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DELTA CONVEYANCE

Final Draft Project Refinements Report

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Document History and Quality Assurance

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Approval Names and Roles

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1. Introduction

The California Department of Water Resources (DWR), the Lead Agency under the California Environmental Quality Act (CEQA) for the Delta Conveyance Project (project), certified the Delta Conveyance Project Final Environmental Impact Report (Final EIR), executed a Notice of Determination documenting project approval of the Bethany Reservoir Alignment, adopted project Findings of Fact and a Statement of Overriding Considerations, and adopted a Mitigation Monitoring and Reporting Program (MMRP) on December 21, 2023 (California Department of Water Resources 2023b, 2023c).

During preparation of the EIR, the Delta Conveyance Design and Construction Authority (DCA) completed Engineering Project Reports (EPRs) that present conceptual engineering information for the project and alternatives. The EPR conceptual engineering designs were based upon limited geotechnical information, especially for potential construction locations along the Bethany Reservoir Alignment. Therefore, the conceptual engineering designs included conservative criteria. For example, the Bethany Reservoir Pumping Plant location was assumed to have liquifiable soils; and therefore, the conceptual design was developed with more concrete, steel, ground improvement, and other construction methods as compared to designs on locations with less risk-based geotechnical conditions.

Following certification of the Final EIR, DWR directed DCA to further evaluate several project features presented in the Delta Conveyance Final Draft Bethany Reservoir Alternative EPR (DCA 2022a) and the Final Draft Engineering Project Report Update Bethany Reservoir Alternative EPR (DCA 2023) and consider potential design or construction refinements to improve constructability and operations. The conceptual evaluation resulted in refinements that are considered by the DCA to be reasonable and credible based on industry experience. These analyses included consideration of geotechnical information collected from late 2021 through May 2024 which was not available during preparation of the EPRs.

The conceptual evaluations described in this Project Refinements Report reviewed the EPR conceptual designs with respect to this additional geotechnical information as well as consideration of biological resources. All of the refinements presented in this Project Refinements Report would be constructed within the temporary construction footprints described in the EPRs and evaluated in the Final EIR. The EPRs and Final EIR assumed that all of the area within the temporary construction footprint would be totally disturbed over a long-term period. Therefore, the Final EIR included mitigation measures for total disturbance within the construction footprint.

This Project Refinements Report only addresses locations, configurations, construction methods, and long-term maintenance methods for potential physical facilities for five refinements. This document does not address operational criteria, including, but not limited to, the patterns of diversions of water from the Sacramento River at the intakes and water deliveries from existing facilities used for the California State Water Project (SWP) and Federal Central Valley Project (CVP) water users.

As the refinement concepts are further analyzed and prior to DWR making any decisions to approve potential refinements, DWR will determine whether subsequent environmental review is required under the California Environmental Quality Act (CEQA) and if project permits will require modification.

1.1 Organization of this Report

The Project Refinements Report identified the following five refinements that will result in minor engineering modifications to some project facilities.

- **Section 2:** Refinement 1 – Intake Structure Configuration
- **Section 3:** Refinement 2 – Optimization of Tunnel Profile and Shaft Dimensions
- **Section 4:** Refinement 3 – Pumping Plant Below Ground Configuration
- **Section 5:** Refinement 4 – Surge Basin Slab Configuration
- **Section 6:** Refinement 5 – Bethany Reservoir Aqueduct Dimensions

2. Refinement 1 – Intake Structure Configuration

2.1 Purpose of the Refinement

The EPR conceptual design of the intake configuration was based upon geotechnical information available during preparation of the EPR. The EPR conceptual design concepts were based upon conservative foundation concepts due to the limited geotechnical information. Following completion of the EPR, the results of geotechnical investigations conducted from late 2021 through May 2024 were reviewed to determine if conceptual design could be modified to reduce materials required for structural foundations. In addition, the EPR design of the intakes was modified to improve constructability and increase on-site safety measures for operations and maintenance workers.

2.2 Description of the Refinement

The EPR intake structure configuration includes thirty 60-inch-diameter discharge pipes, each connected to one intake tee screen, to convey water from the intake structure to the sedimentation basin. This refinement would combine two 60-inch diameter pipelines within the intake structure into a single 84-inch diameter pipeline for a total of fifteen 84-inch diameter pipelines that would convey water from the intake structure to the sedimentation basin. Each end bay of the EPR concept design intake structure included an access hatch on top of the intake structure with a vertical stairway for periodic operational access. This refinement would include two additional internal stairways and four access structures that would extend 13 feet above the top deck of the intake structure.

Following the EPR, additional geotechnical information was obtained and additional criteria were developed to modify the design concepts to reduce concrete quantities, ground improvement materials, drilled piers, and construction complexity; and improve hydraulic function and access for workers to reduce safety risks.

Key features of Refinement 1 include:

- Revision to the number of discharge pipes connecting the intake structure to the sedimentation basin to improve the efficiency of constructing the discharge pipes.
- Addition of two internal stairways to comply with the requirements of the California Building Code (CBC) for structure access and egress.
- Widening of the two end bays on either side of the intake structure to improve function of the space for access, material handling, and storage.
- Addition of intake access structures above the stairways that would extend 13-feet above the top of the intake structure.
- Revision to cofferdam back wall from 5-foot-wide deep mechanically mixed (DMM) wall to 3-footwide diaphragm wall and extending the depth of the wall from elevation -100 feet to -130 feet in elevation to improve constructability and performance.
- Reduction of the total number of foundation-drilled piers following updated foundation design with new geotechnical data.

