5 Construction Approach

The general construction approach for the onshore mechanical fine mesh screen and closed cooling technologies is to perform as much construction work as possible during non-outage periods. The non-outage work schedule is estimated to be two shifts working 5 days per week, 10 hours per day. During outage periods, the work schedule would be adjusted to working 24 hours per day, 7 days per week to minimize outage durations while adhering to regulatory fatigue rules in performing work on or near safety-related SSCs.

In the case of the modular wedge wire/tunnel technology installation, unit outages would not be required, and marine construction work hours would be adjusted in response to weather conditions.

5.1 Onshore Mechanical (Active) Intake Fine Mesh Screening Technology

The primary construction work components of this technology option are the modifications to the existing DCPP once-through cooling system screens, which consist of the following:

- Replacement of six of the existing once-through traveling screens associated with Unit 1 and six of the screens associated with Unit 2 with larger dual-flow traveling screens
- Addition of one additional screen wash pump for each unit, below the concrete deck to support the increased screen wash and fish wash return flows associated with the traveling screen replacement
- Replacement of the existing Units 1 and 2 traveling screen control panel with seven new panels for each unit (one for each new traveling screen and one for the remaining once-through traveling screen)
- Replacement of the existing screen wash pump control panels for Units 1 and 2 by adding new panels to control the new pumps
- Addition of one automatic backwash strainer on the screen wash supply line to the Unit 1 screen, and one on the Unit 2 screens
- Addition of a new trash trough on top of concrete deck for Unit 1 and Unit 2 to collect the trash from the screens and transport it to the existing trash grinder located in the intake structure between the Units 1 and 2 traveling screens
- Addition of fish return trough above the concrete deck to direct the fish return flow from the new Units 1 and 2 dual-flow screens to the north-end intake structure
- Installation of the Units 1 and 2 fish return systems to north of the plant intake cove through a single pipe/trough
- Removal and disposal of the existing traveling screens
- Concrete cutting and structural modification of the existing intake deck at the new traveling fine mesh screen locations to fit the larger screens
- Modification of the existing screen wash piping
- Removal and reinstallation/relocation of existing forebay level sensors

The construction approach for the onshore mechanical (active) intake fine mesh screening technology would be to complete the installation work on the new systems for Units 1 and 2 during non-outage periods. The partial unit outages would consist of reducing the output of one unit to between 50% and 60% power and taking one CW pump out of service at a time, installing three screens in three dewatered bays, starting up the three screens and CW pump, then moving to the next pump and three bays and installing and starting up the next three screens. Unit 1 would be completed first, followed by Unit 2.

5.1.1 Fish Recovery System

The non-outage construction work operations would begin with the installation of fish recovery system conduit that is approximately 1,020 feet long from the intake structure to the end of the new discharge point, with an invert elevation of -12 feet below water level. From the intake structure, a 36-inch-diameter, aboveground FRP pipe, setting on foundations and pipe supports every 20 feet, would be routed approximately 360 feet north to a 5-foot-diameter 20-foot-deep drop shaft. From the bottom of the drop shaft (See Drawing 25762-110-P1K-WL-00071), a 5-foot-diameter tunnel would be bored and lined to the discharge point consisting of a headwall and reinforced concrete pipe covered with armor stone. The headwall and concrete pipe would be set by divers, and the armor stone would be set from a barge. The drop shaft and concrete tunnel conduit would be lined with an HDPE liner. The fish recovery piping on the intake structure would be supported a minimum of 4 feet above the concrete deck on hangers and begin at Unit 2 with 28-inch diameter FRP pipe to provide 3,600 gpm flow and transition to a 36-inch-diameter pipe to provide 7,200 gpm flow. A large portion of the 176 electrical circuits, including conduit, wire, and grounding are necessary for the installation of seven control panels for each unit. Piping commodities for the new system and the screen wash system would be installed during non-outage periods and terminated during the outage. Construction work would also include the addition of a new concrete trash trough on top of the existing intake deck to collect trash from the screens, which transport the trash to the existing trash grinder located in the intake structure between the Units 1 and 2 traveling screens. The trash trough would be formed and concrete would be placed during non-outage periods.

5.1.2 Dual-Flow Traveling Screens

The existing single-flow traveling screen deck opening size is 5 feet 4 inches x 11 feet 3 inches with the longer length running north and south. The new dual-flow traveling screen requires an 8-foot 6-inch x 15-foot 6-inch opening size in the 2-foot-thick concrete deck slab with the longer length running east and west. The construction approach would be to wire saw cut and lift sections of the reinforced concrete deck to enlarge the openings. This work would be performed during non-outage periods.

The construction approach for the installation of the six new dual-flow screens in each unit would be to schedule partial unit outages to complete the balance of the installations. The partial unit outages would consist of bringing Unit 1 to between 50% and 60% power and taking one CW pump out of service at a time. The partial outage work would begin by taking CW pump 1-2 out of service first, since this will facilitate the installation of the new screen wash pump for Unit 1. Installation of stop logs and sealing off the ocean intake flow in three bays are necessary to dewater one half of the unit’s intake structure. Three screens would be installed in three dewatered bays, the three screens and CW pump would be started up, and then, moving to the next pump and three bays, the next three screens would be installed and started up. Unit 1 would be completed first, followed by Unit 2.

Once the intake is dewatered, the existing traveling screens would be removed and disposed of. The intake well interior would then be cleaned via hydro lasers, and resulting marine growth would be vacuumed and disposed of. Concrete would be formed and placed in the void areas left from the old screen locations. The new screen support mounts and anchors would be installed, the frames erected, the screens mounted, and the connecting piping and differential level control mounting brackets and instruments installed. The electrical terminations would then be made to the control panels and integrated with the existing CW pump controls.

To facilitate the installation of the new screen wash pumps, a 30-inch-diameter slab penetration will be core drilled in the deck at elevation -2.1' in the Unit 1 pumphouse and then subsequently in Unit 2. The pump foundation base will be placed, the new pump shaft suction will be extended to elevation -13', and the new pumps will be assembled. The pump wash piping will be piped in series to the existing screen wash system and the backwash strainers will be installed. Once the new system is operable, the existing traveling screen control panels would be removed and existing screen wash pump controls abandoned in place on the existing panels.

5.2 Offshore Modular Wedge Wire Screening Technology

The major modular wedge wire screening technology construction work components consist of:

- Geophysical subsurface investigation borings and bathometric survey
- Installation of the drop shaft cofferdam in the intake cove
- Installation of the main tunnel drop and construction access shafts by sequential excavation, drilling and shooting, shaft wall forming, and concrete placements to the tunnel invert elevation of -220'
- Installation of the top heading crown, first and second bench, and starter tunnel by drilling, shooting, excavation, and material removal
- Installation of the concrete wall liner in the starter tunnel
- Installation of tunnel boring machine rails
- Assembly of tunnel boring machine (TBM) and conveyor system
- Installation of auxiliary air and pumping systems
- Boring of the 30-foot-diameter tunnel approximately 1,000 feet
- Disposal of excavated material off site
- Installation of rock bolts and ceiling reinforcement supports
- Lining of tunnel as necessary
- Disassembly and removal of conveyor, TBM, and rail system
- Installation of the six 12-foot-diameter offshore intake drop shafts
- Installation of connection piping laterals to intake drop shafts
- Installation of wedge wire screens and armor protection of piping
- Modification and flood-up of main drop shaft

- Installation of cofferdam for emergency backup water supply
- Installation of reinforced concrete emergency water structure
- Installation of the enclosed shoreline breakwater
- Installation of interior breakwater seal liner

The construction approach for the installation offshore modular wedge wire screening technology would be to complete the entire marine construction installation without a unit outage.

5.2.1 Installation of Main Intake Tunnel Drop Shaft

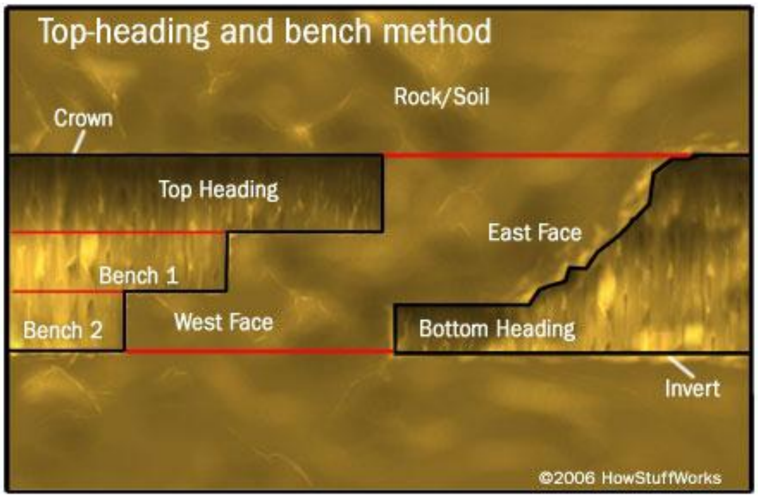
Upon completion of the geotechnical borings, subsurface investigations, detailed design, and issuance of permits, work would begin with the installation of the main drop shaft in the intake cove. This work would entail road improvements south of the plant out to the south breakwater jetty to facilitate material handling. Work on the drop shaft installation would begin with the +30-foot-diameter riser shaft cofferdam caisson in the intake cove:

Excavation would continue into the rock via drilling and shooting/excavation in sequential steps or lifts downward, with the forming and wall concrete placements in lifts. The work operation would be repeated down to tunnel invert elevation of about -220’:

5.2.2 Installation of Main Intake Tunnel Starter Tunnel

Once the tunnel drop shaft is at invert elevation of -220’, horizontal drilling and shooting would commence to form the top heading crown, followed by the first and second benches:

The starter tunnel operation consists of the installation of auxiliary air, pumps, drilling and shooting, excavation, material removal, and rock bolt and ceiling reinforcement with safety netting installation, and progresses until the starter tunnel is long enough to facilitate the TBM:



5.2.3 Installation of Main Intake Tunnel Starter Tunnel Liner

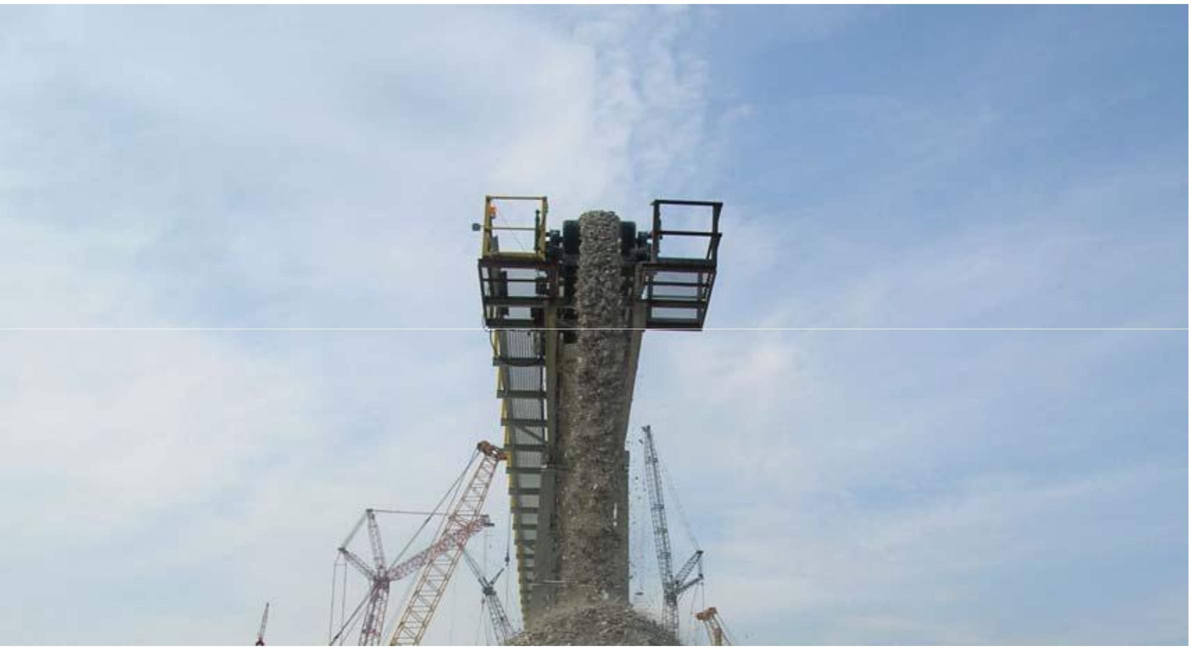
Installation of the concrete wall liner in the starter tunnel is the next sequential work activity, with the installation of bottom rail system, formwork placement on the crown and walls, and concrete pump placement of 1-to-2-feet-thick concrete wall. This is followed by formwork removal in preparation for TBM assembly:

5.2.4 Installation of the Main Intake Tunnel

Installation of the main intake tunnel would begin with the assembly of the TBM, which would be lowered piece by piece down the drop shaft and assembled:

Once the TBM is assembled, the conveyor system would then be erected:

The TBM would begin boring operations, with the excavated material conveyed behind and vertically up the drop shaft to another horizontal conveyor belt, where it would be trucked away from the intake area:



5.2.5 Installation of Rock Bolts and Ceiling Reinforcement Supports

As the tunneling progresses, inspections would be performed and requirements for ceiling reinforcements would be identified and installed along with any required concrete tunnel liners for unstable rock areas:

5.2.6 Installation of Auxiliary Air and Pumping Systems

As the tunnel progresses forward, additional conveyor system sections would be added. Air quality would be continuously monitored, and auxiliary air ducting would be added. The intake flows from water seeping into the tunnel through fisher cracks would be monitored and the water diverted to sumps and pumped to the surface.

5.2.7 Disassembly and Removal of Conveyor, TBM Disposition, and Rail System Removal

Upon completion of the tunnel boring, the conveyor system would be dismantled and transported to the surface.

There are two options for dispositioning the TBM once the boring is complete. Depending on the cost, age, and usefulness of the TBM, it can be disassembled piece by piece and brought to the surface and shipped off site to be used for future boring work.

The second option is to extend the length of the tunnel boring and abandon the TBM under the sea by placing a concrete wall in the end of the tunnel, as was done with the boring machines on the Chunnel Tunnel between France and England. Upon completion of the conveyor system and TBM, the rail system supporting the TBM operations would be removed and taken to the surface.

5.2.8 Installation of Offshore Intake Drop Shafts

The installation of the six 12-foot-diameter offshore intake drop shafts would begin with a drilling platform supported from and anchored to the sea bed floor, over the main tunnel in about 70–75 feet of water (about 630 feet off shore). The top of the platform would sit substantially above the water level.

The sequence is to first install an 18-foot-diameter conductor casing from the top of the platform down into the sea bed and then auger down to rock:

The next step is to insert a 16-foot-diameter auger bit and drill through the sea bed soil and into the rock:

A 15-foot-diameter drill casing is then lowered inside the 18-foot conductor casing and reaches from the top of the sea bed down into the rock to form a seal.

Once the drill casing is set, a 14-foot-diameter rock socket is drilled to a depth just above the 30-foot-diameter tunnel. A 12-foot-diameter steel drop shaft intake liner is then inserted into the 14-foot-diameter rock socket boring, and grout is placed between the liner and the rock socket from the bottom of the boring up to the sea bed elevation. The liner has interior steel diaphragm plates in the bottom and top of the liner (see Figure 5.2-1).

The sea bed is excavated around the top section of the drop shaft and the top manifold section and 10-foot-diameter manifold pipes (as shown in Figures 4.2-6, 4.2.7, 4.2-8, and 4.2-9) are bolted on by divers to the upper-section liner containing the upper diaphragm. The manifold piping is backfilled and covered with armor stone, and the wedge wire screens (as shown in Figure 4.2-19) are bolted onto the manifold piping (see Figure 5.2-2).

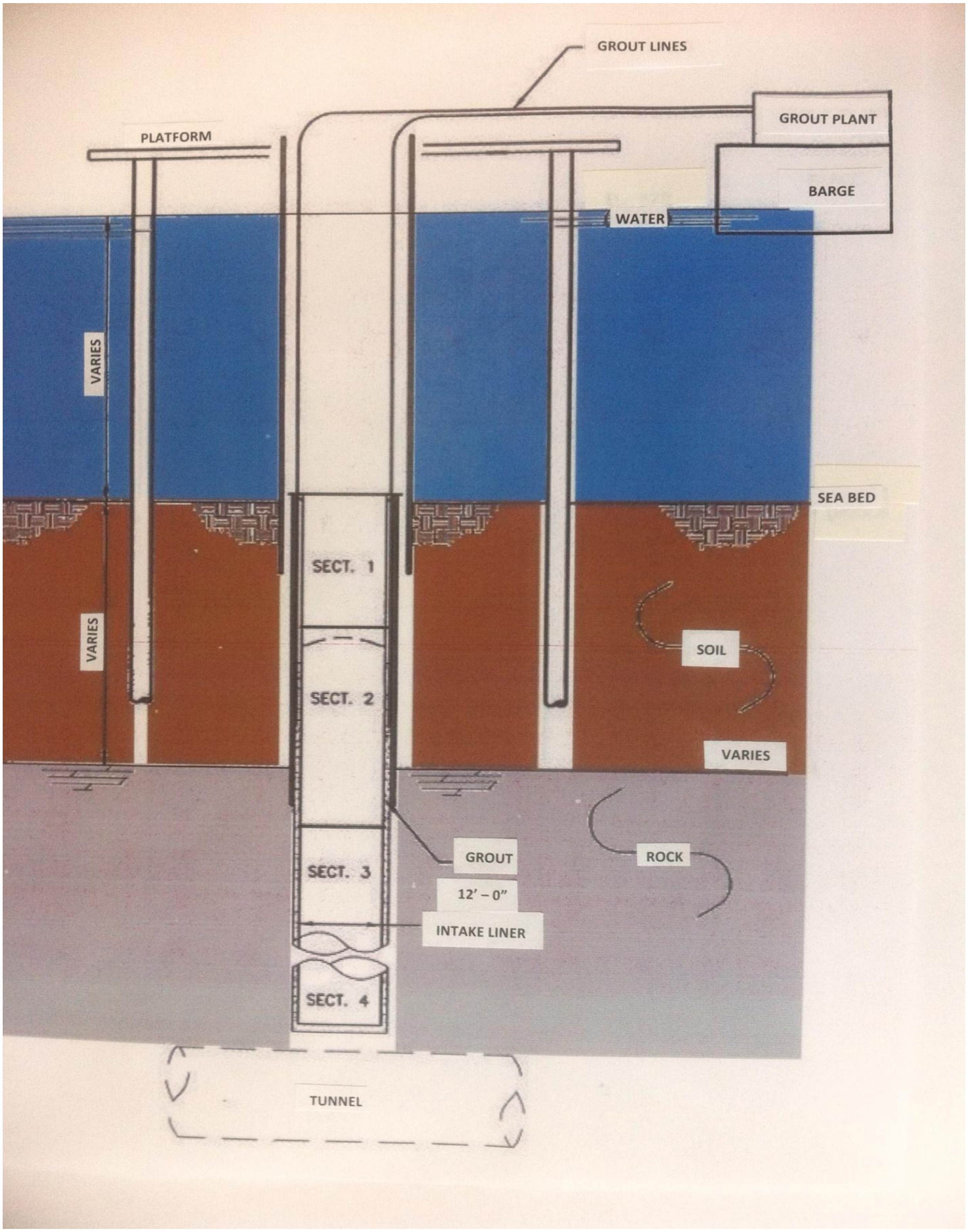


Figure 5.2-1. Installation of Offshore Intake Drop Shafts

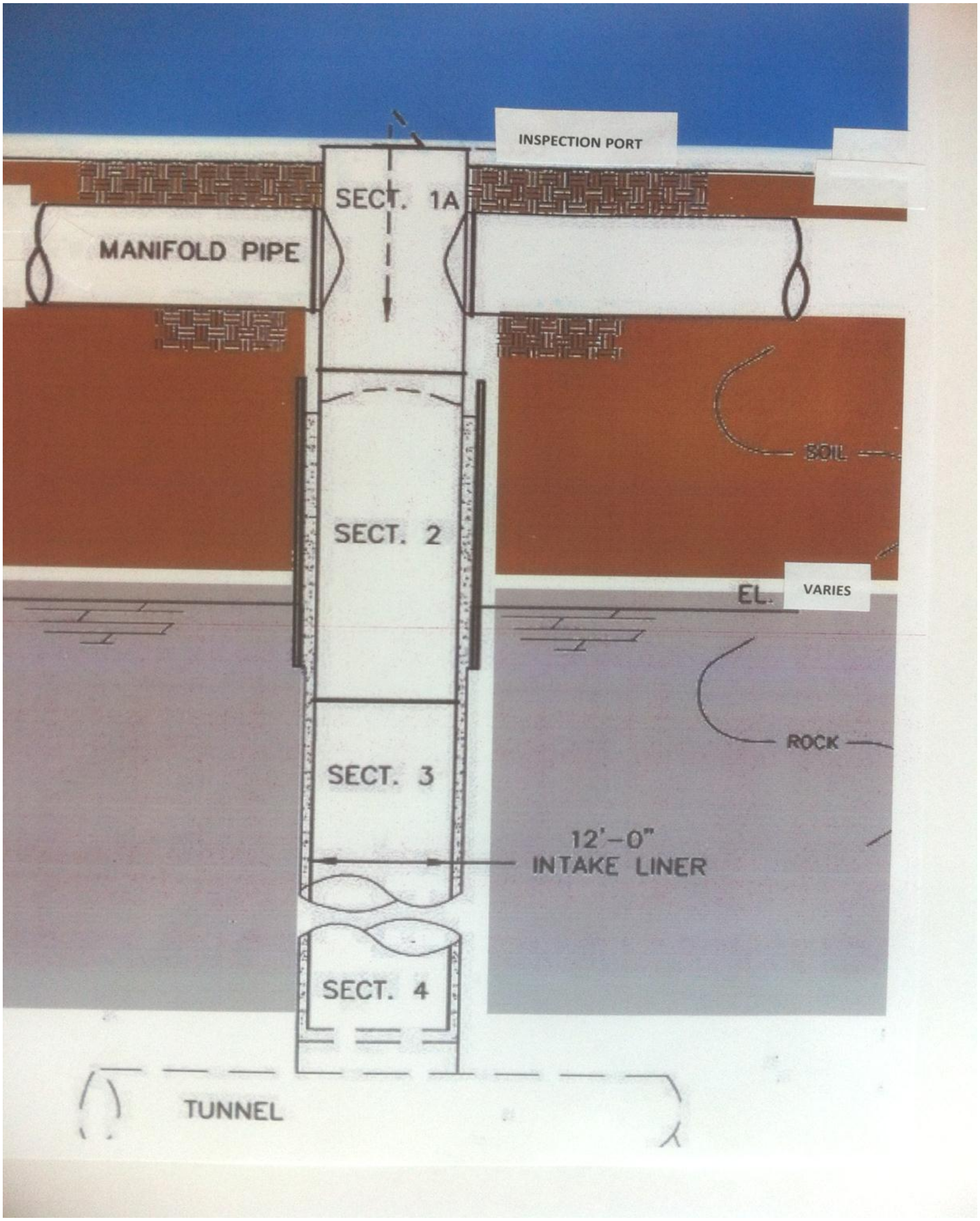


Figure 5.2-2. Installation of Offshore Intake Manifold Piping

Inside the tunnel, an overhead excavation is made upward from the tunnel ceiling to the offshore drop shafts, and the lower diaphragm seal is removed.

This operation is then moved to the next drop shaft location about 50 feet further out to sea, and the operation is repeated until all six drop shafts have been installed. When the tunnel has been cleaned of all debris and pumps, and the air ventilation system has been removed, the tunnel is ready for flood-up and removal of the upper diaphragm seal. Once the tunnel is flooded, divers will enter through the access inspection port located in the top section of the manifold piping and remove the upper diaphragm seal.

5.2.9 Main Drop Shaft Modification

The main drop shaft modification operation entails removing the riser shaft cofferdam caisson section and is performed during flood-up operations. The cofferdam whalers and sheet piling above the cove bottom are extracted and lifted out of the water.

5.2.10 Installation of Cofferdam for Emergency Backup Water Supply

The construction approach for the installation of the emergency cooling intake structure located inside the new breakwater as shown in Figure 4.2-3 will require a narrow cofferdam to be installed. The cofferdam will be installed and the interior will be excavated and dewatered. A dewatering system will be installed inside the cofferdam, and the resulting inflow will be pumped to silt screened discharge back to the sea.

