing 345 kV lines between Hillje and W. A. Parrish Station, and between W. A. Parrish Station and O'Brien. These existing transmission lines rights-of-way may be used or widened for this new line.

- Length: Approximately 70 miles
- Counties traversed: Wharton, Fort Bend
- Owner: CenterPoint Energy[1]

Marion Substation to Elm Creek Substation

A new single-circuit 345 kV line, nominally 14 miles in length, will be connected between Marion and Elm Creek. There is an existing 345 kV line between these substations, thus the new line could be able to use or widen this existing corridor

- Length: Approximately 14 miles
- Counties traversed: Guadalupe
- Owners: CenterPoint Energy and Lower Colorado River Authority[1]

East Bernard Substation to Flewellen Substation

Construct a new 29-mile 138 kV transmission line from existing East Bernard Substation to existing Flewellen Substation.

- Length: 29 miles
- Counties traversed: Fort Bend, Austin, Wharton}
- Owner: CenterPoint Energy[1]

In addition, certain upgrades of existing transmission facilities will be required. This will consist principally of reconductoring of existing transmission circuits and installation of new transformers at existing substations.

3.7.3 Transmission Line Rights-of-Way (Corridors)

The following describes the power transmission system features and the applicable regulations governing transmission system and facilities design, construction, operation, and maintenance.

Transmission service providers in the Electric Reliability Council of Texas (ERCOT) region are subject to regulations of the Public Utility Commission of Texas (PUCT), which requires that new transmission facilities and interconnections consider alternative means for providing necessary transmission capacity that are least costly, operationally sound, and use existing capacity when available. (PUCT 2008)

1. Indicates ownerships are tentative. ERCOT planning process establishes final ownership.

In accordance with PUCT requirements, an interconnection study was prepared by the transmission service provider in 2008 to address power transmission options for VCS Unit 1 and 2. The power transmission system interconnections described herein are, in large part, based on this study.

The end result of the selection process is the identification of a preferred corridor for each transmission line. Selection of transmission line rights-of-way is described in Section 9.4 and Subsection 2.2.2. The lengths, widths, and area of rights-of-way, including modification and use of existing rights-of-way, are also described in that section.

Ruling spans for transmission lines will be defined during detailed design of the lines by the transmission service provider. The transmission line corridors of the transmission system are described in detail in Subsection 3.7.2. Single-tower lines occupy nominal 150-foot-wide final rights-of-way in the respective corridor. Parallel and adjacent lines require nominal final right-of-way widths of 300 feet and 450 feet for colocated cases of two or three lines, respectively, to accommodate the side-by-side towers.

Topographic maps for transmission corridors that have been studied to date are provided in the Electrical Transmission Corridor Study, referenced in Subsections 2.2.2 and 2.2.4.

3.7.3.1 Transmission Line Rights-of-Way Ecological and Cultural Surveys

The Texas PUCT will select the transmission corridor routes during the Certificate of Convenience and Necessity (CCN) process. As part of final transmission corridor selection, the transmission service provider will provide the PUCT with information on the ecological and cultural resources along the alternative corridors. Given that the final results of the PUCT CCN process are not available, the VCS ER relied upon a macro-corridor analysis that included the review of publicly available information on ecological and cultural resources. The results of the macro-corridor analysis are described in Section 2.4 and Subsection 2.5.3. Section 2.2 describes the Texas PUCT process for final selection of the preferred transmission line right-of-way.

3.7.3.2 Transmission Corridor Maintenance

The safe and reliable operation of transmission lines and corridors will be maintained through regular inspection of the structures, insulators, access areas, and vegetation in the rights-of-way. These inspections will consist of ground patrols (truck) and/or aerial (airplane/helicopter) patrols. Transmission lines normally require minimal maintenance. However, the line owners will regularly inspect the transmission lines to identify problems caused by weather, vandalism, vegetation growth, etc.

In areas that are not in active agricultural cultivation, the line owners will manage vegetation within the rights-of-way using a variety of methods, including trimming, mowing, and the use of growth regulators and herbicides, targeting species that are incompatible with the safe access, operation, and maintenance of the transmission system.

The line owners' right-of-way maintenance program is site-specific. The exact manner in which maintenance will be performed will depend on location, type of terrain, and the surrounding environment. Vegetation removal will be minimized consistent with safe and reliable operation of the transmission lines. Each area of the right-of-way will be addressed based on site-specific vegetation. Endangered or threatened species, if present, are considered and accommodated in the maintenance program. Growth regulators and herbicides, when selectively used, will meet federal, state, and local regulations.

3.7.3.3 **Transmission System Operation**

The transmission lines owners will continue to operate and maintain their respective transmission lines after they are constructed. Protocol agreements between Exelon and the line owners will establish the communications protocols with the transmission service operators. These protocols facilitate prompt and effective communications between the transmission service operators and the VCS plant operators. The transmission service operators regularly inspect their substations and perform regular maintenance and necessary repair or replacement of equipment.

The safe and reliable operation of transmission lines and corridors will be maintained through regular inspection of the structures, insulators, access areas, and vegetation in the right-of-ways as noted in Subsection 3.7.3.2.

3.7.3.4 **Noise**

Transmission lines and high-voltage substations can produce noise from corona discharge (the electrical breakdown of air into charged particles at the conductor surfaces). The noise, referred to as corona noise, occurs when air ionizes near irregularities such as nicks, scrapes, dirt, or insects on the conductors. Corona noise is composed of both broadband noise, characterized as a crackling noise, and pure tones, characterized as a humming noise. Corona noise, which is greater with increased voltage, is also affected by weather. During dry weather, the noise level is low and often indistinguishable from background noise. In wet conditions, water drops collecting on conductors can cause louder corona discharges.

During rain showers, the corona noise would likely not be readily distinguishable from background noise. During very moist, non-rainy conditions, such as heavy fog, the resulting small increase in the background noise levels is not expected to result in annoyance to adjacent residents.

The noise levels resulting from transmission system operations of the transmission system will be in accordance with the state and local code requirements. Actual decibel noise levels will be held to a minimum by proper sizing of conductors and the use of corona-free hardware. Corona-induced noise along existing 345 kV transmission lines is very low or inaudible.

Additional information regarding noise levels resulting from transmission system operation is provided in Subsection 5.6.3.4.

3.7.3.5 Transmission Line Design and Methods of Construction

345 kV overhead transmission lines will be constructed with steel towers to provide robust, proven, and long-lived infrastructure that provides electrical clearances and design factors consistent with the National Electrical Safety Code (NESC). (IEEE 2007)

The transmission service provider will construct the new 345 kV towers for the transmission lines using the utility's standard-type steel towers with designs providing clearances consistent with the NESC. Figure 3.7-2 represents a typical lattice construction tower. Tubular steel monopole construction could also be used. Tower foundations are of concrete construction and use foundation configurations and depths appropriate for local soil conditions. Conductor spans are maximized to reduce the number of towers required. This is beneficial to reduce overall line cost and to minimize tower access road and local site disturbance requirements. The dimensions, material, color, and finish of the transmission structures will be in accordance with AEP design practices.

The 345 kV transmission lines use bundle-type conductors in groups of two for each of the three current-carrying phases. This conductor configuration will be implemented for the new transmission lines to mitigate corona and audible noise formation. Transmission lines crossing roads and railroads will comply with NESC requirements for clearances. The design of all towers includes grounding methods with either ground rods or a counterpoise ground system. Lightning protection is provided by shield wires positioned above the current-carrying conductors.

The PUCT regulations impose standards of construction and operation of transmission facilities. When determining standard practices, the PUCT shall be guided by the provisions of the American National Standards Institute, NESC, and such other applicable codes and standards that are generally accepted by the industry, except as modified by the PUCT. Line owners are required to construct, install, operate, and maintain their respective transmission lines in accordance with the NESC, as a minimum, and in such a manner to best accommodate public safety needs.

Conductor minimum electrical clearances to ground will be in accordance with the requirements of the NESC. Conductor clearances, spacings, and geometry will limit electrostatic field effects sufficiently to ensure that maximum induced shock current to ground for a vehicle parked under the line will be consistent with the NESC 5-milliamp standard.

The indicated owners will construct these new transmission lines. The line owners and constructors are expected to implement mitigation measures adapted to the specifics of each project in accordance with Chapter 16 Section 25.101(d) of the Texas Administrative Code (PUCT 2008) and may include such requirements as:

- Selective clearing of the right-of-way to minimize the amount of flora and fauna disturbed.
- Implementation of erosion control measures.
- Reclamation of construction sites with native species of grasses, forbs, and shrubs.
- Returning the site to its original contours and grades.

The transmission line owners must obtain Certificates of Convenience and Necessity from the PUCT for new transmission lines. The development of related environmental impact studies of alternative transmission corridors and the selection of final transmission line rights-of-way is a detailed and lengthy process. Detailed design and construction of the transmission lines will be done close to the time of the need to be in service, and likely not before 2012.

References

IEEE 2007. Institute of Electrical and Electronics Engineers (IEEE), *National Electrical Safety Code (NESC)*, C2-2007, 2007 Edition.

PUCT 2008. Public Utility Commission of Texas, *Texas Administrative Code, Title 16, Sections 25.101(d) and 25.195(c)*, available at http://info.sos.state.tx.us/pls/pub/readtac$ext.TacPage?sl=T&app=9&p_dir=F&p_rloc=97111&p_tloc=14741&p_ploc=1&pg=2&p_tac=&ti=16&pt=2&ch=25&rl=101, accessed June 19, 2008.