- Increased length for each of the fifteen 84-inch-diameter discharge pipes to accommodate the addition of a 50-foot-wide access corridor along State Route 160.
- Refined extents of ground improvement beneath intake structure.

Refinement 1 would not change:

- Intake construction footprint.
- 40-foot tall Gantry Crane on the top of the intake structure.
- Operational performance of individual fish screens because the number or pipes between the tee-screens and the intake control gates will not change.
- No change in hardscape area at the intakes; and therefore, no change in runoff volume from the intake sites.

Changes of the intake structure between the EPR and Refinement 1 are summarized in Table 2-1 and Figure 2-1.

Table 2-1. Comparison of Intake Design Concepts for EPR and Refinement 1

Item	EPR Items to be Deleted with Refinement 1	Refinement 1 Items to be Added with Refinement 1
Discharge Pipes from Intake Structure to Sedimentation Basin	• Thirty 60-inch diameter pipes	• Fifteen 84-inch diameter pipes
Gate Box Structure	• 30 structures	• None
Slide Gates	• Sixty 60-inch slide gates (two per gate box)	• Thirty 60-inch slide gates (One per Tee Screen and flow meter) • Fifteen 84-inch slide gates (one per discharge pipe)
Set-in Intake Vault Pipe	• Thirty 39-foot long pipes	• Thirty 29-foot long pipes
Cofferdam Backwall Foundation and Structural Design Method	• 5-foot thick Deep Mixing Methods (DMM) Walls with Tie-back Anchors – 132, 124 square feet	• 3-foot thick Double Wall with Tie-Back Anchors – 161,00 square feet
42-inch diameter Drilled Piers	• 1,215 piers (92,340 feet total) • 80 feet deep	• 666 piers (46,620 feet total) • 70 feet deep
Ground Improvement	• 102,600 cubic yards of grout placed by jet grouting	• 79,721 cubic yards of grout placed by jet grouting
Reinforced concrete for gate box dividing walls, thrust blocks and wider end bays	• Not applicable	• 5,293 cubic yards
Stairwells	• 2 – one at each End Bay	• 2 – one at each End Bay • 2 – internal stairways so that emergency access is equal to or less than every 300 feet

Item	EPR Items to be Deleted with Refinement 1	Refinement 1 Items to be Added with Refinement 1
Access to Stairwells from top of Intake (on outside)	• 2 - Access Hatches at the same elevation as the top of the intake structure	• 4 – Stairway Exit Structures – • 13-feet High x 22.3-feet Long x 5.3-feet wide • To be constructed above top of the intake structure • Height of these structures would be lower than the 40-foot tall Gantry Crane

