DRAFT INTEGRATED GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SAN FRANCISCO BAY TO STOCKTON, CALIFORNIA NAVIGATION STUDY

APPENDIX A: Civil Site

APRIL 2019

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1. Purpose of Appendix

This appendix summarizes the civil engineering design criteria for the proposed San Francisco Bay to Stockton Navigation Improvement Project. The project area includes the West Richmond Channel, Pinole Shoal Channel, and the Suisun Bay Channel (i.e., from Carquinez Strait to Avon), including Bulls Head Reach, and is collectively referred to as the S.F. Bay to Stockton Navigation Improvement Project in the integrated General Reevaluation Report and Environmental Impact Statement/Environmental Impact Report (hereinafter, integrated document). This project is referred to more generically as the "SF Bay to Stockton Project", or the "Project" in this appendix. This appendix includes a discussion of the type of dredging equipment that is anticipated to be used on this project, and information on the Transbay Cable utility, which lies beneath the Pinole Shoal Channel, as well as the dredged material placement sites that are likely to be used for this project. This report will serve as an appendix to the study's integrated document.

As discussed in the integrated document, the Project, is a single-purpose navigation improvement project which proposes to deepen the West Richmond Channel, Pinole Shoal Channel, and the Bulls Head Reach of the Suisun Bay Channel. A feasibility level analysis and a subsequent recommendation to the Chief of Engineers is provided in the General Reevaluation Report. This appendix provides the details of the civil engineering portion of the analysis.

2. Background

The study area *(Figure 1*) for the Project includes the West Richmond Channel, Mare Island/San Pablo Bay Channel (Pinole Shoal Channel), and the Suisun Bay Channel up to Avon. Combined, these channels make up the western portion of the S.F. Bay to Stockton Channel. The authorized S.F. Bay to Stockton Navigation Improvement Project actually begins just outside the Golden Gate Bridge at the 55-ft mean lower low water (MLLW) Main Ship Channel and transits Central San Francisco Bay, San Pablo Bay, Suisun Bay, and the San Joaquin River to the Port of Stockton Bay (*Figure 1*). This Project will only include the western reach areas located in San Francisco, Alameda, Marin, and Solano Counties. The total length of the S.F. Bay to Stockton Channel to Avon is approximately 44 miles. The western reach (S.F. Bay to Avon) of the navigation channels are currently maintained to a depth of 35-ft MLLW, with 2-feet of allowable over depth. The Ship Channel through the West Richmond Channel is naturally deeper than the other two channels and currently does not contain any sediment above 38-ft MLLW. For the purposes of this study, only the Pinole Shoal Channel (PSC), including a small area west of the beginning of the PSC where a rock formation with a peak elevation of 39.7-ft MLLW exists, and the Bulls Head Reach (BHR) portion of the Suisun Bay Channel to Avon will be evaluated. In addition, a sediment trap is planned within the Bulls Head Reach, which will help manage the effects of excessive shoaling in a small portion of the BHR that has often required additional dredging outside of the normal maintenance cycle.

The BHR and the PSC channels have specific environmental work windows. The work windows were established to protect sensitive life stages of special status fish which use both channels. The PSC work window begins 1 June and ends on 30 November in any year. This work window was established to support the critical life cycle of salmonids. The BHR work window begins 1 August and ends on 30 November in any year. The work window for the BHR was established to support the critical life cycles of salmonids, and delta smelt. Because of the critical nature of delta smelt, the U.S. Fish and Wildlife Service has prohibited the use of hopper dredging in the BHR. It is anticipated all dredging in the PSC and BHR will be completed within a single work window, including all normally scheduled maintenance dredging for both channels.

The current tentatively selected plan (TSP) is not based solely on the lowest cost to deepen both the PSC and BHR channels to 38-ft MLLW, but rather to deepen both channels and to transport and place the dredged material at the sites that are most likely to be cost effective and environmentally acceptable to the resource agencies. Further discussion of the beneficial use of dredged material can be found in Section 5.2.

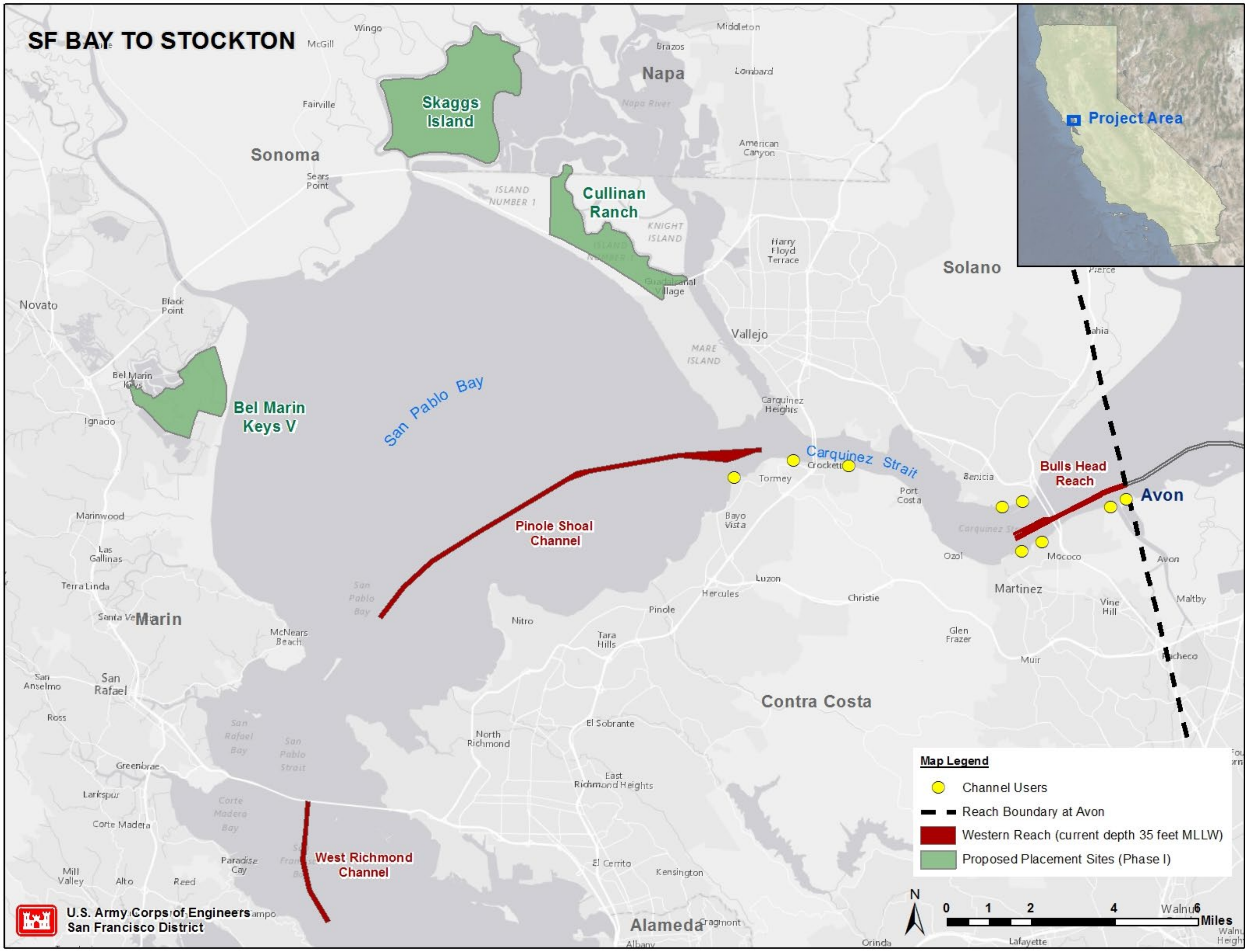


Figure 1 - San Francisco Bay to Stockton Navigation Improvement Study Area.

3. Channel Design

3.1. USACE Ship Channel Design Requirements

The reference for ship channel design is Engineering Manual (EM) 1110-2-1613 *Hydraulic Design of Deep-Draft Navigation Projects* dated 31 May 2006. The first step in channel design is to determine what the design vessel will be. This is typically based on what is the largest vessel that transits the channel, or a portion of the channel to its eventual destination, or port of call. The San Francisco Bar Pilots and the refinery vessel pilots were consulted to determine; what is most likely to be largest vessel(s) to call at the refineries in the future if the channels were deepened. For the West Richmond Channel, Pinole Shoal Channel, the design vessel is the Suezmax Class, and the design vessel for the portion of the Suisun Bay Channel leading up to the Interstate 680 Benicia-Martinez Bridge, is a vessel in the Panamax Class. The largest oil tanker was anticipated to be a 175,000 DWT vessel from the Suezmax Class. The typical overall length (LOA) of a Suezmax Class vessel is 900-ft with a width (beam) of 164-ft. The draft, or depth of the Suezmax vessel below the waterline, when optimally loaded is approximately 40-ft. However, the oil tankers that call at the refineries in this project are not fully loaded because they will offload product at other ports before they call in S.F. Bay. The draft that will be used for this project will be 35-ft (38-ft MLLW Alternative), and 34-ft (37-ft MLLW Alternative) based on the 3-ft of minimum under keel clearance (UKC) that is required for safe passage by the San Francisco Bar Pilots (Pilots). The UKC value also includes 1-ft of squat.

The channel width is defined as the distance between the toes of the channel. The toe is the intersection of the channel bottom and the channel side slope. The width for the existing PSC channel varies from 600-ft to 800-ft, in the straight channel sections, and 1,200-ft in the PSC maneuvering basin, and the width for the existing BHR channel varies from 600-ft to 300-ft. The existing channels were designed for one-way ship traffic and this project does not propose a change to two-way traffic. The majority of the existing channels are classified as a “Trench-Type” and the remaining portions of the channels are naturally deep and do not require deepening. The minimum required width for the design vessel is determined by using the information in Table 8-2 of EM 1110-2-1613 and the vessel traffic information found in the annual waterborne commerce statistics managed by the Institute of Water Resources. The current in the PSC and BHR channels are greatly influenced by the tidal flows in San Pablo Bay and the natural flow of the Sacramento and San Joaquin Rivers into San Pablo Bay. The total transit time from the Golden Gate Bridge to the refinery berths at Avon can take five to six hours to travel the 32-mile distance. During that transit, the vessel may experience half of a tide cycle coupled with the flow of the river system. The design vessel may experience a 5-knot following flood tide at the Golden Gate Bridge on an in-bound vessel, and arrive at the Avon facilities against a 5-knot river current 5-hours later. The oil tankers that transit these channels travel without tug boat assistance at a minimum speed of 4 knots relative to the prevailing current in the channel in order to maintain control of the vessel. However, if the vessel is transiting in-bound on a flood tide, or out-bound on an ebb tide, and is optimally loaded, tug boat assistance is required to keep the net maximum vessel speed below 7-knots. Therefore, the appropriate

Beam Multiplier for Maximum Current in a straight Trench Cross Section is 4 in Table 8-2. The resulting minimum channel width required for one-way ship traffic is (164-ft.) X (4) = 656-ft. This value is greater than the existing 600-ft channel width, therefore; in order to determine whether the channel needs to be widened, a ship simulation study must be performed.

The design vessel for the 300-ft wide portion of the BHR Channel that is between the Interstate 680 Benicia-Martinez Bridge and Avon is a Panamax Class tanker vessel with an LOA of approximately 590-ft and a beam of 105-ft. The appropriate Beam Multiplier for Maximum Current in a straight Trench Cross Section is 2.75 in Table 8-2 because these vessels will always be under tug assist while they transit under the bridge. The resulting minimum channel width required for one-way ship traffic is (105-ft.) X (2.75) = 288-ft. This value is less than the existing 300-ft width for the BHR channel, so no adjustments to the channel width are necessary for this portion of the project.

As part of the design process for deepening a deep draft channel, consideration of vessel-generated bow waves on channel side slopes was evaluated. The assumptions for this evaluation are:

- The design vessel remains the same as the existing ships that currently call at the ports and refineries.
- The existing ships will carry more cargo to take advantage of the deeper draft.
- The number of vessel calls will remain the same.
- The design vessel speed is unchanged from existing conditions.

The basic channel design remains a "Trench-Type" per EM 1110-2-1613 Hydraulic Design of Deep Draft Navigation Projects, dated May 2006. Because the channel side slopes remain entirely below the water surface, there is no wave to break against the side slope. Therefore, regardless of how deep the channel is deepened, there will be no erosion of the side slopes due to vessel-generated bow waves.

3.2. Ship Simulation Study

A Ship Simulation Study (*Vessel Simulation Navigation Study of the Proposed John F. Baldwin Ship Channel – Phase III Proposed Channel Improvements*, DTMA 91-88-C-80024, Final Report, dated August 1992) was performed during the 1990's while the Sacramento District (SPK) was responsible for the project because it was in their Area of Responsibility. SPK contracted a Vessel Simulation Navigation Study with Marine Safety International in 1992. The Study used a USACE-approved numerical model that met the acceptance criteria identified in EM 1110-2-1613. The design vessel for the Study was the Exxon Benicia, which has since ben decommissioned and scrapped. The Pilots were the participating users for the simulation study. In addition to the proposed deepening alternatives, the SPK preliminary design included some minor channel realignments but did not include any widening. The Pilots made recommendations for relocation of navigation aids and channel realignment details that would increase navigation safety and satisfy their concerns. The final study report confirmed that if the aforementioned recommendations were incorporated into the proposed channel design, there would be no need for any widening of the proposed channel. Since the Ship Simulation was performed, all of the Pilot recommendations have been incorporated into the existing channel configurations, with the exception of the actual deepening. At this point the Ship Simulation Study effort is considered to be complete and no further action is required.