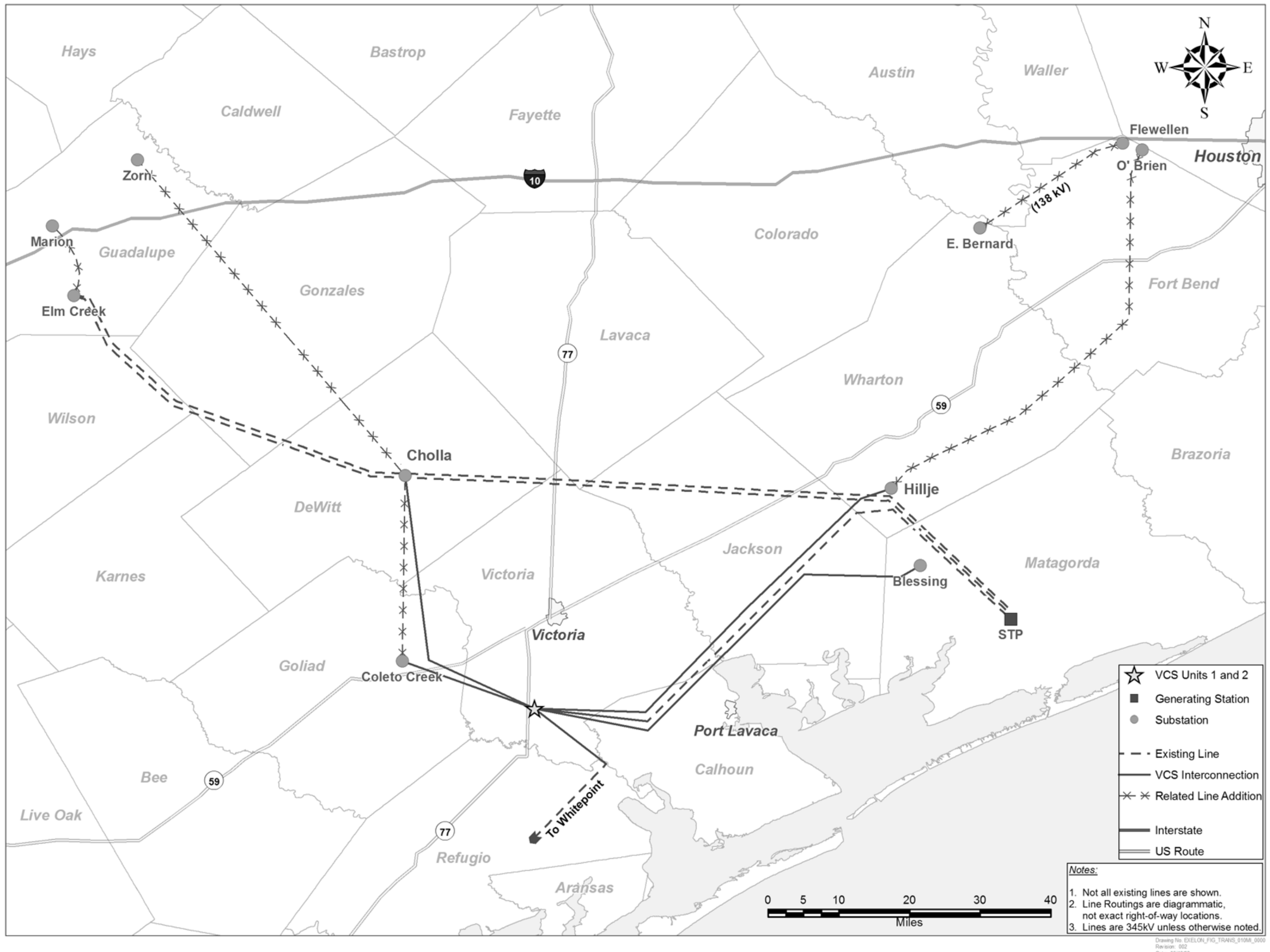

Figure 3.7-1 Transmission Corridors Conceptual Location Plan

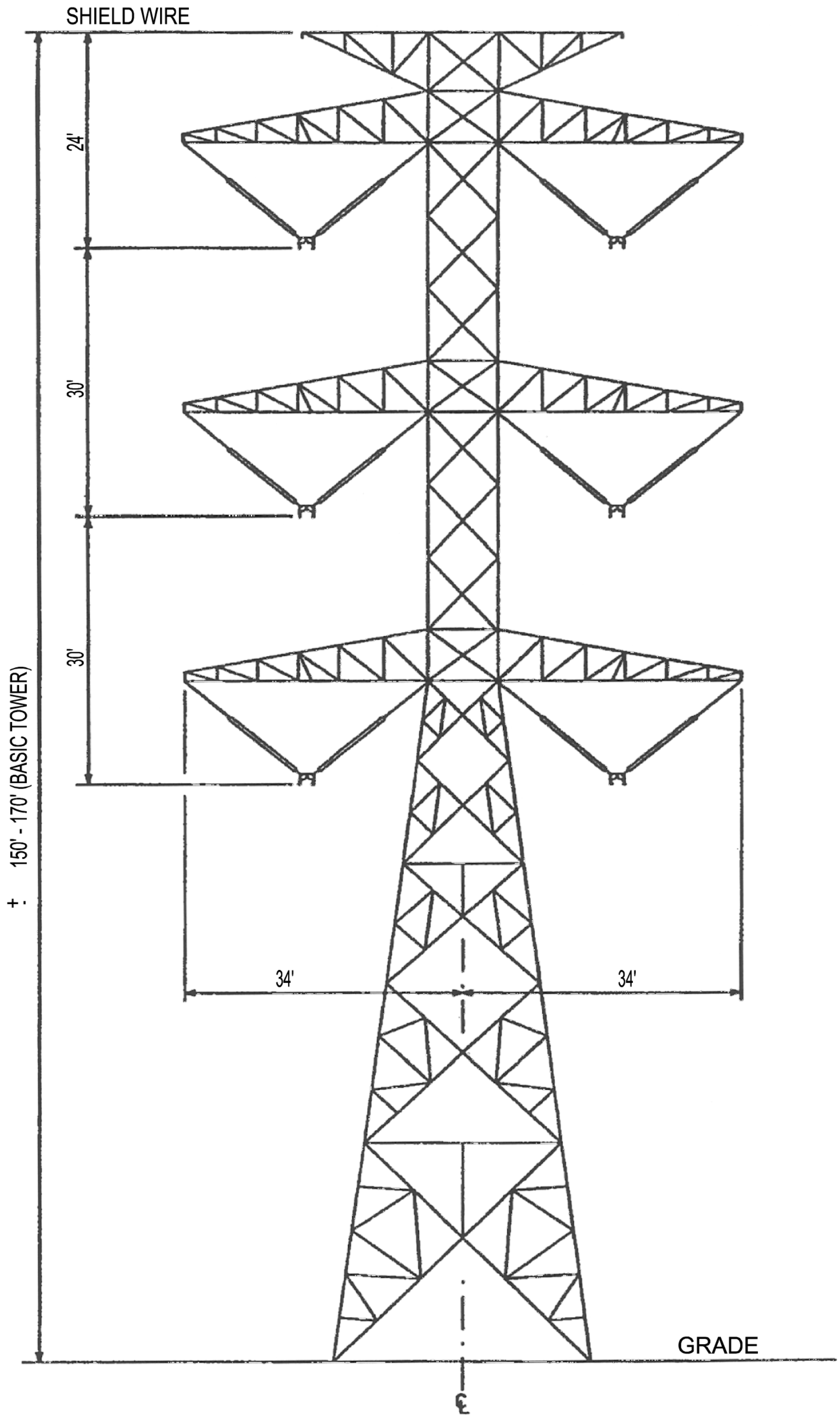

Figure 3.7-2 345 kV Transmission Tower

3.8 Transportation of Radioactive Materials

Operation of two ESBWR units at the VCS will require transportation of unirradiated fuel, irradiated fuel (spent nuclear fuel), and radioactive waste. The subsections that follow describe transportation of these three types of radioactive materials. Subsection 5.7.2 addresses the conditions in subparagraphs 10 CFR 51.52(a)(1) through (5) regarding use of Table S-4 to characterize the impacts of radioactive materials transportation and provides an analysis of the radiological impacts from incident-free transportation of these materials. Section 7.4 addresses radiological transportation accidents.

3.8.1 Transportation of Unirradiated Fuel

Transportation of new fuel assemblies to the site from a fuel fabrication facility will be in accordance with U.S. Department of Transportation (U.S. DOT) and U.S. NRC regulations. As described in Subsection 3.2.1, the initial fuel loading will consist of 1132 fuel assemblies for one ESBWR unit (GEH Sep 2007). On an annualized basis, refueling will require approximately 216 to 236 fuel assemblies for 1 ESBWR unit. The fuel assemblies will be fabricated at a fuel fabrication plant and shipped by truck to the site before fuel load. The details of the container designs, shipping procedures, and transportation routes will be in accordance with U.S. DOT (49 CFR 173 and 178) and U.S. NRC (10 CFR 71) regulations and depend on the requirements of the suppliers providing the fuel fabrication services. The truck shipments will not exceed 73,000 pounds net as governed by federal and state gross vehicle weight restrictions.

3.8.2 Transportation of Irradiated Fuel

Spent fuel assemblies will be discharged from each unit on a 24-month refueling cycle and will remain in the spent fuel pool at each ESBWR unit for at least five years while short half-life isotopes decay, as required in 10 CFR 961, Appendix E. As discussed in DCD Section 9.1, each unit will have a spent fuel pool with capacity for at least 10 calendar years of fuel discharges plus one full core offload (GEH Sep 2007). After a minimum 5-year decay period, the fuel will be removed from the pool and packaged in casks for storage on site and eventual transport offsite. The spent fuel will be transferred to the independent spent fuel storage installation facility or a disposal facility. Packaging of the fuel for offsite shipment will comply with applicable U.S. DOT (49 CFR 173 and 178) and U.S. NRC (10 CFR 71) regulations for transportation of radioactive material. As required by the Nuclear Waste Policy Act of 1982, Section 302, U.S. DOE is responsible for spent fuel transportation from reactor sites to a repository and will make the decision on transport mode.

3.8.3 Transportation of Radioactive Waste

Solid low-level waste will be the only type of radwaste transported off site in accordance with 10 CFR 51.52(a)(4). As described in Subsection 3.5.4, low-level radioactive waste will be packaged to meet transportation and burial site acceptance requirements. Packaging of waste for offsite shipment will comply with applicable U.S. DOT (49 CFR 173 and 178) and U.S. NRC (10 CFR 71) regulations for transportation of radioactive material. The packaged waste will be stored on site on an interim basis before being shipped offsite to a licensed processing or disposal facility. On site storage for six months volume of packaged waste will be provided in the Radwaste Building (GEH Sep 2007). Radioactive waste will be shipped offsite by truck.

3.8.4 **References**

GEH Sep 2007. General Electric - Hitachi Nuclear Energy, *ESBWR Design Control Document*, Revision 4, September 2007.

3.9 Construction Activities

Section 3.9, while not specifically a requirement of NUREG-1555, provides a description of construction activities for the VCS Units 1 and 2.

The description of construction activities is pertinent to addressing potential impacts of plant construction as described primarily in Chapter 4. Preconstruction/site preparation and construction activities, processes, and procedures are described in this section.

Site activities are expected to be performed in the following sequence:

Preconstruction and Site Preparation Phase

Preconstruction planning and exploration activities, including a new meteorology tower at the northwest corner of the plant property, soil sampling and testing, geophysical borings, and monitoring wells have been undertaken. Such activities are not defined as "construction" as defined by 10 CFR 50.10(a)(2) and are permissible before the COL is issued.

Activities before the COL is issued include the installation of temporary facilities, construction support facilities, service facilities, utilities, barge unloading facilities, excavations and backfill of facility structures and foundations, and the construction of structures, systems, and components (SSCs) that are not specifically described as construction activities in 10 CFR 50.10(a)(1) will be performed.

Construction Completion Phase

Once the COL has been issued, those construction activities described in 10 CFR 50.10(a)(1) such as subsurface preparation, placement of backfill and concrete within the excavation, and installation of foundations will begin. The other remaining construction activities, including in-place erection of reactor building, turbine building, placement of equipment, etc., will also commence.

For the purpose of analysis in this Environmental Report, a construction schedule based on providing electric generation output in December 2015 (Unit 1), and June 2017 (Unit 2) is assumed. The description of site preparation and construction activity sequences described above assumes that construction of Unit 1 begins following the site preparation for both Units 1 and 2, and the construction of Unit 2 begins approximately 18 months following commencement of Unit 1 construction.

The schedule assumes 18 months duration for site preparation activities before the COL is issued, with the start of major power plant construction activities after the COL is issued. For Unit 1, a duration of 42 months from issuance of the COL to fuel load, and a period of 6 months from fuel load to commercial operation is assumed. Unit 2 commercial operation is assumed to be 18 months after Unit 1.