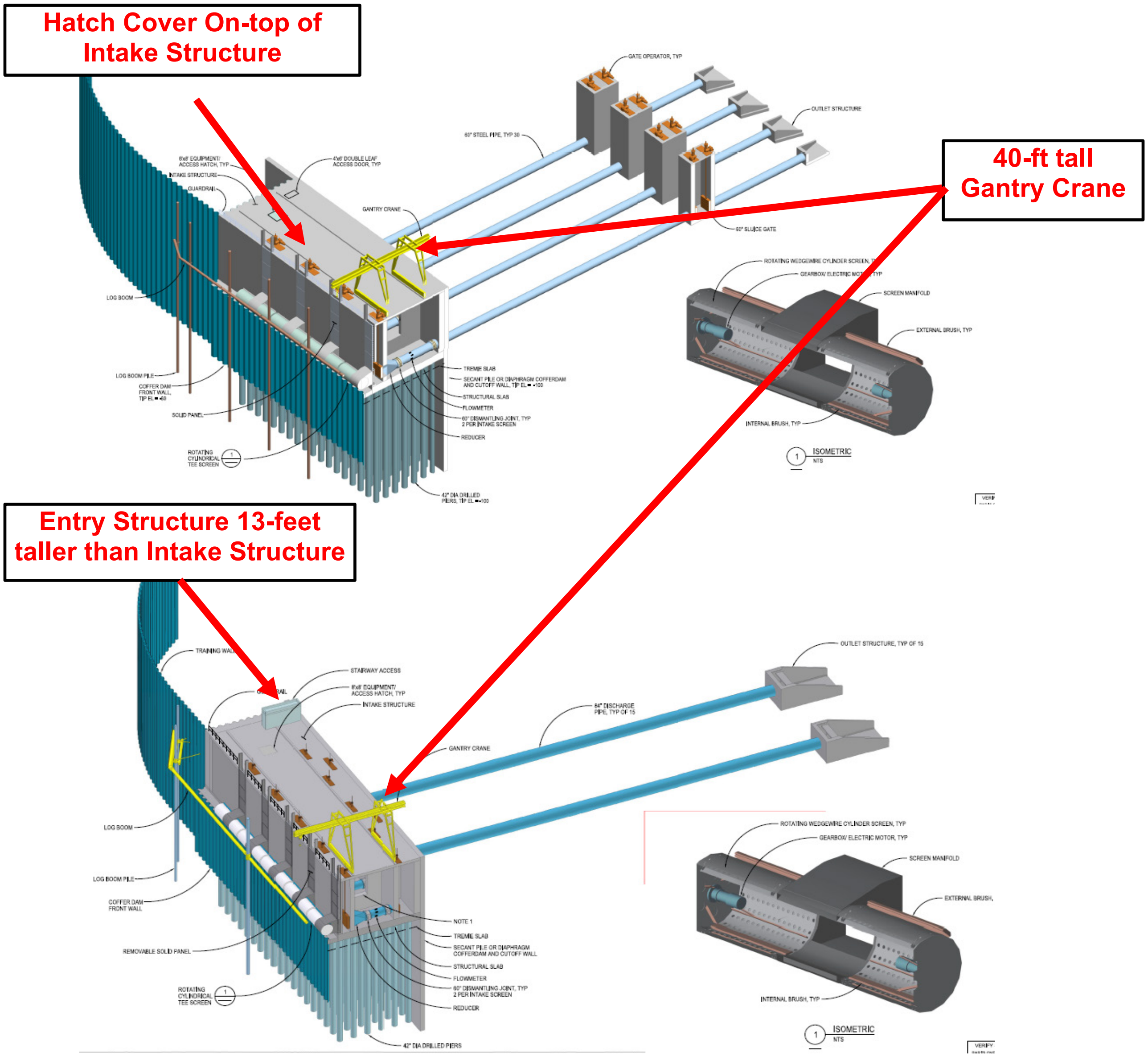


Figure 2-1. Comparison of Intake Configuration as Described in the EPR and Refinement 1

3. Refinement 2 – Optimization of Tunnel Profile and Shaft Dimensions

3.1 Purpose of the Refinement

Refinement 2 addresses the following two "sub-refinements" to reduce soil excavation and concrete volumes at tunnel shafts between Intake 3 and the Surge Basin as compared to the EPR conceptual design:

- Lower the tunnel profile from Lower Roberts Island tunnel launch shaft to the Surge Basin to avoid a future conflict with the East Bay Municipal Utility District (EBMUD)'s proposed Mokelumne Aqueduct Resiliency Project (MARP).
- Reduce the thickness of the diaphragm walls, shaft liners, shaft slab thickness and diameters of the intakes outlet shafts, maintenance and receptions shafts

3.2 Description of the Refinement

3.2.1 Lower Tunnel Profile from Lower Roberts Island to Surge Basin

In the EPR, the tunnel profile between Lower Roberts Island and the Surge Basin at the Bethany Reservoir Pumping Plant was designed to be located below the lowest zone of liquefaction and to be at least 75 feet below the bottom of the San Joaquin River and the bottom of the Stockton Deep Water Ship Channel.

The tunnel conceptual design crossed under the existing Mokelumne Aqueducts between the Lower Roberts Island tunnel launch shaft site and the Upper Jones Tract Maintenance Shaft. At this crossing, the Mokelumne Aqueducts are installed above the ground surface and sit on pipe saddles that are supported on piles. The piles at the tunnel crossings have tip elevations of approximately -38 feet. EBMUD's future 15-foot-diameter MARP tunnel is being considered to be constructed with an invert (bottom) elevation of -126 feet. The EPR did not include design concepts for crossing the future MARP because the MARP was not included in the FEIR as a cumulative project because the Notice of Preparation (NOP) for the MARP project was released on March 28, 2022, which was after the January 15, 2020, release date of the Delta Conveyance Project NOP. At this time, the reasonably foreseeable probable future project has been in the planning stage since 2022 and is anticipated to be further defined in the coming years. EBMUD submitted comments to DWR as comments on the Draft EIR describing the potential MARP location. However, because the MARP was not included in the Final EIR cumulative project, no changes were included in the Final EIR.

Following completion of the EPR and Final EIR, several evaluations were considered based upon available geotechnical information and standard engineering practices. The results of those studies indicated that the there should be at least 20 feet between the invert of the MARP tunnel and the top of the project tunnel at the crossing. To provide this minimum separation, Refinement 2 will lower the project tunnel profile between Lower Roberts Island and the Surge Basin to avoid conflicts with the proposed MARP based upon available information. The tunnel slope would be steeper from Lower Roberts Island to just past the MARP crossing and then become flat from that location to the Surge

Basin. The lowered project tunnel profile would still be located below the lowest zone of liquefaction and at least 75 feet below the bottom of the San Joaquin River and the bottom of the Stockton Deep Water Ship Channel. The shaft inverts would be lowered as described in Table 3-1 and shown in Figures 3-1 and 3-2.

Table 3-1. Comparison of Shaft Invert Elevations between Lower Roberts Island and Surge Basin in the EPR and Refinement 2

Tunnel Shaft	EPR Shaft Invert	Refinement 2 Invert
Lower Roberts Island	-156.49 feet	-156.49 feet
Upper Jones Tract	-151.19 feet	-183.5 feet
Union Island	-161.43 feet	- 183.5 feet
Surge Basin	-164.18 feet	-183.5 feet

