Subject:	**Southern Forebay Siting Analysis (Final Draft)**
Project feature:	Southern Forebay
Prepared for:	California Department of Water Resources (DWR) / Delta Conveyance Office (DCO)
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1. Purpose and Introduction

The purpose of this technical memorandum (TM) is to present the identification, evaluation, and recommendation of a preferred site for the Delta Conveyance Project (Project) Southern Forebay (SF). This TM summarizes the following components:

- SF's key features
- Alternative sites identified and evaluated
- Criteria used for the evaluation
- Recommendation for the SF's preferred site

1.1 Organization

This TM includes the following main sections:

- Purpose and Introduction
- Methodology
- Southern Forebay Sizing
- Analysis and Evaluation
- Conclusions and Recommendations
- References
- Document History and Quality Assurance

1.2 Background

The Southern Forebay would be used for equalization storage, to provide the buffer between the Project supply and demand. The SF Forebay would be an at-grade storage reservoir, formed by a constructed ring levee arrangement. It would be located near the existing Clifton Court Forebay (CCF) in the South Delta. The Project South Delta Pumping Plant (SDPP) would discharge flow from upstream Project facilities into the forebay. Flow would then be discharged from the forebay into the South Delta Conveyance Facilities (SDCF) for further conveyance into the State Water Project (SWP) and potentially into the federal Central Valley Project (CVP).

The maximum Project supply, which could extend for several days or weeks at a time during favorable river conditions, is expected to be a relatively constant flow, delivered to South Delta from the North Delta intakes via the Project tunnel and pumping system. The Project demand is the flow exported from South Delta by the state and, potentially, federal water projects. The demand can vary during a daily operating

period to facilitate power management and downstream flow control. The differences in daily supply and demand flow timing and magnitude would result in the need for balancing storage.

The supply flows would be pumped from the Project tunnel system into the SF. Supply flows are stored in the forebay as needed, and subsequently discharged into the SDCF for conveyance of the demand flow to the existing State Water Project (SWP) Harvey O. Banks Pumping Plant (Banks) and potentially to the Central Valley project (CVP) C. W. "Bill" Jones Pumping Plant (Jones). Figure 1 provides a schematic of the SF and SDCFs in the Project configuration in the South Delta area.