The Pilots also requested that USACE consider an extraordinary measure, such as a sediment trap to control excessive shoaling that occurs in the Suisun Bay Channel in the Bulls Head reach north of the Martinez Bridge. This measure is discussed in Section 3.4 below.

3.3 Pinole Shoal Channel (PSC)

The PSC is located in the San Pablo Bay in Marin, Solano, and Contra Costa Counties, California and begins just northeast of the Interstate 580 San Rafael Bridge and extends east 10.4 miles to an area west of the Intestate 80 Carquinez Bridge near the mouth of the Napa River (*Attachment 1*).

Hydrographic surveys have determined there is an existing rock formation located in the shipping lane west of the beginning of the PSC (*Figures 2 and 3*). This formation is presumed to be associated with the San Franciscan formation on the San Pablo Bay bottom. The rock formation was recently surveyed and is located 1,260-ft west of STA 0+00, and the peak is found to be at approximately 39.7-ft MLLW. Even though this rock formation is not in the federal channel, it is located in the shipping lane and will need to be addressed as part of this project to provide safe navigation at the minimum TSP depth of 38-ft MLLW. The rock formation will be lowered so that there is a minimum of 3-ft of additional clearance below the 2-ft of overdepth tolerance. This means that the Project will be lowering the rock formation to approximately 43-ft MLLW for the 38-ft depth. Although the rock formation has not been specifically sampled, it is assumed that because of its predicted hardness, the removal will likely require using a pneumatic jack-hammer attachment that would be mounted to an excavator mounted on a work barge. The jack-hammer would chisel the rock down to the desired elevation. The material could then be retrieved from the bay floor using a clamshell bucket, placed on a work barge, and disposed elsewhere. This material could also be left alone on the bay floor where it is naturally deep, if the resource agencies agree that it will not be detrimental to any critical habitat. It may be required to mitigate the effects of the equipment being used by deploying a bubble screen to absorb any sound or wave energy generated by the jack-hammer. The estimated quantity of rock to be removed is approximately 40 cubic yards (CY) to achieve a safe navigation depth of 43-ft MLLW for the 38-ft TSP depth, within an area of approximately 950 square feet.

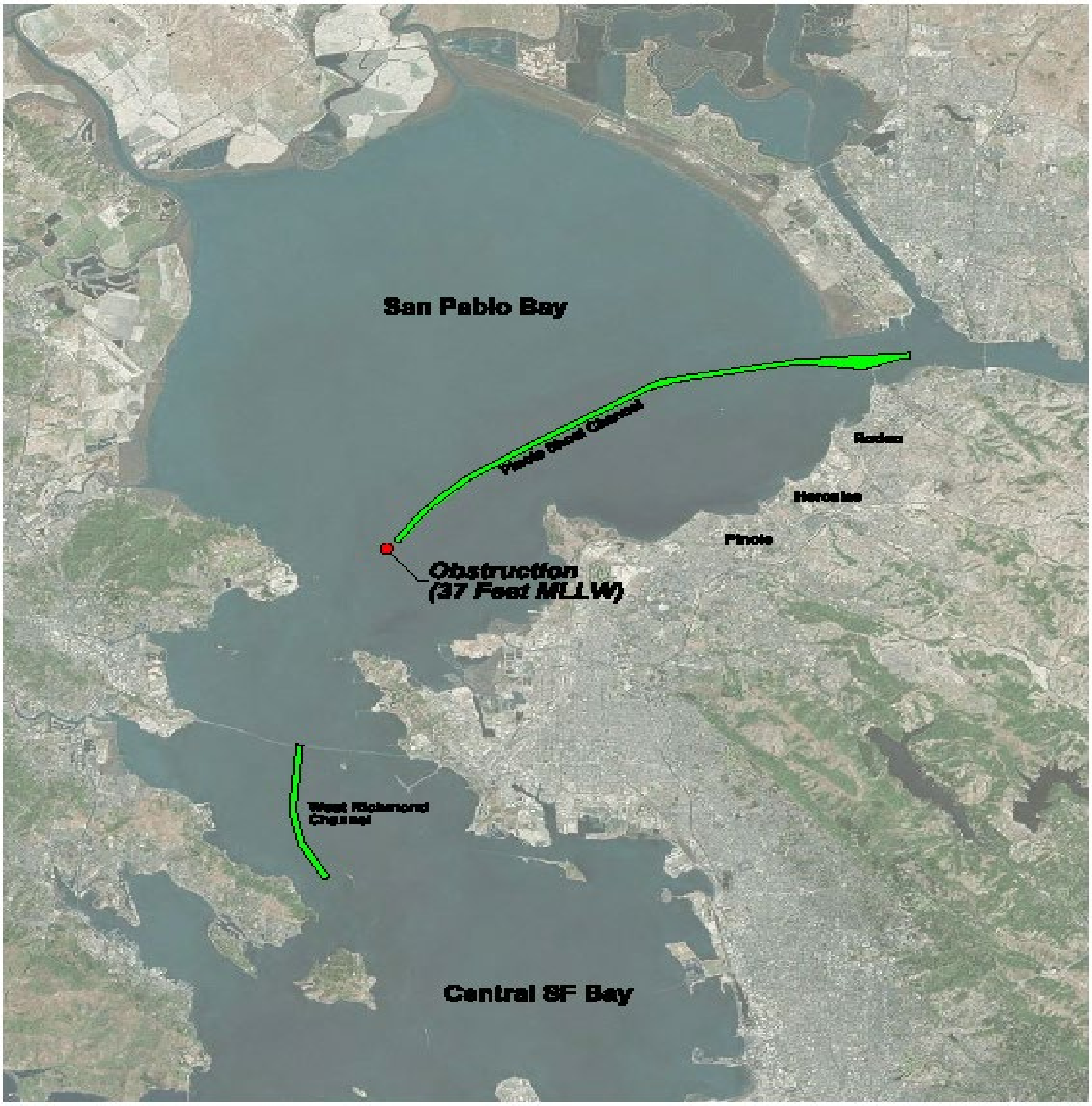


Figure 2 - Pinole Shoal Channel Obstruction.

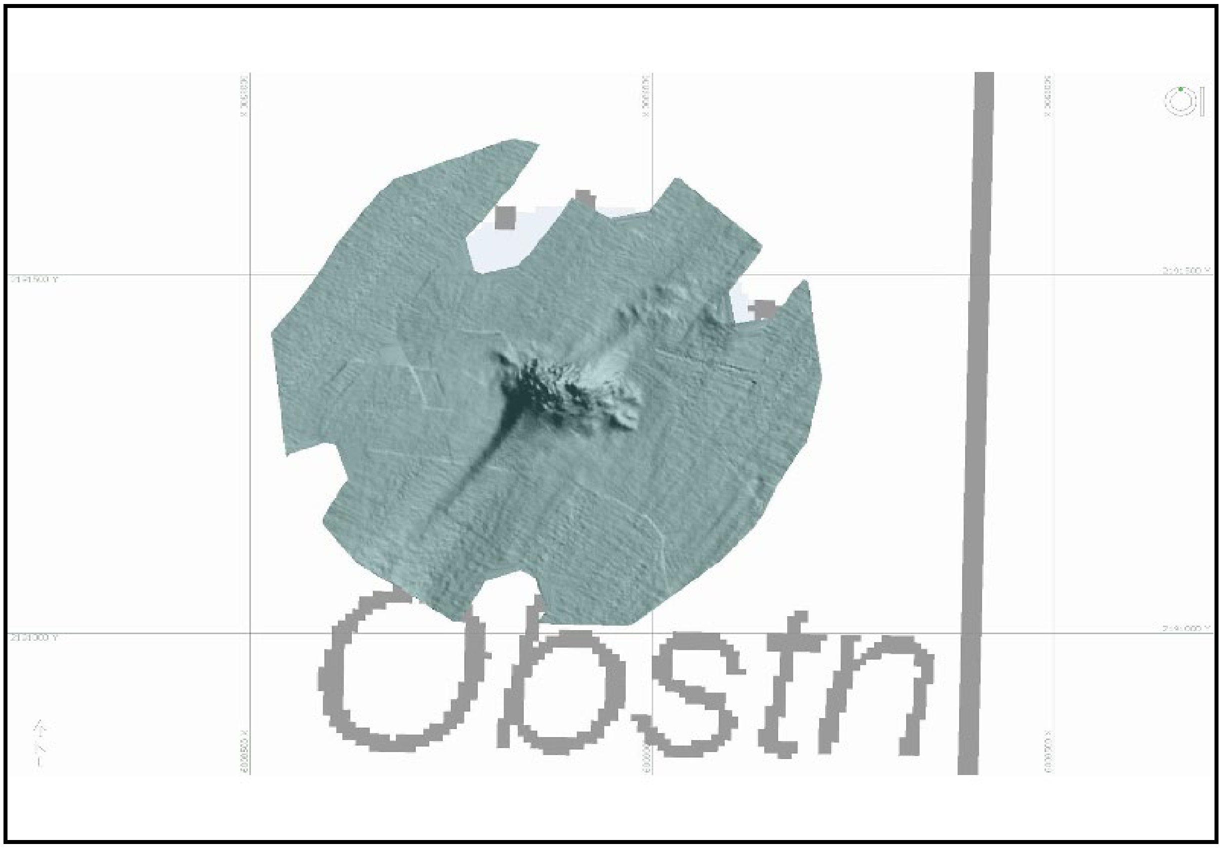


Figure 3 – Pinole Shoal Obstruction Detail – STA -12+60.

The PSC will not need to be re-aligned or widened because all of the recommendations for realignment from the Ship Simulation Study have already been executed, and the project design vessels that currently use the channel, are easily accommodated by the existing channel configuration. The current channel configuration also meets the design criteria provided in EM 1102-2-1613. The PSC boundaries will not differ from the current authorized alignment. An analysis of the historical channel sediment data is documented in the **Geotechnical Appendix.** The analysis indicates that the side slope cannot be cut vertically for the deepening because it would likely fail based on the sediment physical characteristics. The analysis indicates that the sediment will be stable if it is excavated at a minimum 3H: 1V slope (*Figure 4b*).

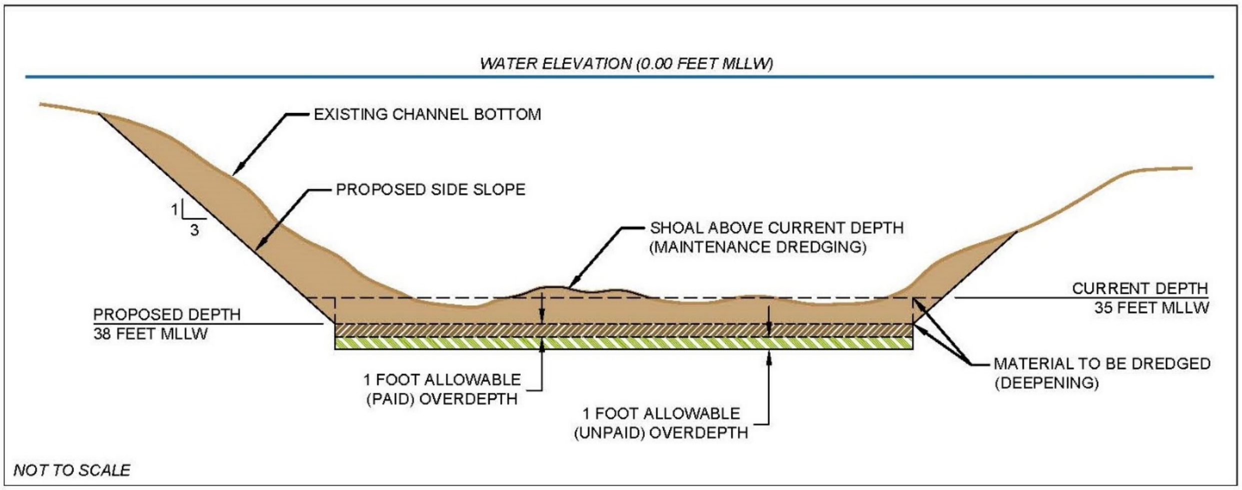


Figure 4a – Typical PSC and BHR Channel Cross Section.