In the event the time between construction starts on Units 1 and 2 is extended, the overall construction time will be extended. The duration of sequential construction of Units 1 and 2 is estimated to be approximately 7 years (from site preparation activities to commercial operation of Unit 2, assuming an 18-month schedule stagger).

3.9.1 Construction Procedures and Processes

As part of the overall construction program for VCS, procedures and processes are necessary to ensure protection of the local environmental conditions during construction. These procedures and processes include developing a Construction Environmental Controls Plan (CECP), which is described in this section. The following CECP is pertinent to a construction activity that will be developed and in place before construction activity begins.

Construction Environmental Controls Plan

The CECP contains descriptions of the environmental management controls that will be used at VCS to assist in meeting the overall environmental management objectives for the project.

The processes for achieving these objectives include:

- Summary Matrix of Environmental and Permit Requirements for Construction

  A summary matrix of environmental requirements for construction will be prepared for the relevant construction phase environmental requirements. The summary will include a listing of the specific permit requirements for VCS, the titles of the individuals responsible for ensuring compliance with each requirement, a calendar of scheduled activity start dates by which compliance with each requirement must be completed, and the current status of each action item. Section 1.2 generally describes the permits required for construction.

- Environmental Awareness Training

  Environmental awareness training will be required as part of the generic site training and orientation for construction personnel. The type of training will be based on the need and types of job functions at the site. The training will be provided before construction personnel perform work at VCS. The training will be based on the environmental requirements applicable to VCS and will cover such topics as general site maintenance, erosion and sediment control, protection of sensitive areas, hazardous material/waste handling, and spill prevention and response. The training sessions will stress the importance of maintaining "environmental awareness" as part of the employee's everyday duties. Environmentally sensitive areas on and adjacent to the site, as well as construction exclusion zones, will be described and located on project drawings, and physically marked in the field.

- Environmental Compliance Reviews/Coordination Meetings

  Periodic site environmental compliance reviews/coordination meetings will be conducted to discuss current and future construction work activities as they relate to maintaining environmental compliance. The meetings will also provide a forum to discuss and resolve outstanding environmental corrective actions/issues.

- Environmental Compliance Inspections and Documentation

Periodic environmental compliance field inspections of construction activities will be performed by VCS personnel. The field inspections will be conducted and documented to confirm that the site activities remain in compliance with the applicable environmental requirements for the project.

Onsite areas/activities covered during the inspections will include:

- Adherence with approved clearing limits, buffers, and exclusion zones
- Installation and maintenance of erosion and sediment control measures
- Implementation of required mitigation measures for work in and around environmentally sensitive resources, as described in Section 4.6 (e.g., wetlands, rivers and streams, potential archeological sites)
- Solid waste management activities (e.g., checking for sufficient number of trash containers, waste segregation, use of designated storage areas, labeling)
- Hazardous materials management activities (e.g., taking inventory or inspections to verify containers are correctly stored to minimize spills, reduce exposure, and prevent fires/explosions)
- Implementation of fugitive dust control measures (e.g., watering roads, covering truck loads)

Environmental inspection reports will be used to document the results of each site inspection and to note and describe any areas of concern requiring corrective actions.

3.9.2 **Environmental Procedures**

Environmental procedures will be prepared and implemented to address the federal, state, and local regulatory requirements. Site-specific permit requirements that address measures for mitigation of environmental impacts will be incorporated. Various types of environmental procedures for the construction of VCS are described in Subsections 3.9.2.1 through 3.9.2.11.

3.9.2.1 **Noise and Vibration**

Procedures related to mitigating noise and vibration impacts from construction activities will be employed. Such measures may include:

- Limiting, as much as practicable, noise and vibration generating activities to certain hours.
- Minimizing construction noise-producing and vibratory activities in sensitive areas.
- Using less vibration-producing equipment and/or methods such as staggering activities.
- Using appropriate noise control equipment on vehicles and equipment such as mufflers and/or dampeners.
- Notifying regulatory agencies and nearby residents regarding atypical noise and vibration events (e.g., pile driving).

3.9.2.2 **Air Quality (Fugitive and Vehicular Emissions)**

Air quality protection procedures will be developed that employ methodologies to minimize, as much as practicable, the generation of fugitive dust from construction activities and reduce the emissions from construction equipment and vehicles. Fugitive dust control measures such as watering of roads, covering truck loads and material stockpiles, reducing materials-handling activities, and limiting vehicle speed may be employed, when appropriate. Visual inspection of emission control equipment will be undertaken.

3.9.2.3 **Erosion and Sediment Control**

Erosion and sediment control procedures will be developed that describe the measures to be taken during the course of construction. These procedures will describe temporary and permanent measures undertaken and include relevant engineering drawings illustrating the erosion and sediment control design features. Depending on site conditions and permit requirements, this information typically includes:

- Defined clearing limits and maintenance of existing vegetative cover
- Details of site grading
- The extent of topsoil stripping and stockpiling
- Design of temporary erosion controls (e.g., silt fencing, mulching, erosion control blankets, temporary seeding)
- Design of permanent erosion controls (e.g., reestablishing natural drainage patterns, vegetated swales, permanent seeding/plantings)
- Design and location of check dams, riprap, detention basins, and sediment barriers
- Details of slope restoration and protection
- Design of roads and equipment crossings
- Site-specific designs that maintain drainage patterns

3.9.2.4 **Construction Water Management**

Construction water management procedures will be developed and employed to manage water runoff and miscellaneous discharges from the construction areas and to prevent and/or minimize contamination of surface waters due to project activities. The discharge flows that will be addressed include, but are not limited to:

- Storm water discharges
- Construction dewatering flows
- Sanitary wastes
- Vehicle wash water discharges, if necessary

Upon completion of the detailed design, the temporary and permanent water management measures will be addressed in the VCS Erosion and Sediment Control Plan and Water Management Plan. These plans and the relevant design drawings referenced therein will address the nature and volume of the discharges, the points of discharge, and the erosion and sediment control measures used to control construction water discharge and runoff. They will also address methods and techniques employed to prevent and/or minimize contamination of storm water from construction activities.

3.9.2.5 Protection of Sensitive Resources

Procedures and programs will be established to avoid, minimize, or mitigate, as necessary, impacts to sensitive resources either within the site or in the immediate surrounding areas that may be impacted during construction. The primary control measure for each of the areas described below is avoidance. Where avoidance is not feasible, the measures to be used are addressed in this subsection.

Sensitive areas will be identified during preconstruction surveys as part of the overall site investigation and permitting effort. Mitigation measures will be addressed under the VCS permits described in Section 1.2.

Environmentally sensitive resources that may be encountered during construction activities at the site, along with the typical mitigation measures required to eliminate and/or minimize impacts on these resources, follow:

Wetlands

Wetlands will be identified during preconstruction surveys. Exclusion and/or silt fencing or other barriers will be installed at such a time during the construction period as is appropriate to adequately protect those areas identified. Certain unavoidable activities may require temporary incursions into identified wetlands. Impacts to wetlands will be mitigated and/or remediated by following permit conditions that may include:

- Reduction of clearing limits and preservation of existing vegetative cover
- Maintenance of existing drainage patterns
- Prohibitions/restrictions on equipment and vehicular travel
- Prohibition of maintenance/refueling near wetland boundaries

Rivers and Streams

Exclusion fencing and/or silt fencing or other barriers will be installed at such a time during the construction period, as appropriate, to adequately protect those areas identified. Mitigation measures for direct impacts to waterways (e.g., pipeline crossings, access road construction, and discharge pipe installation) will be spelled out in the relevant permits. Mitigation/remediation measures may include:

- Limitations on the length of time of a disturbance
- Limitations or restrictions on seasonal in-water work

- Reduction in clearing limits and preservation of existing vegetative cover in or near stream banks
- Limitations on the installation design of specified crossings (e.g., mat bridges)
- Use of silt curtains, coffer dams, or other sediment transport barriers
- Restrictions on fill activities and materials
- Restoration of stream beds, banks, and natural vegetation

Areas of Special Status (protected or unique wildlife or vegetation habitats)

Based on preconstruction surveys, exclusion fencing and/or silt fencing or other barriers will be installed at such a time during the construction period, as appropriate, to adequately protect those areas identified. In the event construction activities encounter special status wildlife species or their habitat, work in the immediate area would be halted and the appropriate agency officials and/or environmental consultants would be contacted to determine proper mitigation measures before resuming work.

Archeological/Cultural Resource Areas

Based on preconstruction surveys, buffer zones will be established and exclusion fencing or other barriers will be installed at such a time during the construction period, as appropriate, to adequately protect those areas identified. In the event that construction activities encounter buried archeological/cultural resources, work in the immediate area would be halted and an archeological expert (such as a professional archeologist or representative from the Texas Historical Commission) would be contacted to determine proper mitigation measures before resuming work.

3.9.2.6 Unanticipated Discoveries

Procedures will be developed to address unanticipated discoveries made during construction. These procedures will address the onsite and offsite notification of parties having relevant interest or jurisdiction over the discovery. Those contacted would include local or state authorities having jurisdiction, depending on the nature of the discovery. Others to be notified would be onsite management or those with the authority to stop work if that is deemed the appropriate action.

Unanticipated discoveries may include:

- Suspected contaminated soils or groundwater
- Unidentified or suspicious drums, tanks, or piping
- Unidentified building foundations
- Suspected cultural artifacts
- Bones

In the event a discovery is made and it is deemed appropriate to stop work in the area, the sequence of events will be to cease activities in the vicinity of the unanticipated discovery and to immediately report the situation to the appropriate authorities.

For unanticipated discoveries that would be hazardous to human life, health, or safety, the site safety representative would also be immediately notified. Additional investigations, sampling, analysis, and notifications to appropriate agencies will be performed as appropriate.

3.9.2.7 **Hazardous Materials and Petroleum Management**

The hazardous materials and petroleum management procedures will describe the management program that will be implemented and how petroleum products and applicable chemical substances (termed "hazardous materials") will be managed to minimize the potential for threats to human health, safety, and the environment. The management program will address the need for Material Safety Data Sheets for applicable materials brought on site, and county/state-specific requirements regarding handling, storage, use, and disposal.

3.9.2.8 **Solid Waste Management (Hazardous/Nonhazardous Wastes)**

Solid waste management procedures will be used to describe the management program for handling construction wastes generated at the site. The management program will address nonhazardous wastes and hazardous wastes through separate procedures. In all cases, the management program will be compliant with the relevant environmental requirements including county and state-specific waste handling and transportation practices and approvals, waste minimization activities, and offsite recycling of certain common construction wastes (e.g., used oil, antifreeze, scrap metal, wood).

3.9.2.9 **Asbestos and Lead-Based Paint**

In the event that hazardous materials such as asbestos, asbestos-containing material, or lead-based paint are encountered, a process will be established to address the county/state-specific regulatory requirements for containment and/or removal of such materials by trained, authorized personnel. Site-specific procedures will also address regulations governing the overall management of the removal and abatement work including:

- Prework notifications
- Removal by certified contractors
- Handling before disposal
- Transport to and disposal at licensed facilities
- Post-work closure reports

3.9.2.10 **Spill Prevention and Response**

The spill prevention and response procedures will address how to manage hazardous materials, petroleum products, and related wastes in such a manner as to prevent releases and to minimize the potential for threats to human health and the environment in the event of a release. The management program will address the need for secondary containment, spill response materials, spill magnitude thresholds for reporting the release (e.g., reportable quantities), emergency response actions, and notification requirements for project personnel and county/state agencies.