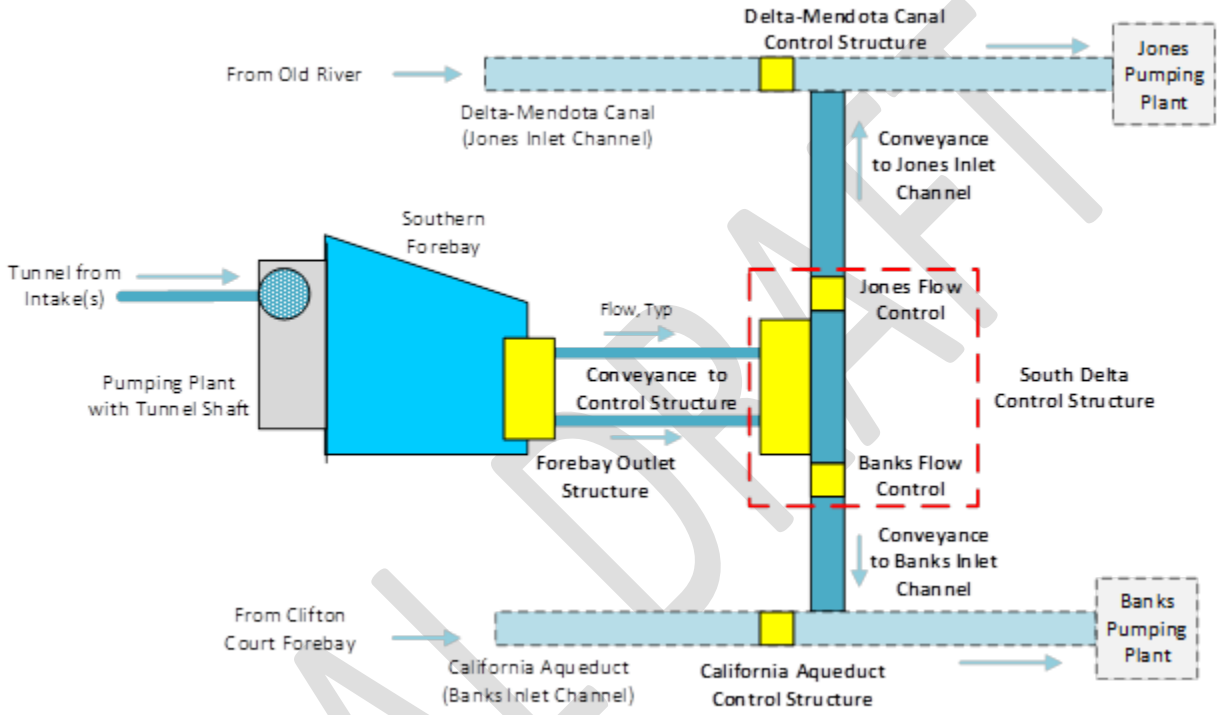


Figure 1. South Delta Conveyance Facilities Schematic

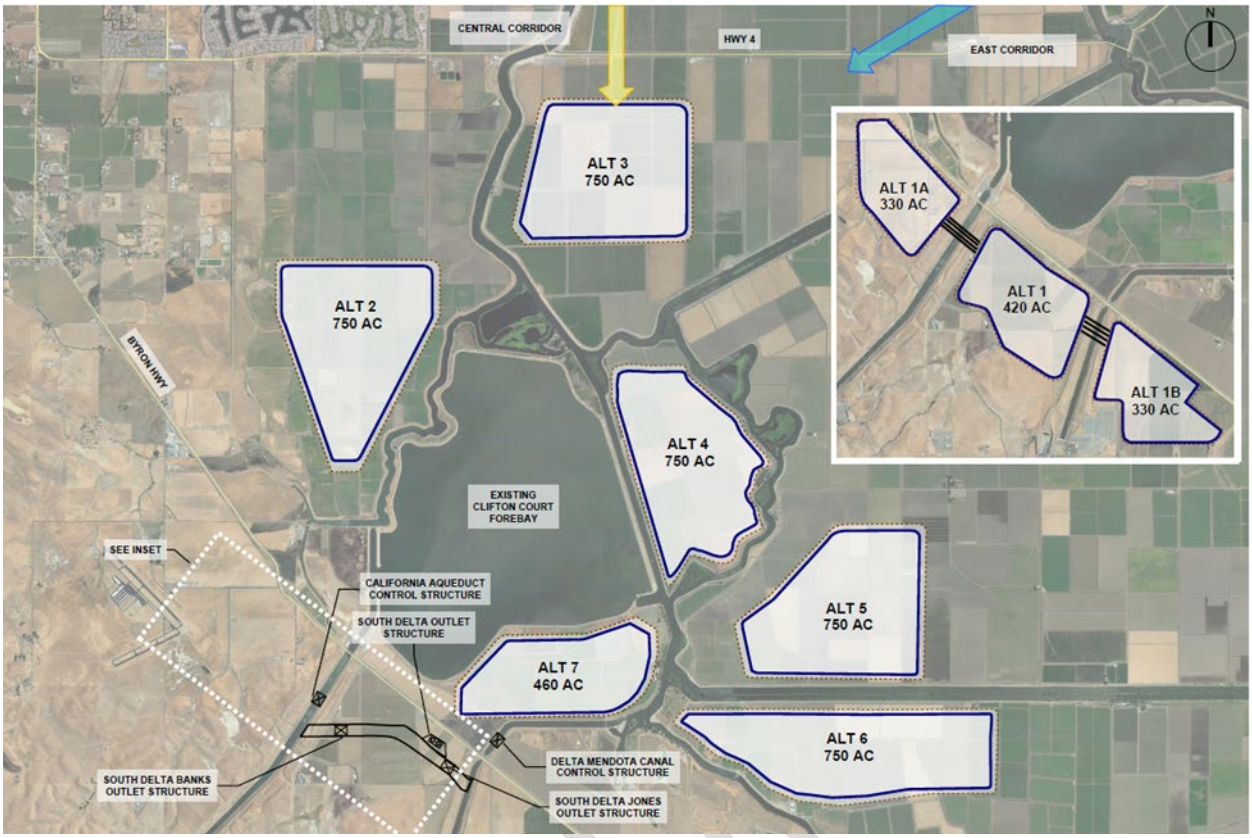
The SF's primary functions include:

- Storing supply flows delivered from the upstream Project facilities.
- Balancing flows between the upstream supply facilities and the downstream state (Banks PP) demand facilities.
- Maintaining water surface elevations (WSELs) high enough to provide the hydraulic head required to drive demand flows by gravity from the SF through the SDCF and the California Aqueduct to the existing Banks and potentially through the Delta-Mendota Canal to the existing Jones.

1.3 Summary of Results

The following points summarize the results of the siting study:

- An initial desktop study and field visit was undertaken to identify alternative sites for the SF and resulted in seven site alternatives (Figure 2). Of these, five were screened out, leaving two final alternatives (Section 4.2).



Source: Google Earth

Figure 2. Initial Alternatives Sites for the Southern Forebay

- The final two alternatives were further evaluated according to the following eight criteria:
  1) System Configuration
  2) System Operational Compatibility
  3) Property and Land Use
  4) Existing Infrastructure
  5) Geotechnical Conditions
  6) Logistics
  7) Environmental and Permitting Conditions
  8) Relative Cost
- Each alternative was assigned a rating of favorable, acceptable, or undesirable (represented graphically by green, yellow, and red, respectively) for each evaluation category. Table 1 shows the results of the evaluation.

Table 1. South Forebay Siting Analysis

Southern Forebay Final Alternative Site Evaluation Results

Criterion	Alternative 2	Alternative 5
	Qualitative Score	
System Configuration Compatibility	**Favorable**	**Favorable**
System Operational Compatibility	**Favorable**	**Acceptable**
Property and Land Use	**Favorable**	**Acceptable**
Existing Infrastructure	**Favorable**	**Favorable**
Geotechnical Conditions	**Acceptable**	**Acceptable**
Logistics	**Favorable**	**Undesirable**
Environmental and Permitting	**Acceptable**	**Acceptable**
Relative Cost	**Acceptable**	**Undesirable**

Using the results of the analyses and evaluation of the final alternative sites, Alternative 2 is recommended as the preferred site for the Southern Forebay. Alternative 2 has the best characteristics for an adequately sized site that is compatible with adjusted sizing once the dual operations at the SDCF are better understood.

2. Methodology

The methodology to identify the Southern Forebay's preferred location included the following tasks:

- Establish required forebay size
- Identify alternative SF sites
- Perform initial screening of alternative sites
- Identify evaluation criteria
- Compare alternative sites
- Recommend preferred SF site

The following assumptions were used for this analysis:

- All alternative sites are required to connect to either the central or eastern Project tunnel corridor.
- Incoming Project tunnels enter the SDPP on the upstream side of the SF, and two (double-barrel) outgoing Project tunnels exit the SF on the downstream side.
- All alternatives assumed a minimum offset of 300 feet (toe of embankment to toe of embankment) from the existing CCF and other waterways with new SF embankments to avoid new facilities impacting the structural integrity of existing facilities. This offset would need to be verified as part of the SF's further development.
- For sizing analyses, the SF was assumed to be used for diurnal storage to balance the 24-hour-per-day supply flow into the forebay and the 12-hour-per-day demand flow from the forebay to Banks. In accordance with DCO direction, operations staff indicated the 12-hour demand period would be expected to be a suitable design parameter for flow balancing to accommodate power management and downstream flow control flexibility needed for overall SWP operations. It was also assumed that the demand flow from the SF to Jones was constant and didoes not require balancing storage.