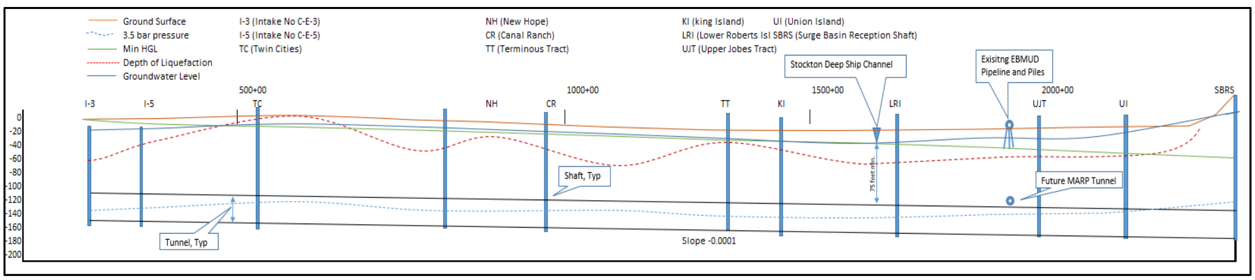


Figure 3-1. EPR Tunnel Profile between Intakes and Surge Basin

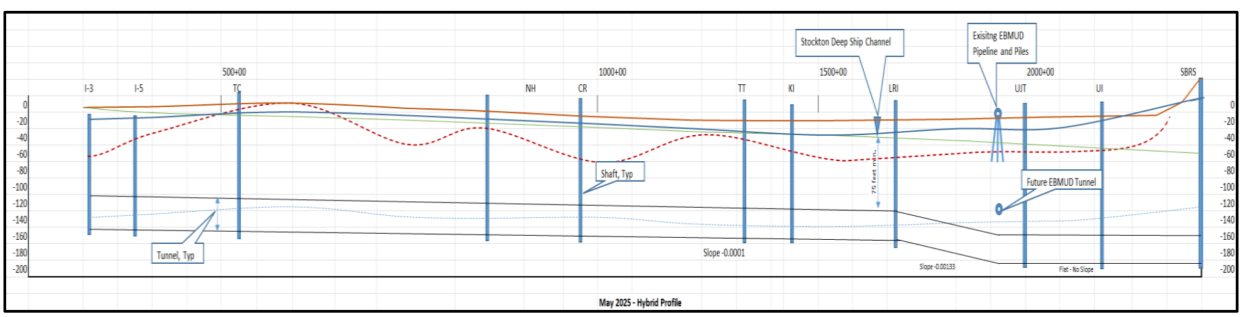


Figure 3-2. Refinement 2 Tunnel Profile between Intakes and Surge Basin

3.2.2 Reduce Sizes of Reception and Maintenance Shafts

The EPR design concept was based upon the shaft internal diameters, diaphragm wall thickness , lining thickness, and invert slab thickness, as summarized in Table 3-2. As the conceptual design proceeded, additional geotechnical information, including considerations for potential liquefaction, was reviewed and used to identify design concepts to reduce the size of tunnel shaft diameter excavation and the depth of the tunnel invert slab thickness, as summarized in Table 3-2. The steel reinforcement requirements for the shafts were updated and the conceptual design assumed independent structures that do not engage in load sharing. No changes would occur at the tunnel launch shafts because the diameter and the invert slab thickness of the launch shaft sites will be designed to accommodate tunnel boring machine operations. The invert slab thickness at the Surge Basin would not be modified from the

EPR design concept due to the need to integrate the Surge Basin with the Bethany Reservoir Pumping Plant. The shaft pad height at the intake shafts would be reduced by 5 feet. These changes are summarized in Table 3-2.

Table 3-2. Comparison of Shaft Dimensions Between Intakes and Union Island in the EPR and Refinement 2

Tunnel Shaft	EPR Internal Diameter (feet)	Refinement 2 Internal Diameter (feet)	EPR Wall Thickness (feet)	Refinement 2 Wall Thickness (feet)	EPR Slab Depth (feet)	Refinement 2 Slab Depth (feet)
Intake 3(B)	80	70	8	6.5	30	20
Intake 5(C)	80	70	8	6.5	30	20
Twin Cities Complex	115	115	8	8	30	30
New Hope Tract	70	66	8	6.5	30	20
Canal Ranch Tract	70	66	8	6.5	30	20
Terminous Tract	70	66	8	6.5	30	20
King Island	70	66	8	6.5	30	20
Lower Roberts Island	115	115	8	8	30	30
Upper Jones Tract	70	66	8	6.5	30	20
Union Island	70	66	8	6.5	30	20

3.2.3 Summary of Changes from EPR to Refinements 2

Key features of Refinement 2 include:

- Increased tunnel shaft depth at Upper Jones Tract, Union Island, and the Surge Basin.
- Decreased tunnel shaft diameter at the intakes and reception and maintenance shafts (not including the Surge Basin).
- Excavation volume for tunnel shafts (including intakes) in Sacramento County would be reduced due to the reduced tunnel shaft diameters and/or reduced invert tunnel slabs from 179,400 cubic yards to 155,600 cubic yards.
- Excavation volume would increase due to deeper tunnel shafts downstream of Lower Roberts Island. However, due to the reduced tunnel shaft diameters and/or reduced invert tunnel slabs, excavation volume would be reduced from 309,600 cubic yards to 281,150 cubic yards.
- Reduced invert slab thickness will reduce the duration of 24-hour tremie concrete pours at the intakes and reception and maintenance shafts.

Refinement 2 would not change:

- Tunnel shaft construction footprint.
- Tunnel length.

