South Bay Salt Pond Restoration Project

Beneficial Reuse Feasibility Study

Prepared for:

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1. EXECUTIVE SUMMARY

1.1 Introduction

As the largest wetland restoration project on the West Coast, the South Bay Salt Pond (SBSP) Restoration Project provides a rare opportunity to beneficially reuse millions of cubic yards of dredged and upland material generated in the San Francisco Bay area. In a climate currently where approximately 2.5 MCY of dredged material (annualized) is generated every year, the SBSP Restoration Project has the capacity to be the next significant beneficial reuse site in the Bay Area, and in-turn provide the Bay Area with a cost-competitive means to achieve its Long Term Management Strategy (LTMS) beneficial reuse goals.

The ultimate goal of this work is to align the fill capacity of the SBSP Restoration Project with Bay Area needs for a regional beneficial reuse site in a cost competitive manner with current disposal practices. The overall scope of this study is as follows.

- Develop an Implementation Strategy that leverages studies completed to date for projects in the region. These include studies, environmental documents and permit approvals for the Sonoma Baylands, Montezuma Wetlands, Hamilton, and Bair Island Restoration Projects approvals as well as the studies and NEPA/CEQA documents for the Long Term Management Strategy (LTMS) for dredged material disposal;
- Conduct focused research studies and coordinate with regulatory and resource agencies to reduce uncertainties, and to address the concerns that agencies have expressed with respect to using material from unidentified sources;
- Perform a conceptual cost analysis to determine the cost-competitiveness of potential USACE maintenance dredging projects placing material as the SBSP Restoration Project compared to their Base Plan disposal location.
- Identify an environmental review strategy and permitting framework that would work within the context of the current NEPA/CEQA Phase II document for the SBSP Restoration Project to minimize supplemental documents.

1.2 South Bay Salt Pond Restoration Project

The SBSP Restoration Project (Project) comprises the Alviso Complex (8,000 acres), the Eden Landing Complex (5,500 acres), and the Ravenswood Complex (1,600 acres). A public process to design and implement the restoration project is being led by the California State Coastal Conservancy (SCC), the U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Wildlife (CDFW). The Final EIR/S was adopted in late 2007 and the first phase of restoration started in 2008.

The Programmatic EIR/S considered three alternatives over a 50-year planning horizon: *No Action*, *Managed Pond Emphasis* (50 percent tidal habitat and 50 percent managed pond by area), and *Tidal Emphasis* (90 percent tidal habitat and 10 percent managed pond by area). The ideal project would fall between the *Managed Pond Emphasis* and the *Tidal Emphasis* with guidance from an Adaptive Management Plan.

Ten years into the Project, the first phase of restoration is complete and the Phase II EIR/S's (one for Alviso and Ravenswood Complexes; one for Eden Landing Complex) are being drafted for agency and public approval. Approximately 3,700 acres have been restored to-date (25 percent of the Project), with over 11,000 acres remaining. The remaining ponds are the more challenging of the Project, which will require a balancing of restoration and flood control sequencing.

Of the remaining ponds to be restored, dredged material can be placed to raise the bottom elevation of subsided ponds (for tidal marsh habitat creation), improve levees, create upland transition zones, create habitat islands, fill existing ditches, and create flood protection levees (in the form of a land mass at Eden Landing or USACE-certified levees in the Alviso Ponds as part of the Shoreline Study).

1.2.1 Pond Capacities

The following capacities for the pond complexes assume the restoration reaches the EIR/S *Tidal Emphasis Alternative* where the majority of ponds are restored to tidal habitat, as opposed to managed ponds. These volumes do not reflect either natural sedimentation in the ponds over the project lifetime – which would reduce the capacity – or sea level rise, which could potentially increase the capacity. The target elevation for tidal habitat is typically within one foot of the local MHHW level.

Table 1-1. Pond Complex Beneficial Reuse Capacities

Pond Complex	Potential Volume to Raise Bottom Elevation (MCY)	Potential Volume to Create UTZ (MCY)
Alviso	59.5	1.8
Eden Landing	11.4	0.9[b]
Ravenswood	0.5[a]	0.3

Notes:
[a] Volume to fill drainage ditches, not raise the bottom elevation wholesale.
[b] Volume to create UTZ (0.3 MCY) and a land mass (0.6 MCY)

The marsh elevation deficit at the Ravenswood Pond Complex is relatively small – less than two feet. Ravenswood has a well-formed set of marsh channels, so it is not desirable for wholesale placement of dredged material. Use of dredged material for raising marsh elevations is potentially desirable at the Eden Landing Pond Complex. The Alviso Pond Complex has the largest capacity for dredged material based on its relatively large area and its deeply subsided ponds.

If the deeper-subsided ponds are opened to tidal action without importing fill it will, at a minimum, take years for suspended sediments in the Bay to settle out and raise the pond grades to the desired marsh elevations. The ponds at Ravenswood and Eden Landing may gain sufficient sediment to reach the target elevations with natural accretion within the 50-year project lifespan; however reaching the target elevations in the deepest ponds in the Alviso complex by natural accretion is dependent on how soon the ponds are opened to tidal action.

Even if some or all of the ponds remain below their target elevations, they still represent valuable habitat. Combination pond and marsh areas, with a narrower fringing marsh or upland transition zone (UTZ), could be targeted in place of fully tidal ponds and would provide a valuable habitat mix. Nevertheless, importing fill to increase the bottom elevation of some or all of the ponds is desirable – particularly for the Alviso Pond Complex – to expedite the establishment of tidal marsh. The volumes here should be viewed as capacities rather than needs, with the proviso that more sediment placement is generally better.

1.3 Beneficial Reuse Opportunities

1.3.1 Long-Term Management Strategy for Dredged Material Disposal

The Long-Term Management Strategy (LTMS) program was created in 1990 to coordinate dredged material disposal practices in the San Francisco Bay region. In 1996, the LTMS established the San Francisco Bay Dredged Material Management Office (DMMO) to streamline the application and permitting process for dredged material. The DMMO is comprised of representatives from all permitting and resource agencies and functions under the auspices of the USACE. All dredging and disposal activities require approval from the DMMO (DMMO 2002).

The environmentally preferred alternative identified in the LTMS Final EIS/EIR includes beneficial reuse of at least 40 percent of material dredged in the San Francisco Bay region, no more than 40 percent placement at the San Francisco Deep Ocean Disposal Site (SF-DODS), and no more than 20 percent placement at in-Bay sites.

In 2012, the LTMS agencies completed a comprehensive 12-year review of the program. A cost review showed that costs were generally highest for beneficial reuse and upland placement and lowest for in-bay placement, with the ocean site SF-DODS having intermediate placement costs. The LTMS agencies recommended adopting increased flexibility and innovation for in-Bay disposal volume limits, as well as encouraging more beneficial reuse and new kinds of beneficial reuse (LTMS, 2013).

The USACE, San Francisco District developed the South San Francisco Bay Dredged Material Management Implementation Plan (the DMMIP, USACE 2011a, 2012a) to support their ability to meet the material placement targets of the LTMS. As part of the DMMIP, they estimated the costs to dredge, haul, offload, and pump material to the ponds, as well as the cost to continue to place material at SF-DODS. The DMMIP found that the cost to place material at the Eden Landing and Ravenswood pond complexes was lower than the cost associated with disposal at SF-DODS, even when the offloader costs excluded economies of scale. For the Alviso complex, the cost for placement was lower than the cost for disposal at SF-DODS, except for the scenario where offloading the dredged material was performed without the advantage of economies of scale.

1.3.2 Material Available in the San Francisco Bay Area

Material generated from federal and mid-sized non-federal navigation dredging projects in San Francisco Bay total to about 2.4 MCY (annualized volume), with 1.6 MCY from federal projects and 0.7 MCY from mid-sized non-federal projects (see Table 4-1). There is likely to be competition for the sediment from other projects; the Montezuma Wetlands Project is still accepting material, and the next wetland restoration project anticipated to use significant quantities of dredged material is Bel Marin Keys Unit V Restoration Project (also owned by SCC). Given its location in Suisun Bay, the Bel Marin Keys Unit V Project is much closer to the dredging projects, however the timescale is shorter (eight to ten years) than the SBSP Restoration Project. Bel Marin Keys Unit V Project will likely reduce the available volume anticipated to go to SBSP while operational, but this will not be the case for more than a few years.

The Redwood City Harbor Deepening project is a federal capital improvement project likely to be cost-effective for material to be placed at the SBSP site. The Redwood City Harbor Deepening Study is investigating deepening Redwood City's Navigation Channel project beyond its authorized depth of -30 feet MLLW. The Redwood City Harbor is in San Mateo County, less than five miles northwest of the Ravenswood Pond Complex. The dredged material volume created by the deepening project is estimated at 1-3 MCY (USACE, 2013b).

Two large construction companies who are knowledgeable of upland material availability in the bay area were consulted to estimate sources over a 3-year planning horizon within approximately 20 miles of the SBSP site. Potentially 2.2 MCY could be available annually, however significant competition is expected from other construction sites requiring fill. Sediment suitability could also be a challenge, and would eliminate some upland material from placement at the SBSP Restoration Project. The advantage of the SBSP Restoration Project is its ability to accept large volumes of material; the disadvantage is that it has little flexibility to accept lesser quality material.

1.4 Beneficial Reuse: Implementation Challenges

There are three main considerations in implementing beneficial reuse of dredged material for the SBSP project.

- Material Delivery and Placement: Can the material be brought to the ponds and placed in an efficient and cost-effective manner?
- USACE Cost Sharing Policy Compliance: Can material generated by USACE O&M dredging be placed in the ponds within the scope of O&M cost sharing regulations? This does not restrict non-USACE dredging or capital projects.
- Environmental Regulatory Compliance: What are the environmental requirements associated with placements of dredged material in the ponds?

1.4.1 Material Delivery and Placement

Physically, the efficiency of placing materials at the ponds depends on the dredging methods used. This affects the water content of the dredged material, the navigation depth needed for the material to be brought to the transfer facility, and the overall efficiency of the dredging and material placement process.

The majority of the dredging projects in the San Francisco Bay use either a clamshell dredge with material transported to the disposal site using scows, or a hopper dredge in which the dredge and discharge equipment are combined into a single vessel.

1.4.1.1 Material Delivery to Ponds

The primary challenge in delivering dredged material to the SBSP beneficial reuse sites is the shallow water in the South Bay. To move the material the last few miles over the shallow mudflats, the hopper dredge or scow would be offloaded at a deep water transfer site and the dredged material would be pumped to the receiver site by pipeline. Potential transfer sites for the three pond complexes are shown in Figure 5-3.

A hydraulic offloader consists of a transfer pump connected to a pipeline that runs from the transfer site to the receiving site. The hydraulic offloader pumps water into a scow or hopper compartment to create a slurry and an intake line feeds the transfer pump. The transfer site requires the following infrastructure: mooring dolphins with navigation lights, hydraulic offloader mounted on a barge, pipeline, one or more booster pumps stationed along the pipeline, and support equipment such as barges, diesel generators, and site security.

Alternative to an offloader, a direct pump facility (for connection to hopper dredges) or an unconfined aquatic transfer facility (ATF) could be considered; however a direct pump facility is only applicable for pumping short distances (such as Ravenswood), and an ATF has significant environmental challenges (and has never been permitted in the Bay Area) making it an unlikely transfer method.

1.4.1.2 Placement of Dredged and Upland Material

Placement of material via hydraulic transport involves dealing with a significant quantity of water in the slurry: dredged material slurry in a pipeline is typically four-to-five parts of water for every one part sediment. In order to receive dredged material as slurry, the pond complexes must have infrastructure in-place prior to any material delivery. Dredged material placement requires containment cells and water control structures (adjustable discharge weirs and pumps) to capture and slowly decant the millions of gallons of slurry mixture pumped into the site. Decant water released back into the Bay must comply with the WDRs as defined in the project's RWQCB permit.

Existing levees would be improved to contain the slurry, and new internal dikes would be needed to create independent settlement cells. The material for these improvements would most likely be excavated on site using large construction equipment. The levees and dikes would need to be protected to prevent erosion near areas of high water velocities.

Because the pond bottoms (historic marsh plains) are composed of soft soils, specialized low ground pressure construction equipment would be used for excavating and placing levee material. This is a significant construction cost element that has to be completed before dredged material can be brought to the site. If material from upland construction projects is available in a timely and cost-effective manner, this is a very attractive option to support internal haul routes.

Prior to construction of any of these features, the upland material must be transported and delivered to the ponds, most likely by trucks. Once haul routes are determined and the existing infrastructure has been assessed for its ability and capacity to handle the truck traffic, the placement location of the material within the ponds must be determined. Ideally, the placement location is close to the final resting spot for the material to limit re-handling expenses.

1.4.2 USACE Cost Sharing Policy Compliance

Well over half of the regular dredging in San Francisco Bay is performed by the USACE under its congressionally authorized Operations and Maintenance (O&M) program. The dredging is conducted based on annual appropriations from Congress.

Under the O&M program, USACE regulations require the identification of a *Federal Standard* or the *Base Plan*. The Federal Standard is defined as the least costly dredged material disposal or placement alternative (or alternatives) that is consistent with sound engineering practices and meets all federal environmental requirements. This standard is often expressed as the "least cost, environmentally acceptable" alternative. Costs associated with placement under the Base Plan are assigned to the navigational purpose of the project. If there is a desire by a local sponsor for the material to be placed elsewhere as a beneficial reuse activity, any incremental costs are shared between the USACE and the non-federal sponsor. The cost sharing for navigation and beneficial reuse projects under the Water Resources Development Act (WRDA) 2014 is as follows:

- Maintenance dredging performed under the O&M program is 100 percent federal funded for channels down to -50 feet MLLW. For deeper channels, the incremental cost is 50 percent federal funded.
- Restoration projects are up to 65 percent federal funded. This would include federal funding for any incremental costs associated with beneficial reuse of dredged material. However, the nonfederal costs include 100 percent of the following items:
    - Lands, Easements, Rights-of-way, Relocations, and Dredged or excavated material disposal areas (LERRD); and
    - Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) of the restored site.
- The costs of LERRD and OMRR&R may be applied to the 35 percent nonfederal portion of beneficial reuse projects.

In the case of the SBSP beneficial reuse site, the LERRD would include construction and operation of the transfer facility as well as preparation of the receiving site for material placement. (Lands, easements, rights-of-way, and relocations should be minimal.) Even if the overall cost of material disposal at the SBSP beneficial reuse site is less than that of the Base Plan, the nonfederal sponsor would be responsible for 100 percent of the LERRD and OMRR&R costs.

Capital improvement dredging projects are subject to different authorization rules. Congressional authorization and appropriations are sought by the USACE and the local sponsor, and a cost-sharing agreement is set up between the two entities. Additionally, Section 217 of the Water Resources Development Act (WRDA) of 1996 provides guidance for public-private partnerships in the design, construction, management, or operation of dredged material disposal facilities in connection with construction or maintenance of Federal navigation projects.

- Under Section 217 (c), the USACE could enter into an agreement with either the SCC or a private entity to design, construct, manage, and operate a dredged material disposal facility at the SBSP Restoration Project. The private entity would provide financing for the facility, and would be reimbursed over time through the payment of subsequent user fees, which could include the payment of a disposal or tipping fee for placement of dredged material. The level of user fees would be approved by the USACE in cooperation with the SCC, and would be sufficient to provide a reasonable return on investment to the private entity.

- Under Section 217 (a), provided that additional capacity is available beyond that required by USACE projects, medium-sized dredging projects by ports or others could also place the material at the SBSP project. USACE approval of the level of user fees is not required in this case.

1.4.3 Environmental Regulatory Compliance

Three main project elements will require environmental review and permitting: sediment quality; water quality; and short-term construction impacts associated with material transportation and placement activities and infrastructure.

1.4.3.1 Sediment Quality

For the SBSP Restoration Project to be economically feasible, the project should accept as much material as possible to cover the high capital costs for an offloading facility and site preparation. Consequently, the SBSP Restoration Project should plan to accept both cover and foundation material, similar to the Montezuma Wetlands Restoration Project. Use of foundation material may raise regulatory agency concerns over the desiccation of imported, dredged material fill at tidal marsh restoration sites – specifically the effects of material that is allowed to dry out during stockpiling or after placement at the marsh site, but before tidal flow is reintroduced to the site.

Concerns include the potential for increased leaching of metals from dredge sediments upon drying and oxidation followed by wetting, particularly wetting with fresh water (e.g., rain). San Francisco Bay dredged sediments are often fine-grained materials with low organic content (less than one percent), are anoxic when dredged, and can become increasingly acidic upon oxidation. Hardening and deep desiccation cracks may form upon drying due to the high clay content of Bay Mud, increasing the exposure to rain and consequent leaching. This may expose invertebrate-eating shorebirds to leached metals while foraging in the dredged material, mosquitoes may harbor in deep cracks, benthic organisms may colonize poorly in hard clay, and vegetation may be stressed.

In response to this, restoration projects utilizing dredged material in the Bay Area have been required by permitting agencies either to keep dredged material wet until tidal action is restored, or conduct a monitoring program to detect and prevent leached metals from entering the Bay, among other measures. If dredging project schedules and reuse schedules do not match in time, the necessity of storing and handling these materials in the wet can cause a significant impediment to dredged material reuse. Given the long timescales and complexity of the SBSP Restoration Project, there will be no single management approach to wetting and drying issues. The most likely way ahead would involve monitoring; management of drying ponds to avoid the worst potential impacts listed above; and careful management of foundation material in particular.

1.4.3.2 Water Quality

Decant water discharged into the Bay from the containment cells must meet waste discharge requirements. Water quality in the receiving water body also must be monitored and comply with water quality criteria (such as dissolved oxygen, turbidity, total suspended solids, etc.). Stormwater management during the placement of dredged material would be similar to decant water management at all pond complexes. If a pond is to receive flood flows while dredged material is placed, there would have to be adequate space to contain the expected volume of water and still comply with water quality objectives. Because dredging work windows in the South Bay are from June through the end of November, the majority of dredged material placement will occur prior to the rainy season.

1.4.3.3 Transport and Placement Infrastructure and Activities

Environmental review for placement activities associated with beneficial reuse may need to evaluate impacts from:

- Navigational access for dredges/scows and site access for construction equipment
- Transfer site infrastructure (offloader, pipeline, booster pumps, barges, scows, etc.)
- Upland stockpile and rehandling facilities (for either dredged or upland material)
- Site preparation such as sediment slurry containment infrastructure (grading, water control structures, levee improvements, etc.)

These activities may impact the following resources: traffic/navigation, noise, air quality, water quality, greenhouse gases, recreation, and biological. Best management practices, such as fish screens on all water intake pumps, should be incorporated into the project design to reduce impacts.

1.5 Case Studies

This section describes four major case studies where dredged material, largely from USACE projects, was used in wetland restoration.

- The Sonoma Baylands Demonstration Project was one of the first such major projects, and its success was one element in the increasing interest in beneficial reuse of dredged material.
- The Hamilton Wetland Restoration Project (HWRP) was technically very similar to – although much smaller than – the SBSP project. Many of the technical issues that must be addressed by the SBSP Restoration Project have been investigated in the HWRP.
- The Bair Island Restoration Project used a private contractor to manage the placement of dredged material from the Redwood City Harbor maintenance dredging at Inner Bair Island. The contracting vehicle used may form a basis for beneficial reuse at the SBSP Restoration Project.
- The Montezuma Wetlands Restoration Project (MWRP) is unusual in being a privately owned and operated facility. It has had limited success in attracting dredged material somewhat due to competition with the HWRP, highlighting the risks taken by private operators in this field.

The Oakland Harbor deepening projects created the material placement infrastructure for the Sonoma Baylands project, HWRP and MWRP. In contrast, Inner Bair Island was limited to receiving only O&M material (two episodes for a total of approximately 275,000 CY) from

Redwood City Harbor. Each of these case studies provide lessons learned that apply to implementation of the SBSP Restoration Project.

1.6 Conceptual Implementation Design and Costs

In order for dredged material to be placed at the SBSP Restoration Project on a large-scale basis, placement at the Project must cost less than the USACE dredging project's Base Plan, *or* the Base Plan site must be unavailable to receive some or all of the dredged material. SF-DODS is the Base Plan for Oakland Inner and Outer Harbor and Richmond Inner and Outer Harbor; the most likely reason SF-DODs may be unavailable to receive some or all of the dredged material is if LTMS places a limitation on deep-ocean placement.

Even if unit costs for placement at SBSP are low, there is a significant up-front cost associated with the construction of an offloader and other placement infrastructure. There are institutional challenges associated with this up-front expenditure:

- The SCC does not have the funding to establish and operate an offloading facility to transport dredged material to the ponds, nor to prepare the ponds for receiving upland and dredged material.
- USACE O&M procedures do not allow the USACE to provide funding for the offloading facility or for preparation of the ponds.
- USACE procedures for capital improvement projects do allow the USACE to provide this funding, but this is subject to federal cost sharing agreements.

A public-private partnership could potentially bridge the funding gap, allowing a private interest to provide financing for the establishment and operation of the site, with costs covered by user fees. A conceptual cost analysis of this scenario is provided, showing that beneficial reuse at the SBSP Restoration Project is generally cost competitive with the Federal Base Cost of USACE's South Bay maintenance dredging projects (see Table 7-5).

The sediment volumes and sources assumed in the cost estimate are realistic, assuming coordination with USACE continues to move forward and an agreement is made in the future. If in the future the dredgers change their equipment to fit a new beneficial reuse practice in the Bay Area, as they did when SF-DODS first became the primary disposal location, the costs to beneficially reuse material should decrease and prove to be very competitive.

1.7 Implementation Strategy

Redwood City Harbor O&M dredged material beneficially reused and placed at Inner Bair Island was the result of two MOUs (2006-2007) between the site own, USFWS, and the dredging sponsor, USACE, and executed through a bid contract issued by USACE to a private contractor. A similar public private partnership is recommended for beneficially reusing material at the SBSP Restoration Project involving the collaboration of numerous institutional parties.

Acting as the project owner and overall program manager, the SCC would be responsible for developing and publishing a RFP to award to a third party contractor to manage a group of ponds as a disposal site for a fixed period. The SCC would also encourage participation and support from the regulatory agencies (particularly the LTMS Agencies and DMMO), coordinate

Memorandums of Understanding (MOUs) with the USACE, select and manage a contractor, prepare CEQA documentation, as well as other activities (see Section 8.2).

The entity managing the sediment placement – assumed here to be a private contractor – would be responsible for up-front and operational costs associated with the sediment placement. In addition, the contractor would have the general responsibility for financing, providing infrastructure to, and operating the placement site as a landfill, within the constraints of regulatory and permitting requirements and the agreement with the SCC. The contractor would be responsible for designing, obtaining permits for, constructing, and operating the offloader facility and on-site improvements. The contractor would be allowed to charge a tipping fee to those placing material.

The LTMS-DMMO agencies, thru the LTMS Implementation Plan policies and the Alternative Analysis protocol, would provide incentives to send material to the SBSP Restoration Project. For example, additional material could be disposed of at inexpensive in-bay disposal sites such as SF-11 in return for a certain quantity disposed of at SBSP.

The USACE's participation is critical to provide planning stability to the third-party contractor. A MOU would be necessary between USACE and SCC that would commit the USACE to placing a given quantity of material under appropriate circumstances. Other smaller Ports and private dredgers could also join the MOU, or at a minimum benefit from one between USACE and SCC.

Based on review of the documents for other beneficial reuse sites, there is no uniform precedent for addressing the components of dredged material reuse at restoration sites. Most commonly, the NEPA/CEQA documents for beneficial reuse sites analyzed the impacts of placing dredged materials at the sites, and impacts associated with site improvements and infrastructure needed to receive and place dredged materials. In some cases, supplemental environmental review documentation was completed to address proposed changes in infrastructure from the original projects (e.g., BMKV and Cullinan Ranch).

1.8 Eden Landing Pilot Project

Capital improvement projects have a critical role in kick starting beneficial reuse. In three of the four successful case studies described in Section 6, the infrastructure to transport and place dredged material at the site could be constructed only because of the 42-ft. and 50-ft. Oakland Harbor Deepening Projects. Once the infrastructure is in place, it becomes cost-effective to continue its use for O&M material.

At present, the only upcoming federal capital improvement navigation project close to the SBSP is the Redwood City Harbor Deepening (Section 4.3.2). This will generate approximately 1-2 MCY of material – much less than was generated by the Oakland Harbor Deepening Projects. However, the Eden Landing Land Mass (Section 3.6) being planned by ACFCD will require significant quantities of sediment to construct – estimated at 600,000 CY based on the conceptual cross sections provided by ACFCD, cited in URS 2012a.

The phases of the beneficial reuse pilot project would be as follows.

- Land Mass Phase: Material dredged from the Redwood City Harbor Deepening Project would be transported by scow to the Eden Landing Deep Water Transfer Site. It would be offloaded, pumped to shore via pipeline and used to construct the Eden Landing Land Mass.
- Eden Landing Phase 1: Material dredged from the Redwood City Harbor Deepening Project would continue to be transported by scow to the Eden Landing Deep Water Transfer Site and be pumped to shore via pipeline. It would be used to increase the bottom elevation of Pond E2. Decant water would flow from Pond E2 through Ponds E1, E4, and E7, allowing solids to settle out of the water column.
- Eden Landing Phase 2: Once the Redwood City Harbor Deepening Project is complete, the transfer infrastructure would remain in place but O&M material from the Redwood City Harbor and other federal and non-federal projects would be used to complete the restoration of Pond E2 and increase the bottom elevations of Ponds E1, E4, and E7. The pipe discharge location would be moved as material is spread, working from the waterside ponds (E1, E2) inland to allow for the longest settling time prior to reaching the Bay.
- Eden Landing Phase 3: A booster pump would be constructed at the shoreline to allow more distant ponds to receive material.

The objective would be to develop MOUs between the different institutional partners (USACE, Port of Redwood City as local sponsor, ACFCD, SCC, CDFW, and the LTMS Agencies) that would establish a cooperative framework for executing the Pilot Project. These MOUs would be needed to provide certainty to a third-party contractor (or other entity) to make the up-front investment required for the construction of the placement infrastructure.

The following is a potential schedule of the Eden Landing Pilot Project:

- SBSP Eden Landing Phase II EIR/S completed in 2016 (includes offloader and placement at the Land Mass and ponds for the deepening material and future O&M material) [must be complete before construction can begin at Eden Landing].
- Redwood City Deepening Project EIR/S completed in 2016 (includes the dredging and transport to Eden Landing; excludes the offloader and placement). Chief of Engineer's Report, Preconstruction Engineering and Design (PED) phase and U.S. Congressional construction authorization completed 2018 or 2019.
- Redwood City Deepening Project Construction of the offloader and Land Mass site preparation at Eden Landing during 2019 or 2020.
- Redwood City Deepening project completed in 2020 or 2021 (approximately 1-year).
- Once the SBSP Eden Landing Phase II EIR/S is completed in 2016, the SCC must begin coordinating a MOU with USACE and mid-sized private dredgers to ensure a consistent O&M sediment supply for Eden Landing. This is a key component to developing and awarding an RFP to a third-party contractor to continue operation of the offloader and placement of material at Eden Landing.

- Continuation of operating Eden Landing as a beneficial reuse site beginning 2020 or 2021, before the offloader or pipeline is removed from the Deepening Project.

1.9 Summary and Recommendations

- Other than Redwood City Deepening, it is unlikely that there will be any more capital improvement projects to jump start the upfront infrastructure investment of the SPSP Restoration Project.
- In order for the SBSP Restoration Project to be cost competitive with the Federal Standard for maintenance dredging projects in the San Francisco Bay Area, a long term commitment (in the form of a MOU) must be made that material will be beneficially used, rather than disposed of offshore.
- Dredge contractors will begin to change their operations to fit a new beneficial reuse practice only if they see that a long term commitment is being made.
- The USACE must also consider changing their contracting strategy to fit with beneficial reuse in the San Francisco Bay Area since the USACE dredge Essayons cannot pump off. Current projects performed by the Essayons may need to be performed with private contractor dredges capable of beneficial reuse.
- Any MOU between SCC, USACE, CDFW, ACFCD, DMMO and others should include the non-federal dredge project participants (e.g. Port of Redwood City) and dredging contractors. As Federal budgets continue to shrink, buy-in from non-Federal dredging sources and dredging contractors will be critical to the success of the project.
- Other upland placement sites (Montezuma, BMKV, and Cullinan) must also be somehow included in the overall beneficial reuse plan so all projects can be a success and not be viewed as competitors for the dredge material.
- SCC would benefit from taking an active role in Redwood City Deepening project to lobby for the material to be used for the Eden Landing Land Mass. Additional pilot projects for other SBSP locations could utilize mid-size private dredging projects, such as the Port of Oakland, Port of Richmond, and Port of San Francisco berth dredging material.
- SCC would benefit from an Upland Material Placement Strategy to use upland material most efficiently in preparation of dredged material placement. The Placement Strategy would inventory the current material amounts being used under the levee O&M permits, and then develop a placement plan keeping the larger project in mind.

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ACRONYMS

ATF	Aquatic Transfer Facility
BCDC	San Francisco Bay Conservation and Development Commission
CDFG	California Department of Fish and Game (now CDFW)
CDFW	California Department of Fish and Wildlife
CY	Cubic Yards
DMMIP	Dredged Material Management Implementation Plan
DMMP	Dredged Material Management Plan
EIR/S	Environmental Impact Report/Statement
FEMA	Federal Emergency Management Agency
ISP	Initial Stewardship Plan
LERRD	Lands, Easements, Rights-of-way, Relocations, and Dredged or excavated material disposal areas
LTMS	Long Term Management Strategy for dredged material
MCY	million cubic yards
MHHW	Mean Higher High Water
MHW	Mean High Water
MLLW	Mean Lower Low Water
MLW	Mean Low Water
MSL	Mean Sea Level
MTL	Mean Tide Level
NAVD88	North American Vertical Datum of 1988
O&M	Operations and Maintenance
OMRR&R	Operation, Maintenance, Repair, Replacement, and Rehabilitation
PMT	Project Management Team
RWQCB	Regional Water Quality Control Board
SBSP	South Bay Salt Ponds
SCC	California State Coastal Conservancy
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
TSP	Tentatively Selected Plan
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency

USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTZ	Upland Transition Zone
WQC	Water Quality Certification
WRDA	Water Resources Development Act

2. INTRODUCTION

2.1 Purpose & Need

The South Bay Salt Pond Restoration Project located in South San Francisco Bay, is the largest tidal wetland restoration project on the West Coast. The Project will transform a former salt-production system of aging levees, water control structures, and subsided pond bottoms into valuable marsh habitat while improving flood protection and public access. When complete, it will restore 15,100 acres of industrial salt ponds to a rich mosaic of tidal wetlands and other habitats. The Project comprises the Alviso Complex (8,000 acres), the Eden Landing Complex (5,500 acres), and the Ravenswood Complex (1,600 acres). Figure 2-1 shows the location and general outline of the Project.

Imported material could potentially be used for the following restoration and flood protection purposes:

- Raising the bottom elevation of subsided ponds that are to be restored as tidal habitat;
- Improvement of levees in the pond complexes;
- Creation of upland transition zones (UTZs);
- Creation of habitat islands in managed ponds;
- Filling existing drainage ditches at the Ravenswood Pond Complex.

By far the largest potential volume is associated with raising the bottom elevation of subsided ponds, estimated up to approximately 70 million cubic yards (assuming most ponds are restored to tidal habitat, although managed pond habitat is also acceptable). This volume is based off reaching the habitat target elevation for each pond complex, which is typically within one foot of the local MHHW level. The ponds at Ravenswood and Eden Landing may gain sufficient sediment to reach the target elevations with natural accretion within the 50-year project lifespan; however reaching the target elevations in the deepest ponds in the Alviso complex by natural accretion is dependent on how soon the ponds are opened to tidal action. Imported material could supplement natural accretion and speed the restoration of the ponds.

Federal and private navigation projects annually dredge about 2.5 million CY from the Bay. The Long Term Management Strategy (LTMS) goal is to beneficially reuse at least 40 percent of material dredged in the San Francisco Bay region, place no more than 40 percent at the San Francisco Deep Ocean Disposal Site (SF-DODS), and place no more than 20 percent at in-Bay sites. Given the regulatory support for beneficial reuse, the SBSP Restoration Project is in a position to provide the Bay Area with a large-scale beneficial reuse site for years to come.

The goal of the Study is to develop a comprehensive plan for securing approvals to opportunistically receive material from aquatic and upland sources for pond restoration and flood protection features throughout the project area. This report in particular describes potential pond capacities, current sources of dredged and upland material, an implementation strategy and a path forward with a potential pilot project at Eden Landing.

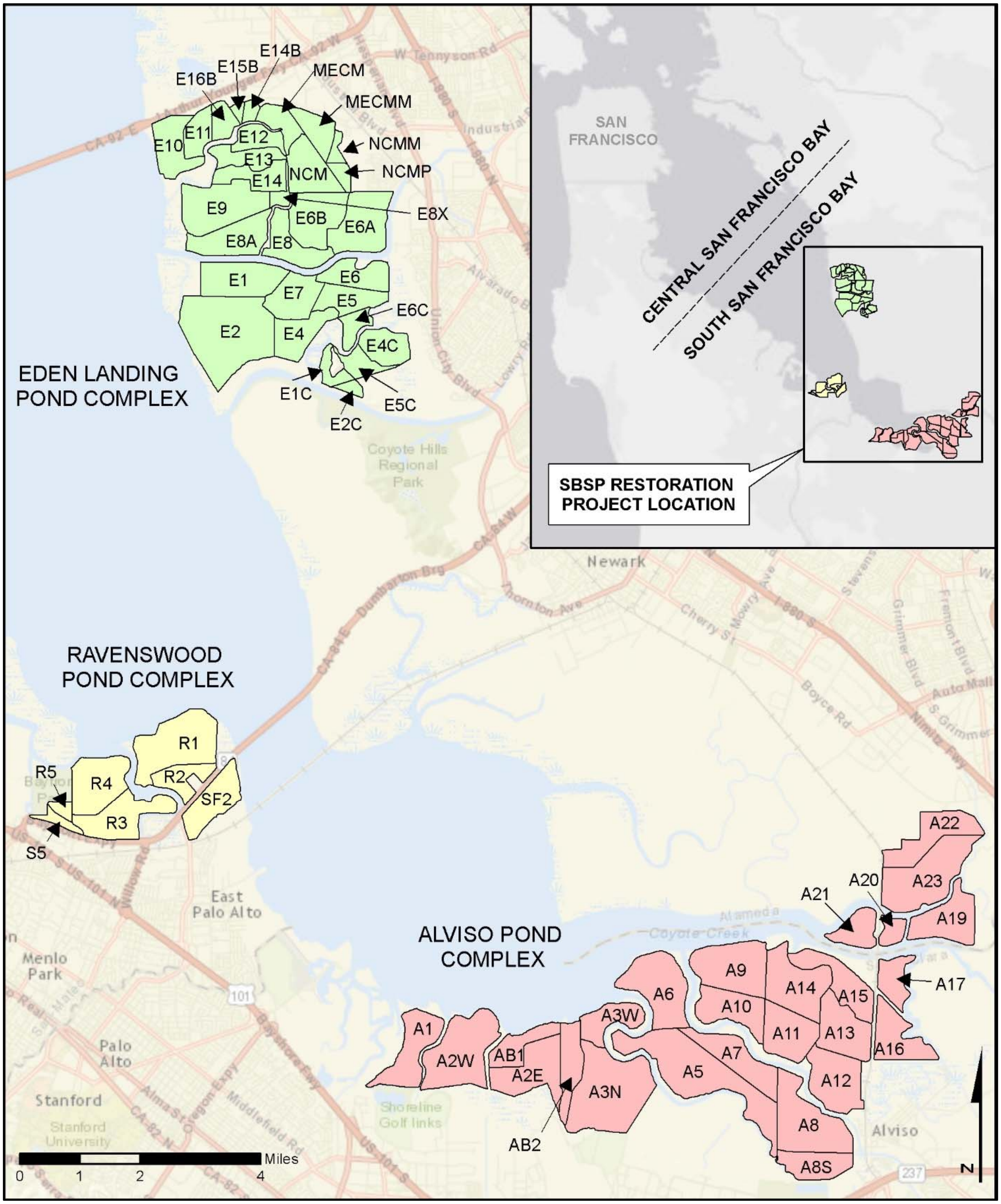

Figure 2-1. South Bay Salt Pond Restoration Project Location

2.2 Scope of Work

The ultimate goal of this work is to align the fill capacity of the SBSP Restoration Project with Bay Area needs for a regional beneficial reuse site in a cost competitive manner with current disposal practices. The overall scope of this study is as follows.

- Develop an Implementation Strategy that leverages studies completed to date for projects in the region. These include studies, environmental documents and permit approvals for the Sonoma Baylands, Montezuma Wetlands, Hamilton, and Bair Island Restoration Projects approvals as well as the studies and NEPA/CEQA documents for the Long Term Management Strategy (LTMS) for dredged material disposal;
- Conduct focused research studies and coordinate with regulatory and resource agencies to reduce uncertainties, and to address the concerns that agencies have expressed with respect to using material from unidentified sources;
- Perform a conceptual cost analysis to determine the cost-competitiveness of potential USACE maintenance dredging projects placing material as the SBSP Restoration Project compared to their Base Plan disposal location.
- Identify an environmental review strategy and permitting framework that would stay within the context of the current NEPA/CEQA Phase II document for the SBSP Restoration Project to minimize supplemental documents.

Specific objectives and scope of work are:

1. Identify suitable locations and required infrastructure for short-term storage or direct placement of material delivered to the site by other parties. Identify locations for transfer equipment.
2. Identify regulatory, engineering and community issues associated with the various locations and project elements required to place the material and potentially stockpile the material. Identify material management requirements and rough order of magnitude costs to deliver the material.
3. Specify the types of material acceptable (physical characteristics) for the different project features or uses such as expediting marsh development, filling borrow ditches, creating upland transitions zones, and constructing engineered levees.
4. Prepare a conceptual plan relating material chemical and biological suitability (cover/non-cover/material suitable for aquatic disposal, etc.) to each of the project features, and uses.
5. Coordinate with other efforts to facilitate beneficial reuse of material dredged from San Francisco Bay such that the SBSP Restoration Project is given priority in regional plans (e.g. the Long Term Management Strategy for the Placement of Dredged Material in the San Francisco Bay Region (LTMS) Program and the US Army Corps of Engineers' (USACE) development of a long-term Dredged Material Management Plan (DMMP) for San Francisco Bay).
6. Provide support to the PMT with stakeholder outreach and support NEPA/CEQA analyses to be able to proceed with the actions in the plan.

3. SOUTH BAY SALT POND RESTORATION PROJECT

3.1 Background

The U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Wildlife (CDFW) acquired the former salt ponds from Cargill, Inc. in 2003. A public process to design and implement the restoration project is being led by the California State Coastal Conservancy (SCC), USFWS and CDFW. The restoration plan was adopted in 2008 and the first phase of restoration started later that year. Design and implementation is being led by a Project Management Team (PMT) including state, federal, and local agencies, as well as private foundations.

The analysis, regulatory approval, acquisition, design, and construction associated with the SBSP Restoration Project has been ongoing for more than 10 years. Table 3-1 lists regulatory and planning documents that represent significant milestones for the project.

Table 3-1. Milestone Documents of the SBSP Restoration Project

Date	Document	Author	Highlights
2002	SBSP Restoration Feasibility Analysis	S. Siegel & P. Bachand	Summary of research and analysis prior to pond acquisition.
2003 Jun.	SBSP Initial Stewardship Plan (ISP)	Life Science!	Plan for Cargill to transition pond ownership to USFWS and CDFW.
2004 Mar.	SBSP ISP Final EIR/S	Life Science!	Environmental report detailing preliminary restoration and impact.
2007 Dec.	SBSP Final EIR/S	EDAW, et al.	Environmental report detailing alternatives evaluation, impacts and mitigation measures. Covers both programmatic plans and Phase I construction
2011 Jun.	DMMIP Preliminary Draft Reconnaissance Study	U.S. Army Corps of Engineers, San Francisco District	Preliminary evaluation as a beneficial reuse location.
2012 Feb.	DMMIP SBSP Restoration Project: Conceptual Beneficial Use Analysis	U.S. Army Corps of Engineers, San Francisco District	Evaluation as a beneficial reuse site. Dredged material fill volume estimates, delivery costs, and environmental issues.
2015 Spring (anticipated)	SBSP Final EIR/S (Phase II) Alviso & Ravenswood	URS	Phase II environmental report detailing alternatives evaluation for Alviso and Ravenswood Pond Complexes.
2016 (anticipated)	SBSP Final EIR/S (Phase II) Eden Landing	URS	Phase II environmental report detailing alternatives evaluation for Eden Landing Pond Complex.

3.2 Physical Conditions in the South Bay

3.2.1 Tides

Mixed semi-diurnal tides enter the Bay through the Golden Gate and are reflected and amplified in the South Bay. The tidal range increases from the Golden Gate going towards the South Bay (Table 3-2). Figure 3-1 shows the locations of NOAA tide gauges in the South Bay.

Table 3-2. Tidal Statistics for San Francisco Bay (feet)

Tidal Plane	Presidio		Alameda		San Mateo Bridge, West		Dumbarton Bridge		Coyote Creek	
	MLLW	NAVD	MLLW	NAVD	MLLW	NAVD	MLLW	NAVD	MLLW	NAVD
MHHW	5.84	5.90	6.59	6.36	7.72	6.97	8.51	7.27	9.00	7.48
MHW	5.23	5.29	5.97	5.74	7.09	6.33	7.88	6.64	8.42	6.90
MTL	3.18	3.24	3.55	3.32	4.14	3.38	4.54	3.30	4.83	3.31
MSL	3.12	3.18	3.45	3.22	4.11	3.36	4.57	3.33	4.92	3.40
MLW	1.14	1.19	1.13	0.90	1.19	0.43	1.20	-0.04	1.24	-0.28
NAVD88	-0.06	0.00	0.23	0.00	0.75	0.00	1.24	0.00	1.52	0.00
MLLW	0.00	0.06	0.00	-0.23	0.00	-0.75	0.00	-1.24	0.00	-1.52

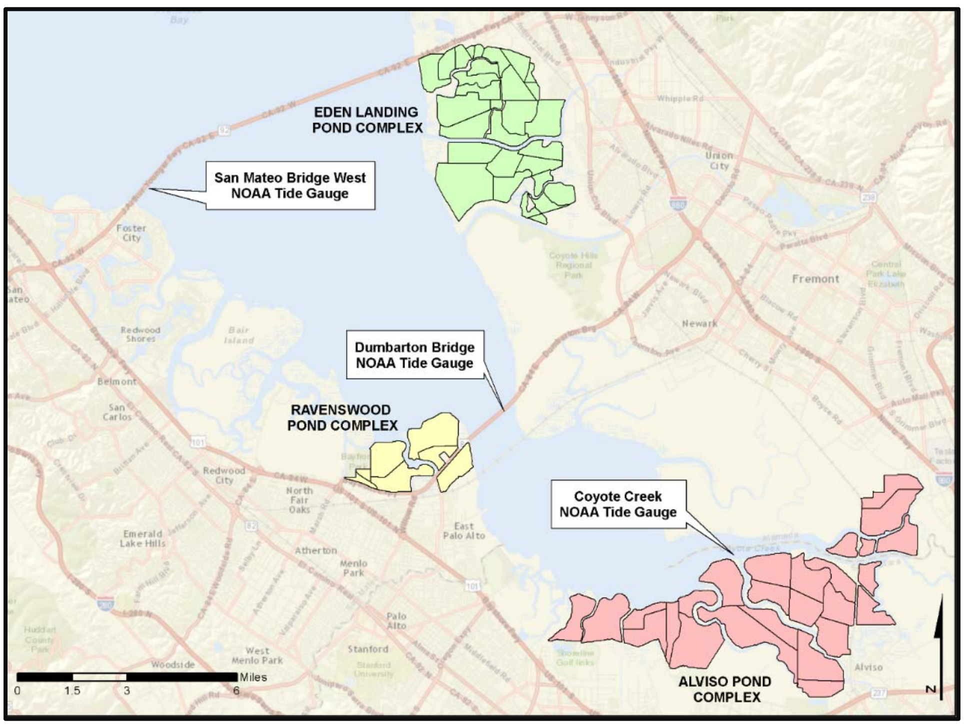

Figure 3-1. Tide Gauges in South San Francisco Bay

3.2.2 Salinity

Salinity in the South Bay fluctuates with exchange with the Central Bay, freshwater inflows from local municipal wastewater treatment plants, and evaporation. The Sacramento/San Joaquin

Delta supplies 90 percent of the freshwater inflow into the Bay, driving seasonal salinity variation. Typical salinities within the South Bay as a whole are near oceanic levels (33 parts per thousand), whereas the far South Bay (south of Dumbarton Bridge) is brackish year-around due to the freshwater inflows from winter/spring channels and wastewater treatment. Delta freshwater inflows can extend down into the South Bay during wet winters, creating vertical density stratification in the South Bay channel plants (EDAW *et. al.* 2007).

3.2.3 Bathymetry

South San Francisco Bay is a large basin with a deep channel surrounded by broad shallow areas, mudflats and fringing tidal marsh. Deep-hulled ships are restricted to the 33-55 foot deep channels, unable to navigate the less than 13 feet average depth in the surrounding shallows. In the Bay south of Dumbarton Bridge, the average depth is only three feet and 75 percent of the surface area consists of mudflats.

3.3 SBSP Restoration Project Objectives

The primary objectives of the SBSP Restoration Project are: (EDAW *et. al.* 2007)

- Restore and enhance a mix of wetland habitats;
- Provide wildlife-oriented public access and recreation; and
- Provide for flood management in the South Bay.

The salt pond containment dikes currently provide flood protection, so restoration of the ponds will include raising crest elevations and bolstering dikes to function as levees. These actions are intended to maintain or improve flood control and protect against anticipated sea level rise. The PMT adopted the SBSP Final EIR/S in 2008.

3.4 SBSP Programmatic Alternatives – Managed Pond & Tidal Emphasis

The SPSP EIR/S considered three alternatives over a 50-year planning horizon.

<u>Programmatic Alternative A</u>: No Action

<u>Programmatic Alternative B</u>: *Managed Pond Emphasis* with 50 percent tidal habitat and 50 percent managed ponds by area

<u>Programmatic Alternative C</u>: *Tidal Emphasis* with 90 percent tidal habitat and 10 percent managed ponds by area

The EIR/S concluded that the ideal long-term management of the SBSPs would fall between Programmatic Alternatives B and C, with guidance from an Adaptive Management Plan to determine the extent of achievable restoration based on uncertainties such as sea level rise. Initial construction is more similar to the *Managed Pond Emphasis*, with breached, relatively deep ponds that are constantly inundated. However, through a combination of later phased restoration actions and natural sediment gain, the pond elevations will increase over time, and the restored ponds will approach the *Tidal Emphasis* condition.

The Adaptive Management Plan incorporates lessons learned from earlier phases into future decisions to ultimately achieve project objectives. Monitoring information will feed into decision-making, creating a feedback loop, with management triggers providing warning signals to decision makers when unforeseen environmental impacts are detected.

From the perspective of dredged material beneficial reuse, a phased, long-term restoration approach coincides with the long-term needs of an O&M dredging project. Federal and private dredging occurs from once a year to once every five years, depending on the location and sedimentation rates. Having a reliable, economically-feasible placement location within the Bay will encourage regional beneficial reuse. Over the decades ahead, the flexibility inherent in the adaptive management approach will work with the fluctuations in the dredging market.

3.5 Phased Restoration Plans

3.5.1 Initial Stewardship Plan

The California Department of Fish and Wildlife (CDFW) and the USFWS acquired 15,100 acres of South Bay Salt Ponds from Cargill Inc. in 2003. These agencies developed the Initial Stewardship Plan (ISP) to guide their interim operation and maintenance until the final restoration plan was adopted in 2008. The ISP included the following elements:

- Cease commercial salt operations
- Introduce tidal hydrology to ponds where feasible
- Maintain existing high quality open water and wetland wildlife habitat, including habitat for migratory and resident shorebirds and waterfowl
- Maintain ponds in a restorable condition to facilitate future long-term restoration
- Minimize initial stewardship management costs
- Meet all regulatory requirements, especially discharge requirements to maintain water quality standards in the South Bay

As part of the ISP, three of the Alviso ponds – A19, A20, and A21 (known as the Island Ponds) were opened to tidal action. Five breaches were made to existing levees in March 2006.

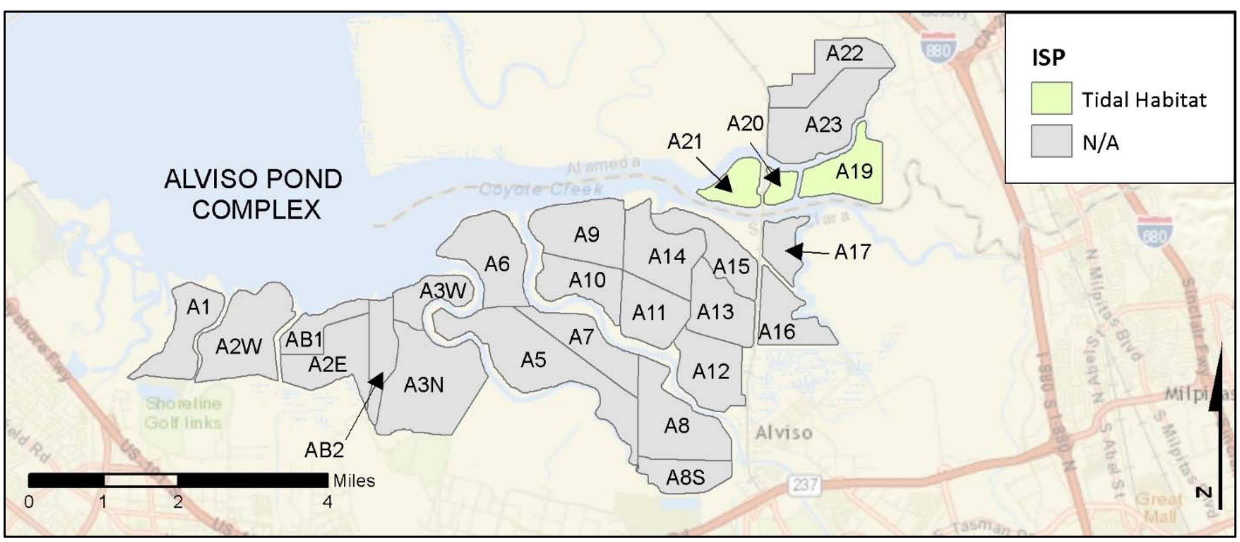

Figure 3-2. Initial Stewardship Plan (ISP) Pond Restoration Actions

3.5.2 SBSP Phase I

Phase I restoration started construction in 2009, and is near completion. This phase of restoration concentrated on ponds that could be restored without significant input of sediment. Figure 3-3 shows the ponds that were restored during Phase I.

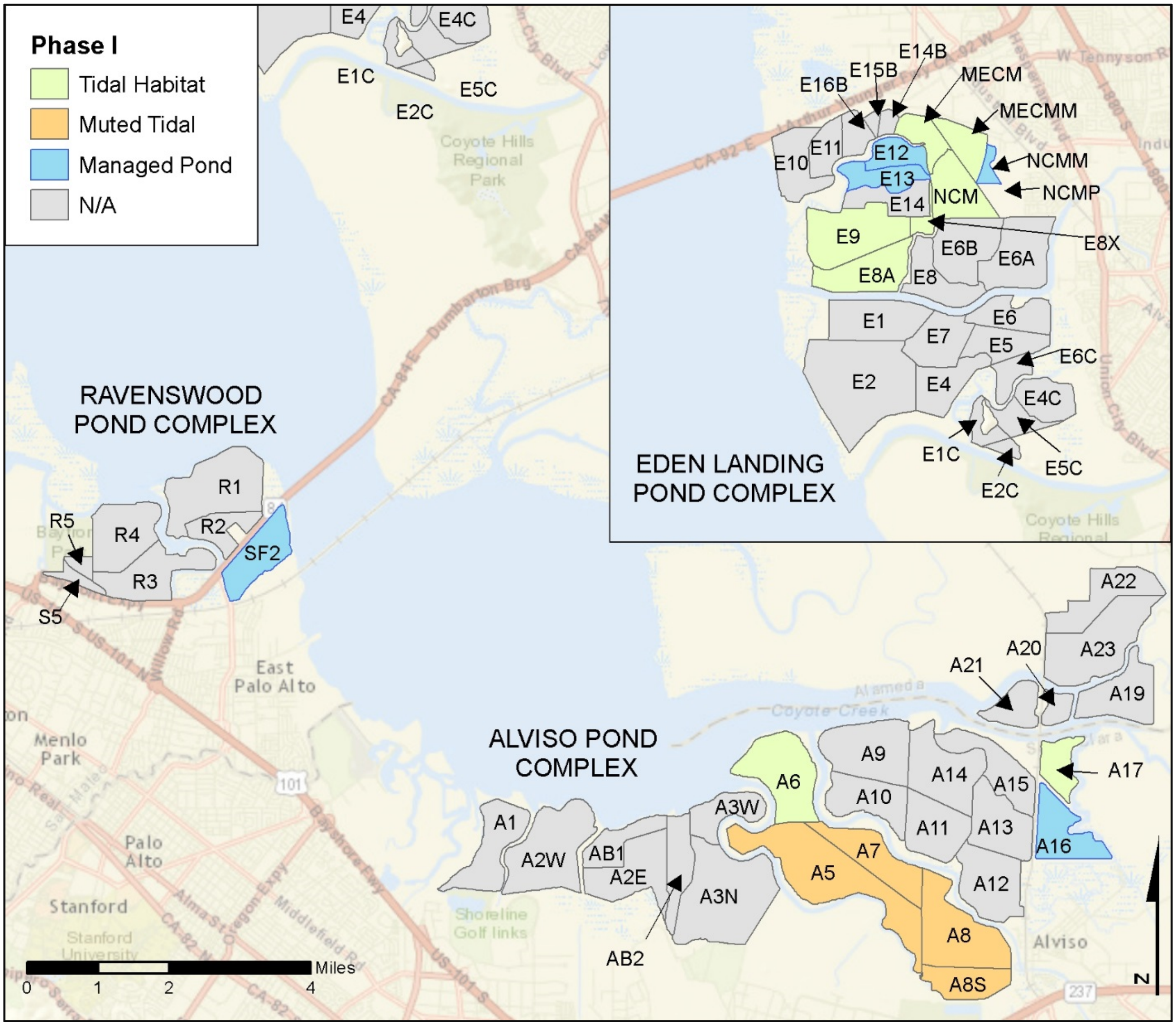

Figure 3-3. Phase I Pond Restoration Actions

Alviso Pond A8 was reconfigured with muted tidal action (which also affects Ponds A5 and A8S, although these were not the focus of the Phase I action). The muted tidal habitat was designed to be reversible in case there were adverse effects sediment and water quality impacts due to historic mercury contamination. Monitoring of mercury concentrations in water bird eggs (tern and avocet) in Ponds A8, A7, and A5 do not show any significant effects of the initial restoration (U.S. Geological Survey [USGS] 2014), so these ponds may reach their eventual goal of full tidal habitat sooner than expected.

3.5.3 SBSP Phase II

The SBSP Project Management Team, via more than two years of planning and public input, is pursuing Phase II projects in the three pond complexes. Opportunities and constraints have been identified for all three complexes, and an alternatives analysis has been completed for the Ravenswood and Alviso Complexes. A Draft Phase II EIR/S for the Ravenswood and Alviso Complexes is anticipated to be completed early 2015. The alternatives analysis was completed for the Eden Landing Complex in June 2014, and work on this EIR/S will begin after the completion of the Alviso and Ravenswood EIR/S. Figure 3-4 summarizes the tentative Phase II restoration actions.