3. Southern Forebay Sizing

3.1 Volume Sizing Scenarios

The sizing of the SF is based on the need to provide equalization storage between the Project's supply and demand flow. Sizing is also influenced by the available land area and the effective storage depth available to facilitate gravity discharge of demand flow to Banks. Note, Jones operates at lower approach channel water levels and even if flow was to be provided to Jones, its operating parameters would not control the gravity discharge requirements for the SF.

Two cases were developed for the sizing of the SF:

1) Diurnal storage case
2) Normal export pumping maintenance case

3.1.1 Diurnal Storage Case

The diurnal storage case scenario would size the SF to store the supply flow during the 12-hour-per-day period when there may be no Banks demand flow requirements. Flows during the supply period for delivery to the CVP would simply be passed through the forebay to Jones and would not affect diurnal storage.

Subsequent to storage through the supply period, Banks and Jones would operate during a 12-hour demand period to export both the stored flow and the continually incoming supply flow. This scenario assumes the 24-hour SWP supply flows are directly exported for 12 hours and stored for 12 hours. Therefore, the full daily flow volume supplied to the forebay must be the total export volume pumped by the Banks PP during the 12-hour off-peak period. This scenario results in the following storage and maximum export pumping limitations:

- 3,000-cubic-feet-per-second (cfs) Supply Flow Scenario:
  - Storage needed = 3,000 acre-feet (AF)
  - 12-hour average demand flow = 6,000 cfs
- 4,500-cubic-feet-per-second (cfs) Supply Flow Scenario:
  - Storage needed = 4,500 AF
  - 12-hour average demand flow = 9,000 cfs
- 6,000-cfs Supply Flow Scenario:
  - Storage needed = 6000 AF
  - 12-hour average demand flow = 12,000 cfs
- 7,500-cfs Supply Flow Scenario (1,500 cfs is continually discharged through the SF to the CVP facilities):
  - Storage needed = 6,000 AF
  - 12-hour average demand flow = 13,500 cfs

Banks has a maximum pumping capacity of 10,670 cfs. Jones has a maximum capacity of 4,600 cfs. When the 12-hour average demand flow exceeds Banks capacity, either Jones must be operated, or the demand pumping period would need to be more than 12 hours per day. In any case, the storage requirement shown is the maximum value required for the diurnal storage case.

3.1.2 Normal-export Pumping Maintenance Case

The normal-export pumping maintenance case would also have the SF providing diurnal storage, as noted for the diurnal storage case. However, this case would also provide buffer storage to help maintain normal demand pumping through typical water management activities.

Banks is typically operated at less than its design capacity. DWR staff suggest it is typically operated at approximately 9,000 cfs, or lower, during for the demand period. Operating at 9,000 cfs would result in a demand pumping volume of 9,000 AF for 12 hours of operation. If a total of 9,000 AF of storage was provided, operations staff would have a 12-hour operational buffer to balance downstream flows, dual operations with the existing South Delta diversion facilities, and power management. This operational buffer would depend on Banks operations, so would be independent of the supply pumping capacity.

If this operational storage buffer was exhausted, it could be restored to the full 9,000 AF later by keeping the daily pumping volume supplied from the SF to less than the supply volume for a few days. The time to restore the storage volume would depend on supply capacity, Banks pumping rate, and supply from existing South Delta diversions.

3.1.3 Forebay Volume Requirement

In accordance with the two volume sizing scenarios, a design volume requirement of 9,000 AF was established for the SF siting analysis. This value is the greater of the two scenarios considered for the analysis.

3.2 Controlling Elevations

3.2.1 Southern Forebay Embankment Height and Size

A critical part of siting the SF is the height of the embankment around its perimeter. DWR recommended an external flood water surface elevation (WSEL) (including the effect of sea level rise [SLR]) of 20.8 feet (North American Vertical Datum of 1988 [NAVD88]), plus freeboard (CCR Title 23) of 6 feet for the design of the new forebay facilities. Freeboard above the flood elevation of 6 feet is required in accordance with Title 23 of the California Code of Regulations (CCR) (2014). The flood level recommendation plus the freeboard requirement results in a top elevation of at least 26.8 feet for the SF embankment. The top elevation may be increased after considering interior water levels, overflows, and additional flood modeling, and after SLR analysis was completed. However, since new information is not yet available, this siting analysis was conducted using a top of embankment elevation of 26.8 feet. For sizing purposes, an internal and external side slope of 4 (horizontal [H]):1 (vertical [V]) was used. To enable access to the forebay, a 24-foot access road was included along the top of the embankment.

3.2.2 Interior Forebay Water Surface Elevations

The WSELs inside the SF are the driving hydraulic head for gravity conveyance of flows through the SDCF to Banks and Jones.

The design minimum forebay level is the lowest WSEL that can drive the design flow capacity through the facilities and still provide the necessary WSELs at Banks and Jones. In practice, the minimum forebay level varies and depends on the desired pumping rate and the flow split between Banks and Jones. The design minimum forebay WSEL would be independent of Project capacity because it would include conveying

the peak design flow capacity of both Banks (10,670 cfs) and the potential Jones allotment of 1,500 cfs for one Project option. The design minimum forebay WSEL would be 5.5 feet to meet the minimum WSEL at the inlet to Banks. Coincidentally, the estimated WSEL required to deliver 9,000 cfs to the preferred inlet WSEL at Banks with up to 3,000 cfs being conveyed to Jones would also be 5.5 feet. Therefore, conveyance to Banks controls the driving head, and elevation 5.5 feet was used as the minimum WSEL for sizing the SF.