5.2.11 Installation of Reinforced Concrete Emergency Water Structure

Construction of the structure entails installation of two poured-in-place concrete box culverts with 5-x-7-foot openings with dual stop log closures in each of the culverts (see Figure 4.2-10). The top of the structure will coincide with the top of the breakwater.

5.2.12 Installation of the Enclosed Shoreline Breakwater

The construction approach for the extension of the south breakwater jetty would be to complete the wedge wire screens and tunnel work and put the system into operation. The next step would be to complete the installation of the emergency backup water intake structure, then close off the cove. Once the emergency water intake structure is in place and the cofferdam is removed, work would begin on the breakwater with the stone setting and backfilling operations from north and south ends of the breakwater to the structure.

5.2.13 Installation of the Interior Breakwater Seal Liner

The construction approach to the interior breakwater seal liner would be to complete the new break water with concrete cap, and then roll out and fasten the fabric liner from the concrete cap down to the cove bottom. The fabric liner would then be grout filled, creating an impervious barrier.

5.3 Closed-Cycle Cooling, Passive Draft Dry Air; Mechanical Draft Dry Air; Wet Natural Draft; Wet Mechanical Draft; and Hybrid Wet/Dry Cooling

The major construction work components of the closed-cycle cooling technologies are:

- Relocation of the 230 kV offsite power feed
- Expansion of the 500 kV switchyard and installation of six additional breakers
- Subsurface investigation and excavation for the cooling tower footprint
- Erection of the cooling towers
- Installation of CW pipe and duct to the new pumphouses
- Installation of four new transformers near the cooling towers
- Building and powering of the two new pumphouses with four pumps each; switchgear and ductbank
- Demolition of five existing buildings within the CW duct excavation footprint and rebuilding of buildings 102, 519, and 527 outside the footprint
- Installation of the underground piping and valves, concrete duct work
- Demolition and relocation of underground interferences west of the turbine buildings
- Demolition of the existing CW ducts and decommissioning of existing intake pumps and abandonment of the power feed from the plant
- Demolition of the low pressure condenser interiors and retubing with new tube sheets in each unit
- Rebuilding of the low pressure turbines in each unit

For the wet cooling technology options only, the following are additional construction work components:

- Addition of a desalination plant
- Addition of a water treatment plant, recycle water tank, and freshwater storage pond
- Installation of pipelines and pumping stations from the San Luis Obispo and Morro Bay wastewater treatment facilities to the plant site new water treatment facility
- Installation of a new service cooling water and condensate cooler heat exchangers

For the dry cooling technology options only, the following are additional construction work components:

- New saltwater cooling system pumps and piping from the intake structure to the new plant service water cooling heat exchangers and condensate coolers.

For the mechanical draft wet and dry technology options only, the following is an additional construction work component:

- Powering the mechanical draft fans

The construction approach for the closed cooling system options are all very similar in that the cooling tower grade elevation for the five different technologies is set at elevation 115' and is located north of the plant. All cooling tower layout location footprints avoid the Indian burial grounds.

The 12-foot-diameter CW pipe routing from the cooling towers across the Diablo Creek to the new pumphouses are all very similar for each option. The construction of the new pumphouses for each unit, the power and control routing, and the concrete conduit duct from the turbine buildings to the pumphouses are the same for all options, as well as the demolition of the existing buildings, excavation, interference removal, and demolition of the current CW system ducting west of the turbine buildings. The rebuilding of the condensers and low pressure turbines for each option is the same.

The sequence of the construction activities and installations for each of the closed-cycle cooling options is shown on the individual Level 2 schedules.

5.3.1 230 kV Power Transmission Line Rerouting

To accommodate the mountain excavation activities, the first construction activity would be relocated about a mile of the existing 230 kV offsite power transmission line from Morro Bay-Mesa Line, which would be rerouted outside the excavation footprint to the east. This would entail the installation of new foundations and transmission towers further east, restringing new two-conductor three-phase cable and grounding/communications wire, and scheduling a minor outage to perform the de-terminations of the existing lines and re-termination of the new lines. Removal of the existing transmission towers and installation of temporary barriers to protect the existing switchyard area during excavation would follow.

5.3.2 500 kV Switchyard Expansion

To power the closed cooling options, the expansion of the existing 500 kV switchyard would be necessary, which would entail installation of six additional breakers (two bays). The area west of the existing 500 kV switchyard would be graded to the same elevation and new breakers would be installed and interconnected to the new transformers via monopole towers to feed the new transformers near the cooling towers.

5.3.3 Excavation Activities

Of the five options, there are two different footprints to accommodate the number of cooling towers in each tower array. The wet mechanical and hybrid technologies have two tower (one per unit) arrays, while the dry mechanical, dry natural, and wet natural technologies have four tower (two per unit) arrays, which drive the excavation quantities required for each of the two footprints. The flat platform area for the two cooling towers is approximately 62 acres, and the flat platform area for the four cooling towers is approximately 109 acres.

The excavation quantity required to accommodate the two-tower footprint is approximately 190 million cubic yards, while the four-tower footprint requires approximately 316 million cubic yards of excavation. Excavation work would be very similar to the excavation performed for the new Qinshan Nuclear Units 2 and 3, which is located next to the operating Unit 1 in a mountainous area on the East China Sea south of Shanghai, China. The construction approach would be to use drilling and shooting, large shovel excavators (22 cubic yard buckets) and large off-road trucks (100-ton payload) to haul excavated material approximately 5 miles away to the spoils areas. Potential spoils areas that could hold the largest quantity of excavated material have been identified (see Drawings 25762-110-CEK-7200-00001, -00002, -00003, -00004, and -00005). The potential spoils areas have varying low points from approximately elevation 400’ to elevation 680’ that could be filled to an approximate elevation of 1,000’ to 1,400’. Figures 5.3-1 and 5.3-2 are preliminary renderings showing the fill areas for the two- and four-tower configurations, respectively.

Figure 5.3-1. Two-Tower Spoils Area

Figure 5.3-2. Four-Tower Spoils Area

The excavation duration for the two-tower configuration would be approximately 25 months, and the four-tower duration would be approximately 41 months, with about 3 months' mobilization time. The mobilization will facilitate environmental controls, stormwater management, erosion control, fugitive dust controls, equipment assembly, and infrastructure facilities setup.

With regard to the excavation of rock for the cooling tower footprints, a stepped configuration (40-foot vertical and 100-foot horizontal steps from elevation 115' [grade] up to elevation 900' or 1,100') as shown on Drawings 25762-110-CEK-7200-00001, -00002, -00003, -00004, and -00005 assumes that the excavated material is strong, sound rock with minimal fractures and horizontal bedding. If the rock is fractured or jointed, or has bedding planes that slope into the excavation, then additional measures will have to be taken (such as rock bolts) to ensure excavation stability (these measures have not been included in the estimate). Geotechnical borings and subsurface investigations would be made prior to the final detailed design of the excavation, and environmental impact studies would be conducted to facilitate the permitting process.

Subsurface areas would be excavated for foundations, pumphouses, duct, and pipe during a non-outage period, while the existing circulating system, diesel fuel storage tanks, and the balance of duct and pipe installations west of the turbine buildings would be demolished during a dual unit outage period.

5.3.4 Circulating Water Piping and Duct Excavation

The eight 12-foot-diameter FRP CW pipes from the cooling tower array would be routed to the new Unit 1 pumphouse area and cross Diablo Creek, requiring an approximately 150-foot-wide and 25-foot deep excavation and the existing Diablo Creek buried duct to be extended east of the excavation footprint.

The piping would be installed in 40-foot lengths on a bed of sand with laminated restrained wrapped ridged joints without thrust blocks (see Section A_A on Drawings 25762-110-P1K-WL-00010, -00020, -00030, -00040 and -00050).

A 344,000 cubic yard excavation from the new Unit 1 pumphouse area to the new Unit 2 pumphouse and to the turbine buildings is required to facilitate the installation of 40,000 cubic yards of poured-in-place reinforced concrete duct. The area north of the Unit 1 turbine excavated during non-outage periods. The area to the west of the turbine buildings would be excavated during the outage period. The two belowground, 50,000-gallon emergency diesel fuel oil storage tanks would be removed. The existing concrete CW intake and discharge ducts (12,514 cubic yards) would be demolished and removed as part of the excavation during the dual-unit plant outage period. Drawing 25762-P1K-WL-00013 illustrates the area of demolition. The eight existing CW duct ends (intake and discharge) outside the excavation would be sealed with concrete closures and abandoned in place.

An excavation for the new saltwater cooling lines for the dry cooling tower options would be routed from the intake structure parallel to the existing 1-1 conduit to the new excavation west of the Units 1 and 2 turbine buildings (see Drawings 25762-P1K-WL-00011 and 12), and then to the plant service cooling water heat exchangers and condensate coolers.

Buildings 102 (30,200 sq ft), 519 (9,600 sq ft), 520 (1,600 sq ft), 521 (2,880 sq ft), and 527 (1,250 sq ft), which are located within the excavation area, would be demolished. The cost to replace these buildings with new buildings has been included in the estimate.

5.3.5 Cooling Tower Erection

The dry natural draft, wet natural draft, wet mechanical draft, and hybrid wet/dry cooling towers are pour-in-place, reinforced concrete structures erected on mass concrete foundations requiring foundation excavation. Substructure foundations are typically excavated, formed and placed via concrete pumps, while the superstructure is formed in lifts and concrete is placed via a bucket using a tower crane in the interior of the structures. Once the civil construction is complete, the mechanical/piping equipment is installed. For the wet mechanical and hybrid towers, the electrical commodities to power the forced draft fans are installed.

Mechanical draft dry air cooling towers are relatively low-profile towers that sit on many small pier foundations poured in place, with a concrete slab under each four-tower array. The mechanical draft fin-fan dry air towers arrive onsite in modular sections, which are essentially bolted together, anchored to the foundation, and connected to the 12-foot-diameter circulating water supply and return piping. The electrical commodities are then installed and terminated to power the forced draft fans.

While the two dry cooling technologies do not have water treatment packages, the three wet cooling technologies have standard desalination and water treatment packages with an excavated and lined 5-million-gallon freshwater storage pond onsite and gravity feed to the cooling towers.

In addition to the desalination plant for the wet technologies, recycle water pump stations will be built at the San Luis Obispo Waste Water Treatment Facility (WWTF) located at 35 Prado Road (see Figure 5.3-3) and the New Morro Bay Water Reclamation Facility (WRF) that will be located either at the Morro Bay Power Plant (Site E) or Morro Valley (Site B) (see Figure 5.3-4). (The final site for the new Morro Bay WRF has not yet been selected.)

Open cut and buried ductile iron recycled water pipeline (14-inch diameter) would be routed from the San Luis Obispo WWTF south along Highway 101, about 0.6 miles to Los Osos Valley Road, boring under the highway, and follow Los Osos Valley Road 9.8 miles to South Bay Boulevard at Los Osos, where the Morro Bay supply tie-in point would be reached, for a total of 10.4 miles. From the new Morro Bay WRF to the tie-in point, buried ductile iron pipe (10-inch diameter) would be routed either along Atascadero Road at the power plant to Route 1 or from the power plant to Route 1 into Quintana Road to South Bay Road, to the tie-in point at South Bay Road and Los Osos Valley Road, which is 6 to 8 miles. From the tie-in point to the site, the ductile iron pipe diameter would increase to 18 inches, and the routing would follow Los Osos Valley Road to Pecho Valley Road to the site, which is another 10.8 miles, to the 100,000-gallon, field-erected, recycled water storage tank at the onsite recycle water treatment plant. The belowground piping would be ductile iron, while the aboveground piping at the water treatment plants would be fabricated from FRP.

Buried saltwater intake piping to feed the desalination plant would be routed from the new saltwater pumps installed at the existing intake structure to the desalination plant, and the brine discharge piping would be routed back to the ocean at the station discharge structure.

The dry technology tower arrays and piping routing are illustrated in Drawings 25762–P1K-WL-00010, and -00020. The wet technology tower arrays and piping are illustrated in Drawings 25762-P1K-WL-00030, -00040, and -00050.

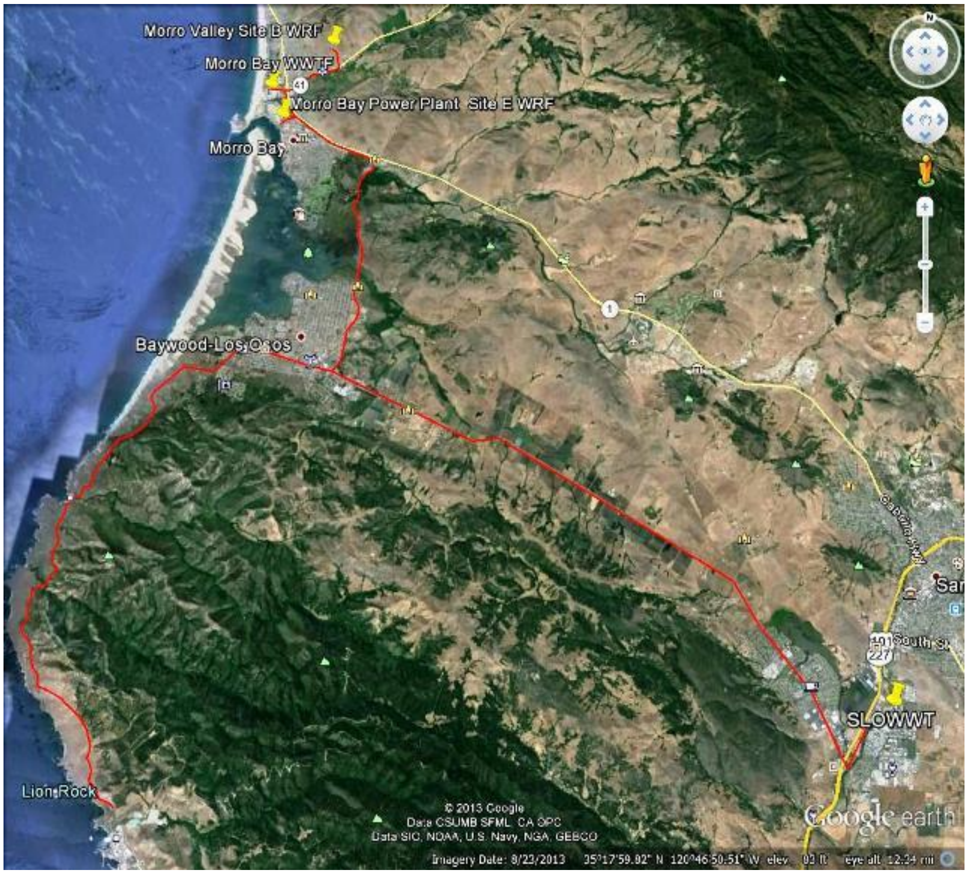


Figure 5.3-3. Map Showing Location of San Luis Obispo WWTF

Figure 5.3-4. Map Showing Proposed Locations of New Morro Bay WRF

5.3.6 Pumphouses

The pumphouses for all the closed cooling options are located in the same manner. Each unit will have a separate pumphouse consisting of a vertical pump concrete structure with four vertical circulating water pumps with 108-inch butterfly valves, concrete intake and discharge header boxes, and a concrete valve pit with four 108-inch isolation butterfly valves. The pumphouses have an electrical building for switchgear and underground duct banks for power and control electrical installations. Construction of the pumphouses and appurtenances calls for excavation, installation of reinforced concrete structures, with foundations; walls and slabs with embedded items; and subsequent backfilling operations. Following the civil work, the installation of mechanical equipment and piping and electrical equipment, conduit, tray, wire, and electrical terminations will follow.

5.3.7 Concrete Production

The closed-cycle cooling technology calls for large quantities of concrete for the construction of the cooling towers, pumphouses, and circulating water duct. To ease traffic congestion, and to provide a quality and least cost approach to concrete supply, concrete batch plant(s) would be erected on site, and the cement, aggregate, and admixtures shipped to the site. Onsite concrete mixer trucks would deliver the concrete from the batch plant to the points of placement.

5.3.8 Structural Backfill

To accommodate the structural backfill requirements, a crushing/screening/blending plant would be located at the excavation spoils area to manufacture the necessary backfill material from the excavated spoils.

5.3.9 Parking

To accommodate the construction workforce parking requirements and ease traffic on the plant access road, it is expected that the construction workforce will park in remote parking areas off site and be bused to the work locations on site.

5.3.10 Construction Workforce Populations

To accommodate the three different technologies, the construction workforce population on site will vary during the course of installation activities. The approximate construction workforce populations required to accomplish the various schedule durations would be as follows:

For the closed-cycle cooling options the construction population would consist of approximately 500 personnel (per shift) would work two shifts, 5 days per week, 10 hours per day during the mountain excavation. Following the excavation, the non-outage schedule would continue and the workforce population would increase to approximately 675 personnel per shift to accomplish the cooling tower erection and piping, underground, and pumphouse installations. During the dual-unit outage period, the work schedule would be adjusted to working 24 hours per day, 7 days per week to minimize outage duration and would require approximately 440 persons per shift performing the outage scope of work.

For the onshore mechanical fine mesh screen option, a construction population consisting of approximately 75 personnel per shift (would work two shifts, 5 days per week, 10 hours per day during the 6-monthly pre-outage period (excluding work on the intake structure bar rack cleaning system). During the 12 months of partial unit outages, a construction workforce consisting of approximately 85 personnel per shift would work 24 hours, per day, 7 days per week, to minimize outage durations.

The onshore mechanical wedge wire/tunnel technology option will not require unit outages and marine construction work hours would be two shifts, 5 days per week, 10 hours per day and would periodically adjusted in response to weather conditions. The total workforce population over the 41-month construction period would consist of approximately 120 personnel between the two shifts.

6 Schedule Development

6.1 Summary

Phase 2 evaluated three general classifications of technologies: closed-cycle cooling systems, onshore mechanical fine mesh system technology, and offshore modular wedge wire systems technology. The closed-cycle cooling technologies include dry natural draft, a wet natural draft cooling, a dry mechanical draft, a wet mechanical draft and hybrid technologies. All of these closed-cycle cooling technologies incorporate the use of a separate cooling tower structure and circulating water system and employ a single combined outage for each unit. The onshore mechanical fine mesh and modular wedge wire technologies do not require plant outages to implement. The closed cooling technologies require overall schedule durations ranging from 8 to 9 years after Notice to Proceed (NTP), while the onshore mechanical (active) fine mesh screening technology and the offshore modular wedge wire screening system technology offer overall schedule durations of approximately 4 years and 5 years after NTP, respectively. Schedule specifics for each of these seven approaches are detailed below. For each of the technologies, NTP occurs following permit approval for implementation, which is typically approximately a 5-year period.

Each of the technologies was evaluated and a schedule developed to cover the design, construction, and commissioning of that technology. The philosophy underpinning the schedule development process was to 1) minimize PG&E’s outlay of funds until such time as the permitting process was nearing completion, 2) determine the most efficient design and construction sequence, and 3) design and construct the project so that the time one or both of the units are offline is kept to an absolute minimum. The process used to develop the schedule for each technology is discussed in detail below.

6.2 Base Key Schedule Durations

The timescale of the milestone schedules in this report is shown in an “ordinal calendar” format to depict amount of time after Notice to Proceed (NTP). It is shown in years (not in months).

Milestone Description (years from NTP)	Wet Natural Draft Cooling	Wet Mechanical (Forced) Draft Cooling	Hybrid Wet/Dry Cooling	Passive Draft Dry/Air Cooling	Mechanical (Forced) Draft Dry/Air Cooling	Onshore Mechanical (Active) Intake Fine Mesh Screening Systems	Offshore Modular Wedge Wire Screening Systems
CEQA Review Process	-5.0	-5.0	-5.0	-5.0	-5.0	-4.3	-5.0
Notice to Proceed	0	0	0	0	0	0	0
Pre-Outage Construction Complete	7.3	7.1	6.1	5.9	6.5	n/a	n/a

Milestone Description (years from NTP)	Wet Natural Draft Cooling	Wet Mechanical (Forced) Draft Cooling	Hybrid Wet/Dry Cooling	Passive Draft Dry/Air Cooling	Mechanical (Forced) Draft Dry/Air Cooling	Onshore Mechanical (Active) Intake Fine Mesh Screening Systems	Offshore Modular Wedge Wire Screening Systems
Outage Complete and T/O to Operations	8.8	8.6	7.6	7.4	8.0	3.3 *	4.4 *
Total Duration (approximate)	14	14	13	13	13	8	10

* No outages required

6.3 General Schedule Qualifications and Assumptions

General schedule qualifications and assumptions are as follows:

- There is a standard approach to secure required permitting and leases that is valid and used for all of the technologies evaluated.
- Permitting durations are based on recent California related power plant permitting experience and the individual regulatory agency guidance on review periods.
- Considering related permits and their respective processes, the CEQA permit will require the most time during the permitting process.

6.4 Closed-Cycle Cooling Technologies

The closed-cycle cooling technology solution consists of five distinct approaches, with a separate schedule developed for each approach. The project team initially collaborated to identify individual tasks/milestones and the appropriate sequence in which the work needed to proceed. Engineering, permitting, construction, and startup task durations were evaluated, based on their complexity, physical location, effect on station operation, and past performance on previous Bechtel projects. Procurement, vendor, and subcontract durations were confirmed with potential suppliers or supported with past performance metrics on Bechtel projects. The project team then worked to optimize each schedule, focusing on minimizing outage duration, permitting risk, and impacts to plant operations.

The basic structure is the same for each of the closed-cycle cooling technologies schedules; however, the dry mechanical and dry natural options do not consider the desalination plant/water or reclaim water, since it is not required. The primary variability of these schedules is due to the different durations for mountain excavation and cooling tower configurations. The wet natural draft cooling requires a larger amount of excavation due to the number of cooling towers and the fact that makeup water is required. The summary level project implementation schedule developed for each of the five closed cooling options is provided in Figures 6.4-1 through 6.4-5. The dry natural draft option is forecasted to be the shortest closed cooling schedule duration, completing in approximately 8 years; while the wet natural option is forecasted to be the longest duration, completing in approximately 9 years. Each of these schedules includes an initial 5-year period prior to NTP that is dedicated solely to submitting and acquiring permit approvals.

It is important to note that for all of the closed-cycle cooling options, construction activities are independently scheduled to focus on the area outside the current plant protected area, separate from the construction activities inside the protected area. This approach was used to maximize productivity and minimize impact on the operating plants.

6.5 Closed-Cycle Schedule Qualifications and Assumptions

Closed-cycle schedule qualifications and assumptions are as follows:

- Procurement/construction work will not begin until after permit approval is received, except for the bid preparation to relocate the 230 kV power line. The engineering specifications bid and evaluation process would be completed, but a purchase order issue was assumed to not take place until the permitting process is completed.
- Limited equipment award, especially for equipment design activities, may be a source of schedule improvement to be considered during implementation. It would be a PG&E decision to assume some risk in this area based on confidence gained during the permitting process and may be deemed reasonable and acceptable.
- Mountain excavation duration based on the estimated volume of material to be excavated is a major segment of the overall schedule duration (estimated volumes are 316 million cubic yards for the dry natural, wet natural and dry mechanical options, and 190 million cubic yards for the wet mechanical and hybrid options).
- For each closed-cycle cooling technology, the construction approach is to complete as much of the scope as possible for the cooling towers prior to the plant outages, leaving the circulating water pipe removal and installation tie-ins and hookups, to minimize outage time.