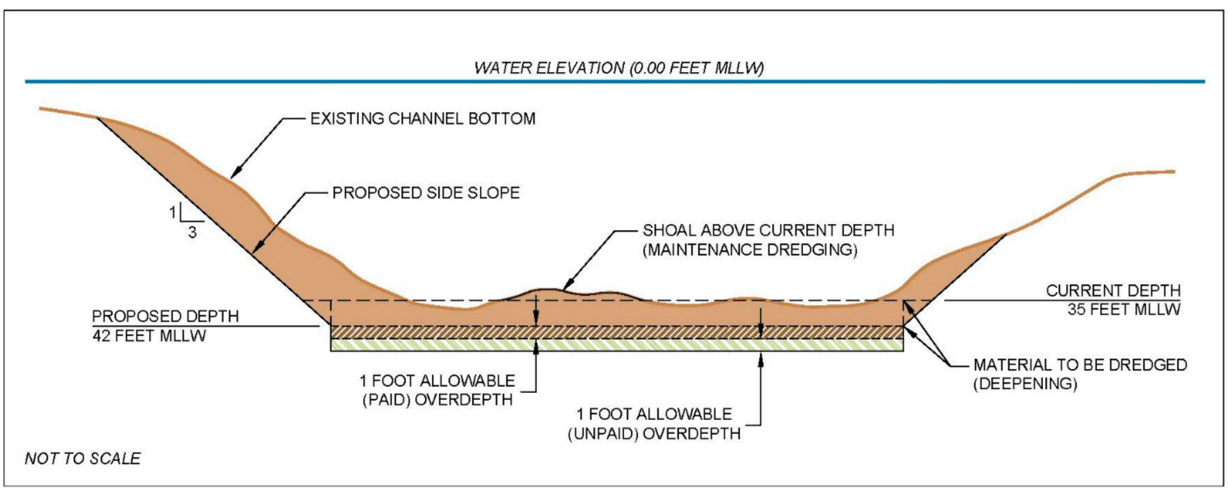


Figure 4b – Typical BHR Channel Sediment Trap Cross Section.

3.4. Suisun Bay Channel/Bulls Head Reach

The BHR portion of the Suisun Bay Channel begins approximately 1 mile south of the Interstate 680 Benicia-Martinez Bridge and extends east approximately 3 miles to the Avon Wharf (*Attachment 2*). The BHR design will also not need to be widened or re-aligned for the same reasons as the PSC. The proposed improved channel includes 3H: 1V side slopes (*Figure 4a*) as does the proposed sediment trap (*Figure 4b*), which is located between STA 62+00 and STA 88+00. The proposed side slopes are based on the sediment physical characteristics and the slope stability analysis that is included in the **Geotechnical Appendix**.

Since 2000, a total of 9 separate emergency dredging actions have been performed in BHR (*Table 3.4)* with an average frequency of approximately 2.67 years. The average cost per emergency dredging event is approximately $310,700 and all but two of the actions were performed with the Government hopper dredges. The average cost and quantity of using a Government hopper dredge is approximately $271,400/94,000 CY, and the average cost and quantity using a commercial clamshell dredge is approximately $448,300/22,500 CY. These costs include mobilization and demobilization of the dredging equipment. Since the addition of a second Interstate 680 highway bridge in 2007, there has been an increase in shoaling in the Bulls Head Reach. It is perceived the increase in shoaling is associated with the configuration and proximity of the new bridge piers to the existing bridge piers in the channel footprint, which are causing more sediment to deposit in the channel footprint during the ebb tide. During the period from 2009 to 2014, six separate advance maintenance efforts were also included with the scheduled O&M dredging. These advance maintenance efforts dredged the area between STA 62+00 and STA 88+00 to a depth of 37-ft MLLW plus 2-ft of overdepth in 2009, 2010, and 2011. Three of the events were included with the commercial clamshell dredging contracts and two were included with the Government hopper dredging efforts. These efforts were not entirely successful and emergency dredging was again required in 2010 and 2011 outside of the scheduled O&M dredging. Beginning in 2012, the depth of advance maintenance was increased to 38-ft MLLW plus 2-ft of overdepth and since then, emergency dredging outside of the scheduled O&M dredging has not been required. The average cost and quantity of advance maintenance using a Government hopper dredge is approximately $183,200/26,900 CY. The average cost and quantity of advance maintenance using a commercial clamshell dredge is approximately $488,200/20,000 CY. These average costs do not include mobilization and demobilization of dredging equipment. The average quantity of sediment removed from between STA 62+00 and STA 88+00 for the "emergency" dredging actions, and discounting the quantity from 2002 because it may include a larger dredge area, is approximately 35,100 CY.

Table 3.4 – Historical BHR Emergency Dredging Episodes.

Year	Dredge Plant	Disposal Site	Volume (CY)	Unit Price	Total Cost
2000	Gov't Hopper	SF-11	20,964	$2.16	$45,200.00
2000	Clamshell	SF-16	28,000	$18.16	508,479.93
2001	Gov't Hopper	SF-16	105,779	$2.04	$216,000.00
2001	Clamshell	Sherman Island	16,997	$19.78	$336,269.40
2002	Gov't Hopper	SF-16	422,798	$2.03	$860,198.00
2006	Gov't Hopper	SF-16	72,627	$2.20	$159,458.33
2009	Gov't Hopper	SF-16	12,001	$10.03	$120,399.31
2010	Gov't Hopper	SF-16	8,718	$6.24	$54,427.78
2012	Gov't Hopper	SF-16	15,631	$29.40	$443,859.72

Note: Total Cost includes mobilization and demobilization costs.

A shoal analysis was performed on this area of the channel in 2015 and is included in the **Water Resources Appendix**. The analysis recommends continuing advance maintenance, or construct a permanent sediment trap between STA 62+00 and STA 88+00 to a depth of 42-ft MLLW for the 38-ft TSP depth (*Figure 4b*). The proposed sediment trap in BHR will be excavated to a depth that will be 4-ft below the selected alternative depth and will also have 2-ft of allowable overdepth, and side slopes that are cut at a 3H: 1V horizontal to vertical ratio. The location of the proposed sediment trap is based on historical hydrographic survey data from the previous 17 years. The historical survey data indicates that this area of the BHR shoals in at a much higher rate than the rest of the Suisun Bay Channel, to the point where this area sometimes requires an additional dredging episode outside of scheduled O&M dredging cycles. In some years, emergency dredging outside of the environmental work window, and advance maintenance dredging occurred in order to keep the channel clear for commercial ship traffic. The shoal analysis indicates that the proposed sediment trap will capture a sufficient amount of material between dredge cycles to greatly reduce, if not eliminate the need for emergency dredging between maintenance cycles. Table 3.5 below shows that performing advance maintenance dredging to a depth of 37-ft MLLW plus 1-ft of additional paid overdepth in the area between STA 62+00 and STA 88+00 eliminated the need for a second dredging event in the same area during the same dredge year. Since advance maintenance dredging was included in the Suisun Bay Channel maintenance dredging project beginning in 2013, the average amount of sediment removed as a part of the advance maintenance dredging is approximately 19,620 CY, which is an approximately 56 percent reduction when compared with the average emergency dredging event from the period before advance maintenance dredging was initiated. Also, in addition to extending the utility of the federal channel between maintenance cycles, the advance maintenance eliminated the cost associated with executing more than a single maintenance dredging event per year.

Table 3.5 – Historical BHR Advance Maintenance Dredging STA 62+00 to STA 88+00

Year	Dredge Plant	Disposal Site	Dredged Volume (CY)
2013	Gov't Hopper	SF-16	25,930
2014	Gov't Hopper	SF-16	20,373
2015	Clamshell	SF-16	23,711
2017	Clamshell	SF-16	11,470
2018	Clamshell	SF-16	16,623

For the immediate future, hopper dredges will no longer be permitted to dredge in the Suisun Bay Channel, including BHR, because of the presence of delta smelt, which is a listed endangered species. Therefore, all future without-project emergency and/or advance maintenance dredging actions will be performed using clamshell dredge plants. The current estimated cost for an emergency dredging action is approximately $720,000 and the estimated cost of advance maintenance is approximately $625,000. Currently, each advance maintenance effort must be consulted and coordinated with the environmental resource agencies and the Major Subordinate Command (South Pacific Division) for authorization and approval. This effort can take two to three months to complete at an annual cost of approximately $75,000 in labor for all involved. This effort could be eliminated if the sediment trap was included as a permanent feature of the project. The estimated additional cost associated with the construction of the sediment trap, which is dredging an additional estimated 94,600 CY including 1-ft of paid over depth, is approximately $972,000 for the 38-ft TSP depth. Prior to 2013, emergency dredging was necessary, on average every 2.67 years. Since the initiation and refinement of advance maintenance dredging in the Bulls Head Reach, the need for emergency dredging has been all but eliminated. Based on this empirical evidence, the initial investment in the sediment trap will pay for itself within two years after construction is completed. A more detailed analysis of the costs and benefits associated with the proposed sediment trap are included in the **Economic Appendix.**

4. Estimated Dredging Volumes

The estimated dredge quantities for both the PSC and BHR channels were computed with Hypack hydrographic survey software. The dredge quantities for the PSC are summarized in Table 4.1, and the quantities for the BHR to Avon are summarized in Table 4.2. Soundings were taken by multi-beam hydrographic survey equipment and are referenced to the MLLW datum. The plane grids and coordinates are based on the Lambert projection, NAD 83 California Zone 3 for the PSC and NAD 83 California Zone 2 for the BHR.

For cost accounting purposes, estimated O&M volumes will include the volumes to 36-ft MLLW for the 37-ft and 38-ft alternatives. Likewise, the deepening volumes will begin at 36-ft MLLW for the 37-ft and 38-ft alternatives. These total volumes include all of the required material above the current project depth (35-ft MLLW) plus 1-foot of paid overdepth, which is everything that would be paid for by the project O&M account.

Table 4.1 - Estimated Pinole Shoal Channel Volumes.

Depth (feet)	Station	Volume (CY)	1-foot Paid Overdepth (CY)	1-foot Non-Paid Overdepth (CY)	Total (CY)
-37	0+00 to 548+08	92,900	304,000	304,000	**700,900**
-38	0+00 to 548+08	410,400	516,750	516,750	**1,443,900**

Table 4.2 - Estimated Bulls Head Reach Volumes.

Depth (feet)	Station	Volume (CY)	1-foot Paid Overdepth (CY)	1-foot Non-Paid Overdepth (CY)	Total (CY)
-37	0+00 to 62+00	600	700	900	2,200
-41	62+00 to 88+00	35,300	13,000	15,000	63,300
-37	88+00 to 160+00	3,600	7,500	9,000	20,100
	TOTAL	**39,500**	**21,200**	**24,900**	**85,600**
-38	0+00 to 62+00	2,500	4,000	5,500	12,000
-42	62+00 to 88+00	69,500	25,100	26,000	120,600
-38	88+00 to 160+00	9,500	8,000	9,200	26,700
	TOTAL	**81,500**	**37,100**	**40,700**	**159,300**

4.1. Estimated Future O&M Volumes

The historical average annual shoal rates for the PSC is approximately 127,500 CY/year and approximately 25,000 CY/year for the BHR portion of the Suisun Bay Channel. However, recently the PSC maintenance dredging has changed from an annual maintenance cycle to a 2-year cycle. The change in the maintenance cycle also includes requiring that specific high shoaling-areas within the channel footprint be dredged to their full 2-ft of overdepth in order to optimize channel utility between maintenance dredging cycles. Therefore, the estimated future O&M volume for the PSC will be approximately 350,000 CY/2-Yr for the TSP. These shoal rates are based on the condition surveys from the previous 15 years. The estimated future O&M dredging volumes for the PSC and BHR channels were determined by calculating the historical average dredging volumes for these projects from the previous 15 years. These figures are shown in Table 4.3 below. The average volumes are anticipated to increase by 15 percent based on the observed average increase in O&M volumes from the Oakland Harbor 50-ft Navigation Improvement Project that was completed in 2010, and the Richmond Inner Harbor 38-ft Navigation Improvement Project that was completed in 1998. Both of these projects demonstrated an increase in annual O&M dredge volumes that averages approximately 15 percent. The shoal rate for the Bulls Head Reach was determined independently based on the shoal analysis in the **Water Resources Appendix**. The analysis determined that if a sediment trap was excavated 4-ft deeper than the rest of the BHR, the sediment trap would provide sufficient capacity for the annual shoaling that is typically encountered. This will allow the entire Suisun Bay Channel to be maintained on a one year dredging cycle without the need for interim emergency dredging in the BHR.

Table 4.3 - Estimated Future O&M Volumes.