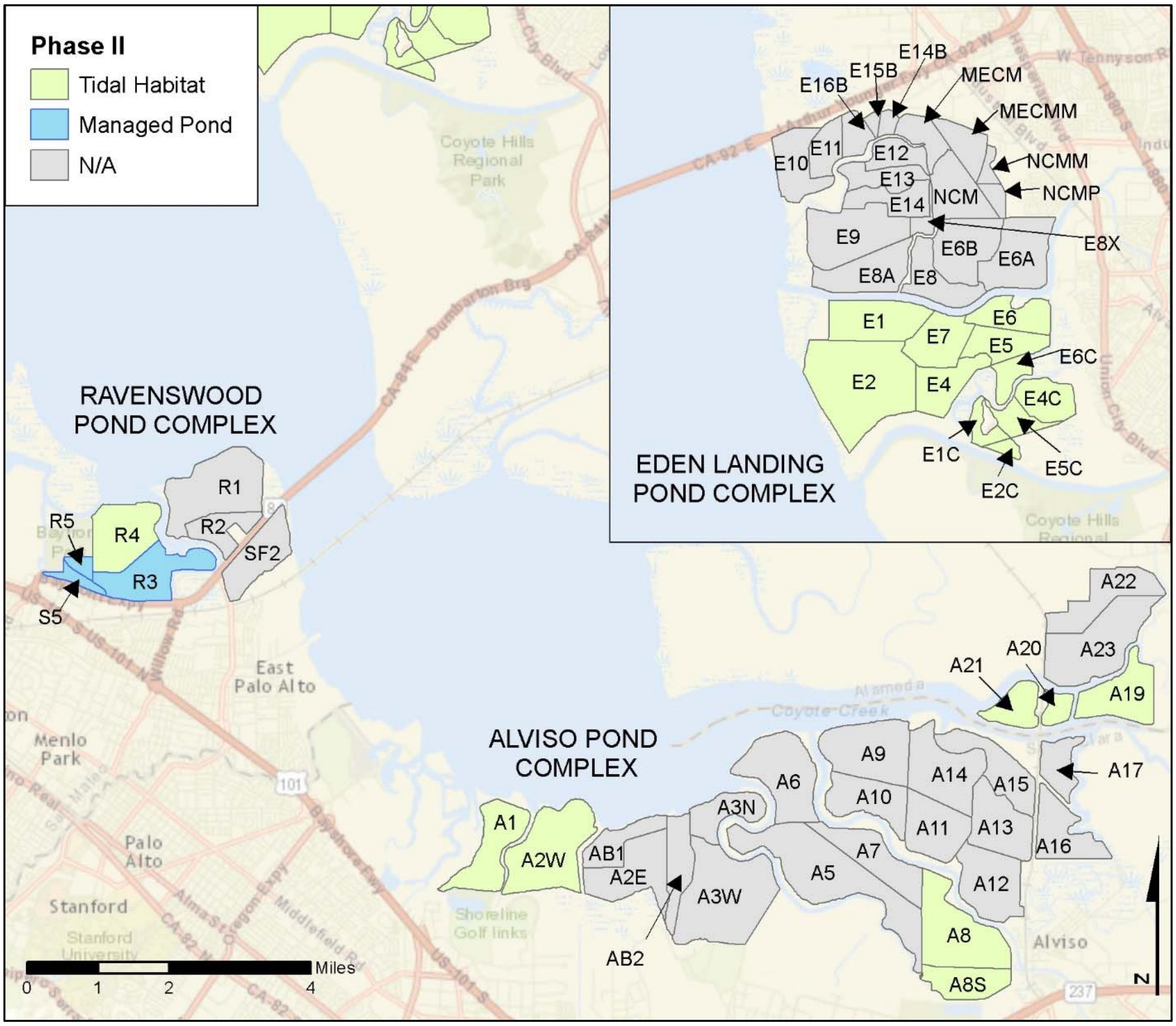

Figure 3-4. Tentative Phase II Pond Restoration Actions

3.5.4 Potential Later Phases

Later phases will be defined and scheduled as earlier phases are permitted and constructed. Figure 3-5 illustrates the 50-year goal for the SBSP Restoration Project, under the Tidal Habitat

Emphasis Alternative. UTZ and potential land mass locations are shown here for illustration: however, their location and design are still to be developed.

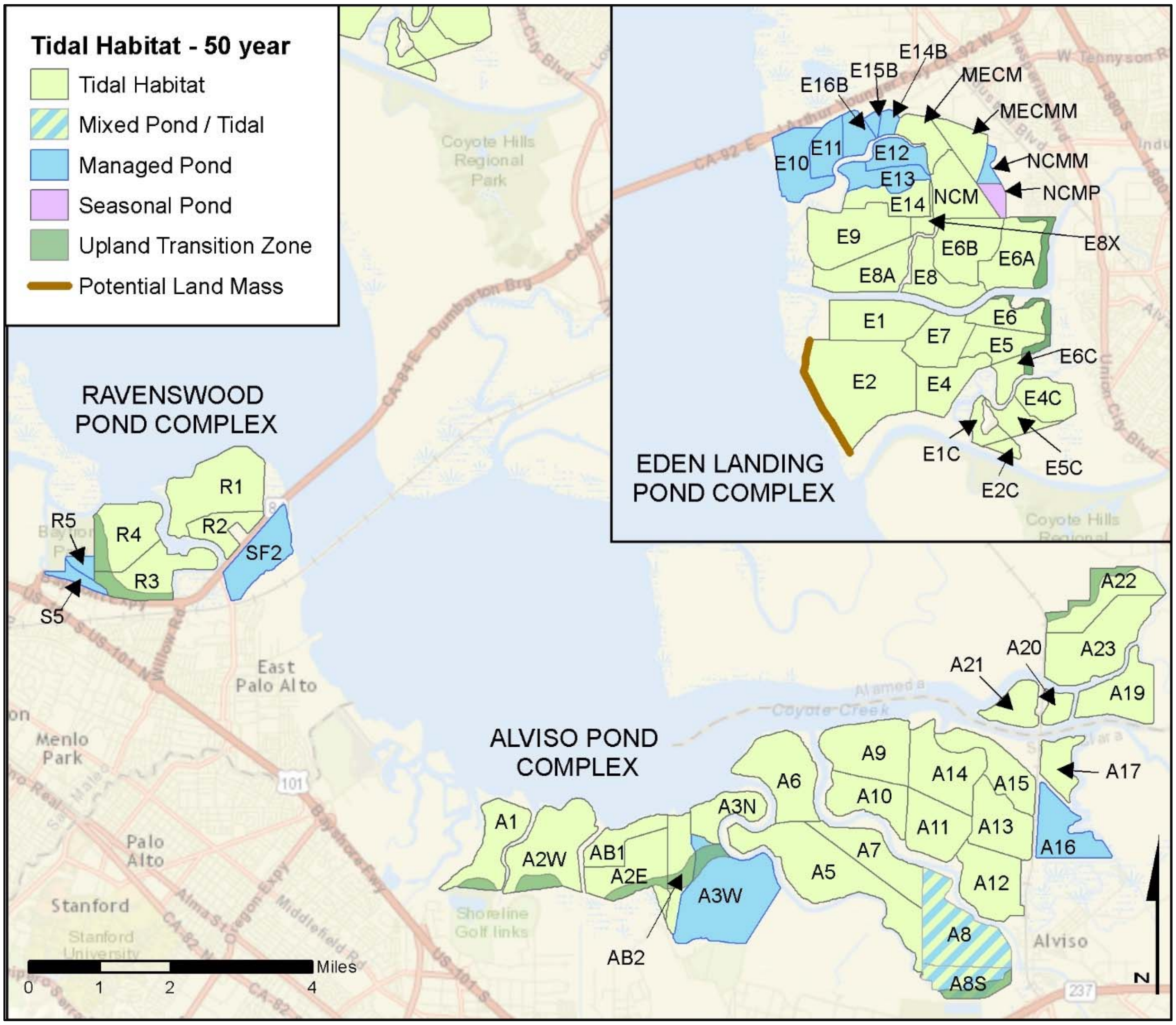

Figure 3-5. Tidal Habitat Alternative – 50-year Goal

This figure shows not only the final pond type – tidal, managed pond, seasonal pond, or a combination – but also the potential locations of Upland Transition Zones (UTZs) and the potential Land Mass at Eden Landing.

The UTZs are transitional areas between tidal habitat and levees, and are highly valuable ecologically. No UTZs were constructed during the ISP or Phase I (although some habitat islands were constructed) but there is potential for UTZ construction during Phase II and later phases.

3.5.5 Related Project: South San Francisco Bay Shoreline Study

3.5.5.1 Introduction

The South San Francisco Bay Shoreline Study is a separate, congressionally-authorized study being conducted by the Santa Clara Valley Water District (SCVWD) and the State Coastal

Conservancy (SCC), partnered with the USACE. This study will recommend a number of restoration and flood control projects, including phased pond-breaching in the Alviso Pond Complex and Pond A18, and construction of a flood protection levee and UTZ. This section summarizes the study background and anticipated recommendations.

3.5.5.2 Flooding in South San Francisco Bay

Flooding in the South Bay is generally caused by high water levels, due to a combination of high tides and low barometric pressure, in combination with wind waves. High rainstorm runoff can erode and/or overtop salt pond barriers and channel levees.

The Federal Emergency Management Agency (FEMA) is updating its floodplain maps for the Bay Area, and preliminary maps have been published. The preliminary results indicate that all three of the SBSP complexes would be inundated under 100-year flood conditions. Santa Clara County is at particular risk of flood damage and significant backland areas in Santa Clara County – upland of the Alviso ponds – would also be inundated under 100-year flood conditions. Figure 3-6 shows the preliminary floodplain mapping in the affected area.

This preliminary mapping is based on the assumption that non-accredited FEMA levees (i.e., all the pond levees) fail under flood conditions and provide no protection. Historically, this has not been the case: in practice, it appears that the levees in the pond complexes (approximately 150 miles total) do provide flood protection to the backland areas1. The SBSP restoration must include a flood protection component. Otherwise, the risk of flooding in the South Bay may be significantly increased and it may more closely resemble the preliminary map in Figure 3-6.

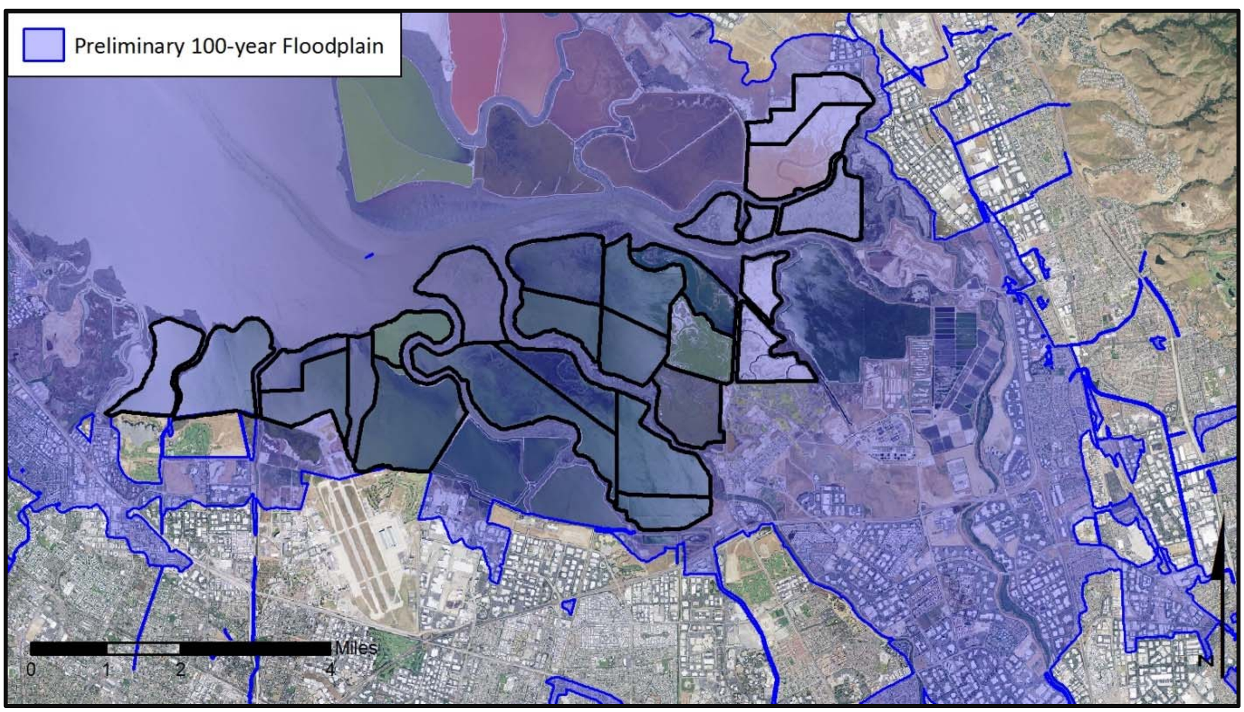

Figure 3-6. Preliminary FEMA Floodplain Map, Alviso Ponds and Backlands

[1] New FEMA analysis procedures (FEMA 2013) do allow the protection provided by non-accredited levees to be taken into account in developing flood maps.

3.5.5.3 South San Francisco Bay Shoreline Study

The USACE initiated the congressionally-authorized South San Francisco Bay Shoreline Study to investigate flood mitigation throughout South San Francisco Bay, from Palo Alto to San Leandro. However, in order to keep the study to a manageable size, the study area was divided into four parts, with an interim Feasibility Study for each.

The Santa Clara Valley Water District (SCVWD) and the State Coastal Conservancy (SCC) partnered with the USACE to conduct the first part of the South San Francisco Bay Shoreline Study. The Study's purpose is to identify flood mitigation, ecosystem restoration, and public access improvement projects for federal funding within the Alviso Pond Complex and adjoining South San Francisco Bay areas. The USFWS and City of San Jose (land owners) are also involved in the planning process.

Currently the Shoreline Study is in the drafting stage of the EIR/S, expected to be available for public review in late 2014. The Final EIR/S and Feasibility Report will be available in 2015, with potential congressional approval following shortly after. Design of the selected projects is planned to begin in 2015, with construction starting in 2017 after Congress appropriates funds.

3.5.5.4 Tentatively Selected Plan

Initially, the Shoreline Study included both restoration – pond breaching for tidal habitat – and flood protection. At present, only the flood protection element is being evaluated, with the restoration element deferred to a later project.

Figure 3-7 illustrates the levee alignment in the Tentatively Selected Plan (TSP) and highlights the ponds that were considered for potential later restoration to tidal habitat by the Study (USACE 2012a); note that Pond A18 is not part of the SBSP project area.

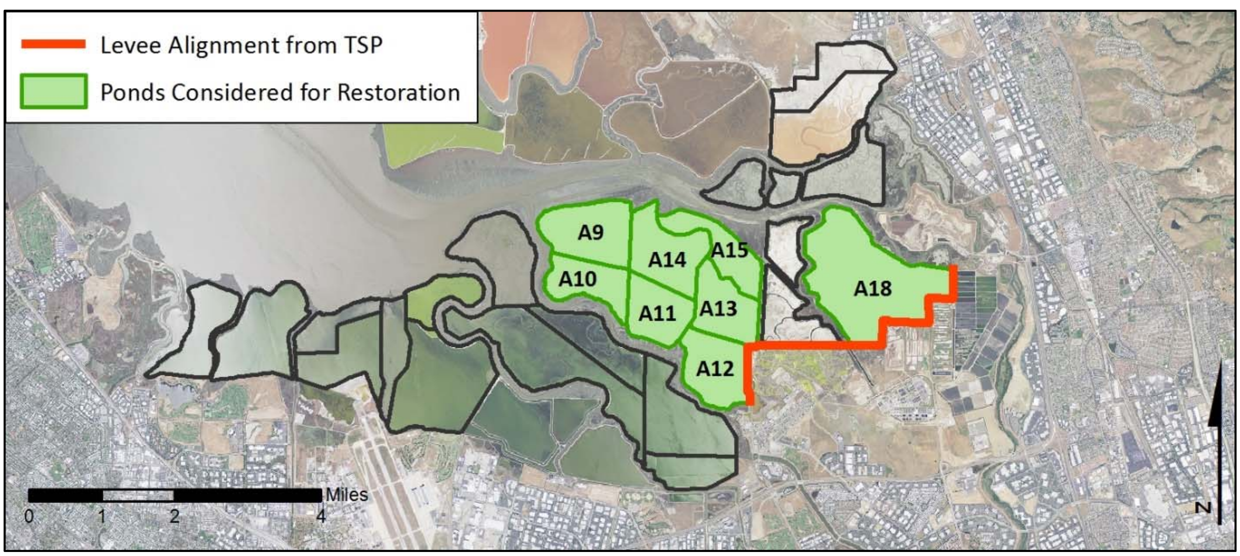

Figure 3-7. South San Francisco Bay Shoreline Study: Tentatively Selected Plan

3.6 Related Project: Land Mass at Eden Landing

The Land Mass at Eden Landing is a concept being developed by the Alameda County Flood Control District (ACFCD) to provide flood protection once the ponds are opened. The current concept is for a mound, with a crest width at least 100 feet wide and crest elevation several feet above the 100-year flood elevation (including allowance for sea level rise), constructed along the outboard edge of Ponds E1 and E2. The Alameda County Flood Control Channel (ACFCC) and Old Alameda Creek will allow tidal circulation into the ponds behind the land mass.

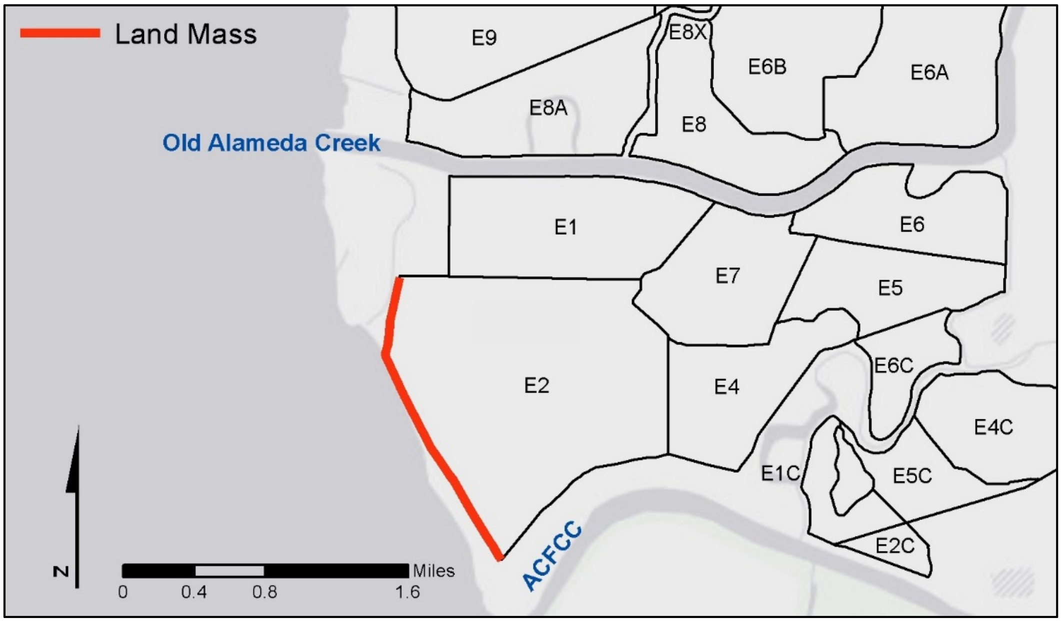

Figure 3-8. Eden Landing Land Mass

The purpose of the land mass is to retard water and waves that might otherwise flood into the ponds and developed backland areas during significant flood conditions, protecting those areas in the absence of a certified levee system. It would force tidal flows that could potentially flood urbanized areas through the wetlands to dampen tidal surges, lowering the water surface elevation near the urbanized areas. The goal is to negate the need for a FEMA-certified or engineered levee along the landside boundary of the wetlands, adjacent to Ponds E6 and E5. The construction of the landmass for flood control purposes provides an opportunity to construct a large area of ecologically-valuable upland transitional habitat.

Conceptually, the land mass might consist of two retaining berms and the space between them filled with dredged disposal material. The inboard slope of the berm could be made shallow – as little as a three percent slope – to provide transition habitat (URS 2012a).

3.7 Capacity of the SBSP Restoration Project to Receive Dredged Material

3.7.1 Potential Uses of Dredged Material

The challenge of the SBSP restoration is to transform a former salt-production system of aging levees, water control structures, and subsided ponds into valuable tidal marsh habitat while improving flood protection and public access.

Imported sediment could potentially be used for the following purposes:

- Improvement of levees in the pond complexes;
- Creation of UTZs;
- Creation of habitat islands in managed ponds;
- Filling existing drainage ditches at the Ravenswood Pond Complex;
- Raising the bottom elevation of subsided ponds that are to be restored as tidal habitat.

Other associated projects that could make use of imported sediment are:

- Creation of the land mass at Eden Landing;
- Creation of the flood protection levee at Alviso proposed by the South Bay Shoreline Study.

By far the largest potential volume is associated with raising the bottom elevation of subsided ponds. Ideally, those ponds that are restored as tidal habitat will accumulate sediment from the South Bay over time, until they reach the elevation of the surrounding marshes. Surrounding marsh elevations were determined in the DMMIP (USACE 2012b).

The target elevation is slightly different for the three pond complexes based on local characteristics, but is typically within one foot of the local MHHW level (as defined in Section 3.2.1). Table 3-3 provides the target elevations and local MHHW levels.

Table 3-3. Target Elevations for Tidal Habitat

Pond Complex	Surrounding Marsh Elev. (ft., NAVD88)	Local MHHW (ft., NAVD88)
Alviso	7.71	7.48
Eden Landing	6.92	6.97
Ravenswood	6.23	7.27

Figure 3-9 shows the difference between the current pond elevations and the target elevation for tidal marsh habitat. For Ravenswood, the elevation deficit is generally less than two feet and for Eden Landing it varies up to four feet over most of the complex. However, at the Alviso pond complex, two of the ponds are at elevations below 0 ft. NAVD88, meaning they are approximately eight feet below the elevation of the surrounding marsh. Ponds A3N, A3W, A8, A8S, A12, and A13 have all subsided significantly and lie more than six feet below the target elevation for tidal habitats. Ponds A3N, A12 and A13 are planned for tidal habitat rather than managed pond restoration under the *Tidal Emphasis* alternative, while Ponds A3W, A8, and A8S are planned for managed pond restoration.

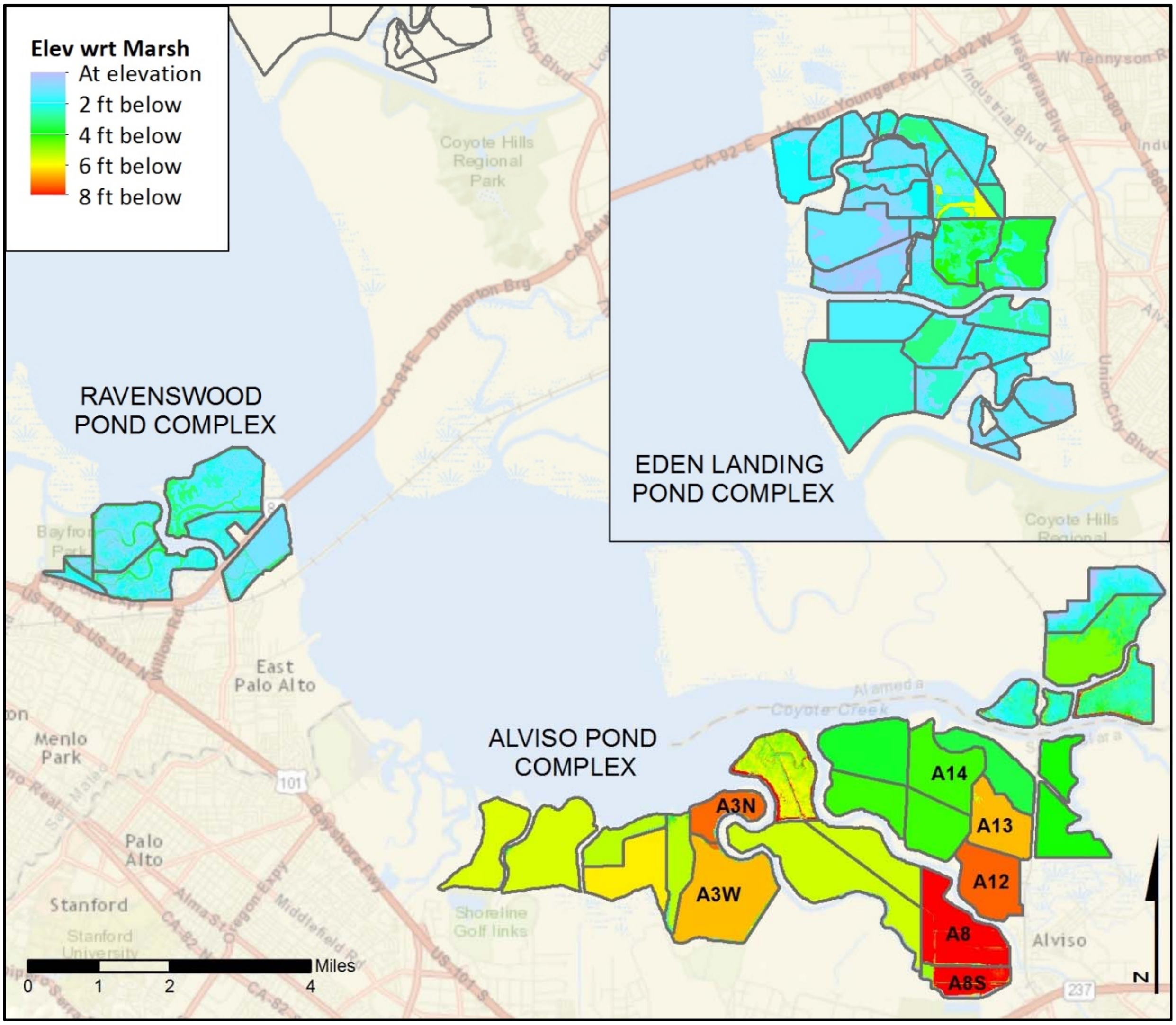

Figure 3-9. Elevation Difference between Project Ponds and Surrounding Marsh; Deepest Ponds Labeled

3.7.2 Natural Sedimentation and Sea Level Rise

If these deeper ponds are opened to tidal action without importing fill, it will, at a minimum, take years for suspended sediments in the Bay to settle out and raise the pond grades to the desired marsh elevations. The ponds at Ravenswood and Eden Landing may gain sufficient sediment to reach the target elevations with natural accretion within the 50-year project lifespan; however reaching the target elevations in the deepest ponds in the Alviso complex by natural accretion is dependent on how soon the ponds are opened to tidal action.

As part of the ISP, three of the Alviso ponds (A19, A20, and A21; known as the Island Ponds) were opened to tidal action. Five breaches were made to existing levees in March 2006. The Year 4 Monitoring Report (SCVWD *et al* 2010) reported that all three ponds accumulated substantial sediment after breaching, as shown in Figure 3-10**Error! Reference source not found.**. The observed sedimentation rates far exceed the sediment rates in natural salt marshes in the South

Bay, which are of the order of 0.01 ft./year. Pond A19, which is furthest from the South Bay, experienced the lowest rates of accretion.

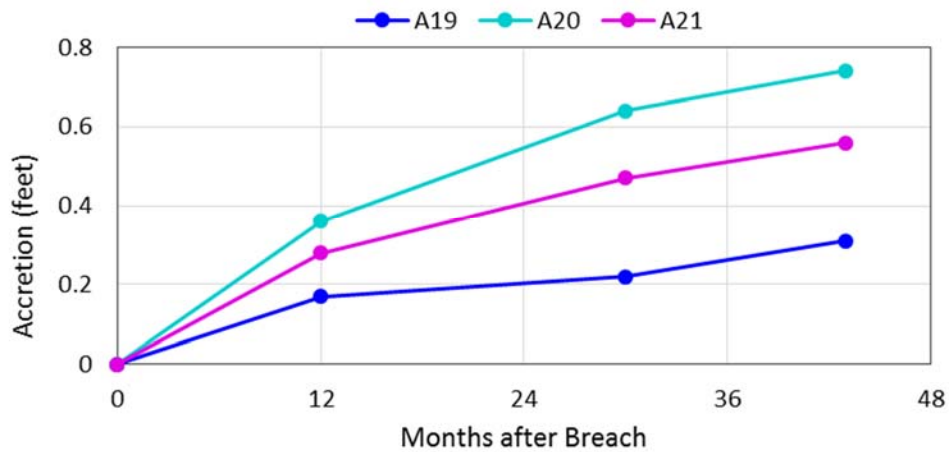

Figure 3-10. Accretion at Island Ponds after Breach: Initial Stewardship Plan

The rate of marsh accretion depends on the elevation of the pond; the more subsided the pond the longer the period of tidal inundation and the greater sedimentation. As the pond bottom raises, the deposited sediments consolidate and compact and the accretion rate rounds out.

Figure 3-11 provides the sea level rise (SLR) values from NRC 2012. Given the projected SLR range and ongoing pond subsidence, it is unknown if sediment accretion in all restored tidal areas will be adequate to reach target marsh elevations. Although accretion rates in the Island Ponds appear promising, sedimentation rates will differ for other ponds in closer/farther proximity to tidal sediment sources. Beneficial reuse of dredged material is therefore a key component of an adaptive management strategy for SLR.

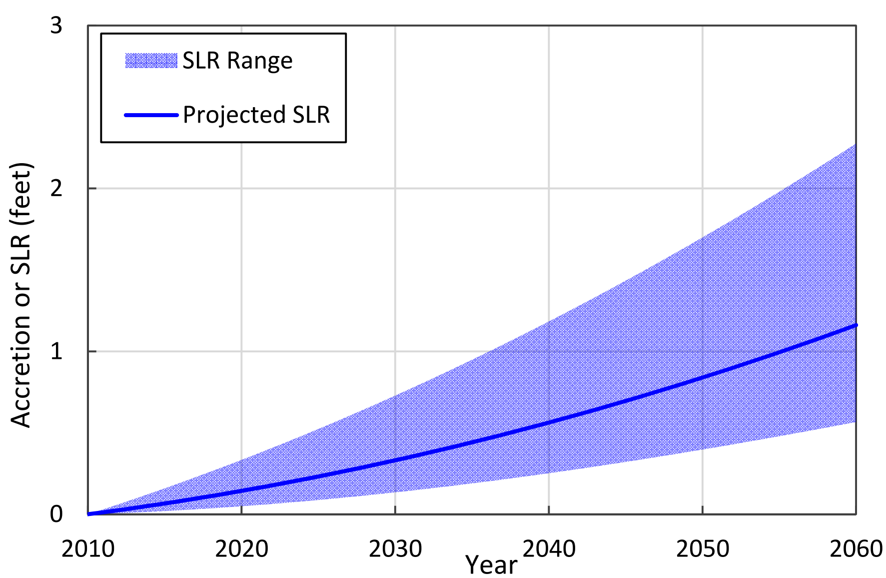

Figure 3-11. Sea Level Rise Projections (NRC 2012)

3.7.3 Ravenswood

The marsh elevation deficit at the Ravenswood pond complex is relatively small – less than two feet. Placing dredged material would raise grades to the desired marsh elevation, however it would essentially cover all existing features. There is uncertainty as to whether historical channels covered in dredged material will scour out and reform once open to tidal action. The ponds at Ravenswood have a well formed set of marsh channels (Figure 3-12). Wholesale placement of dredged material in these ponds is not considered desirable for this reason.

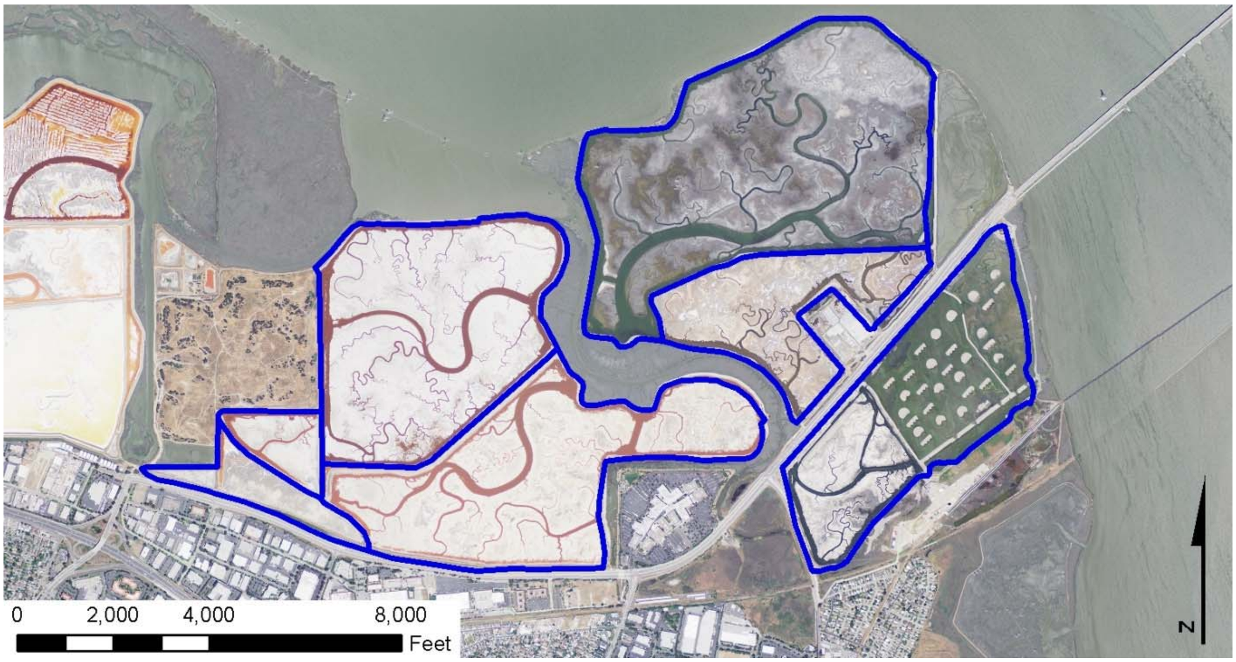

Figure 3-12. Existing Marsh Channels at Ravenswood Pond Complex

There are two potential targeted uses of sediment at Ravenswood, totaling up to 750,000 CY:

- Several of the ponds have deep perimeter drainage ditches, which are likely to capture all the tidal prism if they are not filled prior to dike breaching. Filling the Ravenswood drainage ditches might use 500,000 CY of sediment
- UTZs at Ravenswood might use up to 250,000 CY of sediment.

3.7.4 Eden Landing

Use of dredged material for raising marsh elevations is potentially desirable at the Eden Landing pond complex. Most of the volumes provided in this section and for the Alviso pond complex were estimated by the USACE San Francisco District (USACE 2012b), with additions and modifications by M&N based on a similar approach. The calculated volumes would raise each pond from its current elevation to that of the nearby marshes (Table 3-3). The existing pond elevations and areas were estimated from LiDAR surveys, which were conducted from June 11, 2010 through November 07, 2010 for the USGS San Francisco Coastal LiDAR project (Dewberry 2011). The elevation data were provided to the USACE by the San Francisco Estuary Institute (the GIS data collector and distributor for the SBSP Restoration Project). For ponds that were inundated at the time of the 2010 LiDAR survey, the DMMP used elevations from earlier surveys. Table 3-4 gives the resulting volumes for the Eden Landing Pond Complex.

Table 3-4. Eden Landing Pond Complex Potential Capacity

Pond	Preferred Restoration Alternative (Tidal Emphasis)	Potential Use of Dredged Material					Potential Volume to Raise Bottom Elevation (CY)
		Raise bottom elevation	Construct or improve levees	Construct UTZ or land mass	Construct habitat island	Restoration Complete – N/A	
Phase I							
E8	Tidal Habitat*	•				•*	505,000
E8A	Tidal Habitat					•	-
E8X	Tidal Habitat					•	-
E9	Tidal Habitat					•	-
E12	Managed Pond					•	-
E13	Managed Pond					•	-
SF2	Managed Pond					•	-
MECM†	Tidal Habitat					•†	-
MECMM†	Tidal Habitat					•†	-
NCM†	Tidal Habitat					•†	-
NCMM†	Managed Pond			•	•	•†	-
NCMP†	Managed Pond			•	•	•†	-
Phase II							
E1	Tidal Habitat	•		•			1,040,000
E1C	Tidal Habitat	•	•				140,000
E2	Tidal Habitat	•		•			2,385,000
E2C	Tidal Habitat	•	•				80,000
E4	Tidal Habitat	•	•	•			480,000
E4C	Tidal Habitat	•	•				760,000
E5	Tidal Habitat	•		•			500,000
E5C	Tidal Habitat	•	•				315,000
E6	Tidal Habitat	•		•			545,000
E6C	Tidal Habitat	•		•			215,000
E7	Tidal Habitat	•	•	•			775,000
Later Phases							
E6A	Tidal Habitat[X]	•					1,530,000
E6B	Tidal Habitat[X]	•					1,310,000
E10	Managed Pond			•	•		-
E11	Managed Pond			•	•		-
E14	Tidal Habitat[X]	•					280,000
E14B	Managed Pond			•	•		-
E15B	Managed Pond			•	•		-
E16B	Managed Pond			•	•		-
Eden Landing All Phases – Raise Bottom Elevation							**10,860,000**
Eden Landing All Phases – UTZ at 3% Slope							**283,000**

* Restored as Reversibly Muted Tidal in Phase I: may be able to accept sediment in a later phase.
† These ponds were not in the Phase I plans but appear to need little restoration work.
[X] These ponds are likely to remain as a Managed Pond for the foreseeable future.

In addition to these volumes, the Eden Landing Land Mass proposed by ACFCD might use up to 600,000 CY of material, based on the conceptual layout and cross section provided by ACFCD, cited in URS 2012a.

These volumes do not reflect either natural sedimentation in the ponds over the project lifetime – which would reduce the capacity – or sea level rise, which could potentially increase the capacity. The relative rates of natural sedimentation and sea level rise are not known, and are both likely to change over time. Rates of natural sedimentation could decrease if the available sediment in the South Bay is limited, in which case the existing reservoir of suspended sediment could be used up. The rate of sea level rise is expected to increase over time. Therefore, the values provided here could be used for detailed planning of near-term projects at intermediate ponds. They should only be considered as order-or-magnitude estimates over the 50-year project lifetime.

3.7.5 Alviso

The Alviso Pond Complex has the largest capacity for dredged material, based on its relatively large area and (more important) its deeply subsided ponds. Table 3-5 provides an estimate of the capacity of the Alviso Pond Complex, based on the existing pond elevations and surrounding marsh elevation. Similar to the Eden Landing potential capacity, these are order-of-magnitude estimates over the 50-year project lifetime.

Table 3-5. Alviso Pond Complex Potential Capacity

Pond	Preferred Restoration Alternative (Tidal Emphasis)	Potential Use of Dredged Material					Potential Volume to Raise Bottom Elevation (CY)
		Raise bottom elevation	Construct or improve levees	Construct UTZs or land mass	Construct habitat islands	Restoration Complete – N/A	
Initial Stewardship Plan							
A19	Tidal Habitat					•	-
A20	Tidal Habitat					•	-
A21	Tidal Habitat					•	-
Phase I							
A5	Tidal Habitat*	•				•*	6,615,000
A6	Tidal Habitat*					•	-
A7	Tidal Habitat*	•					2,275,000
A8	Tidal Habitat	•	•	•			5,945,000
A8S	Tidal Habitat*	•		•		•*	2,125,000
A16	Managed Pond					•	-
A17	Tidal Habitat					•	-
Phase II							
A1	Tidal Habitat	•		•			3,040,000
A2W	Tidal Habitat	•		•			5,190,000
Later Phases							
A2E	Mixed Pond/Tidal	•	•	•	•		3,750,000

Pond	Preferred Restoration Alternative (Tidal Emphasis)	Potential Use of Dredged Material					Potential Volume to Raise Bottom Elevation (CY)
		Raise bottom elevation	Construct or improve levees	Construct UTZs or land mass	Construct habitat islands	Restoration Complete – N/A	
A3N	Tidal Habitat	•					2,035,000
A3W	Mixed Pond/Tidal	•	•	•	•		440,000
A22	Tidal Habitat	•	•	•			660,000
A23	Tidal Habitat	•	•	•			2,320,000
AB1	Tidal Habitat	•	•				1,505,000
AB2	Mixed Pond/Tidal	•	•	•	•		1,150,000
Shoreline Study							
A9	Tidal Habitat	•					2,795,000
A10	Tidal Habitat	•					2,550,000
A11	Tidal Habitat	•					3,290,000
A12	Tidal Habitat	•	•	•			4,380,000
A13	Tidal Habitat	•		•			3,390,000
A14	Tidal Habitat	•					3,420,000
A15	Tidal Habitat	•	•	•			2,665,000
Alviso All Phases – Raise Bottom Elevation							**59,540,000**
Alviso All Phases – UTZ at 3 percent Slope							**1,786,000**

* Restored as Reversibly Muted Tidal in Phase I: may be able to accept sediment in a later phase. For example, Phase II EIR is investigating expansion of UTZ in Pond A8S.

Even if some or all of the ponds remain below their target elevations, they still represent valuable habitat. Combination pond and marsh areas, with a narrower fringing marsh or upland transition zone (UTZ), could be targeted in place of fully tidal ponds and would provide a valuable habitat mix. Nevertheless, importing fill to increase the bottom elevation of some or all of the ponds is desirable – particularly for the Alviso Pond Complex – to expedite the establishment of tidal marsh. The volumes here should be viewed as capacities rather than needs, with the proviso that more sediment placement is generally better.

4. BENEFICIAL REUSE OPPORTUNITIES

4.1 Introduction

This section describes potential sources of sediment from dredging projects and upland construction projects that are likely to become available within the next five to ten years.

Dredging projects in San Francisco Bay potentially provide substantially more material than upland construction projects, and the main impetus for changing dredged material disposal practices is the multi-agency Long Term Management Strategy, described in Section 4.2. After this background discussion, Sections 4.3 and 4.4 provide estimates of the likely volumes of sediment available from dredging and upland construction projects respectively.

4.2 Long-Term Management Strategy (LTMS) for Dredged Material Disposal

4.2.1 Background and Development of the LTMS

Dredged material disposal practices in the SF Bay Area have undergone a significant evolution over the past two decades. Prior to 1972, dredged material from San Francisco Bay navigation channels was disposed of at one of the eleven nearby open-water disposal sites (USACE, 1990). By the early 1980s, five of these disposal sites were in use (SF-08 San Francisco Bar Channel, SF-11 Alcatraz, SF-10 San Pablo Bay, SF-09 Carquinez Strait, and SF-16 Suisun Bay disposal sites) with most material disposed at the Alcatraz Disposal Site. Figure 4-1 shows the location of these sites, together with the deep ocean disposal site SF-DODS and five significant beneficial reuse sites that have been available in recent years.

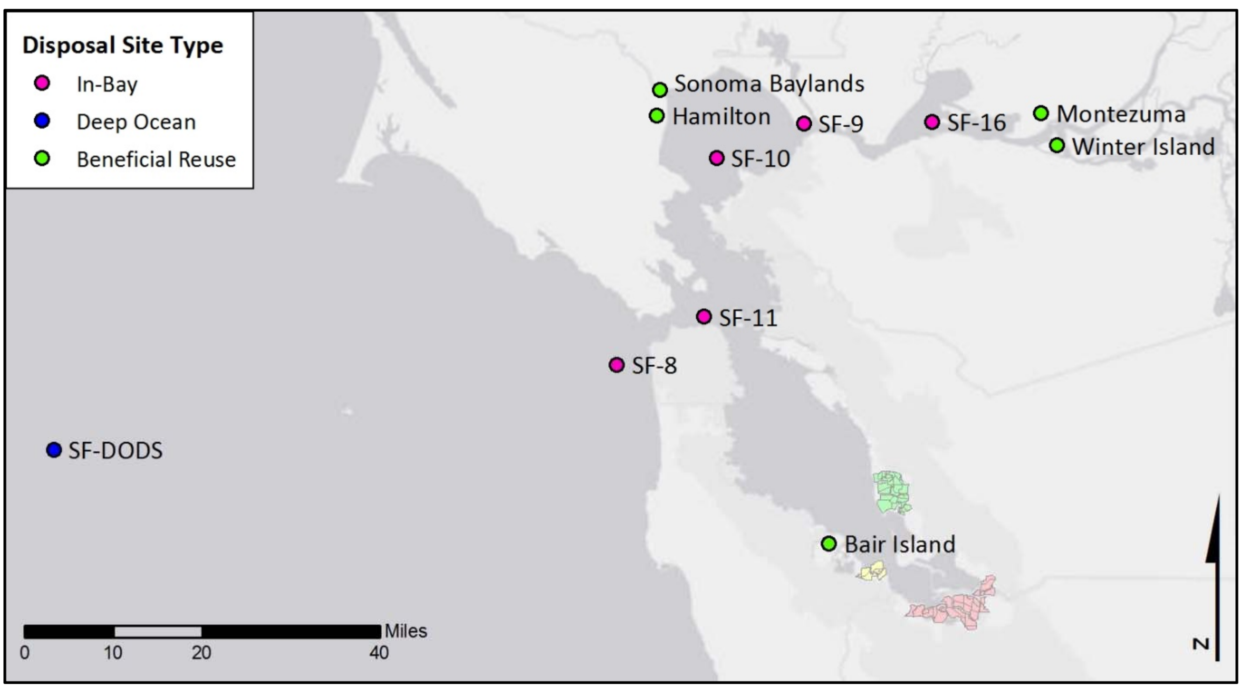

Figure 4-1. Recently Used Dredged Material Disposal and Beneficial Reuse Sites In and Around SF Bay

In 1982 the most used disposal site, Alcatraz Disposal Site SF-11, was surveyed and a large, underwater mound of material was discovered. The mound had grown to become a navigational hazard. Navigation and environmental groups voiced concern that the dredged material disposed there was not dispersing. As a result, the Long-Term Management Strategy (LTMS) program was created in 1990 to coordinate dredged material disposal practices in the San Francisco Bay region. The geographic scope of the LTMS program comprises the estuarine waters of the San Francisco Bay region, portions of the Sacramento-San Joaquin Delta west of Sherman Island, and the western portion of the Sacramento River Deep Water Ship Channel (SRDWSC) and Stockton Deep Water Ship Channel.

At the beginning of the LTMS effort, LTMS agencies estimated 8 MCY annually (400 MCY over 50 years) would require disposal in the San Francisco Bay region between 1990 and 2040 (USACE, 1990). That estimate has reduced considerably with the closure of the Mare Island Naval Shipyard and Alameda Naval Air Station, as well as declining suspended sediment loads in the Bay. The current bay-wide estimate is about 2 to 3 MCY annually.

Pre-LTMS, 80 percent of dredged material was disposed in the Bay, with only 10 percent disposed in the ocean and the remaining 10 percent at upland/reuse sites. The LTMS studies noted the lack of beneficial use of dredged material within the Bay, despite potential opportunities such as habitat restoration, beach nourishment, aquaculture, solid waste landfill cover, parks and recreation, and construction and industrial/commercial use.

In 1996, the LTMS established the San Francisco Bay Dredged Material Management Office (DMMO) to streamline the application and permitting process for dredged material. The DMMO is comprised of representatives from all permitting and resource agencies and functions under the auspices of the USACE. The DMMO has also provided the means to track dredging projects, volume of dredged material, and disposal method to determine if the program is meeting its goals (listed below). All dredging and disposal activities require approval from the DMMO who determines the suitability of the material for the proposed disposal method based on testing results from approved sediment sampling and analysis plans (DMMO 2002).

4.2.2 LTMS Management Plan

In 2001 the LTMS Management Plan was finalized by the USACE, USEPA, BCDC, and SFBRWQCB. The LTMS goals were, and still remain (USACE *et al.* 2001):

- To maintain in an economically and environmentally sound manner those channels necessary for navigation in San Francisco Bay and Estuary and eliminate unnecessary dredging activities in the Bay and Estuary;
- To conduct dredged material disposal in the most environmentally sound manner;
- To maximize the use of dredged material as a resource; and
- To maintain the cooperative permitting framework for dredging and disposal applications.

The Final EIS/EIR for the LTMS identified environmental impacts associated with dredged material placement in-Bay, in the ocean environment, and at beneficial reuse sites. The environmentally preferred alternative identified in the LTMS Final EIS/EIR includes beneficial reuse of at least 40 percent of material dredged in the San Francisco Bay region, no more than 40 percent placement at the San Francisco Deep Ocean Disposal Site (SF-DODS), and no more than 20 percent placement at in-Bay sites.

To implement these goals, the 2001 LTMS Management Plan established a 12-year step-down decrease of the overall in-Bay disposal volume, with the ultimate goal of in-Bay disposal of no more than 1.25 MCY per year. Separate transition targets were developed for USACE projects; medium-sized non-Federal dredging projects; and small non-Federal dredging projects. Small projects are defined as those with a project depth of less than -12 feet MLLW and generating less than 50,000 cubic yards (cy) per year on average.

The step-down transition targets are shown in Figure 4-2.

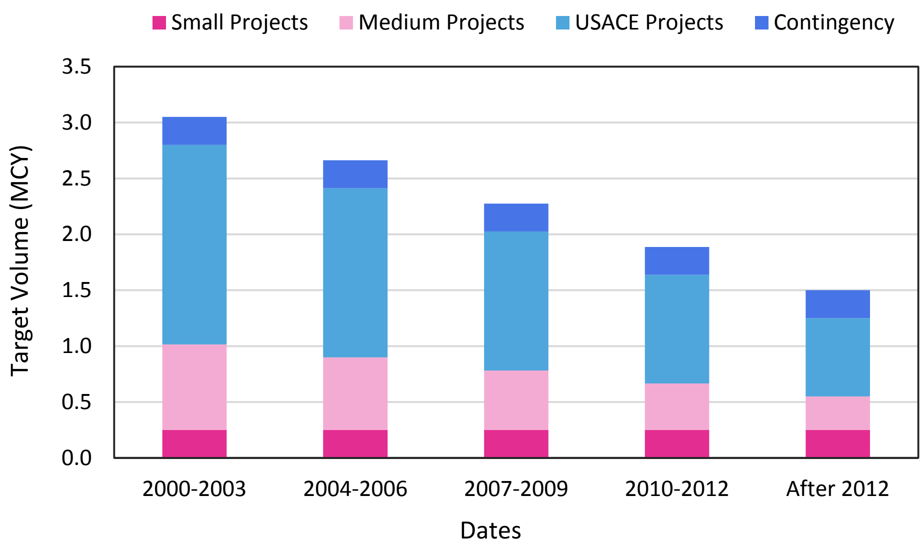

Figure 4-2. LTMS In-Bay Disposal Transition Targets

The limit for in-Bay disposal was set at 2.8 MCY (plus 0.25 MCY contingency) in 2000, decreasing by 387,500 cubic yards every three years, for a period of 12 years. The long-term goal is less than 1 MCY to be placed in-bay. The in-bay target volume is kept constant at 0.25 MCY per year for small projects.

In 2012, the LTMS agencies completed a comprehensive 12-year review of the program. Based on this review process, the LTMS agencies concluded that the LTMS goals remain appropriate and largely implementable, and that the program has been successfully implemented to date. The LTMS agencies recommended that the basic program continue. This continuation requires approximately 80 percent of dredged sediment to be targeted for beneficial reuse or out-of-Bay disposal, and only 20 percent targeted for in-Bay disposal. Given the changed conditions since establishment of the program, the LTMS agencies recommended adopting increased flexibility and innovation in implementing the program's goals. Specifically, the LTMS agencies are assessing potential changes in the program's implementation to accommodate changing—or adding flexibility to—in-Bay disposal volume limits, encouraging more beneficial reuse and new kinds of beneficial reuse (LTMS, 2013).

4.2.3 Implementation of the LTMS

The DMMO, through its member agencies, executes the policies stated in the Management Plan including the authorization and permitting of dredging and disposal in SF Bay.

As a result of the LTMS and the transition targets, there has been impetus to identify and implement beneficial reuse in the form of wetlands restoration and several large wetland restoration projects have been constructed, including those shown in Figure 4-1. Other beneficial reuse options are also possible: at Winter Island, the dredged material is used in levee maintenance.

With expanded use of beneficial reuse, the transition targets shown in Figure 4-2 have been met (although the in-bay fraction has not dropped to 20 percent of the whole). Figure 4-3 shows the trends in material placement through 2010 (BCDC, SFBRWQCB, USACE, USEPA 2012).

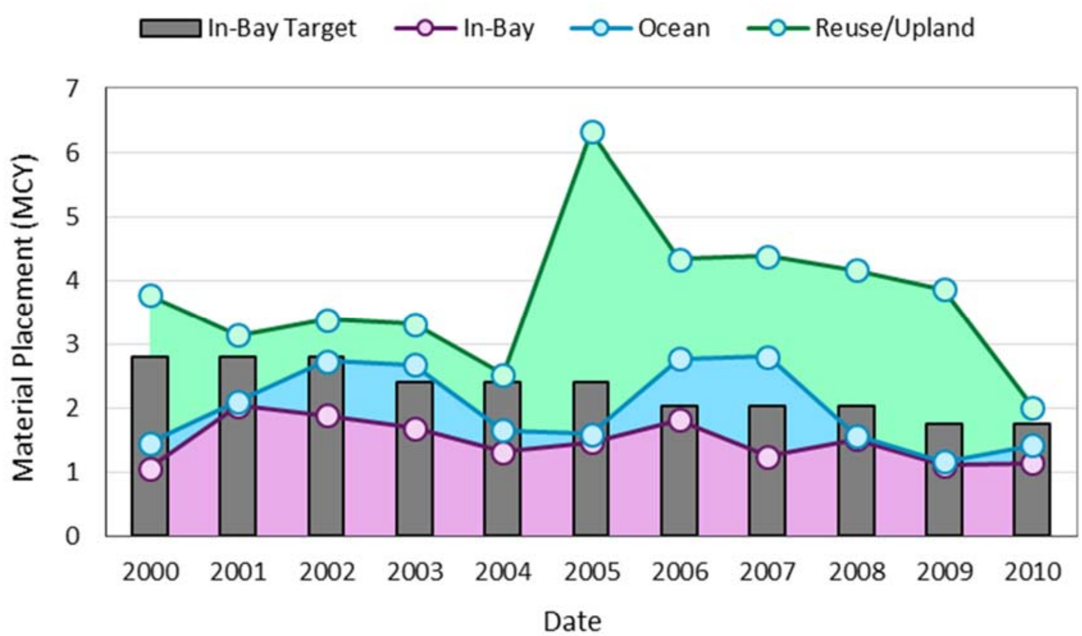

Figure 4-3. Material Placement and Transition Targets for In-Bay Use

Costs associated with material placement at beneficial reuse sites and at the ocean site SF-DODS have been higher than historical costs for placement at in-bay sites. Figure 4-4 illustrates the range of placement costs, including mobilization/demobilization, for USACE maintenance dredging in San Francisco Bay between FY 1999 and 2011 (the dotted line for the Bar Channel represents relatively costly placement for one year, 1999). Costs were generally highest for beneficial reuse and upland placement and lowest for in-bay placement, with the ocean site SF-DODS having intermediate placement costs (BCDC, SFBRWQCB, USACE, USEPA 2012, Appendix C).

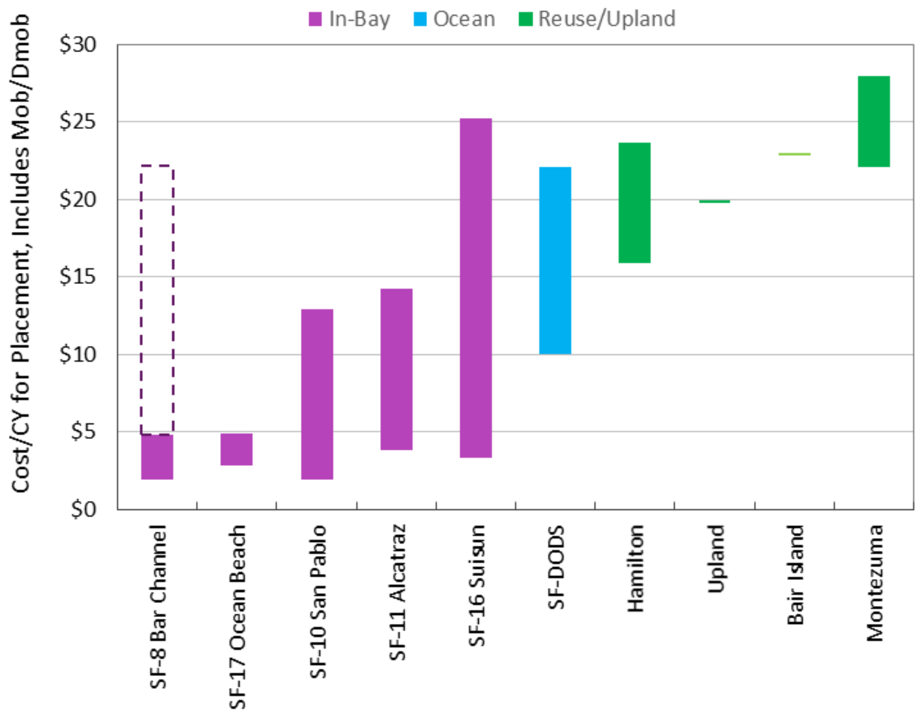

Figure 4-4. Material Placement Costs for USACE Projects, FY 1999-2011

The USACE, San Francisco District developed the South San Francisco Bay Dredged Material Management Implementation Plan (the DMMIP, USACE 2011a, 2012a) to support their ability to meet the material placement targets of the LTMS. As part of the DMMIP, they estimated the costs to dredge, haul, offload, and pump material to the ponds, as well as the cost to continue to place material at SF-DODS. Three scenarios for material placement at SBSP were investigated:

- Offloading the dredged material from the hauling equipment and pumping it to the placement site, including economies of scale for larger projects;
- Offloading the dredged material from the hauling equipment and pumping it to the placement site, but without economies of scale for larger projects;
- Dropping dredged material from the hauling equipment into an area of the South Bay designated as an unconfined aquatic transfer facility and allowing the material to accumulate until it is re-dredged and pumped to the placement area.