- Reusable tunnel material volume at the tunnel launch shaft sites.
- Operational performance of the tunnel will not change because the hydraulic grade line is above the crown of the tunnel and would not be modified by tunnel profile, and tunnel shaft depths, diameters, or invert slab depths.
- No change in groundwater dewatering flows at the tunnel shafts because the shaft diaphragm walls and the invert slabs will be constructed prior to removal of groundwater in the shaft as described in the EPR. The diaphragm walls will isolate the shaft from the groundwater.
- No change in hardscape area at the tunnel shafts; and therefore, no change in runoff volume from the tunnel shaft sites.

4. Refinement 3 – Pumping Plant Below Ground Configuration

4.1 Purpose of the Refinement

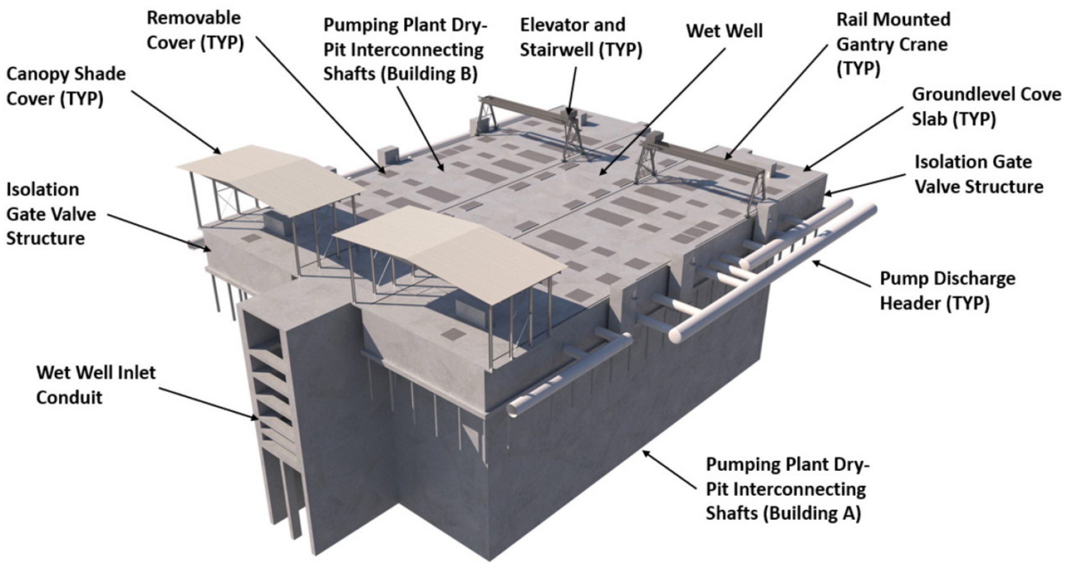
Refinement 3 will reconfigure the foundation and below ground structural layout at the Bethany Reservoir Pumping Plant to allow construction from the bottom up rather than from the top story down, which will improve constructability at the pumping plant, reduce excavation soils and concrete quantities at the Bethany Complex Batch Plant, and reduce safety risks for construction workers.

4.2 Description of the Refinement

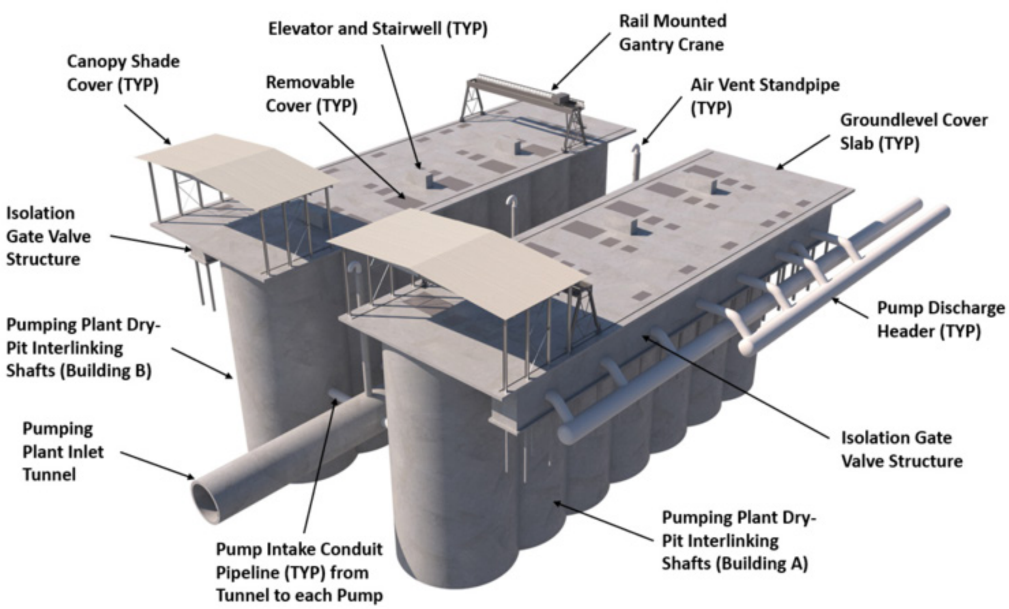
The foundation and layout of the Bethany Reservoir Pumping Plant described in the EPR was based upon limited geotechnical information and configured to locate structures near other structures that have functional dependencies. The site layout accounted for operations and maintenance access and setbacks required by codes, with the goal of limiting the facility footprint's permanent areas of impact. Water from the tunnel was conveyed from the Surge Basin through a wet well inlet to the pumping plant wet well inlet. The pumping plant was a five-story structure completely constructed below-ground. However, due to the assumed geotechnical condition related a high potential of liquefaction, the structure would need to be constructed "upside-down" or from the top story just below ground level to the bottom of the pumping plant for each story to have adequate structural support. After the first story was constructed near the ground surface, remaining excavations and wall and floor construction would need to occur under the first floor, similar to mining construction methods. Diaphragm walls would be installed around the pumping plant walls and throughout the interior of the structure. This type of structure is called a "vertical deep-box diaphragm wall arrangement."