The maximum forebay level is the highest level that water can reasonably be stored in the SF during operating periods. As noted, the top elevation of the SF embankment is currently established at elevation 26.8 feet (may be subject to change) to provide suitable isolation from the WSEL associated with the 200-year flood plus SLR on the outside of the forebay. The forebay embankment must also be higher than the maximum operating water surface inside the forebay by the sum of interior wave runup height and freeboard. Wave runup height is predicted to be about 3 feet for the inside of the SF (DHCCP, 2009), and the freeboard requirement is 1.5 feet (DWR, 2018). Therefore, the maximum operating water level inside the forebay would be elevation 22.3, using this equation:

top elevation 26.8 feet – 3 feet wave runup – 1.5 feet freeboard = 22.3 feet (Eq. 1)

The maximum water surface occurs during an overflow event when the forebay spills to the surrounding area. The spillway is assumed to be sized so 1.5 feet of head would be required to drive the overflow rate over the spillway crest. Therefore, the spillway crest would be set at elevation 20.8 feet. Then, accounting for 3 feet of interior wave runup height (DHCCP, 2009) to protect against nuisance spills during wind events, the maximum no-spill water surface during operations would be at elevation 17.8 feet. Comparing this value to the minimum operating WSEL of 5.5 results in a 12.3-foot normal operating band. For forebay siting purposes, a nominal 12-foot operating band was selected to result in a maximum WSEL of 17.5 feet, which is similar, but slightly lower than elevation 17.8 feet.

During more detailed development of the SF, additional considerations associated with the spillway elevation relative to the interior operating levels, external flood level, and driving water surface over the spillway crest would be further evaluated. Those evaluations may result in a slightly modified elevation for the top of the embankment.

In summary, the SF WSEL would normally vary between about elevation 5.5 feet and elevation 17.5 feet. Under low-flow scenarios, the forebay level could be reduced with a lower limit slightly below elevation 0 feet, corresponding to the lowest acceptable WSEL at Banks.

Using the normal operation range of 12 feet (elevation 5.5 to 17.5 feet), a water surface area of about 750 acres would be required to store 9,000 AF of storage according to the normal export pumping scenario described.

3.3 Other Areas

A setback of about 300 feet was used to establish the footprint of the SF for all areas adjacent to other waterways, roads, and the CCF. This setback was assumed to help make sure the new forebay would be sited at a location where new embankment construction would likely result in stability issues for the adjacent levees along these existing water features. The embankment geometry would require a width of about 200 to 315 feet at 4H:1V side slopes. The SF outlet structure would require a short section of widened embankment and is not considered significant for the assumed forebay footprint. The SDPP and associated buildings and control facilities represent the largest facility within the SF, and a 15-acre site area was used for forebay layouts.

3.4 Forebay Size Requirement

Using the normal operating range of the water surface inside the SF of 12 feet (elevation 5.5 to 17.5 feet), and the requirement for 9,000 AF of storage in accordance with the normal export pumping maintenance scenario, a water surface area of about 750 acres would be required.

This area, coupled with the setback distance, the width of the embankment, and the other area requirements described, was used as the basis for identifying and evaluating alternative forebay sites.

4. Analysis and Evaluation

The following analysis and evaluation activities were used to identify and select a preferred SF location. First, seven initial alternative sites were identified to represent the most logical locations for siting the SF (Figure 2). Then, the alternative sites were screened relative to major issues and characteristics associated with each site. The remaining alternative sites were evaluated in accordance with specific evaluation criteria and compared. A preferred site is recommended based on the analysis and evaluation.

4.1 Identification of Alternative Sites

Siting constraints used to identify the seven initial alternative sites included the following:

- Proximity to Banks and associated inlet channel
- Compatibility with eastern and central Project tunnel corridors
- Consideration of previously considered forebay sites
- Compatibility with potential SDCF, which was assumes to have a configuration similar to that presented for 2018 WaterFix CER (California WaterFix, 2018)
- Suitable undeveloped land area

Alternatives 2 and 7 were previously considered as Project forebay sites. Alternative 4 was also previously considered as a potential location to expand the existing CCF. The additional four alternatives were identified based on the siting constraints.

4.2 Initial Screening of Alternative Sites

After conceptual layouts were developed for the seven initial site alternatives, the alternatives were analyzed to review their key characteristics and screen out the less preferred alternatives. Alternatives 1, 3, 4, 6, and 7 were screened out during this process.

Alternative 1 was screened out for the following reasons:

- The forebay would need to be separated into two reservoirs (Alternative 1 plus either Alternative 1A or 1B) to achieve the preferred capacity because of limiting topography and existing channels and structures. Accommodating this geometry would be expected to be substantially more costly and complex than the other alternatives.
- Undesirable physical constraints, including excessive cut slopes and setback requirements, would complicate the use of this location.

- Multiple utility relocations, including up to six high-voltage overhead transmission lines, would be required.
- Proximity to Byron Airport and to an alternative alignment for the planned development of State Highway 239 along the alignment of the existing Byron Highway (Caltrans, 2015) would complicate implementation.
- Difficult logistics would result for upstream Project tunnel drives.

Alternative 3 was screened out for the following reasons:

- Outlet tunnels (planned as two tunnels) were substantially longer than other alternatives; therefore, would be more costly than the other alternatives.
- Additional headloss for the gravity flow condition in the downstream SDCF associated with the added length of the outlet tunnel may limit the forebay operating range and require a larger forebay and additional acreage.

Alternative 4 was screened out for the following reasons:

- Difficult access would result in more costly logistics.
- Physical space constraints would limit flexibility because the alternative is surrounded by existing waterways on all sides.
- Outlet tunnels (planned as two tunnels) were longer than most other alternatives; therefore, would be more costly than the other alternatives.
- Additional headloss for the gravity flow condition in the downstream SDCF associated with the added length of the outlet tunnel may limit the forebay's operating range and require a larger forebay and additional acreage. Because the site would be constrained to about 750 acres, it may not be suitable to provide the desired storage volume.

Alternative 6 was screened out for the following reasons:

- Difficult access would result in more costly logistics.
- It would result in substantially longer upstream tunnel lengths.
- It would be adjacent to the new Mountain House development area.
- Alternative 5 is similar but has better characteristics and is located farther from the Mountain House development area, which makes Alternative 6 an unnecessary alternative.

Alternative 7 was screened out for the following reasons:

- The available water surface area of approximately 460 acres would be insufficient to meet the Project objectives for SF sizing.
- The major relocation of a high-voltage overhead transmission line would be required.
- It would require difficult logistics for facility construction and Project tunnel drives.

4.3 Final Alternative Sites

The results the initial forebay site analysis resulted in the selection of Sites 2 and 5 as the best alternative sites for the SF. These sites were formally evaluated.