Depth (feet)	Channel	Ave. Annual Volume (CY)	Estimated Annual Increase (CY)	Future Estimated Annual O&M Total (CY)
-37	Pinole Shoal Channel	127,500	22,500	150,000
-37	Bulls Head Reach	25,000	4,500	29,500
-41	Sediment Trap	0	5,700	5,700
	TOTAL	**152,500**	**32,700**	**185,200**
-38	Pinole Shoal Channel	127,500	48,400	175,900
-38	Bulls Head Reach	25,000	20,700	45,700
-42	Sediment Trap	0	8,900	8,900
	TOTAL	**152,500**	**78,000**	**230,500**

5. Dredged Material Disposal Sites

The determination of disposal sites and dredging equipment for this project was accomplished using the guidance and direction provided in EM 1110-2-5025 *Dredging and Dredged Material Disposal* dated 25 March 1983. Prior to determining what dredging equipment will be used, it is necessary to determine where the dredged material is suitable to be disposed, or placed. This will require that the material to be dredged has been sampled and tested in accordance with standard Corps sampling and testing guidance criteria and protocols, as well as satisfying the State of California's regional (S.F. Bay) Water Quality Control Board's (SFBRWQCB) requirements for sampling and testing of dredged material. The U.S. Environmental Protection Agency (EPA) has delegated its authority for enforcement of the Clean Water Act (CWA) and Coastal Zone Management Act (CZMA) to the State of California, which in turn assigned the CWA responsibility to the state's Water Control Board. The SFBRWQCB together with various other federal, state, and local agencies, comprise the Dredged Material Management Office (DMMO). The DMMO reviews and approves all dredging permit applications, sampling and testing plans, and the testing results for all dredging projects within the San Francisco Bay and San Pablo Bay. The DMMO will issue a Suitability Determination to the applicant that identifies all the disposal sites the dredged material is suitable to be disposed or placed at. The San Francisco District's (District) Regulatory office heads the DMMO, as well as issues all Corps 401(b) permits for all non-federal dredging projects. Since the Corps does not issue permits to itself, the Corps is not required to have a permit to dredge federal projects from any agency. The SFBRWQCB, which is the permitting agency for all aquatic in-bay disposal sites and all upland placement sites within their region, typically issues the District a certification to dispose dredged material that includes waste discharge requirements (WDR) for the various disposal sites. The EPA is responsible for permitting disposal of dredged material at the deep ocean disposal sites and typically issues the District an approval for the episodic use of an ocean disposal site. A third agency, the Bay Conservation and Development Commission (BCDC) was delegated the authority for enforcement of the CZMA by the state, and also reviews dredging projects for compliance with the Bay Plan. The Bay Plan is part of the Long Term Management Strategy (LTMS) for controlling where and how dredged material will be disposed, placed, and managed within the greater San Francisco Bay region. The goals of the LTMS are to limit annual in-bay disposal to not more than 1.25 MCY (including all fed and non-fed dredging projects), or a maximum of 20 percent of the total annual volume dredged, a minimum of 40 percent beneficial use placement, and a maximum of 40 percent deep ocean disposal. These LTMS goals are measured based on a running 3-year average. The BCDC reviews all permit applications from a programmatic view with respect to a programmatic Consistency Determination (CD) they issue, and makes recommendations for disposal sites to achieve the annual LTMS goals. BCDC typically issues the District a Letter of Agreement with a Consistency Notification the District is in compliance with their CD, and also issues an approval for the episodic use of a specific disposal site(s) for each federal dredging project, whether it's for maintenance dredging or new work.

Currently, all maintenance (O&M) material that is dredged from these two channels is disposed at the "federal Standard" in-bay disposal sites, San Pablo Bay (SF-10) for the PSC, and Suisun Bay (SF-16) for the BHR. These sites are available only for O&M material and not for new work, or deepening material. The in-bay disposal sites are generally dispersive for the typical O&M dredged material within the San Pablo and San Francisco Bays. The deepening material, or the material below the allowable over-depth for maintenance dredging has not been sampled and tested extensively. However, the testing results from the sampling that has occurred in the past indicates the material is suitable for placement in wetland or marsh sites as cover material at all of the currently permitted beneficial use upland sites, as well as being suitable for disposal at the deep ocean disposal sites. Additional sediment sampling and testing is required because the testing criteria has changed since the sediment was last sampled and tested. This task will be performed during the Pre-construction and Design Phase (PED). The results of the additional sampling and testing could potentially determine that some of the sediment is not suitable for beneficial use as cover material, which could impact the total project cost. If the sediment is found to be suitable as non-cover, or foundation material, it is likely that the dredged sediment would be disposed at SF-DODS because there is an estimated additional $17/CY charge to manage non-cover material at a beneficial use upland site. Disposal of dredged material at SF-DODS is less expensive than placing the dredged material at a beneficial use as non-cover, or as cover, however; there would likely be an additional cost for mitigation associated with the impacts to habitat caused by dredging. At present, the resource agencies have agreed in principle that the beneficial use of dredged material at an upland site is acceptable mitigation for habitat impacts from dredging, but not for dredged material disposed at SF-DODS. It is not known at this time what the mitigation is likely to be, or the cost of it.

5.1. San Francisco Deep Ocean Disposal Site (SF-DODS)

The SF-DODS is located in the Pacific Ocean, approximately 55 nautical miles west of the Golden Gate Bridge. The site is approximately 70 nautical miles from the beginning of the Pinole Shoal Channel and approximately 88 miles from the beginning of the Suisun Bay Channel. The site was established in 1994 by the Long Term Management Strategy agencies, and is managed by the EPA Region 9.

Dredged material is typically hauled to the ocean disposal site in large scows by tug boats where it is dumped (*Figure 5*) in a specified surface disposal zone. The EPA (Region 9) restricts the use of SF-DODS and enforces a list of requirements including; all scow shipping must follow the designated haul route to avoid impacts to the established marine sanctuary adjacent to the Farallon Islands, and no dredged material is allowed to be leaked or spilled from the scows during transit to the ocean disposal sites. The District is also required to monitor and sample the SF-DODS annually whenever it has been authorized for disposal of dredged material in any year. EPA routinely monitors scow trips to SF-DODS using monitoring equipment that the Corps requires dredging contractors to install on their scows as part of Dredge Quality Management. The transport of dredged material to the SF-DODS can only be allowed when weather and sea state conditions do not interfere with safe transportation and do not create risk of spillage, leak or other loss of dredged material in transit to the SF-DODS. No scow trips are allowed to be initiated when the National Weather Service has issued a gale warning for local waters during the time period necessary to complete dumping operations, or when wave heights are 16-feet or greater.

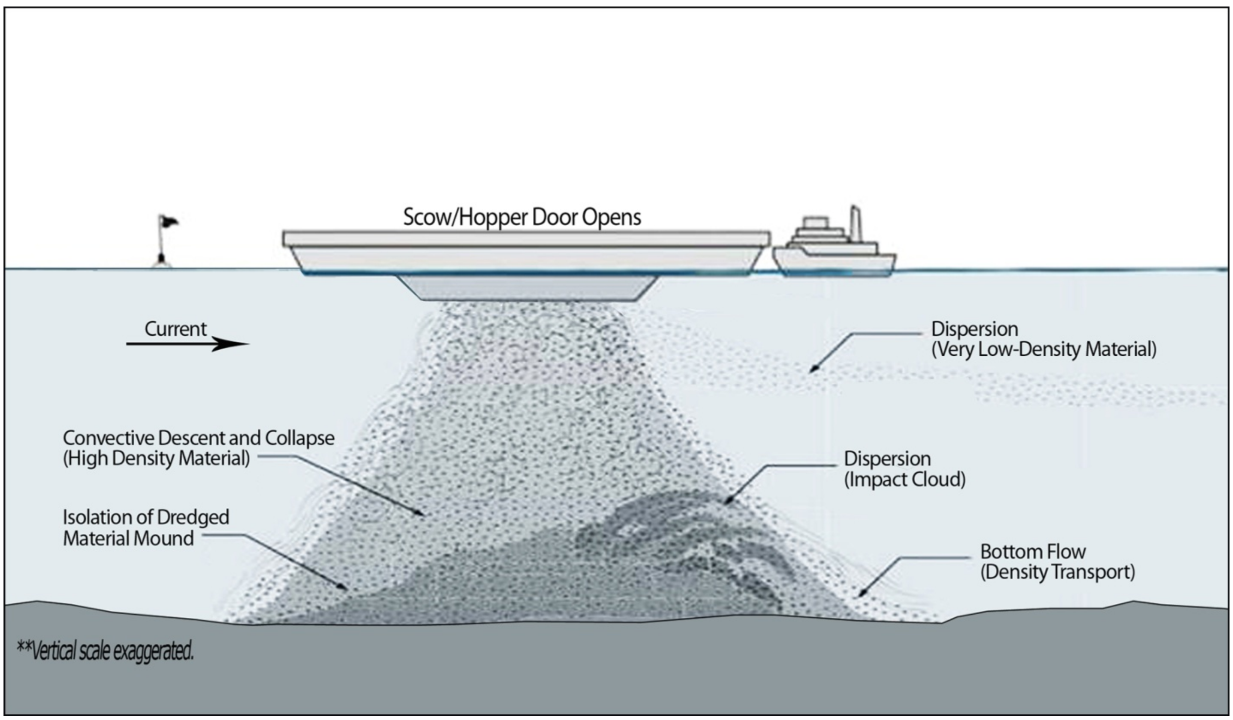


Figure 5 – Bottom Dump Scow at Aquatic Disposal Site.

As shown in Table 6.1, the total amount of time estimated to dredge with a mechanical clamshell, transport all the dredged material from the PSC and the BHR, and place at the SF-DODS site for the 37-ft alternative is approximately 4.6 months and 9 months for the 38-ft alternative.

5.2. Beneficial Use of Dredged Material

As part of the Corps' Ecosystem Restoration Mission, the consideration for the beneficial use of dredged material must be included in the development of navigation improvement projects as well as the maintenance dredging of all authorized navigation projects. EM 1110-2-5026 *Beneficial Uses of Dredged Material* dated 30 June 1987 was used as the guidance for determining which disposal sites best met the criteria for achieving feasible environmental benefits from the beneficial reuse of dredged material.

This Project was originally authorized under the Rivers and Harbors Act, Public law 89-298, of October 1965, which included channel improvements for the Main Ship Channel, West Richmond Channel, as well as the Pinole Shoal and Suisun Bay Channels. The dredged material from the Main Ship Channel was to be disposed at the ocean disposal site adjacent to the Main Ship Channel (SF-8) and the dredged material from the other aforementioned channels was to be beneficially used at various upland locations at the margins of the San Pablo Bay and Suisun Bay. These locations included marshland areas at the northern edges of Suisun Bay, tidal mudflats and diked off farm lands west of Mare Island in San Pablo Bay, and proposed recreation areas that would be filled with dredged material to raise grade. The dredged material was to be beneficially used to restore grade to subsided farmland and improve marshland. The project sponsor, Port of Stockton, was responsible for providing all lands and easements necessary for the disposal sites, as well as the cost to construct any dikes and/or levees needed to contain the dredged material. However, since the initial authorization, many of the proposed upland disposal sites are no longer available to receive dredged material. The Main Ship Channel has since been deepened to its authorized depth of 55-ft MLLW and the dredged material was placed at SF-8. The West Richmond Channel, which has not been deepened to its authorized depth of 45-ft MLLW, but is naturally deeper than the 38-ft TSP depth. The PSC and BHR channels that will be deepened to 38-ft MLLW must use different disposal sites that are cost effective and can also accept the dredged material from these channels. The sites discussed below meet this criteria. As discussed earlier, the O&M material above 35-ft MLLW plus 1-ft of paid over depth material will continue to be disposed at the federal standard in-bay disposal sites, SF-10 and SF-16. O&M Program funds will cover the cost to dredge and dispose O&M material at the "federal Standard" disposal site for the PSC and the BHR channel projects during the deepening of the Project. There is no "federal standard" for a Navigation Improvement project since the project has yet to be constructed and the most cost effective disposal site has not been identified by the construction contract solicitation process. There are two beneficial use upland placement sites that are currently permitted to receive dredged material from the PSC and BHR channels. Both of these sites are wetland restoration sites that have been receiving dredged material for several years and are discussed further in this Section.

The Project Delivery Team (PDT) evaluated all possible beneficial use measures described in EM 1110-2-5026 such as; stockpiling the dredged material for later use as a component of engineered fill material for levee construction, as a landfill cap, or to be used directly as beach nourishment. The PDT determined that there currently was not any significant demand for dredged material as construction fill because of the additional cost to process the material. The dredged material from the Project also does not meet the criteria for beach nourishment because of its fine grained physical characteristics. The PDT considered the concern for the accommodation of sea level rise and climate change, which has brought more focus on the use of dredged material to raise grades in the current marsh areas and former wetland areas that are found in the undeveloped margins of the San Francisco and San Pablo Bays. These potential beneficial use sites would also help provide resiliency and storm surge protection of the established infrastructure in the developed areas that surround the general bay area. The PDT believes the most viable beneficial use for the dredged material from this project is as fill material to raise grades in the wetlands and tidal marsh areas adjacent to the bays in order to accelerate their development.

The current list of permitted beneficial use placement sites includes the Montezuma Wetland Restoration Site (MWRP), and the Cullinan Ranch Tidal Restoration Site (Cullinan). Sediment sampling and testing of the material to be dredged has been performed, and has been determined to be acceptable at these sites. There is a possibility that the dredged material may be suitable for other beneficial use upland sites that may become available in the future, which may be found to be more cost effective. These potential beneficial use sites include the Bel Marin Keys Wetland Restoration site located in San Pablo Bay adjacent to the Hamilton Wetland Restoration Project, and the Eden Landing Restoration Project located on the east side of the central San Francisco Bay near Hayward, CA. The resource agencies consider the placement of dredged material from the Project at one, or more beneficial reuse upland sites as mitigation for the impacts to habitat caused by the deepening of the PSC and BHR Channels. Once completed, these wetland restoration projects will provide storm surge protection associated with climate change, as well as being more able to adjust to Sea Level Rise because of the acceleration of the tidal sedimentation process.