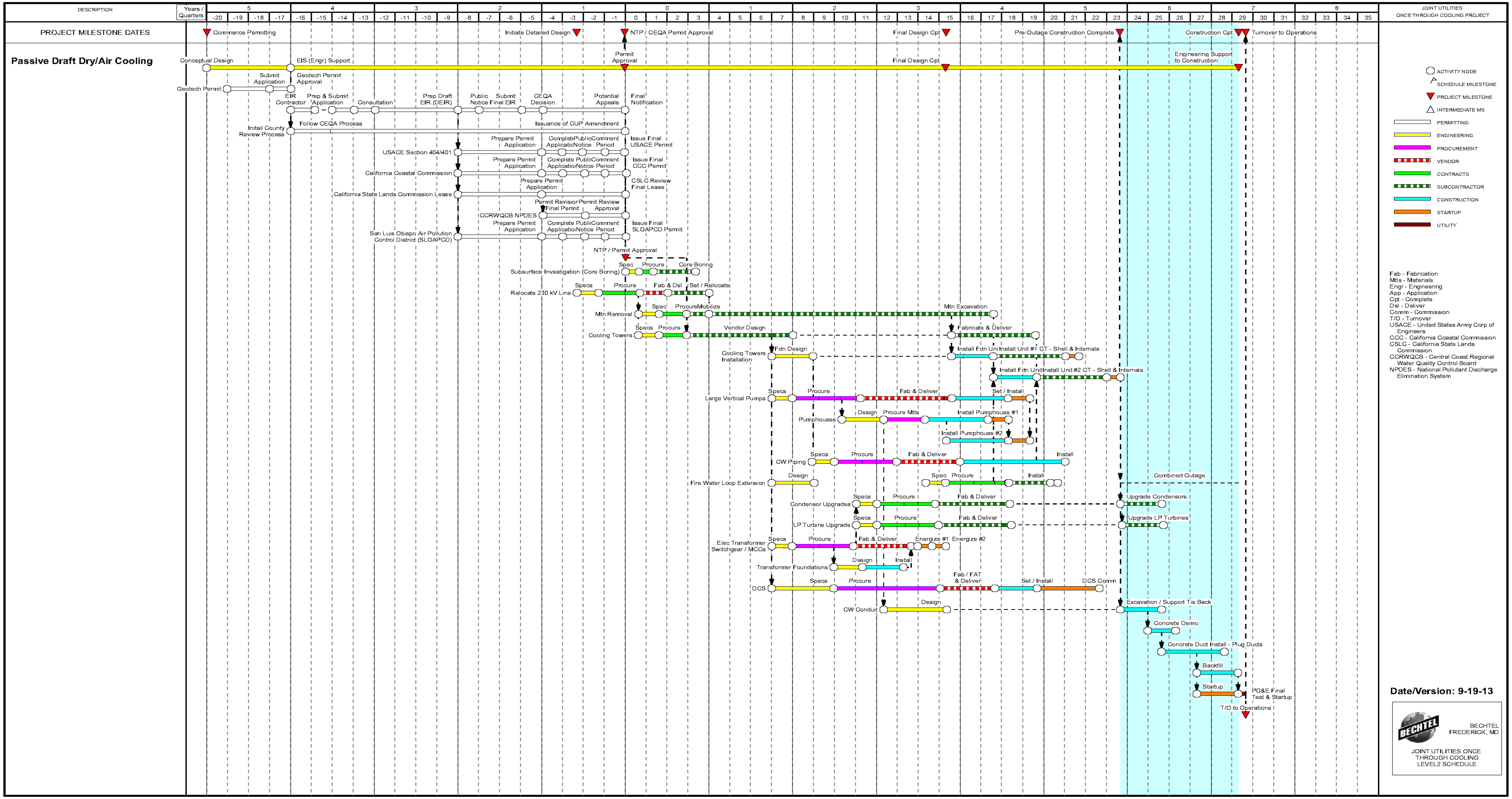


Figure 6.4-1. DCPP Closed Cycle–Passive Draft Dry/Air Dry Natural Cooling

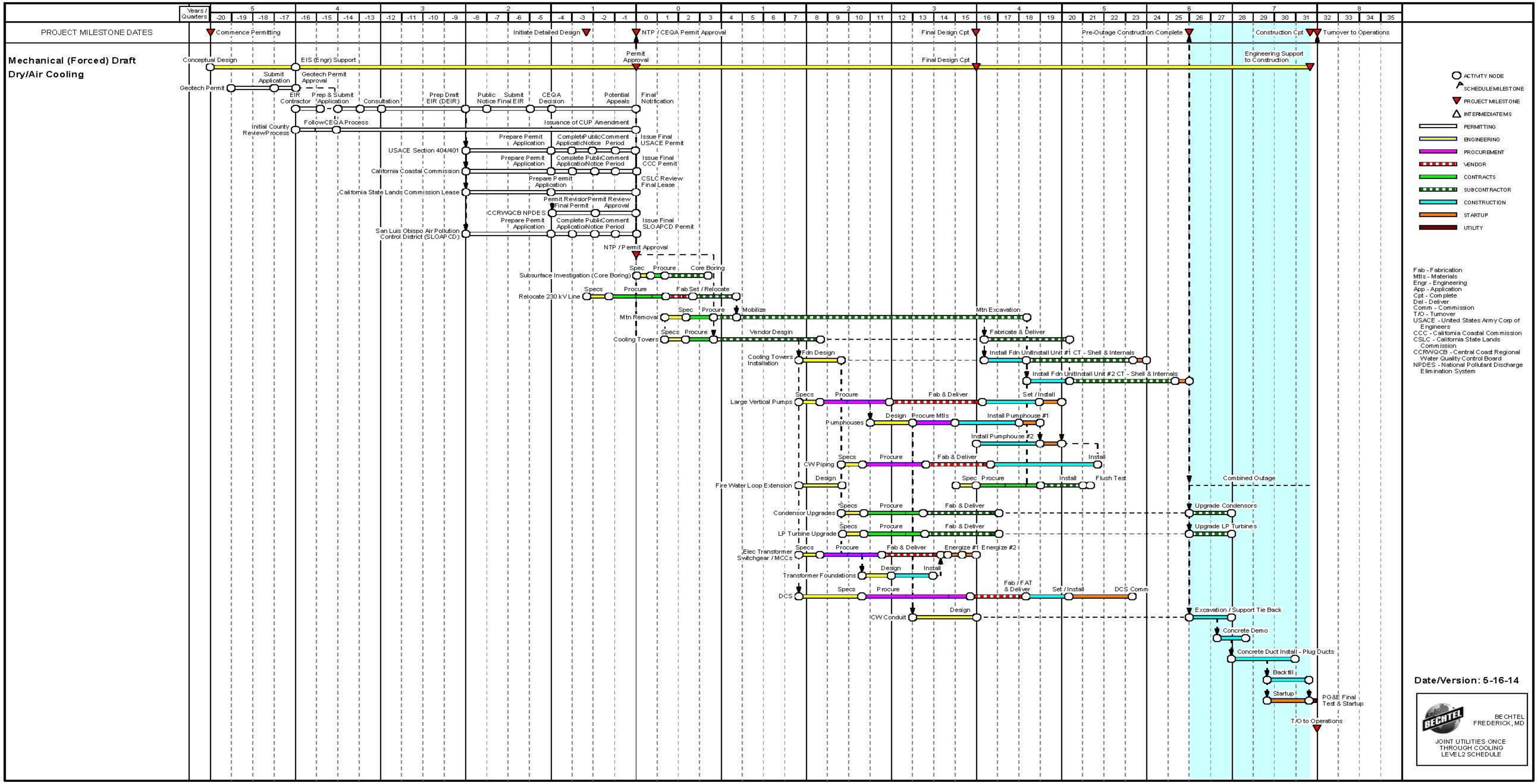


Figure 6.4-2. DCPP Closed Cycle–Mechanical (Forced) Draft Dry/Air Cooling

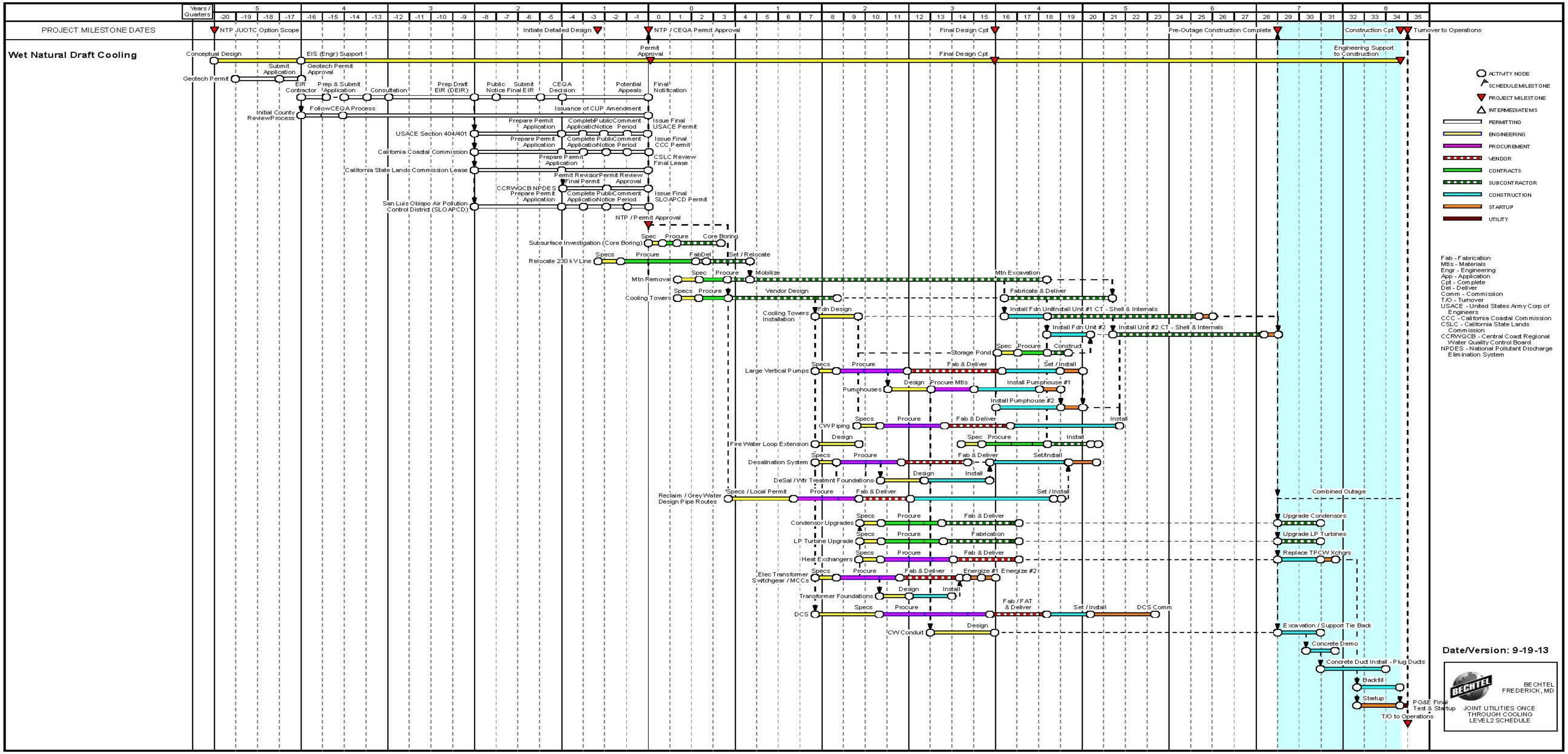


Figure 6.4-3. DCPP Closed Cycle–Wet Natural Draft Cooling

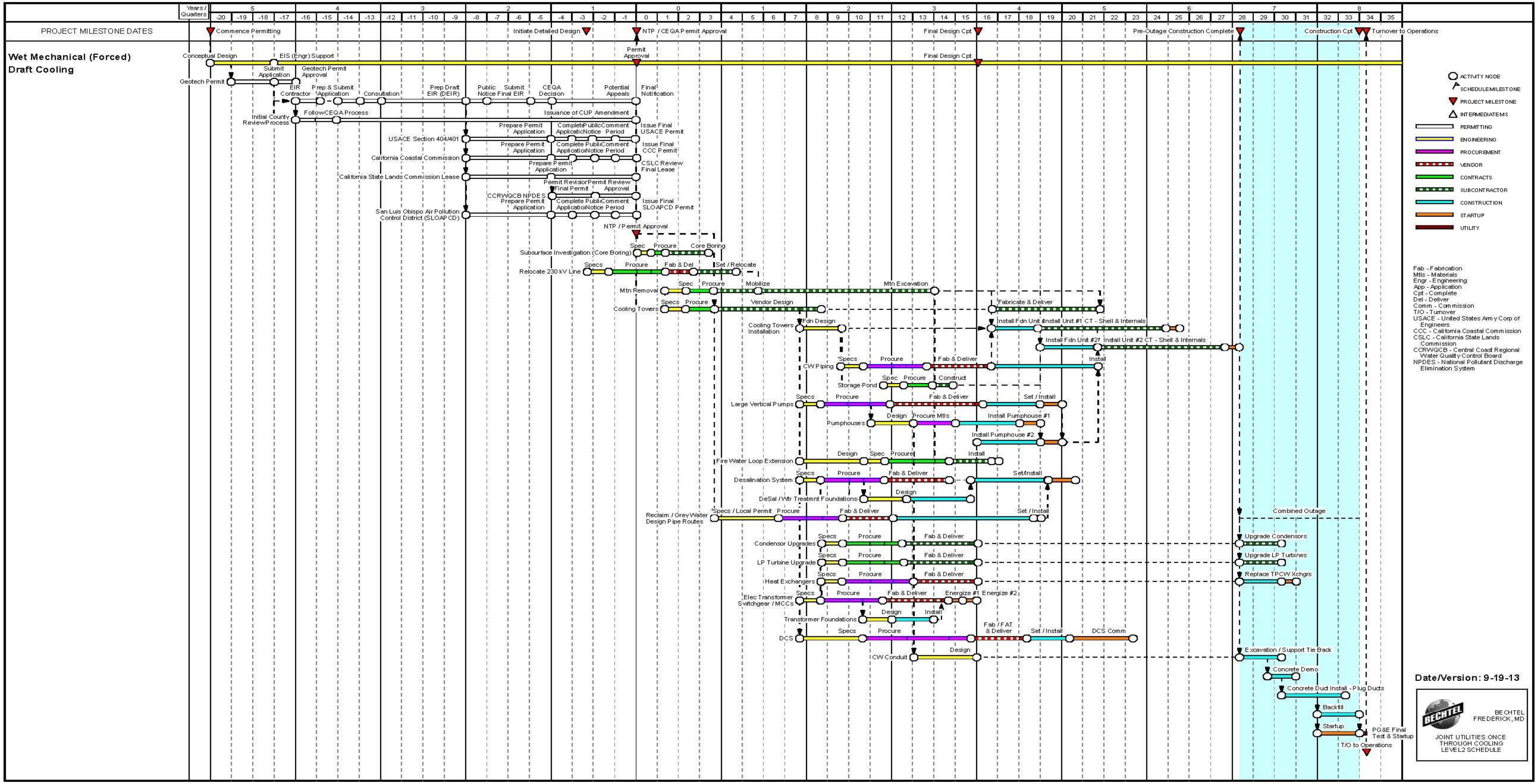


Figure 6.4-4. DCPP Closed Cycle-Wet Mechanial (Forced) Draft Cooling

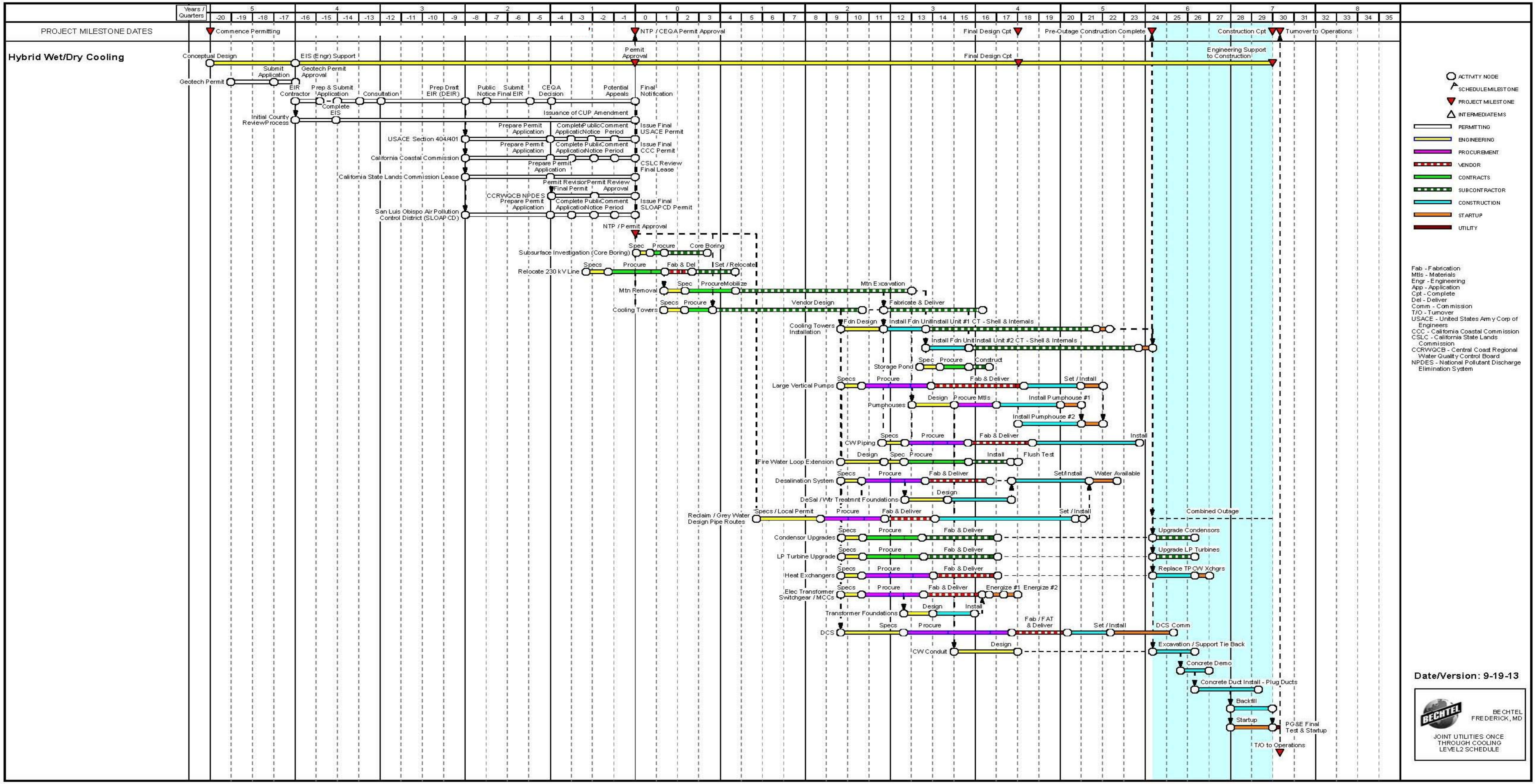


Figure 6.4-5. DCPP Closed Cycle–Hybrid Wet/Dry Cooling

- The closed-cycle options are expected to require a single combined outage to perform final installation and tie-in work. Significant underground piping work is required west of the turbine building.

- Several work fronts (including the heat exchanger replacement, condenser upgrades, and the low pressure turbine upgrade) have the potential to be completed during earlier plant outages if availability allows. The potential for schedule improvement exists, since these potential optimizations are not considered in the schedules.

6.6 Key Events that Start Prior to NTP

Key events to commence before NTP are highlighted below:

- The initial preliminary design will commence to support the development of the Geotech permit as part of the overall permitting process.

- The permitting process for the project commences with the Geotech permitting process while the lead CEQA agency is being assessed and the services of the EIR contractor are secured. Permitting is assumed to be a 4.0-year process, based on the qualifications and assumptions stated previously.

- Initiating relocation of the 230 kV power line is a critical activity that must be performed soon after the CEQA permit is approved in order to avoid impact on mountain excavation activities.

- Initiation of the subsurface investigation for the mountain excavation will directly follow receipt of CEQA permitting approval.

6.7 Critical Path Activities

The critical paths for each closed-cycle cooling technology are essentially the same, since the schedules for each technology are based on the same general approach.

The “primary” critical path for a schedule is defined as the longest sequence of activities in a project plan that must be completed on time for the project to be completed by the expected finish date. The overall project duration cannot be improved without decreasing the length of the critical path. Conversely, if any activity on the primary critical path is delayed for a day, then the entire project will be delayed for a day as well.

The secondary and tertiary critical paths do not directly affect the project completion. However, if the primary critical path is sufficiently improved, then the secondary path would become the longest sequence and the new primary critical path for the project. This is also true for the tertiary path if sufficient improvements can be made to the durations of the primary and secondary critical paths.

These critical paths for the closed-cycle cooling technology options are detailed as follows:

- Primary Path – The primary critical path for the cooling towers runs through the Geotech permit and CEQA permitting process. After the CEQA permit is approved, follow-on critical activities include relocating the 230 kV power line, completing mountain excavation, constructing the cooling towers and constructing the two pumphouses; each are key predecessors to achieving the Pre-outage Construction Complete milestone. The combined outage can commence once the Pre-outage Construction Complete milestone is achieved. The outage start can be delayed until the best appropriate time based on plant operations and generation requirements. For the purpose of this report, the outage start is defined to occur immediately following the Pre-outage Construction Complete milestone. Once the outage work is complete, the project will be ready for turnover to Operations for final plant testing and startup.

- Secondary Path – The secondary critical path begins with the CEQA permit approval and runs through the award of the cooling tower subcontract. The design of the cooling tower foundations and CW piping begins with the receipt of vendor information and progresses through CW piping installation and subsequently is completed with the commencement of the installation outage.

- Tertiary Path – The tertiary critical path begins with CEQA permit approval and runs through the receipt of the cooling tower subcontractor vendor information (VI). Receipt of the cooling tower VI initiates the procurement of the large vertical pumps. Receipt of the large vertical pump VI initiates the design of the pumphouses and subsequently ties into the Pre-outage Construction Complete milestone.

6.8 Outage Work

To minimize the impact to plant operations as much as possible, all possible pre-outage work will be completed prior to starting the outage. Additionally, the outage work will be performed on a 24/7 basis. The durations are based on the production rates required for the excavation quantities and installation of the CW conduit to the west of the plant. Major activities include excavation, demolition of existing concrete conduit, and installation of new concrete duct, tie-ins, backfill, and startup.

6.9 Schedule Risks

The schedule risks that have been identified are summarized below:

- CEQA Final Decision – Delays in receipt of the CEQA Final Decision will delay key equipment procurement and subcontract awards, which in turn will delay the start of physical work.

- EIR Preparation – the closed cooling system will require the preparation of an EIR, which has the potential to significantly extend the permitting process, depending on the EIR extensions of public review and comment periods and difficulties in responding to subsequent information requests.

- Possible Litigation Schedule Impacts – While litigation schedule impacts have not been included, a nominal 1-year appeal period was assumed.

- Mountain Excavation – Mountain excavation durations are based on available geotechnical information provided by PG&E regarding the soil composition and available data of soil properties in the area of the plant site. Results of the final geotechnical borings and associated soil properties could impact the overall excavation duration either positively or negatively.

- Recycle Water Pipe Routes – Recycle water pipe will be routed through existing rights of way in the communities within 20 miles of DCPP. Construction impacts from local communities may affect the duration of this effort. However, it is assumed that the CEQA permitting process will also address the local concerns and that local permitting can be accomplished well within the time period of the CEQA approval.

- Vendor/Subcontractor Schedule Variation – While efforts have been made to appropriately forecast lead times and subcontract durations, there is a risk for variation due to market conditions and other external factors until final contracts are awarded.

- Unknown Underground Conditions – Unknown underground conditions, particularly within the footprint of the operating units, could adversely impact the construction schedule.

- Labor Availability – Availability of qualified labor could negatively affect the construction durations assumed in the schedule.

6.10 Onshore Mechanical Fine Mesh Screening Technology

The summary level project implementation schedule developed for the onshore fine mesh screening option is provided as Figure 6.10-1 and shows an overall duration of approximately 4 years after NTP. As with the closed-cycle cooling and offshore modular wedge wire screening schedule approaches, the project team developed the schedule to ensure complete representation of the total project scope.

Schedule Qualifications and Assumptions

Onshore mechanical fine mesh screening technology schedule qualifications and assumptions are identified below:

- Detailed engineering/procurement/construction work will not begin until after permit approval is received, except for specification development for the fine mesh screens. The specification for the fine mesh screens will be ready for issue to bidders once permit approval is received. There may be a source of additional schedule improvement during implementation; based on confidence gained during the permitting process, PG&E may elect to release other work tasks prior to receiving CEQA approval.

- The construction approach will be to complete as much of the scope as possible during plant operation. The major work effort involves screen removal and installation of new dual-flow screens and control panels.

- The project execution schedule has been developed assuming that the affected unit will remain in operation under reduced intake during the screen replacement work. With the screens being replaced during plant operation, one pump (and associated screen set) will operate at a time and at reduced intake flow and lower power level. This approach offers the advantage of allowing the dual flow screens to be installed without an outage of either unit.

6.11 Key Events that Start Prior to NTP

Key events to commence before NTP are highlighted below:

- The conceptual design and Geotech permit for the fish return discharge area are initiated to support the permitting process.

- The permitting process will begin after the Geotech permit is approved.

- Permitting is assumed to be a 4.25-year process, based on the previously stated assumptions.

6.12 Critical Path Activities

The primary critical path for the onshore mechanical fine mesh screening technology begins with the approval of the Geotech and required permits. Once permitting approvals are received, the critical path continues with the detailed engineering, procurement, fabrication, and installation of the fine mesh screens and the screen wash pumps during the first partial outage for the first unit. Once the partial outage of the first unit partial outage (Outage 1) is complete, the critical path continues through installation of the fine mesh screens for the second unit (Outage 2) and is completed with the second unit turnover to Operations at Year 7.8.