4.4 Identification of Evaluation Criteria

The following criteria were used to evaluate the final SF site alternatives:

- System Configuration Compatibility
- System Operational Compatibility
- Property and Land Use
- Existing Infrastructure
- Geotechnical Conditions
- Logistics
- Environmental and Permitting
- Relative Cost

4.4.1 System Configuration Compatibility

The System Configuration Compatibility criterion addresses compatibilities with the physical layout, upstream and downstream conveyance features, and boundary flexibility, as follows:

- Upstream conveyance compatibility with eastern and central Project tunnel corridors.
- Downstream conveyance compatibility with SDCF, to convey flows to Banks and Jones.
- Boundary flexibility relative to the constraints of existing features, such as canals, sloughs, and roads that could inhibit construction and operational capability.

4.4.2 System Operational Compatibility

The System Operational Compatibility criterion addresses potential operations of the forebay with the SDCF, CCF, federal Old River diversion facilities, and Banks and Jones. The physical capacity is crucial to provide diurnal flow balancing so the intakes and the rest of the system could operate continuously when diversions were available.

- Size constraints: The preferred area is 750 acres of water surface plus embankments, setbacks, and SDPP space. This area varies by site and allows for full flow capacity using a normal operating level. Smaller areas would result in greater operating elevations that may reduce the effectiveness of the storage facility.
- Circulation through reservoir: The length to width ratio of the forebay was considered to minimize dead spots and potential areas for increased sediment accumulation.

4.4.3 Property and Land Use

The Property and Land Use criterion details the number of parcels necessary to be acquired for the forebay site. Each site is contained within a reclamation district, and each site is on existing farmland; therefore, the land use aspects of this criterion were not considered a significant differentiator for this evaluation.

4.4.4 Existing Infrastructure

The Existing Infrastructure criterion included consideration of the existing, readily identifiable infrastructure that may need relocation as part of forebay construction. This infrastructure primarily includes high-voltage overhead transmission lines and canals.

4.4.5 Geotechnical Conditions

The Geotechnical Conditions criterion includes the following significant geotechnical conditions for the forebay sites:

- Foundation conditions: Description of the soil profile according to available information
- Subsidence and settlement potential: Including the liquefaction and settlement potential of the soil
- Neighboring features issues: Proximity to CCF embankments, sloughs, canals, and other features that may cause geotechnical issues
- Seismicity: Including the proximity of the forebay locations to the West Tracy Fault

4.4.6 Logistics

The Logistics criterion includes the logistical effort necessary to access, construct, and operate the forebay, tunnels, PP, and outlet structures. Construction access via rail and road is preferred. Bridges constructed to access the site add complexity and cost. Logistics considerations include:

- Construction ease of access, including temporary facilities, such as rail terminals, bridge upgrades, and highway improvements
- Operational ease of access to forebay, PP, and outlet structures

4.4.7 Environmental and Permitting

The Environmental and Permitting criterion provides a high-level discussion of the following environmental and permitting issues:

- Sensitive habitat disruption, including estimated sensitive habitat disruption
- Special permitting that might differentiate the forebays from each other

4.4.8 Relative Cost

To compare the forebay alternatives, the relative costs were determined qualitatively via lengths of the upstream and outlet tunnels, the construction complexity, and logistical complexity. No cost estimate was prepared for this effort. The following items were considered in the relative cost analysis:

- Upstream tunneling length from a common point along each tunnel corridor (east, central, and west) to the SDPP at the forebay
- Outlet tunnel lengths from the forebay outlet structure to an assumed location of the outlet structure west of Byron Highway
- Qualitative analysis of constructability and logistical differences, such as space constraints, ground conditions, and access

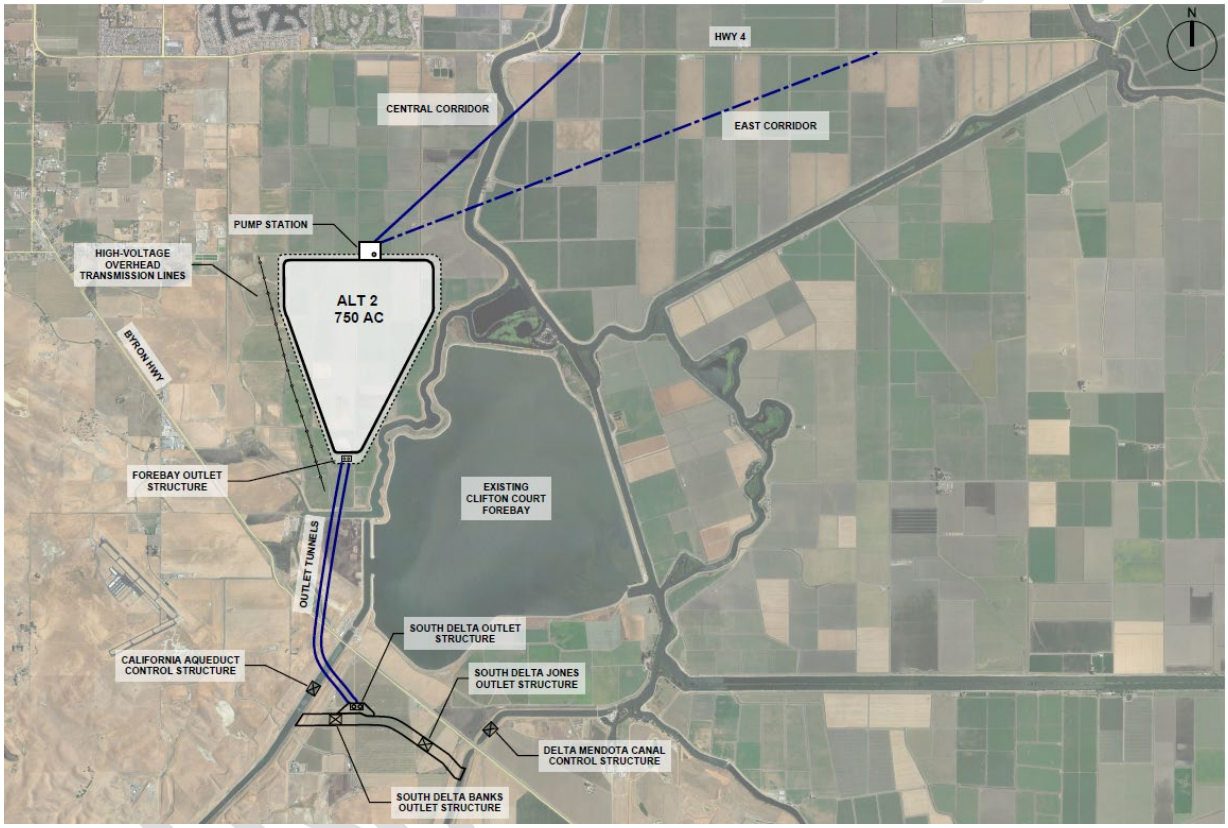
4.5 Alternatives Evaluation and Comparison