5.2.1. Montezuma Wetland Restoration Project (MWRP)

MWRP (*Figure 6*) is a privately owned, ongoing wetland restoration project that accepts both wetland cover and wetland non-cover (foundation) quality material from new work and O&M projects. This site was first used by the Oakland Harbor 50-ft Navigation Improvement Project beginning in 2002 as a beneficial use site for approximately 2.4 million cubic yards (MCY) of deepening material. This site is permitted to receive dredged material that is suitable for wetland cover, as well as dredged material that is not suitable for cover, but as foundation material. The MWRP is currently available to receive up to 12 MCY of dredged material and has an operating off-loader facility in place (*Figure 7*). The project site comprises approximately 2,400 acres at the eastern edge of Suisun Marsh, approximately 17 miles southeast of Fairfield, California (*Figure 1*). As described in the MWRP WDR and Water Quality certification;

"…*The Project will restore approximately 1,877 acres of tidal and seasonal wetlands, and approximately 480 acres of upland buffer zone habitats at the site, which will provide the following environmental benefits:*

- *Restore priority habitats identified by the San Francisco Bay Area Wetlands Ecosystem Goals Project (Baylands Ecosystem Habitat Goals, 1999), including tidal perennial aquatic habitat, saline emergent wetland habitat, tidal sloughs, seasonal wetlands, and perennial grasslands. The restoration of these habitats on the Project site will provide ecological benefits for many* *target species, including delta smelt, Chinook salmon, salt marsh harvest mouse, shorebirds, wading birds and waterfowl, and others.*

- *Increase tidal marsh acreage in Suisun Marsh by approximately 12.6 percent (a 1,713- acre increase from the current total of 13,560 acres). Between 80 and 90 percent of historic tidal marsh in the San Francisco Estuary has been lost to diking, filling, and other development. The California Wetlands Conservation Policy (Executive Order W-59-93) calls not only for "no net loss," but also for a region-wide increase in total wetland acreage and quality. The restored Project marshlands will increase both wetland acreage and quality, because they will have a high degree of "connectivity" to existing wetlands due to their immediate proximity to the existing Suisun Marsh complex.*
- *Maximize beneficial reuse of dredged material as a resource while reducing in-Bay and ocean disposal of dredged sediments, consistent with the goals of the Long Term Management Strategy for the Placement of Dredged Material in the San Francisco Bay Region.*

The restoration incorporates placement of dredged sediment to create a tidal marsh plain separated into high marsh and low marsh. High and low marshes are characterized by their elevations in relation to tide levels and by the frequency and duration of tidal inundation. The different design elevations across the restored marsh plain will be achieved by the engineered placement of sediment into cells separated by levees; the levees will be lowered and notched to provide sufficient tidal prism into the cells after sediment placement is completed. The low and high marsh elevations have been designed to accommodate natural sedimentation after tidal breaching to bring the marsh surface to its final elevation.

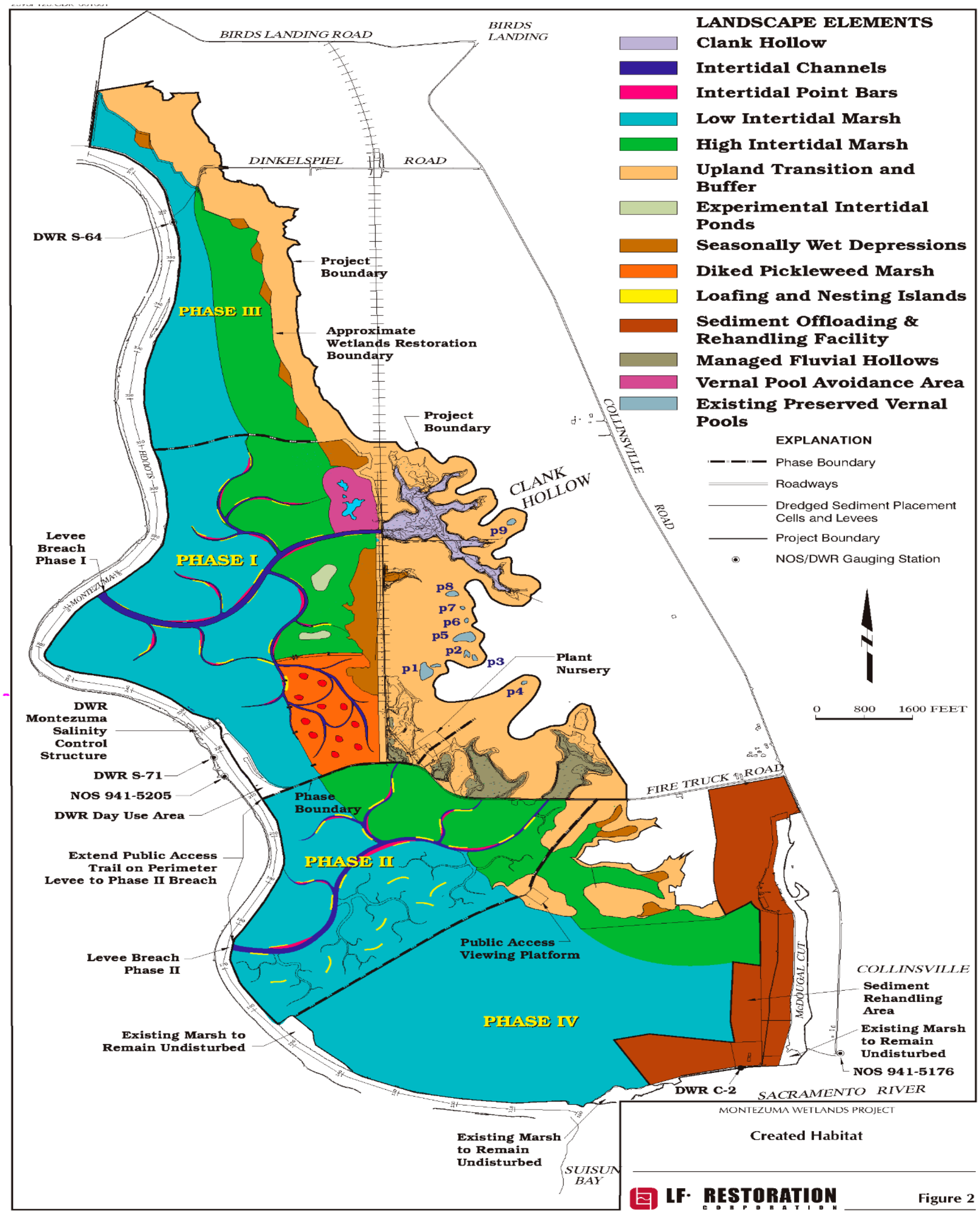


Figure 6 – Montezuma Wetland Restoration Project Site (MWRP).

The project includes a planned sediment rehandling facility in the southeast corner of the property adjacent to an existing oyster shell and sand processing facility. The rehandling facility is intended for dewatering surface-quality dredged sediments for onsite construction use and for potential offsite sale. The rehandling facility was part of the original project design and was evaluated in the EIR/EIS. To date, *it is partially constructed (approximately 40 acres of rehandling cells have been built) but not yet operational. The rehandling facility is located in a portion of the site zoned for industrial use and is completely contained by levees to prevent releases of dried dredged material via erosion, runoff, and wind transport. Decant water generated from drying of material for onsite construction use will either evaporate within the drying area, be discharged to the return water channel, or be recycled onsite for dust control, levee compaction, or irrigation to enhance salt marsh harvest mouse habitat as described in the 2002 Interim Habitat Enhancement Plan for Unfilled Phases. This Order does not regulate the discharge of decant water from dredged material dewatered for offsite use. The Discharger will apply for and obtain all appropriate permits prior to operating the rehandling facility for offsite use of dredged material."*

All site preparation, monitoring, and reporting is performed by the MWRP site, which charges a tipping fee for accepting dredged material. The tipping fee includes the use of the offloader Liberty (*Figure 7*), and all of the tasks associated with removing dredged material from the scows, drawing water from Montezuma Slough to slurry material in the scows. Managing the dredged material on-site including decanting water and water quality monitoring are separately permitted under the MWRP Water Quality certification.

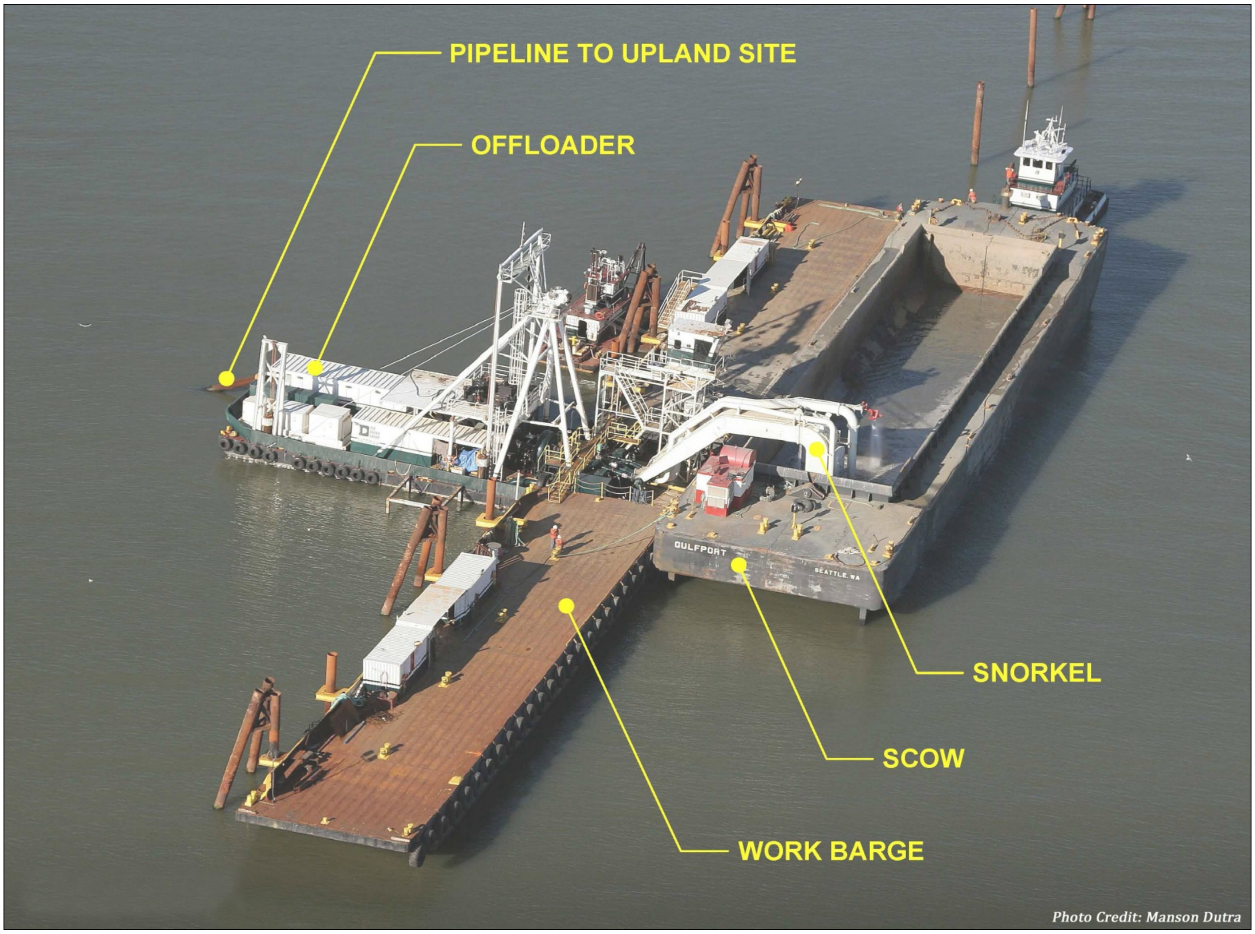


Figure 7 – Offloader Liberty Unloading Scow.

5.2.2 Cullinan Ranch Tidal Wetland Restoration Site

Cullinan Ranch Tidal Restoration Project (Cullinan) is a permitted tidal wetland restoration site that comprises more than 1,500 acres and is located in western Solano County near the city of Vallejo. It is located between State Highway 37 and Dutchman Slough (Figure 8). It is considered a beneficial reuse site and is currently permitted and available to receive wetland cover sediment. The Cullinan site is a former hay/cattle farm that is being restored to tidal marsh. It is part of the San Pablo Bay National Wildlife Refuge located in the northern shore of the San Pablo bay, bordered by South and Dutchman sloughs to the north of state Highway 37 to the south. Cullinan Ranch was historically part of a much larger complex of estuarine tidal marsh in the lower Napa River floodplain, which included the adjacent Napa river wetlands complex, known as the Napa Sonoma Restoration Project. It has a current total capacity of 3 MCY of dredged sediment. The sediment will be used to raise up to 290 acres of the site to marsh plain elevation.

As described in the Cullinan Ranch WDR and Water Quality Certification; "…*The objective of the Cullinan project is to increase suitable habitat for endangered species such as salt marsh harvest mouse,* *California Ridgeway (formerly clapper) rail, soft bird-beak, delta smelt, and anadromous salmonids in the larger San Francisco Bay ecosystem. Specifically, the purpose of the Cullinan project is to;*

- *Restore historic wetlands in San Francisco Bay, particularly in the Napa River estuary.*
- *Restore habitat to recover federal- and state listed special status species.*
- *Provide habitat for a broad range of marsh-dependent birds, mammals, fish and other aquatic organisms, and migratory shorebirds and waterfowl.*
- *Improve connectivity between habitats at the site and adjacent to enable wildlife movement.*
- *Sustain the Napa River estuarine environment with minimal intervention.*
- *Provide wildlife-sensitive public access and recreation.*
- *Maintain existing levels of flood control.*
- *Reduce mosquito breeding habitat.*
- *Minimize long-term management needs, including invasive species management.*

The Cullinan project will restore between 30 and 80 acres of salt marsh harvest mouse habitat at marsh plain elevation. The target habitat is coastal salt, or tidal marsh. The introduction of twice-daily tidal flows to the site will deposit sediments, subsequently raising the site to tidal marsh elevations with salt-tolerant marsh vegetation and meandering slough channels. The project will protect state Highway 37 from flooding by constructing an approximately 3,500-foot-long buttress levee on the north side of Highway 37. The remaining 12,100 feet of highway embankment will be armored to prevent wind-wave erosion. Hydrologic studies determined that if the Cullinan Ranch site were restored without adequately protecting the embankment, the eastern portion of Highway 37 would likely be flooded during combined high tide and storm events and could undergo significant erosion. Tidal marsh restoration at the Cullinan Ranch site cannot be accomplished without protecting the Highway 37 embankment."