Schedule Risks

The schedule risks that have been identified are summarized below:

- Permits and Regulatory Approvals – Delays in receipt of permits and regulatory approvals will delay the procurement of key equipment and in turn delay the start of physical work.
- Appeal Period – A nominal 3-month appeal period has been assumed in conjunction with the CEQA approval process.
- Vendor/Subcontractor Schedule Variation – There is risk for variation due to market conditions and other external factors.
- Possible Need for new Rack Structure – If a new rack structure must be installed, the schedule sequence and durations would change significantly.

6.13 Offshore Modular Wedge Wire Screening System Technology

The Level 2 project implementation schedule developed for the modular wedge wire screening system technology option is provided as Figure 6.13-1 and shows an overall duration of 4.4 years. As with the closed-cycle cooling and onshore fine mesh screening schedule approaches, the project team developed the schedule to ensure complete representation of the total project scope. The overall schedule duration for the onshore mechanical fine mesh screening technology includes 5 years dedicated solely to acquiring permit approvals.

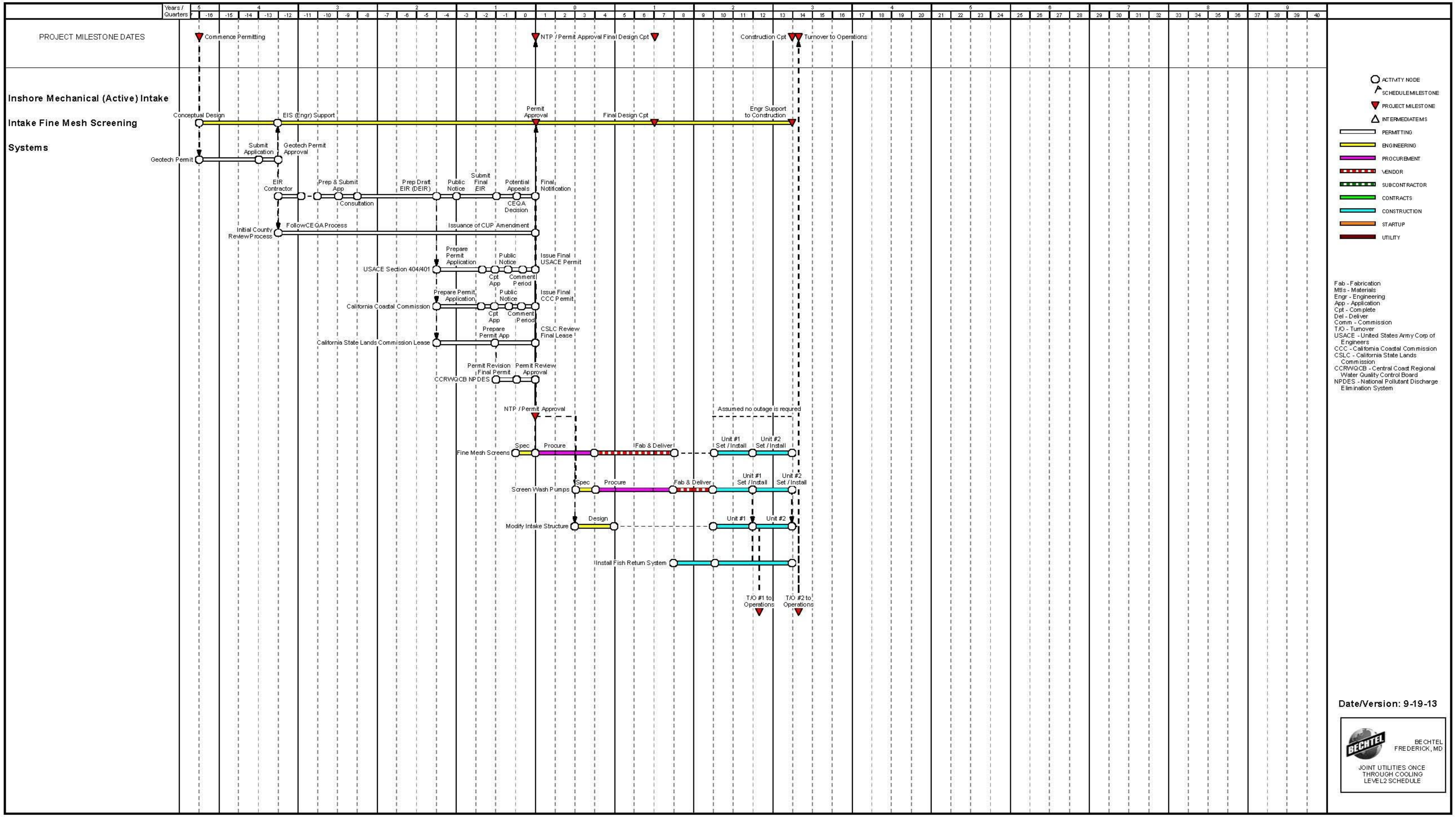


Figure 6.10-1. DCPP Onshore Mechanical (Active) Intake Fine Mesh Fine Mesh Screening

6.14 Schedule Qualifications and Assumptions

Modular wedge wire screening technology schedule qualifications and assumptions are identified below:

- An in-situ testing program for the wedge wire screens will take place during the permitting process in advance of the CEQA permit approval.
- Construction work will not begin until permit approvals are obtained.
- A plant outage will not be required for the installation of the offshore modular wedge wire screening system technology, allowing the plant to operate continually during project execution.

6.15 Key Events that Start Prior to NTP

Key events to commence before NTP are highlighted below:

- The conceptual design and Geotech permit process is initiated to support the permitting process.
- The permitting process will commence after the Geotech permit is approved.
- Permitting is assumed to be a 4.0-year process, based on the previously stated assumptions.
- In-situ testing for biological and debris effects will be accomplished during the permitting process.

6.16 Critical Path Activities

The primary critical path for the modular wedge wire screening technology begins with the acquisition of the Geotech and remaining permits and approval to proceed with the in-situ testing. Once permitting approvals are received, the critical path continues with the award of the detailed engineering leading to the award of the marine subcontract and associated design, procurement, fabrication, and installation of the wedge wire screens and piping headers. The critical path continues through construction of the breakwater enclosure and is completed with the final PG&E testing and turnover to Operations.

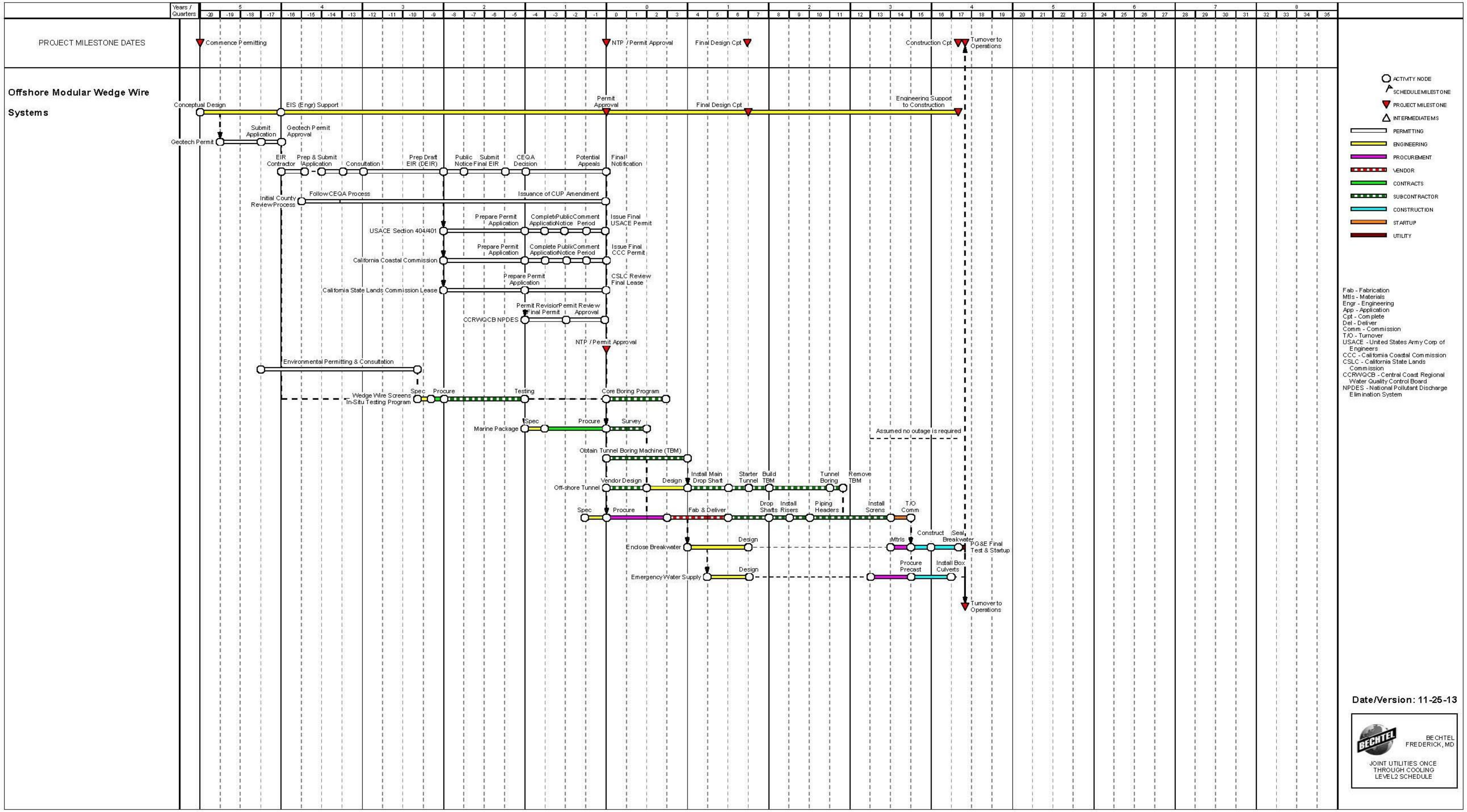


Figure 6.13-1. DCPP Offshore Modular Wedge Wire Screening

Schedule Risks

The schedule risks that have been identified are summarized below:

- Permit Approvals – Delays in receipt of permits will delay the award of key equipment and in turn delay the start of physical work.
- CEQ Permitting Approvals – Significant CEQ permitting appeal activity is assumed (nominal 1-year appeal period).
- Severity of Offshore Fault – The Geotech report indicates that the offshore fault is more severe than previously thought.
- Vendor/Subcontractor Schedule Variation –There is risk for variation due to market conditions and other external factors.

6.17 Schedule Confidence

The schedules developed for each technology are based on quantity information, given work schedule, and historical unit rates. They have been developed without contingency or other schedule allowance to reflect the individual tasks or overall project duration. The schedules are based on recent vendor schedule information and adjusted based on historical schedule knowledge to attain a higher level of confidence in the reflected durations.

The schedules will be further refined during the detail design phase when construction and installation quantities are finalized. The critical path (Section 6.7) identifies the key work scope with the greatest dependence on and sensitivity to the project completion.

7 Estimate Development

7.1 Estimate Overview

For this study, Bechtel implemented its proprietary Estimating Process Integration and Control (EPIC) estimating process to develop the costs for the DCPP, consistent with the Association for Advancement of Cost Engineers International (AACEI) Class 3 estimating standard defined in Section 1.2 of the AACEI standard. The estimating process is depicted in Figure 7.1-1. The estimating methodology used to develop the costs is the same as the one that would be used for any large and complex project. Bechtel used our proprietary cost database developed from new generation, power uprate, and capital equipment replacement project experience. In addition, Bechtel applied our fossil plant estimating experience to support the estimating of similar scope items such as the design and construction of similar cooling water intake structures.

The estimate is founded on a well-defined scope developed by Engineering and refined by Construction and Estimating walking down the DCPP site and providing constructability and execution feedback. Engineering completed the design in the range of 10% to 15%, which yielded the quantities for the commodities used to develop the estimate. Construction refined the execution strategy based on the final quantities and to meet the schedule requirements, which formed the basis for the development of craft labor productivity and craft labor wage rates, and identification of the specialty subcontracts required for the performance of the scope of work. The local craft labor conditions were investigated and craft wage rate information was secured, which was used to develop the labor wages and potential craft incentives to attract and retain qualified craft. Equipment supply was investigated to understand current equipment supply pricing. Equipment supply and install was investigated for the specialty subcontracts identified as part of execution strategy, to understand current equipment supply and installation pricing. This provided the total estimate for the direct cost component in the EPIC model. The replacement turbine costs were provided by PG&E based on its previous experience, which was escalated to current-day pricing.

The indirect cost component, such as startup labor, was estimated based on the scope of work as defined by Engineering. Engineering services labor was estimated based the engineering effort necessary to complete the design. The balance of cost components such as distributable cost, indirect cost, other home office services, and other costs, (e.g., insurance, taxes etc.) was estimated using the Bechtel proprietary database capturing actual cost experience from other projects of similar scope and size. The estimates are based on overnight pricing and exclude escalation. The project price includes a nominal fee for the contractor to perform the scope of work.

The estimating methodology outlined above is consistent with the AACEI Class 3 estimating standard defined in Section 1.2 of the AACEI standard.

7.2 Estimate Classification

The estimate for each technology has been prepared in accordance with AACEI 18R-97: Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries. The estimates provided in this report are being classified as Class 3 estimates.

According to AACEI, “Class 3 estimates are generally prepared to form the basis for budget authorization, appropriation, and/or funding. As such, they typically form the initial control estimate against which all actual costs and resources will be monitored. Typically, engineering is from 10% to 40% complete, and would comprise at a minimum the following: process flow diagrams, utility flow diagrams, preliminary piping and instrument diagrams, plot plan, developed layout drawings, and essentially complete engineered process and utility equipment lists.”

According to AACEI, the estimating methodology for, “Class 3 estimates generally involve more deterministic estimating methods than stochastic methods. They usually involve predominant use of unit cost line items, although these may be at an assembly level of detail rather than individual components. Factoring and other stochastic methods may be used to estimate less-significant areas of the project.”

According to AACEI, the expected accuracy range for, “Class 3 estimates are -10% to -20% on the low side, and +10% to +30% on the high side, depending on the technological complexity of the project, appropriate reference information, and other risks (after inclusion of an appropriate contingency determination). Ranges could exceed those shown if there are unusual risks.”

Following the methodology outlined in Section 7.1 and the estimate standards outlined in this section, the cost estimate details for each of the technologies were developed and are provided in Section 7.3, a summary of all technologies is provided in Table 7.3-1.

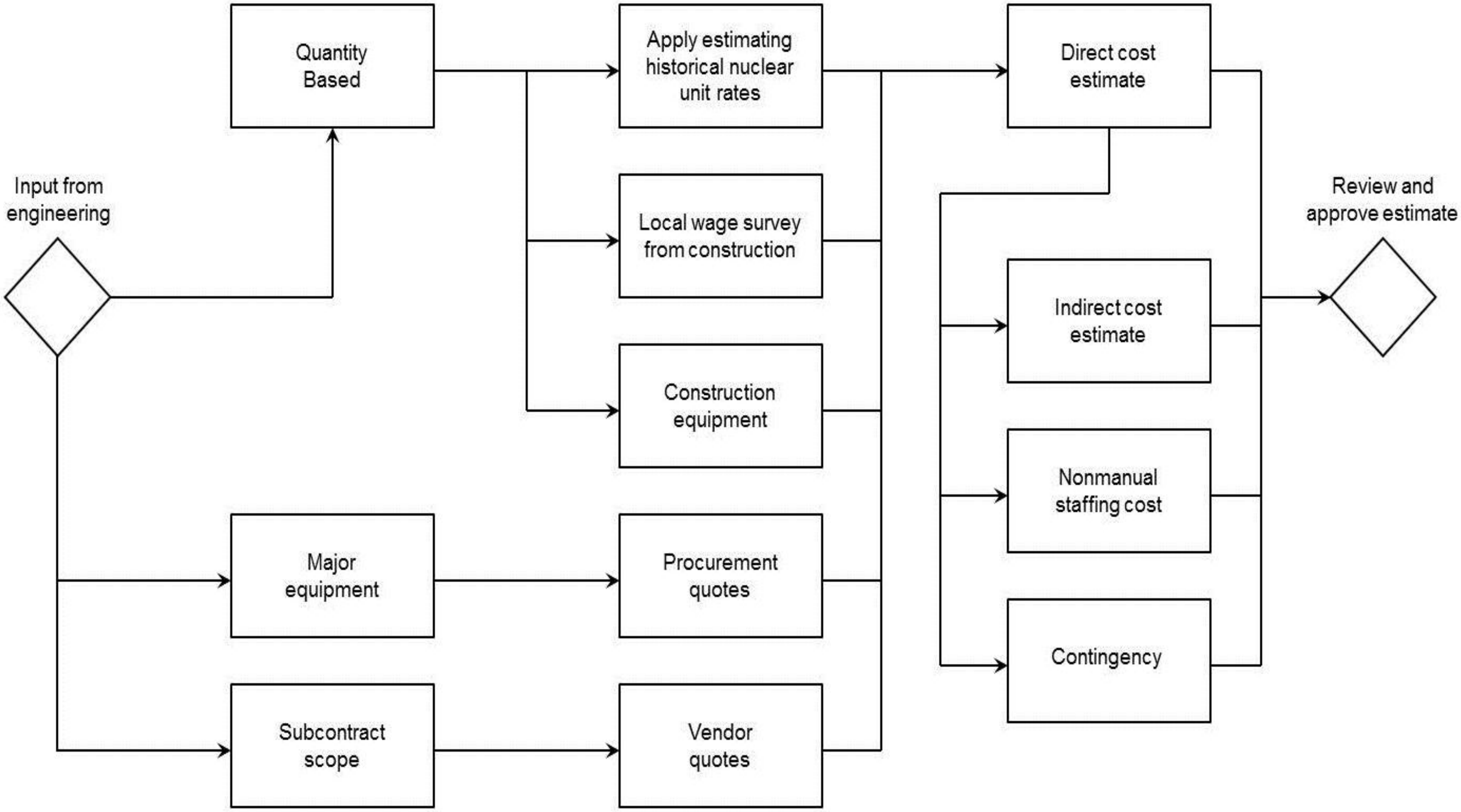


Figure 7.1-1. Phase 2 Estimating Process for Each Technology

7.3 Estimate Summary for All Technologies

The estimates for all technologies are summarized in Table 7.3-1.

Table 7.3-1. Technology Estimate Summary

Technology	Project Cost ($ x 1,000,000)	PG&E Costs ($ x 1,000,000)	Grand Total [1] ($ x 1,000,000)
Mechanical (Forced) Draft Dry/Air Cooling [2]	7,026 – 10,960	3,174	10,200 – 14,134
Passive Draft Dry/Air Cooling [3]	7,038 – 10,979	3,066	10,104 – 14,045
Wet Mechanical (Forced) Draft Cooling	5,501 – 8,581	3,066	8,567 – 11,647
Wet Natural Draft Cooling	7,011 – 10,938	3,174	10,185 – 14,112
Hybrid Wet/Dry Cooling	5,480 – 8,549	3,174	8,654 – 11,723
Onshore Mechanical Fine Mesh Screening	165 – 257	418	583 – 675
Offshore Modular Wedge Wire Screening System	261 – 407	195	456 – 602

[1] All technology estimates include PG&E-provided cost for USNRC review of environmental impact statements.
[2, 3] Includes PG&E-provided steam turbine replacement costs.

7.3.1 Estimate Summary Explained

The estimate summary is explained in Table 7.3.1-1. Separate estimate summaries for each technology are provided in Sections 7.3.2 through 7.3.8.

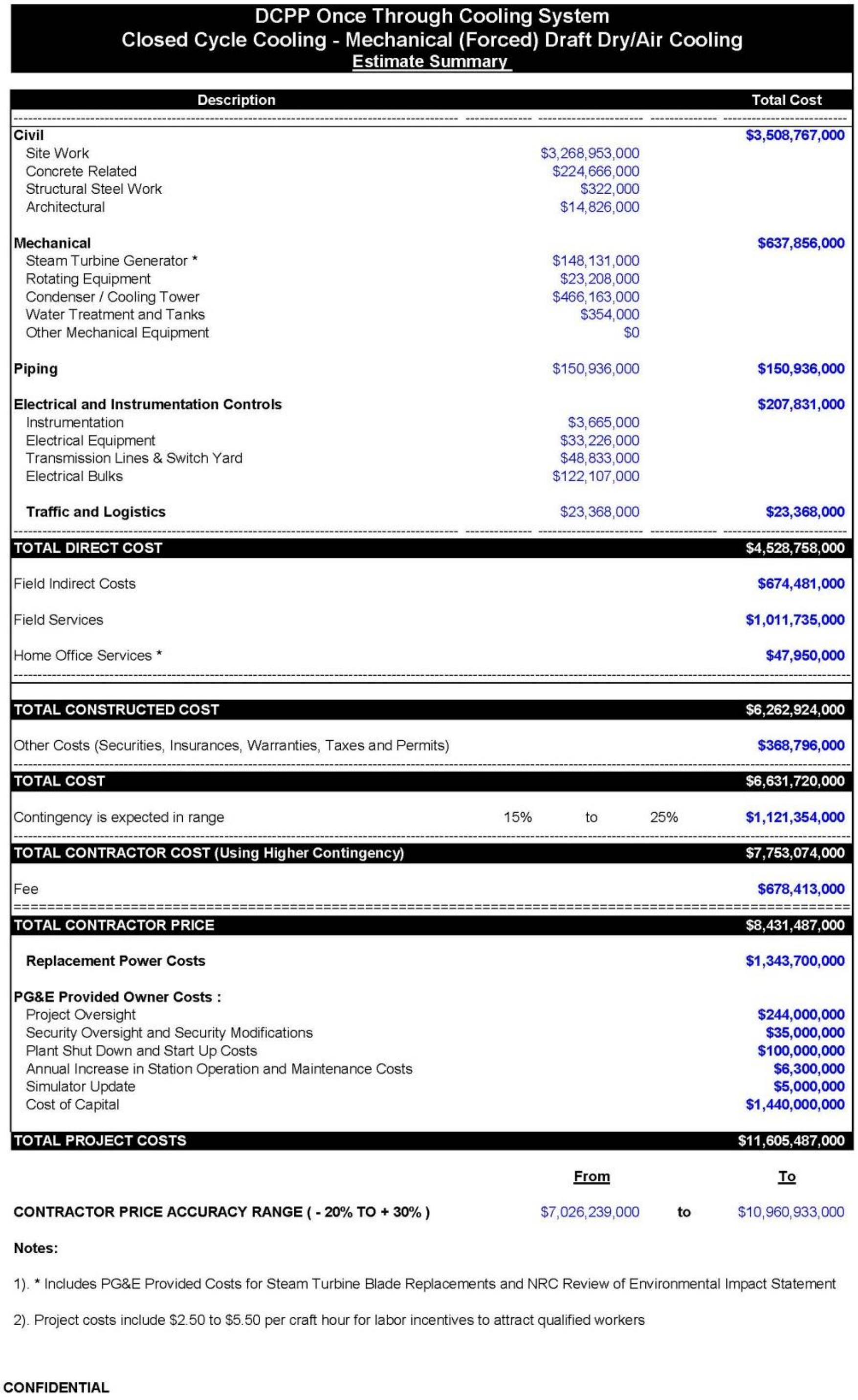
Table 7.3.1-1. Explanation of Technology Estimate Summary

DCPP Once-Through Cooling System TECHNOLOGY OPTION Estimate Summary		
Description		**Comments**
Civil		Typical items included are material, labor and subcontract costs for mountain excavation, foundation excavation and back fill, concrete, structural steel and architectural as applicable.
Mechanical		Typical items included are material, labor and subcontract costs for cooling towers, rotating equipment, steam generator blade replacements, condenser upgrades, water treatment, tanks and other mechanical equipment as applicable

Piping		Typical items included are material, labor and subcontract costs for piping systems associated with recycle water pipe line, service and fire water systems as applicable.
Electrical and Instrumentation Controls		Typical items included are material, labor and subcontract costs associated with instrumentation, electrical equipment, transmission lines, switch yard and electrical bulks as applicable
Traffic and Logistics		Includes freight costs for materials.
TOTAL DIRECT COST		
Other Field Costs (Field Non-Manual, Craft Distributables)		Typical Items included are field craft indirect labor (such as Temporary construction, housekeeping, tool room management, etc.) and materials (such as small tools, consumables, construction equipment, cranes, craft break trailer, office trailers, etc.), field non-manual labor (such as craft supervision, field engineering, safety, quality, field project controls, etc.) and their other direct costs such as (computers, internet, office supplies, business travel, relocation and living costs, etc.).
Engineering Services		Includes engineering and other home office services costs
TOTAL CONSTRUCTED COST		
Other Costs (Securities, Insurances, Taxes Warranties and Permits)		Insurances, Securities, Sales Taxes, Construction Permits, etc.
TOTAL COST		
Contingency is expected in range		Appropriate contingency for unknowns
TOTAL PROJECT COST		
Fee		Contractor fee
PG&E Owner Costs		Project oversight, security oversight and modifications, plant shutdown and startup costs, annual increase in station operation and maintenance costs, simulator update, cost of capital, costs of busing plant Personnel and Remote Parking Lot for Plant Personnel.
TOTAL PROJECT PRICE		

7.3.2 Estimate Summary for Mechanical (Forced) Dry/Air Cooling

Mechanical (forced) dry/air cooling is summarized in the following table.