3.9.2.11 Cleanup and Restoration

Procedures and programs will be developed to describe the activities to be undertaken for cleanup and restoration of the site and other areas used during construction (e.g., offsite laydown yards). The developed procedures and programs will address the cleanup and removal of unused construction materials and debris, restoration of topographical surfaces (e.g., swales, roads, fences, gates, walls) and subsurface features (e.g., drainage tiles, utilities) in accordance with permit requirements and best management practices for permanent site stabilization.

3.9.3 Site Preparation Activities

The site preparation activities and approximate durations are described in Subsections 3.9.3.1 through 3.9.3.13.

Beginning site preparation activities 18 months before the first major construction activity allows for:

- Installation of temporary facilities (e.g., warehouses, concrete batch plant, craft change houses and sanitary facilities)
- Relocation of obstructions and infrastructure within VCS Units 1 and 2 footprint
- Staging of equipment
- Preparation for the plant module assemblies
- Preparation activities to support power plant construction

These activities will prepare the site for construction of VCS. Typical construction activity durations are summarized in Table 3.9-1.

3.9.3.1 Installation and Establishment of Environmental Controls

The construction activities will comply with federal, state, and local environmental regulations and permit requirements. Best management practices will be implemented to minimize impacts during preconstruction and construction activities.

A tabulation of the major land disturbance on and near the site is as follows:

- Construction of the two-unit power block area and related structures will disturb approximately 297 acres.
- Construction of the switchyard area will disturb approximately 90 acres.
- Construction of the heavy haul road, approximately 7.5 miles in length and 80 to 100 feet wide at the road surface and approximately 350 feet wide at the toe of the associated constructed slope, from the Victoria Barge Canal turning basin barge facility to the area of the power block will disturb approximately 318 acres.

- Construction of the onsite construction roads and laydown areas will disturb approximately 384 acres.
- Construction of the cooling basin and an adjacent Guadalupe-Blanco River Authority (GBRA) storage — water basin will disturb approximately 7100 acres.
- Construction of the north spoils area will disturb approximately 50 acres.
- Construction of the south spoils area will disturb approximately 320 acres.
- The relocation of the existing gas lines and construction of the rail spur will disturb approximately 90 acres.
- Installation of the 90-inch diameter water makeup line, approximately 18 miles in length, from the GBRA intake structure to the cooling basin and GBRA Reservoir will disturb approximately 278 acres.
- Installation of the 48-inch diameter blowdown water pipeline, from where the pipeline leaves the heavy haul road right-of-way to the pipeline discharge point at the Guadalupe River, will disturb approximately an additional 12 acres.
- Installation of the 36-inch diameter pipeline, approximately 11 miles in length, from the GBRA Water Storage Reservoir on the VCS site to the Coleto Creek Reservoir, will disturb approximately 151 acres.

3.9.3.2 **Clearing, Grubbing, and Grading**

Clearing the site will begin with the removal of trees to the minimum extent necessary. Scrub vegetation and brush removal will be accomplished through the use of appropriate and approved techniques that may include controlled burning.

Three existing east/west pipelines that cross the plant property (two gas lines that traverse the cooling/storage basin area, and one gas line that is located between the switchyard and power block) will be rerouted to the north around the planned switchyard. The new pipelines will be reconnected at the eastern and western property boundaries.

Existing gas/oil wells that are deemed necessary for in-place abandonment will be filled with concrete or grout, sealed and/or capped, and abandoned in accordance with the applicable guidelines of those regulatory agencies having jurisdiction. Other facilities within the cooling and storage water basin footprint will be removed.

A 50-acre topsoil storage area in a northwest portion of the site and a 322-acre spoils storage area to the south of the cooling water basin will be established. Additional storage areas will be established within the southern portions of the cooling water basin. Approximately 1 foot of topsoil will be removed from the power block and northern half of the cooling and storage water basin area footprint. Topsoil will also be removed from the cooling and storage water basin exterior earthen embankment and water diversion dikes footprint as well as at other areas identified as requiring stripping of the existing topsoil.

The material below the topsoil in the northern half of the cooling water basin will be excavated and used to build the exterior earthen embankment structures and interior water diversion dikes. The topsoil will be moved to the storage areas for later use during final site grading. Excess topsoil will be transported offsite and/or deposited on the outer perimeter of the cooling and storage water basins, placed outside the southern portion of the cooling water basin, or remain in the spoils area. Soil transported offsite will be reused or disposed of in accordance with applicable laws and regulations.

The Construction Utilization Plan, Construction Area of Disturbance, and Plot Plan (Figures 3.9-1, 3.9-2, and 3.9-3) illustrate the areas to be cleared and graded.

3.9.3.3 Road, Rail, and Barge Facility Construction

Construction vehicular traffic access to the site will be via U.S. Highway 77 (U.S. 77) which borders the plant property to the west. A construction access road, which will include an overpass to facilitate northbound and southbound traffic entering and exiting the site, will be constructed from U.S. 77 onto the site property. A site road system will be installed around the site construction areas and the cooling basin. It is anticipated that the roads will be paved (subcourse) to accommodate the traffic, alleviate dust, and minimize stone projectiles from travel on a gravel road system. Upon project completion, the top course would be installed on the paved roads. The roads around the cooling/storage basins would not be paved.

A new rail spur will connect the site to the Burlington Northern Santa Fe Railway line, which passes southeast of VCS property. The rail spur construction will include installation of new bed, ballast, ties and rail from the southeast perimeter of the site property to the northern plant boundary, under a new elevated overpass at U.S. 77 on the plant property to the batch plant and material storage areas. The rail spur will form a 180 degree loop at the material storage areas and pass between the power block area and the switchyard before reconnecting to the western section of the spur. The rail spur will be installed adjacent to the construction laydown areas to facilitate receipt of bulk commodities (e.g., pipe, reinforcing steel, structural steel) and will service the batch plant area to support concrete materials and backfill offloading. Railcar unloading facilities (car shakers, pneumatic railcar unloaders, rotary dumpers, or other effective methods of high volume railcar unloading) will be located at the batch plant, power block, and the southern property area, as deemed appropriate. It is anticipated that the installation of offloading or material handling crane foundations will be required, and heavy lift cranes will be erected for the larger components that are delivered to the site.

The Victoria Barge Canal connects the Gulf Intracoastal Waterway to the Port of Victoria, and will be used for large module delivery. Three bridges span the canal between the Gulf and the Port of Victoria (turning basin) with a limiting height clearance of approximately 50 feet and width clearance of approximately 75 feet. The turning basin barge facility is the preferred option for module receipt and will require minor upgrades to accommodate roll-on/roll-off transporters.

A new heavy haul road will have a total length from the turning basin facility to the Unit 1 nuclear island of approximately 7.5 miles. The road will start at elevation 26 feet (NAVD 88) at the turning basin facility and extend southwest at approximately a 2% upward grade, passing over the levee at the levee's lowest elevation of 45 feet (NAVD 88). The heavy haul road will then turn south paralleling the levee for approximately 1.5 miles. The heavy haul road will continue west towards the site, ramping up to elevation 48 feet (NAVD 88) to a bridge that will be built over the Guadalupe River. The bridge crossing the Guadalupe River will extend approximately 2400 feet, with the road surface at elevation 48 feet (NAVD 88) so as to be above the 100-year flood level. West of the bridge, spanning the Guadalupe River, the heavy haul road will continue at elevation 44 feet (NAVD 88) up to plant grade.

The road embankments will be 25 feet above existing grade, the width of the embankments at the base will be approximately 350 feet. Existing mapped wetlands material will be removed and replaced with structural fill from the cooling basin excavation. Culverts will be installed under the heavy haul road at streams, creeks, and bayous to maintain drainage patterns. Exiting the floodplain area the road will ramp up at a 1% grade to elevation 80 feet (NAVD 88), the site elevation. The road continues to the southwest entering the site and progresses alongside the laydown areas to the power block.

If necessary, hydrological study(s) will be performed on the Guadalupe flood plan to quantify the impact on the flood levels due to the construction of the heavy haul road.

Figures 3.9-1, 3.9-2, and 3.9-3 depict the locations of the rail spur, plant access roads, heavy haul road, and barge facility.

3.9.3.4 Construction Security

Construction security programs and features will be implemented as part of the early site preparation activities. Security structures will include access control points, fencing, lighting, physical barriers, and guardhouses.

Temporary security provisions will be installed in locations where access is to be limited to those having a need to be in that locale. Details of the site security plan are described in Part 8 of the COL application.

3.9.3.5 Temporary Utilities

Temporary utilities will include aboveground and underground infrastructure for power, lighting, communications, potable water, wastewater and waste treatment facilities, fire protection, and construction gasses and air systems. The temporary utilities will support the entire construction site and associated activities, including construction offices, warehouses, storage and laydown areas, fabrication and maintenance shops, the power block, the batch plant facility, test and calibration labs, GBRA intake facility (if alternate provisions for temporary utilities are considered not feasible), and the circulating water intake and discharge areas.

3.9.3.6 Temporary Construction Facilities

The temporary construction parking lot and construction laydown and fabrication areas will be cleared, grubbed, graded, and graveled with a road system to accommodate the site construction traffic.

Temporary construction facilities including offices, warehouses, temporary workshops, sanitary facilities, locker rooms, training facilities, and access facilities will be constructed.

The site of the concrete batch plant will be prepared for cement and aggregate unloading and storage. Cement storage silos and the concrete batch plant will be erected. Dry material storage facilities will be equipment with fugitive dust control systems to meet the requirements of the applicable permits and guidelines.

3.9.3.7 Laydown, Fabrication, and Shop Area Preparation

Activities to support preparation of the laydown, fabrication, and shop areas include:

- Conducting property surveys to establish local coordinates and the placement of benchmarks for horizontal and vertical control
- Developing laydown areas by grading, stabilizing, and surfacing these areas
- Installing construction fencing
- Installing shop and fabrication areas
- Installing concrete work slabs for formwork laydown, module assembly
- Installing equipment maintenance and parking areas
- Installing fuel and lubricant storage areas
- Installing concrete pads for cranes and crane assembly

3.9.3.8 Cooling and Water Storage Basins

The construction of the cooling and water storage basins with the intake structure, discharge structure, the GBRA Coleto Creek pumping station, and the filling of the basins is estimated to extend over a period of approximately 5 years. The extended duration and the importance of these activities dictate that these tasks begin early in the construction schedule.

The existing topography of the plant property is at approximately elevation 85 feet (NAVD 88) at U.S. 77 near the northwest property boundary and slopes downward to an elevation of approximately 65 feet (NAVD 88) at the southwest property boundary. The current elevation of the power block area is approximately 80 feet (NAVD 88). The post-construction finish grade elevation within the protected power block area will be approximately 95 feet (NAVD 88) (the grade elevation adjacent to safety-related structures).