The DMMIP found that for the Eden Landing and Ravenswood complexes the cost under all three scenarios was lower than the cost to dispose of at SF-DODS. For the Alviso complex, the first and third scenario costs were lower than the cost for disposal at SF-DODS, but the cost for the second scenario (offloading the dredged material without the economies of scale) was higher.

4.3 Material from Dredging Projects

4.3.1 Existing Federal and Non-Federal Maintenance Projects

The locations of the federal and mid-sized non-federal navigation dredging projects in SF Bay are shown in Figure 4-5 (this figure excludes the smallest federal projects). Past annual maintenance dredging quantities from these projects, compiled from a sediment source analysis performed for the Bel Marin Keys Wetland Restoration Project (Moffatt & Nichol 2012), are shown in Table 4-1. This table also shows historical locations for disposal of the dredged material. In the past, the in-Bay sites were used by preference due to the low haul distances and associated low costs. Over the past few years, in response to the LTMS, many of these projects are now going to the SF-DODS disposal site. In part, this is because of a lack of suitable beneficial reuse sites. Both Hamilton and Bair Island reuse sites have been or will shortly be filled to capacity, and Montezuma Wetlands is the only operating beneficial reuse site with the necessary site improvements and offloading equipment.

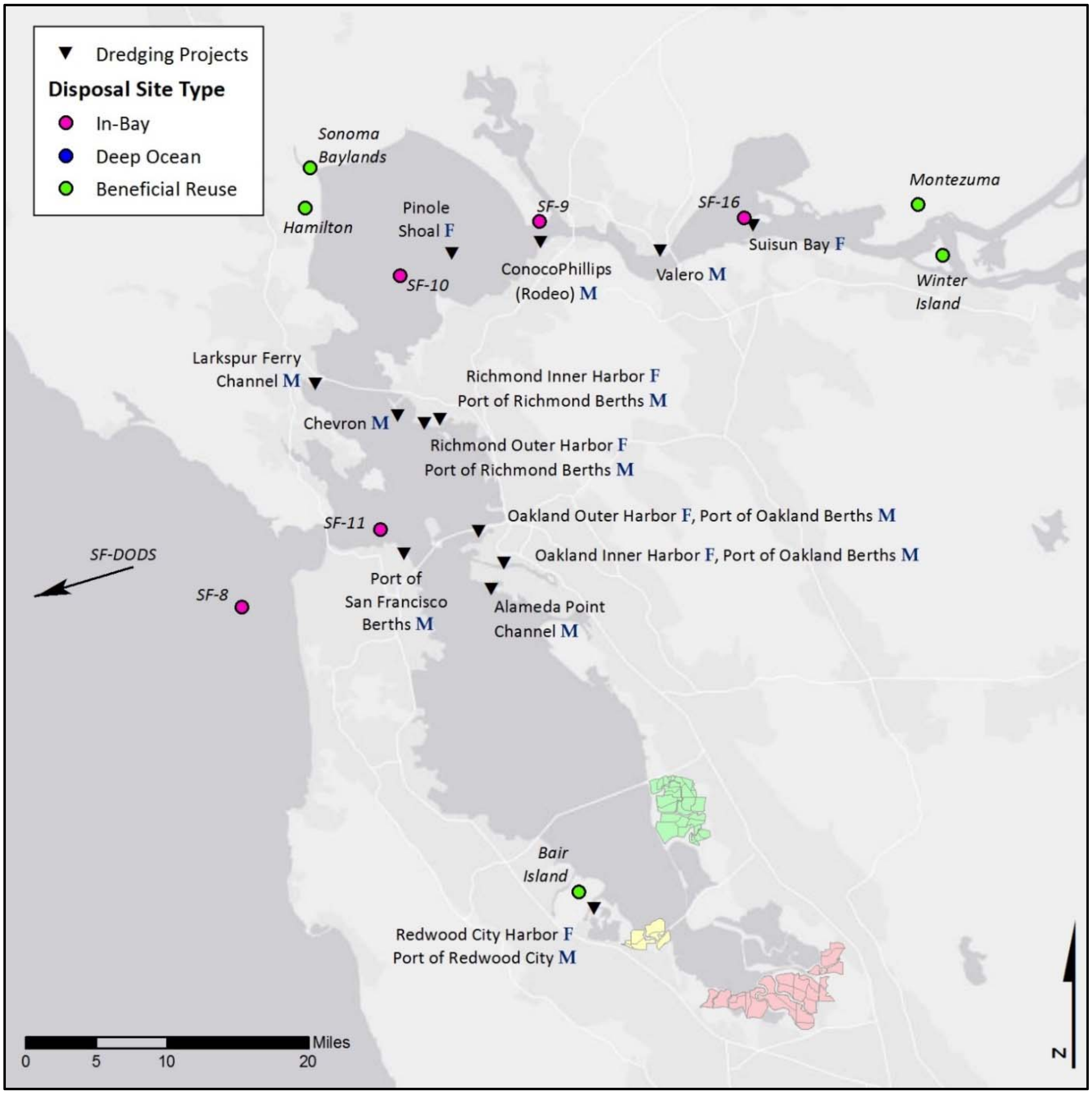

Figure 4-5. Larger Federal (F) and Mid-Sized Nonfederal (M) Navigation Dredging Projects, and Historical Disposal Sites, in San Francisco Bay

Table 4-1. Significant Bay Area Maintenance Dredging Projects

Project	Frequency (years)	Average Volume (CY)	Annualized Volume (CY)	Historical & Current Disposal Site(s)*
Federal Projects				
Redwood City Harbor	3	432,600	144,200	SF-11, Bair Island
Oakland Inner & Outer Harbor	1	482,000	482,000	SF-11, Montezuma, SF-DODS, Hamilton
Richmond Inner Harbor	1	380,400	380,400	SF-11, SF-DODS, Hamilton
Richmond Outer Harbor	1	275,000	275,000	SF-11, SF-10, Hamilton
Pinole Shoal	1	175,000	175,000	SF-10
Suisun Bay	1	175,000	175,000	SF-16
Subtotal – Federal Projects			1,631,600	
Mid-Sized Non-Federal Projects				
Chevron	1	120,000	120,000	SF-11, Hamilton, SF-DODS
Larkspur Ferry Channel	2	245,000	122,500	SF-11, SF-DODS, SF-10
Port of Oakland (Berths)	1	90,000	90,000	SF-11
Port of Redwood City	4	21,000	5,250	SF-11, SF-DODS
Port of San Francisco	1	200,000	200,000	SF-11, SF-DO DS, Hamilton
Port of Richmond (Berths)	3	50,000	16,667	SF-DODS
Valero	4x per year	20,000	80,000	SF-9, SF-11, SF-DODS, Winter Island, Hamilton
ConocoPhillips (Rodeo)	1	40,000	40,000	SF-9, SF-8, Hamilton
Alameda Point Channel	3	210,600	70,200	SF-11, SF-DODS
Subtotal – Mid-Sized Non-Federal Projects			744,600	
Total Maintenance Dredging			**2,376,000**	

* Hamilton Wetland and Bair Island beneficial reuse sites are closed due to capacity limitations. Bel Marin Keys Unit V, adjacent to the Hamilton Wetland, is anticipated to become available in the next few years.

4.3.2 Federal Capital Improvement Projects

Three federal deepening projects that are in the planning phase could generate significant quantities of sediment for beneficial reuse.

- *The San Francisco Bay to Stockton Project* consists of deep-draft navigation channels that extend from the San Francisco Bay to the Port of Stockton. Portions of this channel, from the Port of Richmond and through Suisun Bay (see Figure 4-5), are authorized to -45 feet MLLW but only dredged to -35 feet. The USACE is assessing the feasibility of deepening these portions of the channel, potentially to the full authorized depth. It is possible that more than 20 MCY of material would be generated by this project.
- The *Redwood City Harbor Deepening Study* is investigating deepening Redwood City's Navigation Channel project beyond its authorized depth of -30 feet MLLW. The Redwood City Harbor is in San Mateo County, less than five miles northwest of the Ravenswood Pond Complex. Strong public and Agency support for the beneficial use of dredged material resulted in the initial use of Bair Island as an upland wetland restoration site during the FY 08 and FY 09 O&M operations, and the investigation includes beneficially using the dredged material for habitat restoration. The dredged material volume created by the deepening project is estimated at 1-3 MCY (USACE, 2013b).

Based on the distance of the San Francisco Bay to Stockton Project and the Sacramento River Deep Water Ship Channel Deepening from the South Bay, it is unlikely that the SBSP Restoration Project would be a financially viable dredged material placement option for these projects due to the transport costs. However, it is likely to be cost-effective for material from the Redwood City Harbor Deepening project to be placed at the SBSP site.

4.4 Material from Upland Construction Projects

M&N estimated the volume of material potentially available from upland construction projects with two large construction companies, who are knowledgeable of upland material availability in the bay area. They identified potential projects in a 3-year planning horizon that would produce sizable quantities of upland material within an approximate 20 mile radius of the SBSP Restoration Project.

The projects were aggregated into three groups: Stanford capital projects, Apple and other campuses, and housing projects. The volumes and availability are speculative, as implementation of projects depends heavily on the state of the economy and many owner-specific factors. For example, Apple modified its original design to reuse more material onsite to reduce overall project cost, limiting material available for potential use at the pond complexes. At Stanford, new construction projects depend on donor funding and the nature of any new research initiatives.

Table 4-2 shows the resulting volume estimates. From past experience with the Bair Island Restoration Project, upland material does not necessarily meet screening criteria for wetland cover screening criteria required for marsh fill, and a loss factor was applied Table 4-2 to account for this.

Table 4-2. Upland Material Sources within San Francisco Bay Area

Project Group	Location	Expected Availability	Volume (CY)
Stanford Capital Projects	Stanford	2015 to 2016	1,000,000
Apple and other Campuses	Sunnyvale	2014 to 2016	600,000
Housing Projects	San Jose	2014 to 2015	600,000
		Total Upland Volume	**2,200,000**

While this material is potentially available to the SBSP, construction material can be expected to be disposed of using the lowest cost option. An attractive alternative for construction material is likely to be other construction projects requiring fill. This could be less costly, particularly if the haul distance is less, and the material would be subject to less stringent screening levels compared to the SBSP Restoration Project. The advantage of the SBSP Restoration Project is its ability to accept large volumes of material.

The construction companies described three upcoming development sites in the South Bay and Dumbarton Quarry as potentially accepting upland material, as well as Dumbarton Quarry. The three upcoming development sites will require hundreds of thousands of cubic yards and will have the money to pay for the material. The Dumbarton Quarry is permitted to accept a range of upland material types to fill the quarry and provide a foundation for a public park. The Quarry is scheduled to be filled by approximately 2015.

4.5 Summary of Capacity and Availability

Figure 4-6 summarizes the potential annualized pond capacity (based on the totals in Table 3-4 and Table 3-5, over a 40-year timeframe) and potential upland and dredged sediment availability (based on Table 4-1 and on Table 4-2, over a 5-year timeframe). For example, the 59.5 MCY capacity at the Alviso Pond Complex averages out to approximately 1.5 MCY per year over a 40 year period (the period approximately remaining in the 50-year project life). This figure is presented to allow an order-of-magnitude comparison of the potential sediment capacity and the potential availability.

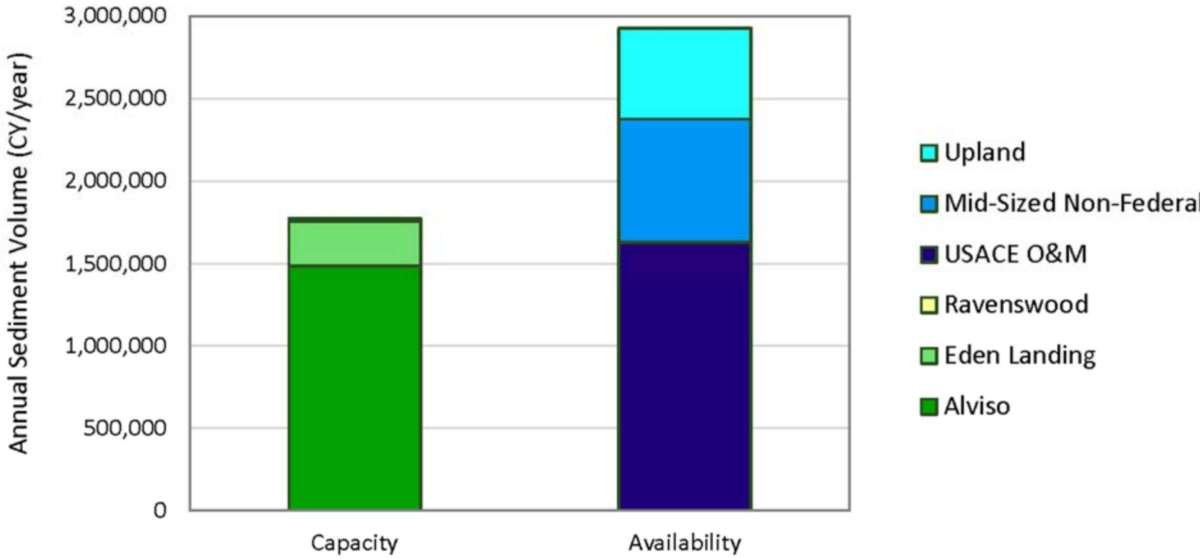

Figure 4-6. Potential Annualized Sediment Capacity and Availability

There is likely to be competition for the sediment from other projects – other upland construction projects for the upland material, and other wetland restoration projects for the dredged material. If future sea level rise proves to be significant then there could be major competition for dredged material from low-lying areas such as San Francisco International Airport.

The Montezuma Wetlands Project is still accepting material, and the next wetland restoration project anticipated to use significant quantities of dredged material is the Bel Marin Keys Unit V Restoration Project (also owned by SCC). Bel Marin Keys Unit V is adjacent to the (completed) Hamilton Wetland Project, and a similar deep water transfer location is at least plausible. Figure 4-7 shows the locations of the Montezuma and Bel Marin Keys Unit V projects and (actual or assumed) transfer locations; similar locations for the SBSP project; and all significant O&M projects. The Suisun Bay Channel, Pinole Shoal, and Richmond Inner and Outer Harbor O&M sites are all much closer to a potential transfer location for Bel Marin Keys Unit V than to the SBSP transfer locations, so the overall placement costs are likely to be less.

However, the Bel Marin Keys Unit V project is planned on a different timescale from the SBSP project – intended to be completed in approximately eight to ten years, rather than to gradually evolve to its desired configuration over decades. Consequently, while this project will likely reduce the available volume anticipated to go to the SBSP project while under construction, this will not be the case over the long term.

Despite these complexities, the following conclusions can be made regarding sediment capacity at the SBSP and sediment availability in San Francisco Bay.

- The pond capacity associated with the Alviso complex dominates over the potential capacity associated with the Eden Landing and Ravenswood complexes.
- The USACE O&M dredging generates the largest quantity of material. However, there are potentially substantial quantities associated with mid-sized, non-Federal projects and with upland construction projects.

- Even if a fraction of the available material is supplied to the SBSP project, it could substantially support the development of marsh habitat.
- If little to no material is available then the SBSP project will rely on natural sedimentation to raise pond elevations. Although tidal marshes elevations may not be achieved, lower habitats (mudflats) are beneficial and require less long-term management costs.

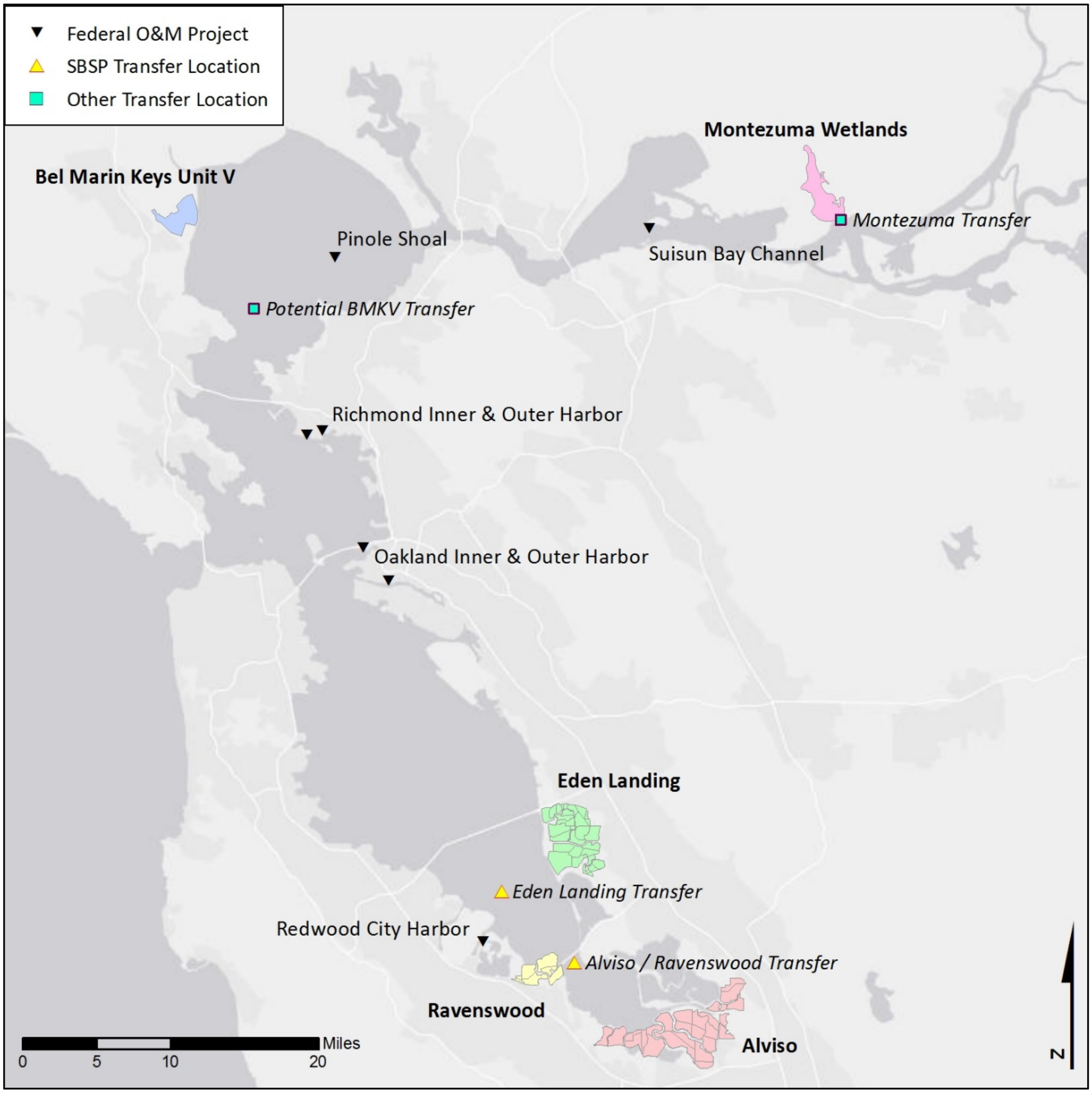

Figure 4-7. Significant Federal O&M Projects and Proposed Restoration Transfer Locations (SBSP and Hamilton / Bel Marin Keys Unit V)

5. BENEFICIAL REUSE: IMPLEMENTATION CHALLENGES

5.1 Introduction

There are three main considerations in implementing beneficial reuse of dredged material for the SBSP project.

- Material Delivery and Placement: Can the material be brought to the ponds and placed in an efficient and cost-effective manner?
- USACE Cost Sharing Policy Compliance: Can material generated by USACE O&M dredging be placed in the ponds within the scope of O&M cost sharing regulations? This evidently does not restrict non-USACE dredging or capital projects.
- Environmental Regulatory Compliance: What are the environmental requirements associated with placements of dredged material in the ponds?

5.2 Material Delivery and Placement

5.2.1 Dredging Methods

5.2.1.1 Introduction

Physically, the efficiency of placing materials at the ponds depends on the dredging methods used. This affects the water content of the dredged material, the navigation depth needed for the material to be brought to the transfer facility, and the overall efficiency of the dredging and material placement process.

The majority of the dredging projects in the San Francisco Bay use either a clamshell dredge with material transported to the disposal site using scows, or a hopper dredge in which the dredge and discharge equipment are combined into a single vessel.

5.2.1.2 Clamshell Dredge with Scow

Clamshell dredges are a common type of mechanical dredge, which excavates sediments with a grab or bucket (Figure 5-1). Mechanical dredges are typically used where the area to be dredged has restricted access or operating space. Mechanical dredging is also often required when the soil is very hard or compacted or when dredging blasted or un-blasted rock. Backhoe dredges are often used to excavate rock or compacted sands and clays due to the positive digging force they can exert.

The clamshell dredging process consists of lowering the bucket to the seafloor, closing the bucket and raising it back to the water surface, and depositing the dredged material into a separate scow. The scow is towed to the disposal site.

Figure 5-1. Clamshell Dredge and Scow (Source: Great Lakes)

The dredging rate for a clamshell dredge and scow combination is determined by the capacity of the bucket (between 2 and 50 CY), scow capacity (from 400 to 7,200 CY), and the number of available scows. Hopper scows, which have closed hulls, are unloaded mechanically by bucket or hydraulically by a pump-out system at the disposal area. Dump scows, with hulls that can be opened to dispose of the sediment, allow for a faster turn-around time in open-water or offshore disposal sites.

The larger clamshell dredge projects in the Bay most commonly use dump scows to dispose of the dredged material at SF-DODS, with some disposal occurring at the in-bay open water sites or at upland sites. Due to the long travel distance from the San Francisco Bay to SF-DODS and the ocean wave environment, the dump scows used to transport the dredged material are normally relatively large, with capacities of 3,000 cubic yards or larger and loaded drafts of 15 to 20 feet. Disposal at the in-bay open water disposal sites or at upland sites normally uses smaller dump scows or hopper scows (400 to 2,000 cubic yards). These smaller scows are more typical of the smaller dredging projects at marinas and other smaller facilities.

5.2.1.3 Hopper Dredges

In hydraulic dredging, material is loosened from its in-situ state and lifted in suspension through a pipe system connected to a centrifugal pump. A hopper dredge incorporates the dredge and discharge equipment into a single vessel. The dredge uses a trailing suction arm to pump dredged material into a hopper contained within the hull of the vessel.

Both self-propelled and towed hopper dredges are in use. When the vessel is fully loaded the drag arm(s) are raised and secured and the vessel moves to the disposal site for unloading.

Figure 5-2. Split-Hull Hopper Dredge Manhattan Island Bottom Dumping Material (Source: Great Lakes)

Hydraulic dredging is most efficient for sands and finer materials sands since they are easily held in suspension. It is typically used for unconsolidated dredged material in channels and basins where the dredge can operate in long sweeps. Hopper dredges are also well suited to rougher, open waters where pipeline dredges and mechanical dredges cannot operate effectively.

Even though a hopper dredge can travel relatively quickly to a placement site (10 to 15 knots), the operation loses efficiency as the transport distance increases. In contrast to a clamshell dredge with scows, where multiple scows normally service a single dredge, with a hopper dredge the same vessel is used for dredging and transport.

Most of the contractor hopper dredges in the Bay Area are equipped with pump out capability. Bottom dump hopper dredges, most commonly split-hull designs similar to a dump scow, allow the dredged material to drop out of the bottom (Figure 5-2). The USACE operates two bottom dump hopper dredges in San Francisco Bay and elsewhere along the West Coast.

- Dredge *Essayons* is a medium-sized hopper dredge, with a hopper volume of 6,423 CY and a loaded draft of 32 feet.
- Dredge *Yaquina* is a small hopper dredge, with a hopper volume of 1,050 CY and a loaded draft of 16 feet.

5.2.1.4 Other Dredge and Delivery Combinations

Other dredge and placement combinations are possible, but are uncommon in San Francisco Bay. Two examples that are appropriate in limited circumstances are the following:

- Clamshell dredges are occasionally used without a scow, in locations where the disposal site is directly adjacent to the dredging site and the material can be placed directly by the dredge.

- A pipeline dredge is a hydraulic dredge that uses a ladder assembly. The pipeline dredge pumps the material through a pipe directly to the disposal site. For longer pipes, a booster pump is needed approximately every two to five miles (depending on the material type).

5.2.2 Contractor vs. USACE Dredges

USACE O&M dredging in San Francisco Bay is typically performed by a mix of contractor clamshell dredges and USACE hopper dredges. Table 5-1 lists the planned USACE O&M dredging for FY-2014. The quantity of upland placement may be larger than typical: the solicitation for the Oakland Inner and Outer Harbor projects allowed for placement at either SF-DODS or upland sites, and the low bid used placement at Winter Island.

Both USACE dredges Essayons and Yaquina are used for USACE dredging from Washington to California, and their availability for dredging in the Bay Area varies from year to year. As a result, the mix of USACE and contractor dredging also varies from year to year.

Table 5-1. FY-14 USACE O&M Dredging

Project	FY-14 Volume (CY)	Dredge Type	Placement Site	Comment
Oakland Inner Harbor	400,000	Clamshell	Montezuma	Placement at SF-DODS or upland permitted Low bidder used Winter Island
Oakland Outer Harbor	400,000	Clamshell	Montezuma	
Redwood City Harbor	550,000	Clamshell	Upland or SF-11, SF-10 as backup	Small business set-aside Not let as of Aug. 2014
Richmond Inner Harbor	250,000	Clamshell	SF-DODS	Contract dredge
Richmond Outer Harbor	250,000	Hopper	SF-11	USACE Dredge *Essayons* Contract dredge was used in FY-13
Suisun Bay	175,000	Hopper	SF-16	USACE Dredge *Yaquina*
Pinole Shoal	150,000	Hopper	SF-10	USACE Dredge *Essayons*

If a beneficial reuse site at the SBSP Restoration Project proves competitive, private dredgers may begin to shift their equipment from ocean disposal dump scows to less costly hopper scows, which are more efficient from an offloading standpoint (and more economical to construct and operate). Hopper scows have minimal moving parts compared to dump scows, requiring less maintenance and less time lost to mechanical failures.

If the dredgers do change their equipment to fit a new beneficial reuse practice, as they did when SF-DODS first became the primary disposal location, beneficial reuse could become more efficient over time. In this case, there could be pressure to decrease the use of the USACE hopper dredges *Essayons* and *Yaquina* in the Bay Area, increasing their use in other parts of their service area.

5.2.3 Material Delivery to Ponds

5.2.3.1 Need for Deep Water Transfer Sites

The primary challenge in delivering dredged material to the SBSP beneficial reuse sites is the shallow water in the South Bay. While a scow or hopper dredge can transport dredged material to within a few miles of the sites, the mudflats offshore of the ponds are too shallow for these vessels to navigate. To move the material the last few miles, the hopper dredge or scow would be offloaded at a deep water transfer site and the dredged material would be pumped to the receiver site by pipeline. Figure 5-3 shows potential deep water transfer sites for the three pond complexes, including depths of -20 ft. NAVD88 (suitable for discharge of most scows, as well as the USACE dredge *Yaquina*) and -35 ft. NAVD88 (also allowing for *Essayons*).

- At Eden Landing, the deep water is approximately three miles from the offshore boundary of the pond complex. The deep water extends to -35 feet.
- At Ravenswood, the deep water is less than one mile from the pond complex. Similar to Eden Landing, the water depth extends to -35 feet.
- At Alviso, the water at -35 ft. depth is approximately one mile further than the water at -20 ft. depth. However, it may be advisable to locate the transfer site another mile further north, so that barges offloading at the site are not required to transit past the railroad bridge. The marked site is three to five miles from the shoreline at the Alviso Pond Complex, and is also convenient for the Ravenswood complex.

5.2.3.2 Offloader Facility

A hydraulic offloader (Figure 5-4) consists of a transfer pump connected to a pipeline that runs from the transfer site to the receiving site. The hydraulic offloader pumps water into a scow or hopper compartment to create a slurry and an intake line feeds the transfer pump.

Typical infrastructure at the transfer site is as follows:

- Mooring dolphins with navigation lights;
- The hydraulic offloader mounted on a barge;
- A pipeline, which transports the material from the transfer site to the receiving site;
- One or more booster pumps stationed along the pipeline to increase the pumping production rate, especially along pipeline routes longer than 3.5 miles;
- Support equipment including barges, diesel generator, tug boats, crew boats, and site security.

If the offloader and booster pumps have diesel engines then external power is not needed for these elements.

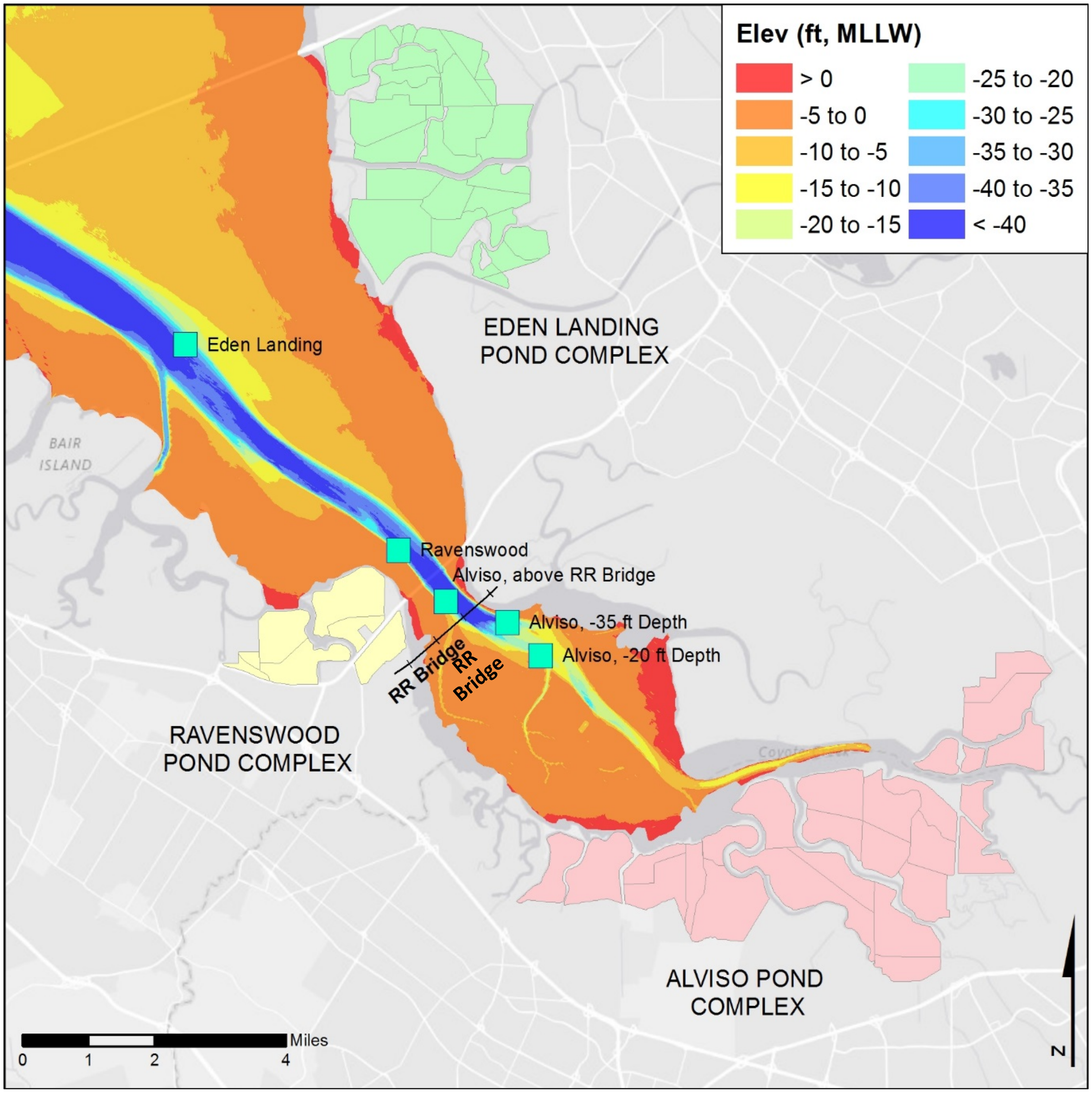

Figure 5-3. South Bay Bathymetry and Potential Deep Water Transfer Sites

Figure 5-4. Offloader at Hamilton Wetland Site (Photo: USACE)

The delivery vessel – scow or hopper – should have a single compartment so the hydraulic offloader can maintain a steady feed to the transfer pump. Compartmentalized scows require intermittent operation of the transfer pump when moving the intake line from one compartment to the next.

Dump scows and hopper scows can be unloaded at deep water sites. Hopper scows are least costly, so that if dredging contractors regularly used deep water transfer site with hydraulic offloaders, they would likely bring in hopper scows for the delivery.

An alternative to the hydraulic offloader is a Toyo pump, which is a large sump pump. The material in the scow or hopper is slurried, similar to the hydraulic offloader system. However, the Toyo pump is lowered into the scow to pump the slurried material through the pipeline to the receiving site.

Toyo pumps are smaller in size compared to hydraulic offloaders, and have correspondingly less pumping capacity. Due to this smaller production rate, Toyo pumps are not likely to be a feasible alternative for offloading at the Eden Landing or Alviso Pond Complexes. Given the shorter pumping distance and the limited volume required in the Ravenswood ponds, a Toyo pump could be potentially be used at the Ravenswood transfer point. However, it would likely not be cost effective given the significantly lower production rate.

5.2.3.3 Direct Pump Facility

In instances where the transfer point is a mile or less from the placement site, a hopper dredge's bow-mounted pumpout system may be sufficient to transfer the material to the site. The transfer point would simply be a bow coupling to a pipeline where the hopper dredge could connect to. Depending on the distance to the receiving site onshore and the discharge pump capability, the hopper dredge could either pump the material by itself or a booster pump could be installed somewhere along the transport pipeline to assist in moving the dredge slurry longer distances. Most hopper dredges in the U.S. fleet can pump off 4,000-5,000 feet without a booster pump; however some of the larger hopper dredges can pump over 10,000 feet without the aid of a booster pump.

While the USACE dredge *Essayons* was originally installed with pumpout capability, this capability was little used and the pumping infrastructure was eventually removed.

5.2.3.4 Unconfined Aquatic Transfer Facility

The USACE, San Francisco District and the SCC prepared an EIS for an unconfined Aquatic Transfer Facility (ATF) to support the Hamilton Wetland and Bel Marin Keys Unit V project (USACE and SCC 2008). The ATF was proposed to be located close to the open water disposal site SF-10. The description provided here is taken from that EIS: however, an open water ATF for the SBSP project would be very similar.

The ATF would consist of excavation of a submerged basin, in which scow and hopper dredges would deposit material dredged from San Francisco Bay into the basin. Material placed in the ATF basin would be later redredged using a hydraulic cutterhead dredge and pumped to the HWRP site through a transfer pipeline. The benefit of an ATF basin compared to an offloader facility is that larger scows and hopper dredges could more efficiently deposit material into the submerged basin, without the need to moor alongside and offload material.

The planned ATF basin at Bel Marin Keys Unit V would measure approximately 1,000 feet by 1,500 feet, and would be excavated to a depth of approximately -45 to -60 feet, 20 to 40 feet below the existing mudline at approximately -20 to -25 feet. This provides for a minimum deposition thickness of 18 feet, and a maximum filled design depth of -27 feet MLLW for dumping a fully loaded hopper dredge. The facility was planned to handle 16 MCY of material in a relatively short period (10 years).

The benefit of the unconfined ATF facility is that it is efficient and cost-effective for dredged material to be placed there. However, the following significant environmental concerns were voiced by NMFS:

- Suspended sediments are generated both during placement of the material, and as a result of resuspension of finer sediments;
- There can be significant impacts on benthic organisms;
- Redredging the ATF basin can lead to fish entrainment.

Because of the immense regulatory hurdles, an ATF has never been permitted in the Bay Area. The high costs and challenges associated with approval of an unconfined ATF rule this option out for the SBSP project.

5.2.3.5 USACE In-Bay Placements in the South Bay

The USACE performed numerical modeling of sediment dispersal following in-bay placement in the South Bay (Delta Modeling Associates and USACE 2014). Disposal at four placement sites, all below the Dumbarton Bridge, was modeled to determine how much of the sediment would naturally disperse to adjacent mudflats and marshes. A small percentage (less than about 3%) of the placed material was found to disperse into adjacent breached ponds, depending on the location of the placement. However, placement in this manner contains the same regulatory challenges as an ATF and is highly unlikely to be approved by environmental agencies. For the same reasons as the ATF, this material delivery method to the ponds is unfeasible.

5.2.4 Placement of Dredged and Upland Material

5.2.4.1 Dredged Material

Placement of material via hydraulic transport involves dealing with a significant quantity of water in the slurry: dredged material slurry in a pipeline is typically four-to-five parts of water for every one part sediment. In order to receive dredged material as slurry, the pond complexes must have infrastructure in-place prior to any material delivery. Dredged material placement requires containment cells and water control structures (adjustable discharge weirs and pumps) to capture and slowly decant the millions of gallons of slurry mixture pumped into the site.

Existing levees would be improved to contain the slurry, and new internal dikes would be needed to create independent settlement cells. The material for these improvements would most likely be excavated on site using large construction equipment. The levees and dikes would need to be protected to prevent erosion near areas of high water velocities.

Because the pond bottoms (historic marsh plains) are composed of soft soils, specialized low ground pressure construction equipment would be used for excavating and placing levee material. This is a significant construction cost element that has to be completed before dredged material can be brought to the site. If material from upland construction projects is available in a timely and cost-effective manner, this is a very attractive option to support internal haul routes.

Weirs would be constructed of durable material (pipe sections, welded metal sheets, etc.) with slots to insert boards and manage the weir height. Temporary portable pumps would be used for soil conditioning or additional water management in the cells when necessary.

Decant water from the dredge slurry would be discharged back into the Bay or a river, depending on the size of the receiving site and capacity for water containment. Decant water released back into the Bay must comply with the Waste Discharge Requirements (WDRs) as defined in the project's Regional Water Quality Control Board (RWQCB) permit. In order for the decant water to meet these standards, the slurry must be allowed a substantial detention time, which means that the facility will occupy a large area. As a pond fills up with slurry, the room remaining for sediment to fall out of suspension before the water can be returned to the Bay diminishes, making it increasingly difficult to meet water quality objectives.

A sampling and analysis plan will ensure compliance with WDRs. The WDRs will specify the sampling point (at the discharge location or 100 feet away) and the required constituents to be monitored.

The type of dredged material determines its behavior out of the pipeline:

- Sand quickly settles and creates mounds, so a dozer must be available to clear the pipe and prevent backup. Alternatively, the pipe is regularly moved or extended to place the sand material in different locations.
- Silts are fine enough to stay suspended in the slurry immediately out of the pipe so mounding is less of a concern.
- When clays are pumped far distances, they mold into "clay balls" which fall out of suspension very close to the discharge point. The remaining turbid water flows out over the containment cell and slowly settles out of the water column.

As a result, the costs associated with placement of sand are typically higher than those associated with placement of silts and clays.

5.2.4.2 Upland Material

Upland material is valuable prior to placement of dredged material within the ponds, because it typically does not require dewatering so it is suitable for stabilizing existing roads, building additional access roads, constructing containment cells for decant water management, and upgrading existing flood protection levees.

Additionally, since upland material is not subject to concerns regarding leaching of contaminants due to wetting and drying, provided that it meets the sediment criteria it is well suited to creating UTZs and habitat islands.

Prior to construction of any of these features, the upland material must be transported and delivered to the ponds, most likely by trucks. Transporting a significant amount of material via trucks poses environmental and traffic related challenges to local jurisdictions. A large trucking operation using highways and other public streets would be limited by local regulations related to hours of operation, noise, air quality, which could require separate environmental review. Also, in many cases there are no access roads to the ultimate end-use location within a given pond. For example, the Inner Bair Island reuse operation required building a bridge for fully loaded trucks across a sewer main as the first element of construction, which came at a significant expense to the contractor.

Once haul routes are determined and the existing infrastructure has been assessed for its ability and capacity to handle the truck traffic, the placement location of the material within the ponds must be determined. Ideally, the placement location is close to the final resting spot for the material to limit re-handling expenses. If that is not possible however, a re-handling facility should be identified where material can be stockpiled and later rehandled with earth-moving equipment to the final placement location. Determining the final placement location of the material is specific to the needs of each complex and each pond, and depends on the material type (grain size, organic content, constituent levels).

Import and placement of upland material has the potential to introduce invasive plants and to amplify existing plant invasions. Avoidance measures can be taken prior to material delivery at the site, such as herbicide treatment and mowing (to reduce seed production). Because herbicide treatments will require time to dissipate prior to placement in the ponds, other mechanical means can be employed to remove undesired plants during stockpiling and after placement at the ponds.

5.3 USACE Cost Sharing Policy Compliance

Well over half of the regular dredging in San Francisco Bay is performed by the USACE under its congressionally authorized Operations and Maintenance (O&M) program. The dredging is conducted based on annual appropriations from Congress.

Under the O&M program, USACE regulations require the identification of a *Federal Standard* or the *Base Plan*. The Federal Standard is defined as the least costly dredged material disposal or placement alternative (or alternatives) that is consistent with sound engineering practices and meets all federal environmental requirements. This standard is often expressed as the "least cost, environmentally acceptable" alternative. Costs associated with placement under the Base Plan are assigned to the navigational purpose of the project. If there is a desire by a local sponsor for the material to be placed elsewhere as a beneficial reuse activity, any incremental costs are shared between the USACE and the non-federal sponsor. The cost sharing for navigation and beneficial reuse projects under the Water Resources Development Act (WRDA) 2014 is as follows:

- Maintenance dredging performed under the O&M program is 100 percent federal funded for channels down to -50 feet MLLW. For deeper channels, the incremental cost is 50 percent federal funded.
- Restoration projects are up to 65 percent federal funded. This would include federal funding for any incremental costs associated with beneficial reuse of dredged material. However, the nonfederal costs include 100 percent of the following items:
    - Lands, Easements, Rights-of-way, Relocations, and Dredged or excavated material disposal areas (LERRD); and
    - Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) of the restored site.
- The costs of LERRD and OMRR&R may be applied to the 35 percent nonfederal portion of beneficial reuse projects.

In the case of the SBSP beneficial reuse site, the LERRD would include construction and operation of the transfer facility as well as preparation of the receiving site for material placement. (Lands, easements, rights-of-way, and relocations should be minimal.) Even if the overall cost of material disposal at the SBSP beneficial reuse site is less than that of the Base Plan, the nonfederal sponsor would be responsible for 100 percent of the LERRD and OMRR&R costs.

There have been cases where USACE dredging was used for wetland restoration.

- Capital improvement dredging projects (for example, deepening and/or widening of an authorized channel, or a new channel) are subject to different authorization rules. Congressional authorization and appropriations are sought by the USACE and the local sponsor, and a cost-sharing agreement is set up between the two entities.

  The Sonoma Baylands and Hamilton Wetlands projects were both authorized by Congress under separate WRDA legislation, allowing project-specific funds to be appropriated for the material placement. The Oakland Harbor 38-ft., 42-ft., and 50-ft. deepening projects were instrumental in implementing these restoration projects. If a wetland restoration element is included in the final phased South San Francisco Bay Shoreline Study then funds could be appropriated for material placement under this project.
- O&M material was placed at the wetland restoration on Inner Bair Island. The land owner (USFWS) built the site improvements after negotiating a memorandum of understanding with the USACE, and after the site improvements were in place, disposal costs did not exceed those of the Base Plan. This was feasible only because of the small distance between the Port of Redwood City and the restoration site.

Section 217 of the Water Resources Development Act (WRDA) of 1996 provides guidance for public-private partnerships in the design, construction, management, or operation of dredged material disposal facilities in connection with construction or maintenance of Federal navigation projects. An approach as described below could be used for the SBSP Restoration Project:

- Under Section 217 (c), the USACE could enter into an agreement with either the SCC or a private entity to design, construct, manage, and operate a dredged material disposal facility at the SBSP Restoration Project. The private entity would provide financing for the facility, and would be reimbursed over time through the payment of subsequent user fees, which could include the payment of a disposal or tipping fee for placement of dredged material. The level of user fees would be approved by the USACE in cooperation with the SCC, and would be sufficient to provide a reasonable return on investment to the private entity.
- Under Section 217 (a), provided that additional capacity is available beyond that required by USACE projects, medium-sized dredging projects by ports or others could also place the material at the SBSP project. USACE approval of the level of user fees is not required in this case.

5.4 Environmental Regulatory Compliance

5.4.1 Introduction

Three main project elements will require environmental review and permitting: sediment quality; water quality; and short-term construction impacts associated with material transportation and placement activities and infrastructure. This section describes each of these issues in turn.

The project owner of any dredged material (i.e. the source of the material) – typically the USACE or a Port – is responsible for characterizing their material and for obtaining the necessary permits to dispose of the material. The SBSP Restoration Project uses the characterization results to accept or deny the material based on the project-specific permits. More laboratory tests are required to demonstrate sediment suitability for marshes compared to other placement sites, and acceptable material may have to be separated from unacceptable material.

The dredger's responsibility for material testing leads to additional costs and uncertainties compared to the requirements for disposal at upland or deep ocean sites.

For instance, upland material from South San Jose area has historically contained metals and pesticides at levels higher than the cover criteria, resulting in the material not being acceptable for cover placement at the Bair Island Restoration Project. As a result, the material supplier may look to other disposal sites, such as local construction projects that accept a wider range of material. The Bair Island Restoration Project did not initially account for this and had difficulty finding suitable material.

5.4.2 Dredging Work Windows

To avoid impacts on listed species and species of special concern within the Bay, dredging and material disposal is limited to environmental work windows. Work windows differ based on location, species present, and time of year. Any project applying for a permit to work outside the work windows will require Endangered Species Act consultation by NMFS (via the Corps).

The South Central and South San Francisco Bay has a work window from June 1st – November 30th for protection of steelhead trout. Other species found in the intertidal zone require consultation year-around (no work window).

5.4.3 Sediment Quality

5.4.3.1 Introduction

Key resource concerns intrinsic to sediment placement include sediment quality, water quality, and associated impacts to biological resources potentially resulting in leaching of metals from the dredged materials. Introduction of invasive plants can also be a concern.

Given that the SBSP Restoration Project is an environmental restoration project, it is essential that all import material be suitable for the intended habitat for sensitive and other species. Both physical and chemical characteristics of import fill are important to a successful restoration project. Physical properties dictate how the material would be placed and where would it function best. Some examples are as follows:

- Material used to create a flood control levee needs to be compacted to achieve the desired strength characteristics. Soft bay mud by itself cannot be used to create levees or tall berms. The sediment may also be required to meet plasticity standards for levee construction if intended to be used for USACE-certified levee construction.
- Material placed to create surface marsh plains needs to have organic content and a low permeability. Therefore, free draining sand cannot be used to create marsh plains. Dredged fine material, if it meets chemical standards, is ideally suited for this purpose.
- It is also less costly to place finer material over large areas, since clay and silt that is placed hydraulically disperses throughout a pond without needing to be mechanically reshaped.
- There is more flexibility in material properties for pond foundation material, which is intended to raise the pond bottom elevation and be covered with suitable material at the surface.

Figure 5-5 shows the grain size of material tested at the USACE dredging sites (DMMO 2014). The projects that are further from the SBSP Restoration Project are also those with the highest sand fractions.

Chemical suitability of material for a marsh environment is a critical consideration in marsh restoration work because of the direct pathway to flora and fauna in marsh habitats (as well as potential exposure to humans). The LTMS program's emphasis on dredged material reuse has resulted in the agencies developing sediment suitability criteria for reuse, classified as *foundation* (less stringent) and *cover* (more stringent) with preliminary guidance on where such material types could be reused.

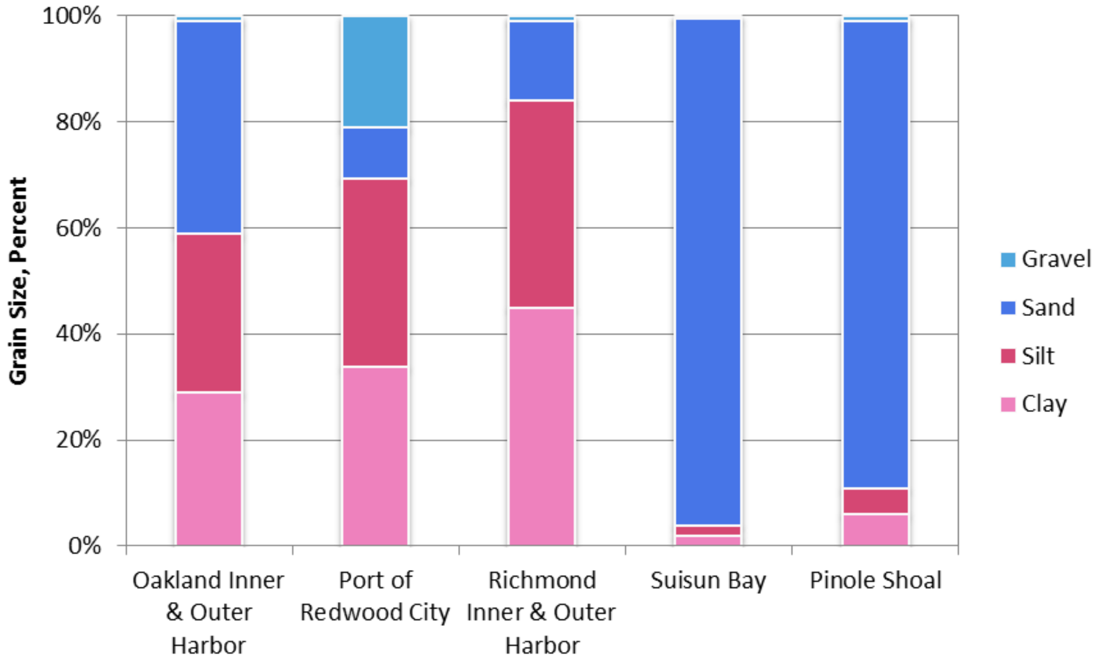

Figure 5-5. Grain Size at USACE Dredging Sites

5.4.3.2 Screening and Testing Guidelines

Beginning in 1991, USEPA and USACE released guidelines for placing dredged material in the deep ocean (*Green Book*, USEPA and USACE, 1991), followed by subsequent guidelines for discharging dredged material in the waters of the US (*Inland Testing Manual*, USEPA and USACE 1998).

In 1992, the National Oceanic and Atmospheric Administration (NOAA) set national effects-based sediment concentrations of chemical constituents of concern. The San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) used ambient concentrations within the Bay, as well as NOAA's guidelines, to set screening values and general testing requirements in 1992 for dredged material placement in beneficial reuse sites (USACE and USEPA 1992). These guidelines were updated in 2000 based on updated ambient San Francisco Bay values and NOAA screening values (*Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines*, SFBRWQCB 2000). The SFBRWQCB also established guidelines for dewatering and using dredged material as foundation for upland construction (*Basin Plan*, SFBRWQCB 1995).

In 2001, the DMMO released *Guidelines for Implementing the Inland Testing Manual in the San Francisco Bay Region* (also known as the Corps Public Notice (PN) 01-01) (DMMO 2001). These guidelines and SFBRWQCB's *Sediment Screening and Testing Guidelines* will form the basis of sediment criteria for the SBSP Restoration Project. Coordination with DMMO will determine the final acceptable criteria.

5.4.3.3 Sediment Criteria for Dredged Material Placement in Beneficial Reuse Sites

In SFBRWQCB's *Sediment Screening and Testing Guidelines*, sediment criteria guidelines for dredged material placement in beneficial reuse sites are a combination of ambient sediment data and NOAA's Effects Range-Median (ERM) and Effects Range-Low (ERL). The ERM is the constituent concentration corresponding to 50 percent likelihood of toxicity, and the ERL correlates to 10 percent likelihood of toxicity. Effects-based conclusions are made from chemical and biological analyses, intended to illuminate the potential for contaminant-related water column, benthic toxicity and benthic bioaccumulation impacts.

In San Francisco Bay, compliance with ambient or ERLs is recommended for wetland *cover* material, while wetland *foundation* material (covered by surface material) should be compared to ERMs. SFBRWQCB predominately recommends use of San Francisco Bay ambient values for cover material, followed by ERLs when ambient values are unavailable. Deviations from these guidelines are often approved if it can be demonstrated that the dredged material is unlikely to impact beneficial uses, and more specifically, if the bioaccumulation potential of the constituent will not result in increased biological effects. For some analytes, such as nickel, the ambient sediment data exceeds national averages due to the local geology, and in these cases the regulatory framework relies heavily on ambient sediment data.

For the SBSP Restoration Project to be most economically feasible, the project should accept as much material as possible to cover the high capital costs for an offloading facility and site preparation. Consequently, the SBSP Restoration Project should plan to accept both cover and foundation material.

Table 5-2 below summarizes the ERLs, ERMs, and San Francisco Bay ambient values (classified by fine- or coarse-grading of the material) given in the *Sediment Screening and Testing Guidelines*. These guidelines apply to both dredged material and upland soil, and were used in the WDRs for the Bair Island Restoration Project.

Table 5-2. Reference Screening Levels for Developing Sediment Criteria

Analyte	ERLs	ERMs	San Francisco Bay Ambient Values	
	Cover	Foundation	<40% fines	<100% fines
Metals (mg/kg)				
Arsenic	8.2	70	13.5	15.3
Cadmium	1.2	9.60	0.25	0.33
Chromium	81	370	91.4	112
Copper	34	270	31.7	68.1
Lead	46.7	218	20.3	43.2
Mercury	0.15	0.71	0.25	0.43
Nickel	20.9	51.6	92.9	112
Selenium			0.59	0.64
Silver	1	3.7	0.31	0.58

Analyte	ERLs	ERMs	San Francisco Bay Ambient Values	
	Cover	Foundation	<40% fines	<100% fines
Zinc	150	410	97.8	158
Pesticides and PCBs (µg/kg)				
Aldrin			0.42	1.1
Chlordane			0.18	0.44
Chlordanes, sum			0.42	1.1
Dieldrin			0.18	0.44
Endrin			0.31	0.78
Hexachlorocyclohexane, sum			0.31	0.78
DDTs, sum	1.58	46.1	2.8	7.0
PCBs, sum	22.7	180	5.9	14.8
PCBs, sum (SFEI 40 list)			8.6	21.6
Polycyclic Aromatic Hydrocarbons (µg/kg)				
PAHs, total	4,022	44,792	211	3390
Low molecular weight PAHs, sum	552	3,160	37.9	434
High molecular weight PAHs, sum	1,700	9,600	256	3060
1-Methylnaphthalene			6.8	12.1
1-Methylphenanthrene			4.5	31.7
2,3,5-Trimethylnaphthalene			3.3	9.8
2,6-Dimethylnaphthalene			5	12.1
2-Methylnaphthalene	70	670	9.4	19.4
2-Methylphenanthrene			11.3	26.6
Acenaphthene	16	500	2.2	31.7
Acenaphthylene	44	640	11.3	26.6
Anthracene	85.3	1,100	9.3	88
Benz(a)anthracene	261	1,600	15.9	244
Benzo(a)pyrene	430	1,600	18.1	412
Benzo(b)fluoranthene			32.1	371
Benzo(e)pyrene			17.3	294
Benzo(g,h,i)perylene			22.9	310
Benzo(k)fluoranthene			29.2	258
Biphenyl			6.5	12.9
Chrysene	384	2,800	19.4	289

Analyte	ERLs	ERMs	San Francisco Bay Ambient Values	
	Cover	Foundation	<40% fines	<100% fines
Dibenz(a,h)anthracene	63.4	260	3	32.7
Fluoranthene	600	5,100	78.7	514
Fluorene	19	540	4	25.3
Indeno(1,2,3-c,d)pyrene			19	382
Naphthalene	160	2,100	8.8	55.8
Perylene			24	145
Phenanthrene	240	1,500	17.8	237
Pyrene	665	2,600	64.6	665

5.4.3.4 Sampling Guidelines

The DMMO provides guidelines for the number of sample stations and composites recommended for characterizing dredged material. Similar sampling quantities are likely to be required for upland material. Table 5-3 summarizes the minimum recommended samples per dredged volume in cubic yards. Additional compositing procedures and sampling instructions can be found in *PN01-01* and the *Inland Testing Manual*.

Table 5-3. Minimum Sediment Sampling Guidelines (DMMO 2001)

Dredge Volume* (*in situ* CY)	Minimum Number of Sample Stations	Number of Composites Analyzed†
5,000 - 20,000	4	1
20,000 - 100,000	8	2
100,000 - 200,000	12	3
200,000 - 300,000	16	4
300,000 - 400,000	20	5
400,000 - 500,000	24	6

* Contact DMMO for guidance on projects smaller than 5,000 cubic yards or larger than 500,000 cubic yards.

† Numbers do not reflect reference and control sediment or other QC samples.