Following completion of the EPR, results from previous geotechnical investigations became available and indicated that the potential for liquefaction was less than assumed during preparation of the EPR. Therefore, under Refinement 3, the wet well will be replaced with a tunnel that will be constructed in an open-face excavation manner with a tunneling shield or using a sequential excavation method. The vertical deep-box diaphragm wall arrangement will be replaced with two underground structures using interlinking circular shaft structures on either side of the tunnel. This type of structure will have a different type of foundation that will be constructed following initial excavation to the bottom of the pumping plant up to the ground surface. This method will be more efficient and safer for construction workers and will reduce excavation soils, concrete quantities, and construction complexity.

Figure 4-1 presents a comparison of the pumping plant schematic for the design concepts under the EPR and Refinement 3.



EPR Configuration of Bethany Reservoir Pumping Plant



Refinement 3 Configuration of Bethany Reservoir Pumping Plant
(NOTE: area between two halves of Pumping Plant will be covered and be similar to EPR Design)

Figure 4-1. Comparison of the Bethany Reservoir Pumping Plant Schematics for EPR and Refinement 3

Key features of Refinement 3 include:

- Improved construction worker safety because construction would occur from the bottom of the excavation to the ground surface.
- Excavation volume in San Joaquin County would be reduced from 2,797,000 cubic yards to 2,237,600 cubic yards.
- Concrete volume would be reduced from 304,300 cubic yards to 243,400 cubic yards.

Refinement 3 would not change:

- Pumping Plant construction footprint.
- No changes in structures above the ground surface, as shown in Figure 4-1.
- Operational performance of the tunnel and pumping plant will not change because the hydraulic grade line would not be modified by this pumping plant below ground structural configuration or method of construction.
- No change in hardscape area at the pumping plant; and therefore, no change in runoff volume from the pumping plant site.

5. Refinement 4 – Surge Basin Slab Configuration

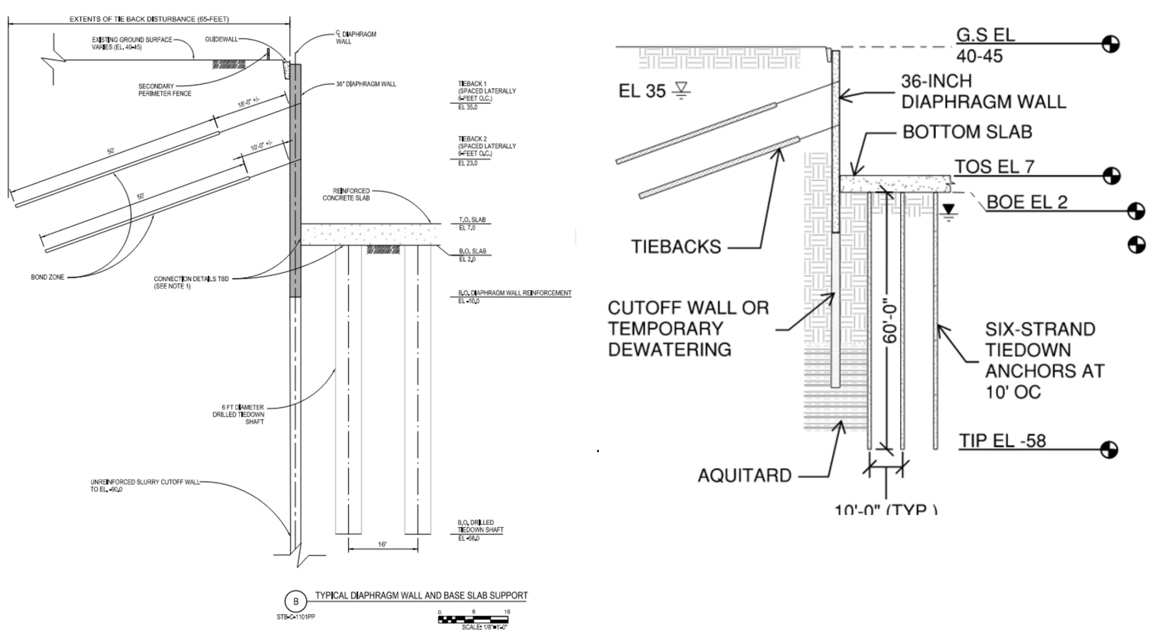
5.1 Purpose of the Refinement

Refinement 4 will reconfigure the foundation design for the Surge Basin slab at the Bethany Complex, which improves constructability and reduces excavation soil volumes, concrete volumes, and the amount of steel placed in the concrete.

5.2 Description of the Refinement

The Surge Basin slab is located above the inlet that connects the tunnel to the pumping plant. Initial geotechnical information available at the time of preparation of the EPR indicated that there was a potential for liquefaction and high groundwater and liquefiable soils that could push upwards and create unstable soil conditions below the slab. These conditions could lead to differential uplift and settlement of the surge basin slab. To avoid surge basin uplift, the EPR included an array of 6-foot-diameter drilled shafts spaced at 16-feet on center. The drilled shafts would extend to depths of 60-feet below the bottom of the slab. The shafts construction would consist of drilling a 6 foot diameter hole, setting a steel reinforcement cage, and tremie pouring concrete to fill the drillhole. The uplift resistance would be provided by a combination of the weight of the slab and drilled shafts and the soil-to-shaft skin friction.