The cooling and water storage basins will have a footprint of approximately 7100 acres. The impounded usable surface area, depending on the water level is approximately 4940 acres for the cooling basin and approximately 1290 aces for the GBRA storage reservoir. The top of the perimeter embankment and interior basin separation embankment, located between the cooling basin and the water storage basin, will be at an approximate elevation of 102 feet (NAVD 88). The interior water flow diversion dikes will have a top elevation of approximately 99 feet (NAVD 88). The bottom elevation of the basins will be approximately 69 feet (NAVD 88) [with a 6-inch silt allowance (69.5 feet (NAVD 88))], with the flow channel formed sloping down to the intake forebay structure at approximate elevation 60 feet (NAVD 88). The high water elevation in the basins, when filled to the design depth, will be approximately 95 feet (NAVD 88). The basins' designs include high water overflow spillway structures. The cooling basin spillway would divert overflow to Kuy Creek to the southwest and the GBRA storage basin spillway would divert overflow to Linn Lake to the northeast. The interior embankment slope design will include features to preclude erosion of the embankments.

As described above, after topsoil removal operations and topsoil storage, excavation of the northeast portion of the basin's area will commence. The excavated material from the northeast portion of the basin area will be used to construct the exterior dam embankment and interior dikes and the heavy haul road, thus leveling the basin's bottom while balancing the excavation cut and fill operation necessary to construct the basin structure.

Temporarily stockpiled topsoil within the basins will be relocated and deposited on the exterior perimeter of the basin's embankments, and also used for the finish grading around the power block area. The topsoil deposited around the basin's exterior will be vegetated for erosion control. A gravel perimeter road around the basins will be constructed with ramps located at appropriate locations to allow access the top of the exterior and interior embankments. These roads will be used for periodic inspection and maintenance purposes.

3.9.3.9 **Cooling Basin Intake and Discharge Structure Installations**

The installation of the intake and forebay structure and the circulating water discharge structure are prerequisites to starting the cooling basin filling operations.

The intake structure will house the eight circulating water pumps, four plant service water (PSW) makeup pumps, two cooling basin blowdown pumps, and eight screen wash pumps. It will occupy a footprint of 166 feet by 454 feet inside the cooling basin.

Once the excavation in the northeast interior perimeter of the cooling basin reaches the bottom of foundation elevation, approximately elevation 47 feet (NAVD 88) for the intake structure and 64 feet (NAVD 88) for the discharge structure, foundations can begin and civil work will continue into the major construction phases.

The intake and discharge structures will be reinforced concrete structures. The intake structure will rise from the bottom of the basin and forebay to the top of the basin embankment, but below the embankment road. The circulating water discharge piping will be routed from the discharge diffuser structure (at the bottom of the basin) over the top of the embankment above the design high water level but below the embankment road. The circulating water, PSW makeup, and cooling basin blowdown piping will be routed over the embankment, but below the embankment road, and go underground at the exterior perimeter of the basin. The 12.5-foot diameter circulating water pipelines will be routed to the turbine building, with the bottom of pipe (invert) elevation approximately 27.5 feet below plant grade [elevation 67.5 feet (NAVD 88)]. The completion of circulating water piping installation will coincide with turbine building pedestal basemat placement.

The 20-inch diameter PSW makeup line will be routed from the cooling basin to the PSW cooling tower basins, and the 18-inch diameter PSW blowdown line will be routed from the PSW pump house to the cooling basin.

3.9.3.10 Blowdown Discharge Line

The 48-inch diameter cooling basin blowdown discharge line will be installed adjacent to the heavy haul road in conjunction with the construction of the heavy haul road. The blowdown line will exit the intake structure and terminate at the Guadalupe River outfall diffuser, south of the existing DuPont Pumping Station Intake. A sheet pile cofferdam system will be installed around the footprint of the new blowdown discharge pipeline and diffuser. Excavation of the discharge pipe outfall diffuser cofferdam will be protected from silting the river by the use of silt screens or other approved techniques. The dewatering pumps required to maintain a dry excavation will likewise use approved silt prevention techniques before discharge to the Guadalupe River. Excavated and dredged material will be transported to a spoils area in the northern portion of the plant property or elsewhere to designated spoils areas as approved by the U.S. Army Corps of Engineers.

3.9.3.11 Guadalupe-Blanco River Authority Pump Stations and Pipelines

To supply the 75,000-acre feet of water per year at a maximum rate of up to 217 cfs to the cooling basin, and 50 cfs to the water storage reservoir, a new pump station will be installed at a location southeast of the North Seadrift Water Treatment Facility (southeast of Green Lake). The intake pump house will be located on the GBRA Calhoun freshwater canal in Calhoun County. The pump house will be a reinforced concrete structure situated on the main canal. The pump house will be a two-level facility, with the lower level being submerged in the canal at elevation 14 feet (NAVD 88), with grade at 29.5 feet (NAVD 88), and the roof elevation at 54 feet (NAVD 88). The pump house will occupy an area of 110 feet by 176 feet (19,360 square feet). The pump house will have a hypochlorite system and screen wash pumps for keeping the flow area clear through the trash screens. The pump house will house five pumps to supply a 90-inch diameter pipeline.

The 90-inch diameter, approximately 18-mile long buried pipeline will be constructed from the GBRA pump station northwesterly along the SH 185 right-of-way to the Heyser Oil Field, then southwest to Black Bayou No. 2 Road, under the Victoria Barge Canal, under the Guadalupe River, to the south end of the cooling and water storage basins on site. Where the pipeline crosses the canal and river, two 60-inch diameter pipes will be used. This will allow for horizontal directional drilling under the two largest water crossings.

At the northeast end of the onsite GBRA reservoir, a second pump station will be constructed, and a buried 36-inch diameter pipeline, approximately 11 miles long, will be routed across the rights-of-way of U.S. 77 and U.S. Highway 59 to a terminus at the Coleto Creek Reservoir.

3.9.3.12 Power Block Earthwork (Excavation)

The power block footprint encompasses the nuclear and turbine island building areas, which include the following major buildings for each unit:

- Reactor building
- Fuel building
- Control building
- Electrical building/TSC
- Radwaste building
- Service building
- Turbine building

In conjunction with the site preparation activities, mass excavation of the power block areas for VCS Units 1 and 2 will occur. The power block areas will be excavated to varying depths as required by the design features of each structure.

The final site grade elevation will be 95 feet (NAVD 88). The deepest foundations in the power block area are for the reactor and fuel buildings, with the bottom of foundation anticipated to be approximately 70 feet below final site grade [elevation 25 feet (NAVD 88)]. The next deepest foundations are to be the radwaste building foundations at 53 feet below final site grade [elevation 42 feet (NAVD 88)]. The control building foundations will be approximately 49 feet below final site grade [elevation 46 feet (NAVD 88)]. The turbine building foundation is to be approximately 26 feet below site grade [elevation 69 feet (NAVD 88)]. The service building bottom of foundation is to be approximately 17 feet below site [elevation 78 feet (NAVD 88)]. The electrical and diesel generator buildings are anticipated to have shallow foundations that are only slightly below site grade. The below grade tunnels interconnecting the buildings are to have a bottom of concrete elevation of approximately 24 feet below site grade [elevation 71 feet (NAVD 88)] (Reference DCD Figures 1.2-1 through 1.2-33)

The circulating water piping will have an invert elevation approximately 27 feet below finished plant grade [elevation 68 feet (NAVD 88)]. The service water piping excavation areas vary in depth and range from approximately 12 to 15 feet below grade [elevation 83 feet to 80 feet (NAVD 88)]. The service water cooling tower basins and pump houses area are to be excavated 30 feet below final site grade at the deepest point [elevation 65 feet (NAVD 88)]. Other yard buildings and tank foundation excavations are relatively shallow (less than 6 feet below plant grade).

It is anticipated that an extensive dewatering system will be installed around the Units 1 and 2 excavation boundary before the mass excavation begins. During the excavation, slope protection and temporary ground support systems will be installed. Swales and/or dikes will be constructed around the excavation areas to prevent surface water/runoff from entering the excavation work area. Drainage sumps and/or temporary well points will be installed at the bottom of the excavations from which surface drainage and/or accumulated groundwater will be pumped to a storm water discharge point that will pipe the water to detention ponds to filter out turbidity and solids. Storm water detention ponds will be located on the west side of Unit 1 and the east side of Unit 2. Water from the power block area will be piped to the detention ponds that ultimately flow to Linn Lake and Kuy creek to the Guadalupe River.

Excavated material will be transferred to designated spoils and backfill borrow storage areas. Material removed from the excavation and evaluated as acceptable for reuse will be stored for common or structural backfill.

In accordance with RG 1.165 (U.S. NRC Mar 1997), Subsection (C.1.3); the open excavations will be geologically mapped and the NRC will be notified when the excavations are open for inspection. In the event any unsuitable sub-foundation material is discovered during the mapping operations, the affected area within the power block will be over-excavated to remove unsuitable material. The over-excavated material will be replaced with structural backfill material after COL issuance.

3.9.3.13 **Module Assembly**

The ESBWR design uses a high degree of modularization. The module components in the nuclear island will be fabricated offsite, shipped to the site via rail, truck, or barge, and assembled into complete modules before being set in the power block. Modules weighing up to 1250 tons will arrive by barge and be transported to the power block area or offloaded in fabrication assembly areas. The assembly of the module components into complete modules onsite will begin during the site preparation phase. The Reactor Building basemat reinforcing module will be the first module assembled during site preparation activities. The containment building liner module assembly will also occur during site preparation phase. The completion of the containment basemat reinforcing steel module assembly is planned to coincide with the completion of Unit 1 reactor building foundation excavation. The setting of completed modules will begin upon receipt of the COL.

3.9.4 **COL Construction Activities**

3.9.4.1 **Power Block Earthwork (Backfill)**

The general plant area inside the protected area boundary is to be brought to plant grade [approximate elevation 95 feet (NAVD 88)].

In preparation for foundation installation, any over-excavated areas (areas where material of unacceptable structural integrity is encountered will be removed until an acceptable structural bearing surface is reached) within the power block will be backfilled to the bottom elevation of foundation. The placement of structural backfill will occur upon issuance of the COL. Backfill material will come from the evaluated and qualified onsite material storage areas, qualified onsite borrow pits, or qualified offsite sources. Potential backfill material may be "lean mix concrete" which is an engineered backfill material produced from the concrete batch plant.

3.9.4.2 Reactor Building Basemat Foundation

The deepest foundations in the power block are the reactor and fuel building basemats, which are installed first. The installation steps include:

- Installation of the electrical grounding grid or mat
- Installation of a mud-mat, a concrete work surface
- Installation of reinforcing steel
- Installation of civil, electrical, mechanical/piping embedded items
- Installation of concrete formwork
- Placement of the structural concrete and the concrete curing process

The activities associated with the nuclear island foundations are safety-related and will occur after the issuance of the COL and any associated ITAAC functions.

3.9.4.3 Structural Construction

Power plant construction of safety-related SSCs will begin upon issuance of the COL. Each ESBWR unit is a series of buildings and structures with systems installed within the structures.

Power plants are typically constructed with the major mechanical and electrical equipment and piping systems installed in each respective elevation as the civil construction advances upward.