Alternatives 2 and 5 were evaluated based on the evaluation criteria, and the results are summarized here.

4.5.1 Alternative 2

Alternative 2 is located on the Byron Tract, northwest of the CCF, south of Highway 4, and northeast of the Byron Highway. The alternative is bound to the east by the Italian Slough and to the west by a high-voltage powerline corridor. Figure 3 shows the following elements:

- Location of Alternative 2
- Conceptual tunnel alignments for the three corridor alignments
- Conceptual tunnel alignment for the outlet tunnels
- Associated SDCF



Source: Google Earth

Figure 3. Alternative 2 and Interconnecting Facilities

The following subsections describe the suitability of Alternative 2 per the evaluation criteria. Also, a rating of favorable, acceptable, or undesirable is provided for each criterion.

4.5.2 System Configuration Compatibility: Favorable

System configuration compatibility is favorable because of the following reasons:

- Upstream conveyance compatibility: Highly compatible with central corridor, and good compatibility with eastern corridor
- Downstream conveyance compatibility, including outlet structures: Good compatibility
- Boundary flexibility: Adequate space available for proper setbacks and flexibility of the exact location of forebay and PP

4.5.3 System Operational Compatibility: Favorable

System operational compatibility is favorable because of the following reasons:

- Size constraints: Adequate acreage readily available on the site
- Circulation through reservoir: Configuration promotes good circulation though the reservoir with no obvious dead spots

4.5.4 Property and Land Use: Favorable

Property and land use is favorable because of the following reasons:

- Permanent property acquisition: Permanent acquisition of six parcels from one landowner would be required
- Adjacent area potentially to be used as laydown and stockpile area also owned by the same owner
- One owner may facilitate land acquisition

4.5.5 Existing Infrastructure: Favorable

Existing infrastructure is favorable because of the following reasons:

- Canals: No significant canals needing relocation
- Power poles: Location is adjacent to high-voltage overhead transmission lines, but no relocation is expected to be required

4.5.6 Geotechnical Conditions: Acceptable

Geotechnical conditions are acceptable because of the following reasons (DWR, 2019):

- Foundation conditions:
  - Peaty, organic soils within top 10 to 15 feet overlying high-plasticity clays
  - Low blow counts (Nf less than 10, where Nf is the unfactored standard penetration test blow count value) in upper 20 feet
  - All underlain by sand with high fines content with low blow counts (Nf less than 15)
- Subsidence and settlement potential:
  - Greater potential for liquefaction in upper soils due to granular layers and low blow counts
  - Greater settlement potential due to soil plasticity
- Neighboring features issues:
  - Shares relatively short stretch adjacent to CCF with Italian Slough between SF and CCF
  - All other boundaries away from adjacent sloughs
  - Adequate space to provide setback
- Seismicity:
  - Close to section of West Tracy Fault currently anticipated to have potential for surface rupture
  - DWR believes there are parallel offset faults to the northeast (URS/JBA, 2007)
  - West Tracy fault lineament immediately to the south of the SF site

4.5.7 Logistics: Favorable

Logistics is favorable because of the following reasons:

- Construction:
  - Road and rail access relatively easy
  - Construction access from Byron Highway and Union Pacific (UP) rail lines
  - Potential for barge access north of Widdows Island, via Old River
  - Site has additional adjacent acreage for a rail terminal and laydown area for construction and storage of reusable tunnel material and excess excavated material from the SDCF
- Operations: Operational access by road would be easily available via Byron Highway; no permanent bridges would be necessary for access

4.5.8 Environmental and Permitting: Acceptable

Environmental and permitting is acceptable because of the following reasons:

- Sensitive habitat disruption: The forebay site would be near sensitive habitat but would not directly impact most habitat areas
- Special permitting:
  - Several typical permits required for the construction of this site
  - Site is near the levees owned by the local reclamation district; approval needed from the local reclamation district and the Central Valley Flood Protection Board
  - Approval also necessary from Contra Costa County for change in land use designation in the General Plan

4.5.9 Relative Cost Components

The relative cost component rating is provided in the next section. Components considered include:

- One upstream tunnel (West – 29,500 feet, Central - 34,200 feet, and East 51,300 feet in length to common points)
- 750-acre SF
- Dual South Delta Outlet Tunnels – 20,600 feet total (combined) length
- Forebay Outlet Structure
- Logistics cost: Rail from UP rail lines and road from the Byron Highway; no major bridges or major relocations appear to be necessary for access