DCPP Once Through Cooling System
Closed Cycle Cooling - Mechanical (Forced) Draft Dry/Air Cooling
Estimate Summary

Description		Total Cost
Civil		$3,508,767,000
Site Work	$3,268,953,000	
Concrete Related	$224,666,000	
Structural Steel Work	$322,000	
Architectural	$14,826,000	
Mechanical		$637,856,000
Steam Turbine Generator *	$148,131,000	
Rotating Equipment	$23,208,000	
Condenser / Cooling Tower	$466,163,000	
Water Treatment and Tanks	$354,000	
Other Mechanical Equipment	$0	
Piping	$150,936,000	$150,936,000
Electrical and Instrumentation Controls		$207,831,000
Instrumentation	$3,665,000	
Electrical Equipment	$33,226,000	
Transmission Lines & Switch Yard	$48,833,000	
Electrical Bulks	$122,107,000	
Traffic and Logistics	$23,368,000	$23,368,000
TOTAL DIRECT COST		$4,528,758,000
Field Indirect Costs		$674,481,000
Field Services		$1,011,735,000
Home Office Services *		$47,950,000
TOTAL CONSTRUCTED COST		$6,262,924,000
Other Costs (Securities, Insurances, Warranties, Taxes and Permits)		$368,796,000
TOTAL COST		$6,631,720,000
Contingency is expected in range	15% to 25%	$1,121,354,000
TOTAL CONTRACTOR COST (Using Higher Contingency)		$7,753,074,000
Fee		$678,413,000
TOTAL CONTRACTOR PRICE		$8,431,487,000
Replacement Power Costs		$1,343,700,000
PG&E Provided Owner Costs :		
Project Oversight		$244,000,000
Security Oversight and Security Modifications		$35,000,000
Plant Shut Down and Start Up Costs		$100,000,000
Annual Increase in Station Operation and Maintenance Costs		$6,300,000
Simulator Update		$5,000,000
Cost of Capital		$1,440,000,000
TOTAL PROJECT COSTS		$11,605,487,000

	From		To
CONTRACTOR PRICE ACCURACY RANGE (- 20% TO + 30%)	$7,026,239,000	to	$10,960,933,000

Notes:

1). * Includes PG&E Provided Costs for Steam Turbine Blade Replacements and NRC Review of Environmental Impact Statement

2). Project costs include $2.50 to $5.50 per craft hour for labor incentives to attract qualified workers

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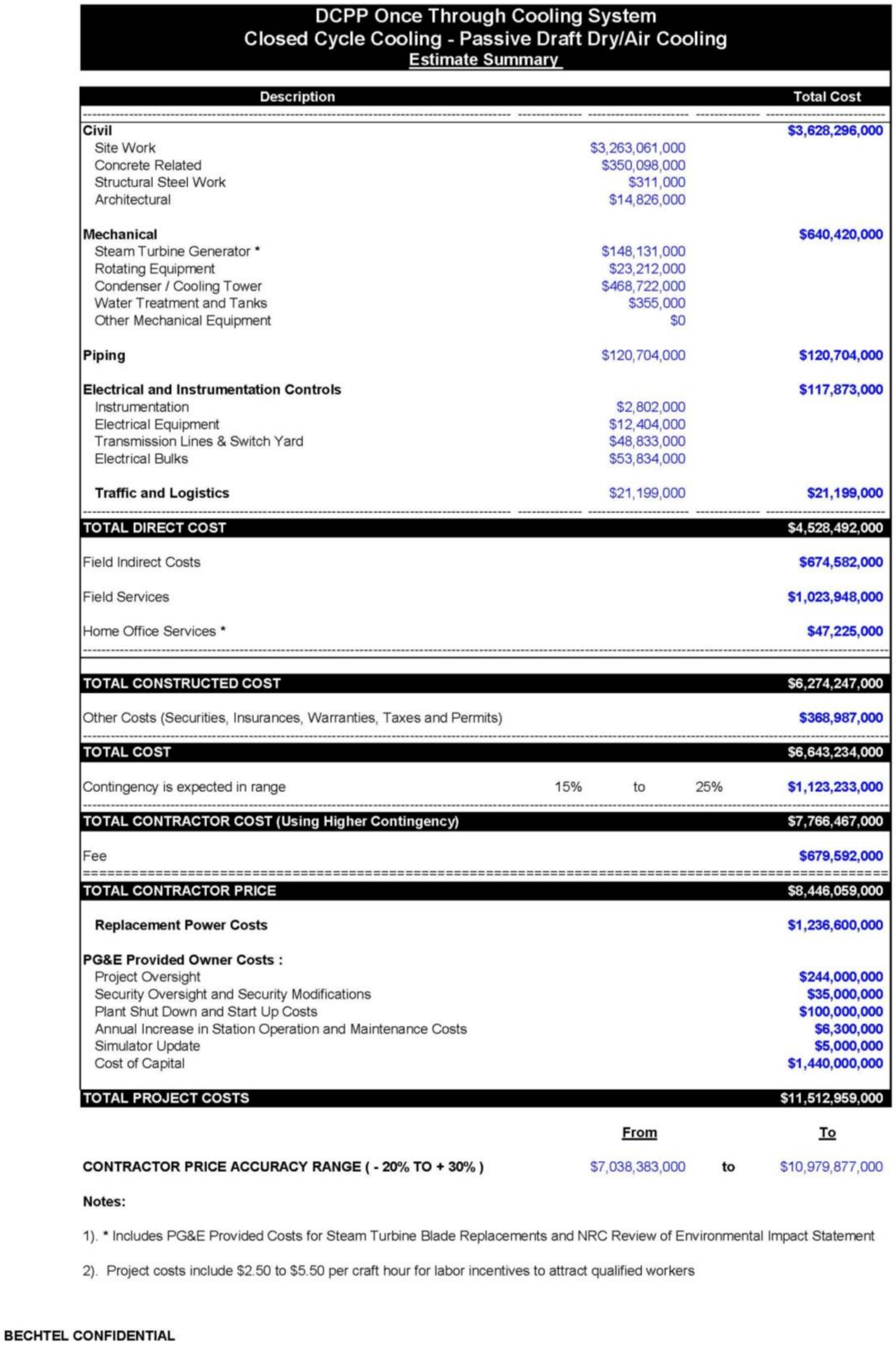
7.3.3 Estimate Summary for Passive Draft Dry/Air Cooling

Passive draft dry/air cooling is summarized in the following table.



DCPP Once Through Cooling System
Closed Cycle Cooling - Passive Draft Dry/Air Cooling
Estimate Summary

Description				Total Cost
Civil				$3,628,296,000
Site Work		$3,263,061,000		
Concrete Related		$350,098,000		
Structural Steel Work		$311,000		
Architectural		$14,826,000		
Mechanical				$640,420,000
Steam Turbine Generator *		$148,131,000		
Rotating Equipment		$23,212,000		
Condenser / Cooling Tower		$468,722,000		
Water Treatment and Tanks		$355,000		
Other Mechanical Equipment		$0		
Piping		$120,704,000		$120,704,000
Electrical and Instrumentation Controls				$117,873,000
Instrumentation		$2,802,000		
Electrical Equipment		$12,404,000		
Transmission Lines & Switch Yard		$48,833,000		
Electrical Bulks		$53,834,000		
Traffic and Logistics		$21,199,000		$21,199,000
TOTAL DIRECT COST				$4,528,492,000
Field Indirect Costs				$674,582,000
Field Services				$1,023,948,000
Home Office Services *				$47,225,000
TOTAL CONSTRUCTED COST				$6,274,247,000
Other Costs (Securities, Insurances, Warranties, Taxes and Permits)				$368,987,000
TOTAL COST				$6,643,234,000
Contingency is expected in range	15%	to	25%	$1,123,233,000
TOTAL CONTRACTOR COST (Using Higher Contingency)				$7,766,467,000
Fee				$679,592,000
TOTAL CONTRACTOR PRICE				$8,446,059,000
Replacement Power Costs				$1,236,600,000
PG&E Provided Owner Costs :				
Project Oversight				$244,000,000
Security Oversight and Security Modifications				$35,000,000
Plant Shut Down and Start Up Costs				$100,000,000
Annual Increase in Station Operation and Maintenance Costs				$6,300,000
Simulator Update				$5,000,000
Cost of Capital				$1,440,000,000
TOTAL PROJECT COSTS				$11,512,959,000
		From		**To**
CONTRACTOR PRICE ACCURACY RANGE (- 20% TO + 30%)		$7,038,383,000	**to**	$10,979,877,000

Notes:

1). * Includes PG&E Provided Costs for Steam Turbine Blade Replacements and NRC Review of Environmental Impact Statement

2). Project costs include $2.50 to $5.50 per craft hour for labor incentives to attract qualified workers

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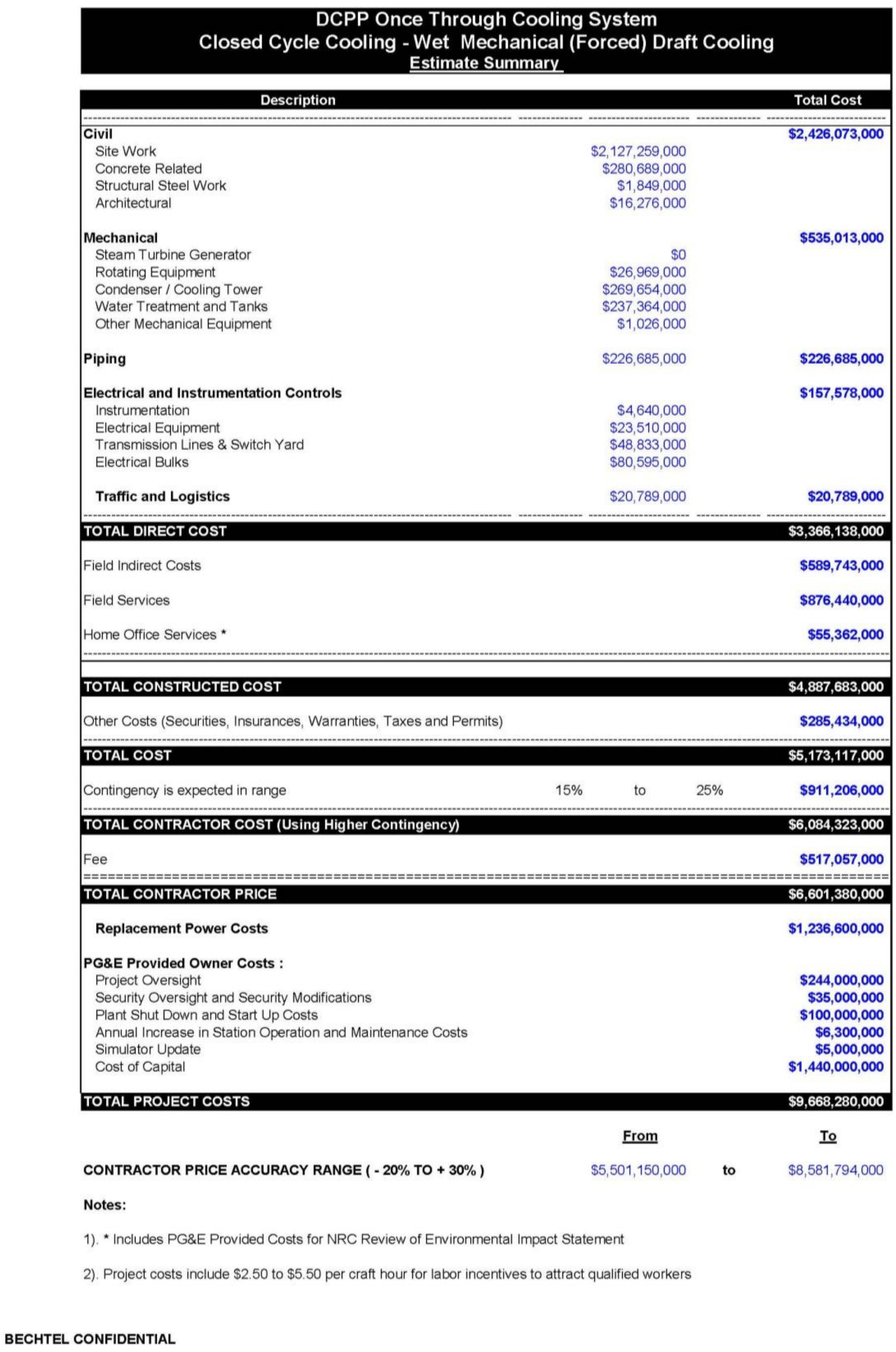
7.3.4 Estimate Summary for Wet Mechanical (Forced) Draft Cooling

Wet mechanical (forced) draft cooling is summarized in the following table.



DCPP Once Through Cooling System
Closed Cycle Cooling - Wet Mechanical (Forced) Draft Cooling
Estimate Summary

Description		Total Cost
Civil		$2,426,073,000
Site Work	$2,127,259,000	
Concrete Related	$280,689,000	
Structural Steel Work	$1,849,000	
Architectural	$16,276,000	
Mechanical		$535,013,000
Steam Turbine Generator	$0	
Rotating Equipment	$26,969,000	
Condenser / Cooling Tower	$269,654,000	
Water Treatment and Tanks	$237,364,000	
Other Mechanical Equipment	$1,026,000	
Piping	$226,685,000	$226,685,000
Electrical and Instrumentation Controls		$157,578,000
Instrumentation	$4,640,000	
Electrical Equipment	$23,510,000	
Transmission Lines & Switch Yard	$48,833,000	
Electrical Bulks	$80,595,000	
Traffic and Logistics	$20,789,000	$20,789,000
TOTAL DIRECT COST		$3,366,138,000
Field Indirect Costs		$589,743,000
Field Services		$876,440,000
Home Office Services *		$55,362,000
TOTAL CONSTRUCTED COST		$4,887,683,000
Other Costs (Securities, Insurances, Warranties, Taxes and Permits)		$285,434,000
TOTAL COST		$5,173,117,000
Contingency is expected in range	15% to 25%	$911,206,000
TOTAL CONTRACTOR COST (Using Higher Contingency)		$6,084,323,000
Fee		$517,057,000
TOTAL CONTRACTOR PRICE		$6,601,380,000
Replacement Power Costs		$1,236,600,000
PG&E Provided Owner Costs :		
Project Oversight		$244,000,000
Security Oversight and Security Modifications		$35,000,000
Plant Shut Down and Start Up Costs		$100,000,000
Annual Increase in Station Operation and Maintenance Costs		$6,300,000
Simulator Update		$5,000,000
Cost of Capital		$1,440,000,000
TOTAL PROJECT COSTS		$9,668,280,000

	From		To
CONTRACTOR PRICE ACCURACY RANGE (- 20% TO + 30%)	$5,501,150,000	to	$8,581,794,000

Notes:

1). * Includes PG&E Provided Costs for NRC Review of Environmental Impact Statement

2). Project costs include $2.50 to $5.50 per craft hour for labor incentives to attract qualified workers

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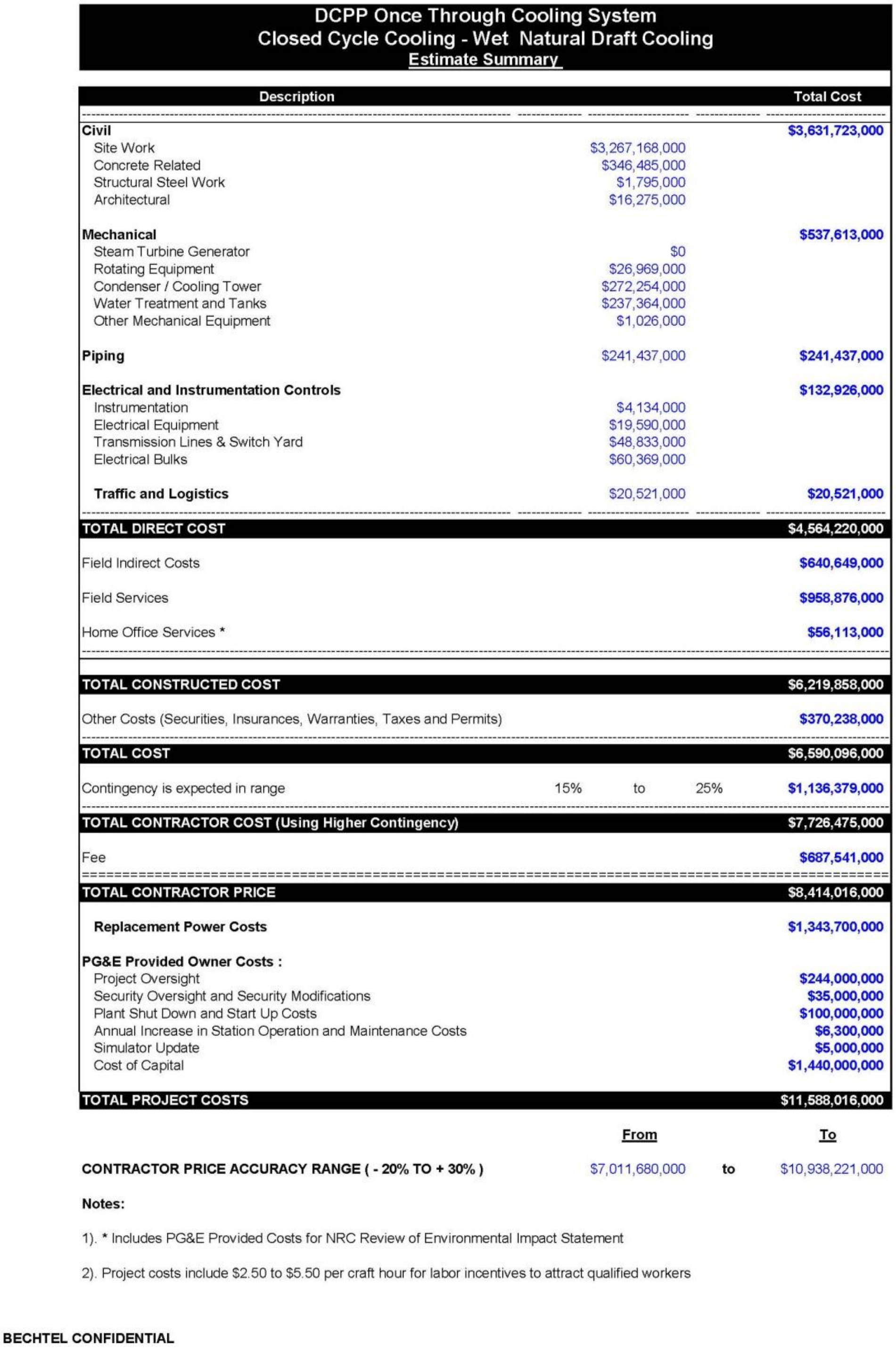
7.3.5 Estimate Summary for Wet Natural Draft Cooling

Wet natural draft cooling is summarized in the following table.



DCPP Once Through Cooling System
Closed Cycle Cooling - Wet Natural Draft Cooling
Estimate Summary

Description		Total Cost
Civil		$3,631,723,000
Site Work	$3,267,168,000	
Concrete Related	$346,485,000	
Structural Steel Work	$1,795,000	
Architectural	$16,275,000	
Mechanical		$537,613,000
Steam Turbine Generator	$0	
Rotating Equipment	$26,969,000	
Condenser / Cooling Tower	$272,254,000	
Water Treatment and Tanks	$237,364,000	
Other Mechanical Equipment	$1,026,000	
Piping	$241,437,000	$241,437,000
Electrical and Instrumentation Controls		$132,926,000
Instrumentation	$4,134,000	
Electrical Equipment	$19,590,000	
Transmission Lines & Switch Yard	$48,833,000	
Electrical Bulks	$60,369,000	
Traffic and Logistics	$20,521,000	$20,521,000
TOTAL DIRECT COST		$4,564,220,000
Field Indirect Costs		$640,649,000
Field Services		$958,876,000
Home Office Services *		$56,113,000
TOTAL CONSTRUCTED COST		$6,219,858,000
Other Costs (Securities, Insurances, Warranties, Taxes and Permits)		$370,238,000
TOTAL COST		$6,590,096,000
Contingency is expected in range	15% to 25%	$1,136,379,000
TOTAL CONTRACTOR COST (Using Higher Contingency)		$7,726,475,000
Fee		$687,541,000
TOTAL CONTRACTOR PRICE		$8,414,016,000
Replacement Power Costs		$1,343,700,000
PG&E Provided Owner Costs :		
Project Oversight		$244,000,000
Security Oversight and Security Modifications		$35,000,000
Plant Shut Down and Start Up Costs		$100,000,000
Annual Increase in Station Operation and Maintenance Costs		$6,300,000
Simulator Update		$5,000,000
Cost of Capital		$1,440,000,000
TOTAL PROJECT COSTS		$11,588,016,000

	From		To
CONTRACTOR PRICE ACCURACY RANGE (- 20% TO + 30%)	$7,011,680,000	to	$10,938,221,000

Notes:

1). * Includes PG&E Provided Costs for NRC Review of Environmental Impact Statement

2). Project costs include $2.50 to $5.50 per craft hour for labor incentives to attract qualified workers

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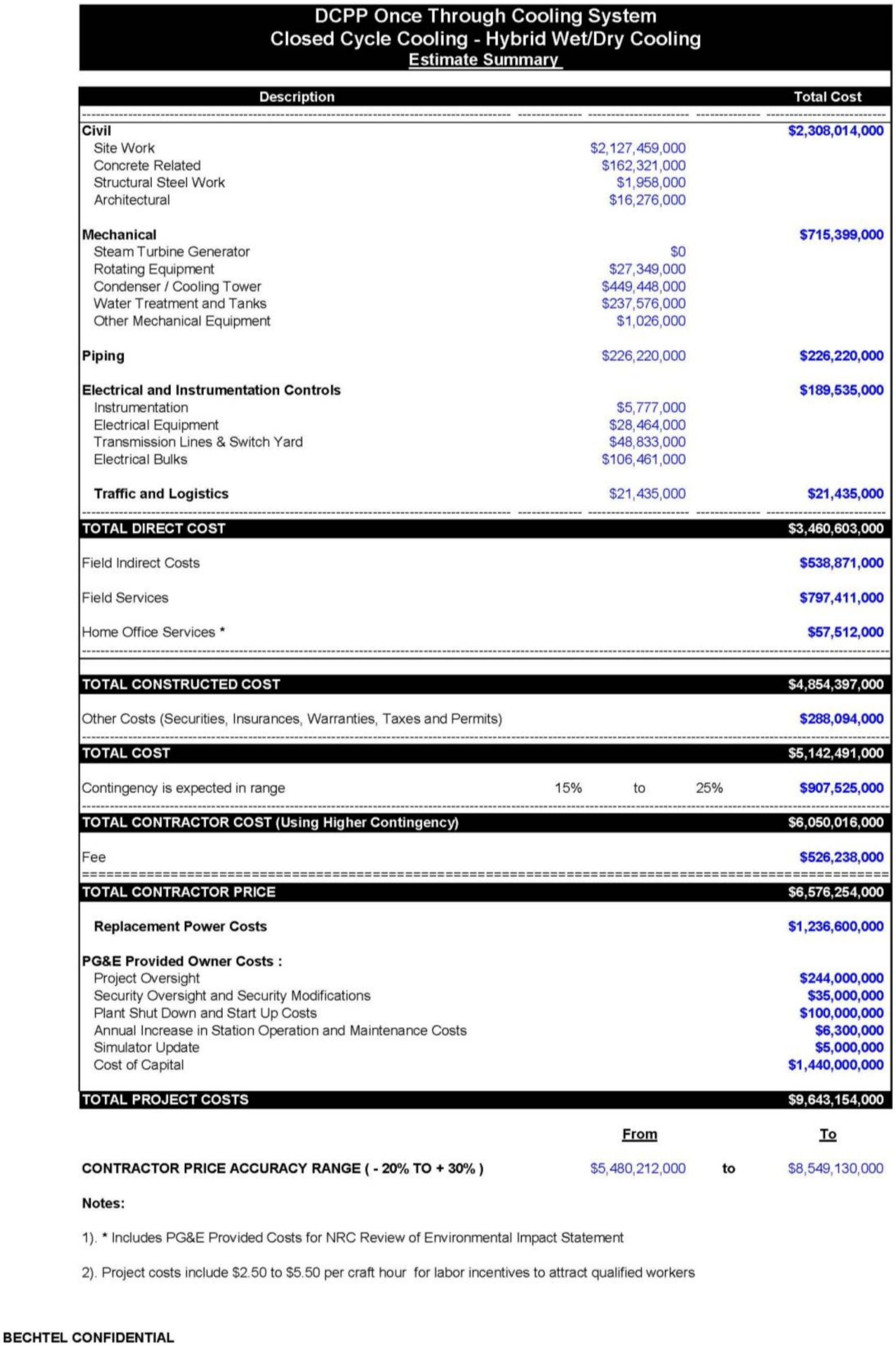
7.3.6 Estimate Summary for Hybrid Wet/Dry Cooling

Hybrid wet/dry cooling is summarized in the following table.