5.4.3.5 Testing Guidelines

Testing guidelines for source material are based on the *Inland Testing Manual*, which defines a tiered sampling framework for projects ranging from low- to high-potential impacts. Testing requirements increase from Tier I projects up to Tier IV projects. If adequate testing exists from previous dredging episodes and the impacts of the project are minimal, the project may be classified as a Tier I and additional testing may not be required. Tier II projects typically require physical and chemical analysis such as total solids, total organic carbon, grain size, metals, butyltins, pesticides, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons

(PAHs) (complete list found in *PN01-01*). Tier III projects may require biological evaluations (water column toxicity, benthic toxicity, and benthic bioaccumulation tests) in addition to physical and chemical analysis. Tier IV projects require more comprehensive, case-specific evaluations.

The SBSP Restoration Project's WDRs specify the analyses required to determine acceptability with the sediment criteria. The required lab analyses are likely to be more stringent than for other disposal sites (such as upland reuse as construction fill) because the majority of the material in the SBSP Restoration Project will be used to create wetland habitat.

5.4.3.6 Preliminary Compatibility Review

Dredged material from several past maintenance and new construction projects has been placed at wetland restoration sites as beneficial reuse, so it appears likely that this material will largely meet screening criteria at the SBSP Restoration Project. Table 5-4 shows some of the placement location used by the dredging projects described in Section 4.3.

Table 5-4. Past Dredged Material Placement at Wetland Beneficial Reuse Sites

Project	Sonoma Baylands	Bair Island	Hamilton Wetland	Montezuma Wetland
USACE New Construction				
Oakland Harbor Deepening	●		●	●
USACE O&M Projects				
Oakland Inner & Outer Harbor			●	●
Redwood City Harbor		●		
Richmond Inner Harbor			●	
Richmond Outer Harbor			●	
Mid-Sized Non-Federal Maintenance				
Chevron			●	
Larkspur Ferry Channel			●	
Port of San Francisco			●	
Valero			●	
ConocoPhillips (Rodeo)			●	

5.4.4 Wetting and Drying of Dredged Material

Wetting and drying issues became of concern to regulatory agencies in the permitting of the Montezuma Wetlands Restoration Project. Regulatory agencies expressed concerns over the desiccation of imported, dredged material fill at tidal marsh restoration sites (SFBRWQCB 2012) – specifically, the effects of material that is allowed to dry out during stockpiling or after placement at the marsh site, but before tidal flow is reintroduced to the site. This was of particular concern because of the placement of slightly foundation (rather than the cleaner cover) material at Montezuma.

There may be potential for increased leaching of metals from dredge sediments upon drying and oxidation followed by wetting, particularly wetting with fresh water (e.g., rain). San Francisco Bay dredged sediments are often fine-grained materials with low organic content (<1 percent), are anoxic when dredged, and can become increasingly acidic upon oxidation. Hardening and deep desiccation cracks may form upon drying due to the high clay content of Bay Mud, increasing the exposure to rain and consequent leaching. This may have the following effects.

- Invertebrate-eating shorebirds and non-diving waterfowl may forage in the dredged material and be exposed to leached metals.
- Mosquitoes may harbor in deep cracks.
- Benthic organisms may not colonize as well in the hard clay.
- Vegetation may be stressed or stifled by leached metals and hardened soils. This is of most concern when the material is reused for higher elevation margins or high marsh fill, which is exposed to fresh rainwater. There is less concern when sediments are placed in the low intertidal areas, where highly buffered marine waters neutralize sediments quickly.

In response to this, restoration projects utilizing dredged material in the Bay Area have been required by permitting agencies either to keep dredged material wet until tidal action is restored, or conduct a monitoring program to detect and prevent leached metals from entering the Bay, among other measures. For example, as part of the permit stipulations for the Montezuma Wetlands Restoration Project, the material was required to be maintained wet until tests showed there was no impact to water quality from placement of the foundation material.

If dredging project schedules and reuse schedules do not match in time, the necessity of storing and handling these materials in the wet can cause a significant impediment to dredged material reuse. Similarly, if a particular pond is to receive dredged material over a number of years, the need to keep the material wet can increase difficulties associated with stormwater management.

Given the long timescales and complexity of the SBSP Restoration Project, there will be no single management approach to wetting and drying issues. For the largest, most subsided ponds, it is unlikely to be feasible to fill the pond to capacity during a single dredging season. Figure 5-6 compares the quantity of dredging generated in a single dredging cycle by the O&M projects listed in Table 4-1 with the pond capacities listed in Table 3-4 and Table 3-5. Even if the five USACE O&M projects closest to the SBSP Restoration Project – Redwood City Harbor, Oakland Inner and Outer Harbor, and Richmond Inner and Outer Harbor – were to place all their material in a single year at the ponds, the total sediment would be approximately 1.6 MCY. This is less than the capacity of most of the Alviso ponds.

It should be noted that tidal marshes naturally wet and dry and material with high organic content (peat) also becomes acidic when it dries. Furthermore, it is necessary to stress the vegetation to some extent in order for the complex marsh ecosystems to develop.

The most likely way ahead would involve monitoring; management of drying ponds to avoid the worst potential impacts listed above; and careful management of foundation material in particular. Monitoring would include both water quality and biological monitoring, to address the possibility that birds making use of managed ponds and subtidal marshes that have not reached their final condition are ingesting contaminants. This will be addressed on a phase-by-phase and even pond-by-pond basis during permitting.

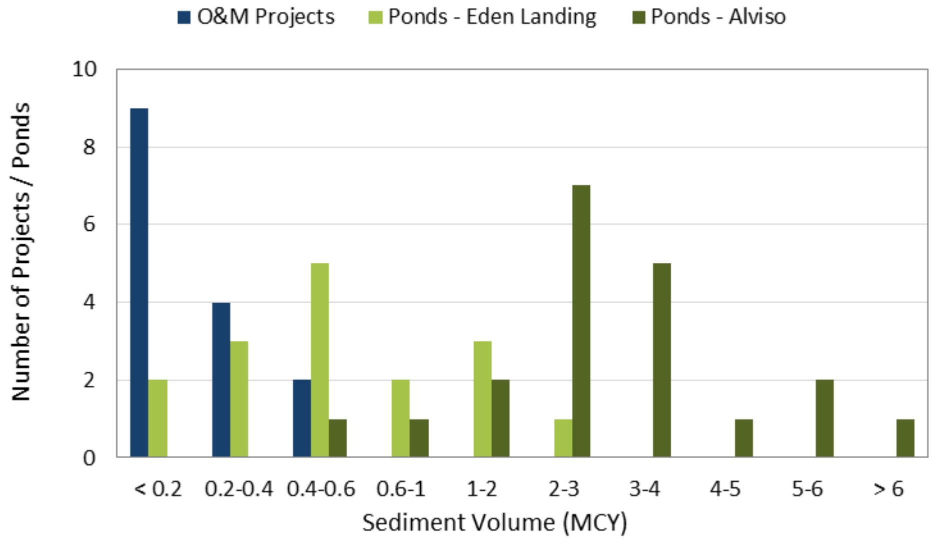

Figure 5-6. Dredged Material Quantities Generated by Single O&M Cycle and Pond Capacities

Appendix A contains a more detailed review of wetting and drying issues and a concept plan developed by the Moffatt & Nichol team to investigate leached materials at recently restored wetlands in the Bay Area. After informal discussions with the SFBRWQCB, it was decided not to move ahead with this plan at present.

5.4.5 Water Quality

5.4.5.1 Waste Discharge Requirements (Decant Water)

Decant water discharged into the Bay from the containment cells must meet waste discharge requirements. As an example, the Hamilton Wetland Restoration Project had effluent limits of total suspended solids less than 100 mg/L and 50 mg/L (90 percent and 50 percent of the time, respectively), a pH range of 6.5 – 8.5, and dissolved sulfide less than 0.1 mg/L (SFBRWQCB 2005). Water quality in the receiving water body also must be monitored and comply with water quality criteria (such as dissolved oxygen, turbidity, total suspended solids, etc.).

5.4.5.2 Stormwater Management

Stormwater management during the placement of dredged material would be similar to decant water management at all pond complexes. As currently all the ponds considered to receive dredged material have controlled inflows, the majority of inflow sources would be rainwater falling on the ponds and surrounding levees. If a pond is to receive flood flows while dredged material is placed, there would have to be adequate space to contain the expected volume of water and still comply with water quality objectives. For the HWRP, the expected surface water was small in comparison to the water generated from the dredged material placement, so the water management systems onsite were sufficiently sized to handle expected stormwater discharges (SFBRWQCB 2005).

Because dredging work windows in the South Bay are from June through the end of November, the majority of dredged material placement will occur prior to the rainy season. Rainwater falling into the ponds would be directed through the ponds in the same path as the decant water, however the decant water would not be present.

5.4.6 Transport and Placement Infrastructure and Activities

Environmental review for placement activities associated with beneficial reuse may need to evaluate impacts from:

- Transport from material source to offloading facility could include both water and upland transport:
    - New access roads may be needed;
    - Dredging may be needed to allow access by fully loaded dredges/scows;
    - Anticipated key resource concerns include traffic/navigation, noise, air quality, greenhouse gases, and recreation.
- Stockpile and handling sites, such as an offloader, upland rehandling facilities for dredged material, sediment slurry containment, and upland transfer facility for material from upland transport:
    - Necessary site improvements/infrastructure may include offloader, transfer pipelines, booster pumps, and electrical infrastructure (if diesel fuel use is not feasible);
    - Impacts of construction, operation, and decommissioning of infrastructure would need to be evaluated;
    - Anticipated key resource concerns include air quality, greenhouse gases, fish entrainment at process water intakes, turbidity from process water, and aesthetics.
- Site preparation and management:
    - Necessary site improvements/infrastructure may include grading; water control structures, including containment berms/dikes, adjustable discharge weirs, and pumps; and levee improvement.

6. CASE STUDIES

6.1 Introduction

This section describes four major case studies where dredged material, largely from USACE projects, was used in wetland restoration.

- The Sonoma Baylands Demonstration Project was one of the first such major projects, and its success was one element in the increasing interest in beneficial reuse of dredged material.
- The Hamilton Wetland Restoration Project (HWRP) was technically very similar to – although much smaller than – the SBSP project. Many of the technical issues that must be addressed by the SBSP Restoration Project have been investigated in the HWRP.
- The Bair Island Restoration Project used a private contractor to manage the placement of dredged material from the Redwood City Harbor maintenance dredging at Inner Bair Island. The contracting vehicle used (although only for two dredging episodes) may form a basis for multi-episode beneficial reuse at the SBSP Restoration Project.
- The Montezuma Wetlands Restoration Project is unusual in being a privately owned and operated facility. It has had limited success in attracting dredged material somewhat due to competition with the HWRP, highlighting the risks taken by private operators in this field.

Three of the restoration sites are in the north part of the Bay Area, with Bair Island in the south, close to the SBSP Restoration Project. Figure 6-1 provides a location map for the sites.

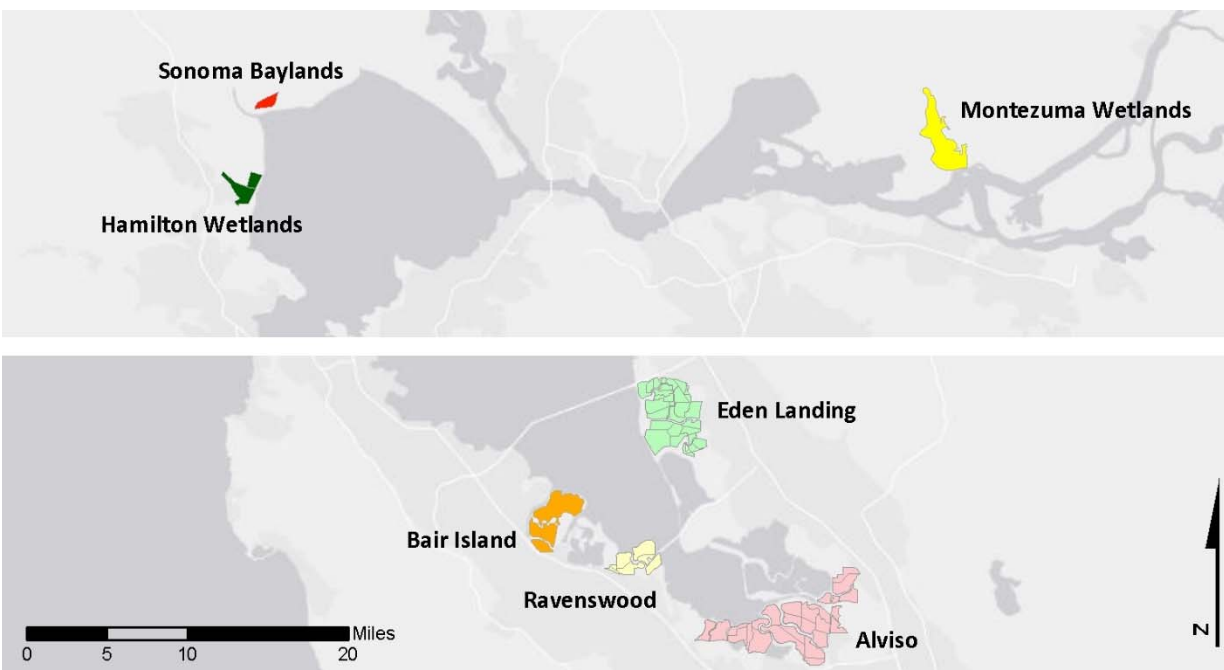

Figure 6-1. Location Map for Case Studies

The three projects in the north part of San Francisco Bay depended on the Oakland Harbor deepening projects to build the material placement infrastructure – the Sonoma Baylands project received material from the -42 ft. project, completed in 1998, and the HWRP and Montezuma Wetlands projects received material from the -50 ft. project, completed in 2010. The HWRP and Montezuma also received O&M material from Oakland Harbor. In contrast, Inner Bair Island received only O&M material from Redwood City Harbor.

6.2 Sonoma Baylands Demonstration Project

Overview

The Sonoma Baylands Demonstration Project restored tidal salt marsh habitat on a 348-acre diked hayfield on the northern shoreline of San Pablo Bay. The former tidal wetlands had been diked and drained, subsiding as much as 12 feet below sea level in some locations. Site elevations were raised to approximately 0.5 feet below the surrounding marsh elevations using 1.7 MCY of dredged material from the 42-ft. Oakland Harbor Deepening Project.

The Sonoma Baylands Demonstration Project represented one of the first large-scale beneficial reuse projects in the Bay Area and as such was extremely successful.

History and Institutional Arrangements

The wetland was constructed by a partnership between the California State Coastal Conservancy (SCC), the USACE, and the Port of Oakland. USEPA provided support through a grant to the State for long-term monitoring of the project.

The Sonoma Baylands parcel was originally selected for preservation as open space rather than as a wetland site and was purchased under a California State Initiative in 1986, with ownership transferred to the SCC. The project was funded by the 1992 Water Resources Development Act (WRDA), State of California funds, and bonds issued by SCC. 75 percent of the cost was covered by USACE, with the remaining falling to the local sponsor, SCC.

In 1989, the USACE built a new perimeter levee to separate the restoration site from a rail line and farm to the north. The site was then filled with clean dredged sediment from the Port of Oakland and Petaluma River approach channel, restoring the site elevations to a level just below mean sea level. (The Petaluma River "Across the Flats" approach channel was included in the Oakland Deepening Project because it had not been maintained to its authorized depth and there was insufficient depth to reach the Sonoma Baylands.) In 1995 the outboard levee was lowered and breached in two locations, to allow bay tides to flush the site daily. At first, bay water was restricted by the narrow ditch that leads to the bay, but in the years 2002-2006 the breach area opened rapidly which has caused increased sedimentation within the site and rapid colonization by the predominant wetland plants.

The California Coastal Conservancy currently owns the property, which is managed by the Sonoma Land Trust. The USACE is responsible for monitoring and maintaining the site and its O&M budget is included in the USACE O&M budget for Oakland Harbor. Consistent with the initial cost share, 25 percent of the monitoring cost is covered by the local sponsor (SCC).

The Sonoma Baylands site is now under an agreement that provides for management by the US Fish and Wildlife Service as part of the San Pablo Bay National Wildlife Refuge, and ownership will eventually be transferred to the US Fish and Wildlife Service.

Even though the Sonoma Baylands project is associated with the Oakland Harbor deepening project, the USACE completed a separate EA for the Sonoma Baylands Demonstration Project in 1994.

Cost

Overall the total cost for the Baylands was about $6 million, roughly a five percent increase in the overall $100 million estimate for the dredging project (Marcus 2000). The 42-ft. Oakland Harbor Deepening Project was completed in 1998.

6.3 Hamilton Wetland Restoration Project / Bel Marin Keys Unit V

Overview

The Hamilton Wetland Restoration Project (HWRP) is located in Marin County, at the site of the decommissioned Hamilton Army Airfield near San Pablo Bay. The original 990-acre parcel was expanded in 2007 to include the 1,600-acre Bel Marin Key Unit V (BMKV) parcel, the status of which is described briefly below. However, this section concentrates on the original HWRP project, which was opened to tidal flow in April 2014.

The levee-protected airfield site had subsided below the elevation of the surrounding properties, including the tidal wetlands immediately adjacent to San Pablo Bay. The HWRP had a capacity of 10.6 MCY of dredged material, used to restore 570 acres of coastal salt marsh and seasonal wetlands, 220 acres of tidal wetlands, and 120 acres of tidal channel and intertidal habitats. Approximately 5.6 MCY was placed from the Oakland Harbor 50-ft. deepening project, with a smaller quantity from other O&M and nonfederal projects.

The marsh wetlands were restored to approximately 1.5 feet below the surrounding marsh plain vegetation: it is anticipated that natural sedimentation will bring the site grades to the full marsh plain elevation.

Bel Marin Keys Unit V

The BMKV Restoration Project has the capacity for 13.8 MCY of dredged material. The BMKV parcel was funded through the WRDA 2007 authorization. However, this authorization modified the cost share from 75 percent federal/25 percent nonfederal in the original agreement to 65/35 percent. The SCC requested a review of the cost share ratio, and stipulated that they would only continue with the BMKV portion if the original 75/25 percent cost share continues. Legislative action is required to maintain this cost share. Resolution of this cost share issue is not anticipated in the near future and the SCC plans to move forward with the project on their own.

History and Institutional Arrangements

The HWRP project is a partnership between the SCC and the USACE. Following closure of the Hamilton Army Airbase in 1994, the SCC assumed the lead in developing a wetland restoration plan for the former airfield and adjacent properties. In 1999, the SCC adopted the Hamilton Wetlands Restoration plan and certified the EIR-EIS for the project. The HWRP was authorized in Section 101(b)(3) of WRDA 1999, with 75 percent federal/25 percent nonfederal cost share. The USACE was responsible for the planning, design and construction of the project, as well as operation of the completed HWRP. SCC owns the property, which was transferred to the State by the US Army between 2003 and 2005.

Between 2008 and 2010, dredged material from the 50-foot Oakland Harbor Deepening Project and other dredging projects was placed at the HWRP. Placement of beneficial reuse material at the site was completed in 2011 and the HWRP pipeline was dismantled in fall of that year. The levee was breached and tidal flow reintroduced in April 2014. Heavy construction is complete, but planting, trail construction, and similar activities are ongoing. Monitoring will continue for a period of 13 years.

Equipment

In response to the USACE Value Engineering process, a Draft Supplemental EIS/EIR was released in 2008, evaluating alternative approaches to deliver dredged material to the HWRP site. The document was completed for a proposed aquatic transfer facility (ATF). Subsequent to the publication of the Draft Supplemental EIS/EIR, the proposed ATF project was put on hold due to environmental concerns and budgetary constraints. Delivery of material to the HWRP used an offloader facility similar to that proposed here for the SBSP project.

The HWRP had an offloader, main offloader barge, anchor piles, two adjacent mooring and fleeting barges, and three booster pumps. The offloader facility was located approximately five miles offshore, in order to provide enough water depth for loaded scows with a capacity 3,000 to 6,000 cubic yards. The first and second booster pumps were operated in series and located 1.5 miles inshore of the offloader. The third booster pump was located at the shoreline, on land, and moved the slurry up to two miles inshore.

At the offloader site, water from the bay was pumped into the dump scow, mixed with the sediment, then the slurry was pumped up to seven miles to the restoration site. At the site, the slurry was pumped in containment cells with weirs and water control structures to manage the decant water. The intake pump had a fish screen and a maximum approach velocity of 0.33 feet per second to prevent fish entrainment.

All pumping equipment was required to be electrically powered so that air quality impacts associated with diesel engines were avoided. This required construction of a new electrical substation for the operation.

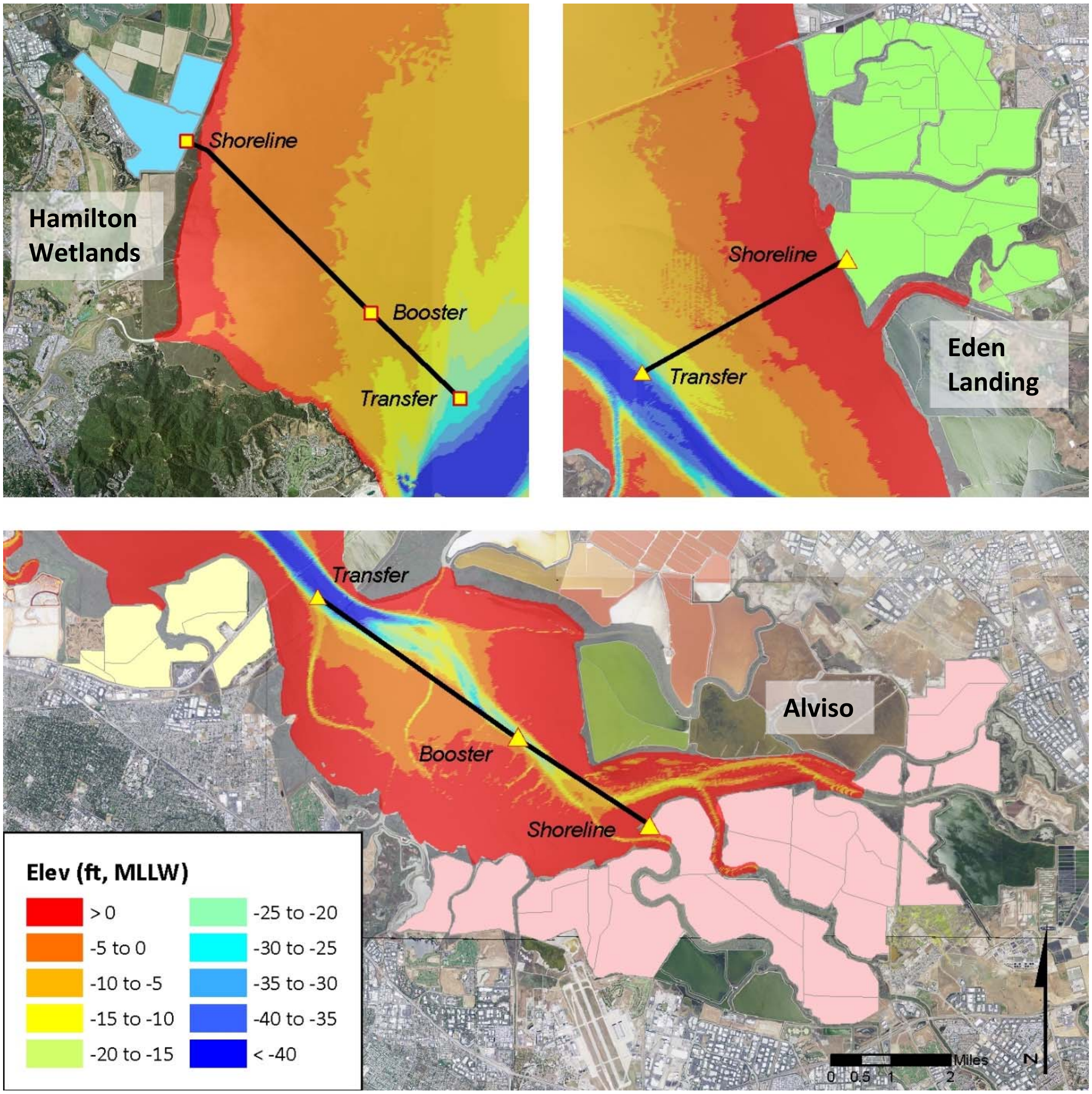

Figure 6-2. Pipeline Alignment and Pump Locations used in HWRP and Potential Alignments and Locations for Eden Landing and Alviso Pond Complexes

Cost

The USACE HWRP website gives the total project costs as $280,280,000, of which $193,127,000 would be paid by USACE and $87,153,000 by SCC. This is approximately evenly shared between the (near-complete) HWRP and the BMKV Restoration Projects.

6.4 Bair Island

Overview

The 2,635-acre Bair Island marsh complex is located in Redwood City. It consists of three distinct areas: Inner Bair (325 acres), Middle Bair (895 acres), and Outer Bair Islands (1,415 acres); see

Figure 6-3. Inner Bair is connected to the mainland and is separated from Middle Bair by Smith Slough; and Middle Bair is separated from Outer Bair by Corkscrew Slough.

Middle and Outer Bair Islands were restored by levee breaching. However, Inner Bair required over a million cubic yards of upland and dredged material to raise the subsided pond bottom elevation. Inner Bair is the focus of this case study because of its reuse of dredged material with minimal site preparation: a single containment berm was constructed to receive approximately 300,000 cubic yards of dredged material from Redwood City Harbor maintenance dredging.

Figure 6-3. Bair Island, Redwood City Harbor, and Ravenswood Location Map

History and Institutional Arrangement

Historically a tidal marsh, Bair Island was used for cattle grazing until 1946, when salt evaporation ponds were constructed and operated through 1965. After multiple development attempts, the CDFG and Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) purchased the land. A memorandum of understanding was signed in 1997 by CDFG and the Refuge, allowing the Refuge to manage and operate CDFG's land as part of the Refuge.

The Bair Island restoration project is being managed and funded by Ducks Unlimited (DU).

Placement of Material at Inner Bair Island

The Sonoma Baylands and HWRP projects hired contractors to transport material to the site and to place it at the site as part of the overall construction package. In contrast, the Bair Island project published an RFP, whereby contractors would propose to operate Inner Bair Island as a landfill, charging a tipping fee to place clean sediment at the site. Sediment from any source that met the physical and chemical criteria could be placed at the site. The contractor provided most of the improvements on the site, and paid the USFWS to monitor (verify) operations and compliance with permitting and contracting terms at the site.

The requirement for monitoring by USFWS arose out of conditions during an initial pilot project, in which 65,000 CY of material was permitted for placement at Inner Bair Island. During performance of this pilot project, deleterious material including asphalt, pipe, and assorted trash was placed on Inner Bair Island. This material was removed after it was discovered by the FWS. The main problem with the pilot project was that there was no process in place to verify that trucks were delivering approved soil material from approved borrow sites; a verifiable chain of custody of the fill material was not developed and a representative of the restoration project with the authority to reject fill was not on site to monitor and log incoming trucks (USFWS 2008).

The Final EIS/EIR for the proposed restoration of Bair Island (USFWS and CDFG 2006) described two alternatives that would use dredged material to raise the marsh plain elevation and for levee expansion: placement of hydraulically dredged material pumped to the site, and transport of the material by truck. Only the first of these was analyzed: the EIS/EIR stated that any environmental review associated with truck transport would be addressed by the project(s) providing fill material to Inner Bair Island.

The contractor managing the site used (and obtained permits for) three different fill sources: dredged material transported by truck in the early phases, before the settlement ponds and other infrastructure was complete; hydraulically placed dredged material from Redwood City Harbor; and clean material from upland construction projects, transported by truck.

It was extremely cost-effective to place dredged material at Inner Bair Island hydraulically, because of its close proximity to Redwood City Harbor – see Figure 6-3. As a result, it was financially feasible to use the relatively small quantities of O&M dredging in this way. A Toyo pump was used to pump material from scows to the placement site.

6.5 Montezuma Wetlands Restoration Project

Overview

The Montezuma Wetlands Restoration Project (MWRP) is the only operating wetland restoration site in the Bay Area that has site improvements and a dedicated hydraulic offloading system in place for receiving dredged material. It is unique because it is also the only large privately owned and operated beneficial reuse facility of this type. Unusually for private wetland restorations, the MWRP is not being constructed as mitigation for any actions – the funding is entirely derived from tipping fees.

The MWRP is located near the confluence of the Sacramento and San Joaquin Rivers at the eastern edge of the Suisun Marsh. The project aims to restore 2,400 acres of grassland and seasonal wetland that have subsided up to 10 feet below original ground elevations. Approximately 17.5 million cubic yards of dredged material will be placed on the 1,600 acres planned for tidal marsh restoration, while other areas designated for other types of wetlands (250 acres) and UTZ habitats (480 acres) will not receive dredged material. (SFBRWQCB 2012).

History and Institutional Arrangements

The MWRP is a privately owned and operated site, which charges a tipping fee to cover the capital and operating costs. The land for the MWRP was privately purchased, and the necessary offloading equipment and on-site infrastructure were built, with the strategic intent of building an upland beneficial reuse site for the 50-ft. Oakland Harbor Deepening Project. The MWRP was the primary disposal site in the EIR/EIS for the 50-ft. Oakland Harbor Deepening Project.

The project obtained approval from the DMMO and permits from the RWQCB, USACE, BCDC, Solano County, and the SLC. NMFS, USFWS, and the CDFG commented during the permitting process. The project is permitted to accept a defined amount of foundation material, which has less stringent sediment criteria compared to cover material (see details in Section 5.4.3.3). The foundation material must be covered by at least three feet of cover material must be placed a minimum 200 lateral feet to the nearest water source or channel to prevent constituent migration.

Site preparation and construction of the offloading facility began once the final permit was granted in September 2001. The project began accepting material from the Oakland Project in December 2003.

The MWRP restoration plan was broken into four phases, each of which will result in tidal action being restored to an independent portion of the site. The original phasing plan is shown in Table 6-1. Similar to the SBSP Restoration Project, an adaptive management approach was set in place, with dates for the later phases not defined. Permits require review and renewal typically every 10 years.

Table 6-1. Original Phasing Plan for MWRP

Phase	Restored Area (Acres)	Sediment Capacity (MCY)	Schedule
Site Preparation	-	-	2001 to 2003
I	531	5.0	2003 to 2007
II	371	4.5	2007 to TBD
III	211	2.5	TBD
IV	515	5.5	TBD
Total	**1,628**	**17.5**	

It was anticipated that the project would be completed relatively quickly, based on the assumption that most or all of the sediment dredged during the 50-ft. Oakland Channel Deepening Project would be placed at MWRP. This did not happen, for two main reasons.

- There was significant agency support for placing material at the HWRP Project.
- Costs to place the material at MWRP were higher than anticipated, and the Port placed additional material at the Middle Harbor Enhancement Area, a restoration site developed for the purpose adjacent to Oakland Harbor.

Table 6-2 provides a breakdown of the actual disposal locations for the 50-ft. Oakland Harbor Deepening Project (USACE 2014).

Table 6-2. Sediment Disposal for the 50-ft. Oakland Harbor Deepening Project: Quantities and Costs

Disposal Site	Volume (MCY)	Unit Price	Cost (Million $)	Comments
MHEA	4.4	$12.38	$54.7	Includes containment structure, grading contracts, & estimated planting, remaining MHEA design and construction costs to complete site use
SF-DODS	1.3	$15.21	$20.2	
MWRP	2.3	$33.05	$77.3	Includes tipping fees
HWRP	3.9	$35.46	$136.9	Does not include HWRP owner construction/demolition/breaching costs. Includes Oakland, Richmond, Redwood City O&M transport and placement. Includes 25 percent of the cost to build site levee and infrastructure cost.
B10/ Landfill	0.3	$64.23	$17.5	Includes hauling and landfill site fees
Total	**12.2**	**$25.09**	**$306.6**	

Note: Construction costs do not include construction supervision and administration, permitting, or design costs unless otherwise noted.

Although the MWRP was successful in attracting some material from the 50-ft. Oakland Harbor Deepening Project, its location in the Suisun Marsh makes it prohibitive for many projects due to long transport distances. MWRP also has a relatively high tipping fee: approximately $28/CY for foundation material and $12/CY for cover material. In combination with the location, disposal at MWRP is often more expensive than at SF-DODs.

The ability to accept both foundation and cover quality material gives it an advantage over other wetland receiver sites that can only accept cover quality material. However, the MWRP requires a ratio of cover quality material for every cubic yard of foundation material delivered, and projects have found this difficult to meet.

In 2012, about 1.1 MCY of dredged material was placed in MWRP: about 66 percent from the Oakland Inner and Outer Harbor Maintenance Dredging and 34 percent from petroleum companies, USCG, and the City of San Francisco Marina, West Basin (DMMO 2013). In 2013, MWRP received about 553,000 CY of dredged material. In both 2012 and 2013, the MWRP received approximately 90% of all dredged material beneficially reused in the Bay Area. Not coincidently, the HWRP stopped accepting material in 2011, allowing the MWRP to capture the market share in years following.

Because of the relatively low quantity of material placed at the site, the project timeline has been extended. In 2010, the Liberty offloader used at the site was leased out to generate revenue and to continue the onsite maintenance and monitoring required to keep the MWRP operational. (SFEI 2010). This highlights the risks to private contractors of constructing and operating a beneficial reuse site for sediment placement, especially when other public beneficial reuse sites are competing for material.

Equipment

The project has deep-water access, which means that a long transfer pipeline to shore is not needed. Instead, the docking area and hydraulic offloading system are close to shore. A pipeline that pumps dredged material slurry to the receiving area. On land, the project includes a holding pond filled by groundwater wells and surface water, and a pipeline to supply slurry water out to the offloader. Sediment placement cells on the site receive slurry, and water control structures direct decant water through the cells and back to the holding pond for recirculation to the offloader. The sediment placement cells containing foundation and cover material are separated.

7. CONCEPTUAL IMPLEMENTATION DESIGN AND COSTS

7.1 Introduction

There are two critical issues that must be resolved in order for dredged material to be placed at the SBSP Restoration Project on a large-scale basis.

First, for all Federal dredging projects – both capital improvement and O&M – a Base Plan is identified, and dredged material may not be placed at a different site if the cost is greater. The Base Plan for both Oakland Inner and Outer Harbor, and Richmond Inner and Outer Harbor, is disposal offshore at SF-DODS. Material that is currently placed at SF-DODS would most readily be moved to the SBSP Restoration Project under one of the following conditions:

- If the costs to place material at the SBSP Restoration Project, including amortized infrastructure costs, are less than the costs to place material at SF-DODS or other available location; *or*
- If SF-DODS is not available to receive some or all of the material for some reason.

The most likely reason for SF-DODS to become unavailable for some or all of the material dredged for navigation channel maintenance or capital construction is the limitation on deep-water material placement in the LTMS. However, to date, voluntary efforts by the USACE and others dredging in San Francisco Bay have reached the intermediate LTMS goals so this does not appear likely in the near term.

Second, even if the unit costs for placement at the SBSP are low, there is a significant up-front cost associated with the construction of an offloader and other placement infrastructure. There are institutional challenges associated with this up-front expenditure:

- The California State Coastal Conservancy (SCC) does not have the funding to establish and operate an offloading facility to transport dredged material to the ponds, nor to prepare the ponds for receiving upland and dredged material.
- USACE O&M procedures do not allow the USACE to provide funding for the offloading facility or for preparation of the ponds.
- USACE procedures for capital improvement projects do allow the USACE to provide this funding, but this is subject to federal cost sharing agreements. Special legislation would be needed to receive assistance with up-front expenditures.

A public-private partnership could potentially bridge the funding gap, allowing a private interest to provide financing for the establishment and operation of the site, with costs covered by user fees.

This section describes a likely implementation scenario for placement of placement of O&M and upland material at the SBSP Restoration Project. A conceptual cost analysis of the scenario is also provided, indicating that the unit costs are comparable the costs for disposal at SF-DODS.

Based on this result, Sections 8 and 9 provide an institutional and environmental strategy for implementing a beneficial reuse program, including a pilot program at Eden Landing.

7.2 Implementation Scenario – Potential Placement Sites

As a concrete implementation scenario, four different placement sites that could accept both dredged and upland material, and a single placement site at Ravenswood that would accept only upland material, are defined. Each placement site includes a group of adjoining ponds (Figure 7-1).

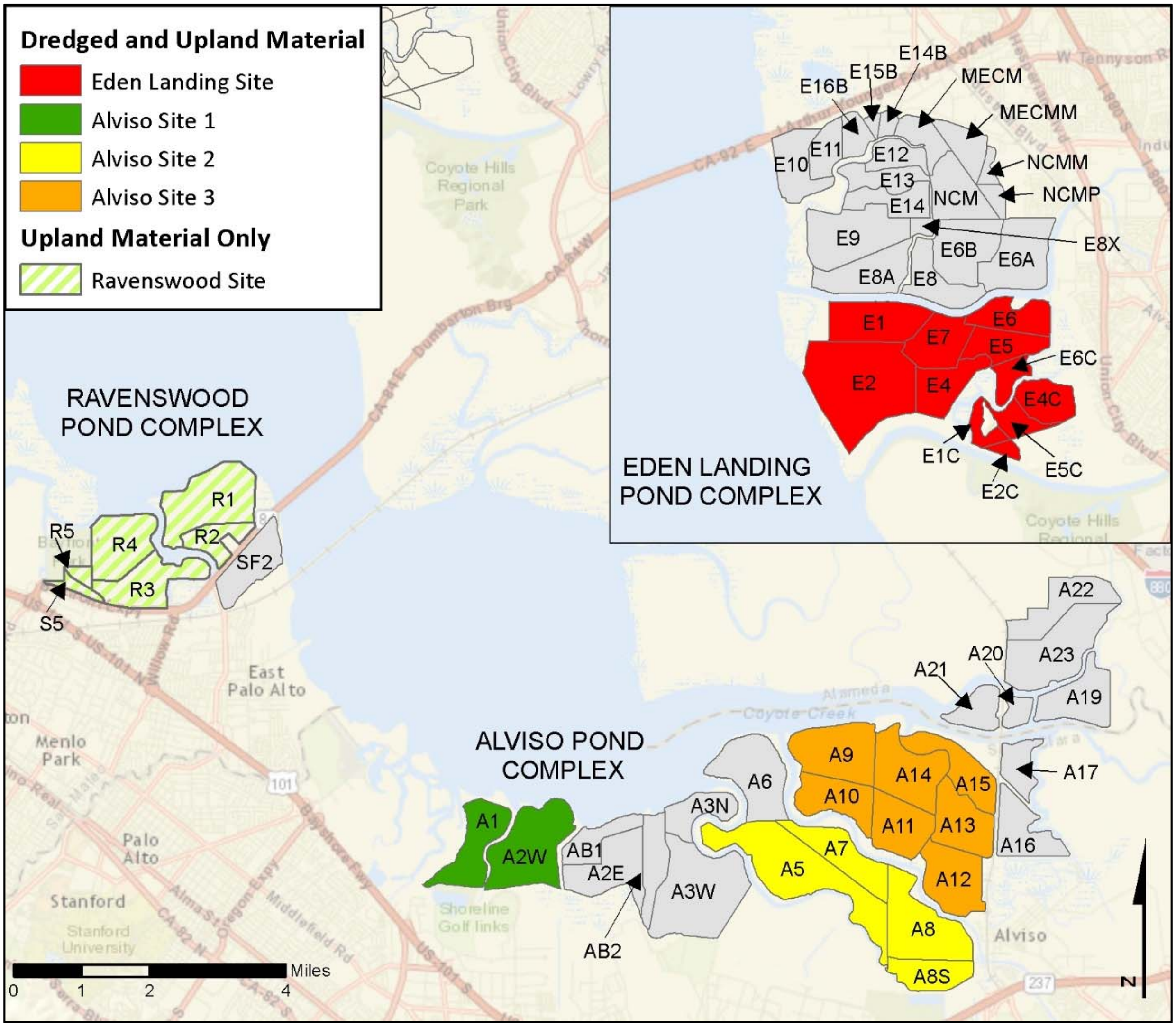

Figure 7-1. Pond Groups Used in Cost Analysis

The Ravenswood Pond Complex is likely to accept only upland material, which is better suited for filling deep drainage ditches than hydraulically placed dredged material (which would also fill in the historic marsh channels).

7.3 Infrastructure for Delivery and Placement of Dredged Material

7.3.1 General

A third party contractor could be awarded a competitive contract to construct the infrastructure needed at each placement site, and to operate the site for a fixed period or until the placement site was filled. Figure 7-2 shows possible layouts for deep water transfer sites and booster pumps at each site.

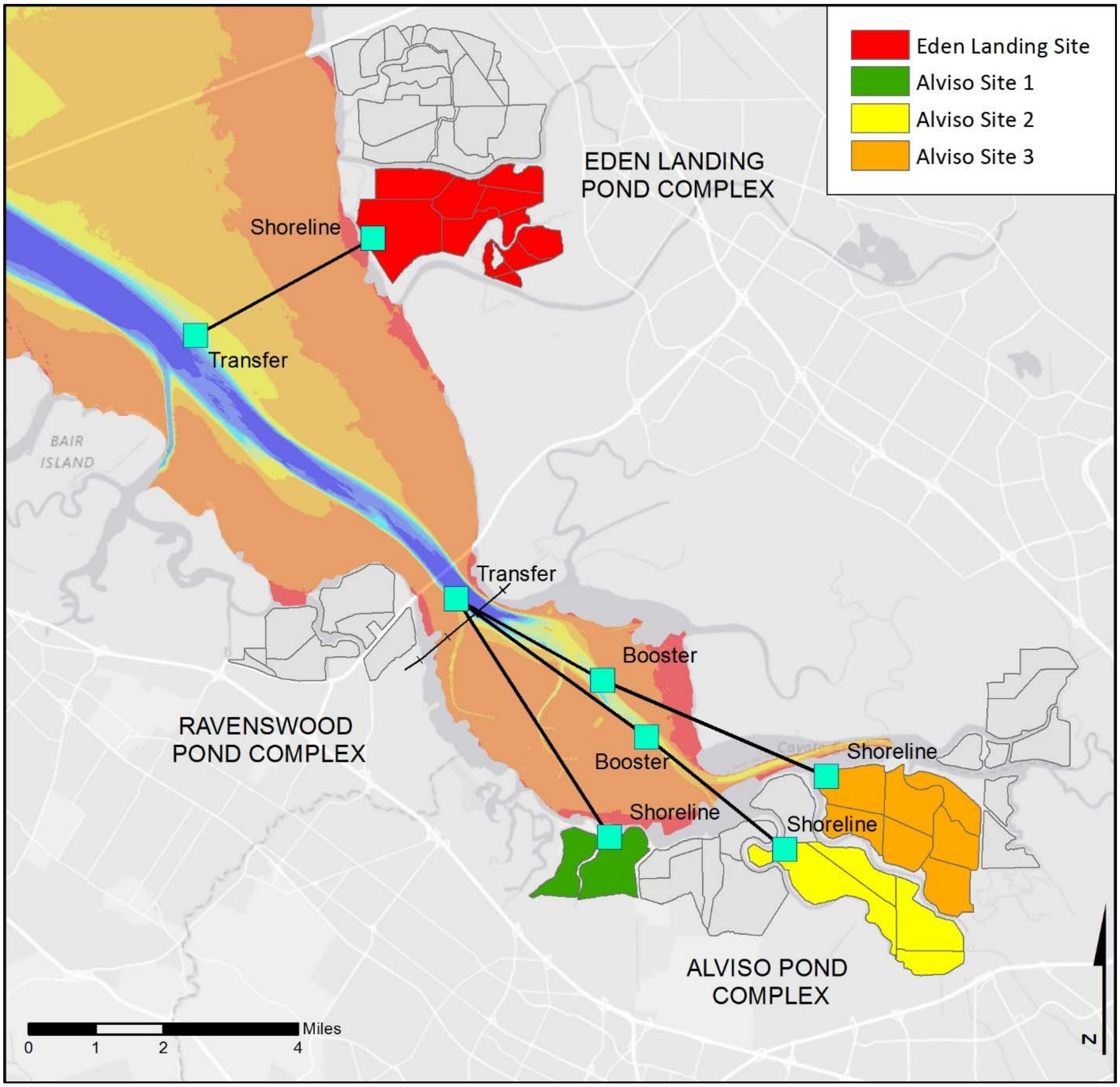

Figure 7-2. Potential Deep Water Transfer Sites and Booster Pumps

The contractor's work would include both the offshore infrastructure at the deep water transfer site, pipelines and booster pumps, and preparation of the placement site to receive dredged material via pipeline.

Capital infrastructure includes mooring dolphins and pipelines (submerged and on land). Once installed, this equipment would remain in place and maintained until the completion of the project. Annual interim mobilizations outside of LTMS work windows would likely occur to safely store portable equipment (a hydraulic offloader, a large diesel generator barge, support barges, and a booster pump).

The offloader would accept material on an ad hoc basis (as material arrives by scow from various dredging projects) 24 hours a day, seven days a week. For the periods when scows are not actively being unloaded, the offloader is on operational standby. Outside of the unloading periods (at least six months of the year when dredging is not anticipated), the Contractor would conduct weekly inspections and maintenance on the installed infrastructure (mooring dolphins, pipelines, safety lights, etc.)

Once the placement sites are filled to the desired capacity, all infrastructure (mooring dolphins, pipeline, etc.) and portable equipment (offloader, barges, etc.) would be demobilized from the site. A separate contract would be released to perform the site restoration work (e.g. earthwork to shape upland transition zones and restoration features).

7.3.2 Eden Landing Pond Complex

The Eden Landing deep-water transfer point shown in Figure 7-2 is approximately 3.8 miles from the closest point of the Eden Landing Placement Site, at Pond E2, which borders the Bay. The distance from this shoreline location and the upland limit of the Eden Landing Placement Site is approximately 3.5 miles. At present, a hydraulic offloader is the most feasible transfer method to deliver material to the ponds, and could accept material from nearly all single-compartment scows and hoppers.

A hopper dredge pump-off system, with a booster pump between the shore and transfer location, is also technically feasible. However, most federal O&M dredging projects in the Bay are currently either dredged mechanically, or dredged by hopper dredges without pump-out capability (see Table 5-1). Under current conditions, this approach would not attract significant quantities of dredged material. If USACE disposal practices were to change such that the SBSP Restoration Project became the most common disposal site, a hopper dredge with a booster pump could become comparative in cost to an offloader and scows.

Eden Landing has a much more reliable deep-water channel than the Alviso Pond Complex: the Federal deep-water channel is maintained down to Redwood City Harbor at a depth of -38 feet. Therefore, the Eden Landing offloader should have adequate water depth to receive any fully loaded scow or hopper dredge.

The upland infrastructure improvements might include the following:

- Initially, the pond levees would be assessed and improved where necessary to retain the dredged material within the ponds. The levees and access roads would be improved where necessary to support heavy equipment, numerous truck trips, and dozers and loaders moving the slurry pipeline throughout the site.
- The placement sites would be prepared to receive dredged material by building containment berms and levees, weirs, and other decant water control structures. The larger ponds would require more containment berms to create long paths and to slow the slurry velocity.
- For the Bay-side ponds E1 and E2, the pipeline from the offshore transfer point would be installed and anchored in-place, surfacing near the outer levee at Pond E2. The discharge pipeline would pass through the outer levee to stabilize it, and would

terminate at a discharge point that would allow dredged material to be pumped into the first containment cell.

- Additional pipeline could be added onto the discharge point to move the discharge along levee north if the dredged material is sandy and mounds quickly.
- For the inland ponds, a booster pump at the shoreline would be needed to move the material to the receiving pond.

Additional booster pumps and a larger shore fleet may be required if significant quantities of sand are included in the dredged material, since the sand settles faster and requires greater pumping velocities and earthmoving equipment compared to finer sediments.

There are a number of ways that the internal containment berms and levees could be constructed:

- Using a crane barge floating in its dredger cut, similar to the method used to build the original salt pond dikes;
- Using low-ground-pressure, long-reach excavator equipment to place the material;
- Using trucks to haul upland or dried dredged material to the site.

A more detailed analysis of construction considerations for the internal berms and levees is given in Appendix B.

7.3.3 Alviso Pond Complex

The Alviso Pond Complex is located in the southern-most part of the Bay, miles beyond the deep-water channel. The pumping distance to the ponds, and the distance of the ponds from the dredging sites, are the largest obstacles to the reuse of dredged material in Alviso: however the capacity of the ponds is substantially more than other complexes. Restoration of ponds within this complex would benefit from a longer-term offloader arrangement to cover the high initial capital costs. A hydraulic offloader and one or two booster pumps would be needed to convey material to the ponds.

The transfer point in Figure 6-2 is located south of Dumbarton Bridge but north of the railroad bridge in the South San Francisco Bay to minimize scow transport delays while navigating in relatively shallow waters near the railroad bridge. The distance from this transfer point to the shoreline of the three Alviso placement sites is between 5 and 7.5 miles. A booster pump would be needed at the shoreline to allow the dredged material to reach all the ponds in the three Alviso placement sites, and a second booster pump between the transfer point and the shoreline is needed for Alviso Sites 2 and 3. The scale of the transfer pipelines for these sites is similar to that for the Hamilton Wetland Restoration Project (Section 6.3).

Based on the permit conditions for the HWRP, it may be necessary for the booster pump to be located in relatively deep water, so that the barge does not bottom out – the layout in Figure 7-2 makes this assumption. However, wave conditions in the South Bay may be too rough for a floating booster pump. An alternative would be to install the pump on a jack-up barge (Figure 7-3), which temporarily supports itself on four legs above the water. At least eight feet of water depth would be required at the booster pump or jack-up barge to do crew changes with a skiff, as the equipment would have to be manned and fueled continuously during use.

Figure 7-3. Jack-Up Barge. Source: IMC Brokers

7.3.4 Electric versus Diesel Offloader

Powering an offloader system and booster stations at any of the three complexes could be significant. Depending on the air emissions permitted for the particular county, a diesel-operated offloader and booster pump may not be permitted. If electric were required, an electrical submarine cable would be run from a power drop off a transmission line onshore. The initial installation cost of the Hamilton Wetland Restoration Project electrical infrastructure to operate the offloader was approximately $15 million. With significant infrastructure costs such as these, alternative approaches should be investigated, such as requiring the contractor to use low emission (Tier III) engines or install selective catalytic reduction systems. The purchase of air quality credits may also be more affordable if the project involves a large quantity of material.

The USACE O&M projects are exempt from air quality requirements. However capital improvement projects such as the Redwood City Deepening would have to comply with the mitigation measures identified in the project's EIR/S. An electric offloader for the Alviso Pond Complex could be cost effective compared to diesel because it has a longer-term schedule and a larger capacity for material compared to the other two complexes.

7.4 Upland Material

This section provides a brief overview of the considerations involved with placement of upland material: the focus of the report is on dredged material placement, which has the potential to provide much greater quantities of sediment. Conceptual costs for placement of dredged material are provided in Section 7.5.

Material is generated in the South Bay by Stanford capital projects, Apple and other campuses, and housing projects. The Alviso Pond Complex is in the best position with the shortest haul routes to receive upland material, followed by Ravenswood. The Ravenswood Pond Complex is within five miles of Inner Bair Island, which has successfully operated as a receiver site for upland material generated by construction projects. One issue for upland material is the strong dependence on economic factors, with major construction projects being delayed or halted during economic downturns.

At each site, a third party contractor could be awarded a competitive contract to construct the infrastructure needed and operate the site for a fixed period of years, or until the placement site was filled. However, generally, the following design and construction steps would occur.

- Existing levees and access roads would be assessed and likely improved to support truck traffic hauling in upland material.
- The first deliveries of upland material could be used to stabilize the levees and create necessary roads for truck and off-road equipment access throughout the complex, including that required for placement of dredged material. Additional uses of upland material are filling the drainage ditches at Ravenswood, and the creation of UTZ and habitat islands at Eden Landing and Alviso.
- The upland material would ideally be delivered to the general area of each placement site where the material is required – such that it does not require rehandling. This would mean the location of the receiving infrastructure would move over time, and haul routes would be revised as needed.
- Alternatively, and more costly, is a re-handling facility where material could be delivered at one central location and moved at a later date to construct the desired features. If material is stockpiled however, maintenance would be required to prevent invasive plant colonization and sediment erosion.

The most obvious environmental impacts of the construction and operation of rehandling facilities for placement of upland materials are associated with the increase in truck traffic. One scenario is that the full 500,000 CY of material required to fill the drainage ditches at the Ravenswood Pond Complex is hauled to the site using haul trucks with a capacity of 10 CY, over three years. The resulting truck traffic requirement would be approximately 70 trucks per day to the rehandling facility.

The potential traffic-related impacts, including accident rates, of this increased traffic would depend on the location of the rehandling facility and existing traffic volume-to-capacity (V/C) ratios. However, based on a 70 truck trips per day, truck accident rates and associated human health and injury risk from the transport of upland material to the sites would be minor and could be reduced through careful site selection and appropriate truck haul-route selections. Air quality impacts would also increase but are expected to be relatively minor.

7.5 Conceptual Cost Analysis for Dredged Material Placement

7.5.1 Overview

Moffatt & Nichol prepared cost estimates for each of the four placement sites receiving dredged material. The cost estimates are attached in Appendix C. The estimates differ according to the material sources and delivery window (schedule), as shown in Table 7-1.

Table 7-1. Cost Scenarios Analyzed

Estimate	Federal O&M Projects	Federal Annual Vol. (MCY)	Non-Federal Annual Vol. (MCY)	Total Annual Vol. (MCY)	Delivery Window
Non-Optimized	Oakland Inner & Outer Harbor Redwood City	0.7 to 1.2	0	0.7 to 1.2	6 months (June to Nov)
Optimized	Oakland Inner & Outer Harbor Redwood City	0.7 to 1.2	0.5 to 1.2	1.3 to 2.2	4 months
Super Optimized	Richmond Inner & Outer Harbor Oakland Inner & Outer Harbor Redwood City	1.2 to 1.6	0.5 to 1.0*	1.7 to 2.6	4 months

* The maximum non-federal volume is lower for the super-optimized schedule because the offloader capacity became the limiting factor

Each estimate (non-optimized, optimized, and super optimized) was prepared for the four placement sites.

The selection of sediment sources was based on the following considerations:

- Projects located in the central and north San Francisco Bay are too far from the South Bay to economically beneficially reuse material at the SBSP Restoration Project. These projects were not included as sediment sources in this analysis.
- The SBSP Restoration Project cannot compete economically with Alcatraz. Projects such as the Port of San Francisco that dispose partially at Alcatraz are uncertain sources for the SBSP Restoration Project. Some such projects were included in the optimized and super optimized estimates; however none were included in the non-optimized estimate.
- The two USACE hopper dredges operated on the West Coast, the Essayons and Yaquina, are not equipped to pump off. Projects performed by these hopper dredges were assumed to dispose of material at open water sites and not at the SBSP Restoration Project in all estimates. These projects also tend to be in the north part of the bay and to contain large sand fractions (least desirable sediment type for raising pond bottom elevations).

- Private dredging projects have considerations other than cost that limit their interest in beneficial reuse sites, such as liability concerns when disposing of material at a mixed-material placement site. Some such projects were included in the optimized and super optimized estimates; however none were included in the non-optimized estimate.

The sediment source analysis assumes that all material delivered to the offloader from the dredging work is found suitable for wetland cover based on the results of each individual project's sediment sampling and analysis program. It is further assumed that all material delivered to the offloader is comprised of primarily mud and silt, as is typical for maintenance dredged material from the selected projects.

7.5.2 Dredged Material Delivery Schedule

A dredged material delivery schedule was generated for each placement site (and each estimate scenario). The durations of the four placement site contracts were determined from the placement capacity, offloading production and the defined annual offloading duration.

The sediment capacity (from the pond volumes in Sections 3.7.4 and 3.7.5) and resulting offloading project durations (not including site preparation time) are listed in Table 7-2. The volume of material delivered to the site is the limiting factor in all project durations, not the offloading production and placement rate.

Table 7-2. Placement Site Volumes and Offloading Durations

Placement Site	Sediment Capacity	Duration, Non-Optimized	Duration, Optimized	Duration, Super Optimized
Eden Landing Site	7.2 MCY	8 yrs.	5 yrs.	4 yrs.
Alviso Site 1	9.2 MCY	10 yrs.	6 yrs.	4 yrs.
Alviso Site 2	17.0 MCY	19 yrs.	11 yrs.	9 yrs.
Alviso Site 3	22.5 MCY	25 yrs.	14 yrs.	11 yrs.

7.5.3 Offloaders

Two offloader locations were defined as shown in Figure 7-2: one for the Eden Landing Complex and one for the three placement sites in the Alviso Complex. Both offloaders are located in the deep water channel (approximately 18 feet deep). No additional dredging was considered. Booster pumps were provided where needed.

The Alviso Offloader location is positioned south of Dumbarton Bridge but north of the railroad bridge in the South San Francisco Bay to minimize scow transport delays while navigating in relatively shallow waters near the railroad bridge.