All site preparation, monitoring, and reporting is performed by the Cullinan site, which charges a tipping fee for accepting dredged material. The tipping fee includes managing the dredged material on-site including decanting water and water quality monitoring, which are separately permitted under the Cullinan Water Quality certification.

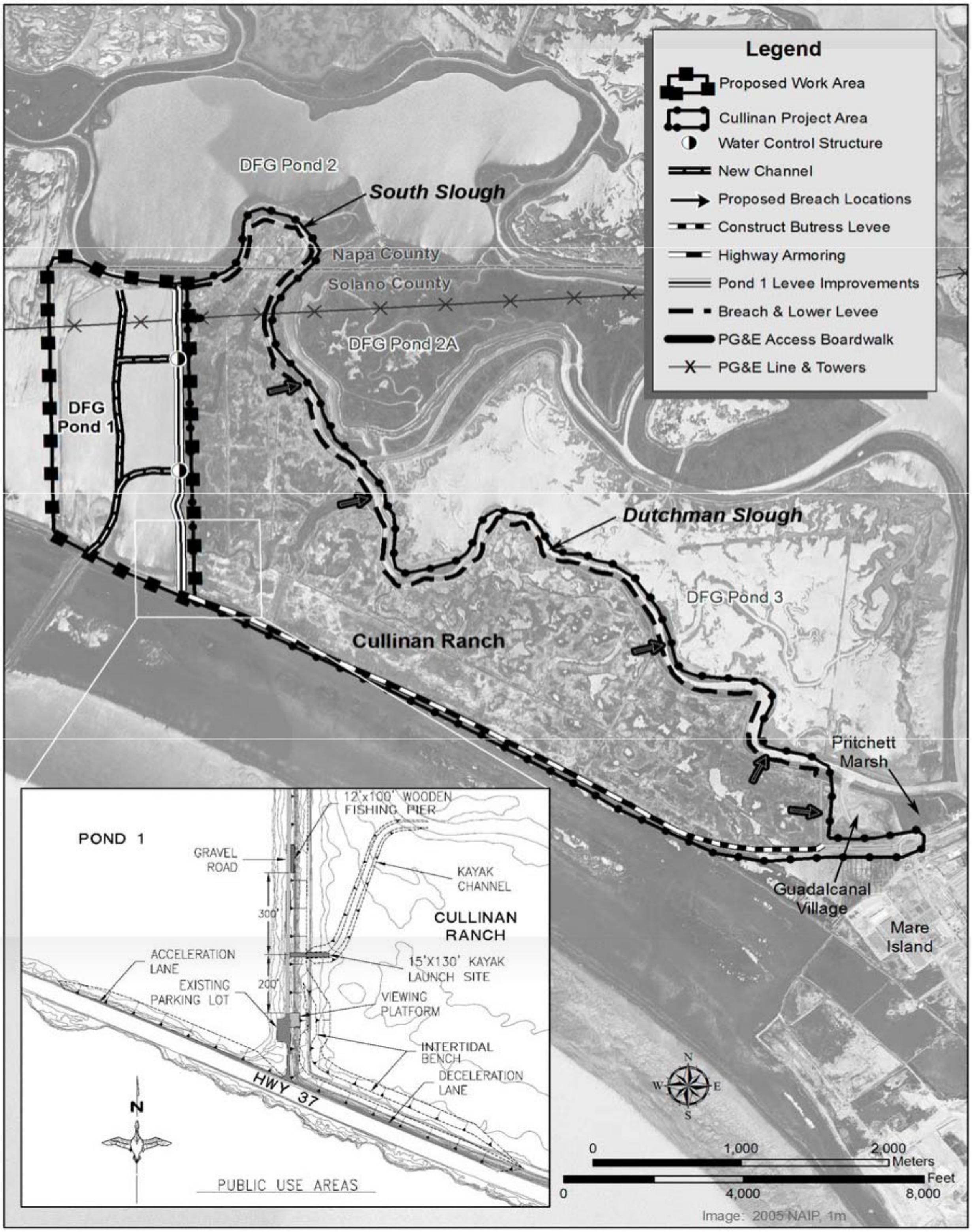


Figure 8 – Cullinan Ranch Site Map.

Recently, O&M material has been placed at the Cullinan using a much less robust offloader system (*Figure 9*) than the offloader currently in use at the MWRP site. The reason this was feasible is because the dredged material was very fine-grained and unconsolidated, which allowed the material to be pumped easily within the Cullinan site without the need for booster pumps or additional heavy equipment to manage and move the dredged material within the site. It is not likely that the deepening material will be as easy to place as the O&M material. Therefore, it will be assumed an offloader with similar capabilities as the one at MWRP site will be needed for any placement of deepening material at the Cullinan site. It is also possible the offloader at the MWRP site (*Figure 7*) could be temporarily located to the Cullinan site, if it is cost effective to do so.

Figure 9 – Cullinan Offloader.

6. Dredging Equipment

As was stated earlier in Sections 2 and 3.4, there is a restriction on the use of hopper dredges in BHR, and it is generally not cost effective to mobilize two different types of dredge plants if the work can be accomplished with one type of dredge plant. Therefore, only mechanical clamshell dredge plants and hydraulic cutterhead pipeline dredge plants were considered for this project. Preliminary cost estimates for dredging, hauling, and placement of dredged material indicate that the most likely dredge plant that will be used for this project is a mechanical clamshell dredge with tug boats and scows (*Figure 10*). This assumption is based on the cost estimating results in the **Cost Appendix** using the Corps of Engineers Dredge Estimating Program (CEDEP). The CEDEP cost estimates will not be included in the **Cost Appendix** because they contain proprietary information, but the dredging cost estimates will be included in the Total Project Cost rollup. The estimated volumes that were entered into the CEDEP software did not include the O&M material that is estimated to be in the project footprint at the time the deepening dredging is scheduled to begin. The PDT assumes that there will be a separate O&M dredging episode prior to the start of the deepening dredging in each channel. The O&M dredging in the PSC will be accomplished using a Government hopper dredge with disposal at the in-bay disposal site in San Pablo Bay, SF-10. The O&M dredging in the BHR will be accomplished with a clamshell dredge plant and scows with disposal at the in-bay site adjacent to the BHR footprint, SF-16. This assumption will make the O&M dredging more efficient and cost effective because the in-bay disposal sites are closer to the project footprints and less expensive to use. Also, in the case of the BHR, there is a possibility that the contractor that is awarded the deepening contract may also be awarded the BHR O&M contract, so the cost of mobilization and demobilization of the clamshell dredge plant and scows that would be used for the O&M dredging would be greatly reduced, if not eliminated for the deepening project. The CEDEP program takes into account the proximity of the dredge areas to the current array of permitted placement sites for the dredged material, the size of the area to be dredged, the depth and thickness of the material to be dredged, and the type of material to be dredged.

6.1. Mechanical Clamshell Dredge Plant

Based on the current hydrographic surveys, estimated quantities for both alternative depths, the prescribed environmental work windows, and the limited information on sediment characteristics, CEDEP has determined the most cost effective combination of mechanical clamshell dredging equipment for the TSP project is; two dredge plants with 21-CY clamshell buckets, four 2,000 CY scows, and two 1,800 HP tug boats for placement at Cullinan, and a single clamshell dredge plant with two 4,000 CY scows and one 1,800 HP tug boat for placement at MWRP. The CEDEP estimate for the 37-ft alternative determined that a single clamshell dredge plant will be sufficient, with three 2,000 CY scows and two 1,800 HP tug boats for placement at Cullinan, and two 4,000 CY scows and one 1,800 HP tug boat for placement at MWRP. The dredged material will be hauled from the PSC to the Cullinan site, and dredged material from the BHR will be hauled to the MWRP site where offloaders will be stationed to unload scows and pump the dredged material into both sites. The dredging contractor will either bring their own offloader for placing dredge material at Cullinan, similar to the offloader in Figure 9, or they will possibly lease the offloader in Figure 7 that is currently located at the MWRP site. The estimated daily production rate per dredge plant for placement at the Cullinan and MWRP sites are estimated to be 5,400 CY and 4,100 CY respectively for the 37-ft alternative, and 9,000 CY and 7,200 CY respectively for the 38-ft alternative (*Table 6.1*). The Napa River that leads to the Cullinan site is too shallow for fully loaded 4,000 CY scows, so the assumption is the scows will be loaded to only 65 percent of their capacity, or less, in order to be hauled to the offloader location, or the contractor may use 2,000 CY scows that can be fully loaded.

The cost estimates for dredging and disposal of material at SF-DODS indicate two mechanical clamshell dredge plants with a 21 CY buckets will be the most cost effective. For disposal at SF-DODS, the number of scows required would increase from three 2,000 CY scows to four 4,000 CY scows. The number of tugboats required would increase from 1 to 3, and the tug boats would also be upgraded to 3,000 horsepower because the open ocean working conditions are much more severe than the protected waters of the San Pablo Bay. The limiting factor for dredging with disposal at SF-DODS is the number of scows available that are certified for deep ocean use by the American Bureau of Ships (ABS). Typically, the dredging contractors do not own more than 4 ABS-certified scows because the cost of maintaining their certification is not offset by the amount of work available that requires ABS-certified scows. See Section 5.1 for additional information regarding the use of SF-DODS.

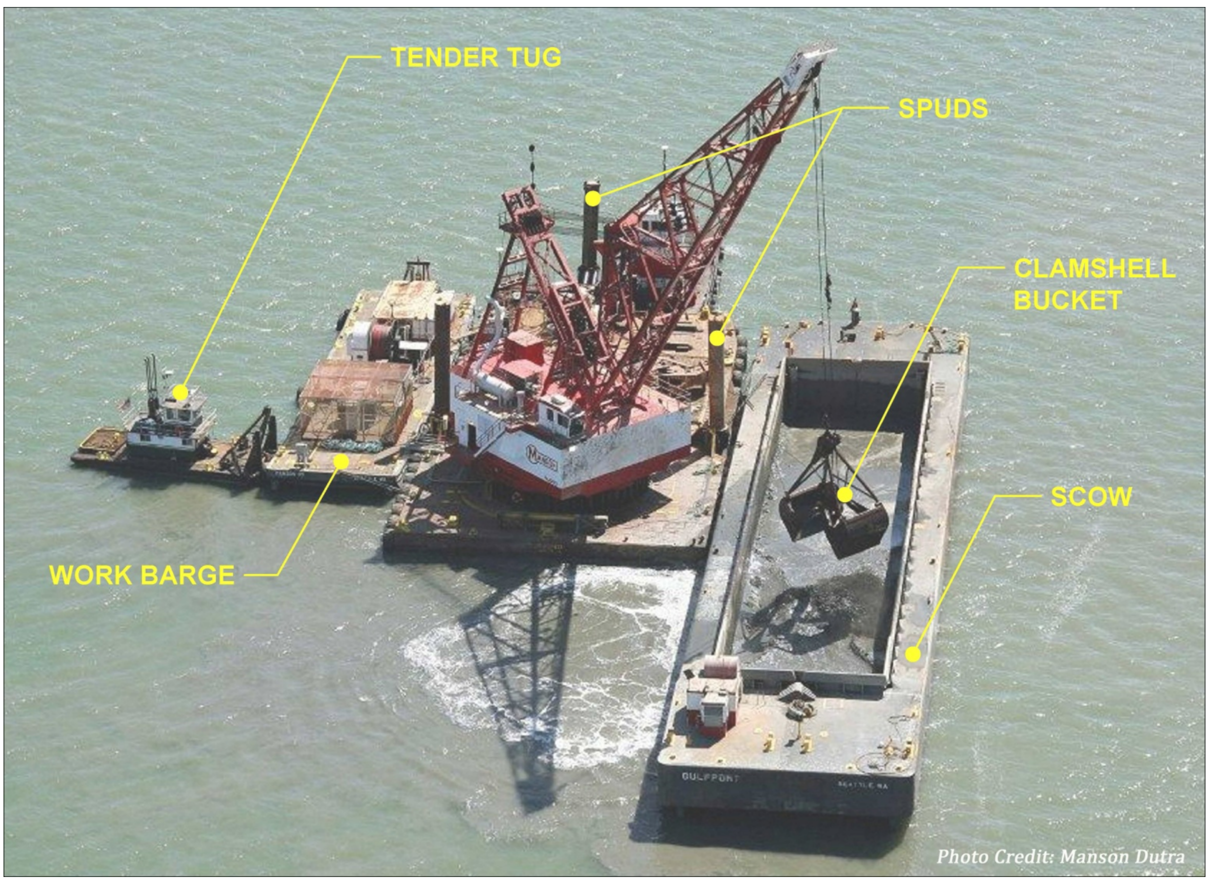


Figure 10 - Typical Clamshell Dredge Plant and Scow.