DCPP Once Through Cooling System
Closed Cycle Cooling - Hybrid Wet/Dry Cooling
Estimate Summary

Description				Total Cost
Civil				$2,308,014,000
Site Work		$2,127,459,000		
Concrete Related		$162,321,000		
Structural Steel Work		$1,958,000		
Architectural		$16,276,000		
Mechanical				$715,399,000
Steam Turbine Generator		$0		
Rotating Equipment		$27,349,000		
Condenser / Cooling Tower		$449,448,000		
Water Treatment and Tanks		$237,576,000		
Other Mechanical Equipment		$1,026,000		
Piping		$226,220,000		$226,220,000
Electrical and Instrumentation Controls				$189,535,000
Instrumentation		$5,777,000		
Electrical Equipment		$28,464,000		
Transmission Lines & Switch Yard		$48,833,000		
Electrical Bulks		$106,461,000		
Traffic and Logistics		$21,435,000		$21,435,000
TOTAL DIRECT COST				$3,460,603,000
Field Indirect Costs				$538,871,000
Field Services				$797,411,000
Home Office Services *				$57,512,000
TOTAL CONSTRUCTED COST				$4,854,397,000
Other Costs (Securities, Insurances, Warranties, Taxes and Permits)				$288,094,000
TOTAL COST				$5,142,491,000
Contingency is expected in range	15%	to	25%	$907,525,000
TOTAL CONTRACTOR COST (Using Higher Contingency)				$6,050,016,000
Fee				$526,238,000
TOTAL CONTRACTOR PRICE				$6,576,254,000
Replacement Power Costs				$1,236,600,000
PG&E Provided Owner Costs :				
Project Oversight				$244,000,000
Security Oversight and Security Modifications				$35,000,000
Plant Shut Down and Start Up Costs				$100,000,000
Annual Increase in Station Operation and Maintenance Costs				$6,300,000
Simulator Update				$5,000,000
Cost of Capital				$1,440,000,000
TOTAL PROJECT COSTS				$9,643,154,000
		From		**To**
CONTRACTOR PRICE ACCURACY RANGE (- 20% TO + 30%)		$5,480,212,000	**to**	$8,549,130,000

Notes:

1). * Includes PG&E Provided Costs for NRC Review of Environmental Impact Statement

2). Project costs include $2.50 to $5.50 per craft hour for labor incentives to attract qualified workers

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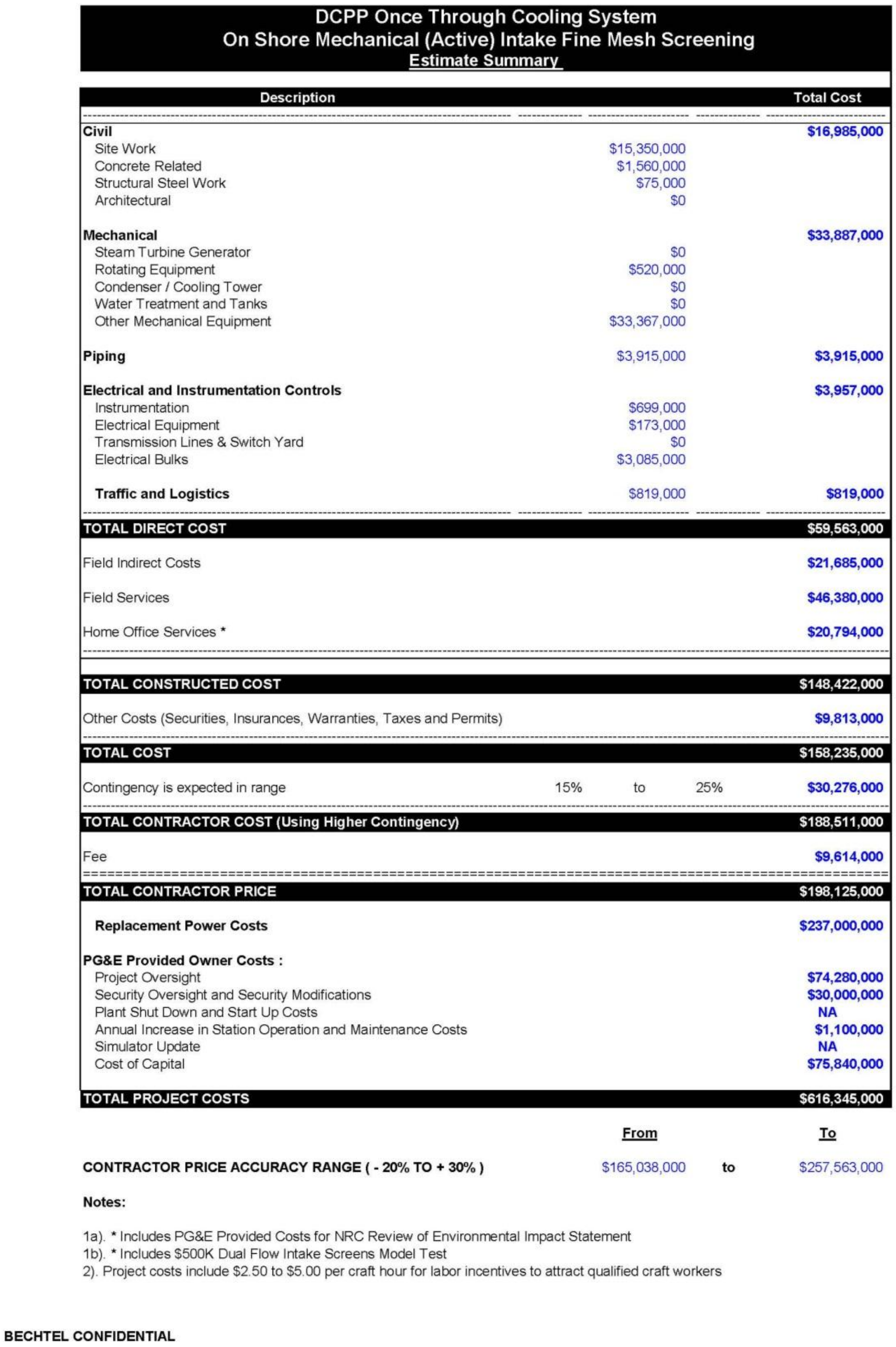
7.3.7 Estimate Summary for Onshore Mechanical (Active) Fine Mesh Screening

Onshore mechanical (active) fine mesh screening is summarized in the following table.



DCPP Once Through Cooling System
On Shore Mechanical (Active) Intake Fine Mesh Screening
Estimate Summary

Description				Total Cost
Civil				$16,985,000
Site Work			$15,350,000	
Concrete Related			$1,560,000	
Structural Steel Work			$75,000	
Architectural			$0	
Mechanical				$33,887,000
Steam Turbine Generator			$0	
Rotating Equipment			$520,000	
Condenser / Cooling Tower			$0	
Water Treatment and Tanks			$0	
Other Mechanical Equipment			$33,367,000	
Piping			$3,915,000	$3,915,000
Electrical and Instrumentation Controls				$3,957,000
Instrumentation			$699,000	
Electrical Equipment			$173,000	
Transmission Lines & Switch Yard			$0	
Electrical Bulks			$3,085,000	
Traffic and Logistics			$819,000	$819,000
TOTAL DIRECT COST				$59,563,000
Field Indirect Costs				$21,685,000
Field Services				$46,380,000
Home Office Services *				$20,794,000
TOTAL CONSTRUCTED COST				$148,422,000
Other Costs (Securities, Insurances, Warranties, Taxes and Permits)				$9,813,000
TOTAL COST				$158,235,000
Contingency is expected in range	15%	to	25%	$30,276,000
TOTAL CONTRACTOR COST (Using Higher Contingency)				$188,511,000
Fee				$9,614,000
TOTAL CONTRACTOR PRICE				$198,125,000
Replacement Power Costs				$237,000,000
PG&E Provided Owner Costs :				
Project Oversight				$74,280,000
Security Oversight and Security Modifications				$30,000,000
Plant Shut Down and Start Up Costs				NA
Annual Increase in Station Operation and Maintenance Costs				$1,100,000
Simulator Update				NA
Cost of Capital				$75,840,000
TOTAL PROJECT COSTS				$616,345,000
			From	To
CONTRACTOR PRICE ACCURACY RANGE (- 20% TO + 30%)			$165,038,000	to $257,563,000

Notes:

1a). * Includes PG&E Provided Costs for NRC Review of Environmental Impact Statement
1b). * Includes $500K Dual Flow Intake Screens Model Test
2). Project costs include $2.50 to $5.00 per craft hour for labor incentives to attract qualified craft workers

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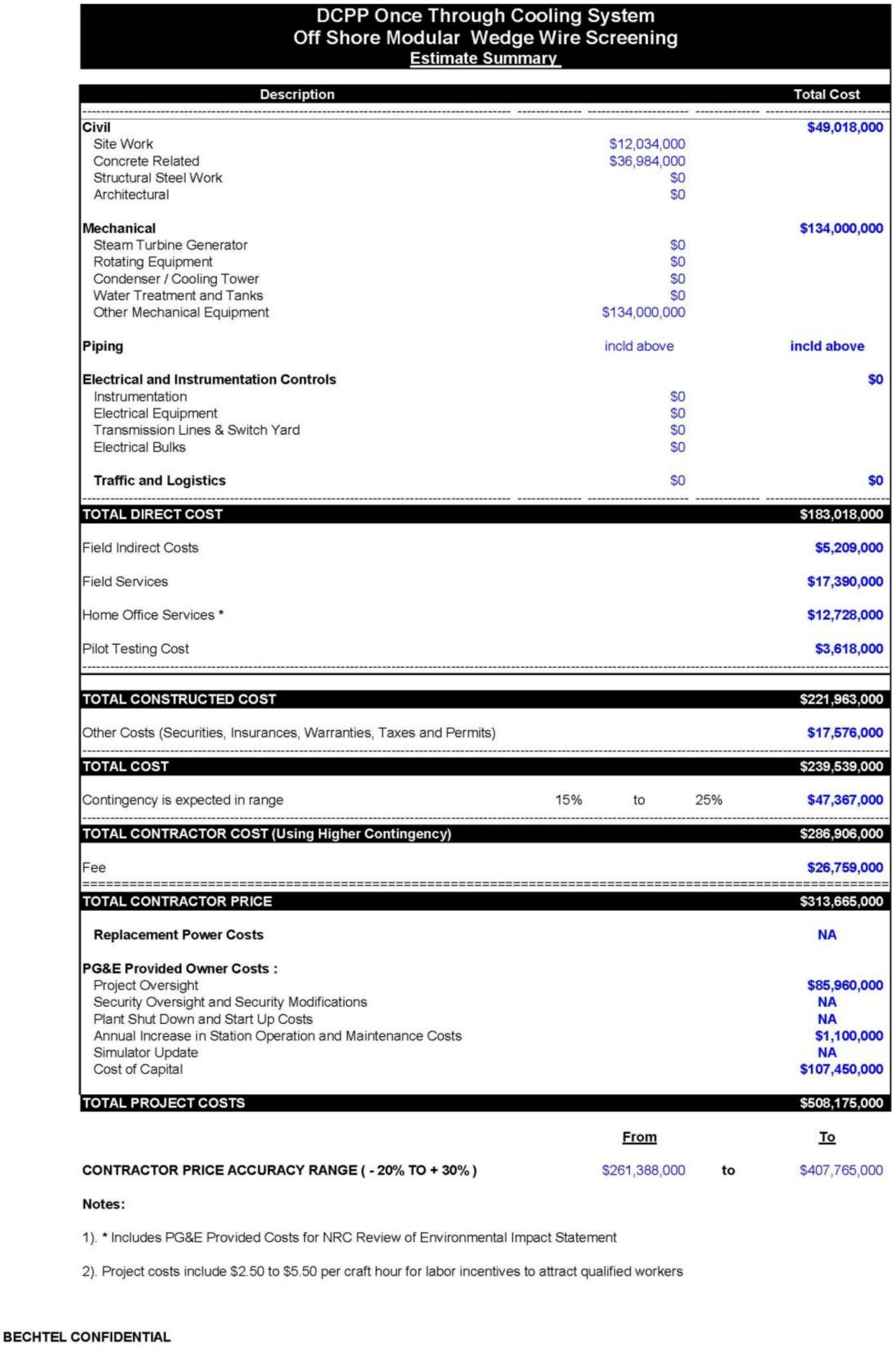
7.3.8 Estimate Summary for Offshore Modular Wedge Wire Screening

Offshore modular wedge wire screening is summarized in the following table.



DCPP Once Through Cooling System
Off Shore Modular Wedge Wire Screening
Estimate Summary

Description		Total Cost
Civil		**$49,018,000**
Site Work	$12,034,000	
Concrete Related	$36,984,000	
Structural Steel Work	$0	
Architectural	$0	
Mechanical		**$134,000,000**
Steam Turbine Generator	$0	
Rotating Equipment	$0	
Condenser / Cooling Tower	$0	
Water Treatment and Tanks	$0	
Other Mechanical Equipment	$134,000,000	
Piping	incld above	**incld above**
Electrical and Instrumentation Controls		**$0**
Instrumentation	$0	
Electrical Equipment	$0	
Transmission Lines & Switch Yard	$0	
Electrical Bulks	$0	
Traffic and Logistics	$0	**$0**
TOTAL DIRECT COST		**$183,018,000**
Field Indirect Costs		**$5,209,000**
Field Services		**$17,390,000**
Home Office Services *		**$12,728,000**
Pilot Testing Cost		**$3,618,000**
TOTAL CONSTRUCTED COST		**$221,963,000**
Other Costs (Securities, Insurances, Warranties, Taxes and Permits)		**$17,576,000**
TOTAL COST		**$239,539,000**
Contingency is expected in range	15% to 25%	**$47,367,000**
TOTAL CONTRACTOR COST (Using Higher Contingency)		**$286,906,000**
Fee		**$26,759,000**
TOTAL CONTRACTOR PRICE		**$313,665,000**
Replacement Power Costs		**NA**
PG&E Provided Owner Costs :		
Project Oversight		**$85,960,000**
Security Oversight and Security Modifications		**NA**
Plant Shut Down and Start Up Costs		**NA**
Annual Increase in Station Operation and Maintenance Costs		**$1,100,000**
Simulator Update		**NA**
Cost of Capital		**$107,450,000**
TOTAL PROJECT COSTS		**$508,175,000**

	From		To
CONTRACTOR PRICE ACCURACY RANGE (- 20% TO + 30%)	$261,388,000	**to**	$407,765,000

Notes:

1). * Includes PG&E Provided Costs for NRC Review of Environmental Impact Statement

2). Project costs include $2.50 to $5.50 per craft hour for labor incentives to attract qualified workers

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The details used to develop estimates above are explained in the following sections.

7.4 Quantity Development

Engineering prepared the scope of work documents and quantity takeoffs in support of a Class 3 estimate and provided those documents to the Estimating department for each closed-cycle cooling technology and the onshore mechanical fine mesh screening technology separately. Estimating prepared an estimate for the technologies based on the following:

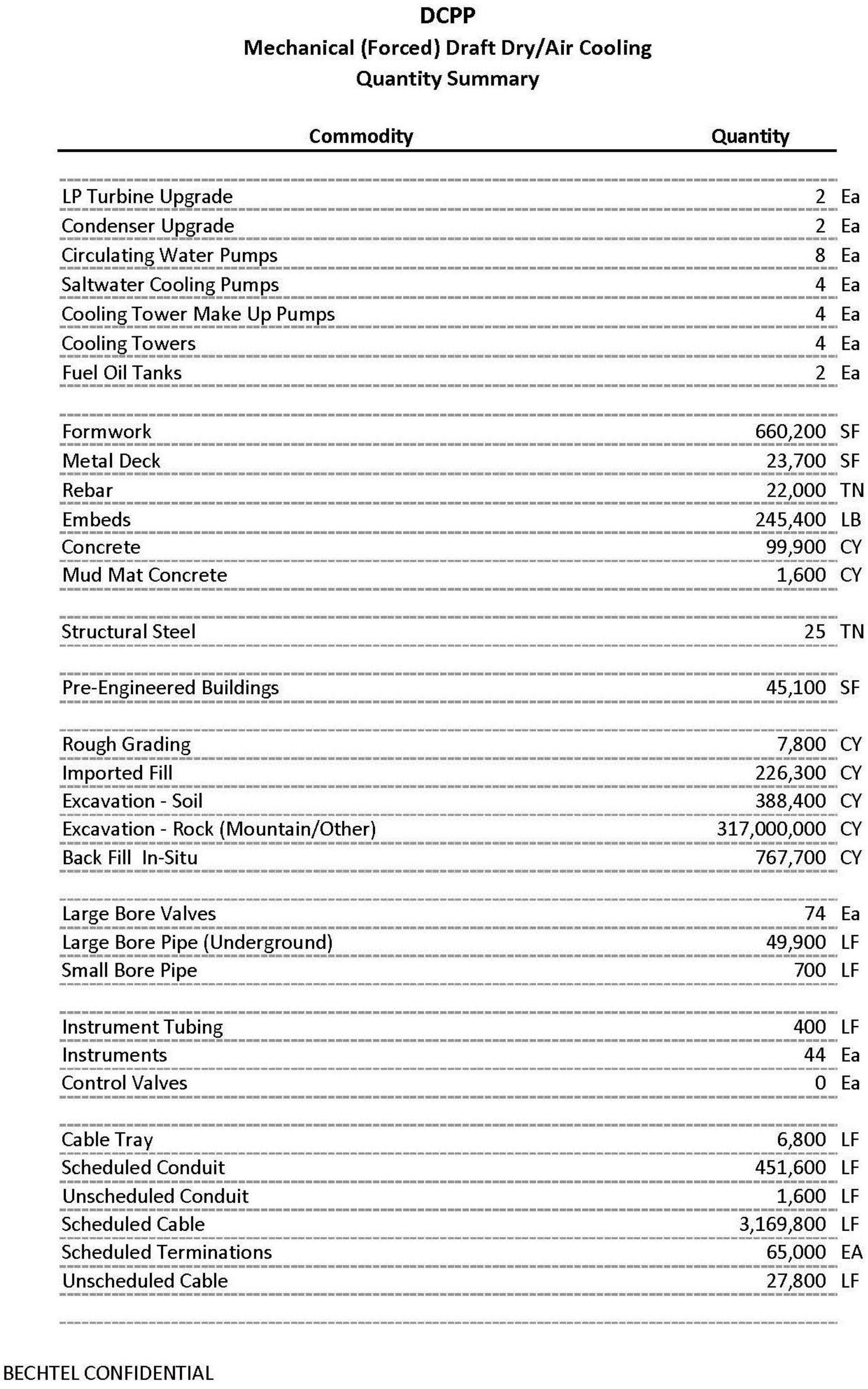
Item	Comments
Plant Layout/General Arrangement	Preliminary plot plans based on equipment layouts from vendors
Site Work	Preliminary based on volume of mountain excavation, CW duct excavation, underground pipeline excavations, and foundation excavations
Concrete	Preliminary foundation designs
Steel	Preliminary steel designs
Mechanical Equipment	Equipment lists
Concrete CW Ducts	Preliminary layout drawings
Piping	Based on preliminary piping and instrumentation diagrams (P&IDs) and layout drawings
Electrical Equipment	Preliminary single-line diagrams
Electrical Bulks	Based on preliminary layout and equipment location
Instruments and Controls	Based on Preliminary P&I Schematics

For the offshore modular wedge wire screening option, Engineering prepared a performance specification with all the necessary drawings and documents to solicit budgetary quotes for a complete marine works package. Estimating validated the quotes received for the marine works package based on clarification meeting with the selected vendor and in house data. Estimating prepared quantity takeoffs from drawings in the performance specification and estimated costs for extending and sealing the existing breakwater on a direct-hire union construction basis. The selected vendor quote and estimate for extending and sealing the existing breakwater form the basis of the offshore modular wedge wire screening estimate.

The following sections provide quantity summaries for each technology.

7.4.1 Mechanical (Forced) Dry/Air Cooling

Mechanical (forced) dry/air cooling quantities are summarized in the following table.



DCPP
Mechanical (Forced) Draft Dry/Air Cooling
Quantity Summary

Commodity	Quantity	
LP Turbine Upgrade	2	Ea
Condenser Upgrade	2	Ea
Circulating Water Pumps	8	Ea
Saltwater Cooling Pumps	4	Ea
Cooling Tower Make Up Pumps	4	Ea
Cooling Towers	4	Ea
Fuel Oil Tanks	2	Ea
Formwork	660,200	SF
Metal Deck	23,700	SF
Rebar	22,000	TN
Embeds	245,400	LB
Concrete	99,900	CY
Mud Mat Concrete	1,600	CY
Structural Steel	25	TN
Pre-Engineered Buildings	45,100	SF
Rough Grading	7,800	CY
Imported Fill	226,300	CY
Excavation - Soil	388,400	CY
Excavation - Rock (Mountain/Other)	317,000,000	CY
Back Fill In-Situ	767,700	CY
Large Bore Valves	74	Ea
Large Bore Pipe (Underground)	49,900	LF
Small Bore Pipe	700	LF
Instrument Tubing	400	LF
Instruments	44	Ea
Control Valves	0	Ea
Cable Tray	6,800	LF
Scheduled Conduit	451,600	LF
Unscheduled Conduit	1,600	LF
Scheduled Cable	3,169,800	LF
Scheduled Terminations	65,000	EA
Unscheduled Cable	27,800	LF

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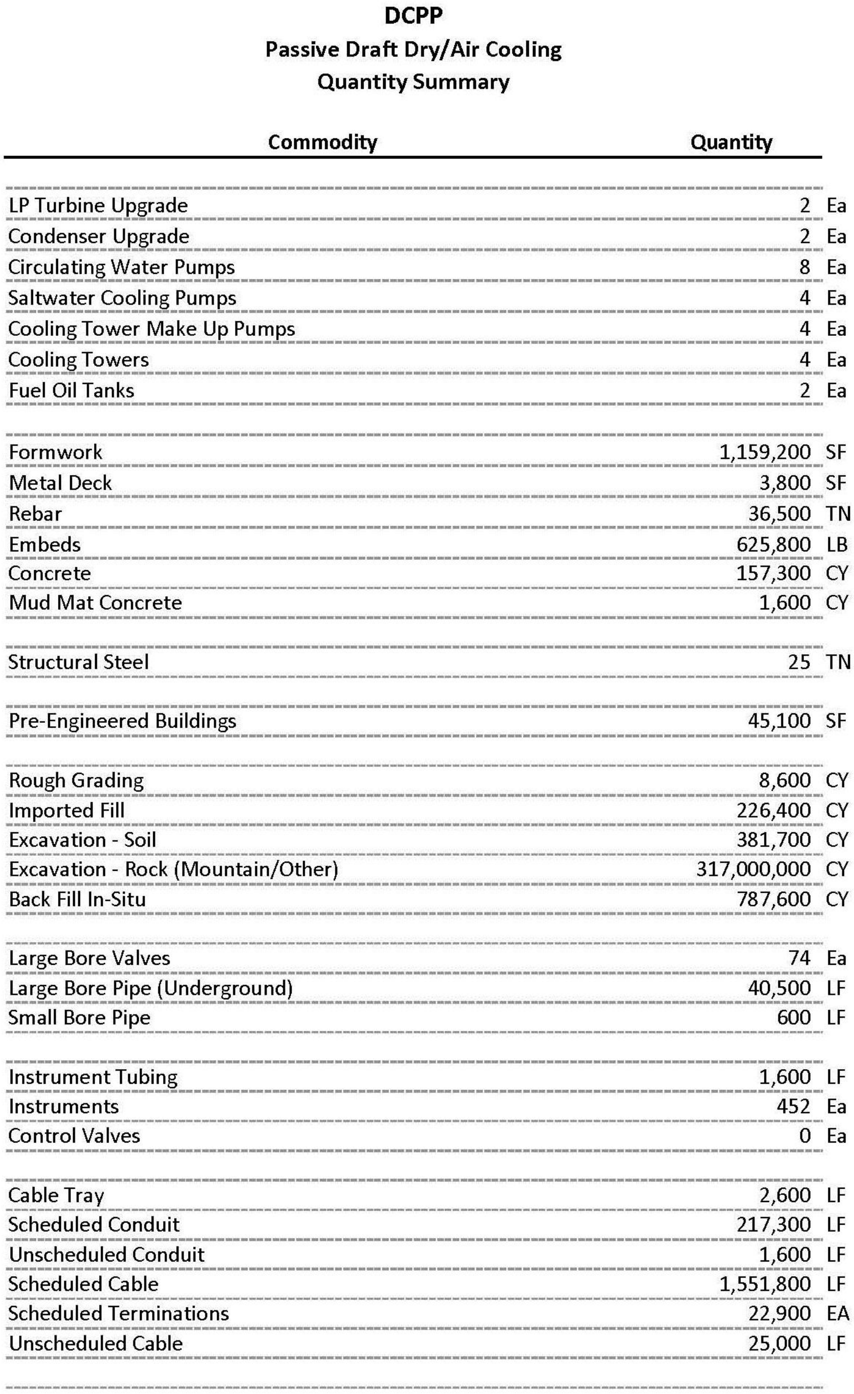
7.4.2 Passive Draft Dry/Air Cooling

Passive draft dry/air cooling quantities are summarized in the following table.