All equipment was assumed to be powered by a large diesel generator barge to avoid a large up-front capital cost for electrical infrastructure installation. Although electrical infrastructure requires a large up-front capital investment – anticipated to be $9 to $12 million for the SBSP Restoration Project – operational costs of electrical equipment are less than diesel fuel. A diesel offloading system may be more economically attractive for a short project (5 years or less). For the SBSP Restoration Project, some project durations for the Alviso Ponds are long enough that the project could potentially benefit from an electrical power supply. There may be also be CEQA limitations that could restrict diesel operations, based on air quality considerations.

7.5.4 Site Preparation to Receive Dredged Material

The cost to prepare each placement site will vary significantly with the size of the placement site, existing levee conditions, and the amount of existing levees within the placement site (i.e. many smaller ponds versus one large pond). However, site preparation costs are estimated at $2 to $3 per cubic yard for the SBSP Restoration Project based on recent beneficial reuse site construction costs. These costs were based off sites that required full infrastructure (there were no existing levees), so site investigations would reduce the cost if the existing levees are found to be in good condition and capable of containing decant water levels above MHW. The site preparation work does not include construction of flood protection levees or final restoration grading at the site (including building UTZs).

7.5.5 Resulting Costs

The total costs for offloading and managing the site during offloading, including all add-on fees, escalation, and contingency are summarized below in Table 7-3. The site preparation cost to receive dredged material is not included, but is expected to add $2 to $3 per cubic yard upfront. The annual cost breakdowns for each placement site are provided in Moffatt & Nichol 2014. Note that each placement site is considered as an individual project: the offloader is not shared between the Alviso sites.

Table 7-3. Offloading and Site Operations Costs

Placement Site	Total Cost, Non-Optimized	Total Cost, Optimized	Total Cost, Super Optimized
Eden Landing Site	$201.2M	$76.6M	$67.6M
Alviso Site 1	$255.2M	$90.8M	$76.6M
Alviso Site 2	$566.8M	$180.9M	$180.6M
Alviso Site 3	$792.8M	$240.0M	$226.2M

A tipping fee (price per cubic yard) is the cost dredgers would pay to dispose of material at the offloader. The revenue generated from the tipping fee would compensate the contractor’s work to install and operate the offloader and associated equipment (pipeline, barges, etc.), prepare the site to receive dredged material, and manage the site during the offloading operation.

For each estimate in this analysis, an average tipping fee was calculated using the costs summarized in Table 7-3, the cubic yard capacities listed in Table 7-2, estimated site preparation costs, and an acceptable profit margin. The tipping fees are summarized in Table 7-4.

Table 7-4. Tipping Fee at Offloader

Placement Site	Non-Optimized	Optimized	Super Optimized
Eden Landing Site	$30.62/CY	$13.23/CY	$12.32/CY
Alviso Site 1	$32.06/CY	$12.38/CY	$11.22/CY
Alviso Site 2	$34.87/CY	$12.63/CY	$12.52/CY
Alviso Site 3	$37.10/CY	$12.66/CY	$12.14/CY

Disposal costs under the Base Plan for the four largest sediment source projects were compared to beneficial reuse costs at the SBSP Restoration Project. Table 7-5 summarizes the results. The SBSP Restoration Project costs assume material is delivered according to the Optimized scenario for Oakland Inner & Outer Harbor and Redwood City Harbor, and according to the Super-Optimized schedule for Richmond Inner & Outer Harbor. Costs are averaged over the project duration.

Table 7-5. SBSP Restoration Project and Federal Standard Comparison: Optimized Schedule

<table>
<tr><th>Placement Site</th><th>Eden Landing Offloader</th><th>Alviso Offloader</th><th colspan="2">Federal Standard</th></tr>
<tr><td>Oakland Inner & Outer Harbor[1]</td><td>$24.62/CY</td><td>$24.40/CY</td><td colspan="2">$21.00 - 28.00/CY[3] (SF-DODS)</td></tr>
<tr><td>Redwood City Harbor[2]</td><td>$21.54/CY</td><td>$21.32/CY</td><td>$16.50/CY (SF-11)</td><td>$28.00/CY[4] (SF-DODS)</td></tr>
<tr><td>Richmond Inner Harbor</td><td>$24.94/CY</td><td>$25.18/CY</td><td colspan="2">$22.00/CY (SF-DODS)</td></tr>
<tr><td>Richmond Outer Harbor</td><td>$25.07/CY</td><td>$25.27/CY</td><td colspan="2">$22.00/CY (SF-DODS)</td></tr>
</table>

[1] As a reference, Oakland Federal Channel to Montezuma/SF-DODS in 2013 was $30.77/CY for approx. 330,600 CY.
[2] Redwood City Harbor Federal Standard is SF-11.
[3] $28.00 was the unit cost from the 2014 bid.
[4] Unit cost from 2010 Berth dredging with disposal at SF-DODS.

Beneficial reuse sites at Eden Landing and Alviso are cost competitive with disposal at SF-DODS for the most likely USACE O&M projects.

7.6 Discussion

This cost estimate shows that beneficial reuse at the SBSP Restoration Project is generally cost competitive with the Federal Base Cost of USACE's South Bay maintenance dredging projects. The sediment volumes and sources assumed in this cost estimate are realistic, assuming coordination with USACE continues to move forward and an agreement is made in the future.

This cost estimate assumes that the current Bay Area dredging equipment, which has been built for offshore disposal, will remain. If however, the Eden Landing or Alviso Offloader is established and proves competitive, private dredgers will begin to shift their equipment from ocean disposal dump scows to less costly hopper scows more suited for offloading. Compared to dump scows, hopper scows are less costly and more efficient from an offloading standpoint. Given the option, dredgers prefer hopper scows to dump scows because hopper scows have minimal moving parts, requiring less maintenance and less time lost to mechanical failures.

If the dredgers change their equipment to fit a new beneficial reuse practice in the Bay Area, as they did when SF-DODS first became the primary disposal location, the costs to beneficially reuse material should decrease and prove to be very competitive.

Looking forward, if the SBSP Restoration Project were to install electrical infrastructure for an offloader at Alviso, the Bay Area dredging community would acknowledge the significant financial investment and undoubtedly include the beneficial reuse site in their future plans.

8. IMPLEMENTATION STRATEGY

8.1 General Approach

A public-private partnership is recommended, similar to that implemented at Inner Bair Island.

The SCC would publish a RFP to manage a group of ponds as a disposal site for a fixed period. The entity managing the ponds – assumed here to be a private contractor – would be responsible for up-front and operational costs associated with the sediment placement.

The third party contractor would be allowed to charge a tipping fee to those placing material. Absolute transparency would be required in developing the tipping fee that is charged to the USACE. However, the contractor would be allowed to set a tipping fee for other users of the site, including non-federal dredging projects and upland sources of material.

8.2 Roles and Responsibilities

Beneficial reuse in the SBSP Restoration Project will depend on the cooperation of numerous parties. The following is a list of potential roles and responsibilities of the SCC, regulatory agencies, dredgers, and the third party contractor.

California State Coastal Conservancy (SCC)

As the project owner and overall program manager, the SCC has multiple responsibilities.

- Encourage participation and support from the regulatory agencies, particularly the LTMS Agencies and DMMO.
- Coordinate MOUs with the USACE.
- Develop and release the RFP, select the contractor, and negotiate contract terms. The contract terms could include the tipping fees paid by the USACE and potentially others.
- Monitor contractor operations and activities on site to confirm that regulatory and permitting requirements are being adhered to. Coordinate with agencies responsible for monitoring.
- Prepare CEQA documentation.
- Perform final restoration grading at the sites.
- The CSCC could actively manage the placement sites and be responsible for construction management oversight throughout the offloading and decanting operations. The placement site design and final restoration grading would be the responsibility of CSCC.

LTMS Agencies and DMMO

Without agency encouragement to beneficially reuse material in the SBSP placement sites, there will be pressure for dredgers to continue to dispose of material at SF-DODS, due to lower uncertainty and suitability of current equipment. In this case, the economies of scale would be reduced and the SBSP placement sites would be less cost competitive with SF-DODS.

The SCC should urge the agencies to provide incentives to send material to the SBSP Restoration Project. For example, additional material could be disposed of at inexpensive in-bay disposal sites such as SF-11 in return for a certain quantity disposed of at SBSP.

USACE and Other Dredgers

The USACE is by far the largest potential supplier of sediment to the SBSP Restoration Project. Its participation is critical to providing planning stability to the third-party contractor.

The SCC should develop a Memorandum of Understanding (MOU) between the USACE and the SCC that would commit the USACE to placing a given quantity of material under appropriate circumstances. Depending on the terms of the MOU, the USACE may also have the ability to approve tipping fees charged to it by the contractor.

Other smaller Ports and private dredgers could also join the MOU, or at a minimum benefit from one between USACE and SCC.

All dredgers would be responsible for testing their material as required by the DMMO and for obtaining permits to place the material at the SBSP placement sites.

Third Party Contractor

The third party contractor would have the general responsibility for financing, providing infrastructure to, and operating the placement site as a landfill, within the constraints of regulatory and permitting requirements and the agreement with the SCC. Specific roles and responsibilities are likely to include the following.

- Providing financing for the offloader facility and on-site improvements, and for operation of the site.
- Designing, obtaining permits for, and constructing the offloader facility and on-site improvements, within the parameters of the RFP. Preparing supplemental CEQA documentation if needed.
- Setting the tipping fees, within the parameters of the RFP, which would include the MOU between the SCC and the USACE.
- Monitoring water quality and sediment quality at the site.
- Demobilizing equipment and returning the site to the SCC at the end of the agreed term.
- Providing financial information to the SCC as required.

8.3 Regulatory

8.3.1 Past and Ongoing Regulatory Activities

8.3.1.1 SBSP Restoration Project

Since 2002, significant environmental and regulatory work has been performed in support of the SBSP Restoration Project. EIR/EIS documents prepared for the phased project, with specific documents covering the ISP, Phase I, and Phase II are listed in Section 3.1 (Table 3-1). Table 8-1 lists key regulatory documents that have been approved for Phase I of the SBSP Restoration Project.

The following permits and approvals were obtained for ISP and Phase I actions:

- Waste Discharge Requirements
- CWA Section 401 Water Quality Certification,
- San Francisco Bay Conservation and Development Commission (BCDC) Permit;
- BCDC Coastal Zone Management Program Consistency Determination (Phase I actions).

Table 8-1. Key Regulatory Document for SBSP Restoration, Phase I

Document	Date	Summary
National Marine Fisheries Service (NMFS) BO	January 2009	The NMFS BO satisfied ESA Section 7 consultation for listed species under the jurisdiction of NMFS. The BO covered Phase I actions as well as operations and maintenance activities for a 10-year period. Subsequent project-level actions (Phase II and beyond) and operations and maintenance will require additional consultation with NMFS.
NMFS Essential Fish Habitat (EFH) Consultation	January 2009	This document completed consultation requirements pursuant to the Magnuson-Stevens Fishery Conservation and Management Act. The EFH consultation covered Phase I actions as well as operations and maintenance activities for a 10-year period. Subsequent project-level actions (Phase II and beyond) and operations and maintenance will require additional consultation with NMFS.
Clean Water Act (CWA) Section 404 Permit	January 2009	The U.S. Army Corps of Engineers issued a Section 404 permit for Phase I actions as well as operations and maintenance activities for a 10-year period.
National Historic Preservation Act (NHPA) Consultation	June 2012	The USFWS and California State Historic Preservation Office (SHPO) signed a Memorandum of Agreement that established a set of stipulations and a treatment plan that would allow the USFWS to carry out the project while satisfying the requirements of Sections 106 and 110(b) of the NHPA. In consultation with the SHPO, the USFWS developed a historic properties treatment plan that will be implemented prior to and during the project.

8.3.1.2 Maintenance Dredging

The USACE and RWQCB are currently preparing an Environmental Assessment (EA)/EIR for the maintenance dredging of the federal navigation channels in San Francisco Bay for 2015 through 2024. The EA/EIR will address the impacts of the transport and placement of dredged materials at permitted placement sites. The EA/EIR will disclose that the USACE may use additional placement sites that have been identified as reasonably foreseeable future placement site options, but that the use of these sites by the USACE would be conditioned upon the completion of supplemental review under NEPA and/or CEQA, and acquisition of required permits from resource and regulatory agencies.

At the completion of the NEPA/CEQA process, it is anticipated that the RWQCB will issue a multi-year Water Quality Certification (pursuant to Section 401 of the CWA) and Waste Discharge Requirements (pursuant to the Porter-Cologne Water Quality Control Act) for continued maintenance dredging of San Francisco Bay federal channels and associated dredged materials placement. It is also anticipated that BCDC will issue a multi-year consistency determination pursuant to the federal consistency provisions of the Coastal Zone Management Act for dredging and placement activities in San Francisco Bay.

8.3.2 Other Beneficial Reuse Site Environmental Documents

Environmental documents completed for other beneficial reuse sites in San Francisco Bay were reviewed to determine how other projects addressed NEPA/CEQA review for use of dredged material in restoration efforts, including necessary transport and infrastructure.

Hamilton Wetlands Restoration Project (HWRP)

The Final EIR/EIS for the HWRP was completed in 1998, and included a program-level analysis of wetland restoration at Bel Marin Keys Unit V (BMKV), which at the time was a proposed expansion of HWRP. Following the acquisition of the BMKV property by the SCC, a Supplemental EIR/EIS addressing project-level impacts of wetland restoration at the BMKV property was completed in 2003. Both the HWRP Final EIR/EIS and BMKV Supplemental EIR/EIS analyzed the impacts associated with placing dredged materials, and the impacts associated with site improvements and infrastructure needed to receive and place dredged materials (Jones and Stokes, 2003).

In 2008, a Draft Supplemental EIS/EIR evaluating alternative approaches to deliver dredged material to HWRP was completed for a proposed aquatic transfer facility (ATF) to be used in transferring dredged materials to the HWRP site (ICF Jones and Stokes, 2008). Subsequent to the publication of the Draft Supplemental EIS/EIR, the proposed ATF project was put on hold due to environmental concerns and budgetary constraints.

Sonoma Baylands Demonstration Project

The Sonoma Baylands project restored tidal salt marsh habitat on a 348-acre diked hayfield on the northern shoreline of San Pablo Bay. Although the Sonoma Baylands project was associated with the Oakland Harbor deepening project, the USACE completed a separate EA for the Sonoma Baylands Demonstration Project in 1994. It is noteworthy that the operations and maintenance budget for the Sonoma Baylands Wetlands Demonstration Project is included in the operations and maintenance budget for Oakland Harbor (USACE, 2013c).

Cullinan Ranch

The Final EIS/EIR for the proposed restoration of land formerly known as Cullinan Ranch, located in the San Pablo Bay National Wildlife Refuge, was completed in 2009. The project description in the EIS/EIR acknowledged that if additional clean material became available, from offsite upland or dredging locations, it could be used to create islands, fill in ditches and toe drains, or raise the general elevation in Cullinan Ranch. Specifically, the document stated that implementation of the preferred restoration alternative would require importing approximately 150,000 cubic yards of offsite fill materials to complete levee reinforcement work. The EIS/EIR identified the number of truck trips that would be required to import offsite fill, the construction route that trucks would use, and that these trips and unloading the material would be a source of emissions (Ducks Unlimited, 2008).

In 2013, the California State Lands Commission completed and certified an EIR Addendum and the USFWS issued a Statement of Environmental Action for the construction and operation of an offloading facility and associated pipeline (BCDC, 2013).

Bair Island

The Final EIS/EIR for the proposed restoration of Bair Island, in Don Edwards San Francisco Bay National Wildlife Refuge, to tidal salt marsh was completed in 2006. The EIS/EIR analyzed two alternatives that would use dredge material to raise the marsh plain elevation and levee expansion. Hydraulically dredged material would be hydraulically pumped to the site through a transfer pipeline. The EIS/EIR analyzed the impacts of installing the transfer pipeline and placing dredged material. Impacts associated with offsite transport of fill material to Inner Bair Island are not included in the EIS/EIR. The EIS/EIR stated that the transport of fill material may require additional environmental review that would be addressed by the project(s) providing fill material to Inner Bair Island (USFWS and CDFG, 2006).

Montezuma Wetlands Restoration Project

The Montezuma Wetlands Restoration Project (MWRP) is a privately owned and operated site that began accepting dredged material in July 2003. The site has all required permits and can accept both cover and foundation material (as described in the RWQCB's Draft Beneficial Reuse Guidelines). The site has deep-water access, as well as a docking area and off-loading equipment. The originally proposed MWRP included use of an offloader; therefore, the impacts of the offloader, associated infrastructure, and dredged material placement were analyzed in a NEPA/CEQA document.

8.3.3 Summary of Environmental Document Review Findings

Based on review of the documents for other beneficial reuse sites, there is no uniform precedent for addressing the components of dredged material reuse at restoration sites. Most commonly, the NEPA/CEQA documents for beneficial reuse sites analyzed the impacts of placing dredged materials at the sites, and impacts associated with site improvements and infrastructure needed to receive and place dredged materials. In some cases, supplemental environmental review documentation was completed to address proposed changes in infrastructure from the original projects (e.g., BMKV and Cullinan Ranch).

The documents differed with respect to whether the analysis of transport of dredged materials to the beneficial reuse site was included, or deferred to supplemental analysis by others.

8.3.4 Agency Coordination

On February 20, 2014, opportunities and constraints associated with the placement of dredged material at SBSPRP were presented to the LTMS Program Managers. Strategies for facilitating the use of dredged material at SBSP Restoration Project were discussed, as well as options for completing the necessary environmental review and permitting. The presentation included the following:

- With additional evidence of sediment accretion over the past few years, the project focus with respect to dredged material placement has shifted from needing dredged material, to having the capacity to accept dredged material.
- There are some deeply subsided ponds that may not accumulate enough sediment over the 50-year project timeline, or early enough as necessitated by the restoration phasing, to meet restoration objectives; in these cases, the application of dredged material would be particularly helpful. Dredged material would also be useful to accelerate the covering and containment of a mercury hot spot at Ponds A5, A7, A8, and A8 South.
- The placement of dredged material in other areas of the project would help restoration and flood protection objectives be realized sooner, and would reduce concern associated with uncertainty that accretion can keep up with sea level rise.
- The greatest challenge to accept dredged material at the SBSP Restoration Project is cost related (offloading infrastructure and site preparation), as well as institutional standards, such as USACE's federal standard that dictates the USACE's disposal for O&M dredging.

Because of the uncertainty with incorporating imported dredged material into SBSP Restoration Project, environmental documents for restoration activities have not addressed potential impacts from the transfer and placement of offsite dredged material at SBSP Restoration Project. The EIS/EIR currently being prepared for the first part of Phase II is assuming sediment will come from upland sources and accretion; however, the document will disclose that dredged material could be placed at the restoration sites, subject to subsequent environmental review, should a mechanism to receive dredge material become available. The LTMS Program Managers agreed this was an adequate approach for the first part of Phase II because it is unlikely that dredged materials would be used. The LTMS Program Managers recommended that a separate environmental review process be completed for infrastructure and site improvements needed to receive dredged materials at SBSP Restoration Project.

8.3.5 Environmental Review Strategy

As demonstrated above, USACE maintenance dredging projects and potential future deepening projects are the largest foreseeable sources of dredged material in San Francisco Bay. In the absence of special legislation, it is unlikely that USACE funding could be used to construct site improvements and infrastructure that would be needed to place dredged materials at SBSPRP. Funding for site improvements and infrastructure could be obtained from other private or public entities or through grants.

To facilitate the use of potential funding opportunities from various parties and opportunities to receive dredged material, it is recommended that a separate NEPA/CEQA and permitting process be completed for the infrastructure (e.g., an offloader, transfer pipelines, etc.) needed to receive dredged materials, and the placement of imported dredged materials in the SBSPRP. The NEPA/ CEQA document could be a Supplemental EIS/EIR to the programmatic document completed in 2007. The analysis in the programmatic EIS/EIR addressed impacts due to the reuse of material dredged from the restoration complex for site improvements, but did not evaluate effects associated with the reuse of materials dredged offsite. Therefore, the Supplemental EIS/EIR should disclose impacts associated with the placement of dredged material to the extent possible based on anticipated locations of dredged material reuse in SBSPRP, as well as site improvements (e.g., berms, levee improvements) that would be needed to accommodate dredged material.

Because restoration needs may evolve over time, additional site-specific analysis for site improvements could be included in the individual environmental documents for subsequent phases of SBSPRP as needed. Transport, rehandling, and placement of upland source materials could be addressed in the Supplemental EIS/EIR along with dredged materials reuse, or included in the individual environmental documents for subsequent phases, depending on the anticipated extent of reuse of upland fill materials.

One challenge that could arise during the environmental review for an offloader, or similar infrastructure to accommodate dredged materials reuse at SBSPRP, is whether the impacts of the necessary infrastructure outweigh the benefits of achieving restoration goals faster if most of restoration objectives could be achieved by accretion. Because of the uncertainty that accretion can keep up with sea level rise, it could likely be demonstrated that the benefits of accelerated restoration and flood protection, along with the beneficial reuse of dredged material (as opposed to in-Bay or ocean disposal), would outweigh impacts associated with infrastructure and site improvements, assuming the program is designed and implemented to minimize adverse environmental impacts.

8.3.6 Permits and Regulatory Approvals Required

Depending on the type of material used (upland or dredged) and the selected transport and placement methods, the following permits and regulatory approvals will likely be required:

- CWA Section 404 Permit from USACE;
- ESA Section 7 consultation with NMFS and USFWS regarding “take” of federally listed threatened or endangered species;
- Magnuson-Stevens Fishery Conservation and Management Act EFH consultation with NMFS;
- Incidental Take Permit from CDFW;
- Water Quality Certification from the RWQCB pursuant to CWA Section 401;
- Waste Discharge Requirements from the RWQCB to receive dredged material;
- National Pollutant Discharge Elimination System permit for general construction activity from the RWQCB;

- BCDC permit and determination of conformity with the California Coastal Act, the McAteer-Petris Act, Coastal Zone Management Act of 1972, and the San Francisco Bay Plan;
- California State Lands Commission authorization for leases within its jurisdiction;
- Operational permits from the Bay Area Air Quality Management District;
- Permits from cities with jurisdiction over the project; and
- Easements or encroachment permits.

In January 2013, the State Water Resources Control Board released the Preliminary Draft Wetland Area Protection and Dredged or Fill Permitting Policy, which includes a wetland definition, a wetland delineation method, and procedures for review and approval of dredge and fill discharges into the waters of the state. This policy contains permit application requirements for ecological restoration projects. A final policy is scheduled to be adopted by the end of 2014.

8.4 Material Quality

The SBSP Restoration Project will be required to obtain waste discharge requirements (WDRs) from the SFBRWQCB to become a certified restoration site permitted to receive material. The WDRs will dictate the material screening procedures and acceptance criteria of any material placed at the ponds. Each potential source material site will conduct laboratory tests in compliance with the WDRs to characterize their material. The DMMO will then review the data and determine if the material is acceptable for placement at the SBSP Restoration Project, or another placement site. The DMMO will likely grant exceptions on acceptance criteria if the SBSP Restoration Project can demonstrate that the material is unlikely to adversely impact beneficial uses.

The WDRs for the Montezuma Wetlands Restoration Project (SFBRWQCB 2012) and the Bair Island Restoration Project (SFBRWQCB 2008) were very similar. Based on these requirements, the following are likely WDRs for the South Bay Salt Ponds Restoration Project.

Decant water discharges into the receiving waters (South San Francisco Bay) are not to cause the following:

- Floating, suspended, or deposited macroscopic particulate matter or foam at any place more than 100 feet from the point of discharge, which persists for longer than 24 hours;
- Bottom deposits or aquatic growths that cause nuisance or adversely affect beneficial uses;
- The temperature of any cold or warm freshwater habitat to be increased by more than five degrees Fahrenheit above natural receiving water temperature;
- Visible, floating, suspended, or deposited oil or other products of petroleum origin;
- Toxic or other deleterious substances to be present in concentrations or quantities, which will cause deleterious effects on wildlife, waterfowl, or other aquatic biota, or which render any of these unfit for human consumption.

Decant water discharges are not to cause the following exceedences in surface water (within one foot of the surface):

- Dissolved Oxygen: 5.0 mg/L, minimum;
- Dissolved Sulfide: 0.1 mg/L, maximum
- pH: Variation from normal ambient pH by more than 0.5 pH units
- Un-ionized Ammonia: 0.025 mg/L as N, annual median; and 0.16 mg/L as N, maximum
- Waters shall not contain bio-stimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses
- Salinity: Outflow from the site will not increase salinity in the receiving waters by more than an average of 5 ppt over natural conditions during any tidal cycle.
- Turbidity of the waters of the State, at any place more than 100 feet from the Project boundary or point of discharge, not to increase by more than the following for more than 24 hours, to the extent practical (for < 50 NTU 5 NTU maximum, for ≥ 50 NTU 10 percent of background, maximum).

Acceptance criteria for dredged material to be placed in the SBSP Restoration Project are likely to be similar to those in Table 8-2. In most cases, the criteria for foundation material are similar to the ERMs in Table 5-2, while the criteria for cover material are based on San Francisco Bay ambient values.

Table 8-2. Montezuma Wetland Restoration Project Dredged Material Acceptance Criteria

Constituent	Cover	Foundation
Metals(mg/kg)		
Arsenic	15.3	70
Cadmium	0.33	9.6
Chromium	112	370
Copper	68.1	270
Lead	43.2	218
Mercury	0.43	1.3 [2]
Nickel	112	200 [2]
Selenium	0.64	1.4 [2]
Silver	0.58	3.7
Zinc	158	410
Organochlorine Pesticides & PCBs (µg/kg)		
Chlordanes, sum	2.3	4.8
Dieldrin	0.72	4.3
DDTs, sum	7.0	100 [2]
Total PCBs (sum of RMP 40 congeners)	22.7	180
Total PAHs (sum of RMP 25 compounds)	3,390	44,792

[1] Surface and Foundation criteria taken from Regional Water Board, Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines, Draft Staff Report, May 2000, except where otherwise noted.

[2] Foundation criteria for mercury, nickel, selenium, and DDT taken from 2000 Order, based on Regional Water Board Sediment Screening Criteria and Testing Requirements for Wetland Creation and Upland Beneficial Reuse, Interim Final, December 1992.

9. EDEN LANDING PILOT PROJECT

9.1 Introduction: Role of Capital Improvement Projects

Capital improvement projects have a critical role in kick starting beneficial reuse. In three of the four successful case studies described in Section 6, the infrastructure to transport and place dredged material at the site could be constructed only because of the 42-ft. and 50-ft. Oakland Harbor Deepening Projects. Bair Island was extremely unusual in that its distance to the Redwood City Harbor is short enough (less than one mile) that it was cost-effective to construct the infrastructure specifically to bring O&M material to the site.

Once the infrastructure is in place, it becomes cost-effective to continue its use for O&M material.

9.2 Upcoming Capital Improvement Projects

At present, the only upcoming federal capital improvement navigation project close to the SBSP is the Redwood City Harbor Deepening (Section 4.3.2). This will generate approximately 1-3 MCY of material – much less than was generated by the Oakland Harbor Deepening Projects. Because of the relatively small quantity of dredged material, it cannot be guaranteed that the costs of the infrastructure to deliver and place the material at the SBSP Restoration Site will be covered by the unit cost savings associated with placing the material at SBSP rather than at SF-DODS.

However, the Eden Landing Land Mass (Section 3.6) being planned by ACFCD will require significant quantities of sediment to construct – estimated at 600,000 CY based on the conceptual cross sections provided in URS 2012a.

The combination of these two capital improvement projects may be sufficient to implement a beneficial reuse program that would continue after the projects are complete, and could supply significant quantities of material to the Eden Landing Pond Complex.

9.3 Proposed Project – Physical Project Elements

Figure 9-1 shows the different features of the proposed pilot project. The deep water transfer location for Eden Landing is extremely convenient for Redwood City Harbor, making it very cost effective for the Redwood City Harbor Deepening Project to use this site for material placement.

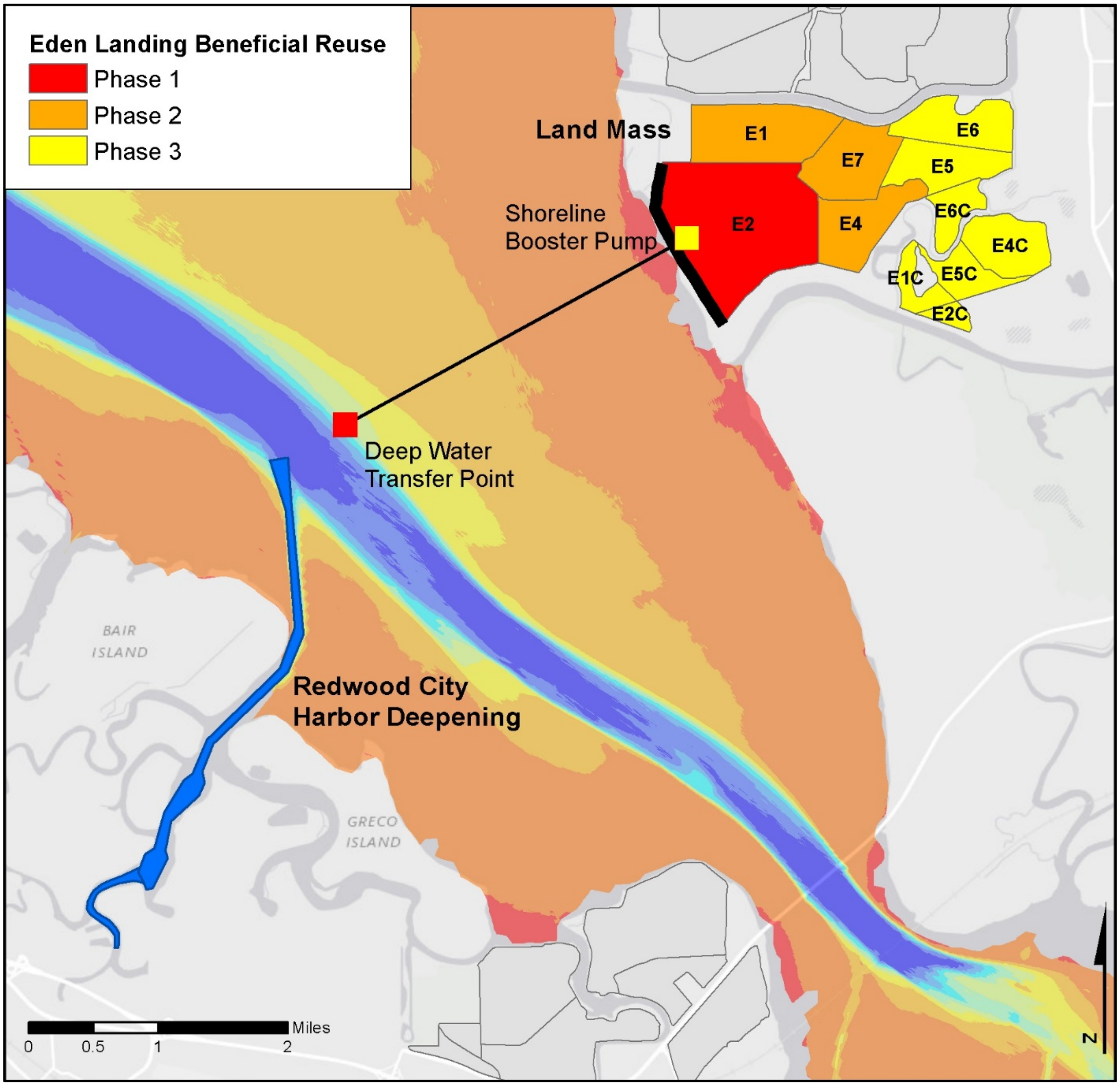

Figure 9-1. Eden Landing Beneficial Reuse Project Elements

The phases of the beneficial reuse project would be as follows.

- Land Mass Phase: Material dredged from the Redwood City Harbor Deepening Project would be transported by scow to the Eden Landing Deep Water Transfer Site. It would be offloaded, pumped to shore via pipeline and used to construct the Eden Landing Land Mass.
- Eden Landing Phase 1: Material dredged from the Redwood City Harbor Deepening Project would continue to be transported by scow to the Eden Landing Deep Water Transfer Site and be pumped to shore via pipeline. It would be used to increase the bottom elevation of Pond E2. Decant water would flow from Pond E2 through Ponds E1, E4, and E7, allowing solids to settle out of the water column.

- Eden Landing Phase 2: Once the Redwood City Harbor Deepening Project is complete, the transfer infrastructure would remain in place but O&M material from the Redwood City Harbor and other federal and non-federal projects would be used to complete the restoration of Pond E2 and increase the bottom elevations of Ponds E1, E4, and E7. The pipe discharge location would be moved as material is spread, working from the waterside ponds (E1, E2) inland to allow for the longest settling time prior to reaching the Bay.
- Eden Landing Phase 3: A booster pump would be constructed at the shoreline to allow more distant ponds to receive material.

Table 9-1 provides the material quantities for each phase.

Table 9-1. Phased Eden Landing Project

Phase	Material Source	Placement Site	Quantity (MCY)
Land Mass Phase	Redwood City Harbor Deepening	Land Mass	0.6
Eden Landing Phase 1	Redwood City Harbor Deepening	Pond E1	1.4
	Federal and Non-Federal O&M	Pond E1	1.0
Eden Landing Phase 2	Federal and Non-Federal O&M	Pond E2	1.0
Eden Landing Phase 3	Federal and Non-Federal O&M	Other Ponds	3.8

9.4 Institutional Partners

The institutional partners for this project would be as follows:

- *U.S. Army Corps of Engineers (USACE)*, as project owner for the Redwood City Harbor Deepening and (later) for much of the O&M material used for both the Land Mass and the SBSP Restoration Project.
- *Port of Redwood City,* as the local sponsor for the Redwood City Harbor Deepening Project.
- *California Department of Fish and Wildlife (CDFW)*, as the land owner of the Eden Landing Pond Complex.
- *Alameda County Flood Control District (ACFCD)*, as local sponsor for the Eden Landing Land Mass.
- *California State Coastal Conservancy (SCC)*, as project owner for the Eden Landing Pond Complex.
- *LTMS Agencies and DMMO*, potentially providing incentives to the USACE to send material to the Land Mass and Eden Landing.

- *Grant-Making Agencies*, potentially providing funds in case the cost-effectiveness of the proposed project falls short of being sufficient for the project to be used as the Base Plan by the USACE.

The objective would be to develop MOUs between the different institutional partners (USACE, Port of Redwood City as local sponsor, ACFCD, SCC, CDFW, and the LTMS Agencies) that would establish a cooperative framework for executing the Pilot Project. These MOUs would be needed to provide certainty to a third-party contractor (or other entity) to make the up-front investment required for the construction of the placement infrastructure.

9.5 Schedule

The following is a potential schedule of the Eden Landing Pilot Project:

- SBSP Eden Landing Phase II EIR/S completed in 2016 (includes offloader and placement at the Land Mass and ponds for the deepening material and future O&M material) [must be complete before construction can begin at Eden Landing].
- Redwood City Deepening Project EIR/S completed in 2016 (includes the dredging and transport to Eden Landing; excludes the offloader and placement). Chief of Engineer's Report, Preconstruction Engineering and Design (PED) phase and U.S. Congressional construction authorization completed 2018 or 2019.
- Redwood City Deepening Project Construction of the offloader and Land Mass site preparation at Eden Landing during 2019 or 2020.
- Redwood City Deepening project completed in 2020 or 2021 (approximately 1-year).
- Once the SBSP Eden Landing Phase II EIR/S is completed in 2016, the SCC must begin coordinating a MOU with USACE and mid-sized private dredgers to ensure a consistent O&M sediment supply for Eden Landing. This is a key component to developing and awarding an RFP to a third-party contractor to continue operation of the offloader and placement of material at Eden Landing.
- Continuation of operating Eden Landing as a beneficial reuse site beginning 2020 or 2021, before the offloader or pipeline is removed from the Deepening Project.

10. SUMMARY AND RECOMMENTATIONS

- Other than Redwood City Deepening, it is unlikely that there will be any more capital improvement projects to jump start the upfront infrastructure investment of the SPSP Restoration Project.
- In order for the SBSP Restoration Project to be cost competitive with the Federal Standard for maintenance dredging projects in the San Francisco Bay Area, a long term commitment (in the form of a MOU) must be made that material will be beneficially used, rather than disposed of offshore.
- Dredge contractors will begin to change their operations to fit a new beneficial reuse practice only if they see that a long term commitment is being made.
- The USACE must also consider changing their contracting strategy to fit with beneficial reuse in the San Francisco Bay Area since the USACE dredge Essayons cannot pump off. Current projects performed by the Essayons may need to be performed with private contractor dredges capable of beneficial reuse.
- Any MOU between SCC, USACE, DMMO and others should include the non-federal dredge project participants and dredging contractors. As Federal budgets continue to shrink, buy-in from non-Federal dredging sources and dredging contractors will be critical to the success of the project.
- Other upland placement sites (Montezuma, BMKV, and Cullinan) must also be included in the overall beneficial reuse plan so all projects can be a success and not be viewed as competitors for the dredge material.
- SCC would benefit from taking an active role in Redwood City Deepening project to lobby for the material to be used for the Eden Landing Land Mass. Additional pilot projects for other SBSP locations could utilize mid-size private dredging projects, such as the Port of Oakland, Port of Richmond, and Port of San Francisco berth dredging material.
- SCC would benefit from an Upland Material Placement Strategy to use upland material most efficiently in preparation of dredged material placement. The Placement Strategy would inventory the current material amounts being used under the levee O&M permits, and then develop a placement plan keeping the larger project in mind.

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APPENDIX A

Draft Concept Plan, Investigation of Wetting and Drying of Dredge Material at Wetland Restoration Sites. Kinnetic Laboratories, Inc. for Moffatt & Nichol. June 2013.

Draft Concept Plan
Investigation of Wetting and Drying of Dredge Material at Wetland Restoration Sites

Kinnetic Laboratories, Inc.
Moffatt & Nichol

June, 2013

1.0 THE PROBLEM

Plans for the restoration of the South Bay Salt Ponds include beneficial reuse of dredged sediments to raise and contour the salt ponds to form new working wetlands. The subsided elevations of these ponds must be raised to construct successful working wetlands as well as to plan for future sea level rise.

- Concerns exist related to wetting and drying of dredged material with respect to potential leaching of metals from the dredged materials due to oxidation and acidification processes.
- Requirements for retention of water over stored dredged material until reused in the wetland construction can be set by the permitting agencies. Since the dredging project schedules and the reuse schedules do not match in time, the necessity of storing and handling these materials in the wet can cause a significant impediment to dredged material reuse.

The purpose of this present study is to investigate chemical processes related to the storage of dredge materials prior to the actual construction phase of the new wetland.

2.0 CONCERNS

Specific concerns may be summarized as follows:

- Regulatory agencies have concerns and questions about potentially increased leaching of metals from dredge sediments upon drying and oxidation, and on the future use of these materials for wetland restoration. San Francisco Bay dredged sediments are often fine-grained materials with low organic content (<1%), are anoxic when dredged, and can become increasingly acidic upon oxidation.
- These sediments often become hard and develop deep cracks upon drying due to the high clay content thus increasing exposure to rain erosion and leaching.
- In particular, when reused for higher elevation margins or high marsh fill, these sediments may stress vegetation if metal leaching due to fresh rainwater is excessive. However, of less concern is the reuse of these sediments in the low intertidal areas, where highly buffered marine waters neutralize sediments quickly.

Basis of concerns are summarized below. Recent literature with respect to metal releases by oxidation of anoxic sediments is briefly reviewed in Appendix A attached: Some key points are bulleted below and are discussed in more detail in Appendix A along with references cited.

- Surficial sediments to be dredged that are in contact with aerobic overlying water show that oxygen penetrates from a few millimeters to centimeters by local sediment re-suspension and/or by enhanced oxygen diffusion from bioturbation. Thus except for the thin upper layers, sediments to be dredged are anoxic.
- Metals are often contained in anoxic sediments as metal sulfides that are relatively insoluble in the pore water thus reducing the bioavailability and toxicity with respect to biota.
- Extensive data in the literature shows that these metals become much more soluble when exposed or mixed with oxygenated waters, as sulfides in the sediments are oxidized to sulfates

releasing hydrogen ions thus dropping the pH and forming ionized metals in solution such as $Zn^{2+}_{(Aq)}$. Metals thus mobilized include Cd, Cu, Pb, Ni, Ag, and Zn that may cause toxicity to benthic organisms

- These soluble metals can be released into the water column upon resuspension of the sediments. Otherwise, releases of metals into an overlying oxygenated water column are limited by diffusion mechanisms within the bottom sediment. Simulation of metal releases from sediments need to include the microscale biogeochemical reactions but also macroscale water and sediment processes of suspension and/or water movements.
- Extensive work on the mobilization of metals upon oxidation and subsequent acidification of sediments has shown that toxicity of metals in anoxic sediments is related to the balance between acid volatile sulfides (AVS) and simultaneously extracted metals (SEM). Recent USEPA methods for prediction of sediment toxicity to benthic organisms have been based upon Equilibrium Partitioning Sediment Benchmarks (ESBs). These methods utilize the balance between SEM and AVS for assessment of potential toxicity due to Cd, Cu, Pb, Ni, Ag, and Zn. Though the chemistry is somewhat different for Cr, the toxic form of hexavalent chromium Cr^{6+} is thermodynamically unstable in anoxic sediments so if 3SEM – AVS < 0, as well as those whose (3SEM – AVS > 0 but still have substantial AVS present should not be toxic due to Cr^{6+}.
- For mercury, the methylated form is far more toxic and has great biomagnification potential. Methylmercury (MeHg) production is facilitated by microbial processes involving sulfate reducing bacteria and iron-reducing bacteria. Methylation rates are thought to occur at the redox boundary and decrease with depth in within the sediment. Microbial populations usually increase with the amount of organic material in a system. High temperatures and anaerobic conditions favor methylation, and low temperatures and/or aerobic condition favor demethylation. In reducing environments, increasing sulfide concentration decreases methylation rates. The neutral form $HgCl_2$, or $(Hg^{2+})_R$ is soluble and is bioavailable as a precursor for methylation by sulfate reducing bacteria.
- Studies have shown that wetting and drying of sediment can stimulate the production of MeHg. Oxygen penetrates into the dried sediment and reduced sulfur compounds get oxidized. These are compounds that tend to bind the inorganic reactive mercury $(Hg^{2+})_R$. Thus the pool of reactive $(Hg^{2+})_R$ is increased.
- Laboratory studies show that the $(Hg^{2+})_R$ readily available for methylation can be significantly increased (up to 60-fold) when buried anoxic sediment containing largely non-reactive Hg^{2+} is mixed with oxygenated water.
- However, the importance of microbial activity versus the availability of $(Hg^{2+})_R$ determine the rate of MeHg production in response to the role of organic matter and redox conditions. A recent synthesis of mercury in San Francisco Bay cites evidence that better drainage (e.g. fully tidal versus managed marsh) and more frequent tidal inundation (e.g. low marsh versus marsh plain) are associated with lower MeHg bioaccumulation.

3.0 BACKGROUND

3.1 San Francisco Bay Dredge Sediment Suitability Determinations for Wetland Restorations

Suitability of dredged sediments for wetland restorations are determined by the regulating agencies working through the Dredged Material Management Office (DMMO) consisting of the agencies with jurisdiction. Within San Francisco Bay, sediment suitability is determined according to guidance from the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB, 2000) entitled “Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines”. This document provides screening and testing guidelines for wetland creation and restoration, including criteria for both wetland surface and wetland foundation materials as well as for reuse in levees or as upland fill. In many cases, dredged materials taken to upland locations are dried either at the final placement site or at a rehandling facility. Rehandling facilities must also be authorized by all appropriate regulatory agencies. Authorization from the SFBRWQCB includes requirements and prohibitions on discharges from such facilities to protect aquatic resources. Requirements are summarized in Table 1.

Because wetland surface materials are in direct contact with biota, required testing includes sediment chemical analyses, bioassay testing with two benthic species covering three life stages, and effluent elutriate chemical testing. Criteria for wetland surface material reuse utilize either San Francisco ambient sediment levels or NOAA ER-L screening levels for sediment chemistry evaluations. Water Quality Objectives (WQOs) are used for effluent elutriate screening levels, and no significant toxicity for the bioassay criteria.

For wetland foundation materials potential but unlikely direct exposure to sediments as well as on-site exposure to leachates after placement is of concern. Thus sediment chemistry along with a Modified WET test of the sediment is required, but no benthic bioassay testing. Sediment criteria are ER-L or PEL, while Basin Plan WQOs are used for the leachate test evaluations.

Table 1. Testing and Criteria for Dredge Sediment Beneficial Uses (From SFBRWQCB, 2000)

Beneficial Reuse environment	**Potential routes of exposure for non-human biological receptors**	**Recommended chemistry test**	**Recommended bioassays**	**Recommended leachate chemistry**	**Screening guidelines for:** 1) chemistry 2) toxicity 3) leachate chemistry
Wetland surface	Direct exposure to sediments	Sediment chemistry for analytes in Table 5 (SFRWQCB, 2000)	Two benthic species covering Three life history stages, see PN 01-01 DMMO "Guidelines for Implementing the Inland Testing Manual in the San Francisco Region"	None	1) ambient or ER-L concentrations for sediment, WQOs for effluent elutriate 2) no significant toxicity 3) not applicable
Wetland Foundation, levees, and construction fill	Potential but unlikely direct exposure to sediments On-site exposure to leachate after placement	Sediment chemistry for analytes in Table 5 (SFRWQCB, 2000)	None	Modified WET	1) ER-M or PEL 2) not applicable 3) Basin Plan WQO's
Landfill daily Cover	No exposure	Testing and acceptability criteria specific to each landfill; contact individual landfills for requirements.			
Any project Involving discharges from dewatering dredged material	Receiving waters exposed to effluent discharge during placement	Elutriate chemistry for analytes in Table 5, (SFRWQCB, 2000)	One species sediment elutriate bioassay	Not Applicable	1) Basin Plan WQO's 2) no significant toxicity 3) not applicable

The DMMO utilizes this document in the determination of general suitability of dredged material for beneficial reuse. However, individual agencies issue the needed permits to reuse or dispose of dredged material for beneficial reuse projects based on site specific conditions. If these sediments, whether dried at the site or at a re-handling facility, were to be used as wetland fill, then changes associated with drying that might affect metal leaching need to be considered in the permit process.

In summary, bulk dredge sediment testing for metals is carried out as defined in the USEPA and USACE inland testing guidance manuals (USEPA/USACE, 1998; USACE, 2003) plus USACE guidance for the San Francisco Bay region by Public Notice 01-01 (USACE, 2001). Bulk sediment testing for metals is done using a nitric acid digestion (EPA Method 6020; EPA 7471A for Hg) for total extractable metals. Sulfide analyses are not commonly done under Public Notice 01-01 guidance in the San Francisco Bay area. Evaluation of sediments for beneficial reuse as wetland surface materials (Hetzel and Collins, 2000) is determined by comparisons of chemical concentrations in the sediments with ambient San Francisco Bay sediment concentrations or by comparison to NOAA ER-L sediment values. These latter NOAA values were determined by correlations of bulk sediment concentrations with bioassay toxicity testing data (Long et al., 1998a; 1998b). Secondly, two benthic bioassay tests are required as further verification that sediments will not be toxic to benthic organisms. For wetland foundation, levees, or fill sediment constituents of concern (COCs) are evaluated by comparisons with ER-M or PEL values, with a modified Di-WET test extractant compared to Water Quality Objectives (WQOs).

3.2 Delta Dredging and Reuse Strategy

The Central Valley Water Resources Control Board utilizes an additional test to evaluate the potential of dredge sediments to oxidize and leach metals into ground waters or into adjacent river waters. Guidelines for testing for upland dredge material disposal in the Central Valley (California Regional Water Quality Control Board, Central Valley Region (CVRWQCB), California Department of Fish and Game, and Delta Protection Commission. 2002) require consideration of the release of metals by measurements designed to indicate whether the sediment will go acid and cause metals to be released into the pore waters or into the ambient waters. Modified WET (Di-WET) or WET tests are also required along with Modified Elutriate Tests (MET) to evaluate discharge of soluble metals to groundwater or decant water back to the ambient river waters.

Analyses of dredge sediment for the Neutralizing Potential/Acid Generation Potential Ratio (N:AGP Ratio) are required**.** The neutralizing potential/acid generation potential ratio (N:AGP Ratio) is a measure of the degree of acid or base that will be generated by a soil upon oxidation and is used in the Central Valley Regional Water Quality Control Board evaluations of dredge sediments. The N:AGP is determined by the methods of Sobek et al. (1978; Draft Method EPA-821-R-91-100) that were developed for acid mine drainage. The N:AGP Ratio is calculated by dividing the neutralization potential as CaCO3/1000 tons of material, by the acid generation potential in tons of CaCO3/1000 tons of material as calculated from total sulfur present A value of one indicates that acid generation and neutralization potentials are equal and that the soil is therefore likely to remain neutral. The CVRWQCB looks for a ratio of neutralizing potential to acid generation potential of at least 3:1 so that enough neutralizing potential will remain to neutralize pH after the sediment oxidizes (CVRWQCB, 2002). This test is done on air dried and pulverized sediments.

3.3 EPA Equilibrium Partitioning Sediment Benchmarks (ESBs)

Extensive work on the mobilization of metals upon oxidation and subsequent acidification of sediments has been done following early work (Di Toro et al., 1990, 1992) showing that toxicity of metals in anoxic sediments is related to the balance between acid volatile sulfides (AVS) and simultaneously extracted metals (SEM). This is because insoluble metal sulfides of certain metals exist in anaerobic sediments which can become soluble when the sediment is oxidized and becomes acidic. More recently, the U.S. Environmental Protection Agency (USEPA, 2005) has developed sediment toxicity prediction methods termed Equilibrium Partitioning Sediment Benchmarks (ESBs) based upon these procedures for use in the protection of benthic organisms for metal mixtures containing Cd, Cu, Pb, Ni, Ag, and Zn.

This equilibrium partitioning sediment benchmark (ESB) approach allows derivations of concentrations of metal mixtures in sediment which should be protective of benthic organisms. These methods account for the varying biological availability of chemicals in different sediments and allow for the incorporation of the appropriate biological effects concentrations. Equilibrium partitioning theory predicts that these metals partition in sediment between acid volatile sulfide (AVS principally iron monosulfide), interstitial (pore) water, benthic organisms, and other sediment phases such as organic carbon. The difference (3SEM –

AVS) between the sum of the molar concentrations of simultaneously extracted metals minus the molar concentration of AVS accurately predicts which sediments are not toxic because of these metals. Sediments containing these metals should not cause direct toxicity to benthic organisms if the 3SEM – AVS is $\leq$ 0.0. Normalization of this difference by total organic carbon (3SEM – AVS)/f_{OC} reduces variability associated with prediction of when sediments will be toxic. These parameters thus have been correlated with measured benthic toxicity data to enable these predictions. Alternatively, if data on dissolved interstitial concentrations of these metals are available for a given sediment, then these metals should not cause toxicity to benthic organisms if the sum of the dissolved interstitial water concentration for each of the metals $3M_{i,d}$ divided by their respective water quality criteria final chronic value (FCV) is $\leq$ 1.0.

Appendix D of the ESB procedures document also provides additional methods for estimating toxicity to benthic organisms due to the presence of chromium (USEPA, 2005). Chromium exists in sediments primarily in two oxidation states, Cr^{3+} which is relatively insoluble and nontoxic, and Cr^{6+} that is much more soluble and toxic. However, Cr^{6+} is thermodynamically unstable in anoxic sediments and AVS is formed only in anoxic sediments so these sediments do not contain the toxic Cr^{6+}. Thus sediments that have 3SEM – AVS < 0, as well as those whose (3SEM – AVS > 0 but still have substantial AVS present should not be toxic due to Cr^{6+}.

An important aspect to deriving ESB values is that the methods necessary to implement the approach must be reasonably standardized or have been demonstrated to produce results comparable to those of standard methodologies. The SEM/AVS extraction method is that of Allen, 1993 (or Draft Method EPA-821-R-91-100). This involves a cold 1M HCl acid extraction and 0.45u filter to determine soluble metals along with trapping and quantifying the volatile sulfides liberated by the acid extraction process.

It should be noted that the analytical method for metals differ somewhat from the regular dredge bulk sediment total extractable metals procedure commonly used in the San Francisco Bay area that includes a hot nitric acid extraction (USACE, 2001, Public Notice 01-01) but not an analyses of acid volatile sulfides.

4.0 APPROACH SUGGESTED IN SCOPE OF WORK

The basic purpose of this present study is to investigate parameters related to the storage of dredge materials prior to the actual construction and flooding phases of the new wetland. In order to investigate effects on leaching of metals as a result of wetting and drying of dredged material, the salt pond restoration work plan called for the following approach:

- Coordinate with regulatory agencies to discuss concerns related to wetting and drying of dredged material, which requires retention of water over dredged material, thus causing a significant impediment to dredged material reuse;
- Collect samples from dredged material placed at Hamilton, Bair Island, Suisun (Pierce Island), Martinez Ponds, and San Leandro Ponds;
- Conduct laboratory testing to investigate the effects of drying on metals concentration, salt concentration, methylation, and redox potential;
- Discuss the results of the analysis with the DMMO agencies at one of their regularly scheduled meetings.

4.1 Alternate Implementation Approaches

Two alternative approaches may be considered. The first would collect dry and wet sediment from the above listed sites and characterize these sediments as to their chemical composition and metal leaching characteristics before and after drying or wetting. These data would provide a survey of properties of sediments stored dry (or wet). However, one-to-one comparisons with original dredge material properties would not be possible. Secondly, changes in these sediments due to their history of hydraulic dredging, drying, rewetting, evaporation, and exposure conditions would not be known, including microbial activity during the long holding times they have experienced.

The second approach would be to obtain two new dredge sediment samples by vibracoring in South Bay west and east (Redwood City and San Leandro Channel). These latter sediments would be tested initially and again after drying and rewetting. These would be a more direct test but would need drying and rewetting under artificial conditions. Dredging, particularly hydraulic dredging exposes the dredge sediment to oxygenated Bay waters during the long mixing times associated with pumping and placement which will effect redox reactions and microbial processes.

4.2 Testing Approach

Samples of wet dredge sediment will be tested initially, then air-dried, rewetted, and retested. Samples of dry sediments will be tested initially, then rewetted and retested. Because of budget concerns, a long time series after rewetting will not be possible and probably not needed for most metals of concern as the redox reaction kinetics in wet dredge materials are relatively rapid (Yong Seok Hong, Kerry A. Kinney, and Danny D. Reible, 2011a: 2011b). Therefore, post rewetting tests will be carried out two weeks after However, for mercury a few additional tests of samples shortly after rewetting will be added to address a concern that a pulse of stored MeHg may be released (Marvin-DiPasquale, Mark, Charles N. Alpers, and Jacob A Fleck, 2009). A similar recommendation was made when initial considerations were being discussed for the short-time drying of Redwood City Harbor Area D dredge sediments in order to facilitate construction and also to physically make room for additional needed dredge materials to be placed into the diked area that was then filled with water and sediment (Ellen Johnck, Personnel Communication).

In addition to bulk sediment testing, leach tests will be run on the sediments using modified WET test procedures for comparisons of the mobility of the dissolved metals in the test sediments.

Sediment Conventional Analytes: pH, Redox Potential, Salinity (Conductivity), Grain Size, Total Organic Carbon, Percent Solids

Metals in Sediments: Metals will be analyzed as required for dredge sediment characterization in the bay area (USACE, 2001) using standard EPA methods meeting required reporting limits. In addition, to Hg, MeHg will be added. For selected samples, the reactive soluble Hg^{2+} species will be included.

Also acid volatile sulfides will be analyzed, including Neutralizing Potential/Acid Generation Potential which includes sulfur speciation and carbonate neutralizing analyses (CVRWQCB, 2002).

In general, analytical testing of metals in sediments will follow dredge protocols for the Bay area, rather than those of the SEM/AVS protocols of the Equilibrium Partitioning Sediment Benchmarks (ESBs) methods that use cold HCl extractions. Thus results will be comparable to dredge sediment characterizations carried out routinely. For mercury analyses, protocols as used by USGS (e.g. Marvin-DiPasquale et al., 2006: Grenier, L. et al., 2010) will be used, and if done commercially, will be done by Brooks Rand Laboratories.

Metals in Waters: Also of interest will be extractable metals to answer questions on potential mobility of soluble metals. A modified Di-Wet test as required in Bay wetland reuse guidance will be used (SFBRWQCB, 2000) which uses a 10 to one water to sediment extraction and is meant to mimic leaching of upland sediments by rainwater. For solubility into salt Bay waters, salt water could be substituted for distilled water keeping the same sediment to water ration for comparison, or the standard MET extraction test (USACE, 2003) could be used as prescribed in Bay wetland guidance (CVRWQCB, 2002) which is designed to mimic decant water discharges.