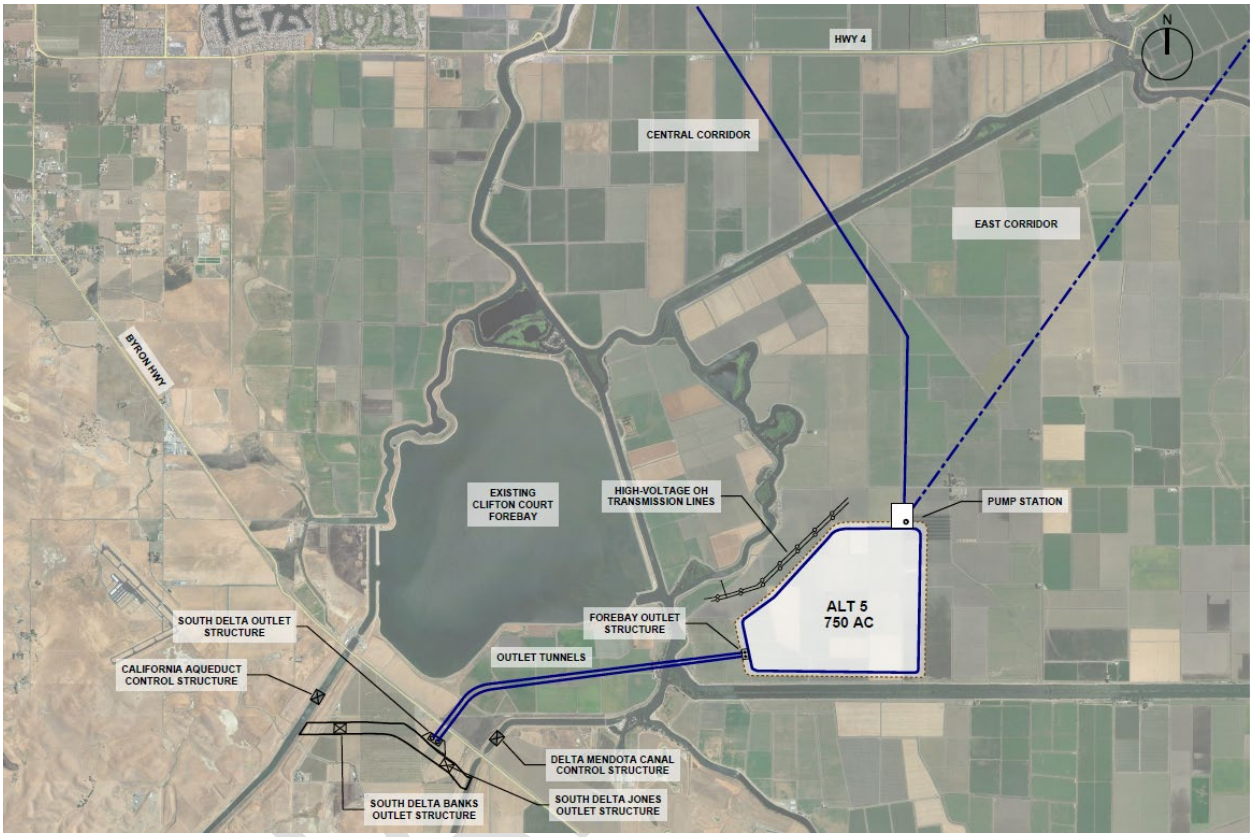
4.6 Alternative 5

Alternative 5 is located on Union Island, east-southeast of the CCF, south of Highway 4, and northeast of the Byron Highway. The alternative is west of the West Canal (leading to the end of the Old River at the beginning of the Delta-Mendota Canal), south of the Victoria Canal, and north of and adjacent to the Grant Line Canal. Figure 4 shows the following elements:

- Location of Alternative 5

- Conceptual tunnel alignments for the three corridor alignments
- Conceptual tunnel alignment for the outlet tunnels
- Associated SDCF

The following subsections describe the suitability of Alternative 5 per the evaluation criteria. Also, a rating of favorable, acceptable, or undesirable is provided for each criterion.



Source: Google Earth

Figure 4. Alternative 5 and Interconnecting Facilities

4.6.1 System Configuration Compatibility: Favorable

System configuration compatibility is favorable because of the following reasons:

- Upstream conveyance compatibility: Highly compatible with central and eastern corridors.
- Downstream conveyance compatibility, including outlet structures: Good compatibility.
- Boundary flexibility: Adequate space available for proper setbacks and flexibility of the exact location of SF and SDPP.

4.6.2 System Operational Compatibility: Acceptable

System operational compatibility is acceptable because of the following reasons:

- Size constraints: Adequate acreage readily available on the site.
- Circulation through reservoir: Potential low circulation in the southeastern corner, but a larger site could be developed to mitigate this issue.

4.6.3 Property and Land Use: Acceptable

Property and land use is acceptable because of the following reasons:

- Permanent property acquisition:
  - Permanent acquisition of two parcels from two landowners
  - Adjacent area potentially to be used as laydown and stockpile area has another owner

4.6.4 Existing Infrastructure: Favorable

Exiting infrastructure is favorable because of the following reasons:

- Canals: One minor canal needing relocation
- Power poles:
  - Location is adjacent to high-voltage overhead transmission lines, but no relocation is expected to be required for forebay
  - Powerlines could require relocation for logistics or access depending on configuration

4.6.5 Geotechnical Conditions: Acceptable

Geotechnical conditions are acceptable because of the following reasons (DWR, 2019):

- Foundation conditions:
  - Organic layer down to 10 feet (Nf less than 10), extending to 25 feet in some places
  - Followed by silt and clay with higher blow counts in areas (Nf greater than 10)
  - Underlain by a thin layer of granular soil, followed by silt and clay, both with low blow counts (Nf less than 15)
- Subsidence and settlement:
  - Greater settlement potential due to deep organic layers in some areas
  - Low blow counts throughout
- Neighboring features issues: Sloughs and canals on three sides but set back from the CCF.
- Seismicity:
  - Furthest offset from anticipated location of West Tracy Fault
  - West Tracy Fault lineament approximately 2,000 feet west of the forebay
  - West Tracy Fault not assumed to be capable of surface rupture in this location (URS/JBA, 2007)

4.6.6 Logistics: Undesirable

Logistics are undesirable because of the following reasons:

- Construction:
  - Construction access from Byron Highway is difficult and would involve at least one major bridge, probably two (Delta-Mendota Canal and Old River)
  - No potential for barge access
  - For rail access, a rail terminal would need to be built on a nearby site; there is not enough room onsite without significantly expanding the site

  - Land south of the CCF could be used for a rail terminal and laydown area for construction plus stockpiling reusable tunnel material and excess excavated material from the SDCF; may require additional acquisition of land and additional logistics for transporting materials between the islands
  - Also, construction congestion could affect access for local residents and operations at the federal Old River diversion facility.
- Operations: Permanent bridges necessary for operational access.