Each power block consists of seven major buildings. The following is a brief description of each major building, along with the approximate maximum height of each above plant grade: **(Note the references noted below are Security-Related Information — Withhold Under 10 CFR 2.390)**

- The reactor building has nine major floor elevations (three stories below grade and six stories above grade) and reaches a height of approximately 162 feet above plant grade. (Reference DCD Figure 1.2-11. Nuclear Island Elevation Section B-B).
- The fuel building has four floor elevations (three stories below grade and one story above grade plus a penthouse structure) and reaches a height of approximately 79 feet above plant grade. (Reference DCD Figure 1.2-10. Nuclear Island Elevation Section A-A).
- The control building has four main floor elevations and reaches a height of approximately 33 feet above plant grade. (Reference DCD Figure 1.2-11. Nuclear Island Elevation Section B-B).
- The turbine building has five main floor elevations and reaches a height of approximately 166 feet above plant grade. (Reference DCD Figure 1.2-19. Turbine Building Elevation Section A-A).
- The radwaste building has four main floor elevations and reaches a height of approximately 40 feet above plant grade. (Reference DCD Figure 1.2-25. Radwaste Building Elevation Section A-A).

- The service building is assumed to have three floor elevations and reach a height of approximately 35 feet above plant grade.
- The electrical building has six floor elevations and reaches a height of approximately 95 feet above plant grade. (Reference DCD Figure 1.2-33. Electrical Building Elevation Section A-A).

Much of the commodity installation will consist of prefabricated civil/structural, electrical, mechanical, and piping modules with field installed interconnections. The balance of the field installation consists of bulk commodity installation. The estimated construction duration for Units 1 and 2 from COL issuance to commercial operation of Unit 2 is approximately 67 months. The major activities for construction of the power block buildings are described in Subsection 3.9.4.4. Table 3.9-1 summarizes the estimated durations for major power block construction activities.

3.9.4.4 Power Block Construction Descriptions

(Reference DCD Figures 1.2-1 through 1.2-33 for the details of the following structures) **(Note the references noted below are Security-Related Information — Withhold Under 10 CFR 2.390)**

Reactor Building

The reactor building has the longest construction duration.

The reactor building, which includes the containment vessel as an integrated structure, is constructed of steel and concrete with three floor elevations below plant grade, and six floor elevations above grade with a footprint of approximately 161 feet by 161 feet. The major activities associated with the reactor building construction following the basemat foundation placement include:

- Erecting the reactor containment vessel modules
- Placing the walls, slabs, platforms, and reactor supports
- Installing the reactor pressure vessel and heat exchangers
- Setting the major mechanical and electrical equipment, piping, and valves
- Installing the suppression pool/wet well and fuel transfer tube
- Setting the refueling machine and the reactor building crane
- Setting the upper reactor building roof structure

The remaining mechanical, piping, HVAC, and electrical installations begin in the lower elevations and continue to the upper elevations. This is the case with each of the other buildings.

Fuel Building

The fuel building is a concrete and steel structure that abuts the Reactor Building, and has a footprint of approximately 161 feet by 69 feet. This building has three floor elevations below plant grade and one floor elevation above plant grade with a HVAC penthouse.

Control Building

The control building is a concrete and steel structure with a footprint of approximately 100 feet by 78 feet. This building has two floor elevations below plant grade and two floor elevations above plant grade.

Turbine Building

The turbine building is a concrete and steel structure with a footprint of approximately 194 feet by 378 feet. The turbine building has one floor below plant grade and four floor elevations above plant grade. The turbine building construction begins with the installation of turbine generator pedestal basemat and the buried circulating water pipe, followed by installation of the turbine generator pedestal columns, steam condenser modules, and turbine generator pedestal deck. The turbine generator building is then erected once the turbine generator pedestal is complete, followed by the turbine building crane. Installation and assembly of the turbine generator may then proceed.

Radwaste Building

The radwaste building is a concrete and steel structure with a footprint of approximately 110 feet by 215 feet with two elevations below plant grade and two levels above plant grade. Construction of the radwaste building begins with basemat installation. After an initial period of civil work (walls, enclosures, and intermediate floors), installation of equipment, piping, cable, and instrumentation occurs in parallel with the remaining civil work.

Service Building

The service building is anticipated to be a steel and concrete structure with insulated metal siding and a brick exterior above plant grade with a footprint of approximately 160 feet by 100 feet, including one elevation below grade and two levels above grade. Construction of the service building begins with basemat installation. After an initial period of civil work (walls, enclosures, and intermediate floors), installation of equipment, piping, cable, and instrumentation occurs in parallel with the remaining civil work.

Electrical and Diesel Generator Buildings

The electrical building is a reinforced concrete structure that has a footprint of 140 feet by 144 feet built on grade and with all six floor elevations above plant grade. Two diesel generator buildings abut the electrical building and each have a footprint of 105 feet by 44 feet and are approximately 28 feet in height.

3.9.4.5 Other Facilities

Other facilities to be constructed/installed include:

- Switchyard, transformers, and transmission lines
- Operator simulator and training facility buildings and warehouse

- Circulating water intake and discharge structures, and cooling basin pump house
- Tunnels and pipe chases
- PSW cooling towers and basins
- Hot and cold machine shop
- Sewage treatment facility
- Fire protection pump house
- Water treatment building
- Guardhouses, sally ports, personnel access and delay fence
- Administration building
- Various yard tanks
- Hydrogen, nitrogen, oxygen, and CO_2 storage facilities

The common yard area construction occurs over 57 months from the start of site preparation. The necessary permits and authorizations will be acquired to ensure compliance with all applicable rules and regulations (see Section 1.2 of the ER).

3.9.5 **Activities Associated with Construction**

Construction activities will involve the movement of workers and construction equipment. Construction personnel will commute to and from the site on local roads. Deliveries to the construction site will be by truck, rail, or barge.

The installation contractors will have procedures in place for spill prevention, control, and countermeasures that include the control of potential petroleum leaks from construction equipment, and remedial actions in the event of such a leak. Response to major spills from construction equipment will also be addressed. Measures will be put in place to control storm water discharges associated with construction activity. An erosion, sediment, and pollution prevention plan specific to the construction activities will be prepared.

During Units 1 and 2 site preparation and plant construction, air quality protection procedures as described in Subsection 3.9.2.2 will be used to minimize and control fugitive dust from construction activities and vehicular traffic. Fugitive dust control measures such as watering of roads, covering truck loads and material stockpiles, reducing material handling activities, and limiting vehicle speed are anticipated to effectively control fugitive dust during construction.

Some level of noise is expected to be generated from operation of construction equipment including earthmoving equipment, trucks, cranes, portable generators, pile drivers, pneumatic equipment, and hand tools. Table 3.9-2 summarizes the expected noise levels (in dBA) from various types of anticipated equipment to be used during construction.

3.9.6 References

Golden 1980. Golden, J., Ouellette, R. P., Saari S., and Cheremisinoff, P. N., *Environmental Impact Data Book*, Chapter 8: Noise, 2nd Printing, Ann Arbor Science Publishers, Inc., Ann Arbor, Michigan, 1980.

U.S. NRC Mar 1997. Regulatory Guide 1.165, *Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion*, March 1997.

Table 3.9-1
Construction Activity Individual Durations

Construction Activity	Approximate Duration*
Preconstruction Activities	
Installation and Establishment of Environmental Controls	4 months (after the acquisition of required permits and authorizations)
Road and Rail Construction	5 months
Security Construction	3 months
Temporary Utilities	6 months
Temporary Construction Facilities	9 months
Lay-down, Fabrication, Shop Area Preparation	5 months
Clearing, Grubbing, and Grading	9 months
Underground Installations	8 months
Unloading Facilities Installation	9 months
Blowdown Discharge Cofferdams and Piling Installation	5 months
Power Block Earthwork (Excavation)	10 months
Module Assembly	15 months
Cooling and Storage water basins, intake pump house, and discharge structure	36 months
COL Construction Activities	
Power Block Earthwork (Backfill)	5 months
Reactor Building Basemat Foundation	5 months
Control Building Foundation	4 months
Radwaste Building Foundation	4 months
Turbine Building Foundation	4 months
Containment Building	42 months
Control, Electrical/DG, Fuel Buildings	36 months
Turbine Building	42 months
Radwaste Building	30 months
Switchyard and Installation of the Main Transformers	9 months
Administration, Simulator and Training Facility Buildings	12 months
Plant Service Water Cooling Tower and PSW Pump House	18 months
Yard Tanks	12 months

* The durations tabulated here include parallel activities and are not additive to the project schedule values.

Table 3.9-2
Peak and Attenuated Noise (in dBA) Levels Expected from Operation of Construction Equipment

Source	Noise Level (peak)	Distance from Source			
		50 feet	100 feet	200 feet	400 feet
Heavy trucks	95	84–89	78–83	72–77	66–71
Dump trucks	108	88	82	76	70
Concrete mixer	105	85	79	73	67
Jackhammer	108	88	82	76	70
Scraper	93	80–89	74–82	68–77	60–71
Dozer	107	87–102	81–96	75–90	69–84
Generator	96	76	70	64	58
Crane	104	75–88	69–82	63–76	55–70
Loader	104	73–86	67–80	61–74	55–68
Grader	108	88–91	82–85	76–79	70–73
Dragline	105	85	79	73	67
Pile driver	105	95	89	83	77
Forklift	100	95	89	83	77