Analytical testing protocols for waters will be by standard EPA methods and required reporting limits for Bay studies, with Hg analyses following USGS methods as appropriate.

Draft Concept Plan
Investigation of Wetting and Drying of Dredge Material at Wetland Restoration Sites

APPENDIX A

BASIS OF CONCERNS OF METAL RELEASES UPON OXIDATION OF DREDGE SEDIMENTS

Basis of Concerns - Acidification of Dredge Sediments Associated with Oxidation

San Francisco Bay bottom sediments consist of sand in areas of higher current velocity channels and can contain shell hash from old remnant oyster beds in the South Bay. However, the majority of sediments dredged in San Francisco Bay are soft mud (Bay Mud). Bay Mud consists of silt and clay particles deposited by flocculation as particulate matter in fresh water aggregates when mixed with saline waters. The surface sediment (Young Bay Mud) overlies ancient Old Bay Mud and tends to be much less densely packed, high in moisture content, and higher in organic carbon than the underlying ancient Old Bay Mud formation. San Francisco Bay dredge materials thus are often finer grained soft bottom deposits consisting of silt with high clay content. Exceptions are when the main channels are dredged where the sand content is higher, or for capital improvement projects where the more consolidated Old Bay Mud may be dredged. Old Bay Mud was deposited previous to the period of industrialization and thus does not contain anthropogenic contaminants but does contain naturally occurring metals. The physical and chemical nature of available dredge materials thus effects the reuse design at a given wetland restoration project.

Metal Sulfides in Dredged Sediments. Surficial sediments are in contact with aerobic overlying water and oxygen may penetrate from a few millimeters to centimeters by local sediment resuspension and/or by enhanced oxygen diffusion from bioturbation. Thus except for the thin upper layers, sediments to be dredged are anoxic. The toxicity of metals in anoxic sediments is greatly controlled by the presence of metal sulfide compounds in the anoxic sediments, commonly called Acid Volatile Sulfides (AVS). The amorphous iron sulfide (FeS(s)), one of the major metal sulfide species in AVS, is more soluble than other divalent metal sulfides, and other dissolved metals precipitate by displacing Fe^{+2} (DiToro, 1990). Consequently, metals are often contained in low solubility forms in anoxic sediments where AVS are in excess of the total extractable metals available in the sediment, thus reducing the bioavailability and toxicity with respect to biota. The concentration of AVS in sediments is defined as the concentration of solid phase sulfide compounds associated with metal sulfides (primarily iron and manganese monosulfides). In marine and freshwater sediments, sulfides of divalent metals form very insoluble compounds. Thus the quantity of AVS represents a “reactive pool” of sulfides that are able to bind and reduce the bioavailability and toxicity of the metals in sediments (DiToro et al. 1990).

Other factors also are important such as organic carbon concentration as organic matter can readily absorb a variety of contaminants including many that would not otherwise have a high affinity to attach to the surface of sediment particles.

When dredge sediments are oxidized, sulfides are oxidized and pH is lowered as acid is generated unless sufficient basic materials such as carbonates are present in the sediment. Though the oxidation redox equations involved can be complex depending on the composition of the sediment they can be illustrated by the following equations of the oxidation of pyrite and neutralizing reaction of carbonates present which tend to limit the resulting pH of the solution.

$$FeS_2\ (s) + (7/2)\ O_2\ (g) + H_2O = Fe^{2+}\ (aq) + 2H^+\ (aq) + 2\ SO_4^{2-}\ (aq)$$
$$CaCO_3\ (s) + H^+\ (aq) = HCO_3^-\ (aq) + Ca^{2+}\ (aq)$$

The relative amount of basic materials in the dredge sediments thus will have a direct influence on the resulting pH and thus the solubility of other metals and their bioavailability.

When marine sediments are hydraulically dredged they are slurried with Bay marine waters (about 15% solids) and pumped to a barge where they are partially dewatered before being dumped at an in-water disposal site or pumped ashore if they are to be reused. If a bucket dredge is used the sediment is loaded onto a barge in a more lumped state, but still must be dumped at an in-water disposal site or re-handled at onshore upland or wetland site. Re-handling often involves slurrying with water and hydraulically pumping into upland storage or into the wetland restoration site. Oxidation due to contact with air and aerobic waters would occur during the dredging process as well as at the final wetland storage or in wetland restoration site. Drying, wetting, and evaporation may also occur at wetland construction sites that can have implications for metal releases.

Marine waters are well buffered with carbonate but fresh waters less so. Thus storage and use in a wetland may include exposure to freshwater (rainwater) or to marine tidal waters depending on physical factors involved in the handling, storage, and final reuse site.

Two recent papers (Hong, Kinney, Reible 2011a, 2011b) address the release of metals from anoxic dredge sediments, one upon resuspension into aerobic river waters. The second paper describes microcosm experiments measuring releases into both fresh and marine overlying waters, including cyclic changes in sediments successively exposed to fresh and marine waters to simulate a river delta intertidal site.

The resuspension experiments were done by bubbling air through a 3.5 liter reactor filled with artificial river water and anoxic dredge sediment (Anacostia River) at a ratio of 25% solids to water for a period of fourteen days with samples taken frequently for the first 6 hours then subsequently less frequently. Stoichiometric equations were written for the major biogeochemical reactions to be used and reaction rate equations were used to model kinetics of the subsequent changes and the release of Ca, Mg, and Zn. The following reactions were modeled using second order kinetic equations and found to describe the experimental data:

$$H^+ + HCO_2^- = CO_{2\,(g)} + H_2O$$
$$FeS_{(s)} + 0.75O_2 + 0{,}5H_2O = FeOOH_{(s)} + S^0_{(s)}$$
$$MnS_{(s)} + 0.5O_2 + 2H^+ = Mn^{2+}\ S^0_{(s)} + H_2O$$
$$ZnS_{(s)} + 0.5O_2 + 2H^+ = Zn^{2+}\ S^0_{(s)} + H_2O$$
$$NH_4^- + 2.0O_2 = NO_3^- + 2.0H^+ + H_2O$$
$$S^0_{(s)} + 1.5O_2 + H_2O = SO_4^{2-} + 2H^+$$
$$Fe^{2+}\ 0.25O_2 + 1.5H_2O = FeOOH_{(s)}\ 2.0H^+$$
$$CaCO_{3(s)} = Ca^{2+} + CO_3^{2-}$$
$$MgCO_{3(s)} = Mg^{2+} + CO_3^{2-}$$
$$FeCO_{3(s)} = Fe^{2+} + CO_3^{2-}$$

The oxidation of AVS and the resulting release of sulfide-bound metals was consistent with a two-step process, a relatively rapid AVS oxidation to elemental sulfur and a subsequent slow oxidation to SO_4^{2-} (aq) with an associated decrease in pH from neutral to acidic conditions. AVS dropped about 40% in one hour and about 90% in 6 hours. The pH in the reactor quickly dropped from an initial pH 6.5 to below pH 6, moved back up to about pH 6.5 for about 6 hours, then dropped again to below pH 6 over the following days. This acidification was the dominant factor for the release of metals into the aqueous phase. Dissolved Mg, Ca, Mn, and Zn were measured versus time in the closed reactor, with Zn and Mn exceeding National Water Quality guidelines. Mn was apparently sorbed by a phase not included in the model. Note that these high concentrations were observed in the closed resuspension experiments and are not likely to be observed in the environment, due to dispersion, dilution, and buffering by the overlying water. The simulation of metals release upon sediment resuspension needs to include both the microscale biogeochemical reactions as well as the macroscale water and sediment transport processes.

The microcosm experiments (Hong, Kinney, Reible 2011b) were conducted in small chambers with flowing water and an air bubbler (1 cm deep, 0.26 ml/min, 0.26 L water volume) over the surface of the sediment. Four microcosms were used, one with fresh water (pH ~6.5), one with salt water (pH `8.3), one alternating (8 day cycle), and one a control.

$Cd_{(Aq)}$, $Zn_{(Aq)}$, and $Mn_{(Aq)}$ release behavior to the overlying water and subsequent metal distribution in both pore water and solid phase were investigated with an Anacostia River test sediment. Complexation with anions and competition with cations in salt water were the most important release mechanisms for total Cd and Mn, respectively, whereas pH was the most important factor for total dissolved $Zn_{(Aq)}$. Total Cd release was substantially higher during exposure to salt water although, as a result of complexation, predicted dissolved Cd^{2+} concentration in the overlying water was higher during exposure to freshwater. Total Zn release was little changed during exposure to salt water and freshwater, although the predicted dissolved Zn^{2+} concentration was also much higher during freshwater exposures. Dissolved $Zn_{(Aq)}$ release into the water was characterized by a steady flux from a large pool in the exchangeable phase or bound to oxides rather than from $ZnS_{(s)}$. For Mn, a sharp increase followed by an immediate decrease was observed possibly by depleting the pool of Mn at the surficial sediment and by creating an aerobic layer scavenging Mn. No significant iron was released because of the rapid oxidation of ferrous iron Fe^{2+} in aerobic surfical sediments and overlying water.

Vertical profiles in the sediment showed that soluble metals in the pore water increased and the sulfides decreased in the top 2 cm of the test sediments that were in contact with flowing, oxygenated water much as we might expect, while the deeper sediments remained essentially unchanged. Releases of metals to the water column were thus limited by diffusion mechanisms within the bottom sediment.

Chromium.

The ESB procedures document (USEPA, 2005 Appendix A) also provides additional methods for estimating toxicity to benthic organisms due to the presence of chromium. Chromium exists in sediments primarily in two oxidation states, Cr^{3+} which is relatively insoluble and nontoxic, and Cr^{6+} that is much more soluble and toxic. However, Cr^{6+} is thermodynamically unstable in anoxic sediments and AVS is formed only in anoxic sediments. Thus these sediments do not contain the toxic Cr^{6+}. Sediments that have 3SEM – AVS < 0, as well as those whose (3SEM – AVS > 0 but still have substantial AVS present should not be toxic due to Cr^{6+}.

Mercury and MethyMercury.

Mercury is a metal of major concern within San Francisco Bay due to high legacy sediment total Hg (THg) concentrations as well as elevated concentrations in tissues of fish and higher organisms in the food chain leading to fish advisories for human consumption. Mercury in San Francisco Bay has thus been the subject of ongoing monitoring (e.g. SFEI, 2011: 2012); a subject of USEPA Total Maximum Daily Load (TMDL) regulatory studies (e.g. SFRWQCB, 2006, 2008); as well as for special studies associated with existing and proposed restoration of wetlands (Best et al., 2009; Marvin-DiPasquale et al., 2009; Grenier, 2010). A recent synthesis of mercury in San Francisco Bay with an emphasis on reducing methylmercury accumulation in the food webs of the bay and its local watersheds has been published (Davis, et al., 2012). Though urban sources of Hg to the Bay are important, the legacy contamination from Hg mines is dominant, including the New Almaden mercury mining district of the Guadalupe River watershed in Lower South bay along with the historic gold mining, which used Hg in the extraction process in the Sierra Nevada watersheds (Davis, et al., 2012). The upstream sources of Hg into the Bay are still significant but the widespread Hg deep in the Bay sediments will continue to be a source of contamination for a long period of time.

Long term average Hg concentrations in Bay sediments have been in the range of 0.2 to 0.3 ppm (SFEI, 2011). Corresponding long term average methylmercury (MeHg) concentrations in sediments have generally been in the range of 0.3 to 0.6 ppb with concentrations of methylmercury in sediment south of the Bay Bridge consistently higher than those in the northern Estuary. Water from the Lower South Bay had the highest average concentration of methymercury (0.11 ppb) with the South Bay next (0.06 ppb).

A study and models of the cycling of mercury in wetlands was carried out (Best, et al., 2009) for wetlands bordering the Hamilton Army Airfield wetlands restoration site. Processes are generally described with respect to methylation of Hg from the sediments. The methylated form MeHg is far more toxic than Hg and has great biomagnification potential. MeHg production is facilitated by microbial processes involving sulfate-reducing bacteria and iron-reducing bacteria. Biotic methylation occurs predominately in the sediment but less so in the water column. However, since the water column volumes are greater, this latter methylation is also important. Methylation maximum rates are thought to occur at the redox boundary, which may vary seasonally and tidally and frequently coincides with the sediment-water interface or somewhat below, but decreases with sediment depth. Microbial populations usually increase with the amount of organic material in a system. High temperatures and anaerobic conditions favor methylation, and low temperatures and/or aerobic conditions favor demethylation. In reducing environments, increasing sulfide concentration decreases methylation rates. Net meHg production reaches an optimum under suboxic and low anoxic conditions. The neutral form $HgCl_2$, or $(Hg^{2+})_R$ is soluble and is bioavailable for methylation by sulfate reducing bacteria. Also, within vegetated sediments of salt marshes, methylation rates are stimulated by root-DOC and oxidizing activity of roots with its inhibitory effect on sulfate reduction decreased with decreasing tidal elevation, with the greatest sufate reduction occurring in the transition zone between marsh and mudflat. Thus methylation can be constrained by limiting the wetland portions of optimum conditions for methylation by designing coastal wetlands with a relatively large zone at high elevation and keeping the edge surface area as small as possible subject to tidal action.

USGS researchers (Marvin-DiPasquale et al. 2006) have methodologically defined sediment “reactive” mercury $(Hg^{2+})_R$ as the fraction of THg in a sediment sample that has not been chemically altered (e.g. digested, oxidized or chemically preserved) and that is readily reduced to elemental Hg by an excess of tin chloride (SnCl2) over a defined (short) exposure time. This operationally defined parameter was developed as a surrogate measure of the fraction of inorganic Hg^{2+} that is most likely available to methylating bacteria responsible for MeHg production. Recent experimental evidence suggests that the $(Hg^{2+})_R$ assay effectively measures the fraction of Hg^{2+} that is associated with simple anions (e.g. $HgSO_4$, $HgCl_2$) in sediment pore water and/or Hg^{2+} that is weakly adsorbed to particle surfaces (Marvin-DiPasquale and others, 2006). Both of these fractions are indeed likely available to sediment microbes for methylation. In a related set of experiments, the concentration of $(Hg^{2+})_R$ measured in a suite of freeze-dried and homogenized environmental samples ranging over four-orders of magnitude in THg (1-24,000 ppm), was strongly correlated (r2 = 0.97) with the amount of MeHg produced when these freeze-dried samples were mixed (at a constant THg amendment level) with fresh sediment containing active populations of Hg(II)-methylating bacteria. These results suggest that the measured $(Hg^{2+})_R$ fraction does provide a reasonable surrogate measure of the fraction of THg that is potentially available for Hg(II)-methylation.

Studies carried out in 2006-2008 in the Cache Creek Settling Basin and the Yolo Bypass freshwater systems (Marvin-DiPasquale et al., 2009) show that wetting and drying of sediment can stimulate the production of toxic MeHg. When wet sediment is initially dried, microbial processes slow or largely cease, including those associated with reactive $(Hg^{2+})_R$ and MeHg degradation. Any MeHg that is in the sediment becomes trapped and is not readily subject to flux out of the sediment into the overlying surface water. Oxygen penetrates into the dried sediment and reduced sulfur compounds get oxidized. These are compounds that tend to strongly bind the inorganic $(Hg^{2+})_R$ precursor to organic MeHg to solid sulfur compounds thus becoming largely non-reactive with respect to methylation. Thus the pool size of reactive $(Hg^{2+})_R$ is increased.

When the sediment is then rewetted, the following sequence of events occur. Some amount of the previously trapped MeHg is released into the new overlying water phase. The microbial processes controlling $(Hg^{2+})_R$ methylation and MeHg degradation begin to increase. Then the previously increased pool of reactive $(Hg^{2+})_R$ formed during the last drying cycle is largely available to bacteria to carry out methylation resulting in a fresh pulse of new MeHg production.

Another valuable study was the South Baylands Mercury Project (Grenier et al., 2010) which examined methylmercury production and food web consequences of conversion of a managed pond (Pond 8) to a tidal marsh. This study looked at the impacts of potential erosion of legacy sediments and mercury due to increased tidal flow in Alviso Slough. To support this study, a laboratory experiment (Marvin-DiPasquale and Cox 2007).was conducted on the mid-Slough sediment representing the 50-175 cm depth zone below the current sediment-water interface to assess the effects of a major erosion event on $(Hg^{2+})_R$ bioavailability. The laboratory experiment demonstrated how the pool size of $(Hg^{2+})_R$, which is the fraction of inorganic Hg^{2+} most readily available for methylation, can be significantly increased (up to 60-fold) when buried anoxic sediment containing largely non-reactive $Hg^{2+}$are scoured and mixed with oxygenated overlying water. This scour would increase the amount of $(Hg^{2+})_R$ that is available for MeHg production and uptake into the food web at least in the short term until the remobilized sediment would mix and be buried Grenier et al., 2010). However, the restored tidal marsh would likely produce less labile organic matter than the pond providing less fuel for methylating bacteria, and leading to less MeHg production. This critical finding illustrates the importance of microbial activity versus the availability of $(Hg^{2+})_R$ for methylation in the MeHg production process and the role organic matter and redox reactions influence MeHg production.

The recent synthesis (Davis, et al., 2012) of mercury in San Francisco Bay with an emphasis on reducing methylmercury accumulation in the food webs cites evidence that better drainage (e.g. fully tidal versus managed marsh) and more frequent tidal inundation (e.g. low marsh versus marsh plain) are associated with lower MeHg bioaccumulation. Lower marsh elevations are more constantly wetted, which may keep them from drying out to the point that re-wetting releases a pulse of MeHg. These observations fit with a basic conceptual model of conditions conductive to Hg^{2+} methylation: frequent inundation in saline environments can help maintain highly reduced sulfidic conditions which can limit Hg solubility and availability for methylation (as opposed to episodic inundation often associated with swings between oxic and anoxic conditions which can increase methylation), and frequent flushing may also disperse and dilute any produced MeHg.

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Draft Concept Plan
Investigation of Wetting and Drying of Dredge Material at Wetland Restoration Sites

APPENDIX B

DRAFT SAMPLING AND ANALYSIS PLAN

South Bay Salt Pond Restoration Project – Phase II Beneficial Reuse Implementation Plan

Draft Concept Plan
Investigation of Wetting and Drying of Dredge Material at Wetland Restoration Sites

APPENDIX C

SAMPLING SITE DESCRIPTIONS

Hamilton

Bair Island

San Leandro Ponds

Martinez Ponds

Suisun (Pierce Island)

Draft Concept Plan
Investigation of Wetting and Drying of Dredge Material at Wetland Restoration Sites

Appendix C

Wetland Samplng Site Descriptions

Hamilton

Bair Island

San Leandro Ponds

Martinez Ponds

Suisun (Pierce Island)

Hamilton Wetlands Project:

The Hamilton Wetland Restoration Project is a beneficial reuse site located west of San Pablo Bay and southeast of the City of Novato in Marin County. The Hamilton site is approximately 1,000 acres in size and is expected to receive approximately 10 million cy of dredge material for wetlands habitat restoration. The site is authorized as a federal project to be constructed by the Corps of Engineers with the Coastal Conservancy acting as the local sponsor.

- Actual habitat restored is 982 acres.
- The site was finished taking dredge material in 2011.
- The final site grade started in 2012 and is expected to be complete this year.
- The outer levee breach is scheduled for fall of 2013.

Hamilton Wetland Restoration Site

Hamilton Wetland Restoration Site Plan

<u>Bair Island:</u>

Bair Island is located in South San Francisco Bay across Redwood Creek from the Port of Redwood City in San Mateo County. The island is now owned by public agencies and is planned for habitat restoration. The U.S. Fish and Wildlife Service have indicated that the inactive salt evaporator ponds could be restored to tidal wetlands using dredged material.

Site history is as follows:

- **1920s:** Fred Bair used the island for cattle grazing, giving the island its name
- **1940s:** Leslie Salt begins salt operations on most of the island
- **1973:** Mobil Oil Company buys Bair Island and proposes building "South Shores", a large residential and office development
- **1981:** City Council of Redwood City approves the development plan. Local residents overturn the City Council's decision by voter referendum.
- **1989:** Tokyo-based developer Kumagai Gumi buys Bair Island to pursue development.
- **1997:** Peninsula Open Space Trust buys Bair Island and turns the land over to the USFWS for inclusion in the Refuge.

Currently

- Outer Bair Island has been breeched Jan 2009.
- Inner Bair Island is currently being raised and will be breached 2013. Most of the material is coming is by trucks and some material is dredge material.
- Middle Bair Island was breeched Jan 2013.
- It appears that small amounts of dredge material were pumped onto the islands before breeching.

Bair Island Wetland Restoration Project

Blair Island Showing Planned Breach Locations and Channels

San Leandro Marina Ponds:

Located near the marina in the City of San Leandro, Alameda County, the ponds cover an area of approximately 100 acres. The ponds are provided by the City of San Leandro for the federal maintenance of the San Leandro Marina Channels, as well as the City's maintenance of the marina itself. The dredged material placed in the ponds is dried and removed for reuse, usually as landfill cover, and the ponds are managed to provide resting habitat for migrating shorebirds. These ponds are dedicated to the exclusive use of the San Leandro Channel and Marina dredging.

- The source material from the marina has been on hold due to extensive costs. Alternative plans have been proposed to keep costs down, San Leandro Marina Harbor Basin: Alternatives Study by ESA, March 2011.
- Need for San Leandro Marina Channel dredging is 105,cubic yards every 4 years. Plus 10,000 cubic yards every eight years for the berths. All of this material would go into the ponds.
- Current need (2011) is 125,000 cubic yards to be dredged.
- Last time the San Leandro Marina channel was dredged was 1997.

San Pablo Marina Disposal Ponds

City of Martinez:

The City of Martinez in Contra Costa County owns and operates an upland disposal site for the disposal of dredged material resulting from the maintenance dredging of the Martinez Marina. Dredged material is placed and dried in the disposal site and then removed for construction and landfill cover. The site is reserved for the exclusive use of Martinez Marina maintenance dredging.

- Starting dredging in Nov 2012 with California Dredging Company which dredged 22,500 cubic yards placed in the Martinez Ponds, project completed in Jan 2013.
- Dredging Frequency is every 3 to 4 years.
- The City has performed regular maintenance dredging utilizing the upland disposal ponds since the marina was constructed in the early 1960s.(LTMS SEPTEMBER 11, 2012, MEETING)
- Maintenance of the disposal ponds between dredging episodes has become an issue because of the possibility habitat developing. (LTMS SEPTEMBER 11, 2012, MEETING)
- Finding a home (disposal site) for the dredged sediment from the settling ponds continues to be an issue. (LTMS SEPTEMBER 11, 2012, MEETING)

Dredge Materials Storage Ponds at Martinez Marina

Pierce Island:

Pierce Island is located in Suisun Slough directly south of Suisun City in Solano County. Suisun City developed a mitigation and disposal plan for former sewage treatment ponds to facilitate the Federal maintenance dredging of Suisun Slough Channel. The site has a capacity of approximately 660,000 cubic yards. The use of this site is restricted to maintenance dredging disposal for the Federal channel and the Suisun City Marina.

- Dredged in Nov – Dec. 2008, approximately 125,000 cubic yards removed to Pierce Island.
- Last time dredged was 2002 with 120,000 cubic yards placed on Pierce Island.
- Nehalem River Dredging, Inc. did the dredging both times.
- This should be up for dredging in the near future, though capacity problems exist at Pierce Island.

Pierce Island Dredge Materials Disposal Site

APPENDIX B

Geotechnical Considerations: South Bay Salt Pond Restoration Project Beneficial Reuse Feasibility Study, Alameda and Santa Clara Counties, California. Hultgren-Tillis Engineers, for Moffatt & Nichol. September 2014.

A California Corporation
Specializing in Geotechnical Engineering

Hultgren-Tillis Engineers

September 16, 2014
Project No. 561.02

Moffatt & Nichol
2185 North California Blvd. Suite 500
Walnut Creek, California 94596

Attention: Ms. Megan Collins

Geotechnical Considerations
South Bay Salt Pond Restoration Project
Beneficial Reuse Feasibility Study
Alameda and Santa Clara Counties, California

Dear Ms. Collins:

BACKGROUND

The project consists of restoring the South Bay Salt Ponds (SBSP) to tidal wetlands and associated habitats. Many of the former salt ponds have subsided. To create optimum wetland habitats, many of the ponds may be filled with materials dredged from navigation channels or other water front projects within San Francisco Bay. These dredged materials will be slurried and pumped as hydraulic fill to the receiving ponds. The ultimate goal is to create self-sustaining tidal wetlands and associated features.

The existing salt ponds are separated by dikes. The dikes were created using a barge-mounted crane with a clam-shell bucket or similar equipment. The crane barge excavated bay mud material in front of the barge and cast the mud on the dike alignment. The excavation created a channel for the crane barge to move forward and place fill further along the dike alignment. As the dikes settled or slope erosion became a concern, fill was added to the dike by excavating more material from the channel. Several episodes of dike filling likely occurred.

Natural sloughs pre-dated the salt ponds. Restoration plans will likely be oriented to re-establish the natural sloughs. Slurried sediments that will be pumped into the former salt ponds will be contained by new and existing dikes. Many of the new dikes will likely parallel the old natural sloughs. On average, about 2 feet of new sediment will be needed to raise the former salt ponds in the Eden Landing area to the desired elevations. In the Alviso area, an average of about 5 feet of new sediment is needed. To accommodate the volume of fluids needed to transport and spread the sediments and to allow some freeboard, containment dikes may need to be constructed about 5 feet higher than the planned sediment elevations. Average containment dike heights may be on the order of 7 and 10 feet at the Eden Landing and Alviso sites, respectively.

Portions of existing dikes may need to be removed or lowered to allow the restored tidal flats and/or marsh to drain properly. Man-made channels, mostly adjacent to the existing salt pond dikes, will need to be blocked so that they do not control tidal drainage.

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SOIL CONDITIONS

The former salt ponds were located on aggrading tidal flats. The subsurface soils are estuary sediments locally known as bay mud. The bay mud consists primarily of fat clay and elastic silts, and sometimes organic clay (Unified Soil Classifications CH, MH, and OH), respectively. The bay mud beneath those ponds that were consistently filled with water are likely normally consolidated or slightly over-consolidated. Beneath the ponds that were allowed to dry, the bay mud is likely over-consolidated. Normally consolidated bay mud is weak and highly compressible. Moisture content is likely to be near the liquid limit. Over-consolidated bay mud is stronger and less compressible. Moisture content will be lower in the over-consolidated bay mud but still too wet in most areas to be readily compacted.

Though not wide spread, sand may be co-mingled with and/or beneath the bay mud, most likely near stream outlets. Where sand is found, it may be loose to medium dense and have a moderate to high potential for liquefaction. Sand is not expected to be found in significant quantities beneath most of the former salt ponds.

STABILITY AND SETTLEMENT

The strength of the bay mud can limit the height to which the dikes can be constructed. Plate 1 summarizes the factors of safety for varying dike heights. For a given set of site conditions, the factor of safety can be increased by using flatter dike embankment slopes. The thickness of the weak foundation materials can also affect the slope inclinations needed to achieve a desired factor of safety. The proximity of borrow ditches to the new dike embankment can affect stability and will need to be considered in design. The analysis results shown on Plate 1 are for locations underlain by 20 feet of bay mud. This plate may be used for conceptual planning, but is not intended for design.

Existing and/or abandoned channels, dredger cuts and sloughs may be filled with sediments that accumulated during the decades of salt production. These sediments are likely to be extremely weak, much weaker than the native bay mud. To construct a containment dike across these features, the very weak sediments will need to be excavated or displaced. Much flatter slopes will be needed in these localized areas.

New dikes will settle as the underlying bay mud consolidates. Allowing for some over-consolidation and assuming an underlying bay mud thickness of 20 feet, new dike embankments with 8 feet of new fill may settle about 3 feet. Twelve feet high new dike fills may settle on the order of 4 feet. Additional settlement due to foundation deformation and creep may occur, if the new dikes are constructed with relatively steep side slopes such that the factor of safety for foundation stability is lower than 1.3 to 1.4. Settlements can vary widely depending on the thickness of bay mud underlying the new dike, the inclination of the side slopes, and on the stress history of the foundation materials within a former salt pond.

DIKE CONSTRUCTION

In general, the available materials for dike construction are too wet to be compacted. They will need to be dried to a moisture content suitable for compaction prior to attempting to compact. The new dikes may be constructed using several methods including, but not limited to those discussed below.

New dikes can be constructed using a crane barge floating in its dredger cut, similar to the method used to build the former salt pond dikes. One advantage of this scheme is that the borrow areas can be kept full of water, aiding in the stability of the adjacent new dike embankment. A drawback is that the excavated materials will be cast up in a very wet condition, extending the drying time needed before the material is ready to be compacted.

A more efficient scheme may be to use a low-ground-pressure, long-reach excavator supported on timber mats over nominally 3 feet of advancing fill. To minimize the stability impact of having the borrow excavation too close to the final dike embankment, the initial several feet of fill can be placed over a much wider base than the final dike footprint. This will allow the excavator to reach further from the final dike footprint. It will also create a wider "drying bed" for the excavated material. With this increased width, most of the material needed to construct a dike can be excavated on the first pass of the excavator. As the material dries, it can be picked up off the drying bed and placed and compacted on the dike alignment. Frequent aeration by disking can be used to accelerate the drying.

A third approach could be hauling material to the dike alignment rather than borrowing immediately to it. Trucks would likely be used and efficient haul routes would need to be planned. The fill could be dried bay mud from another portion of the site or imported fill. The material would be moisture conditioned prior to hauling to the dike, such that it can be spread and immediately compacted.

It was a pleasure working with you on this project and we look forward to future phases of this project.

Sincerely,

Hultgren – Tillis Engineers

Edwin M. Hultgren
Geotechnical Engineer

REGISTERED PROFESSIONAL ENGINEER
EDWIN M. HULTGREN
No. 426
GEOTECHNICAL
STATE OF CALIFORNIA

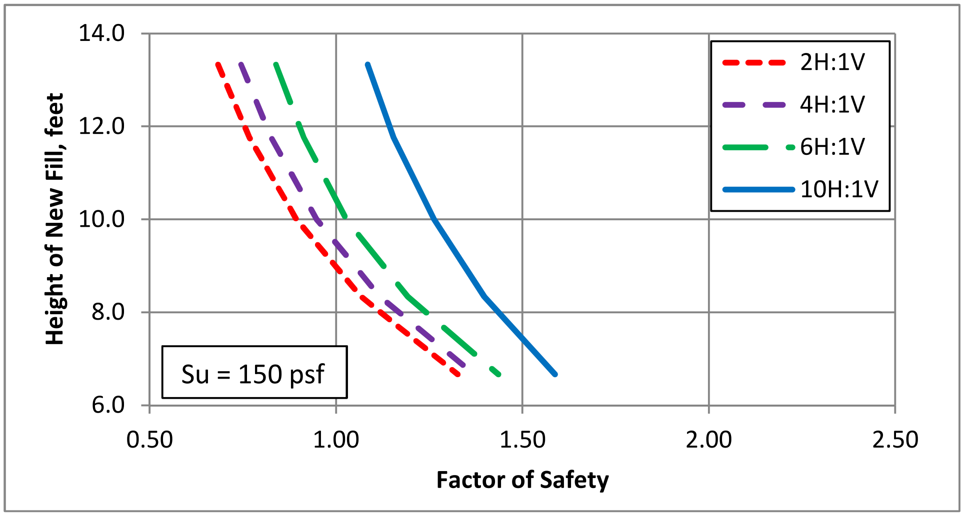
CJY:EMH:JAH:lm:la

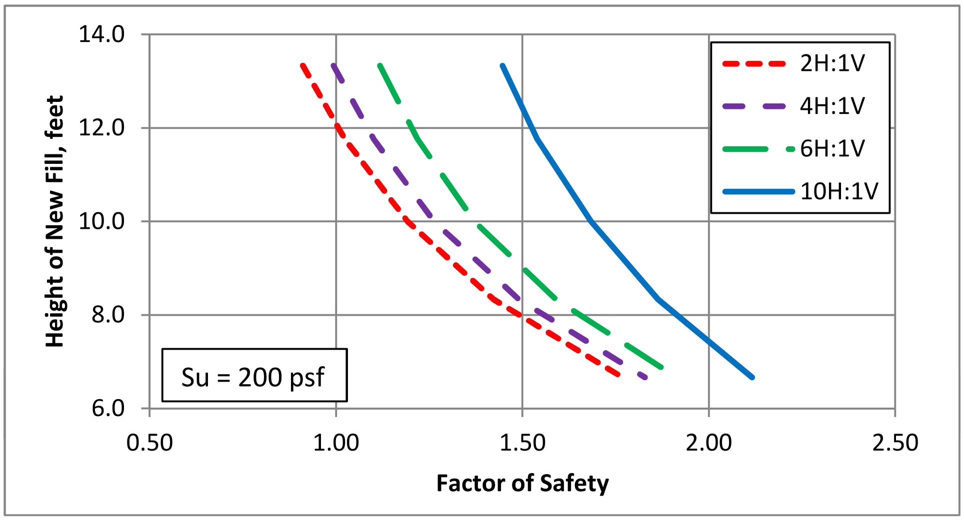
4 copies submitted

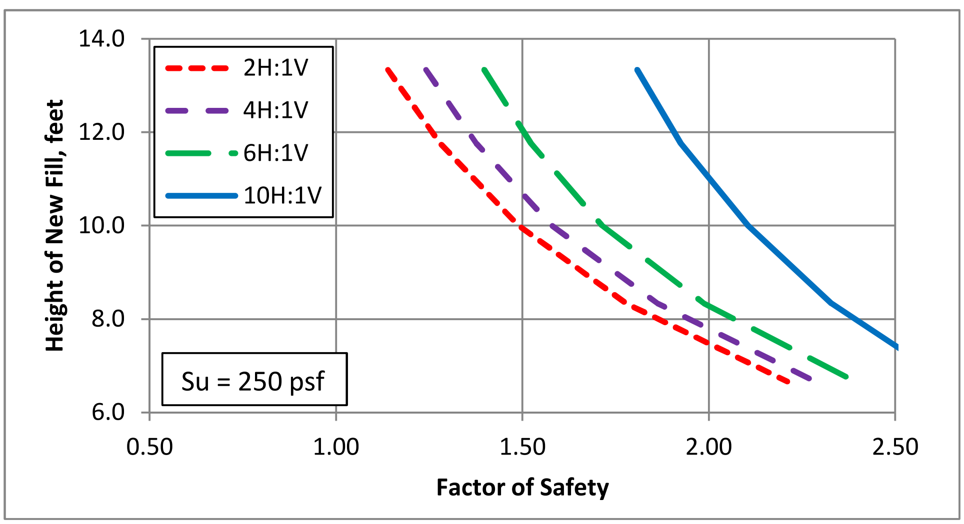
Enclosures: Plate 1 – Stability Charts

cc: Dilip Trivedi, Moffatt & Nichol (via email)

Filename: 56102L01.docx







South Bay Salt Pond Restoration Project Beneficial Reuse Feasibility Study Alameda and Santa Clara Counties, California	**Stability Charts**

Hultgren - Tillis Engineers	Project No. 561.02	Plate No. 1

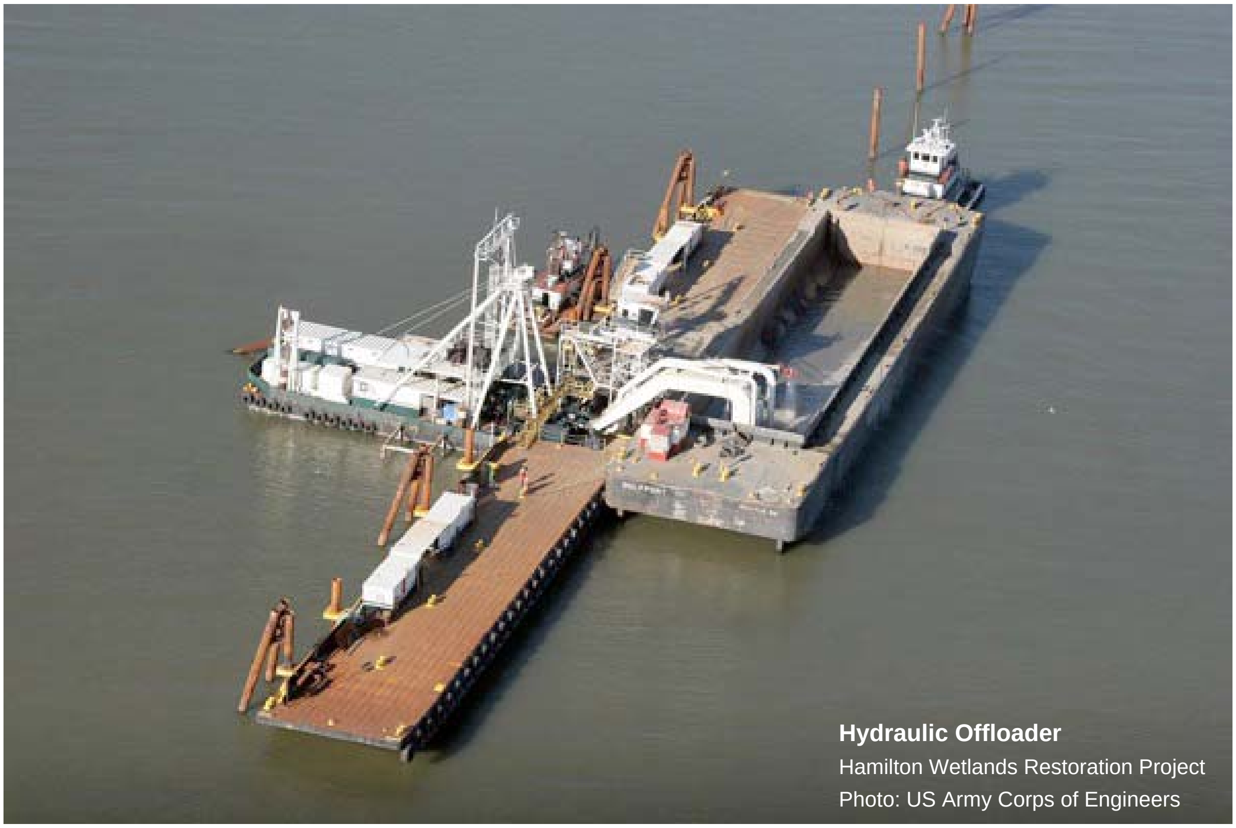
APPENDIX C

South Bay Salt Pond Restoration Project: Beneficial Reuse Feasibility Study. Conceptual Cost Estimate. Moffatt & Nichol. June 2014.

South Bay Salt Pond Restoration Project

Beneficial Reuse Feasibility Study

Conceptual Cost Estimate



Prepared for:

Coastal Conservancy
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2185 No California Blvd., Ste 500
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October 15, 2014
M&N Job No: 7794

CONTENTS

TABLES

FIGURES

ATTACHMENTS

1. INTRODUCTION

1.1 Background

This report presents a concept-level cost analysis of beneficial reuse of dredged material at the South Bay Salt Pond (SBSP) Restoration Project. Four placement sites were defined for the purpose of the analysis, each consisting of groups of nearby ponds as shown in Figure 1.1:

A. Eden Landing Complex - E1, E2, E4, E5, E6, E7, E1C, E2C, E4C, E5C, and E6C
B. Alviso Complex – A1 and A2W
C. Alviso Complex – A5, A7, A8, A8S
D. Alviso Complex – A9, A10, A11, A12, A13, A14, A15

1.2 Scope of Work

This work was performed by Moffatt & Nichol (M&N) under contract to the California State Coastal Conservancy (CSCC). The scope of this specific cost analysis task includes the following:

- Refine a dredged material source list and volumes based on Dredged Material Management Office (DMMO) annual reports and prior M&N work for the CSCC and U.S. Army Corps of Engineers (USACE).
- Obtain dredging and transport costs for the Federal Oakland, Richmond, and Redwood City O&M Projects.
- Identify SBSP Restoration Project pond placement sites and capacities for raising pond bottom elevations with dredged material
- Perform a cost estimate including initial capital costs and annual operational costs for a hypothetical beneficial reuse project placing a minimum of 4 million cubic yards (MCY).
- Compare total beneficial reuse costs (dredging, transport, and tipping fees) to the USACE Federal Standard costs (determined from historic costs).
- Provide recommendations, or options, for the roles and responsibilities of the dredge contractors, third party offloading contractor, and Owner responsibilities for beneficially reusing dredged material.

2. METHODOLOGY

2.1 General Assumptions

Each of the four placement sites was considered separately. At each site, a third party contractor[1] was assumed to win a competitive contract to construct the infrastructure needed and operate the site until the placement site was filled. The contractor's work would include preparation of the placement site to receive dredged material via pipeline.

This estimate assumes one mobilization and demobilization of capital infrastructure including mooring dolphins and a pipeline (submerged and on land). Pipeline distances were estimated from the offloader location to the centroid of the placement site. Once installed, this equipment would remain in place and maintained until the completion of the project. This estimate also assumes annual interim mobilizations outside of Long Term Management Strategy (LTMS) work windows to safely store portable equipment (a hydraulic offloader, a large diesel generator barge, support barges, and a booster pump).

The offloader is assumed to accept material on an ad hoc basis (as material arrives by scow from various dredging projects) 24 hours a day, 7 days a week. For the periods when scows are not actively being unloaded, the offloader is on operational standby. Operational standby requires the offloader to be fully crewed and ready to receive dredge material, with the generators operating for local power only (pump engines are not operating). Outside of the unloading periods (at least 6 months of the year when dredging is not anticipated), an allowance was included for weekly inspections and maintenance on the installed infrastructure (mooring dolphins, pipelines, safety lights, etc.)

Once the placement sites are filled to the desired capacity, all infrastructure (mooring dolphins, pipeline, etc.) and portable equipment (offloader, barges, etc.) would be demobilized from the site. Another contract, not included in this estimate, would be released to perform the site restoration work (e.g. earthwork to shape upland transition zones and restoration features).

2.2 Scenarios Analyzed

Three different cost estimates were prepared based on different schedules (non-optimized vs. optimized vs. super optimized) and material sources (Federal only or Federal and non-Federal). The three cost estimates are described below:

- <u>Non-optimized Estimate:</u> Offloader received and pumped material from the Oakland and Redwood City Federal Maintenance Dredging Projects only. This non-optimized estimate assumed that the Federal dredging projects will be dredged and delivered to the offloader during typical LTMS environmental windows (June 1 through November 30). The available material was spread evenly over the six-month environmental window for each year in operation.

- <u>Optimized Estimate:</u> Offloader received and pumped material from the Oakland and Redwood City Federal Maintenance Dredging Projects and Non-Federal Dredging Projects (approximately 0.5 – 1.2 MCY annually of additional material from medium-

[1] A third-party contractor was assumed to perform the work in this analysis, however a number of entities (e.g. the State of California, Don Edwards National Wildlife Refuge, CSCC) could perform the work. The cost is not expected to change, as program management costs are not included.

sized dredgers such as Ports and private dredgers). The optimized estimate assumed that the Federal and Non-Federal dredging projects were dredged and delivered in as productive a time frame as possible (within the working windows). The available material was condensed into a three to four month annual timeframe.

- Super Optimized Estimate: Offloader received and pumped material from the Oakland, Redwood City, and Richmond (Inner & Outer Harbors) Federal Maintenance Dredging Projects and Non-Federal Dredging Projects (approximately 0.5 – 0.9 MCY[2] annually of additional material from medium-sized dredgers such as Ports and private dredgers). The super optimized estimate was similar to the optimized estimate in assuming the dredging projects were dredged and delivered in as productive a time frame as possible (within the working windows); however it includes the Richmond Inner and Outer Harbor Federal Maintenance Dredging Project. With the additional volume, the available material was still condensed into a three to five month annual timeframe.

Each estimate (non-optimized, optimized, and super optimized) was prepared for the four placement sites.

2.3 Sediment Sources

Attachments A through D contain sediment source analyses for the four placement sites. The analysis for each site includes sediment quantities, distance from the sediment source (dredging location) to the project, and a delivery schedule. Federal and Non-Federal medium sized-dredging projects in the San Francisco Bay Area were considered as potential sources, with dredging projects and volumes gathered from five years of LTMS dredging records, from 2008 to 2012.

The following considerations were used to determine sediment sources:

- Projects located in the central and north San Francisco Bay are too far from the South Bay to economically beneficially reuse material at the SBSP Restoration Project. These projects were not included as sediment sources in this analysis.

- The SBSP Restoration Project cannot compete economically with Alcatraz, as Alcatraz is closer in proximity to most dredging locations and does not have associated site preparation costs in the form of a tipping fee. Projects such as the Port of San Francisco that dispose partially at Alcatraz are uncertain sources for the SBSP Restoration Project. Some such projects were included in the optimized and super optimized estimates; however none were included in the non-optimized estimate.

- The two USACE hopper dredges operated on the West Coast, the Essayons and Yaquina, are not equipped to offload at an offloader. Projects[3] performed by these hopper dredges

[2] The volume from Non-Federal Dredging Projects for the super optimized estimate was less than for the optimized estimate because the super optimized estimate included the Richmond Federal Maintenance Dredging Project. The additional volume from Richmond kept the offloader running near its maximum production rate, leaving less time for smaller Non-Federal projects to deliver material.

[3] The volume dredged by these dredges is notable, however the majority is sand which is not optimal for raising pond bottom elevations. In fiscal year 2013, the USACE dredged with Yaquina the Suisun Bay

were assumed to dispose of material at open water sites and not at the SBSP Restoration Project in all estimates.

- Private dredging projects have considerations other than cost that limit their interest in beneficial reuse sites, such as liability concerns when disposing of material at a mixed-material placement site. Some such projects were included in the optimized and super optimized estimates; however none were included in the non-optimized estimate.

- Some projects, such as the Larkspur Ferry Channel Project, require shallow draft scows which have less capacity than typical scows. Transporting shallow draft scows to the South Bay from the North Bay is not economically attractive compared to transport to Alcatraz. In addition, the frequency of dredging of these smaller non-Federal projects is much less than the Federal Maintenance Projects. These projects were not included as sediment sources in this analysis.

The sediment source analysis assumes that all material delivered to the offloader from the dredging work will be suitable for wetland cover based on the results of each individual project's sediment sampling and analysis program, as required by DMMO. It is further assumed that all material delivered to the offloader is comprised of primarily mud and silt, as is typical, and preferable, of maintenance dredged material. (Silts and clays stay in suspension as the slurry spreads over the decant cell, as opposed to sand, which falls out of suspension quickly beneath the discharge pipe and must be pushed around.)

2.4 Sediment Delivery Schedule

Based on the sediment source quantities, a dredged material delivery schedule was generated for each placement site (and each estimate scenario). Attachments A through D contain the delivery schedules for each placement site following the sediment volume tables. The schedule assumes the sediment will be dredged and delivered to the offloader during typical LTMS dredging environmental windows (June 1 through November 30). Material volume delivery was spread evenly during the environmental window for the non-optimized schedules, and was condensed into a shorter timeframe for the optimized and super optimized schedule.

The durations of the four placement site contracts were determined from the placement capacity, offloading production and the defined annual offloading duration.

2.5 Placement Site Capacities

The capacities of the ponds that make up each of the four placement sites are listed in Table 1. Pond capacities are defined by the volume required to raise the existing pond bottom elevation to the surrounding marsh elevation (USACE 2012). Foundation consolidation and material shrinkage are not included in these capacity estimates. The volumes that would be needed for creation of an upland transition zone are also not included.

(152,213 CY). In fiscal year 2014, the USACE anticipates dredging with Essayons and Yaquina the San Francisco Bar Channel (724,000 CY), Richmond Connecting Channel and Maneuvering Area (792,000 CY), Pinole Shoals (232,000 CY), and Suisun Bay (170,000 CY).

Table 1. Placement Site Capacities

Eden Landing Ponds	Material Capacity for Raising Pond Bottom (CY)	Total Site Capacity (MCY)
E1	1,042,378	7.2
E1C	139,364	
E2	2,387,453	
E2C	78,896	
E4	477,816	
E4C	761,589	
E5	499,607	
E5C	316,684	
E6	542,874	
E6C	215,483	
E7	774,981	

Alviso Ponds	Material Capacity for Raising Pond Bottom (CY)	Total Site Capacity (MCY)
A1	3,039,463	8.2
A2W	5,187,504	
A5	6,612,534	17.0
A7	2,274,783	
A8	5,944,543*	
A8S	2,124,157*	
A9	2,793,144	22.5
A10	2,547,653	
A11	3,288,485	
A12	4,380,116	
A13	3,392,498	
A14	3,420,362	
A15	2,662,779	

Source: DMMIP (USACE 2012)

*Volumes not included in the DMMIP. Calculated using the difference between mean pond elevation and surround marsh as defined in the DMMIP (USACE 2012).

2.6 Offloader Locations

Two offloader locations were defined as shown in Figure 2.1: one for the Eden Landing Complex and one for the three placement sites in the Alviso Complex. Both offloaders were located in the deep water channel (approximately 18 feet deep). No additional dredging was considered.

The Alviso Offloader location was positioned south of Dumbarton Bridge but north of the railroad bridge in the South San Francisco Bay to minimize scow transport delays while navigating in relatively shallow waters near the railroad bridge.

2.7 Offloader Power

In this analysis, all equipment was assumed to be powered by a large diesel generator barge to avoid a large up-front capital cost for electrical infrastructure installation. Although electrical infrastructure requires a large up-front capital investment compared to the mobilization cost of a diesel generator barge, operational costs of electrical equipment are less than diesel fuel. For instance, the Hamilton Wetlands Restoration Project invested about $10 million to install electrical infrastructure to operate an offloader and booster pump. Monthly operating costs for the offloader and booster pump were estimated at about $0.5 million for electric power, whereas costs for the same equipment run by diesel fuel would have totaled to about $1 million a month (twice as much). Operating only about 3 months a year, it would take the project about 7 years to recover the upfront $10 million through operation savings with the electrical infrastructure.

For the SBSP Restoration Project, some project durations for the Alviso Ponds are long enough that the project could benefit from an electrical power supply; however the capital investment may vary depending on the location of the nearest available transmission line and equipment required. Typically, an onshore transformer station would have to be constructed to pull power from an existing transmission line. An overhead pole line would be installed from the transformer station and continued to the Bay edge where another step down transformer would be installed. From the shore-side step down transformer, a submarine power cable would be laid on the Bay bottom out to the offloader and booster pump (if required). An electrical system such as this could increase costs for the SBSP Restoration Project by $9 to 12 million, depending on where the electrical source could be pulled from.

A diesel offloading system may be more economically attractive for a short project (5 years), however there may be CEQA limitations that could restrict diesel operations. Offloading operations and emissions are not covered under the maintenance dredging CEQA; they must either have a separate CEQA authorization or be part of the SBSP Restoration Project CEQA (as discussed in project-specific terms in M&N's Beneficial Reuse Feasibility Study). CEQA may limit NOx emissions to less than 100 tons/year and PM and/or PM10 may also be limited. This may or may not be a substantial limitation depending on whether or not the offloading operation emissions are constrained to the offloader, support vessels, and shore placement equipment. If the towing emissions are included for deepening projects, such as the Redwood City Deepening Project, it would be a significant limitation on yearly operations. Large generators can be fitted with selective catalytic reduction (SCR) systems to reduce emissions, however operation may still be restrained. As a result, most offloaders are equipped to be powered electrically.

Alternatively, there are carbon sequestration benefits that have not been accounted for with the project restoration effort. There could, or could not depending on the Bay Area emission calculation requirements, also be an overall reduction in emissions with the reduced transport distance to the South Bay as opposed to SF-DODs. LTMS's acknowledgement of this carbon sequestration and reduction in overall emissions would be beneficial to move this project through the permitting process.

2.8 Site Preparation to Receive Dredged Material

The placement sites would be prepared to receive dredged material by building containment berms and levees, weirs, and other decant water control structures. Levees would be improved if necessary to support heavy equipment, numerous truck trips, and dozers and loaders moving the slurry pipeline throughout the site. Low ground pressure equipment would excavate in-situ material in pond bottoms to build the containment berms within the placement sites. The larger ponds would require more containment berms to create long paths and to slow the slurry velocity down. Solids would settle out of suspension and the discharge back into the Bay would be low in turbidity. The cost to prepare each placement site will vary significantly with the size of the placement site, existing levee conditions, and the amount of existing levees within the placement site (i.e. many smaller ponds versus one large pond).

Site preparation costs were estimated at $2 to $3 per cubic yard for the SBSP Restoration Project based on recent beneficial reuse site construction costs. These costs were based off sites that required full infrastructure (there were no existing levees), so site investigations would reduce the cost if the existing levees are found to be in good condition and capable of containing decant water levels above MHW. The site preparation work does not include construction of flood protection levees or final restoration grading at the site (including building up transition zones).

2.9 Cost Estimate Assumptions

Costs were generated similar to the Moffatt & Nichol's Offloader Cost and Operational Analysis for USACE's Hamilton Wetland Restoration Project (M&N 2013). The following assumptions were made:

- **Direct Costs:** The cost estimates include direct costs, such as anticipated equipment, labor, and materials necessary to construct the project.
- **Project Overhead:** The cost estimates include the management, engineering, clerical, and support requirements for a general contractor to manage this type of a dredging/fill project. Additional costs were included to account for safety training and supplies, small tools and supplies, and unscheduled overtime.
- **Profit:** The cost estimates include a markup on the total cost to account for contractor profit. The markup cost is based on the contractor's direct labor costs to perform the work, which is typical of projects of this nature.
- **Bond:** The cost estimates include a 1.5% markup for contractor bonds.
- **Initial Capital Costs:** Initial capital costs include the following:
    - Initial one-time equipment mobilization of the offloader, booster pumps, and barges;
    - Pipeline installation;
    - Mooring dolphins purchase and installation; and
    - Other associated startup costs.
- **Operational Costs:** Operational costs include the following:
    - Annual interim mobilization and demobilization of equipment (offloader, booster pumps, barges);
    - Rental or lease costs for an offloader, booster pump(s), barges;
    - Labor and materials required to operate the offloader and booster pumps;
    - Pipeline operation;
    - Movement of the discharge pipe around the placement site;
    - Decant water quality testing such as the sample storage facility, testing laboratory, testing services, implementation of an SWPPP and effluent testing services; and
- **Offloader Productivity:** The offloading productivity was factored to account for delay between scow deliveries as well as for operating inefficiencies due to daily equipment maintenance, refueling, continued working hours, and crew shift changes.
- **Add-On Fees:** Of the total operational costs, a 3% design fee and 6% construction management fee were included in the estimate.
- **Contingency:** The offloader cost estimates include a contingency factor of 25%.
- **Escalation:** Costs have been escalated from 2015 to reflect the year in which construction is scheduled to take place based on the methodology detailed in the USACE EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS) Amendment #4 updated 31 March 2014.
- **Costs Not Included:** No costs were included for the following items:
    - Placement site restoration work including grading for restoration features;
    - Placement site material re-handling;

- Real estate transfer fees or other associated fees;
- Environmental documentation, permitting, mitigation and/or monitoring, or other program management costs; and
- Any electrical equipment; all is assumed to be diesel.

3. RESULTS

3.1 Offloading and Site Management Costs

The costs for offloading and managing the site during offloading, including all add-on fees, escalation, and contingency are summarized below in Table 2. The site preparation cost to receive dredged material is not included. The annual cost breakdowns for each placement site are included in Attachments E – H.

Table 2. Offloading and Site Management Costs

Placement Site	Non-Optimized	Optimized	Super Optimized
Eden Landing	$201.2M	$76.6M	$67.6M
Alviso (A1, A2W)	$255.2M	$90.8M	$76.6M
Alviso (A5, A7, A8, A8S)	$566.8M	$180.9M	$180.6M
Alviso (A9 - A15)	$792.8M	$240.0M	$226.2M

3.2 Offloading Project Durations

The offloading project durations (not including site preparation time) are listed in Table 3. The operating and standby times vary given the estimate scenario and are not shown. Of note, the volume of material delivered to the offloader is the limiting factor in the project duration, not the offloading production and placement rate.

Table 3. Offloading Project Durations

Placement Site	Non-Optimized	Optimized	Super Optimized
Eden Landing	8 yrs.	5 yrs.	4 yrs.
Alviso (A1, A2W)	10 yrs.	6 yrs.	4 yrs.
Alviso (A5, A7, A8, A8S)	19 yrs.	11 yrs.	9 yrs.
Alviso (A9 - A15)	25 yrs.	14 yrs.	11 yrs.

3.3 Tipping Fee

A tipping fee (price per cubic yard) is the cost dredgers would pay to dispose of material at the offloader. The revenue generated from the tipping fee would compensate the contractor's (or other entity's) work to install and operate the offloader and associated equipment (pipeline, barges, etc.), prepare the site to receive dredged material, and manage the site during the offloading operation.

For each estimate in this analysis, an average tipping fee was calculated using the costs summarized in Table 2, the cubic yard capacities listed in Table 1, and estimated site preparation costs. The tipping fees are summarized in Table 4. Site preparation costs were estimated at $2 to $3 per cubic yard.