The mechanical clamshell dredge plant (*Figure 10*) is made up of a large work barge with a large crane mounted on the deck of the barge. The crane has a boom that is long enough to extend out beyond the end of the work barge in any direction and is able to swivel 360 degrees on its mount. A large clamshell bucket is attached to the end of a series of cables at the end of the boom, which allows the bucket to be raised and lowered into the water. The cables also open and close the bucket as it is filled with sediment and then emptied into scows. The scows are open barges that can carry large quantities of sediment while they are towed with tug boats to and from the disposal site. The dredge plant barge has two, or three spuds, which are long vertical piles that are driven with hydraulic pumps into the bay bottom to anchor the dredge while it is digging. While the dredge is anchored in place, the crane will begin digging in a series of arcs extending out and away from the work barge while the clamshell bucket digs down to the intended depth. The scows that are to be filled with sediment are tied to the side of the dredge plant. As soon as one scow is filled and hauled away, another scow is maneuvered into place alongside the dredge and the digging continues. In order to minimize uncontrolled spillage of dredged material while under tow, scow loads will be restricted to not more than 80 percent of their total capacity. As the scows are being filled, the water level in the scows rises to the overflow cavities and will begin to decant from the scows. If it is advantageous to do so, the decanting will continue until the scow reaches its maximum density of solids based on the physical characteristics of the dredged material. While the decanting is occurring, it is very likely that water quality monitoring will be required by the SFBRWQCB during the first five days of dredging to determine if the decant water is increasing local turbidity levels within the dredge area. If the turbidity level threshold is exceeded for any period longer than the periods when the samples are collected, decanting must cease until the turbidity level is below the threshold. If an exceedence has occurred within the first five consecutive days of decanting, water quality monitoring will be required for an additional five days. If there is continued exceedance during the second 5-day period, water quality monitoring will be required for the duration of the decanting operations. If on the other hand, there was no exceedance during the initial 5 days of decanting, or during the second 5-day period, no further water quality monitoring will be required for the remainder of the dredging operations that include decanting.

It is estimated that for this project, the maximum density of the material in a scow will range from approximately 60 to 70 percent solids. As an example, if a 4,000 CY scow is filled to a maximum 80 percent of its capacity;

4,000 CY X .80 = 3,200 CY

and if 70 percent of that quantity is estimated to be solids;

3,200 CY X .70 = 2,240 CY

Therefore, if each 4,000 CY scow is estimated to carry a maximum of approximately 2,240 CY of material and the tug boats that will haul the scows to and from the placement site can haul only one scow per trip, there will be a minimum total of approximately 643 tug boat round trips based on an estimated total volume of approximately 1.44 MCY including 2-feet of overdepth for the 38-ft TSP depth. Likewise if the dredging contractor uses 2,000 CY scows to transport dredged material to the Cullinan site because the depth of the water in the Napa River is the limiting factor, it would take approximately 1,286 tug boat round trips to haul each 1,120 CY scow load.

The digging will begin near the dredge and will progress away from the dredge until the crane boom has been extended out to its maximum length. After the furthest arc has been completed down to the desired depth, the spuds will be lifted out of the bay mud and the dredge plant will be repositioned to the next area to be dredged using small tender tug boats. The spuds will then be lowered to stabilize the dredge and digging will begin again. This relocation operation requires approximately 45 minutes to 1 hour to complete. On average, the mechanical clamshell dredge plant for this project will need to be relocated approximately every 2.5 – 3 hours. The contractor is also required to move all of their dredging equipment out of the shipping channel so they do not create a navigation hazard whenever they are notified by Coast Guard that a large commercial vessel is going to be transiting the channel. These delays each typically take one hour out of the daily production. The dredging contractor will be working 20-hours per day, 7-days a week on this project. Depending on the number of similar delays, a single dredge plant will dig an average of 56,400 square feet (~1.3 acres) per day for the PSC and BHR, per 20-hour day. The estimated duration for construction for both alternative depths using a mechanical clamshell dredge plant are presented in Table 6.1 below.

As shown in Table 6.1, CEDEP has estimated the total amount of time estimated to dredge with a single mechanical clamshell, transport material from the PSC and the BHR, and place at the Cullinan site for the 37-ft alternative is approximately 3.6 (2.4 + 0.2 + 1.0) months and an estimated total quantity of approximately 457,600 CY. CEDEP also predicts that approximately 75 percent of the 1-foot paid overdepth prism and 25 percent of the 1-foot non-pay overdepth prism will be dredged based on the dredging equipment and the haul distance. The total amount of time estimated to dredge with two dredge plants and transport material from PSC to Cullinan and material from BHR to MWRP is 4.9 (3.4 + 0.5 + 1.0) months and an estimated total quantity of approximately 1,045,750 CY for the 38-ft alternative. The total time for each alternative includes 1 month to relocate an offloader from the Cullinan site to the MWRP site.

Table 6.1 - Estimated Construction Duration – Clamshell Dredge Plant.

Channel	Placement Site	Production Rate (CY/day)	37 feet Duration (months)	Production Rate (CY/day)	38 feet Duration (months)
Pinole Shoal	SF-DODS	4,200	3.1	8,400	3.7
	Cullinan Ranch	5,400	2.4	9,000	3.4
	Montezuma	4,200	3.1	8,400	3.7
Bulls Head Reach	SF-DODS	3,100	0.2	3,100	1.2
	Cullinan Ranch	3,700	0.2	7,300	0.5
	Montezuma	4,100	0.2	7,200	0.5

Note: Bulls Head Reach includes the sediment trap. Durations do not include additional month to relocate offloader facility.

For a single mechanical dredge plant (clamshell bucket) operation with placement at the MWRP site, it is anticipated that the dredging contractor will determine the optimal size of the clamshell bucket, and the number of scows and tug boats to use in order to maximize efficiency and minimize cost based on the equipment they have access to. The average haul distance from the BHR project dredge area to the MWRP offloader is 13 miles. After the scow is delivered to the offloader, it will be tied up to the Liberty's mooring system, so that the offloader's snorkel can remove material from the scow. The snorkel simultaneously injects water into the scow to further slurry the material and then pumps the material out of the scow and into the designated cells within the MWRP site. It takes approximately 2-hours to empty a 4,000 CY scow filled with the type of sediment that will be dredged from the two channels. The dredging contractor will attempt to time the emptying of a scow with the arrival of the next filled scow so the tug boat can return the empty scow to the dredge area immediately. The tug boats will be traveling at a maximum speed of approximately 7-knots (8 mph) to and from the offloader. The total time for each scow trip to the offloader, including unloading the scow and returning the scow to the dredge area is approximately 5.5 hours for the BHR dredging. The MWRP offloader facility would operate on the same schedule as the dredging contractor, 24-hours per day, 7-days a week. It is estimated that the offloader will actually be working a total of approximately 10-hours per day over a 24-hour period.

For a two-mechanical dredge plant operation with placement at the Cullinan site, it will be necessary to provide an offloader facility, similar to the MWRP operation. The Cullinan site has two permitted locations for an offloader to anchor, both located in Napa River, and north and south of the mouth of Dutchman Slough. Both locations are accessible by fully loaded scows as large as 2,000 CY. The Cullinan site currently does not have a permanent offloader operation as part of the site. Therefore, the dredging contractor will also be required to mobilize an offloader or subcontract for offloading services. It is anticipated that this offloading operation will be similar to the offloading operation at the MWRP site and will likely employ an offloader similar to the ones pictured in Figures 7 and 9. This offloader unit will also simultaneously slurry the sediment in a scow and pump it out of the scow and into the upland site. Since the water in the Napa River is shallower than the water leading up to Montezuma Slough where the Liberty offloader is located, it is estimated that smaller scows, or light-loaded large scows will be used, which will make the dredging operation less efficient than the offloading operation at MWRP. CEDEP has estimated that two dredge plants with a 21 CY clamshell bucket, three 2,000 CY scows, and two 1800-hp tug boats are likely to be used for placement at the Cullinan site. The average haul distance from the PSC project dredge area to the Cullinan offloader is 10 miles. After the scow is delivered to the offloader, it will be tied up to the working dock, so that the offloader's snorkel can remove material from the scow. It takes approximately 1.5-hours to empty a 2,000 CY scow, or a light-loaded 4,000 CY scow filled with the type of sediment that will be dredged from the two channels. The dredging contractor will attempt to time the emptying of a scow with the arrival of the next filled scow so the tug boat can return the empty scow to the dredge area immediately. The tug boats will be traveling at a maximum speed of approximately 7-knots (8 mph) to and from the offloader. The total time for each scow trip to the offloader, including unloading the scow and returning the scow to the dredge area is approximately 5 hours for the PSC dredging. The Cullinan offloader facility would operate on the same schedule as the dredging contractor, 24-hours per day, 7-days a week. It is estimated that the offloader will actually be working a total of approximately 15-hours per day over a 24-hour period.

6.2. Hydraulic Pipeline Dredge Plant

The next most cost effective dredge plant is a 27-in diameter hydraulic cutterhead pipeline dredge (*Figure 11*) with direct pumping into the Cullinan and MWRP sites. The hydraulic pipe dredge would also require between 6 and 11 booster pumps to assist moving dredged material into the Cullinan and MWRP sites.

Figure 11 – Typical Hydraulic Cutterhead Dredge Plant.

There is a possibility that if a new placement site(s) was permitted in the near future that is closer to the dredge areas, that a hydraulic cutterhead dredge (*Figure 11*) could be used if it is more cost effective to do so. This would be a possibility if the Bel Marin Keys environmental restoration site located on the northern edge of San Pablo Bay is ever brought on line.

The size of the cutterhead dredge is measured by the diameter of its pipeline. CEDEP has estimated that a 27-inch pipeline cutterhead dredge could be used to dredge the PSC and BHR channels and place the material at the Cullinan and MWRP sites. Additional booster pumps are required to complete placement at both Cullinan (6 booster pumps) and Montezuma (11 booster pumps). A 27-inch pipeline would have an estimated daily production rate of 4,500 CY of dredged material depending on the constraints of the placement site being used (including distance and number of booster pumps) and the type of sediment being dredged. The lower daily production rate would result in a longer construction duration as well. For pumping distances greater than 15,000 feet (assuming the use of a 27-inch-diameter cutterhead dredge) from the dredge area, a booster pump would be required for each additional 15,000 feet of pipe. Booster pumps increase the hydraulic pressure within the pipeline to transport dredged sediment longer distances. However, the pumps also reduce the hydraulic efficiency of the operation. As more pumps are added to move the sediment farther along, the efficiency continues to decrease, which results in a longer construction period. The booster pumps are also diesel-powered and would be placed on barges that are moored in the San Pablo Bay, or in Suisun Bay, outside of the channel toes. A tender tug would be used to move the barge-mounted pumps into position when needed. At any one time, up to eleven booster pumps could be operating. The barge-mounted pumps would be moored in the channel via spuds, and positioned such that they do not interfere with commercial shipping traffic. The exact location of the booster pumps would be determined by the dredging contractor at the time the respective channel reach is being dredged. As with the mechanical clamshell operation, the contractor is required to clear the channel to make way for any large commercial vessels once they have been notified of impending traffic by the Coast Guard.

The estimated duration for construction for both alternative depths using a hydraulic cutterhead dredge plant are presented in Table 6.2 below.

Table 6.2 - Estimated Construction Duration – Hydraulic Cutterhead Dredge Plant.

Channel	Placement Site	Production Rate (CY/day)	-37 feet Duration (months)	-38 feet Duration (months)
Pinole Shoal	Cullinan Ranch	7,600	0.5	3.2
	Montezuma	4,500	6.3	8.0
Bulls Head Reach	Cullinan Ranch	7,500	0.1	0.2
	Montezuma	3,500	0.2	0.5

Note: Bulls Head Reach includes the sediment trap. Durations include additional 10 days for pipe maintenance and relocation.

For a hydraulic cutterhead dredge plant operation at the MWRP site, it will not be necessary to use the offloader Liberty. The dredging contractor will bypass the offloader and place the pipeline into the designated cell(s), and pump directly into the MWRP site. This process would reduce, or eliminate the portion of the tipping fee cost associated with the use of the Liberty. The MWRP site will be responsible for managing all sediment once it is placed within the cell(s), including moving the end of the pipe around within the cell(s) in order to spread the sediment evenly, and all water quality associated with decanting water from the cell(s) containing the sediment from the dredging project. Under this scenario, the dredging contractor will also be operating 24-hours per day, 7-days a week. Therefore, dredged sediment will be flowing into the site almost non-stop except when it becomes necessary to relocate the hydraulic dredge plant, or move the end of the pipe within the designated cell. Both of these operations take approximately one hour to complete.

For a hydraulic cutterhead dredge plant operation at the Cullinan site, it will also not be necessary to use an offloader. The dredging contractor will place the pipeline and pump dredged material directly into the designated cell(s) at the Cullinan site. The dredging contractor will be responsible for managing all sediment once it is placed within the cell(s), including moving the end of the pipe around within the cell(s) in order to spread the sediment evenly, as well as managing all water quality associated with decanting water from the cell(s) containing the sediment from the dredging project. Under this scenario, the dredging contractor will also be operating 24-hours per day, 7-days a week. Therefore, dredged sediment will be flowing into the site almost non-stop except when it becomes necessary to relocate the hydraulic dredge plant, or move the end of the pipe within the designated cell. Both of these operations take approximately one hour to complete.