4.6.7 Environmental and Permitting: Acceptable

Environmental and permitting is acceptable because of the following reasons:

- Sensitive habitat disruption: SF site is near sensitive habitat, and site is near moderate modeled habitat for giant garter snake and a nest occurrence for Swainson's hawk.
- Special permitting:
  - Several typical permits required for site construction
  - Site is near the levees owned by the local reclamation district; approvals needed from the local reclamation district and the Central Valley Flood Protection Board
  - Approval also needed from San Joaquin County for change in land use designation in the General Plan

4.6.8 Relative Cost Components

The relative cost component rating is provided in the next section. Components considered include

- One upstream tunnel (West – 52,200 feet, Central – 40,100 feet, and East 43,900 feet in length to common points).
- 750-acre SF.
- Dual South Delta Outlet Tunnels – 26,800 feet total (combined) length.
- Forebay Outlet Structure.
- Logistics cost:
  - Rail from UP lines and road from the Byron Highway
  - Major bridge construction for road traffic to forebay site increases access cost
  - Relocation of some major power transmission line structures may be necessary for access or staging
  - Rail terminal could be constructed on the portion of adjacent land south of the existing CCF

4.7 Relative Cost Comparison

Relative cost was compared by quantitatively comparing the length of tunnels required for each alternative, qualitatively accounting for the cost of logistics improvements, and examining this information to determine which alternative is expected to result in lower overall Project costs. This methodology assumes the cost of the forebay itself and related structures (that is, SDPP, Outlet Structure) are not significantly different between alternatives.

To simplify the cost comparison process, the upstream and downstream tunnel lengths were combined for each alternative. Table 2 includes the combined tunnel length for each alternative and each connecting tunnel corridor. The lengths are highlighted green for the shortest tunnel length for each alternative and are highlighted in red for the longest.

To better understand the cost relationship between each of the options, Table 3 shows the tunneling cost differentials between the alternative as a percent of the lower value. This table shows that Alternative 2 has the lowest tunneling cost for the central corridor. Alternative 5 has a slightly lower expected tunneling cost for the eastern corridor, but the difference of 2 percent is not considered significant.

Table 2. South Forebay Siting Analysis

Comparative Tunnel Lengths for Each Alternative Forebay Site

Alternative	Central Corridor and Outlet Tunnel Lengths (feet)	East Corridor and Outlet Tunnel Lengths (feet)
2	**54,800**	**71,900**
5	**66,900**	**70,700**

Table 3. South Forebay Siting Analysis

Tunnel Cost Differential Expressed as Percentage of Minimum Length

Alternative	Central Corridor and Outlet Tunnel (%)	East Corridor and Outlet Tunnel (%)
2	100	102
5	122	100

Notes:

% = percent

The following subsections summarize the relative cost analyses for Alternative 2 and Alternative 5. A cost criterion rating is also provided for each alternative.

4.7.1 Alternative 2 Relative Cost: Favorable

The Alternative 2 relative cost is favorable because of the following reasons:

- Tunneling cost is lowest for the central corridor and is insignificantly higher for the eastern corridor.
- Overall complexity of logistics is low, with good access and no major constraints.

4.7.2 Alternative 5 Relative Cost: Undesirable

The Alternative 5 relative cost is undesirable because of the following reasons:

- Tunneling cost is highest for the central corridors and is insignificantly lower for the eastern corridor.
- Costs associated with logistics are expected to be high because of the complications with space for the laydown area, canal relocation, and road improvements, and due to extensive bridge

requirements to travel over the Old River and the Delta-Mendota Canal; logistics costs expected to more than compensate for any cost advantage gained from the slightly shorter tunnel.

- Because of the increased complications with logistics, a schedule delay risk and associated cost is more likely than with Alternative 2.

4.8 Summary of Evaluation

Table 4 summarizes the results of the evaluations described in this TM.

Table 4. South Forebay Siting Analysis

South Forebay Alternative Site Evaluation Summary

Criterion	Alternative 2	Alternative 5
	Qualitative Score	
System Configuration Compatibility	Favorable	Favorable
System Operational Compatibility	Favorable	Acceptable
Property and Land Use	Favorable	Acceptable
Existing Infrastructure	Favorable	Favorable
Geotechnical Conditions	Acceptable	Acceptable
Logistics	Favorable	Undesirable
Environmental and Permitting	Acceptable	Acceptable
Relative Cost	Favorable	Undesirable

5. Conclusions and Recommendations

5.1 Conclusions

The results of the analysis indicate Alternative 2 is a better option than Alternative 5. Alternative 2 has favorable characteristics in each evaluation category except Geotechnical Conditions and Environmental and Permitting, where the two sites have acceptable and about equal characteristics. Alternative 2 has a significant advantage over Alternative 5 relative to the complexity of the logistics for access and construction phase work.

The simplified logistics, coupled with a spacious site, should result in Alternative 2 being substantially lower in risk and cost to develop as the SF.

5.2 Recommendation

This information developed for the SF siting analysis results in Alternative 2 being recommended as the preferred site alternative for the development of the SF. Alternative 2 has the best non-cost characteristics for an adequately sized site that is compatible with adjusting sizing once the dual operations at the SDCF are better understood.

6. References

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7. Document History and Quality Assurance

Reviewers listed have completed an internal quality review check and approval process for deliverable documents that is consistent with procedures and directives identified by the Engineering Design Manager (EDM) and the DCA.

Approval Names and Roles			
Prepared by	**Internal Quality Control review by**	**Consistency review by**	**Approved for submission by**
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This interim document is considered preliminary and was prepared under the responsible charge of Philip K. Ryan, California Professional Engineering License C41087.

Note to Reader

This is an early foundational technical document. Contents therefore reflect the timeframe associated with submission of the initial and final drafts. Only minor editorial and document date revisions have been made to the current Conformed Final Draft for Administrative Draft Engineering Project Report version.