As the conceptual design continued, additional geotechnical information was obtained. Based upon this information, Refinement 4 is based upon use of a six-strand tiedown anchors to support the surge basin slab, as shown in Figure 5-1. This design concept would reduce excavation and concrete volumes, and steel placed in the concrete as compared to the EPR concepts, as summarized in Table 5-1. The above ground portion of the surge basin will be 815 feet by 815 feet in both the EPR and Refinement 4.



EPR Surge Basin Slab Configuration **Refinement 4 Surge Basin Configuration**

Figure 5-1. Comparison of Surge Basin Slab Configuration for EPR and Refinement 4

Table 5-1. Estimated Construction Quantities for Surge Basin Slab for EPR and Refinement 4

Item	EPR Drilled Shafts		Refinement 4 Steel Tendon Tiedown	
	Quantity	Unit	Quantity	Unit
Drilled Shafts	2,564	each	N/A	N/A
Drilled Shafts	153,840	feet	N/A	N/A
Drilled Shafts Excavation	161,101	cubic yard (bulk)	N/A	N/A
Rebar	16,269	ton	N/A	N/A
Concrete	163,811	cubic yard (bulk)	N/A	N/A
Tiedown Anchors	N/A	N/A	6,468	each
Tiedown Anchors	N/A	N/A	388,080	feet
Tiedown Excavation	N/A	N/A	5,017	cubic yard (bulk)
6-Strand Tiedown Anchors, 270 ksi – Total Steel Weight	N/A	N/A	862	ton
Tiedown Anchor – Steel Baseplate and Wedge Plate Total Weight	N/A	N/A	174	ton
Tiedowns Anchors – Total Grout Volume	N/A	N/A	4,887	cubic yard (bulk)
Tiedown Stressing and Proof Testing (95% of Tiedowns)	N/A	N/A	6,143	each
Tiedown Performance Testing (5% of Tiedowns)	N/A	N/A	323	each
Tiedown Verification Tests (Two Sacrificial) Tiedowns	N/A	N/A	2	each

Key features of Refinement 4 include:

- Reduced concrete volume and excavation volume.

Refinement 4 would not change:

- Surge Basin construction footprint.
- No changes in structures above the ground surface.
- Operational performance of the tunnel or the surge basin will not change because the hydraulic operating conditions would not be modified by the Surge Basin foundation design or method of construction.
- No change in hardscape area at the Surge Basin; and therefore, no change in runoff volume from the Surge Basin site.

6. Refinement 5 – Bethany Reservoir Aqueduct Dimensions

6.1 Purpose of the Refinement

Refinement 5 will reduce the diameter and spacing between the 4 pipelines that comprise the Bethany Reservoir Aqueduct. This refinement will reduce the volume of excavated soil and need for Controlled low-strength material (CLSM) backfill as compared to the EPR.

6.2 Description of the Refinement

The EPR conceptual design includes the Bethany Reservoir Aqueduct that extends between the Bethany Reservoir Pumping Plant and the Bethany Reservoir Discharge Structure. Most of the alignment between the Bethany Reservoir Pumping Plant and the Bethany Reservoir Conservation Easement will be constructed using the open-trench method except for the crossings of the Central Valley Project Jones Discharge Tubes and the tunneled crossing of the Bethany Reservoir Conservation Easement. The Aqueduct includes four 15-foot internal diameter pipelines. The pipelines will be placed in a trapezoidal-type trench that is 200-feet wide at the top of the trench and 115-feet wide at the bottom of the trench. The pipelines will be placed with 30-feet between the centerline of each pipe and the end pipes will be placed approximately 13-feet from the edge of the trench to the centerline of the outer most pipes. The tops of the pipes will extend above the existing ground surface; however, the trench will be backfilled such that the top of the pipes will be covered by at least 6 feet of soil material. CLSM will be placed in the excavated trench around the pipes to a depth equal to 0.7 times the pipe diameter. Compacted fill will be placed above the CLSM to 6 feet above the top of pipe, as shown in Figure 6-1.

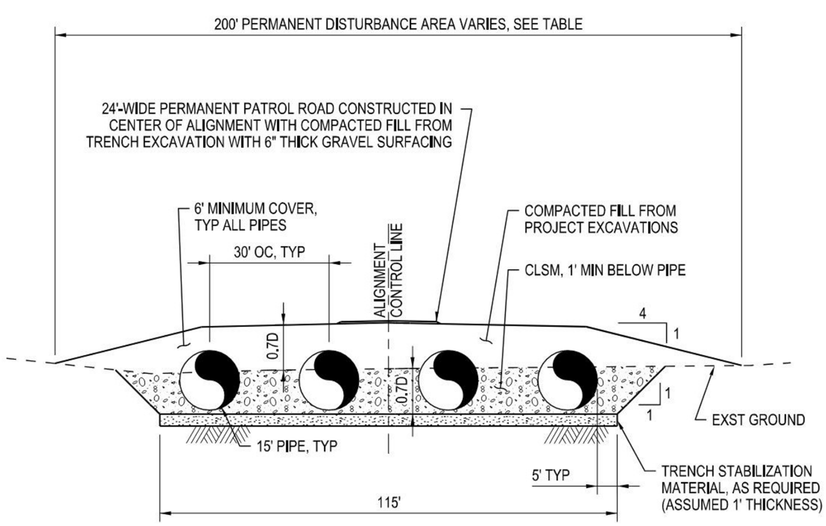


Figure 6-1. Bethany Reservoir Aqueduct Configuration in the EPR

As the conceptual design progressed, refinements were developed to reduce excavation volume and backfill requirements.