Table 4. Tipping Fee at Offloader

Placement Site	Non-Optimized	Optimized	Super Optimized
Eden Landing	$30.62/CY	$13.23/CY	$12.32/CY
Alviso (A1, A2W)	$32.06/CY	$12.38/CY	$11.22/CY
Alviso (A5, A7, A8, A8S)	$34.87/CY	$12.63/CY	$12.52/CY
Alviso (A9 - A15)	$37.10/CY	$12.66/CY	$12.14/CY

3.4 Cost Comparison to Existing Disposal Reuse/Sites

Disposal costs for the four largest sediment source projects, all Federal maintenance projects, were compared to beneficial reuse costs at the SBSP Restoration Project. The Federal standard was used as the disposal site for the Federal maintenance projects. Table 5 summarizes the results. Costs include dredging, transport and disposal tipping fees. The SBSP Restoration Project costs assume material is delivered in an optimized schedule, and costs are averaged over the project duration.

Table 5. SBSP Restoration Project and Federal Standard Comparison

Placement Site	Eden Landing Offloader	Alviso Offloader	Federal Standard		SF-DODS (from DMMIP)
Oakland Inner & Outer Harbor[1]	$24.62/CY	$24.40/CY	$21.00 - 28.00/CY[3] (SF-DODS)		$25.33/CY
Redwood City Harbor[2]	$21.54/CY	$21.32/CY	$16.50/CY (SF-11)	$28.00/CY[4] (SF-DODS)	$33.17/CY
Richmond Inner Harbor	$24.94/CY	$25.18/CY	$22.00/CY (SF-DODS)		$26.02/CY
Richmond Outer Harbor	$25.07/CY	$25.27/CY	$22.00/CY (SF-DODS)		$26.02/CY

[1] As a reference, Oakland Federal Channel to Montezuma/SF-DODS in 2013 was $30.77/CY for approx. 330,600 CY.
[2] Redwood City Harbor Federal Standard is SF-11.
[3] $28.00 was the unit cost from the 2014 bid.
[4] Unit cost from 2010 Berth dredging with disposal at SF-DODS.

Beneficial reuse sites at Eden Landing and Alviso are cost competitive with the Federal Standard costs of USACE's four largest maintenance dredging projects.

4. SUMMARY AND NEXT STEPS

4.1 Summary

The San Francisco Bay Area currently has only one cost-effective, long term beneficial reuse site, the Montezuma Wetlands Project. Given the location and capacity of Montezuma, a South Bay beneficial reuse site is essential to further the LTMS commitment of reducing in-bay disposal, as well as increasing beneficial reuse in the sediment-deprived Bay system. The SBSP Restoration Project represents the type of stable, long-term project that could attract enough dredged material to keep the tipping fee cost competitive with offshore disposal. With very few deepening projects foreseen in the Bay Area, only the collective volume of numerous dredging projects can make a beneficial reuse site possible in the near future.

This cost estimate shows that beneficial reuse at the SBSP Restoration Project is generally cost competitive with the Federal Standard costs of USACE's South Bay maintenance dredging projects. The sediment volumes and sources assumed in this cost estimate are realistic, assuming coordination with USACE continues to move forward and an agreement is made in the future (see Section 4.2). This project requires DMMO support, which will in turn convince the Bay Area dredging community that the SBSP Restoration Project will be a viable beneficial reuse option in the future.

This cost estimate assumes that the current Bay Area dredging equipment, which has been built for offshore disposal, will remain. If however, the Eden Landing or Alviso Offloader is established and proves competitive, private dredgers will begin to shift their equipment from ocean disposal dump scows to less costly hopper scows more suited for offloading. Compared to dump scows, hopper scows are less costly and more efficient from an offloading standpoint. Given the option, dredgers prefer hopper scows to dump scows because hopper scows have minimal moving parts, requiring less maintenance and less time lost to mechanical failures.

If the dredgers change their equipment to fit a new beneficial reuse practice in the Bay Area, as they did when SF-DODS first became the primary disposal location, the costs to beneficially reuse material should decrease and prove to be very competitive.

Looking forward, if the SBSP Restoration Project were to install electrical infrastructure for an offloader at Alviso, the Bay Area dredging community would acknowledge the significant financial investment and undoubtedly include the beneficial reuse site in their future plans.

4.2 Future Roles and Responsibilities

Beneficial reuse in the SBSP Restoration Project depends on the cooperation of numerous parties. The following is a list of potential roles and responsibilities of the regulatory agencies, dredger, third party offloader contractor, and the CSCC.

- Dredgers: The largest sediment volume will be from the USACE. A Memorandum of Understanding (MOU) between USACE and the CSCC would provide future planning stability to both the SBSP Restoration Project as a placement site and USACE as a material source. Other smaller Ports and private dredgers could also join the MOU, or at a minimum benefit from one between USACE and CSCC.
- LTMS/DMMO: Without agency encouragement to beneficially reuse material in the Bay Area, some projects will continue to go to SF-DODS given the available equipment and lower uncertainties associated with a proven disposal site. Material disposed at SF-DODS will reduce the material economies of scale benefit from the SBSP Restoration Project. Incentivized agency backing to send material to the SBSP Restoration Project

in exchange for portions of material to be disposed of in-bay (inexpensively) could kick-start, and maintain, beneficial reuse.

- CSCC: As the project owner, the CSCC would act as the overall program manager and coordinate the MOUs and encourage agency participation. The CSCC could actively manage the placement sites and be responsible for construction management oversight throughout the offloading and decanting operations. The placement site design and final restoration grading would be the responsibility of CSCC.

5. REFERENCES

1. Moffatt & Nichol Hamilton Wetlands Restoration Project Commercially Owned Hydraulic Offloader Cost and Operational Analysis Final Submittal. Prepared for USACE. May 2013.
2. USACE EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS), Amendment #2 updated 31 March 2013.
3. USACE South San Francisco Bay Dredged Material Management Implementation Plan (DMMIP), South Bay Salt Ponds Restoration Project: Conceptual Beneficial Use Analysis, 29 February 2012.

ATTACHMENT A

SEDIMENT SOURCE ANALYSIS
EDEN LANDING (E1, E2, E4 – E7, E1C, E2C, E4C – E6C)

SBSP RESTORATION PROJECT - BENEFICIAL REUSE STUDY
PREDICTED DREDGED MATERIAL DELIVERY SCHEDULE

CONSIDERED PROJECTS	Frequency (Years)	Annual Volume	Volume per Episode2	Historical & Current Disposal Site(s)	Windows	Consulation Required	Distance to Eden Landing Offloader (miles one way)	Distance to Alviso Offloader (miles one way)
Federal								
Oakland Inner & Outer Harbor	1	734,000	734,000	SF-11, Montezuma, SF-DODS, ~~Hamilton~~	Aug. 1 - Nov. 30	4	23.7	29.2
Redwood City Harbor	3	157,000	471,000	SF-11, ~~Bair Island, Hamilton~~	Jun. 1 - Nov. 30	6	3.4	8.9
Richmond Inner Harbor	1	253,000	253,000	SF-11, SF-DODS, ~~Hamilton~~	Jun. 1 - Nov. 30	6	35.3	40.8
Richmond Outer Harbor	1	180,000	180,000	SF-11, SF-10	Jun. 1 - Nov. 30	6	35.3	40.8
Suisun Bay[2]	1	159,000	159,000	SF-16, SF-9	Aug. 1 - Nov. 30	4	62.8	68.4
Pinole Shoal[2]	1	163,000	163,000	SF-10, SF-8, ~~Hamilton~~	Jun. 1 - Nov. 30	6	40.7	46.2
	Subtotal	1,646,000						
Mid-Sized Non-Federal								
Chevron	1	135,000	135,000	SF-11, ~~Hamilton~~, SF-DODS, SF-10, Montezuma	Jun. 1 - Nov. 30	6	32.2	37.8
Larkspur Ferry Channel	4	62,000	248,000	SF-11, SF-10, SF-DODS	Jun. 1 - Nov. 30	6	35.1	40.6
Port of Oakland (Berths)	1	93,000	93,000	SF-11, Montezuma, ~~Hamilton~~	Aug. 1 - Nov. 30	4	25.4	30.9
Port of Redwood City	4	10,000	40,000	SF-11, SF-DODS	Jun. 1 - Nov. 30	6	3.4	8.9
Port of San Francisco	1	173,000	173,000	SF-11, SF-DODS, ~~Hamilton~~	Jun. 1 - Nov. 30	6	23.4	28.9
Port of Richmond (Berths)	3	16,667	50,001	SF-DODS	Jun. 1 - Nov. 30	6	35.3	40.8
Valero[3]	4 X per yr	55,000	55,000	SF-9, SF-11, SF-DODS, Winter Island, Montezuma, ~~Hamilton~~	Aug. 1 - Nov. 30	4	55.6	61.1
ConocoPhillips (Rodeo)	2	13,000	26,000	SF-9, SF-8	Jun. 1 - Nov. 30	6	47.4	52.9
Alameda Point Channel	3	91,000	273,000	SF-11, SF-DODS	Jun. 1 - Nov. 30	6	21.8	27.3
BAE Systems	2	63,000	126,000	SF-11, SF-DODS	Jun. 1 - Nov. 30	6	19.6	25.1
Allied Defense Recycling	4	61,000	244,000	SF-9, SF-DODS	Aug. 1 - Oct. 15	2.5	51.2	56.7
Emeryville Marina	4	14,000	56,000	SF-11	Aug. 1 - Nov. 30	4	28.0	33.5
	Subtotal	786,667						
	Total	2,432,667						

Please check the following projects:

[1]Volumes determined from five years of LTMS records (2008 - 2012).

[2]Suisun Bay and Pinole Shoal Projects are performed by Essayons (USACE dredge), which cannot economically dispose of material at an offloader. Projects are not included as sources.

[3]Valero Project is dredged frequently outside the assumed work windows. Project is not included as a source.

PREDICTED MATERIAL DELIVERY SCHEDULE
EDEN LANDING (E1, E2, E4-E7, E1C, E2C, E4C-E6C, 7.2 MCY) (NON-OPTIMIZED)

Eden Landing (E1, E2, E4-E7, E1C, E2C, E4C-E6C, 7.2 MCY)
Non-Optimized

TOTALS	7,285,000	MCY
	8	Years

(grey)	Consultation Required
(white)	Annual predictions redistributed evenly over non-consultation periods.

2015

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2016

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2017

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2018

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2019

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2020

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

PREDICTED MATERIAL DELIVERY SCHEDULE
EDEN LANDING (E1, E2, E4-E7, E1C, E2C, E4C-E6C, 7.2 MCY) (NON-OPTIMIZED)

Eden Landing (E1, E2, E4-E7, E1C, E2C, E4C-E6C, 7.2 MCY)
Non-Optimized

TOTALS	7,285,000	MCY
	8	Years

(grey) Consultation Required
(white) Annual predictions redistributed evenly over non-consultation periods.

2021

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2022

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

PREDICTED MATERIAL DELIVERY SCHEDULE
EDEN LANDING (E1, E2, E4-E7, E1C, E2C, E4C-E6C, 7.2 MCY) (OPTIMIZED)

Eden Landing (E1, E2, E4-E7, E1C, E2C, E4C-E6C, 7.2 MCY)
Optimized

TOTALS	7,481,002	MCY
	5	Years

Legend:
- Consultation Required
- Annual predictions redistributed evenly over non-consultation periods.
- Consultation Required (later half of month)

2015

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor									157,000	157,000	157,000		471,000
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)									16,667	16,667	16,667		50,001
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	594,000	594,000	594,000	0	**1,782,001**
					CY/day	*0*	*0*	*0*	*19,527*	*19,527*	*19,527*		

2016

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City									13,333	13,333	13,333		40,000
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)									8,667	8,667	8,667		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina									18,667	18,667	18,667		56,000
TOTAL	0	0	0	0	0	0	0	0	419,000	419,000	419,000	0	**1,257,000**
					CY/day	*0*	*0*	*0*	*13,774*	*13,774*	*13,774*		

PREDICTED MATERIAL DELIVERY SCHEDULE
EDEN LANDING (E1, E2, E4-E7, E1C, E2C, E4C-E6C, 7.2 MCY) (OPTIMIZED)

Eden Landing (E1, E2, E4-E7, E1C, E2C, E4C-E6C, 7.2 MCY)
Optimized

TOTALS	7,481,002	MCY
	5	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2017

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel									91,000	91,000	91,000		273,000
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	511,333	511,333	511,333	0	**1,534,000**
					CY/day	*0*	*0*	*0*	*16,809*	*16,809*	*16,809*		

2018

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor								117,750	117,750	117,750	117,750		471,000
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel								62,000	62,000	62,000	62,000		248,000
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)								12,500	12,500	12,500	12,500		50,001
ConocoPhillips (Rodeo)								6,500	6,500	6,500	6,500		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling								97,600	97,600	48,800			244,000
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	580,100	580,100	531,300	482,500	0	**2,174,001**
					CY/day	*0*	*0*	*19,070*	*19,070*	*17,465*	*15,861*		

PREDICTED MATERIAL DELIVERY SCHEDULE
EDEN LANDING (E1, E2, E4-E7, E1C, E2C, E4C-E6C, 7.2 MCY) (OPTIMIZED)

Eden Landing (E1, E2, E4-E7, E1C, E2C, E4C-E6C, 7.2 MCY)
Optimized

TOTALS	7,481,002	MCY
	5	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2019

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron													0
Larkspur Ferry Channel													0
Port of Oakland (Berths)													0
Port of Redwood City													0
Port of San Francisco													0
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	244,667	244,667	244,667	0	**734,000**
					CY/day	*0*	*0*	*0*	*8,043*	*8,043*	*8,043*		

PREDICTED MATERIAL DELIVERY SCHEDULE
EDEN LANDING (E1, E2, E4-E7, E1C, E2C, E4C-E6C, 7.2 MCY) (SUPER OPTIMIZED)

Eden Landing (E1, E2, E4-E7, E1C, E2C, E4C-E6C, 7.2 MCY)
Super Optimized

TOTALS	7,257,001	MCY
	4	Years

Legend	
(dark grey)	Consultation Required
(white)	Annual predictions redistributed evenly over non-consultation periods.
(light grey)	Consultation Required (later half of month)

2015

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor								117,750	117,750	117,750	117,750		471,000
Richmond Inner Harbor								63,250	63,250	63,250	63,250		253,000
Richmond Outer Harbor								45,000	45,000	45,000	45,000		180,000
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)								12,500	12,500	12,500	12,500		50,001
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems								31,500	31,500	31,500	31,500		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	553,750	553,750	553,750	553,750	0	**2,215,001**
					CY/day	*0*	*0*	*18,203*	*18,203*	*18,203*	*18,203*		

2016

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor									84,333	84,333	84,333		253,000
Richmond Outer Harbor									60,000	60,000	60,000		180,000
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City									13,333	13,333	13,333		40,000
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)									8,667	8,667	8,667		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina									18,667	18,667	18,667		56,000
TOTAL	0	0	0	0	0	0	0	0	563,333	563,333	563,333	0	**1,690,000**
					CY/day	*0*	*0*	*0*	*18,519*	*18,519*	*18,519*		

PREDICTED MATERIAL DELIVERY SCHEDULE
EDEN LANDING (E1, E2, E4-E7, E1C, E2C, E4C-E6C, 7.2 MCY) (SUPER OPTIMIZED)

Eden Landing (E1, E2, E4-E7, E1C, E2C, E4C-E6C, 7.2 MCY)
Super Optimized

TOTALS	7,257,001	MCY
	4	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2017

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor													0
Richmond Inner Harbor								63,250	63,250	63,250	63,250		253,000
Richmond Outer Harbor								45,000	45,000	45,000	45,000		180,000
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel								68,250	68,250	68,250	68,250		273,000
BAE Systems								31,500	31,500	31,500	31,500		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	491,750	491,750	491,750	491,750	0	**1,967,000**
					CY/day	*0*	*0*	*16,165*	*16,165*	*16,165*	*16,165*		

2018

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor									157,000	157,000	157,000		471,000
Richmond Inner Harbor													0
Richmond Outer Harbor									60,000	60,000	60,000		180,000
Chevron													0
Larkspur Ferry Channel													0
Port of Oakland (Berths)													0
Port of Redwood City													0
Port of San Francisco													0
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	461,667	461,667	461,667	0	**1,385,000**
					CY/day	*0*	*0*	*0*	*15,176*	*15,176*	*15,176*		

ATTACHMENT B

SEDIMENT SOURCE ANALYSIS
ALVISO (A1, A2W)

SBSP RESTORATION PROJECT - BENEFICIAL REUSE STUDY
PREDICTED DREDGED MATERIAL DELIVERY SCHEDULE

CONSIDERED PROJECTS	Frequency (Years)	Annual Volume	Volume per Episode2	Historical & Current Disposal Site(s)	Windows	Consulation Required	Distance to Eden Landing Offloader (miles one way)	Distance to Alviso Offloader (miles one way)
Federal								
Oakland Inner & Outer Harbor	1	734,000	734,000	SF-11, Montezuma, SF-DODS, ~~Hamilton~~	Aug. 1 - Nov. 30	4	23.7	29.2
Redwood City Harbor	3	157,000	471,000	SF-11, ~~Bair Island, Hamilton~~	Jun. 1 - Nov. 30	6	3.4	8.9
Richmond Inner Harbor	1	253,000	253,000	SF-11, SF-DODS, ~~Hamilton~~	Jun. 1 - Nov. 30	6	35.3	40.8
Richmond Outer Harbor	1	180,000	180,000	SF-11, SF-10	Jun. 1 - Nov. 30	6	35.3	40.8
Suisun Bay[2]	1	159,000	159,000	SF-16, SF-9	Aug. 1 - Nov. 30	4	62.8	68.4
Pinole Shoal[2]	1	163,000	163,000	SF-10, SF-8, ~~Hamilton~~	Jun. 1 - Nov. 30	6	40.7	46.2
	Subtotal	1,646,000						
Mid-Sized Non-Federal								
Chevron	1	135,000	135,000	SF-11, ~~Hamilton~~, SF-DODS, SF-10, Montezuma	Jun. 1 - Nov. 30	6	32.2	37.8
Larkspur Ferry Channel	4	62,000	248,000	SF-11, SF-10, SF-DODS	Jun. 1 - Nov. 30	6	35.1	40.6
Port of Oakland (Berths)	1	93,000	93,000	SF-11, Montezuma, ~~Hamilton~~	Aug. 1 - Nov. 30	4	25.4	30.9
Port of Redwood City	4	10,000	40,000	SF-11, SF-DODS	Jun. 1 - Nov. 30	6	3.4	8.9
Port of San Francisco	1	173,000	173,000	SF-11, SF-DODS, ~~Hamilton~~	Jun. 1 - Nov. 30	6	23.4	28.9
Port of Richmond (Berths)	3	16,667	50,001	SF-DODS	Jun. 1 - Nov. 30	6	35.3	40.8
Valero[3]	4 X per yr	55,000	55,000	SF-9, SF-11, SF-DODS, Winter Island, Montezuma, ~~Hamilton~~	Aug. 1 - Nov. 30	4	55.6	61.1
ConocoPhillips (Rodeo)	2	13,000	26,000	SF-9, SF-8	Jun. 1 - Nov. 30	6	47.4	52.9
Alameda Point Channel	3	91,000	273,000	SF-11, SF-DODS	Jun. 1 - Nov. 30	6	21.8	27.3
BAE Systems	2	63,000	126,000	SF-11, SF-DODS	Jun. 1 - Nov. 30	6	19.6	25.1
Allied Defense Recycling	4	61,000	244,000	SF-9, SF-DODS	Aug. 1 - Oct. 15	2.5	51.2	56.7
Emeryville Marina	4	14,000	56,000	SF-11	Aug. 1 - Nov. 30	4	28.0	33.5
	Subtotal	786,667						
	Total	2,432,667						

Please check the following projects:

[1]Volumes determined from five years of LTMS records (2008 - 2012).

[2]Suisun Bay and Pinole Shoal Projects are performed by Essayons (USACE dredge), which cannot economically dispose of material at an offloader. Projects are not included as sources.

[3]Valero Project is dredged frequently outside the assumed work windows. Project is not included as a source.

SBSP RESTORATION PROJECT
BENEFICIAL REUSE FEASIBILITY

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A1, A2W, 8.3 MCY) (NON-OPTIMIZED)

Alviso (A1, A2W, 8.3 MCY) Non-optimized

TOTALS		
	8,490,000	MCY
	10	Years

Consultation Required (shaded)
Annual predictions redistributed evenly over non-consultation periods. (unshaded)

2015

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2016

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2017

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2018

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2019

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2020

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A1, A2W, 8.3 MCY) (NON-OPTIMIZED)

Alviso (A1, A2W, 8.3 MCY) Non-optimized

TOTALS	8,490,000	MCY
	10	Years

Consultation Required (shaded)
Annual predictions redistributed evenly over non-consultation periods. (unshaded)

2021

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2022

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2023

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2024

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								0	0	0	0		
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	78,500	78,500	78,500	78,500	0	**471,000**
					CY/day	*2,581*	*2,581*	*2,581*	*2,581*	*2,581*	*2,581*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A1, A2W, 8.3 MCY) (OPTIMIZED)

Alviso (A1, A2W, 8.3 MCY) Optimized

TOTALS	8,742,002	MCY
	6	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2015

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor									157,000	157,000	157,000		471,000
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)									16,667	16,667	16,667		50,001
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	594,000	594,000	594,000	0	**1,782,001**
					CY/day	*0*	*0*	*0*	*19,527*	*19,527*	*19,527*		

2016

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City									13,333	13,333	13,333		40,000
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)									8,667	8,667	8,667		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina									18,667	18,667	18,667		56,000
TOTAL	0	0	0	0	0	0	0	0	419,000	419,000	419,000	0	**1,257,000**
					CY/day	*0*	*0*	*0*	*13,774*	*13,774*	*13,774*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A1, A2W, 8.3 MCY) (OPTIMIZED)

Alviso (A1, A2W, 8.3 MCY) Optimized

TOTALS	8,742,002	MCY
	6	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2017

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel									91,000	91,000	91,000		273,000
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	511,333	511,333	511,333	0	**1,534,000**
					CY/day	*0*	*0*	*0*	*16,809*	*16,809*	*16,809*		

2018

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor								117,750	117,750	117,750	117,750		471,000
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel								62,000	62,000	62,000	62,000		248,000
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)								12,500	12,500	12,500	12,500		50,001
ConocoPhillips (Rodeo)								6,500	6,500	6,500	6,500		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling								97,600	97,600	48,800			244,000
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	580,100	580,100	531,300	482,500	0	**2,174,001**
					CY/day	*0*	*0*	*19,070*	*19,070*	*17,465*	*15,861*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A1, A2W, 8.3 MCY) (OPTIMIZED)

Alviso (A1, A2W, 8.3 MCY) Optimized

TOTALS	8,742,002	MCY
	6	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2019

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	420,333	420,333	420,333	0	**1,261,000**
					CY/day	*0*	*0*	*0*	*13,818*	*13,818*	*13,818*		

2020

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron													0
Larkspur Ferry Channel													0
Port of Oakland (Berths)													0
Port of Redwood City													0
Port of San Francisco													0
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	244,667	244,667	244,667	0	**734,000**
					CY/day	*0*	*0*	*0*	*8,043*	*8,043*	*8,043*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A1, A2W, 8.3 MCY) (SUPER OPTIMIZED)

Alviso (A1, A2W, 8.3 MCY) Super Optimized

TOTALS	8,310,001	MCY
	4	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2015

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor								117,750	117,750	117,750	117,750		471,000
Richmond Inner Harbor								63,250	63,250	63,250	63,250		253,000
Richmond Outer Harbor								45,000	45,000	45,000	45,000		180,000
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)								12,500	12,500	12,500	12,500		50,001
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems								31,500	31,500	31,500	31,500		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	553,750	553,750	553,750	553,750	0	**2,215,001**
					CY/day	*0*	*0*	*18,203*	*18,203*	*18,203*	*18,203*		

2016

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor									84,333	84,333	84,333		253,000
Richmond Outer Harbor									60,000	60,000	60,000		180,000
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City									13,333	13,333	13,333		40,000
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)									8,667	8,667	8,667		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina									18,667	18,667	18,667		56,000
TOTAL	0	0	0	0	0	0	0	0	563,333	563,333	563,333	0	**1,690,000**
					CY/day	*0*	*0*	*0*	*18,519*	*18,519*	*18,519*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A1, A2W, 8.3 MCY) (SUPER OPTIMIZED)

Alviso (A1, A2W, 8.3 MCY) Super Optimized

TOTALS	8,310,001	MCY
	4	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2017

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor													0
Richmond Inner Harbor								63,250	63,250	63,250	63,250		253,000
Richmond Outer Harbor								45,000	45,000	45,000	45,000		180,000
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel								68,250	68,250	68,250	68,250		273,000
BAE Systems								31,500	31,500	31,500	31,500		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	491,750	491,750	491,750	491,750	0	**1,967,000**
					CY/day	*0*	*0*	*16,165*	*16,165*	*16,165*	*16,165*		

2018

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor							94,200	94,200	94,200	94,200	94,200		471,000
Richmond Inner Harbor							50,600	50,600	50,600	50,600	50,600		253,000
Richmond Outer Harbor							36,000	36,000	36,000	36,000	36,000		180,000
Chevron							27,000	27,000	27,000	27,000	27,000		135,000
Larkspur Ferry Channel							49,600	49,600	49,600	49,600	49,600		248,000
Port of Oakland (Berths)													0
Port of Redwood City													0
Port of San Francisco							34,600	34,600	34,600	34,600	34,600		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling								97,600	97,600	48,800			244,000
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	292,000	573,100	573,100	524,300	475,500	0	**2,438,000**
					CY/day	*0*	*9,599*	*18,840*	*18,840*	*17,235*	*15,631*		

ATTACHMENT C

SEDIMENT SOURCE ANALYSIS
ALVISO (A5, A7, A8, A8S)

SBSP RESTORATION PROJECT - BENEFICIAL REUSE STUDY
PREDICTED DREDGED MATERIAL DELIVERY SCHEDULE

CONSIDERED PROJECTS	Frequency (Years)	Annual Volume	Volume per Episode2	Historical & Current Disposal Site(s)	Windows	Consulation Required	Distance to Eden Landing Offloader (miles one way)	Distance to Alviso Offloader (miles one way)
Federal								
Oakland Inner & Outer Harbor	1	734,000	734,000	SF-11, Montezuma, SF-DODS, ~~Hamilton~~	Aug. 1 - Nov. 30	4	23.7	29.2
Redwood City Harbor	3	157,000	471,000	SF-11, ~~Bair Island, Hamilton~~	Jun. 1 - Nov. 30	6	3.4	8.9
Richmond Inner Harbor	1	253,000	253,000	SF-11, SF-DODS, ~~Hamilton~~	Jun. 1 - Nov. 30	6	35.3	40.8
Richmond Outer Harbor	1	180,000	180,000	SF-11, SF-10	Jun. 1 - Nov. 30	6	35.3	40.8
Suisun Bay[2]	1	159,000	159,000	SF-16, SF-9	Aug. 1 - Nov. 30	4	62.8	68.4
Pinole Shoal[2]	1	163,000	163,000	SF-10, SF-8, ~~Hamilton~~	Jun. 1 - Nov. 30	6	40.7	46.2
	Subtotal	1,646,000						
Mid-Sized Non-Federal								
Chevron	1	135,000	135,000	SF-11, ~~Hamilton~~, SF-DODS, SF-10, Montezuma	Jun. 1 - Nov. 30	6	32.2	37.8
Larkspur Ferry Channel	4	62,000	248,000	SF-11, SF-10, SF-DODS	Jun. 1 - Nov. 30	6	35.1	40.6
Port of Oakland (Berths)	1	93,000	93,000	SF-11, Montezuma, ~~Hamilton~~	Aug. 1 - Nov. 30	4	25.4	30.9
Port of Redwood City	4	10,000	40,000	SF-11, SF-DODS	Jun. 1 - Nov. 30	6	3.4	8.9
Port of San Francisco	1	173,000	173,000	SF-11, SF-DODS, ~~Hamilton~~	Jun. 1 - Nov. 30	6	23.4	28.9
Port of Richmond (Berths)	3	16,667	50,001	SF-DODS	Jun. 1 - Nov. 30	6	35.3	40.8
Valero[3]	4 X per yr	55,000	55,000	SF-9, SF-11, SF-DODS, Winter Island, Montezuma, ~~Hamilton~~	Aug. 1 - Nov. 30	4	55.6	61.1
ConocoPhillips (Rodeo)	2	13,000	26,000	SF-9, SF-8	Jun. 1 - Nov. 30	6	47.4	52.9
Alameda Point Channel	3	91,000	273,000	SF-11, SF-DODS	Jun. 1 - Nov. 30	6	21.8	27.3
BAE Systems	2	63,000	126,000	SF-11, SF-DODS	Jun. 1 - Nov. 30	6	19.6	25.1
Allied Defense Recycling	4	61,000	244,000	SF-9, SF-DODS	Aug. 1 - Oct. 15	2.5	51.2	56.7
Emeryville Marina	4	14,000	56,000	SF-11	Aug. 1 - Nov. 30	4	28.0	33.5
	Subtotal	786,667						
	Total	2,432,667						

Please check the following projects:

[1]Volumes determined from five years of LTMS records (2008 - 2012).

[2]Suisun Bay and Pinole Shoal Projects are performed by Essayons (USACE dredge), which cannot economically dispose of material at an offloader. Projects are not included as sources.

[3]Valero Project is dredged frequently outside the assumed work windows. Project is not included as a source.

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A5, A7, A8, A8S, 17.0 MCY) (NON-OPTIMIZED)

Alviso (A5, A7, A8, A8S, 17.0 MCY) Non-optimized

TOTALS	17,243,000	MCY
	19	Years

(grey)	Consultation Required
(white)	Annual predictions redistributed evenly over non-consultation periods.

2015

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2016

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2017

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2018

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2019

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2020

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A5, A7, A8, A8S, 17.0 MCY) (NON-OPTIMIZED)

Alviso (A5, A7, A8, A8S, 17.0 MCY) Non-optimized

TOTALS	17,243,000	MCY
	19	Years

Consultation Required (shaded)
Annual predictions redistributed evenly over non-consultation periods.

2021

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2022

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2023

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2024

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2025

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2026

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A5, A7, A8, A8S, 17.0 MCY) (NON-OPTIMIZED)

Alviso (A5, A7, A8, A8S, 17.0 MCY) Non-optimized

TOTALS	17,243,000	MCY
	19	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.

2027

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2028

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2029

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2030

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2031

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2032

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A5, A7, A8, A8S, 17.0 MCY) (NON-OPTIMIZED)

Alviso (A5, A7, A8, A8S, 17.0 MCY) Non-optimized

TOTALS	17,243,000	MCY
	19	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.

2033

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A5, A7, A8, A8S, 17.0 MCY) (OPTIMIZED)

Alviso (A5, A7, A8, A8S, 17.0 MCY) Optimized

TOTALS	17,019,004	MCY
	11	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2015

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor									157,000	157,000	157,000		471,000
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)									16,667	16,667	16,667		50,001
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	594,000	594,000	594,000	0	**1,782,001**
					CY/day	*0*	*0*	*0*	*19,527*	*19,527*	*19,527*		

2016

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City									13,333	13,333	13,333		40,000
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)									8,667	8,667	8,667		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina									18,667	18,667	18,667		56,000
TOTAL	0	0	0	0	0	0	0	0	419,000	419,000	419,000	0	**1,257,000**
					CY/day	*0*	*0*	*0*	*13,774*	*13,774*	*13,774*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A5, A7, A8, A8S, 17.0 MCY) (OPTIMIZED)

Alviso (A5, A7, A8, A8S, 17.0 MCY) Optimized

TOTALS	17,019,004	MCY
	11	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2017

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel									91,000	91,000	91,000		273,000
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	511,333	511,333	511,333	0	**1,534,000**
					CY/day	*0*	*0*	*0*	*16,809*	*16,809*	*16,809*		

2018

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor								117,750	117,750	117,750	117,750		471,000
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel								62,000	62,000	62,000	62,000		248,000
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)								12,500	12,500	12,500	12,500		50,001
ConocoPhillips (Rodeo)								6,500	6,500	6,500	6,500		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling								97,600	97,600	48,800			244,000
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	580,100	580,100	531,300	482,500	0	**2,174,001**
					CY/day	*0*	*0*	*19,070*	*19,070*	*17,465*	*15,861*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A5, A7, A8, A8S, 17.0 MCY) (OPTIMIZED)

Alviso (A5, A7, A8, A8S, 17.0 MCY) Optimized

TOTALS	17,019,004	MCY
	11	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2019

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	420,333	420,333	420,333	0	**1,261,000**
					CY/day	*0*	*0*	*0*	*13,818*	*13,818*	*13,818*		

2020

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City									13,333	13,333	13,333		40,000
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)									8,667	8,667	8,667		26,000
Alameda Point Channel									91,000	91,000	91,000		273,000
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina									18,667	18,667	18,667		56,000
TOTAL	0	0	0	0	0	0	0	0	510,000	510,000	510,000	0	**1,530,000**
					CY/day	*0*	*0*	*0*	*16,765*	*16,765*	*16,765*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A5, A7, A8, A8S, 17.0 MCY) (OPTIMIZED)

Alviso (A5, A7, A8, A8S, 17.0 MCY) Optimized

TOTALS	17,019,004	MCY
	11	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2021

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor									157,000	157,000	157,000		471,000
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)									16,667	16,667	16,667		50,001
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	594,000	594,000	594,000	0	**1,782,001**
					CY/day	*0*	*0*	*0*	*19,527*	*19,527*	*19,527*		

2022

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								244,667	244,667	244,667			734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron								45,000	45,000	45,000			135,000
Larkspur Ferry Channel								82,667	82,667	82,667			248,000
Port of Oakland (Berths)								31,000	31,000	31,000			93,000
Port of Redwood City													0
Port of San Francisco								57,667	57,667	57,667			173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)								8,667	8,667	8,667			26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling								97,600	97,600	48,800			244,000
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	567,267	567,267	518,467	0	0	**1,653,000**
					CY/day	*0*	*0*	*18,648*	*18,648*	*17,044*	*0*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A5, A7, A8, A8S, 17.0 MCY) (OPTIMIZED)

Alviso (A5, A7, A8, A8S, 17.0 MCY) Optimized

TOTALS	17,019,004	MCY
	11	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2023

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel									91,000	91,000	91,000		273,000
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	511,333	511,333	511,333	0	**1,534,000**
					CY/day	*0*	*0*	*0*	*16,809*	*16,809*	*16,809*		

2024

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor									157,000	157,000	157,000		471,000
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City									13,333	13,333	13,333		40,000
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)									16,667	16,667	16,667		50,001
ConocoPhillips (Rodeo)									8,667	8,667	8,667		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina									18,667	18,667	18,667		56,000
TOTAL	0	0	0	0	0	0	0	0	592,667	592,667	592,667	0	**1,778,001**
					CY/day	*0*	*0*	*0*	*19,483*	*19,483*	*19,483*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A5, A7, A8, A8S, 17.0 MCY) (OPTIMIZED)

Alviso (A5, A7, A8, A8S, 17.0 MCY) Optimized

TOTALS	17,019,004	MCY
	11	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2025

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron													0
Larkspur Ferry Channel													0
Port of Oakland (Berths)													0
Port of Redwood City													0
Port of San Francisco													0
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	244,667	244,667	244,667	0	**734,000**
					CY/day	*0*	*0*	*0*	*8,043*	*8,043*	*8,043*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A5, A7, A8, A8S, 17.0 MCY) (SUPER OPTIMIZED)

Alviso (A5, A7, A8, A8S, 17.0 MCY) Super Optimized

TOTALS	17,171,003	MCY
	9	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2015

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor								117,750	117,750	117,750	117,750		471,000
Richmond Inner Harbor								63,250	63,250	63,250	63,250		253,000
Richmond Outer Harbor								45,000	45,000	45,000	45,000		180,000
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)								12,500	12,500	12,500	12,500		50,001
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems								31,500	31,500	31,500	31,500		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	553,750	553,750	553,750	553,750	0	**2,215,001**
					CY/day	*0*	*0*	*18,203*	*18,203*	*18,203*	*18,203*		

2016

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor									84,333	84,333	84,333		253,000
Richmond Outer Harbor									60,000	60,000	60,000		180,000
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City									13,333	13,333	13,333		40,000
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)									8,667	8,667	8,667		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina									18,667	18,667	18,667		56,000
TOTAL	0	0	0	0	0	0	0	0	563,333	563,333	563,333	0	**1,690,000**
					CY/day	*0*	*0*	*0*	*18,519*	*18,519*	*18,519*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A5, A7, A8, A8S, 17.0 MCY) (SUPER OPTIMIZED)

Alviso (A5, A7, A8, A8S, 17.0 MCY) Super Optimized

TOTALS	17,171,003	MCY
	9	Years

Legend:
- Consultation Required (dark grey)
- Annual predictions redistributed evenly over non-consultation periods. (white)
- Consultation Required (later half of month) (light grey)

2017

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor													0
Richmond Inner Harbor								63,250	63,250	63,250	63,250		253,000
Richmond Outer Harbor								45,000	45,000	45,000	45,000		180,000
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel								68,250	68,250	68,250	68,250		273,000
BAE Systems								31,500	31,500	31,500	31,500		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	491,750	491,750	491,750	491,750	0	**1,967,000**
					CY/day	*0*	*0*	*16,165*	*16,165*	*16,165*	*16,165*		

2018

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor							94,200	94,200	94,200	94,200	94,200		471,000
Richmond Inner Harbor							50,600	50,600	50,600	50,600	50,600		253,000
Richmond Outer Harbor							36,000	36,000	36,000	36,000	36,000		180,000
Chevron							27,000	27,000	27,000	27,000	27,000		135,000
Larkspur Ferry Channel							49,600	49,600	49,600	49,600	49,600		248,000
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco							34,600	34,600	34,600	34,600	34,600		173,000
Port of Richmond (Berths)							10,000	10,000	10,000	10,000	10,000		50,001
ConocoPhillips (Rodeo)							5,200	5,200	5,200	5,200	5,200		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling								97,600	97,600	48,800			244,000
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	307,200	611,550	611,550	562,750	513,950	0	**2,607,001**
					CY/day	*0*	*10,099*	*20,104*	*20,104*	*18,499*	*16,895*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A5, A7, A8, A8S, 17.0 MCY) (SUPER OPTIMIZED)

Alviso (A5, A7, A8, A8S, 17.0 MCY) Super Optimized

TOTALS	17,171,003	MCY
	9	Years

Legend	
(dark grey)	Consultation Required
(white)	Annual predictions redistributed evenly over non-consultation periods.
(light grey)	Consultation Required (later half of month)

2019

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor									84,333	84,333	84,333		253,000
Richmond Outer Harbor									60,000	60,000	60,000		180,000
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	564,667	564,667	564,667	0	**1,694,000**
					CY/day	*0*	*0*	*0*	*18,562*	*18,562*	*18,562*		

2020

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor													0
Richmond Inner Harbor								63,250	63,250	63,250	63,250		253,000
Richmond Outer Harbor								45,000	45,000	45,000	45,000		180,000
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City								10,000	10,000	10,000	10,000		40,000
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)								6,500	6,500	6,500	6,500		26,000
Alameda Point Channel								68,250	68,250	68,250	68,250		273,000
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina								14,000	14,000	14,000	14,000		56,000
TOTAL	0	0	0	0	0	0	0	490,750	490,750	490,750	490,750	0	**1,963,000**
					CY/day	*0*	*0*	*16,132*	*16,132*	*16,132*	*16,132*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A5, A7, A8, A8S, 17.0 MCY) (SUPER OPTIMIZED)

Alviso (A5, A7, A8, A8S, 17.0 MCY) Super Optimized

TOTALS	17,171,003	MCY
	9	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2021

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor								117,750	117,750	117,750	117,750		471,000
Richmond Inner Harbor								63,250	63,250	63,250	63,250		253,000
Richmond Outer Harbor								45,000	45,000	45,000	45,000		180,000
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)								12,500	12,500	12,500	12,500		50,001
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems								31,500	31,500	31,500	31,500		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	553,750	553,750	553,750	553,750	0	**2,215,001**
					CY/day	*0*	*0*	*18,203*	*18,203*	*18,203*	*18,203*		

2022

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor													0
Richmond Inner Harbor								63,250	63,250	63,250	63,250		253,000
Richmond Outer Harbor								45,000	45,000	45,000	45,000		180,000
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel								62,000	62,000	62,000	62,000		248,000
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)								6,500	6,500	6,500	6,500		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling								97,600	97,600	48,800			244,000
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	558,100	558,100	509,300	460,500	0	**2,086,000**
					CY/day	*0*	*0*	*18,346*	*18,346*	*16,742*	*15,138*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A5, A7, A8, A8S, 17.0 MCY) (SUPER OPTIMIZED)

Alviso (A5, A7, A8, A8S, 17.0 MCY) Super Optimized

TOTALS	17,171,003	MCY
	9	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2023

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron													0
Larkspur Ferry Channel													0
Port of Oakland (Berths)													0
Port of Redwood City													0
Port of San Francisco													0
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	244,667	244,667	244,667	0	**734,000**
					CY/day	*0*	*0*	*0*	*8,043*	*8,043*	*8,043*		

ATTACHMENT D

SEDIMENT SOURCE ANALYSIS
ALVISO (A9 – A15)

SBSP RESTORATION PROJECT - BENEFICIAL REUSE STUDY
PREDICTED DREDGED MATERIAL DELIVERY SCHEDULE

CONSIDERED PROJECTS	Frequency (Years)	Annual Volume	Volume per Episode2	Historical & Current Disposal Site(s)	Windows	Consulation Required	Distance to Eden Landing Offloader (miles one way)	Distance to Alviso Offloader (miles one way)
Federal								
Oakland Inner & Outer Harbor	1	734,000	734,000	SF-11, Montezuma, SF-DODS, ~~Hamilton~~	Aug. 1 - Nov. 30	4	23.7	29.2
Redwood City Harbor	3	157,000	471,000	SF-11, ~~Bair Island, Hamilton~~	Jun. 1 - Nov. 30	6	3.4	8.9
Richmond Inner Harbor	1	253,000	253,000	SF-11, SF-DODS, ~~Hamilton~~	Jun. 1 - Nov. 30	6	35.3	40.8
Richmond Outer Harbor	1	180,000	180,000	SF-11, SF-10	Jun. 1 - Nov. 30	6	35.3	40.8
Suisun Bay[2]	1	159,000	159,000	SF-16, SF-9	Aug. 1 - Nov. 30	4	62.8	68.4
Pinole Shoal[2]	1	163,000	163,000	SF-10, SF-8, ~~Hamilton~~	Jun. 1 - Nov. 30	6	40.7	46.2
	Subtotal	1,646,000						
Mid-Sized Non-Federal								
Chevron	1	135,000	135,000	SF-11, ~~Hamilton~~, SF-DODS, SF-10, Montezuma	Jun. 1 - Nov. 30	6	32.2	37.8
Larkspur Ferry Channel	4	62,000	248,000	SF-11, SF-10, SF-DODS	Jun. 1 - Nov. 30	6	35.1	40.6
Port of Oakland (Berths)	1	93,000	93,000	SF-11, Montezuma, ~~Hamilton~~	Aug. 1 - Nov. 30	4	25.4	30.9
Port of Redwood City	4	10,000	40,000	SF-11, SF-DODS	Jun. 1 - Nov. 30	6	3.4	8.9
Port of San Francisco	1	173,000	173,000	SF-11, SF-DODS, ~~Hamilton~~	Jun. 1 - Nov. 30	6	23.4	28.9
Port of Richmond (Berths)	3	16,667	50,001	SF-DODS	Jun. 1 - Nov. 30	6	35.3	40.8
Valero[3]	4 X per yr	55,000	55,000	SF-9, SF-11, SF-DODS, Winter Island, Montezuma, ~~Hamilton~~	Aug. 1 - Nov. 30	4	55.6	61.1
ConocoPhillips (Rodeo)	2	13,000	26,000	SF-9, SF-8	Jun. 1 - Nov. 30	6	47.4	52.9
Alameda Point Channel	3	91,000	273,000	SF-11, SF-DODS	Jun. 1 - Nov. 30	6	21.8	27.3
BAE Systems	2	63,000	126,000	SF-11, SF-DODS	Jun. 1 - Nov. 30	6	19.6	25.1
Allied Defense Recycling	4	61,000	244,000	SF-9, SF-DODS	Aug. 1 - Oct. 15	2.5	51.2	56.7
Emeryville Marina	4	14,000	56,000	SF-11	Aug. 1 - Nov. 30	4	28.0	33.5
	Subtotal	786,667						
	Total	2,432,667						

Please check the following projects:

[1]Volumes determined from five years of LTMS records (2008 - 2012).

[2]Suisun Bay and Pinole Shoal Projects are performed by Essayons (USACE dredge), which cannot economically dispose of material at an offloader. Projects are not included as sources.

[3]Valero Project is dredged frequently outside the assumed work windows. Project is not included as a source.

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (NON-OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Non-optimized

TOTALS	22,589,000	MCY
	25	Years

(grey)	Consultation Required
(white)	Annual predictions redistributed evenly over non-consultation periods.

2015

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2016

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2017

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2018

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2019

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2020

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (NON-OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Non-optimized

TOTALS	22,589,000	MCY
	25	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.

2021

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2022

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2023

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2024

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2025

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2026

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (NON-OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Non-optimized

TOTALS	22,589,000	MCY
	25	Years

Legend	
(shaded)	Consultation Required
(unshaded)	Annual predictions redistributed evenly over non-consultation periods.

2027

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2028

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2029

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2030

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2031

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2032

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (NON-OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Non-optimized

TOTALS	22,589,000	MCY
	25	Years

Consultation Required (shaded)
Annual predictions redistributed evenly over non-consultation periods. (unshaded)

2033

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2034

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2035

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2036

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

2037

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

2038

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						0	0	0	0	0	0		
FEDERAL TOTAL	0	0	0	0	0	0	0	183,500	183,500	183,500	183,500	0	**734,000**
					CY/day	*0*	*0*	*6,032*	*6,032*	*6,032*	*6,032*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (NON-OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Non-optimized

TOTALS	22,589,000	MCY
	25	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.

2039

FEDERAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor						78,500	78,500	78,500	78,500	78,500	78,500		471,000
FEDERAL TOTAL	0	0	0	0	0	78,500	78,500	262,000	262,000	262,000	262,000	0	**1,205,000**
					CY/day	*2,581*	*2,581*	*8,613*	*8,613*	*8,613*	*8,613*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Optimized

TOTALS	22,511,005	MCY
	14	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2015

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor									157,000	157,000	157,000		471,000
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)									16,667	16,667	16,667		50,001
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	594,000	594,000	594,000	0	**1,782,001**
					CY/day	*0*	*0*	*0*	*19,527*	*19,527*	*19,527*		

2016

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City									13,333	13,333	13,333		40,000
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)									8,667	8,667	8,667		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina									18,667	18,667	18,667		56,000
TOTAL	0	0	0	0	0	0	0	0	419,000	419,000	419,000	0	**1,257,000**
					CY/day	*0*	*0*	*0*	*13,774*	*13,774*	*13,774*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Optimized

TOTALS	22,511,005	MCY
	14	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2017

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel									91,000	91,000	91,000		273,000
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	511,333	511,333	511,333	0	**1,534,000**
					CY/day	*0*	*0*	*0*	*16,809*	*16,809*	*16,809*		

2018

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor								117,750	117,750	117,750	117,750		471,000
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel								62,000	62,000	62,000	62,000		248,000
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)								12,500	12,500	12,500	12,500		50,001
ConocoPhillips (Rodeo)								6,500	6,500	6,500	6,500		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling								97,600	97,600	48,800			244,000
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	580,100	580,100	531,300	482,500	0	**2,174,001**
					CY/day	*0*	*0*	*19,070*	*19,070*	*17,465*	*15,861*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Optimized

TOTALS	22,511,005	MCY
	14	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2019

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	420,333	420,333	420,333	0	**1,261,000**
					CY/day	*0*	*0*	*0*	*13,818*	*13,818*	*13,818*		

2020

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City									13,333	13,333	13,333		40,000
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)									8,667	8,667	8,667		26,000
Alameda Point Channel									91,000	91,000	91,000		273,000
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina									18,667	18,667	18,667		56,000
TOTAL	0	0	0	0	0	0	0	0	510,000	510,000	510,000	0	**1,530,000**
					CY/day	*0*	*0*	*0*	*16,765*	*16,765*	*16,765*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Optimized

TOTALS		
	22,511,005	MCY
	14	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2021

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor									157,000	157,000	157,000		471,000
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)									16,667	16,667	16,667		50,001
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	594,000	594,000	594,000	0	**1,782,001**
					CY/day	*0*	*0*	*0*	*19,527*	*19,527*	*19,527*		

2022

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								244,667	244,667	244,667			734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron								45,000	45,000	45,000			135,000
Larkspur Ferry Channel								82,667	82,667	82,667			248,000
Port of Oakland (Berths)								31,000	31,000	31,000			93,000
Port of Redwood City													0
Port of San Francisco								57,667	57,667	57,667			173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)								8,667	8,667	8,667			26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling								97,600	97,600	48,800			244,000
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	567,267	567,267	518,467	0	0	**1,653,000**
					CY/day	*0*	*0*	*18,648*	*18,648*	*17,044*	*0*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Optimized

TOTALS	22,511,005	MCY
	14	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2023

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel									91,000	91,000	91,000		273,000
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	511,333	511,333	511,333	0	**1,534,000**
					CY/day	*0*	*0*	*0*	*16,809*	*16,809*	*16,809*		

2024

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor									157,000	157,000	157,000		471,000
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City									13,333	13,333	13,333		40,000
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)									16,667	16,667	16,667		50,001
ConocoPhillips (Rodeo)									8,667	8,667	8,667		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina									18,667	18,667	18,667		56,000
TOTAL	0	0	0	0	0	0	0	0	592,667	592,667	592,667	0	**1,778,001**
					CY/day	*0*	*0*	*0*	*19,483*	*19,483*	*19,483*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Optimized

TOTALS	22,511,005	MCY
	14	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2025

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	420,333	420,333	420,333	0	**1,261,000**
					CY/day	*0*	*0*	*0*	*13,818*	*13,818*	*13,818*		

2026

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel								62,000	62,000	62,000	62,000		248,000
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)								6,500	6,500	6,500	6,500		26,000
Alameda Point Channel								68,250	68,250	68,250	68,250		273,000
BAE Systems													0
Allied Defense Recycling								97,600	97,600	48,800			244,000
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	518,100	518,100	469,300	420,500	0	**1,926,000**
					CY/day	*0*	*0*	*17,032*	*17,032*	*15,427*	*13,823*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Optimized

TOTALS	22,511,005	MCY
	14	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2027

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor									157,000	157,000	157,000		471,000
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)									16,667	16,667	16,667		50,001
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	594,000	594,000	594,000	0	**1,782,001**
					CY/day	*0*	*0*	*0*	*19,527*	*19,527*	*19,527*		

2028

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor													0
Richmond Outer Harbor													0
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City									13,333	13,333	13,333		40,000
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)									8,667	8,667	8,667		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina									18,667	18,667	18,667		56,000
TOTAL	0	0	0	0	0	0	0	0	419,000	419,000	419,000	0	**1,257,000**
					CY/day	*0*	*0*	*0*	*13,774*	*13,774*	*13,774*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (SUPER OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Super Optimized

TOTALS	22,309,004	MCY
	11	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2015

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor								117,750	117,750	117,750	117,750		471,000
Richmond Inner Harbor								63,250	63,250	63,250	63,250		253,000
Richmond Outer Harbor								45,000	45,000	45,000	45,000		180,000
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)								12,500	12,500	12,500	12,500		50,001
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems								31,500	31,500	31,500	31,500		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	553,750	553,750	553,750	553,750	0	**2,215,001**
					CY/day	*0*	*0*	*18,203*	*18,203*	*18,203*	*18,203*		

2016

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor									84,333	84,333	84,333		253,000
Richmond Outer Harbor									60,000	60,000	60,000		180,000
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City									13,333	13,333	13,333		40,000
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)									8,667	8,667	8,667		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina									18,667	18,667	18,667		56,000
TOTAL	0	0	0	0	0	0	0	0	563,333	563,333	563,333	0	**1,690,000**
					CY/day	*0*	*0*	*0*	*18,519*	*18,519*	*18,519*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (SUPER OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Super Optimized

TOTALS	22,309,004	MCY
	11	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2017

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor													0
Richmond Inner Harbor								63,250	63,250	63,250	63,250		253,000
Richmond Outer Harbor								45,000	45,000	45,000	45,000		180,000
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel								68,250	68,250	68,250	68,250		273,000
BAE Systems								31,500	31,500	31,500	31,500		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	491,750	491,750	491,750	491,750	0	**1,967,000**
					CY/day	*0*	*0*	*16,165*	*16,165*	*16,165*	*16,165*		

2018

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor							94,200	94,200	94,200	94,200	94,200		471,000
Richmond Inner Harbor							50,600	50,600	50,600	50,600	50,600		253,000
Richmond Outer Harbor							36,000	36,000	36,000	36,000	36,000		180,000
Chevron							27,000	27,000	27,000	27,000	27,000		135,000
Larkspur Ferry Channel							49,600	49,600	49,600	49,600	49,600		248,000
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco							34,600	34,600	34,600	34,600	34,600		173,000
Port of Richmond (Berths)							10,000	10,000	10,000	10,000	10,000		50,001
ConocoPhillips (Rodeo)							5,200	5,200	5,200	5,200	5,200		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling								97,600	97,600	48,800			244,000
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	307,200	611,550	611,550	562,750	513,950	0	**2,607,001**
					CY/day	*0*	*10,099*	*20,104*	*20,104*	*18,499*	*16,895*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (SUPER OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Super Optimized

TOTALS	22,309,004	MCY
	11	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2019

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor									84,333	84,333	84,333		253,000
Richmond Outer Harbor									60,000	60,000	60,000		180,000
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	564,667	564,667	564,667	0	**1,694,000**
					CY/day	*0*	*0*	*0*	*18,562*	*18,562*	*18,562*		

2020

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor													0
Richmond Inner Harbor								63,250	63,250	63,250	63,250		253,000
Richmond Outer Harbor								45,000	45,000	45,000	45,000		180,000
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City								10,000	10,000	10,000	10,000		40,000
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)								6,500	6,500	6,500	6,500		26,000
Alameda Point Channel								68,250	68,250	68,250	68,250		273,000
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina								14,000	14,000	14,000	14,000		56,000
TOTAL	0	0	0	0	0	0	0	490,750	490,750	490,750	490,750	0	**1,963,000**
					CY/day	*0*	*0*	*16,132*	*16,132*	*16,132*	*16,132*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (SUPER OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Super Optimized

TOTALS	22,309,004	MCY
	11	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2021

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor								117,750	117,750	117,750	117,750		471,000
Richmond Inner Harbor								63,250	63,250	63,250	63,250		253,000
Richmond Outer Harbor								45,000	45,000	45,000	45,000		180,000
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)								12,500	12,500	12,500	12,500		50,001
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems								31,500	31,500	31,500	31,500		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	553,750	553,750	553,750	553,750	0	**2,215,001**
					CY/day	*0*	*0*	*18,203*	*18,203*	*18,203*	*18,203*		

2022

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor													0
Richmond Inner Harbor								63,250	63,250	63,250	63,250		253,000
Richmond Outer Harbor								45,000	45,000	45,000	45,000		180,000
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel								62,000	62,000	62,000	62,000		248,000
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)								6,500	6,500	6,500	6,500		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling								97,600	97,600	48,800			244,000
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	558,100	558,100	509,300	460,500	0	**2,086,000**
					CY/day	*0*	*0*	*18,346*	*18,346*	*16,742*	*15,138*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (SUPER OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Super Optimized

TOTALS	22,309,004	MCY
	11	Years

Consultation Required
Annual predictions redistributed evenly over non-consultation periods.
Consultation Required (later half of month)

2023

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor													0
Richmond Inner Harbor								63,250	63,250	63,250	63,250		253,000
Richmond Outer Harbor								45,000	45,000	45,000	45,000		180,000
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City													0
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel								68,250	68,250	68,250	68,250		273,000
BAE Systems								31,500	31,500	31,500	31,500		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	491,750	491,750	491,750	491,750	0	**1,967,000**
					CY/day	*0*	*0*	*16,165*	*16,165*	*16,165*	*16,165*		

2024

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor								183,500	183,500	183,500	183,500		734,000
Redwood City Harbor								117,750	117,750	117,750	117,750		471,000
Richmond Inner Harbor								63,250	63,250	63,250	63,250		253,000
Richmond Outer Harbor								45,000	45,000	45,000	45,000		180,000
Chevron								33,750	33,750	33,750	33,750		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)								23,250	23,250	23,250	23,250		93,000
Port of Redwood City								10,000	10,000	10,000	10,000		40,000
Port of San Francisco								43,250	43,250	43,250	43,250		173,000
Port of Richmond (Berths)								12,500	12,500	12,500	12,500		50,001
ConocoPhillips (Rodeo)								6,500	6,500	6,500	6,500		26,000
Alameda Point Channel													0
BAE Systems													0
Allied Defense Recycling													0
Emeryville Marina								14,000	14,000	14,000	14,000		56,000
TOTAL	0	0	0	0	0	0	0	552,750	552,750	552,750	552,750	0	**2,211,001**
					CY/day	*0*	*0*	*18,171*	*18,171*	*18,171*	*18,171*		

PREDICTED MATERIAL DELIVERY SCHEDULE
ALVISO (A9 - A15, 22.5 MCY) (SUPER OPTIMIZED)

Alviso (A9 - A15, 22.5 MCY) Super Optimized

TOTALS	22,309,004	MCY
	11	Years

Legend:
- (dark grey) Consultation Required
- (white) Annual predictions redistributed evenly over non-consultation periods.
- (light grey) Consultation Required (later half of month)

2025

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Oakland Inner & Outer Harbor									244,667	244,667	244,667		734,000
Redwood City Harbor													0
Richmond Inner Harbor									84,333	84,333	84,333		253,000
Richmond Outer Harbor									60,000	60,000	60,000		180,000
Chevron									45,000	45,000	45,000		135,000
Larkspur Ferry Channel													0
Port of Oakland (Berths)									31,000	31,000	31,000		93,000
Port of Redwood City													0
Port of San Francisco									57,667	57,667	57,667		173,000
Port of Richmond (Berths)													0
ConocoPhillips (Rodeo)													0
Alameda Point Channel													0
BAE Systems									42,000	42,000	42,000		126,000
Allied Defense Recycling													0
Emeryville Marina													0
TOTAL	0	0	0	0	0	0	0	0	564,667	564,667	564,667	0	**1,694,000**
					CY/day	*0*	*0*	*0*	*18,562*	*18,562*	*18,562*		

ATTACHMENT E

OFFLOADER COST ESTIMATE SUMMARY
EDEN LANDING (E1, E2, E4 - E7, E1C, E2C, E4C - E6C)
NON-OPTIMIZED, OPTIMIZED, AND SUPER OPTIMIZED SCHEDULES

OFFLOADER COST ESTIMATE SUMMARY
EDEN LANDING (E1, E2, E4-E7, E1C, E2C, E4C-E6C, 7.2 MCY)

OPTIMIZED SCHEDULE

Year	Predicted Dredging Quantity (CY)	Production Rate (CY/hr)	Unloading Time (Hrs)	Op. Standby Time (Hrs)	Unloading Cost ($/hr)	Unloading Cost ($)	Maintenance of Facility during Non-Unloading (Months)	Maintenance of Facility during Non-Unloading ($)	Interim Mob/Demob ($)	Mob/Demob (initial) ($)	Cost Subtotal ($)	Unit Cost ($/cy)	Design Fee @ 3% ($)	CM @ 6% ($)	Contingency @ 25% ($)	Cost to CCC in 2013 dollars ($)	Escalation ($)	Totals Cost	Totals Unit Cost	Duration (Months)
2015	1,782,001		1,069	1,121	$4,224	$9,250,560	1	$10,000	$279,000	$3,942,000	$13,481,560	$7.57	$404,447	$808,894	$3,370,390	$18,065,290	1.00	$18,065,290	$10.14	3.0
2016	1,257,000		754	1,436	$4,224	$9,250,560	9	$88,000	$279,000	$0	$9,617,560	$7.65	$288,527	$577,054	$2,404,390	$12,887,530	1.02	$13,132,510	$10.45	3.0
2017	1,534,000	1,667	920	1,270	$4,224	$9,250,560	9	$88,000	$279,000	$0	$9,617,560	$6.27	$288,527	$577,054	$2,404,390	$12,887,530	1.04	$13,395,085	$8.73	3.0
2018	2,174,001		1,304	1,616	$4,224	$12,334,080	8	$78,000	$279,000	$0	$12,691,080	$5.84	$380,732	$761,465	$3,172,770	$17,006,047	1.06	$18,029,434	$8.29	4.0
2019	734,000		440	1,750	$4,224	$9,250,560	9	$88,000	$279,000	$0	$9,617,560	$13.10	$288,527	$577,054	$2,404,390	$12,887,530	1.08	$13,936,327	$18.99	3.0
	7,481,002		4,488	7,192		$49,336,320		$352,000	$1,395,000	$3,942,000	$55,025,320	$7.36	$1,650,760	$3,301,519	$13,756,330	$73,733,929		$76,558,647	$10.23	16.0
				16 months															*$/Mo*	*$4,784,915*
			280 Avg. Hrs/Mo unloading																	

<u>Cost Estimate Assumptions:</u>

1.) No costs are included for disposal site preparation, rehandling or any other upland infrastructure placement requirements.
2.) No costs are included for real estate transfer fees, environmental documentation, permitting, mitigation and/or monitoring, program management costs or other associated fees.
3.) The costs and quantities are for the Oakland and Redwood City Federal Maintenance Dredging Projects along with mid-sized non-federal projects including ports and private dredgers.
4.) Total volume considered for the project is 7.2 MCY (1.0 MCY to E1, 0.1 MCY to E1C, 2.4 MCY to E2, <0.1 MCY to E2C, 0.5 MCY to E4, 0.8 MCY to E4C, 0.5 MCY to E5, 0.3 MCY to E5C, 0.5 MCY to E6, 0.2 MCY to E6C, and 0.8 MCY to E7).
5.) Dredging projects are scheduled to fit within the San Francisco Bay Dredging Work Windows and have been optimized to be completed based on a the minimum monthly productions using four large dump scows.
6.) Unloading equipment hourly costs are based on the Hamilton Wetlands Restoration Project (BMK V) Offloader Cost Estimate dated May 2013.
7.) Costs and dredging cycles are based on a single Unloader contract.
8.) Mob/Demob costs include booster pump installation, pipeline installation, and diesel generator installation costs.
9.) All equipment costs assume diesel engines for the Offloader and Booster Pump.
10.) The Offloader, booster pump and support barges will be demobilized at the end of the year and taken offsite. Only the mooring dolphin piles and pipeline will remain onsite.
11.) Costs have been included to maintain site security, pumps, navigation lights on the mooring pile dolphins, and inspect the placement site during the non-unloading periods.
12.) Costs have been escalated to reflect the year in which construction could take place based on USACE EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS) using Table A-2 from Amendment #4 updated 31 March 2014.