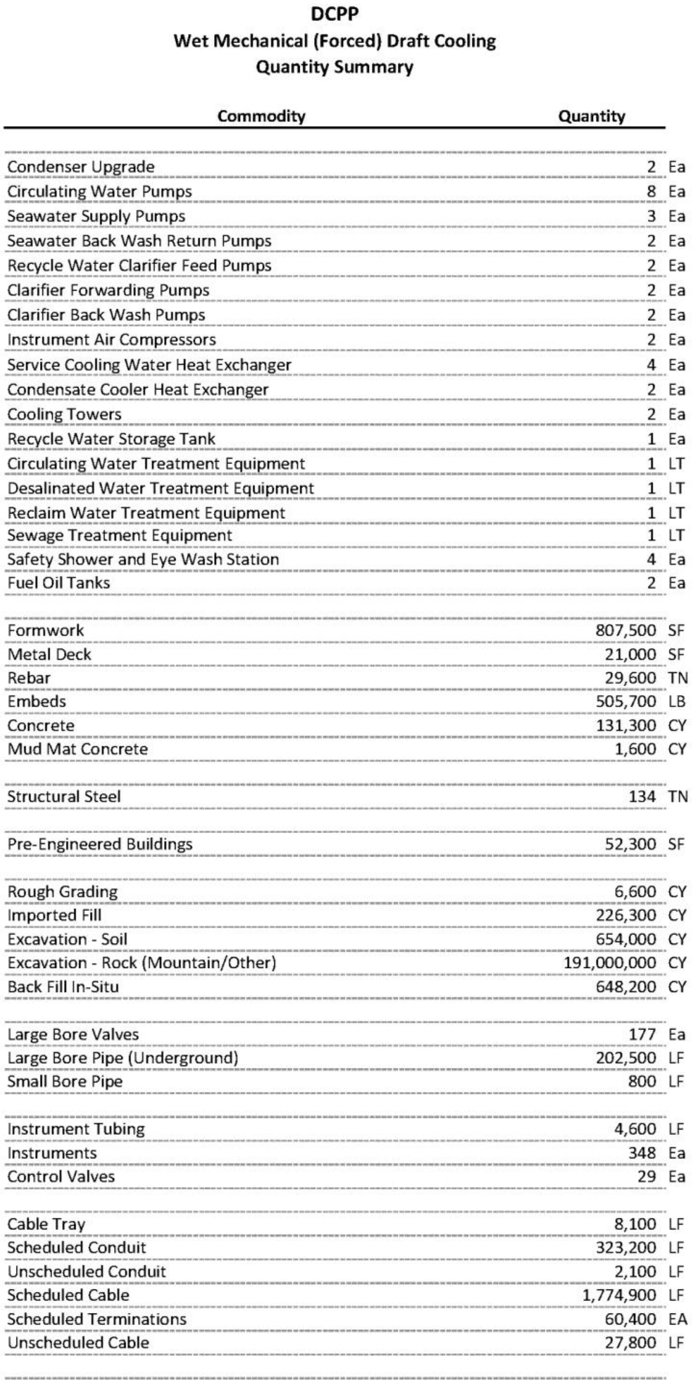


DCPP
Passive Draft Dry/Air Cooling
Quantity Summary

Commodity	Quantity	
LP Turbine Upgrade	2	Ea
Condenser Upgrade	2	Ea
Circulating Water Pumps	8	Ea
Saltwater Cooling Pumps	4	Ea
Cooling Tower Make Up Pumps	4	Ea
Cooling Towers	4	Ea
Fuel Oil Tanks	2	Ea
Formwork	1,159,200	SF
Metal Deck	3,800	SF
Rebar	36,500	TN
Embeds	625,800	LB
Concrete	157,300	CY
Mud Mat Concrete	1,600	CY
Structural Steel	25	TN
Pre-Engineered Buildings	45,100	SF
Rough Grading	8,600	CY
Imported Fill	226,400	CY
Excavation - Soil	381,700	CY
Excavation - Rock (Mountain/Other)	317,000,000	CY
Back Fill In-Situ	787,600	CY
Large Bore Valves	74	Ea
Large Bore Pipe (Underground)	40,500	LF
Small Bore Pipe	600	LF
Instrument Tubing	1,600	LF
Instruments	452	Ea
Control Valves	0	Ea
Cable Tray	2,600	LF
Scheduled Conduit	217,300	LF
Unscheduled Conduit	1,600	LF
Scheduled Cable	1,551,800	LF
Scheduled Terminations	22,900	EA
Unscheduled Cable	25,000	LF

7.4.3 Wet Mechanical (Forced) Draft Cooling

Wet mechanical (forced) draft cooling quantities are summarized in the following table.



DCPP
Wet Mechanical (Forced) Draft Cooling
Quantity Summary

Commodity	Quantity	
Condenser Upgrade	2	Ea
Circulating Water Pumps	8	Ea
Seawater Supply Pumps	3	Ea
Seawater Back Wash Return Pumps	2	Ea
Recycle Water Clarifier Feed Pumps	2	Ea
Clarifier Forwarding Pumps	2	Ea
Clarifier Back Wash Pumps	2	Ea
Instrument Air Compressors	2	Ea
Service Cooling Water Heat Exchanger	4	Ea
Condensate Cooler Heat Exchanger	2	Ea
Cooling Towers	2	Ea
Recycle Water Storage Tank	1	Ea
Circulating Water Treatment Equipment	1	LT
Desalinated Water Treatment Equipment	1	LT
Reclaim Water Treatment Equipment	1	LT
Sewage Treatment Equipment	1	LT
Safety Shower and Eye Wash Station	4	Ea
Fuel Oil Tanks	2	Ea
Formwork	807,500	SF
Metal Deck	21,000	SF
Rebar	29,600	TN
Embeds	505,700	LB
Concrete	131,300	CY
Mud Mat Concrete	1,600	CY
Structural Steel	134	TN
Pre-Engineered Buildings	52,300	SF
Rough Grading	6,600	CY
Imported Fill	226,300	CY
Excavation - Soil	654,000	CY
Excavation - Rock (Mountain/Other)	191,000,000	CY
Back Fill In-Situ	648,200	CY
Large Bore Valves	177	Ea
Large Bore Pipe (Underground)	202,500	LF
Small Bore Pipe	800	LF
Instrument Tubing	4,600	LF
Instruments	348	Ea
Control Valves	29	Ea
Cable Tray	8,100	LF
Scheduled Conduit	323,200	LF
Unscheduled Conduit	2,100	LF
Scheduled Cable	1,774,900	LF
Scheduled Terminations	60,400	EA
Unscheduled Cable	27,800	LF

7.4.4 Wet Natural Draft Cooling

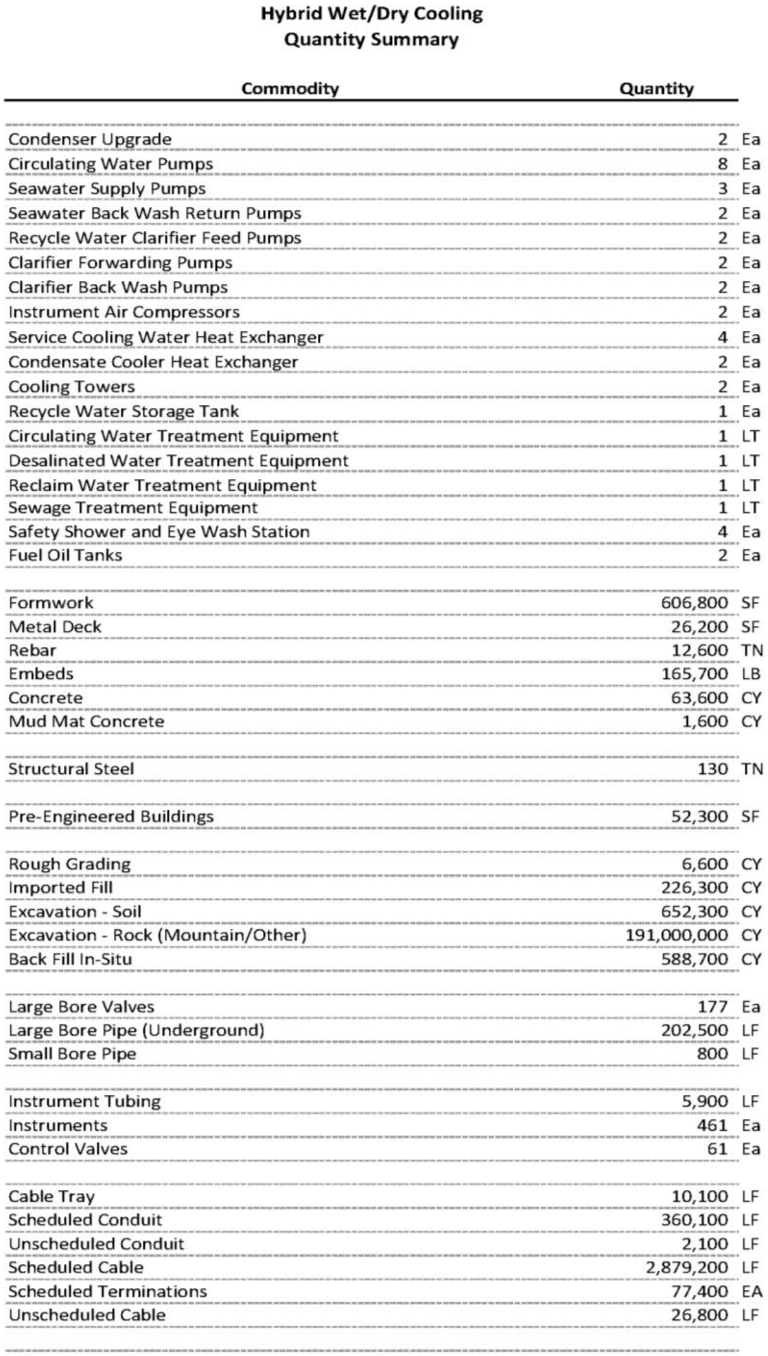
Wet natural draft cooling quantities are summarized in the following table.

DCPP
Wet Natural Draft Cooling
Quantity Summary

Commodity	Quantity	
Condenser Upgrade	2	Ea
Circulating Water Pumps	8	Ea
Seawater Supply Pumps	3	Ea
Seawater Back Wash Return Pumps	2	Ea
Recycle Water Clarifier Feed Pumps	2	Ea
Clarifier Forwarding Pumps	2	Ea
Clarifier Back Wash Pumps	2	Ea
Instrument Air Compressors	2	Ea
Service Cooling Water Heat Exchanger	4	Ea
Condensate Cooler Heat Exchanger	2	Ea
Cooling Towers	4	Ea
Recycle Water Storage Tank	1	Ea
Circulating Water Treatment Equipment	1	LT
Desalinated Water Treatment Equipment	1	LT
Reclaim Water Treatment Equipment	1	LT
Sewage Treatment Equipment	1	LT
Safety Shower and Eye Wash Station	4	Ea
Fuel Oil Tanks	2	Ea
Formwork	952,000	SF
Metal Deck	14,300	SF
Rebar	40,100	TN
Embeds	718,300	LB
Concrete	173,800	CY
Mud Mat Concrete	1,600	CY
Structural Steel	130	TN
Pre-Engineered Buildings	52,300	SF
Rough Grading	10,100	CY
Imported Fill	226,300	CY
Excavation - Soil	643,900	CY
Excavation - Rock (Mountain/Other)	317,000,000	CY
Back Fill In-Situ	829,200	CY
Large Bore Valves	177	Ea
Large Bore Pipe (Underground)	205,900	LF
Small Bore Pipe	900	LF
Instrument Tubing	4,100	LF
Instruments	271	Ea
Control Valves	29	Ea
Cable Tray	6,300	LF
Scheduled Conduit	249,200	LF
Unscheduled Conduit	2,300	LF
Scheduled Cable	1,278,500	LF
Scheduled Terminations	48,900	EA
Unscheduled Cable	34,800	LF

7.4.5 Hybrid Wet/Dry Cooling

Hybrid wet/dry cooling quantities are summarized in the following table.



Hybrid Wet/Dry Cooling
Quantity Summary

Commodity	Quantity	
Condenser Upgrade	2	Ea
Circulating Water Pumps	8	Ea
Seawater Supply Pumps	3	Ea
Seawater Back Wash Return Pumps	2	Ea
Recycle Water Clarifier Feed Pumps	2	Ea
Clarifier Forwarding Pumps	2	Ea
Clarifier Back Wash Pumps	2	Ea
Instrument Air Compressors	2	Ea
Service Cooling Water Heat Exchanger	4	Ea
Condensate Cooler Heat Exchanger	2	Ea
Cooling Towers	2	Ea
Recycle Water Storage Tank	1	Ea
Circulating Water Treatment Equipment	1	LT
Desalinated Water Treatment Equipment	1	LT
Reclaim Water Treatment Equipment	1	LT
Sewage Treatment Equipment	1	LT
Safety Shower and Eye Wash Station	4	Ea
Fuel Oil Tanks	2	Ea
Formwork	606,800	SF
Metal Deck	26,200	SF
Rebar	12,600	TN
Embeds	165,700	LB
Concrete	63,600	CY
Mud Mat Concrete	1,600	CY
Structural Steel	130	TN
Pre-Engineered Buildings	52,300	SF
Rough Grading	6,600	CY
Imported Fill	226,300	CY
Excavation - Soil	652,300	CY
Excavation - Rock (Mountain/Other)	191,000,000	CY
Back Fill In-Situ	588,700	CY
Large Bore Valves	177	Ea
Large Bore Pipe (Underground)	202,500	LF
Small Bore Pipe	800	LF
Instrument Tubing	5,900	LF
Instruments	461	Ea
Control Valves	61	Ea
Cable Tray	10,100	LF
Scheduled Conduit	360,100	LF
Unscheduled Conduit	2,100	LF
Scheduled Cable	2,879,200	LF
Scheduled Terminations	77,400	EA
Unscheduled Cable	26,800	LF

7.4.6 Onshore Mechanical Fine Mesh Screening

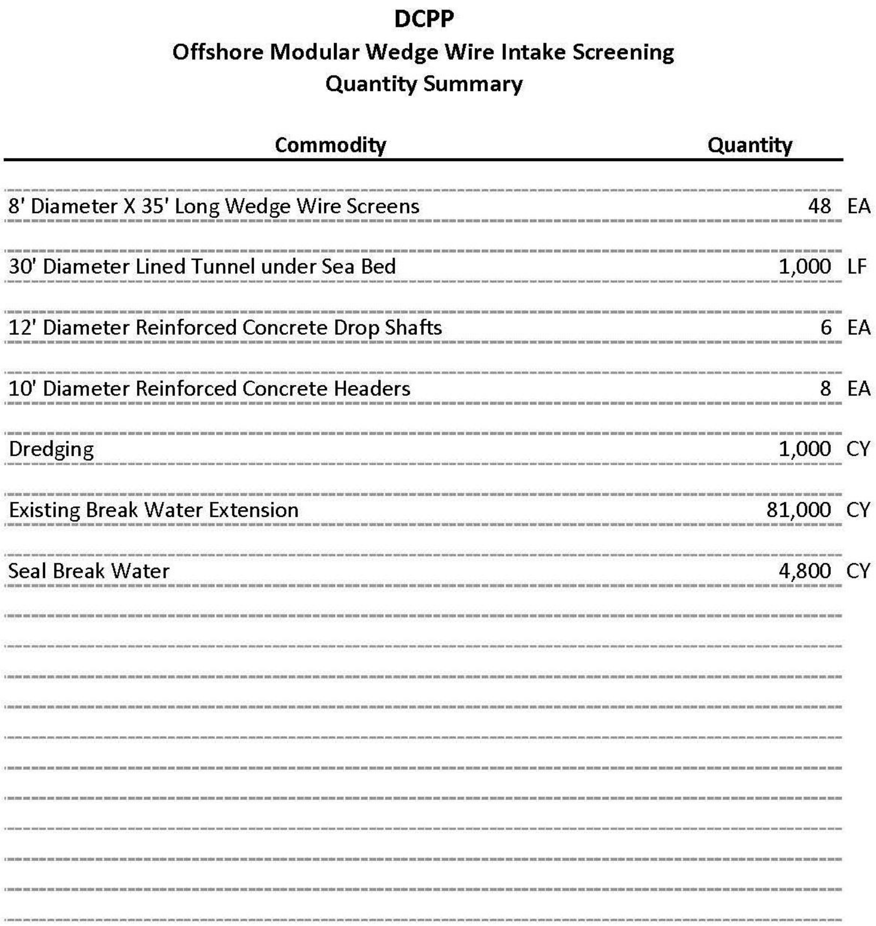
Onshore mechanical fine mesh screening quantities are summarized in the following table.

DCPP
Onshore Mechanical (Active) Intake Fine Mesh Screening
Quantity Summary

Commodity	Quantity	
Screen Wash Pumps	2	Ea
Dual Flow Travelling Screens with Fish Catcher	12	Ea
Excavated Soil	300	CY
Soil Backfill	200	CY
Structural Steel	4	TN
Concrete	50	CY
Formwork	5,400	SF
Embeds	1,300	LB
Rebar	17	TN
Piling & Caissons	20	LF
Large Bore Valves	36	Ea
Large Bore Hangers	60	Ea
Fiberglass Pipe (large bore)	1,100	LF
Small Bore Pipe	200	LF
Instruments	20	Ea
Control Valves	24	Ea
Instrument Tubing	500	LF
A/G Conduit	2,600	LF
Low Voltage Cable	32,600	LF

7.4.7 Offshore Modular Wedge Wire Screening System

Offshore modular wedge wire screening system quantities are summarized in the following table.



DCPP
Offshore Modular Wedge Wire Intake Screening
Quantity Summary

Commodity	Quantity	
8' Diameter X 35' Long Wedge Wire Screens	48	EA
30' Diameter Lined Tunnel under Sea Bed	1,000	LF
12' Diameter Reinforced Concrete Drop Shafts	6	EA
10' Diameter Reinforced Concrete Headers	8	EA
Dredging	1,000	CY
Existing Break Water Extension	81,000	CY
Seal Break Water	4,800	CY

7.5 Direct Material and Subcontract Pricing

7.5.1 Closed-cycle Cooling Technology Supply Bids

Closed-cycle cooling technology equipment supply bids are highlighted below:

- FRP
- Cooling towers (passive draft dry/air and mechanical [forced] draft dry/air)
- Electrical transformers
- Heat exchangers
- Condenser upgrades
- Water treatment plant
- Desalination plant
- Vertical pumps
- Butterfly valves

7.5.2 Onshore Mechanical Fine Mesh Screening Technology Supply Bids

Onshore mechanical fine mesh screening technology supply bids are highlighted below:

- Onshore mechanical fine mesh screens

7.5.3 Closed-Cycle Cooling Technolgy Supply and Install Bids

Closed-cycle cooling technology supply and install bids are highlighted below:

- Cooling towers (hybrid, wet mechanical and wet natural)

7.5.4 Offshore Modular Wedge Wire Screening System Technology Supply and Install Bids

Offshore modular wedge wire screening system technology supply and install bids are highlighted below:

- Marine works

The pricing for the balance of equipment and bulk materials were based on actual pricing from current projects.

Mountain excavation and disposal costs for all closed-cycle cooling options were developed as subcontracted costs on a dollar per cubic yard of excavated rock basis based on equipment schedules for the work involved and number of Teamsters, equipment operators, and other craft labor required to perform the work. The rock blasting portion of the costs are based on a vendor quotation. The haul distance and disposal site included in the estimate is within 5 miles of the plant site (Reference Table 4.3-5, Mountain Excavation Quantities).

Steam turbine rotor replacement costs for the passive draft dry/air cooling and mechanical (forced) draft dry/air cooling options were provided by the Owner in 2005 dollars and escalated to 2013 dollars.

Freight costs are included at 6% of applicable equipment and bulk material costs for all options based on historical experience.

7.6 Construction

7.6.1 Direct Craft Labor Hours

Direct craft hours for each option were estimated based on standard labor installation rates appropriate for the work involved plus adjustments for the following:

- Work in an operating nuclear facility
- Work within protected areas
- Congestion and interferences
- Design complexities
- Time needed to transport labor on buses to and from the plant
- Labor efficiencies due to work schedules
- Outage work efficiencies
- Safety-related training classes

7.6.2 Craft Labor Wages

Craft wages were estimated based on a May 2013 wage survey of the prevailing union local agreements in the southern California area. Labor costs were developed based on an anticipated work schedule to minimize schedule duration. It is assumed that labor fatigue rules do not apply for this scope. For scheduled non-outage-related work, craft wages are based on two shifts working 10-hour days 5 days per week. For scheduled outage-related work, craft wages are based on two shifts working 12-hour days 7 days per week. Closed-cycle cooling technologies were priced as a combination of non-outage and outage work based on schedule requirements. The onshore mechanical fine mesh screening and offshore modular wedge wire screening system technologies were priced as non-outage work. Travel incentives were included in the estimate to attract and retain qualified craftworkers.

7.6.3 Field Indirect Costs

Construction field indirect material costs, e.g., construction equipment, small tools, purchased utilities required during the construction period, office trailers, temporary buildings, craft labor change facilities, and craft busing costs, are based on ratios of indirect materials to direct labor hours from current and historical projects worked in existing nuclear facilities.

Field indirect labor hours were estimated as a percentage of direct craft labor hours for each option, based on review of ratios from current and historical projects worked in existing nuclear facilities.

Startup field indirect material costs, e.g., vendor testing services, flushes, testing equipment, tools, vehicles, and other consumable supplies were developed based on scope of work documents and engineered quantities for each technology.

Startup craft labor hours were estimated based on specific requirements for each technology.

7.7 Home Office Services

Engineering developed service hours by discipline to provide a complete design for each technology and based on anticipated engineering deliverables,

Other home office services hours, e.g., Project Management, Project Controls, Procurement, Administrative Services, Accounting, Information Systems, Quality Management, Construction department functional support, Startup department functional support and Contracts Management department functional support were estimated for each option based on current and historical projects worked in existing nuclear plants.

7.8 Engineering Services Subcontracts

7.8.1 Closed-Cycle Cooling Technologies

Geotechnical subsurface and topographical studies, National Fire Protection Association inspection services, seismic analysis services, traffic consultant services, and archeological consultant services were assumed to be required and priced based on historical costs for similar services. Costs for USNRC review of the environmental impact statement were provided by PG&E.

7.8.2 Onshore Mechanical Fine Mesh Screening Technology

Costs for traffic consultant services were assumed to be required and priced based on historical costs for similar services .Costs for USNRC review of the environmental impact statement were provided by PG&E.