Key features of Refinement 5 include:

- Reduce internal diameter of the pipes from 15-feet to 13.83 feet. A portion of the reduction is related to reducing the steel pipe wall thickness from 0.75 inch to 0.69 inch, as shown in Figure 6-2.
- Reduce space between pipe centerlines from 30 feet to 21 feet and reduce the distance from the outside wall of the end pipes from the trench wall from 13 to 7.5 feet.
- Reduce the bottom width of the trench from 115 feet to 77 feet.
- Excavation will be reduced from 1,060,300 cubic yards to 842,800 cubic yards.
- Soil needed for CLSM and compacted backfill will be reduced from 1,395,550 cubic yards to 1,187,500 cubic yards.

Refinement 5 would not change:

- Construction footprint for the aqueduct.
- The trench top width and height.
- The length of the aqueduct.
- No changes in structures above the ground surface.
- Operational performance of the Bethany Reservoir Aqueduct.
- No change in hardscape area along the aqueduct; and therefore, no change in runoff volume from the Surge Basin site.

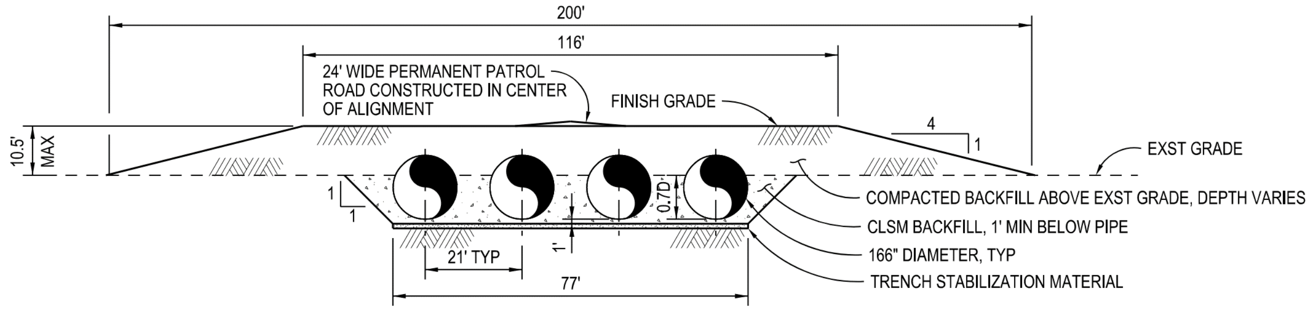


Figure 6-2. Bethany Reservoir Aqueduct Configuration in the Refinement 5

7. References

American Concrete Institute (ACI). 1995. Building Code Requirements for Structural Concrete: (ACI 318-95); and Commentary (ACI 318R-95). Farmington Hills, Michigan.

California Building Code (CBC). 2022. Title 24, Part 2: California Code of Regulations.

California Department of Water Resources (DWR). 2023. Delta Conveyance Project Final Environmental Impact Report. December. SCH# 2020010227.

Chow, V.T. 1959. Open-channel hydraulics: New York, McGraw-Hill Book Co.

Delta Conveyance Design and Construction Authority (DCA). 2022. *Delta Conveyance Engineering Project Report – Central and Eastern Options*. Final Draft. May 2022.

Delta Conveyance Design and Construction Authority (DCA). 2022. Delta Conveyance Final Draft Engineering Project Report. Bethany Reservoir Alternative. May.

Delta Conveyance Design and Construction Authority (DCA). 2023a. *Engineering Project Report Update – Central and Eastern Corridor Options.* Final Draft. November 2023.

Delta Conveyance Design and Construction Authority (DCA). 2023. Delta Conveyance Final Draft Engineering Project Report Update. Bethany Reservoir Alternative. November.

East Bay Municipal Utility District (EBMUD). 1967. Third Mokelumne Aqueduct. Structure Locations, Elevations and Pile Data for Elevated Pipe As-Built Drawings.

Sabatini, P. J. et al. 1999. "FHWA GEC 4 – Federal Highway Administration." U.S. Department of Transportation Federal Highway Administration. June. www.fhwa.dot.gov/engineering/geotech/pubs/if99015.pdf.

Stockton Port District. 2009. Board of Commissioners Minutes Resolution # 7631. October5, 2009.

U.S. Army Corps of Engineers (USACE). 1994. Engineering and Design: Hydraulic Design of Flood Control Channel. Department of the Army: USACE, Washington, D.C. Engineer Manual. No. 1110-2-1601. June 30. https://www.publications.usace.army.mil/Portals/76/Publications/EngineerManuals/EM_1110-2-1601.pdf.

U.S. Bureau of Reclamation (Reclamation). 1971. Research Report No. 24 – Hydraulic Design of Stilling Basin for Pipe or Channel Outlets.