Source: Golden 1980

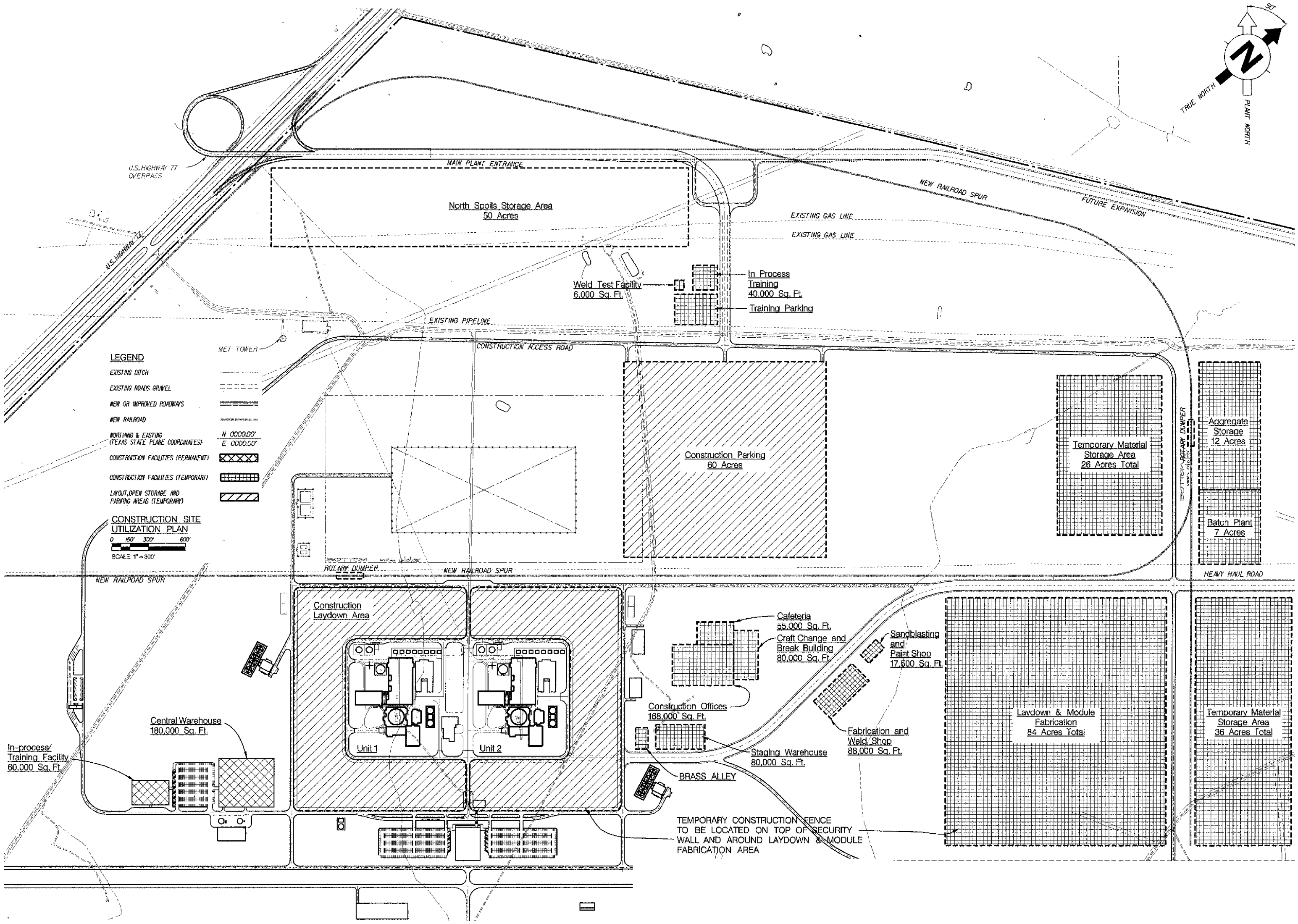

Figure 3.9-1 Construction Utilization Plan

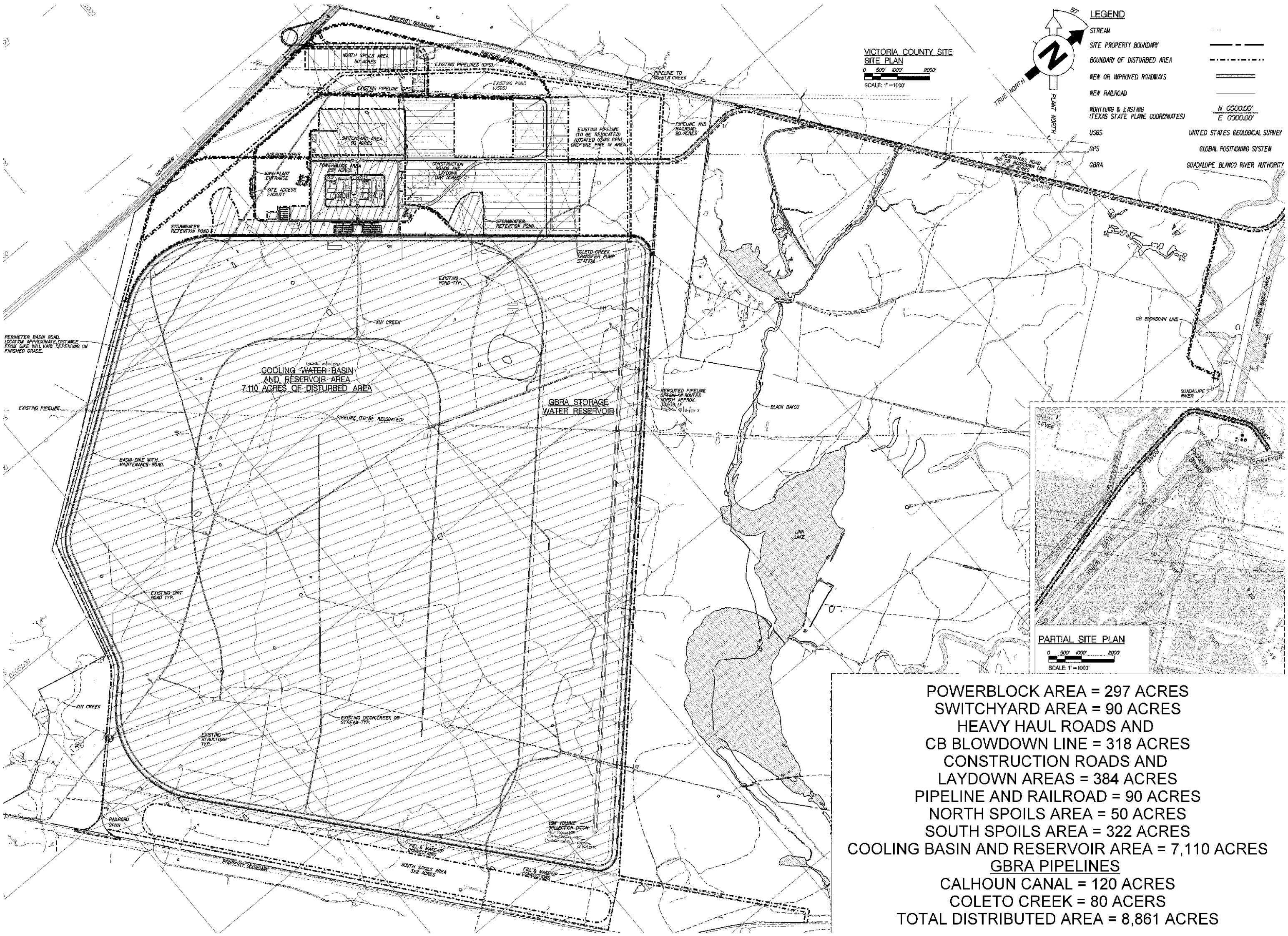

Figure 3.9-2 Construction Area of Disturbance

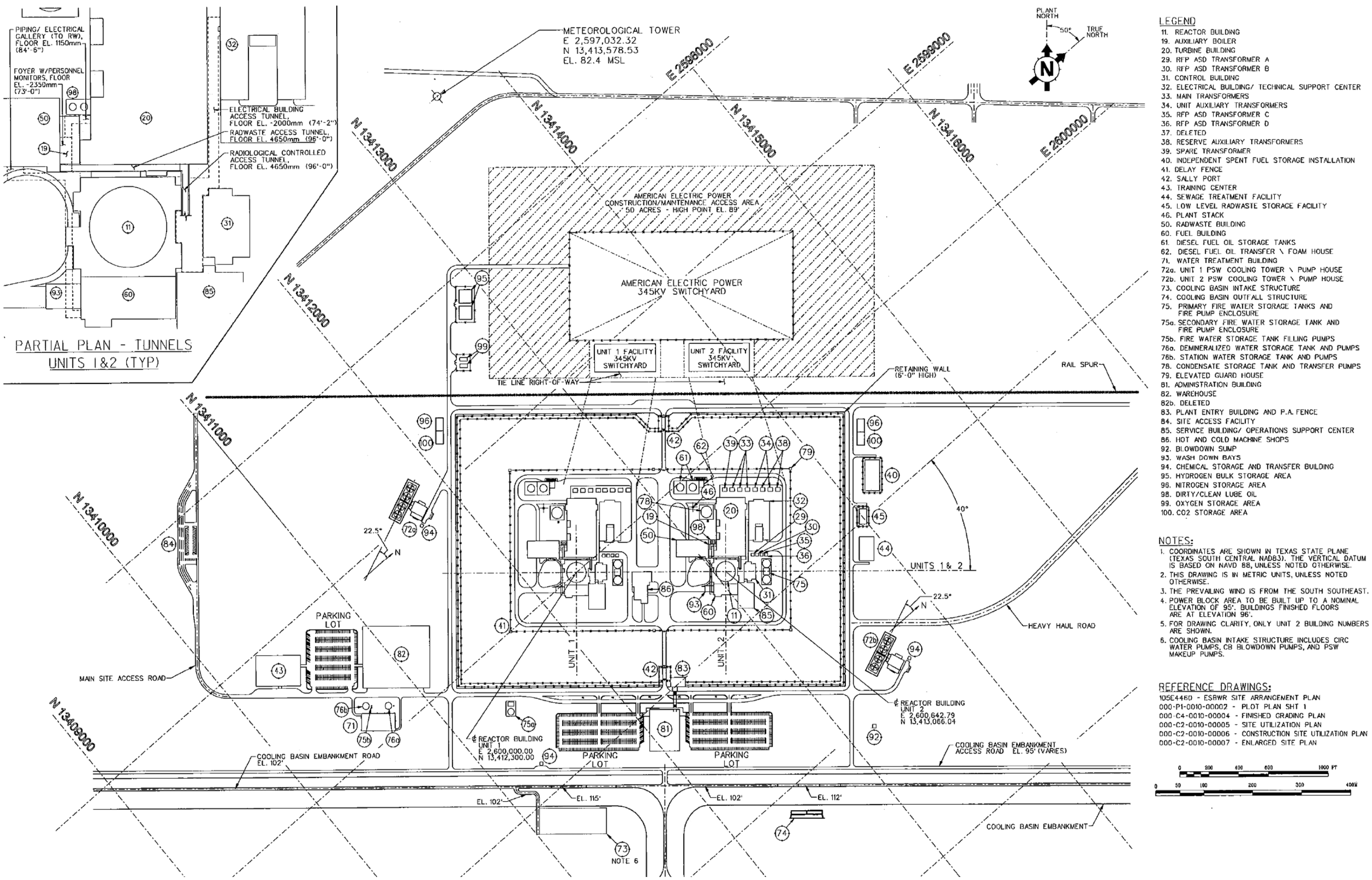

Figure 3.9-3 Plot Plan

3.10 Workforce Characterization

In order to ascertain the environmental impact of building and operating a two-unit power plant, a description of the workforce required to construct and operate the new units must be characterized and analyzed.

3.10.1 Construction Workforce

The construction workforce will consist of two components, (1) field craft labor and (2) field nonmanual labor. Field craft labor is the largest component of the construction workforce, approximately 80% of the field workforce in conventional BWR nuclear plant construction. The field craft labor force is comprised of civil, electrical, mechanical, piping, and instrumentation personnel used during the installation and start up of the units. The field nonmanual labor makes up the balance of the construction workforce; approximately 20% when the design engineering is performed offsite. The field nonmanual labor force comprises field management, field supervision, field engineers, quality assurance/quality control, environmental, safety and health, and administrative/clerical staff.

Table 3.10-1 illustrates the percentage makeup of each skill set for the field craft and field nonmanual labor. This skill set makeup is representative of a conventional BWR nuclear power plant construction site force.

In order to bound the workforce makeup, it is assumed that 5% to 10% of the skilled craft workforce would be drawn from within 50 miles of the VCS site. The remainder of the craft labor workforce is assumed to come from outside the 50-mile area. Nonmanual labor is assumed to come from contractor personnel from outside the 50-mile area.

The ESBWR design concept uses a number of prefabricated large modules. This modularization shifts some of the work (and workforce) to other locations that are outside the 50-mile radius of the site, and decreases the onsite construction staff and duration. The construction duration and estimated onsite workforce presented here is used as the basis for the Chapter 4 analyses and assumes a high degree of offsite fabrication.