Although the USACE CEDEP cost estimating software indicates that this assortment of equipment is capable of dredging the project using the assumed upland placement sites in a cost effective manner, in reality, it may not be feasible to assemble the estimated number of booster pumps needed for this project simply because any one contractor may not have access to that many pumps at one time. Also, it is very likely that the Bay Area Air Quality Management District threshold limits for nitrous oxides will be exceeded because of the extraordinary amount of diesel-powered equipment in operation at any time, and the project will not be permitted without mitigation. Therefore, it is not likely that a dredging contractor will submit a bid to dredge this project with a hydraulic cutterhead dredge unless an upland site that is much closer to the dredge areas becomes available, however; the associated hydraulic cutterhead dredging operations have been provided in this discussion.

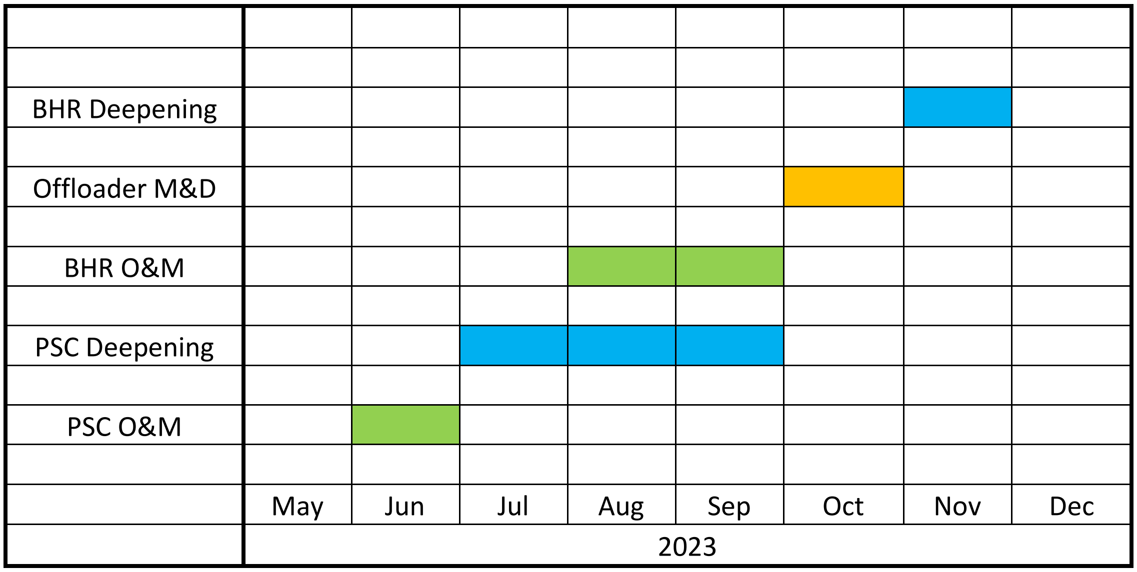
7. Order of Work

Regardless of the placement site and dredging equipment, all dredging will begin at the western-most end of the Project. This means that the dredging will begin at the western end of PSC where the previously discussed rock formation is located, and progress easterly to the end of the project boundary at the Avon terminal in the BHR. Refer to *Table 7-1* below for an estimated 38-ft TSP construction schedule. The O&M dredging for the PSC will be performed using a Government hopper dredge prior to the start of the deepening contract. The O&M dredging will remove the material above 35-ft MLLW plus 1-ft of paid overdepth, and it will be transported and disposed at the “federal standard” disposal site in San Pablo Bay, SF-10. The environmental work window for O&M dredging is the same as the work window for the deepening project. The PSC O&M dredging would begin on 1 June and can be completed within approximately 10 to 20 days, depending on the volume of material to be dredged. A separate O&M dredging contract for the BHR using a clamshell dredge plant will be awarded and dredging will begin on 1 August and is estimated to be completed in mid-September. The O&M material from BHR will be disposed at the “federal standard” in-bay disposal site near Suisun Bay, SF-16. The deepening contract work for the PSC would begin in mid to late-June after the O&M dredging is completed. Assuming a clamshell dredge plant is used, the deepening material will be dredged, loaded into scows, transported and placed at the Cullinan beneficial use upland sites via an offloader facility. It is estimated the daily production rate for a single mechanical clamshell dredge operation will be approximately 4,200 CY per day for the PSC and 3,100 CY per day for the BHR with disposal at SF-DODS. The estimated daily production rates for placement at the beneficial use upland sites is 9,000 CY per day for the PSC (assumes 2 dredge plants, 4 scows), and 7,200 CY per day for the BHR (assumes 1 dredge plant, 2 scows) with disposal at Cullinan and MWRP, respectively. The environmental work window closes on 30 November for both channels. If the PSC deepening is started no later than mid-June of 2023, it is estimated that the PSC dredging will be completed by 30 September 2023. The offloader facility would then be remobilized from Cullinan to MWRP during October, and the BHR deepening dredging would be started on approximately 1 November and is estimated to be completed by mid- to late-November of 2023. It is possible to consult for an extension to the work window for the PSC provided that all dredged material is placed at a beneficial use upland site after 30 November, however; it is not confirmed the resource agencies will allow new work dredging to continue past the established work window. The resource agencies have already stated that there will be no extensions granted for the BHR because of the delta smelt concerns. Since the current TSP proposes to place all dredged material at beneficial use upland sites, there is a possibility that the deepening dredging cannot be completed within a single work window regardless of the O&M dredging that will also be performed during the same work window.

Based on the estimated quantities of dredged material for the 37-ft and 38-ft alternative depths, and using a hydraulic cutterhead pipeline dredge plant, the longest estimated duration of construction for the 37-ft alternative with disposal at the MWRP site is approximately 6.5 months (*Table 6.2*). The longest estimated duration of construction for the 38-ft alternative using a hydraulic cutterhead dredge plant with disposal at the MWRP site is approximately 8.5 months (including 10 days for pipe maintenance and relocation) with an estimated total of 1,144,700 CY (1,031,000 CY for PSC plus 113,800 CY for BHR). It is assumed that the O&M dredging would be accomplished in the same manner as described above for the mechanical clamshell dredging scenario. The resource agencies do not permit in-bay disposal using hydraulic pipeline dredging in the PSC or the BHR because of fish entrainment concerns for delta smelt, so there is no cost savings possibility associated with mobilizing a hydraulic dredge plant for the PSC or BHR maintenance dredging projects. Since this project cannot be completed within a single environmental work window using a single hydraulic cutterhead pipeline dredge plant, it is not likely this project will be bid using a hydraulic pipeline dredge because of the additional cost to mobilize a second dredge plant. The estimated cost to mobilize a single hydraulic cutterhead dredge plant, pipeline, and booster pumps is approximately 75 percent more than the cost to mobilize two clamshell dredge plants, tug boats, and scows.

These estimated durations imply that if the dredging begins in June in any year, both of the alternative depth projects that included the use of a hydraulic cutterhead pipeline dredge plant with upland placement could not be completed within one year’s dredging work window without the need to consult with the appropriate resource agencies after the work window closes. This consultation would likely result in the requirement for placement of dredged material at a beneficial use upland site after 30 November for PSC only. Work outside of the BHR work window is prohibited regardless of the disposal site. However, the estimated duration of construction for both of the alternative depth projects that includes the use of two hydraulic dredge plants for the PSC and one for the BHR, with placement at a beneficial use upland site would be completed within one single dredging contract in any year, including completion of all O&M dredging for each channel.

Table 7-1 Estimated 38-ft TSP Construction Schedule



8. Utility Surveys

USACE conducted a project utility investigation (*Utility Investigation Report – San Francisco to Stockton Deep Water Ship Channel*, dated May 2011) of the entire project footprint in 2011 to identify all of the public and private utilities that intersect the SF Bay to Stockton Project footprint. The investigation identified two utilities that are in the project footprint that could be affected by the deepening project. These utilities are the trans-bay cable transmission line (*Figure 12*) owned by Trans Bay Cable, LLC (TBC), and the Rodeo Sanitary District sanitary sewer outfall. The sanitary sewer outfall is located in the Carquinez Straight at the edge of the naturally deep channel in between where the PSC ends and the BHR begins, and will not be investigated further. There are also three pipelines owned by the Kinder-Morgan energy services company that cross the Bulls Head Reach underneath and parallel to the Interstate 680 Benicia-Martinez Bridges. However, this portion of the Bulls Head Reach is naturally deeper than 40-feet MLLW and will not be dredged as part of this project. Therefore, the only utility that was analyzed to determine if the utility was installed at a location and depth that may impact the proposed project channel improvements is the trans-bay cable utility owned by TBC.

The utility survey that was conducted in 2011 provided As-Built drawings from TBC for their 10 inch diameter direct current (DC) transmission line that was constructed in 2010. The As-Built drawings were reviewed and compared with the Corps' hydrographic condition survey that was performed at approximately the same period that the trans-bay cable was installed. The drawings indicate that the TBC utility crosses the PSC in two locations, STA 62+00 and from STA 468+00 to STA 547+11. In both locations, the channel is naturally deeper than the proposed dredging depth of 38-ft MLLW. The As-Built drawings indicate the TBC cable was buried to a depth that is approximately 6-feet below the proposed 38-ft channel bottom for both crossing locations. The cable utility does not intersect the other federal channels in the remainder of the project footprint. Therefore, it has been determined that the TBC trans-bay cable utility will not be impacted by the S.F. Bay to Stockton Navigation Improvement Project with a 38-ft TSP depth.

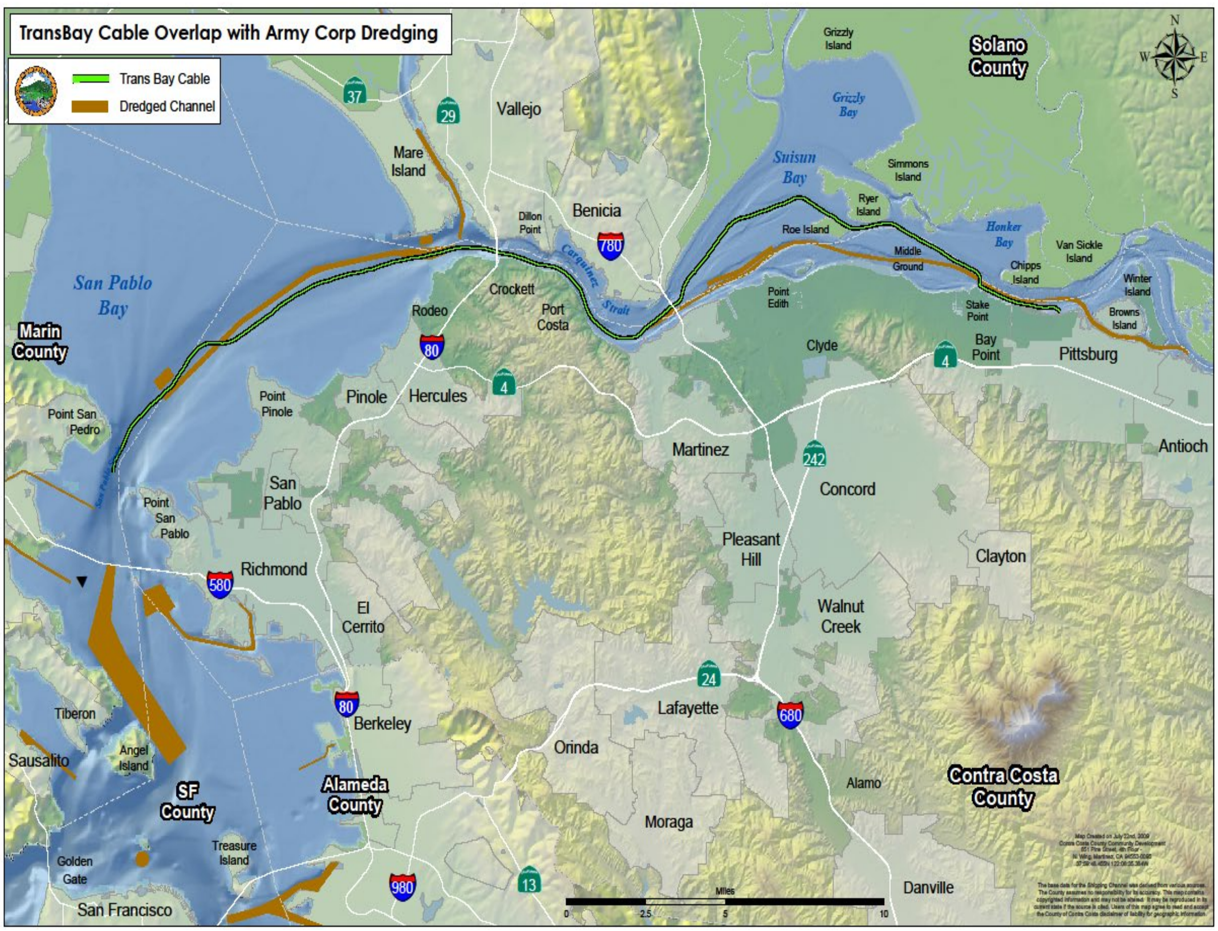


Figure 12 – Transbay Cable Utility.