7.8.3 Offshore Modular Wedge Wire Screening System Technology

Traffic consultant services, seismic analysis services, the hydrographic survey, the bathymetric survey, and the offshore geotechnical subsurface study were assumed to be required and priced based on historical costs for similar services. Costs for USNRC review of the environmental impact statement were provided by PG&E. Wedge wire screen in-situ pilot testing was based on a budgetary quotation.

7.9 Procurement Services Subcontracts

For each technology, Bechtel supplier quality inspection services were priced based on historical data.

7.9.1 Field Non-manual

Based on professional skill sets required for work in a nuclear plant, for each technology field non-manual hours for field administration and direct supervision of the work involved for each option were estimated as percentage of craft hours based on current and historical projects.

Field staff relocation costs were estimated based on actual domestic employment conditions from similar historical projects in the same geographical area.

7.9.2 Startup

Based on the work involved and professional skill sets required for each technology, Startup developed non-manual staffing plans for field administration and direct startup supervision of startup of all equipment and systems.

Relocation costs for the field startup staff were estimated based on the actual domestic employment conditions from similar historical projects in the same geographical area.

7.10 Other Costs

7.10.1 Insurances

Umbrella coverage is assumed to be included as part of workmen’s compensation insurance built into craft labor costing rates.

Builder’s risk is based on typical rates for work in nuclear plants.

Marine transit coverage is based on typical industry rates.

7.10.2 Securities

A letter of credit for 120 months valued at 10% of project price is included for all options and is priced at 125 bps per annum.

A warranty letter of credit for 1 year valued at 5% of price is included for all options and is priced at 150 bps per annum.

7.10.3 Warranty

Costs have been included at 0.50% of total constructed cost.

7.10.4 Taxes

Costs have been included at 7.5% of all field direct and field indirect materials.

7.10.5 Escalation

Costs have been excluded from the estimate, which is in 2013 dollars.

7.10.6 Contingency

A contingency evaluation was performed by the project team that considered, among other things, the scope of work definition, completeness of the engineering design, knowledge of the pricing basis used for the estimates, and craft labor hours. The results of the evaluation fell within the band of 15% to 25%, the typical contingency level for a Class 3 estimate.

7.10.7 Permits

Costs included in the estimates are from the following tables:

- IFMS-1, DCPP Environmental Permit/Approval Cost Assessment Onshore Mechanical (Active) Intake Fine Mesh Screening System
- WW-1, DCPP Environmental Permit/Approval Cost Assessment Offshore Modular Wedge Wire Screening System
- CC-1, DCPP Environmental Permit/Approval Cost Assessment Dry/Air Cooling Technologies – Passive Draft and Mechanical (Forced) Draft
- CC-2, DCPP Environmental Permit/Approval Cost Assessment Wet Cooling Technologies – Natural Draft, Mechanical (Forced) Draft and Hybrid Wet/Dry (Fresh and Reclaimed Water)

7.10.8 Replacement Power Costs

Replacement power costs were provided by the Nuclear Review Committee and were developed using the California average market price based on forwards ($/MWh) of $46.76 per MWh per E3's 2013 forecast average energy price estimate (http://www.ethree.com). The cost calculation is based on 1,155 MW x 24 hours x 2 units x 0.9 capacity factor (CF) as follows:

- Mechanical (Forced) Draft Dry/Air Cooling – 576 days
- Passive Draft Dry/Air Cooling – 530 days
- Hybrid Wet/Dry Cooling – 530 days
- Wet Mechanical (Forced) Draft Cooling – 530 days
- Wet Natural Draft Cooling – 576 days
- Onshore Mechanical Fine Mesh Screening – 183 days at 50% capacity
- Offshore Modular Wedge Wire Screening – 0 days

7.11 Qualifications and Assumptions

The following are qualifications and assumptions:

1. The existing fire water system has adequate pressure and flow.
2. No load increase is expected on the turbine building floor due to condenser and steam turbine upgrades.
3. Unaffected mechanical, piping, electrical, and instrumentation systems will not be affected by modifications.
4. Existing intake structure civil, mechanical, and electrical features will accommodate modifications with no major modifications.
5. Existing equipment in the intake structure will be left in place except as noted.
6. The haul route and disposal site for mountain excavation is within 5 miles of site.
7. Field non-manual staff turnover for long durations has not been considered.
8. Replacement power costs are included with PG&E costs.
9. Mitigation costs that were clearly defined in the permit process are included as part of permitting related costs.

10. Brine return dilution piping system is required for closed cooling technologies with desalination plants.
11. Steam turbine upgrades are not required for the wet technology options.
12. Cooling tower makeup is by gravity flow from water holding pond for the wet technology options. Pumps are not required.
13. Underground utilities relocations have not been considered for the new fish recovery tunnel included in the offshore modular wedge wire screening system technology.
14. Emergency stop logs for the offshore modular wedge wire screening system technology will be removed using an existing mobile maintenance crane.
15. HVAC for all new buildings was accounted for in the estimated cost per square foot.
16. Potable water for the desalination plant is available from the existing potable water system.
17. Existing plant sanitary system can accept sanitary waste from new facilities and buildings.
18. Existing plant potable water system has adequate pressure to accommodate additional facilities and buildings.
19. Electrical equipment for the onshore mechanical fine mesh screens technology will be located in the existing pumphouse.
20. No new duct bank or cable tray is required for the onshore mechanical fine mesh technology traveling screens. Electrical raceway for existing traveling screens will be reused or extended for new onshore mechanical fine mesh technology replacement screens.
21. Mechanical designs for the new onshore mechanical (active) intake fine mesh screening systems will use available piping, supports, and platforms used for the existing pumphouse screening system.
22. For the new mechanical (active) intake fine mesh screening systems technology, existing traveling screens servicing the existing safety-related ASW system pumps will not require modification.
23. Additional screen wash water requirements for the new onshore mechanical (active) intake fine mesh screening systems technology will be provided by the new CW pumps.
24. Work at the intake structure will be inside a security protected area.
25. No radiological or contaminated areas will be encountered.
26. The mountain area is available for new cooling towers.
27. Geotechnical data is based on existing plant data. New geotechnical data will be needed to confirm validity.

7.12 Exclusions

The following exclusions apply:

1. Real estate costs for recycle water processing and pumping facility
2. Right of way costs for recycle water pipelines
3. Asbestos and lead abatement
4. Remediation costs associated with mountain excavations and CW duct installation
5. Allowance for impact mitigation and/or offsets associated with permit approval conditions

6. Mitigation costs, except for those in Tables IFMS-1, WW-1, CC-1, and CC-2, which are unpriced
7. Traffic control along the recycle water pipeline route
8. Scrap values of demolished equipment and structures, which are assumed to be offset by disposal costs
9. Harbor seal and marine craft relocations
10. Unexpected underground interferences, which have been excluded from estimate
11. Bar rack screening structure for the onshore mechanical fine mesh screening technology
12. Fuel removal, disposal, and replenishment for the fuel oil storage tanks being demolished and replaced

8 References

1. Bechtel Power Corporation, “Independent Third-Party Interim Technical Assessment for the Alternative Cooling Technologies or Modifications to the Existing Once-Through Cooling System for Diablo Canyon Power Plant,” Report No. 25762-000-30R-G01G-00009, Rev. 0, prepared for Pacific Gas and Electric Company and the California State Water Resources Control Board Nuclear Review Committee, November 5, 2012.

2. Pacific Gas and Electric Company, “Report on the Analysis of the Shoreline Fault Zone, Central Coastal California,” report to the U.S. Nuclear Regulatory Commission for Diablo Canyon, January 2001.

3. Tenera Environmental, “Report Supplement: Length-Specific Probabilities of Screen Entrainment of Larval Fish Based on Head Capsule Measurements (Incorporating NFPP Site-Specific Estimates,” October 29, 2013.

4. Gregor M. Cailliet, “Technical Expert Review of Tenera Documents,” Moss Landing Marine Laboratories, October 30, 2013.

5. Peter Raimondi, “Review of Report Supplement: Length-Specific Probabilities of Screen Entrainment of Larval Fish Based on Head Capsule Measurements (Incorporating NFPP Site-Specific Estimates), October 29, 2013,” University of California, Santa Cruz, November 20, 2013.

Attachment 1: Phase 1 Report: Independent Third-Party Interim Technical Assessment for the Alternative Cooling Technologies to the Existing Once-Through Cooling System for Diablo Canyon Power Plant

(Attachment 1 under separate cover)

Attachment 2: DCPP Offshore Modular Wedge Wire Screen Field Pilot Testing Plan

A.1 Introduction and Purpose

This narrative represents an overview of a preliminary plan for conducting a pilot study for a narrow-slot wedge wire screen (WWS) at the proposed offshore wedge wire location for Pacific Gas and Electric's (PG&E's) Diablo Canyon Power Plant (DCPP). The narrative is based on two proposals received by ALDEN Research Laboratory, Inc. (ALDEN) (Reference A-1) and Tenera Environmental (Tenera) (Reference A-2). The engineering design for the study will be done by ALDEN and the design of biological sampling will be by Tenera. Both entities will jointly oversee the design, planning, preparation, testing, and evaluation of the test results.

DCPP uses power plant cooling water from the Pacific Ocean through a shoreline intake protected by breakwaters. The pilot study would evaluate both the biological and engineering feasibility of the WWS system.

The primary objectives of the pilot study are to determine:

- The biological exclusion efficiency of both a 2.0-mm and a 6.0-mm cylindrical T-shape WWS in comparison with an open port for reducing impingement and entrainment and by comparing concentrations of ichthyoplankton from samples collected through an intake fitted with a WWS and an intake designed to screen out only larger organisms.
- The operating performance relative to biofouling.
- The operating performance relative to debris clogging.

The deliverable for this pilot study will be a report that combines the engineering and biological sampling program components of the study. The report will be submitted to the California State Water Resources Control Board as part of the Once-Through Cooling Policy Nuclear-Fueled Power Plant (NFPP) Special Studies. More details on the study and deliverables are provided below.

A.2 Scope of the Study

The pilot study is anticipated to be performed through four tasks:

- Task 1 is the development of a study plan and commencement of the required federal, state, and local permitting.
- Task 2 is the engineering design of the pilot WWS deployment and biological sampling facilities.
- Task 3 lays out a biological sampling plan.
- Task 4 investigates debris, biofouling, and screen cleaning potentials and evaluates the effort and techniques needed to facilitate operability.

A.2.1 Plan Details Development

The objective of this task is to develop a study plan for pilot-scale WWS evaluation at DCPP. The study plan will be used by PG&E to support the initiation of permitting processes and associated consultations with the US Army Corps of Engineers, California Coastal Commission, California State Lands Commission, State Water Quality Control Board, Central Coast Regional Water Quality Control Board, National Marine Fisheries Service, San Luis Obispo County, and other interested parties. . This process will assess the overall need to secure such permits as Section 404/10 Permit, Coastal Development Permit, State Lands Lease, Scientific Collecting Permit, and NPDES Discharge Permit. The test plan will be developed in cooperation with Bechtel, ALDEN, Tenera, PG&E, and these interested regulatory agencies. The study plan will include:

- Justification for testing WWSs at the station, including a summary of existing data on the efficacy of WWSs
- Detailed engineering design of the pilot-scale test facility, including screens, pumping, piping, and anchoring systems (Task 2)
- Detailed sampling operation and processing and quality assurance/quality control (QA/QC) plans for system operation and the methods used to collect and process biological samples and monitor clogging and biofouling (Tasks 3 and 4)
- Permitting strategy that supports implementation of the pilot study

A.2.2 Engineering Design and Testing

The design of a WWS pilot study at DCPP, with a proposed intake deployment located about 600 feet offshore, will require significant effort to ensure that the screen deployment and study objectives are met. The deployment would include two WWSs (2.0-mm and 6.0-mm slot openings) and one open port. At this initial stage, the following design features and components are anticipated:

- 2.0-mm and 6.0-mm slot opening, copper-nickel alloy, 24-inch-diameter cylindrical WWSs by Johnson Screens
- A single open port with a 3/8-inch (9.5-mm) mesh located adjacent to pilot screens
- Tee-screens and open port mounted to a large weighted frame for support and stability
- Submerged high density polyethylene (HDPE) piping routed to the shoreline or the nearest breakwater
- Pipe anchored with ballast weights along its route and with rip rap near the shoreline as necessary
- Submersible pump(s) located in protected near-shore enclosure(s)
- Onshore sampling facilities and power supply

The proposed designs were sized to provide a through-slot average velocity of approximately 0.5 ft/sec for 24-inch-diameter tee-screens and at the face of an open port. The 2-mm screen would be designed for a maximum flow of 4 cfs (1,795 gpm) and the 6-mm screen for a maximum flow of 6 cfs (2,693 gpm) based on the final screen size and to achieve the design through-slot velocity of 0.5 ft/sec.

The WWSs and open port would be constructed of copper-nickel alloy because this material has been shown to retard biofouling growth. The open port with a 3/8-inch mesh across the opening is required to provide a baseline entrainment estimate. The screens would be mounted to a heavy frame anchored on the sea floor near the proposed full-scale deployment location. It is important for the pilot-scale test screens to be located at or near the deployment location because both biological efficacy and debris/biofouling would be affected by the ambient currents. At DCPP the deployment location would be approximately 600 feet offshore in 70 feet of water (Figure A.1).

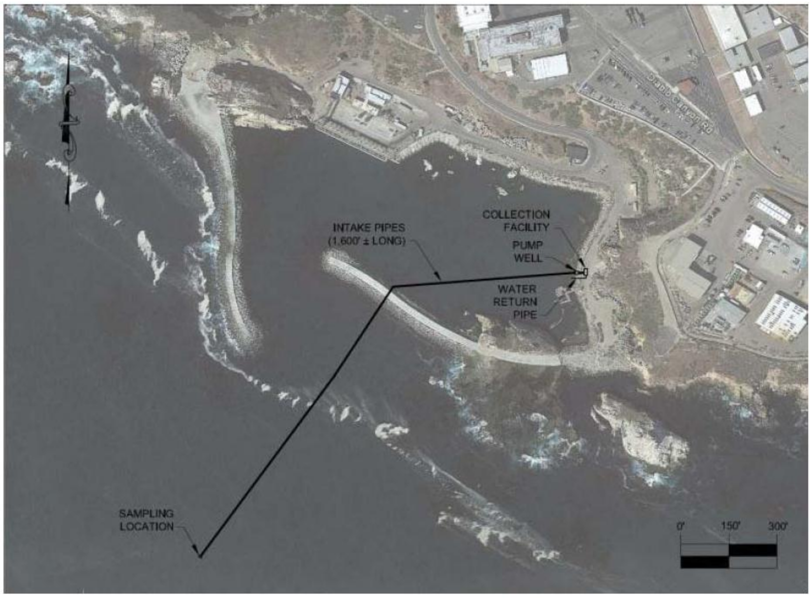


Figure A.1. Preliminary Wedge Wire Pilot Study Layout at DCPP (Reference A-1)

The two test screens and open port would be connected to an onshore sampling facility via HDPE pipes. HDPE pipe material was selected because it can be installed using a “float-and-sink method” that is expected to be less expensive and faster than other installation methods. The pipes for the 2-mm screen and open port would have a 12-inch internal diameter (ID), and the pipe for the 6-mm screen would have a 15-inch ID. These pipes are sized for a velocity of approximately 5 ft/sec to reduce the risk of sediment and biofouling build-up in the pipes. The pipes would be anchored to the bottom with concrete ballast weights. Riprap would be added in the near-shore area to help secure and protect the pipes.

Flow through the pipes would be provided by three submersible, fish-friendly pumps located in a wet well installed near the sampling facility. This pump chamber would be designed to protect the pumps during storm events. The pump discharges would be connected to the sampling system, where they would either be routed through the sampling equipment or discharged back to the Pacific Ocean.

The sampling systems would be located near the shoreline to reduce additional piping needs. At DCPP, the intended sampling location could be behind the breakwater near the existing boat ramp (Figure A.1), but it also could be located on breakwaters and/or a barge used to reduce installation cost if determined to be warranted by the pilot study. The system would be designed to allow simultaneous sampling from either of the two WWSs and the open port. Biological efficacy would be determined by comparing the egg and larval concentrations of the screened and unscreened intakes, as outlined in Section 2.3. The pumps would discharge into vertically-oriented conical plankton nets suspended in water-filled tanks. The nets would have 335-µm mesh netting and a codend cup to collect the entrained organisms. The filtered water would flow through pipes back to the ocean.

The engineering design section of the study will include detailed drawings of the WWS deployment, including redundant intake lines for both the wedge wire screen and unscreened intake. The design will allow the collection of paired samples to determine the effectiveness of the WWS at reducing entrainment. The redundant lines for each intake will allow one of the lines to be closed off and cleaned while sampling is continued in the second line. This design component is critical to the study due to the potential settlement and growth of fouling organisms in the intake lines. The concentrations of larvae passing through the intake lines will be reduced due to feeding by the fouling organisms. The engineering design will incorporate all the system components necessary for collecting samples from the two intakes, including the intake pump outlets where the samples will be collected. The sample collection pumps will use “fish friendly” impellers to minimize damage to the fragile fish larvae that are the target organisms for the study. The collection pumps will be sized to collect a minimum sample volume of 100 m^3 (26,417 gal) over a 60-minute period. The system will also be designed so that the WWS module can be exchanged to allow testing of more than one slot width.

The materials and costs to install the pilot WWSs and sampling equipment are preliminary in nature, based on conceptual designs, and do not reflect detailed, site-specific conditions. Detailed site investigations and engineering analyses, as well as consultation with local contractors, are required to refine the design and associated costs. The costs to complete a detailed design and cost estimate will vary, depending on the final requirements of the study plan (Task 1).

A.2.3 Biological Sampling

The biological sampling component of the study design will include details on the sampling, sample processing, analysis, and QA/QC. The sampling will likely be proposed to take place over a 12-month period with more intensive sampling efforts during the peak larval periods from March to June. The sampling effort will be adaptively managed to allow sampling to be reduced or curtailed if the study goals are achieved. All of the larval fishes collected during the sampling will be measured to determine the size range of larvae effectively excluded from entrainment by the WWS. Impingement of organisms on the WWS will be evaluated through an underwater video, system, which will also be used to monitor debris accumulation on the screen. The underwater video system and its cabling will be incorporated into the engineering design.

Task 3 will comprise finalizing the sampling, sample processing, and QA/QC program which includes collecting the entrainment samples from the pilot-scale screens, processing the samples in the laboratory, entering and analyzing data, and assembling a report summarizing the approach and results.

The biological sampling study will be designed to provide information on the efficacy of the WWSs for minimizing entrainment. Determining the screens’ efficacy requires that a sufficient number of organisms are present to provide data that can be analyzed statistically; therefore, a greater number of samples will be targeted during periods of peak abundance (described in more detail below). Biological samples will also be collected, though less frequently, over the balance of the 12-month study duration to account for changes that could occur throughout the year in species composition and larval size distribution (each of which may impact screening efficacy).

Final collection procedures would be based on the design of the sampling facility (Task 2), best professional judgment, and input from resource agencies. If desired, entrainment samples at DCPP could be collected concurrently with WWS samples to help quantify the location benefit associated with moving the point of withdrawal from the shoreline at the surface to an offshore, submerged location.

The study period should run for at least 12 months. During that time, the screens would be operated 24 hours per day and monitored for clogging by debris and biofouling (Task 4). In addition to the remote monitoring of clogging, underwater video cameras with battery packs would be positioned to collect data on debris and impingement. Entrainment sampling would be targeted during periods of peak ichthyoplankton abundance. At DCPP, approximately half of the total entrainment occurs between April and June. By contrast, peak algae impingement occurs at DCPP during the fall and winter. Since a primary goal of testing is to determine the screen's ability to handle potentially heavy debris loads, the debris and biofouling testing would need to extend beyond the period of peak ichthyoplankton abundance.

Biological sampling would be conducted every other week over the 12-month study duration. More samples could be collected during the months of highest ichthyoplankton density (April, May, and June) to estimate the screens' efficacy for minimizing entrainment. Fewer samples would be collected during the other 9 months to account for changes in species composition and larval size distribution that could occur throughout the year. During the primary sampling period, collections would be made every other week on three consecutive days. Since ichthyoplankton abundance is typically highest during evening and night hours, the majority of biological sampling would occur between 1800 and 0600 hours. However, some sampling would be done during daylight hours to determine if there are species differences. During the remaining 9 months, collections would be made every other week on a single day.

Paired samples would be collected with one of the two WWSs and the open pipe. As many paired samples as possible will be collected during each sampling event. The exact number would depend on the time required to divert flow, wash down nets, and transfer sample contents to jars for transport to the laboratory. Approximately 50 to 100 m^3 (measured with an in-line flow meter) would be filtered through a 335-µm mesh plankton net and codend suspended in water to minimize damage to larval fish. At the end of the collection, contents of the net would be rinsed into the codend, transferred to a labeled jar, and preserved in 5%–10% buffered formalin-seawater solution.

The objective of the biological sampling will be to collect as many paired samples as possible during periods of peak ichthyoplankton abundance. To the greatest extent possible, flexibility would be incorporated into the study design so that sampling could be terminated early when a requisite number of paired samples with ample organism density are collected. Similarly, sampling could be extended if insufficient numbers of organisms are collected during the predetermined sampling duration. The ultimate goal would be to collect enough paired samples to make valid statistical comparisons of larval fish densities between the screens and open port and to develop an estimate of biological effectiveness with reasonably tight confidence intervals.

Samples would be processed under a dissecting microscope in the ichthyoplankton processing laboratory. Fish eggs and larvae would be removed, enumerated, and identified to lowest taxonomic level possible. The notochord length (NL) and head capsule depth (HCD) for a subsample of larvae would be measured. A QA/QC program would be applied to all laboratory processing.

A.2.4 Debris and Biofouling Study

The pilot study screens would be constructed of a copper-nickel alloy that has been shown to significantly reduce biofouling of wedge wire screens. However, this alloy does have limitations. Once a biofilm develops, biofouling organisms (e.g., mollusks) may be able to colonize the screen surface. During a 12-month study period, the screens would be monitored to determine the biofouling and debris accumulation rate. The sampling pumps would operate continuously throughout the entire study duration to estimate the biofouling and debris loading rates. This monitoring would be done both remotely with battery-powered cameras and with regular diver inspections. The frequency of diver inspections would be based on the expected battery life of the cameras. Each of the test screens would be equipped with differential pressure cells to monitor the impact of biofouling and debris on the head loss through the screens. This impact is important to monitor so that a cleaning schedule can be developed for a full-scale installation and because excessive head loss across the screens can impact the sampling pumps. The screens would not be cleaned during the study period unless the head loss starts to impact the flow through the screens.

A.3. Study Duration

The pilot study schedule will depend on the final study plan and screen facilities design. The initial estimate to complete the study from study plan development to demobilization is approximately 2.5 years (not including the up-front permitting period), with entrainment, biofouling, and debris sampling lasting about 1 year but could be increased depending on the data. Included in the schedule is a 6-month window between the completion of the final engineering design and the start of construction. Included in this 6-month window are the material and equipment lead times. The permitting process is expected to be completed in a nominal 2-year period that precedes the commencement of installing pilot test components and any subsequent sampling.

A.4. Results of Pilot Study

Comparing collected aquatic life through a sampling program will provide necessary information for finalizing screen slot size and performance. Use of collected samples data will assist in the following interpretations:

a. Comparison of the WWS data against the open intake will determine the effectiveness of the wedge wire operation for reducing the entrainment and impingement.

b. Comparison of the 2-mm and 6-mm slot screens’ aquatic life samples will determine the incremental effectiveness of 2-mm slot screen over 6-mm screen.

c. Comparison of the 2-mm and 6-mm slot screens’ trash and debris loading will determine the impact of smaller screen size on screen performance due to debris loading.

After evaluation of results, if the incremental effectiveness of the foregoing three items is insignificant and debris loading reduction is still desired, a screen slot size larger than 6 mm can be considered. On the other hand, if comparison shows a clear advantage in biological efficacy of 2-mm over 6-mm slot screens and insignificant incremental effectiveness for Item c above, then 2-mm slot screens can be used.

A.5. References

A-1 ALDEN Research Laboratory, Inc., *Preliminary Evaluation of Narrow-Slot Wedge Wire Screen Pilot Studies at the Diablo Canyon and San Onofre Nuclear Generating Stations,* May 2013.

A-2 Tenera Environmental, *Proposal for Preparation of an Engineering and Study Design for Testing the Effectiveness of Wedge Wire Screens at Diablo Canyon Power Plant –* Proposal SLO2013-28, July 26, 2013.