The total onsite construction workforce for sequential construction of two units at the VCS site is estimated to be approximately 25 jobhours per net kilowatt of generating capacity. To achieve the Exelon in-service date, the schedule assumes 6 months for site preparation, 12 months early site work activities, 42 months from the start of first nuclear concrete placement to Unit 1 fuel load, and 6 months for startup. Unit 2 fuel load is scheduled 18 months after Unit 1 for a total schedule duration of 84 months. Based on this schedule, the maximum onsite, peak construction workforce for two ESBWR units with a large cooling basin is estimated to be 6300 people, working 5 days per week, 10 hours per day (see Table 3.10-2 and Figure 3.10-1).

3.10.2 Workers Relocation and Commuting

It is assumed that construction workers typically commute up to 50 miles to the jobsite. Assuming 5 percent of the construction craft workforce will be available to the VCS project from within 50 miles, approximately 315 local crafts people could be used to staff the construction of Units 1 and 2. The balance of the construction workforce is assumed to come from outside the 50-mile radius. For the analysis of construction impacts in Chapter 4, it is assumed the field nonmanual labor workforce will relocate to the area from outside the 50-mile radius. This analysis assumes that 70% to 80% of the construction workforce will be employed for more than 3 years. Similarly, this analysis assumes that 95% of the craft labor from outside the 50-mile radius will seek temporary housing, and 95% of the field nonmanual labor staff will relocate to the area and seek permanent housing. For the purposes of this analysis, it is assumed that 95%of the construction workforce will try to locate within the 50-mile area to minimize their commute distance.

3.10.3 **Operations Workforce**

A study commissioned by the DOE (DOE May 2004) estimated the additional operations workforce for a new ESBWR unit constructed at a greenfield site. Applying the DOE study analysis to the VCS site, it is estimated that the onsite operations workforce for the first unit will be 649 people, and nonoperational offsite support staffing would be 51 people. An additional 406 onsite people will be necessary for the second unit, and an additional 38 personnel for offsite staff. The total onsite operations personnel onsite would be 1055, with 89 offsite support staff.

Operations staffing for each unit would begin approximately 2 years before fuel load of each unit, to allow time for simulator training and startup testing support, and increase to the full compliment of personnel at the time of fuel load.It is assumed the operations staff would be recruited and trained from outside the 50-mile site radius.

Section 3.10 References

DOE May 2004. U.S., Department of Energy, *Study of Construction Technologies and Schedules, O&M Staffing and Cost, Decommissioning Costs and Funding Requirements for Advanced Reactor Designs.* available at http://nuclear.energy.gov/np2010/reports/1DominionStudy52704.pdf, accessed December 5, 2007.

Table 3.10-1
Percent Construction Labor Force by Skill Set for Two ESBWRs

Labor	Installation Items - Responsibility	Percent of Total Workforce for Construction
Mechanical Equipment	NSSS, Turbine Generator, Condenser, Process Equipment, HVAC	2.5
Electrical	Equipment, Cable, Cable Tray, Conduit, Wire, Connections	10
Concrete	Concrete and Reinforcing Steel	10
Structural steel	Structural and Miscellaneous Steel	2.5
Other civil	Piling, Architectural Items, Painting, Yard Pipe, Earthwork	15
Piping/instrumentation	Pipe, tubing, valves, hangers/supports	12
Site support	Scaffolding, Equipment Operation, Transport, Cleaning, Maintenance, etc	16
Specialty labor	Fireproofing, Insulation, Rigging, etc	12
Non-manual labor	Management, Supervision, Field Engineering, Quality Control/Quality Assurance, Safety and Health, Administration	20

Table 3.10-2
Estimated Construction Workforce and Construction Duration for Two ESBWR Units

Month	Workforce Strength	Month	Workforce Strength	Month	Workforce Strength	Month	Workforce Strength
Site preparation begins month -18		8	5250	34	5800	60	3200
-18	200	9	5500	35	5750	61	3000
-17	400	10	5700	36	5700	62	2500
-16	600	11	5900	37	5650	63	2000
-15	800	12	6100	38	5600	64	1500
-14	1000	13	6300	39	5550	65	1300
-13	1200	14	6300	40	5500	66	1100
-12	1400	15	6300	41	5450		
-11	1600	16	6300	42	5400		
-10	1800	17	6300	43	5300		
-9	2000	18	6300	44	5200		
-8	2200	19	6300	45	5100		
-7	2400	20	6300	46	5000		
-6	2600	21	6300	47	4900		
-5	2800	22	6300	48	4800		
-4	3000	23	6300	49	4700		
-3	3200	24	6300	50	4600		
-2	3400	25	6250	51	4500		
-1	3600	26	6200	52	4400		
1	3800	27	6150	53	4300		
2	4000	28	6100	54	4200		
3	4200	29	6050	55	4100		
4	4400	30	6000	56	4000		
5	4600	31	5950	57	3800		
6	4800	32	5900	58	3600		
7	5000	33	5850	59	3400		

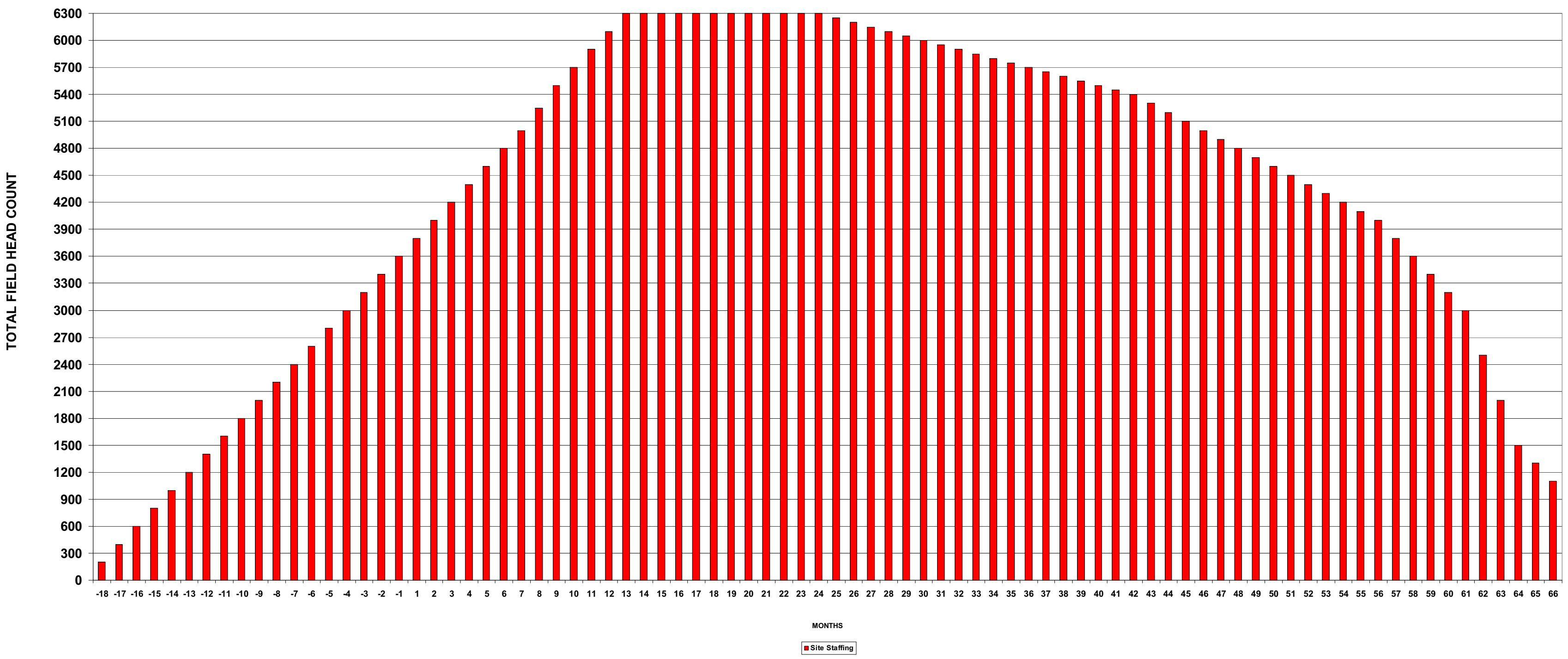

Figure 3.10-1 Projected Construction Workforce by Month for Two ESBWR Units

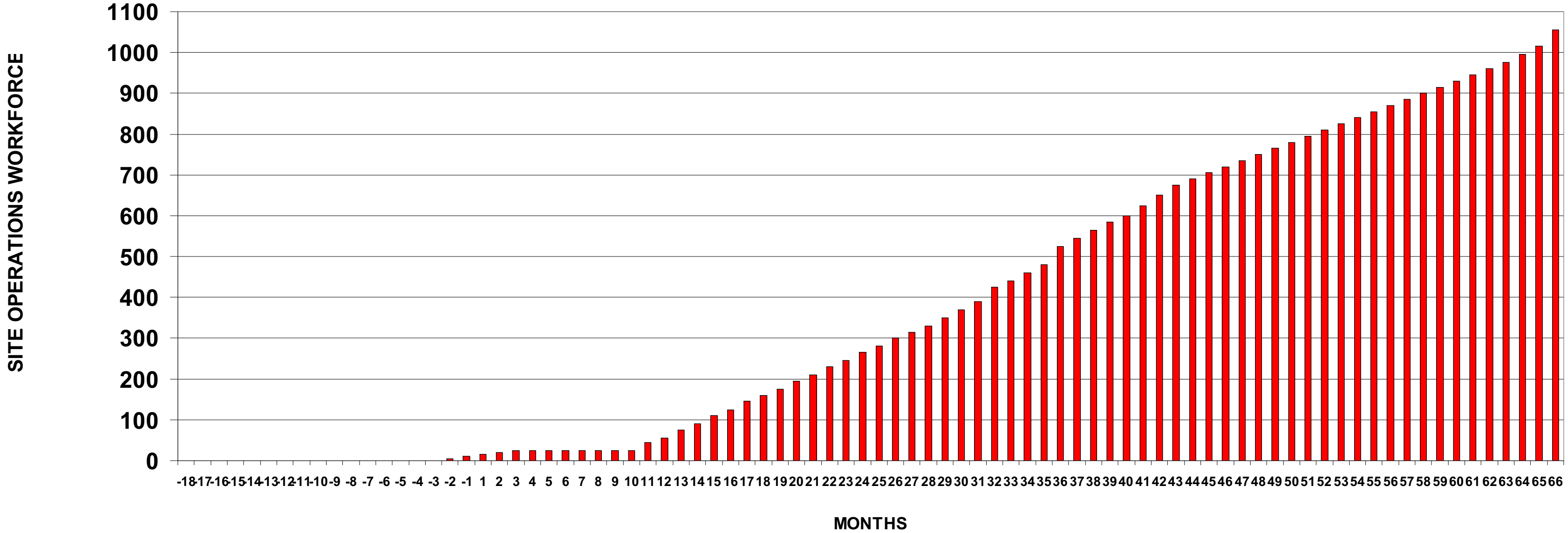

Figure 3.10-2 Projected Operations Workforce by Month for Two ESBWR Units