OFFLOADER COST ESTIMATE SUMMARY
EDEN LANDING (E1, E2, E4-E7, E1C, E2C, E4C-E6C, 7.2 MCY)

NON-OPTIMIZED SCHEDULE

Year	Predicted Dredging Quantity (CY)	Production Rate (CY/hr)	Unloading Time (Hrs)	Op. Standby Time (Hrs)	Unloading Cost ($/hr)	Unloading Cost ($)	Maintenance of Facility during Non-Unloading (Months)	Maintenance of Facility during Non-Unloading ($)	Interim Mob/Demob ($)	Mob/Demob (initial) ($)	Cost Subtotal ($)	Unit Cost ($/cy)	Design Fee @ 3% ($)	CM @ 6% ($)	Contingency @ 25% ($)	Cost to CCC in 2015 dollars ($)	Escalation ($)	Totals Cost	Totals Unit Cost	Duration (Months)
2015	1,205,000		723	3,657	$3,814	$16,705,320	1	$10,000	$288,000	$3,940,000	$20,943,320	$17.38	$628,300	$1,256,599	$5,235,830	$28,064,049	1.00	$28,064,049	$23.29	6.0
2016	734,000		440	3,940	$3,814	$16,705,320	6	$60,000	$288,000	$0	$17,053,320	$23.23	$511,600	$1,023,199	$4,263,330	$22,851,449	1.02	$23,285,833	$31.72	6.0
2017	734,000		440	3,940	$3,814	$16,705,320	6	$60,000	$288,000	$0	$17,053,320	$23.23	$511,600	$1,023,199	$4,263,330	$22,851,449	1.04	$23,751,417	$32.36	6.0
2018	1,205,000	1,667	723	3,657	$3,814	$16,705,320	6	$60,000	$288,000	$0	$17,053,320	$14.15	$511,600	$1,023,199	$4,263,330	$22,851,449	1.06	$24,226,600	$20.11	6.0
2019	734,000		440	3,940	$3,814	$16,705,320	6	$60,000	$288,000	$0	$17,053,320	$23.23	$511,600	$1,023,199	$4,263,330	$22,851,449	1.08	$24,711,116	$33.67	6.0
2020	734,000		440	3,940	$3,814	$16,705,320	6	$60,000	$288,000	$0	$17,053,320	$23.23	$511,600	$1,023,199	$4,263,330	$22,851,449	1.10	$25,205,231	$34.34	6.0
2021	1,205,000		723	3,657	$3,814	$16,705,320	6	$60,000	$288,000	$0	$17,053,320	$14.15	$511,600	$1,023,199	$4,263,330	$22,851,449	1.13	$25,709,213	$21.34	6.0
2022	734,000		440	3,940	$3,814	$16,705,320	6	$60,000	$288,000	$0	$17,053,320	$23.23	$511,600	$1,023,199	$4,263,330	$22,851,449	1.15	$26,223,595	$35.73	6.0
	7,285,000		4,370	30,670		$133,642,560		$430,000	$2,304,000	$3,940,000	$140,316,560	$19.26	$4,209,497	$8,418,994	$35,079,140	$188,024,190		$201,177,053	$27.62	48.0
				48 months															*$/Mo*	*$4,191,189*
			91 Avg. Hrs/Mo unloading																	

Cost Estimate Assumptions:

1.) No costs are included for disposal site preparation, rehandling or any other upland infrastructure placement requirements.
2.) No costs are included for real estate transfer fees, environmental documentation, permitting, mitigation and/or monitoring, program management costs or other associated fees.
3.) The costs and quantities are for the Oakland and Redwood City Federal Maintenance Dredging Projects.
4.) Total volume considered for the project is 7.2 MCY (1.0 MCY to E1, 0.1 MCY to E1C, 2.4 MCY to E2, <0.1 MCY to E2C, 0.5 MCY to E4, 0.8 MCY to E4C, 0.5 MCY to E5, 0.3 MCY to E5C, 0.5 MCY to E6, 0.2 MCY to E6C, and 0.8 MCY to E7).
5.) Dredging projects are scheduled to fit within the San Francisco Bay Dredging Work Windows and are assumed to be spread evenly across the six month work window.
6.) Unloading equipment hourly costs are based on the Hamilton Wetlands Restoration Project (BMK V) Offloader Cost Estimate dated May 2013.
7.) Costs and dredging cycles are based on a single Unloader contract.
8.) Mob/Demob costs include booster pump installation, pipeline installation, and diesel generator installation costs.
9.) All equipment costs assume diesel engines for the Offloader and Booster Pump.
10.) The Offloader, booster pump and support barges will be demobilized at the end of the year and taken offsite. Only the mooring dolphin piles and pipeline will remain onsite.
11.) Costs have been included to maintain site security, pumps, navigation lights on the mooring pile dolphins, and inspect the placement site during the non-unloading periods.
12.) Costs have been escalated to reflect the year in which construction could take place based on USACE EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS) using Table A-2 from Amendment #4 updated 31 March 2014.

OFFLOADER COST ESTIMATE SUMMARY
EDEN LANDING (E1, E2, E4-E7, E1C, E2C, E4C-E6C, 7.2 MCY)

SUPER OPTIMIZED SCHEDULE

Year	Predicted Dredging Quantity (CY)	Production Rate (CY/hr)	Unloading Time (Hrs)	Op. Standby Time (Hrs)	Unloading Cost ($/hr)	Unloading Cost ($)	Maintenance of Facility during Non-Unloading (Months)	Maintenance of Facility during Non-Unloading ($)	Interim Mob/Demob ($)	Mob/Demob (initial) ($)	Cost Subtotal ($)	Unit Cost ($/cy)	Design Fee @ 3% ($)	CM @ 6% ($)	Contingency @ 25% ($)	Cost to CCC in 2015 dollars ($)	Escalation ($)	Totals Cost	Totals Unit Cost	Duration (Months)
2015	2,215,001		1,329	1,591	$4,290	$12,526,648	1	$10,000	$278,000	$3,942,000	$16,756,648	$7.57	$502,699	$1,005,399	$4,189,162	$22,453,908	1.00	$22,453,908	$10.14	4.0
2016	1,690,000	1,667	1,014	1,176	$4,290	$9,394,986	9	$90,000	$278,000	$0	$9,762,986	$5.78	$292,890	$585,779	$2,440,746	$13,082,401	1.02	$13,331,085	$7.89	3.0
2017	1,967,000		1,180	1,740	$4,290	$12,526,648	8	$80,000	$278,000	$0	$12,884,648	$6.55	$386,539	$773,079	$3,221,162	$17,265,428	1.04	$17,945,399	$9.12	4.0
2018	1,385,000		831	1,359	$4,290	$9,394,986	9	$90,000	$278,000	$0	$9,762,986	$7.05	$292,890	$585,779	$2,440,746	$13,082,401	1.06	$13,869,671	$10.01	3.0
	7,257,001		4,353	5,867		$43,843,267		$270,000	$1,112,000	$3,942,000	$49,167,267	$6.78	$1,475,018	$2,950,036	$12,291,817	$65,884,137		$67,600,063	$9.32	14.0
				14	*months*														*$/Mo*	*$4,828,576*
			311	*Avg. Hrs/Mo unloading*																

Cost Estimate Assumptions:

1.) No costs are included for disposal site preparation, rehandling or any other upland infrastructure placement requirements.
2.) No costs are included for real estate transfer fees, environmental documentation, permitting, mitigation and/or monitoring, program management costs or other associated fees.
3.) The costs and quantities are for the Oakland, Redwood City, and Richmond (Inner & Outer) Federal Maintenance Dredging Projects along with mid-sized non-federal projects including ports and private dredgers.
4.) Total volume considered for the project is 7.2 MCY (1.0 MCY to E1, 0.1 MCY to E1C, 2.4 MCY to E2, <0.1 MCY to E2C, 0.5 MCY to E4, 0.8 MCY to E4C, 0.5 MCY to E5, 0.3 MCY to E5C, 0.5 MCY to E6, 0.2 MCY to E6C, and 0.8 MCY to E7).
5.) Dredging projects are scheduled to fit within the San Francisco Bay Dredging Work Windows and have been optimized to be completed based on a the minimum monthly productions using four large dump scows.
6.) Unloading equipment hourly costs are based on the Hamilton Wetlands Restoration Project (BMK V) Offloader Cost Estimate dated May 2013.
7.) Costs and dredging cycles are based on a single Unloader contract.
8.) Mob/Demob costs include booster pump installation, pipeline installation, and diesel generator installation costs.
9.) All equipment costs assume diesel engines for the Offloader and Booster Pump.
10.) The Offloader, booster pump and support barges will be demobilized at the end of the year and taken offsite. Only the mooring dolphin piles and pipeline will remain onsite.
11.) Costs have been included to maintain site security, pumps, navigation lights on the mooring pile dolphins, and inspect the placement site during the non-unloading periods.
12.) Costs have been escalated to reflect the year in which construction could take place based on USACE EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS) using Table A-2 from Amendment #4 updated 31 March 2014.

ATTACHMENT F

OFFLOADER COST ESTIMATE SUMMARY
ALVISO (A1, A2W)
NON-OPTIMIZED, OPTIMIZED, AND SUPER OPTIMIZED SCHEDULES

OFFLOADER COST ESTIMATE SUMMARY
ALVISO (A1, A2W, 8.2 MCY)

OPTIMIZED SCHEDULE

Year	Predicted Dredging Quantity (CY)	Production Rate (CY/hr)	Unloading Time (Hrs)	Op. Standby Time (Hrs)	Unloading Cost ($/hr)	Unloading Cost ($)	Maintenance of Facility during Non-Unloading (Months)	Maintenance of Facility during Non-Unloading ($)	Interim Mob/Demob ($)	Mob/Demob (initial) ($)	Cost Subtotal ($)	Unit Cost ($/cy)	Design Fee @ 3% ($)	CM @ 6% ($)	Contingency @ 25% ($)	Cost to CCC in 2013 dollars ($)	Escalation ($)	Totals Cost	Totals Unit Cost	Duration (Months)
2015	1,782,001		1,069	1,121	$4,224	$9,250,560	1	$10,000	$279,000	$3,942,000	$13,481,560	$7.57	$404,447	$808,894	$3,370,390	$18,065,290	1.00	$18,065,290	$10.14	3.0
2016	1,257,000		754	1,436	$4,224	$9,250,560	9	$88,000	$279,000	$0	$9,617,560	$7.65	$288,527	$577,054	$2,404,390	$12,887,530	1.02	$13,132,510	$10.45	3.0
2017	1,534,000	1,667	920	1,270	$4,224	$9,250,560	9	$88,000	$279,000	$0	$9,617,560	$6.27	$288,527	$577,054	$2,404,390	$12,887,530	1.04	$13,395,085	$8.73	3.0
2018	2,174,001		1,304	1,616	$4,224	$12,334,080	8	$78,000	$279,000	$0	$12,691,080	$5.84	$380,732	$761,465	$3,172,770	$17,006,047	1.06	$18,029,434	$8.29	4.0
2019	1,261,000		756	1,434	$4,224	$9,250,560	9	$88,000	$279,000	$0	$9,617,560	$7.63	$288,527	$577,054	$2,404,390	$12,887,530	1.08	$13,936,327	$11.05	3.0
2020	734,000		440	1,750	$4,224	$9,250,560	9	$88,000	$279,000	$0	$9,617,560	$13.10	$288,527	$577,054	$2,404,390	$12,887,530	1.10	$14,214,993	$19.37	3.0
	8,742,002		5,244	8,626		$58,586,880		$440,000	$1,674,000	$3,942,000	$64,642,880	$7.39	$1,939,286	$3,878,573	$16,160,720	$86,621,459		$90,773,640	$10.38	19.0
				19	*months*														*$/Mo*	*$4,777,560*
			276	*Avg. Hrs/Mo unloading*																

Cost Estimate Assumptions:

1.) No costs are included for disposal site preparation, rehandling or any other upland infrastructure placement requirements.
2.) No costs are included for real estate transfer fees, environmental documentation, permitting, mitigation and/or monitoring, program management costs or other associated fees.
3.) The costs and quantities are for the Oakland and Redwood City Federal Maintenance Dredging Projects along with mid-sized non-federal projects including ports and private dredgers.
4.) Total volume considered for the project is 8.2 MCY (3.0 MCY to A1 and 5.2 MCY to A2W).
5.) Dredging projects are scheduled to fit within the San Francisco Bay Dredging Work Windows and have been optimized to be completed based on a the minimum monthly productions using four large dump scows.
6.) Unloading equipment hourly costs are based on the Hamilton Wetlands Restoration Project (BMK V) Offloader Cost Estimate dated May 2013.
7.) Costs and dredging cycles are based on a single Unloader contract.
8.) Mob/Demob costs include booster pump installation, pipeline installation, and diesel generator installation costs.
9.) All equipment costs assume diesel engines for the Offloader and Booster Pump.
10.) The Offloader, booster pump and support barges will be demobilized at the end of the year and taken offsite. Only the mooring dolphin piles and pipeline will remain onsite.
11.) Costs have been included to maintain site security, pumps, navigation lights on the mooring pile dolphins, and inspect the placement site during the non-unloading periods.
12.) Costs have been escalated to reflect the year in which construction could take place based on USACE EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS) using Table A-2 from Amendment #4 updated 31 March 2014.

OFFLOADER COST ESTIMATE SUMMARY
ALVISO (A1, A2W, 8.2 MCY)

NON-OPTIMIZED SCHEDULE

Year	Predicted Dredging Quantity (CY)	Production Rate (CY/hr)	Unloading Time (Hrs)	Op. Standby Time (Hrs)	Unloading Cost ($/hr)	Unloading Cost ($)	Maintenance of Facility during Non-Unloading (Months)	Maintenance of Facility during Non-Unloading ($)	Interim Mob/Demob ($)	Mob/Demob (initial) ($)	Cost Subtotal ($)	Unit Cost ($/cy)	Design Fee @ 3% ($)	CM @ 6% ($)	Contingency @ 25% ($)	Cost to CCC in 2015 dollars ($)	Escalation ($)	Totals Cost	Totals Unit Cost	Duration (Months)
2015	1,205,000		723	3,657	$3,814	$16,705,320	1	$10,000	$288,000	$3,940,000	$20,943,320	$17.38	$628,300	$1,256,599	$5,235,830	$28,064,049	1.00	$28,064,049	$23.29	6.0
2016	734,000		440	3,940	$3,814	$16,705,320	6	$60,000	$288,000	$0	$17,053,320	$23.23	$511,600	$1,023,199	$4,263,330	$22,851,449	1.02	$23,285,833	$31.72	6.0
2017	734,000		440	3,940	$3,814	$16,705,320	6	$60,000	$288,000	$0	$17,053,320	$23.23	$511,600	$1,023,199	$4,263,330	$22,851,449	1.04	$23,751,417	$32.36	6.0
2018	1,205,000		723	3,657	$3,814	$16,705,320	6	$60,000	$288,000	$0	$17,053,320	$14.15	$511,600	$1,023,199	$4,263,330	$22,851,449	1.06	$24,226,600	$20.11	6.0
2019	734,000	1,667	440	3,940	$3,814	$16,705,320	6	$60,000	$288,000	$0	$17,053,320	$23.23	$511,600	$1,023,199	$4,263,330	$22,851,449	1.08	$24,711,116	$33.67	6.0
2020	734,000		440	3,940	$3,814	$16,705,320	6	$60,000	$288,000	$0	$17,053,320	$23.23	$511,600	$1,023,199	$4,263,330	$22,851,449	1.10	$25,205,231	$34.34	6.0
2021	1,205,000		723	3,657	$3,814	$16,705,320	6	$60,000	$288,000	$0	$17,053,320	$14.15	$511,600	$1,023,199	$4,263,330	$22,851,449	1.13	$25,709,213	$21.34	6.0
2022	734,000		440	3,940	$3,814	$16,705,320	6	$60,000	$288,000	$0	$17,053,320	$23.23	$511,600	$1,023,199	$4,263,330	$22,851,449	1.15	$26,223,595	$35.73	6.0
2023	734,000		440	3,940	$3,814	$16,705,320	6	$60,000	$288,000	$0	$17,053,320	$23.23	$511,600	$1,023,199	$4,263,330	$22,851,449	1.17	$26,748,109	$36.44	6.0
2024	471,000		283	4,097	$3,814	$16,705,320	6	$60,000	$288,000	$0	$17,053,320	$36.21	$511,600	$1,023,199	$4,263,330	$22,851,449	1.19	$27,283,024	$57.93	6.0
	8,490,000		5,093	38,707		$167,053,200		$550,000	$2,880,000	$3,940,000	$174,423,200	$20.54	$5,232,696	$10,465,392	$43,605,800	$233,727,088		$255,208,186	$30.06	60.0
					60 months														*$/Mo*	*$4,253,470*
			85 Avg. Hrs/Mo unloading																	

Cost Estimate Assumptions:

1.) No costs are included for disposal site preparation, rehandling or any other upland infrastructure placement requirements.
2.) No costs are included for real estate transfer fees, environmental documentation, permitting, mitigation and/or monitoring, program management costs or other associated fees.
3.) The costs and quantities are for the Oakland and Redwood City Federal Maintenance Dredging Projects.
4.) Total volume considered for the project is 8.2 MCY (3.0 MCY to A1 and 5.2 MCY to A2W).
5.) Dredging projects are scheduled to fit within the San Francisco Bay Dredging Work Windows and are assumed to be spread evenly across the six month work window.
6.) Unloading equipment hourly costs are based on the Hamilton Wetlands Restoration Project (BMK V) Offloader Cost Estimate dated May 2013.
7.) Costs and dredging cycles are based on a single Unloader contract.
8.) Mob/Demob costs include booster pump installation, pipeline installation, and diesel generator installation costs.
9.) All equipment costs assume diesel engines for the Offloader and Booster Pump.
10.) The Offloader, booster pump and support barges will be demobilized at the end of the year and taken offsite. Only the mooring dolphin piles and pipeline will remain onsite.
11.) Costs have been included to maintain site security, pumps, navigation lights on the mooring pile dolphins, and inspect the placement site during the non-unloading periods.
12.) Costs have been escalated to reflect the year in which construction could take place based on USACE EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS) using Table A-2 from Amendment #4 updated 31 March 2014.

OFFLOADER COST ESTIMATE SUMMARY
ALVISO (A1, A2W, 8.2 MCY)

SUPER OPTIMIZED SCHEDULE

Year	Predicted Dredging Quantity (CY)	Production Rate (CY/hr)	Unloading Time (Hrs)	Op. Standby Time (Hrs)	Unloading Cost ($/hr)	Unloading Cost ($)	Maintenance of Facility during Non-Unloading (Months)	Maintenance of Facility during Non-Unloading ($)	Interim Mob/Demob ($)	Mob/Demob (initial) ($)	Cost Subtotal ($)	Unit Cost ($/cy)	Design Fee @ 3% ($)	CM @ 6% ($)	Contingency @ 25% ($)	Cost to CCC in 2015 dollars ($)	Escalation ($)	Totals Cost	Totals Unit Cost	Duration (Months)
2015	2,215,001	1,667	1,329	1,591	$4,300	$12,556,793	1	$10,000	$277,000	$3,942,000	$16,785,793	$7.58	$503,574	$1,007,148	$4,196,448	$22,492,963	1.00	$22,492,963	$10.15	4.0
2016	1,690,000		1,014	1,176	$4,300	$9,417,595	9	$90,000	$277,000	$0	$9,784,595	$5.79	$293,538	$587,076	$2,446,149	$13,111,357	1.02	$13,360,592	$7.91	3.0
2017	1,967,000		1,180	1,740	$4,300	$12,556,793	8	$80,000	$277,000	$0	$12,913,793	$6.57	$387,414	$774,828	$3,228,448	$17,304,483	1.04	$17,985,993	$9.14	4.0
2018	2,438,000		1,463	2,187	$4,300	$15,695,992	7	$70,000	$277,000	$0	$16,042,992	$6.58	$481,290	$962,580	$4,010,748	$21,497,609	1.06	$22,791,289	$9.35	5.0
	8,310,001		4,985	6,695		$50,227,174		$250,000	$1,108,000	$3,942,000	$55,527,174	$6.68	$1,665,815	$3,331,630	$13,881,793	$74,406,413		$76,630,836	$9.22	16.0
				16	*months*														*$/Mo*	*$4,789,427*
			312	*Avg. Hrs/Mo unloading*																

Cost Estimate Assumptions:

1.) No costs are included for disposal site preparation, rehandling or any other upland infrastructure placement requirements.
2.) No costs are included for real estate transfer fees, environmental documentation, permitting, mitigation and/or monitoring, program management costs or other associated fees.
3.) The costs and quantities are for the Oakland, Redwood City, and Richmond (Inner & Outer) Federal Maintenance Dredging Projects along with mid-sized non-federal projects including ports and private dredgers.
4.) Total volume considered for the project is 8.2 MCY (3.0 MCY to A1 and 5.2 MCY to A2W).
5.) Dredging projects are scheduled to fit within the San Francisco Bay Dredging Work Windows and have been optimized to be completed based on a the minimum monthly productions using four large dump scows.
6.) Unloading equipment hourly costs are based on the Hamilton Wetlands Restoration Project (BMK V) Offloader Cost Estimate dated May 2013.
7.) Costs and dredging cycles are based on a single Unloader contract.
8.) Mob/Demob costs include booster pump installation, pipeline installation, and diesel generator installation costs.
9.) All equipment costs assume diesel engines for the Offloader and Booster Pump.
10.) The Offloader, booster pump and support barges will be demobilized at the end of the year and taken offsite. Only the mooring dolphin piles and pipeline will remain onsite.
11.) Costs have been included to maintain site security, pumps, navigation lights on the mooring pile dolphins, and inspect the placement site during the non-unloading periods.
12.) Costs have been escalated to reflect the year in which construction could take place based on USACE EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS) using Table A-2 from Amendment #4 updated 31 March 2014.

ATTACHMENT G

OFFLOADER COST ESTIMATE SUMMARY
ALVISO (A5, A7, A8, A8S)
NON-OPTIMIZED, OPTIMIZED, AND SUPER OPTIMIZED SCHEDULES

OFFLOADER COST ESTIMATE SUMMARY
ALVISO (A5, A7, A8, A8S, 17.0 MCY)

OPTIMIZED SCHEDULE

Year	Predicted Dredging Quantity (CY)	Production Rate (CY/hr)	Unloading Time (Hrs)	Op. Standby Time (Hrs)	Unloading Cost ($/hr)	Unloading Cost ($)	Maintenance of Facility during Non-Unloading (Months)	Maintenance of Facility during Non-Unloading ($)	Interim Mob/Demob ($)	Mob/Demob (initial) ($)	Cost Subtotal ($)	Unit Cost ($/cy)	Design Fee @ 3% ($)	CM @ 6% ($)	Contingency @ 25% ($)	Cost to CCC in 2013 dollars ($)	Escalation ($)	Totals Cost	Totals Unit Cost	Duration (Months)
2015	1,782,001		1,069	1,121	$4,624	$10,126,560	1	$10,000	$279,000	$3,942,000	$14,357,560	$8.06	$430,727	$861,454	$3,589,390	$19,239,130	1.00	$19,239,130	$10.80	3.0
2016	1,257,000		754	1,436	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$8.35	$314,807	$629,614	$2,623,390	$14,061,370	1.02	$14,328,664	$11.40	3.0
2017	1,534,000		920	1,270	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$6.84	$314,807	$629,614	$2,623,390	$14,061,370	1.04	$14,615,155	$9.53	3.0
2018	2,174,001		1,304	1,616	$4,624	$13,502,080	8	$78,000	$279,000	$0	$13,859,080	$6.37	$415,772	$831,545	$3,464,770	$18,571,167	1.06	$19,688,740	$9.06	4.0
2019	1,261,000		756	1,434	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$8.32	$314,807	$629,614	$2,623,390	$14,061,370	1.08	$15,205,694	$12.06	3.0
2020	1,530,000	1,667	918	1,272	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$6.86	$314,807	$629,614	$2,623,390	$14,061,370	1.10	$15,509,743	$10.14	3.0
2021	1,782,001		1,069	1,121	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$5.89	$314,807	$629,614	$2,623,390	$14,061,370	1.13	$15,819,862	$8.88	3.0
2022	1,653,000		991	1,199	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$6.35	$314,807	$629,614	$2,623,390	$14,061,370	1.15	$16,136,381	$9.76	3.0
2023	1,534,000		920	1,270	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$6.84	$314,807	$629,614	$2,623,390	$14,061,370	1.17	$16,459,135	$10.73	3.0
2024	1,778,001		1,066	1,124	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$5.90	$314,807	$629,614	$2,623,390	$14,061,370	1.19	$16,788,288	$9.44	3.0
2025	734,000		440	1,750	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$14.30	$314,807	$629,614	$2,623,390	$14,061,370	1.22	$17,124,004	$23.33	3.0
	17,019,004		10,207	14,613		$114,767,680		$880,000	$3,069,000	$3,942,000	$122,658,680	$7.21	$3,679,760	$7,359,521	$30,664,670	$164,362,631		$180,914,796	$10.63	34.0
				34 months															*$/Mo*	*$5,321,023*
			300 Avg. Hrs/Mo unloading																	

Cost Estimate Assumptions:

1.) No costs are included for disposal site preparation, rehandling or any other upland infrastructure placement requirements.
2.) No costs are included for real estate transfer fees, environmental documentation, permitting, mitigation and/or monitoring, program management costs or other associated fees.
3.) The costs and quantities are for the Oakland and Redwood City Federal Maintenance Dredging Projects along with mid-sized non-federal projects including ports and private dredgers.
4.) Total volume considered for the project is 17.0 MCY (6.6 MCY to A5, 2.3 MCY to A7, 5.9 MCY to A8, 2.1 MCY to A8S).
5.) Dredging projects are scheduled to fit within the San Francisco Bay Dredging Work Windows and have been optimized to be completed based on a the minimum monthly productions using four large dump scows.
6.) Unloading equipment hourly costs are based on the Hamilton Wetlands Restoration Project (BMK V) Offloader Cost Estimate dated May 2013.
7.) Costs and dredging cycles are based on a single Unloader contract.
8.) Mob/Demob costs include booster pump installation, pipeline installation, and diesel generator installation costs.
9.) All equipment costs assume diesel engines for the Offloader and Booster Pump.
10.) The Offloader, booster pump and support barges will be demobilized at the end of the year and taken offsite. Only the mooring dolphin piles and pipeline will remain onsite.
11.) Costs have been included to maintain site security, pumps, navigation lights on the mooring pile dolphins, and inspect the placement site during the non-unloading periods.
12.) Costs have been escalated to reflect the year in which construction could take place based on USACE EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS) using Table A-2 from Amendment #4 updated 31 March 2014.

OFFLOADER COST ESTIMATE SUMMARY
ALVISO (A5, A7, A8, A8S, 17.0 MCY)

NON-OPTIMIZED SCHEDULE

Year	Predicted Dredging Quantity (CY)	Production Rate (CY/hr)	Unloading Time (Hrs)	Op. Standby Time (Hrs)	Unloading Cost ($/hr)	Unloading Cost ($)	Maintenance of Facility during Non-Unloading (Months)	Maintenance of Facility during Non-Unloading ($)	Interim Mob/Demob ($)	Mob/Demob (initial) ($)	Cost Subtotal ($)	Unit Cost ($/cy)	Design Fee @ 3% ($)	CM @ 6% ($)	Contingency @ 25% ($)	Cost to CCC in 2015 dollars ($)	Escalation ($)	Totals Cost	Totals Unit Cost	Duration (Months)
2015	1,205,000		723	3,657	$4,114	$18,019,320	1	$10,000	$288,000	$3,940,000	$22,257,320	$18.47	$667,720	$1,335,439	$5,564,330	$29,824,809	1.00	$29,824,809	$24.75	6.0
2016	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.02	$25,080,064	$34.17	6.0
2017	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.04	$25,581,521	$34.85	6.0
2018	1,205,000		723	3,657	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$15.24	$551,020	$1,102,039	$4,591,830	$24,612,209	1.06	$26,093,318	$21.65	6.0
2019	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.08	$26,615,167	$36.26	6.0
2020	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.10	$27,147,356	$36.99	6.0
2021	1,205,000		723	3,657	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$15.24	$551,020	$1,102,039	$4,591,830	$24,612,209	1.13	$27,690,171	$22.98	6.0
2022	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.15	$28,244,187	$38.48	6.0
2023	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.17	$28,809,117	$39.25	6.0
2024	1,205,000	1,667	723	3,657	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$15.24	$551,020	$1,102,039	$4,591,830	$24,612,209	1.19	$29,385,247	$24.39	6.0
2025	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.22	$29,972,866	$40.83	6.0
2026	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.24	$30,572,260	$41.65	6.0
2027	1,205,000		723	3,657	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$15.24	$551,020	$1,102,039	$4,591,830	$24,612,209	1.27	$31,183,717	$25.88	6.0
2028	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.29	$31,807,523	$43.33	6.0
2029	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.32	$32,443,679	$44.20	6.0
2030	1,205,000		723	3,657	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$15.24	$551,020	$1,102,039	$4,591,830	$24,612,209	1.34	$33,092,473	$27.46	6.0
2031	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.37	$33,754,477	$45.99	6.0
2032	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.40	$34,429,406	$46.91	6.0
2033	1,205,000		723	3,657	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$15.24	$551,020	$1,102,039	$4,591,830	$24,612,209	1.43	$35,118,120	$29.14	6.0
	17,243,000		10,344	72,876		$342,367,080		$1,090,000	$5,472,000	$3,940,000	$352,869,080	$20.46	$10,586,072	$21,172,145	$88,217,270	$472,844,567		$566,845,479	$32.87	114.0
				114 months															*$/Mo*	*$4,972,329*
			91 Avg. Hrs/Mo unloading																	

Cost Estimate Assumptions:

1.) No costs are included for disposal site preparation, rehandling or any other upland infrastructure placement requirements.
2.) No costs are included for real estate transfer fees, environmental documentation, permitting, mitigation and/or monitoring, program management costs or other associated fees.
3.) The costs and quantities are for the Oakland and Redwood City Federal Maintenance Dredging Projects.
4.) Total volume considered for the project is 17.0 MCY (6.6 MCY to A5, 2.3 MCY to A7, 5.9 MCY to A8, 2.1 MCY to A8S).
5.) Dredging projects are scheduled to fit within the San Francisco Bay Dredging Work Windows and are assumed to be spread evenly across the six month work window.
6.) Unloading equipment hourly costs are based on the Hamilton Wetlands Restoration Project (BMK V) Offloader Cost Estimate dated May 2013.
7.) Costs and dredging cycles are based on a single Unloader contract.
8.) Mob/Demob costs include booster pump installation, pipeline installation, and diesel generator installation costs.
9.) All equipment costs assume diesel engines for the Offloader and Booster Pump.
10.) The Offloader, booster pump and support barges will be demobilized at the end of the year and taken offsite. Only the mooring dolphin piles and pipeline will remain onsite.
11.) Costs have been included to maintain site security, pumps, navigation lights on the mooring pile dolphins, and inspect the placement site during the non-unloading periods.
12.) Costs have been escalated to reflect the year in which construction could take place based on USACE EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS) using Table A-2 from Amendment #4 updated 31 March 2014.

OFFLOADER COST ESTIMATE SUMMARY
ALVISO (A5, A7, A8, A8S, 17.0 MCY)

SUPER OPTIMIZED SCHEDULE

Year	Predicted Dredging Quantity (CY)	Production Rate (CY/hr)	Unloading Time (Hrs)	Op. Standby Time (Hrs)	Unloading Cost ($/hr)	Unloading Cost ($)	Maintenance of Facility during Non-Unloading (Months)	Maintenance of Facility during Non-Unloading ($)	Interim Mob/Demob ($)	Mob/Demob (initial) ($)	Cost Subtotal ($)	Unit Cost ($/cy)	Design Fee @ 3% ($)	CM @ 6% ($)	Contingency @ 25% ($)	Cost to CCC in 2015 dollars ($)	Escalation ($)	Totals Cost	Totals Unit Cost	Duration (Months)
2015	2,215,001		1,328	1,592	$4,610	$13,460,155	1	$10,000	$279,000	$3,942,000	$17,691,155	$7.99	$530,735	$1,061,469	$4,422,789	$23,706,147	1.00	$23,706,147	$10.70	4.0
2016	1,690,000		1,014	1,176	$4,610	$10,095,116	9	$90,000	$279,000	$0	$10,464,116	$6.19	$313,923	$627,847	$2,616,029	$14,021,915	1.02	$14,288,459	$8.45	3.0
2017	1,967,000		1,180	1,740	$4,610	$13,460,155	8	$80,000	$279,000	$0	$13,819,155	$7.03	$414,575	$829,149	$3,454,789	$18,517,667	1.04	$19,246,956	$9.78	4.0
2018	2,607,001		1,563	2,087	$4,610	$16,825,193	7	$70,000	$279,000	$0	$17,174,193	$6.59	$515,226	$1,030,452	$4,293,548	$23,013,419	1.06	$24,398,317	$9.36	5.0
2019	1,694,000	1,667	1,016	1,904	$4,610	$13,460,155	8	$80,000	$279,000	$0	$13,819,155	$8.16	$414,575	$829,149	$3,454,789	$18,517,667	1.08	$20,024,648	$11.82	4.0
2020	1,963,000		1,177	1,743	$4,610	$13,460,155	8	$80,000	$279,000	$0	$13,819,155	$7.04	$414,575	$829,149	$3,454,789	$18,517,667	1.10	$20,425,054	$10.41	4.0
2021	2,215,001		1,328	1,592	$4,610	$13,460,155	8	$80,000	$279,000	$0	$13,819,155	$6.24	$414,575	$829,149	$3,454,789	$18,517,667	1.13	$20,833,456	$9.41	4.0
2022	2,086,000		1,251	1,669	$4,610	$13,460,155	8	$80,000	$279,000	$0	$13,819,155	$6.62	$414,575	$829,149	$3,454,789	$18,517,667	1.15	$21,250,285	$10.19	4.0
2023	734,000		440	1,750	$4,610	$10,095,116	9	$90,000	$279,000	$0	$10,464,116	$14.26	$313,923	$627,847	$2,616,029	$14,021,915	1.17	$16,412,952	$22.36	3.0
	17,171,003		10,298	15,252		$117,776,352		$660,000	$2,511,000	$3,942,000	$124,889,352	$7.27	$3,746,681	$7,493,361	$31,222,338	$167,351,732		$180,586,272	$10.52	35.0
				35	*months*														*$/Mo*	*$5,159,608*
			294	*Avg. Hrs/Mo unloading*																

Cost Estimate Assumptions:

1.) No costs are included for disposal site preparation, rehandling or any other upland infrastructure placement requirements.
2.) No costs are included for real estate transfer fees, environmental documentation, permitting, mitigation and/or monitoring, program management costs or other associated fees.
3.) The costs and quantities are for the Oakland, Redwood City, and Richmond (Inner & Outer) Federal Maintenance Dredging Projects along with mid-sized non-federal projects including ports and private dredgers.
4.) Total volume considered for the project is 17.0 MCY (6.6 MCY to A5, 2.3 MCY to A7, 5.9 MCY to A8, 2.1 MCY to A8S).
5.) Dredging projects are scheduled to fit within the San Francisco Bay Dredging Work Windows and have been optimized to be completed based on a the minimum monthly productions using four large dump scows.
6.) Unloading equipment hourly costs are based on the Hamilton Wetlands Restoration Project (BMK V) Offloader Cost Estimate dated May 2013.
7.) Costs and dredging cycles are based on a single Unloader contract.
8.) Mob/Demob costs include booster pump installation, pipeline installation, and diesel generator installation costs.
9.) All equipment costs assume diesel engines for the Offloader and Booster Pump.
10.) The Offloader, booster pump and support barges will be demobilized at the end of the year and taken offsite. Only the mooring dolphin piles and pipeline will remain onsite.
11.) Costs have been included to maintain site security, pumps, navigation lights on the mooring pile dolphins, and inspect the placement site during the non-unloading periods.
12.) Costs have been escalated to reflect the year in which construction could take place based on USACE EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS) using Table A-2 from Amendment #4 updated 31 March 2014.

ATTACHMENT H

OFFLOADER COST ESTIMATE SUMMARY
ALVISO (A9 – A15)
NON-OPTIMIZED, OPTIMIZED, AND SUPER OPTIMIZED SCHEDULES

OFFLOADER COST ESTIMATE SUMMARY
ALVISO (A9 - A15, 22.5 MCY)

OPTIMIZED SCHEDULE

Year	Predicted Dredging Quantity (CY)	Production Rate (CY/hr)	Unloading Time (Hrs)	Op. Standby Time (Hrs)	Unloading Cost ($/hr)	Unloading Cost ($)	Maintenance of Facility during Non-Unloading (Months)	Maintenance of Facility during Non-Unloading ($)	Interim Mob/Demob ($)	Mob/Demob (initial) ($)	Cost Subtotal ($)	Unit Cost ($/cy)	Design Fee @ 3% ($)	CM @ 6% ($)	Contingency @ 25% ($)	Cost to CCC in 2013 dollars ($)	Escalation ($)	Totals Cost	Totals Unit Cost	Duration (Months)
2015	1,782,001		1,068	1,122	$4,624	$10,126,560	1	$10,000	$279,000	$3,942,000	$14,357,560	$8.06	$430,727	$861,454	$3,589,390	$19,239,130	1.00	$19,239,130	$10.80	3.0
2016	1,257,000		754	1,436	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$8.35	$314,807	$629,614	$2,623,390	$14,061,370	1.02	$14,328,664	$11.40	3.0
2017	1,534,000		920	1,270	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$6.84	$314,807	$629,614	$2,623,390	$14,061,370	1.04	$14,615,155	$9.53	3.0
2018	2,174,001		1,303	1,617	$4,624	$13,502,080	8	$78,000	$279,000	$0	$13,859,080	$6.37	$415,772	$831,545	$3,464,770	$18,571,167	1.06	$19,688,740	$9.06	4.0
2019	1,261,000		756	1,434	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$8.32	$314,807	$629,614	$2,623,390	$14,061,370	1.08	$15,205,694	$12.06	3.0
2020	1,530,000		917	1,273	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$6.86	$314,807	$629,614	$2,623,390	$14,061,370	1.10	$15,509,743	$10.14	3.0
2021	1,782,001	1,668	1,068	1,122	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$5.89	$314,807	$629,614	$2,623,390	$14,061,370	1.13	$15,819,862	$8.88	3.0
2022	1,653,000		991	1,199	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$6.35	$314,807	$629,614	$2,623,390	$14,061,370	1.15	$16,136,381	$9.76	3.0
2023	1,534,000		920	1,270	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$6.84	$314,807	$629,614	$2,623,390	$14,061,370	1.17	$16,459,135	$10.73	3.0
2024	1,778,001		1,066	1,124	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$5.90	$314,807	$629,614	$2,623,390	$14,061,370	1.19	$16,788,288	$9.44	3.0
2025	1,261,000		756	1,434	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$8.32	$314,807	$629,614	$2,623,390	$14,061,370	1.22	$17,124,004	$13.58	3.0
2026	1,926,000		1,155	1,765	$4,624	$13,502,080	8	$78,000	$279,000	$0	$13,859,080	$7.20	$415,772	$831,545	$3,464,770	$18,571,167	1.24	$23,068,330	$11.98	4.0
2027	1,782,001		1,068	1,122	$4,624	$10,126,560	9	$88,000	$279,000	$0	$10,493,560	$5.89	$314,807	$629,614	$2,623,390	$14,061,370	1.27	$17,815,784	$10.00	3.0
2028	1,257,000		754	1,436	$4,624	$10,126,560	8	$78,000	$279,000	$0	$10,483,560	$8.34	$314,507	$629,014	$2,620,890	$14,047,970	1.29	$18,154,858	$14.44	3.0
	22,511,005		13,495	18,625		$148,522,880		$1,124,000	$3,906,000	$3,942,000	$157,494,880	$7.00	$4,724,846	$9,449,693	$39,373,720	$211,043,139		$239,953,767	$10.66	44.0
				44 months															*$/Mo*	*$5,453,495*
			307 Avg. Hrs/Mo unloading																	

Cost Estimate Assumptions:

1.) No costs are included for disposal site preparation, rehandling or any other upland infrastructure placement requirements.
2.) No costs are included for real estate transfer fees, environmental documentation, permitting, mitigation and/or monitoring, program management costs or other associated fees.
3.) The costs and quantities are for the Oakland and Redwood City Federal Maintenance Dredging Projects along with mid-sized non-federal projects including ports and private dredgers.
4.) Total volume considered for the project is 22.5 MCY (2.8 MCY to A9, 2.5 MCY to A10, 3.3 MCY to A11, 4.4 MCY to A12, 3.4 MCY to A13, 3.4 MCY to A14, and 2.7 MCY to A15).
5.) Dredging projects are scheduled to fit within the San Francisco Bay Dredging Work Windows and have been optimized to be completed based on a the minimum monthly productions using four large dump scows.
6.) Unloading equipment hourly costs are based on the Hamilton Wetlands Restoration Project (BMK V) Offloader Cost Estimate dated May 2013.
7.) Costs and dredging cycles are based on a single Unloader contract.
8.) Mob/Demob costs include booster pump installation, pipeline installation, and diesel generator installation costs.
9.) All equipment costs assume diesel engines for the Offloader and Booster Pump.
10.) The Offloader, booster pump and support barges will be demobilized at the end of the year and taken offsite. Only the mooring dolphin piles and pipeline will remain onsite.
11.) Costs have been included to maintain site security, pumps, navigation lights on the mooring pile dolphins, and inspect the placement site during the non-unloading periods.
12.) Costs have been escalated to reflect the year in which construction could take place based on USACE EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS) using Table A-2 from Amendment #4 updated 31 March 2014.

OFFLOADER COST ESTIMATE SUMMARY
ALVISO (A9 - A15, 22.5 MCY)

NON-OPTIMIZED SCHEDULE

Year	Predicted Dredging Quantity (CY)	Production Rate (CY/hr)	Unloading Time (Hrs)	Op. Standby Time (Hrs)	Unloading Cost ($/hr)	Unloading Cost ($)	Maintenance of Facility during Non-Unloading (Months)	($)	Interim Mob/Demob ($)	Mob/Demob (initial) ($)	Cost Subtotal ($)	Unit Cost ($/cy)	Design Fee @ 3% ($)	CM @ 6% ($)	Contingency @ 25% ($)	Cost to CCC in 2015 dollars ($)	Escalation ($)	Totals Cost	Totals Unit Cost	Duration (Months)
2015	1,205,000		723	3,657	$4,114	$18,019,320	1	$10,000	$288,000	$3,940,000	$22,257,320	$18.47	$667,720	$1,335,439	$5,564,330	$29,824,809	1.00	$29,824,809	$24.75	6.0
2016	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.02	$25,080,064	$34.17	6.0
2017	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.04	$25,581,521	$34.85	6.0
2018	1,205,000		723	3,657	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$15.24	$551,020	$1,102,039	$4,591,830	$24,612,209	1.06	$26,093,318	$21.65	6.0
2019	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.08	$26,615,167	$36.26	6.0
2020	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.10	$27,147,356	$36.99	6.0
2021	1,205,000		723	3,657	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$15.24	$551,020	$1,102,039	$4,591,830	$24,612,209	1.13	$27,690,171	$22.98	6.0
2022	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.15	$28,244,187	$38.48	6.0
2023	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.17	$28,809,117	$39.25	6.0
2024	1,205,000		723	3,657	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$15.24	$551,020	$1,102,039	$4,591,830	$24,612,209	1.19	$29,385,247	$24.39	6.0
2025	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.22	$29,972,866	$40.83	6.0
2026	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.24	$30,572,260	$41.65	6.0
2027	1,205,000	1,667	723	3,657	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$15.24	$551,020	$1,102,039	$4,591,830	$24,612,209	1.27	$31,183,717	$25.88	6.0
2028	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.29	$31,807,523	$43.33	6.0
2029	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.32	$32,443,679	$44.20	6.0
2030	1,205,000		723	3,657	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$15.24	$551,020	$1,102,039	$4,591,830	$24,612,209	1.34	$33,092,473	$27.46	6.0
2031	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.37	$33,754,477	$45.99	6.0
2032	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.40	$34,429,406	$46.91	6.0
2033	1,205,000		723	3,657	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$15.24	$551,020	$1,102,039	$4,591,830	$24,612,209	1.43	$35,118,120	$29.14	6.0
2034	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.46	$35,820,333	$48.80	6.0
2035	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.48	$36,536,907	$49.78	6.0
2036	1,205,000		723	3,657	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$15.24	$551,020	$1,102,039	$4,591,830	$24,612,209	1.51	$37,267,553	$30.93	6.0
2037	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.54	$38,012,847	$51.79	6.0
2038	734,000		440	3,940	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$25.02	$551,020	$1,102,039	$4,591,830	$24,612,209	1.58	$38,773,075	$52.82	6.0
2039	1,205,000		723	3,657	$4,114	$18,019,320	6	$60,000	$288,000	$0	$18,367,320	$15.24	$551,020	$1,102,039	$4,591,830	$24,612,209	1.61	$39,548,525	$32.82	6.0
	22,589,000		13,551	95,949		$450,483,000		$1,450,000	$7,200,000	$3,940,000	$463,073,000	$20.50	$13,892,190	$27,784,380	$115,768,250	$620,517,820		$792,804,718	$35.10	150.0
				150	*months*														*$/Mo*	*$5,285,365*
			90	*Avg. Hrs/Mo unloading*																

Cost Estimate Assumptions:

1.) No costs are included for disposal site preparation, rehandling or any other upland infrastructure placement requirements.
2.) No costs are included for real estate transfer fees, environmental documentation, permitting, mitigation and/or monitoring, program management costs or other associated fees.
3.) The costs and quantities are for the Oakland and Redwood City Federal Maintenance Dredging Projects.
4.) Total volume considered for the project is 22.5 MCY (2.8 MCY to A9, 2.5 MCY to A10, 3.3 MCY to A11, 4.4 MCY to A12, 3.4 MCY to A13, 3.4 MCY to A14, and 2.7 MCY to A15).
5.) Dredging projects are scheduled to fit within the San Francisco Bay Dredging Work Windows and are assumed to be spread evenly across the six month work window.
6.) Unloading equipment hourly costs are based on the Hamilton Wetlands Restoration Project (BMK V) Offloader Cost Estimate dated May 2013.
7.) Costs and dredging cycles are based on a single Unloader contract.
8.) Mob/Demob costs include booster pump installation, pipeline installation, and diesel generator installation costs.
9.) All equipment costs assume diesel engines for the Offloader and Booster Pump.
10.) The Offloader, booster pump and support barges will be demobilized at the end of the year and taken offsite. Only the mooring dolphin piles and pipeline will remain onsite.
11.) Costs have been included to maintain site security, pumps, navigation lights on the mooring pile dolphins, and inspect the placement site during the non-unloading periods.
12.) Costs have been escalated to reflect the year in which construction could take place based on USACE EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS) using Table A-2 from Amendment #4 updated 31 March 2014.

OFFLOADER COST ESTIMATE SUMMARY
ALVISO (A9 - A15, 22.5 MCY)

SUPER OPTIMIZED SCHEDULE

Year	Predicted Dredging Quantity (CY)	Production Rate (CY/hr)	Unloading Time (Hrs)	Op. Standby Time (Hrs)	Unloading Cost ($/hr)	Unloading Cost ($)	Maintenance of Facility during Non-Unloading (Months)	Maintenance of Facility during Non-Unloading ($)	Interim Mob/Demob ($)	Mob/Demob (initial) ($)	Cost Subtotal ($)	Unit Cost ($/cy)	Design Fee @ 3% ($)	CM @ 6% ($)	Contingency @ 25% ($)	Cost to CCC in 2015 dollars ($)	Escalation ($)	Totals Cost	Totals Unit Cost	Duration (Months)
2015	2,215,001		1,328	1,592	$4,635	$13,533,241	1	$10,000	$279,000	$3,942,000	$17,764,241	$8.02	$532,927	$1,065,854	$4,441,060	$23,804,083	1.00	$23,804,083	$10.75	4.0
2016	1,690,000		1,013	1,177	$4,635	$10,149,931	9	$90,000	$279,000	$0	$10,518,931	$6.22	$315,568	$631,136	$2,629,733	$14,095,367	1.02	$14,363,307	$8.50	3.0
2017	1,967,000		1,179	1,741	$4,635	$13,533,241	8	$80,000	$279,000	$0	$13,892,241	$7.06	$416,767	$833,534	$3,473,060	$18,615,603	1.04	$19,348,749	$9.84	4.0
2018	2,607,001		1,563	2,087	$4,635	$16,916,551	7	$70,000	$279,000	$0	$17,265,551	$6.62	$517,967	$1,035,933	$4,316,388	$23,135,839	1.06	$24,528,104	$9.41	5.0
2019	1,694,000		1,016	1,904	$4,635	$13,533,241	8	$80,000	$279,000	$0	$13,892,241	$8.20	$416,767	$833,534	$3,473,060	$18,615,603	1.08	$20,130,554	$11.88	4.0
2020	1,963,000	1,667	1,177	1,743	$4,635	$13,533,241	8	$80,000	$279,000	$0	$13,892,241	$7.08	$416,767	$833,534	$3,473,060	$18,615,603	1.10	$20,533,078	$10.46	4.0
2021	2,215,001		1,328	1,592	$4,635	$13,533,241	8	$80,000	$279,000	$0	$13,892,241	$6.27	$416,767	$833,534	$3,473,060	$18,615,603	1.13	$20,943,640	$9.46	4.0
2022	2,086,000		1,251	1,669	$4,635	$13,533,241	8	$80,000	$279,000	$0	$13,892,241	$6.66	$416,767	$833,534	$3,473,060	$18,615,603	1.15	$21,362,673	$10.24	4.0
2023	1,967,000		1,179	1,741	$4,635	$13,533,241	8	$80,000	$279,000	$0	$13,892,241	$7.06	$416,767	$833,534	$3,473,060	$18,615,603	1.17	$21,789,961	$11.08	4.0
2024	2,211,001		1,325	1,595	$4,635	$13,533,241	8	$80,000	$279,000	$0	$13,892,241	$6.28	$416,767	$833,534	$3,473,060	$18,615,603	1.19	$22,225,721	$10.05	4.0
2025	1,694,000		1,016	1,174	$4,635	$10,149,931	8	$80,000	$279,000	$0	$10,508,931	$6.20	$315,268	$630,536	$2,627,233	$14,081,967	1.22	$17,149,087	$10.12	3.0
	22,309,004		13,374	18,016		$145,482,342		$810,000	$3,069,000	$3,942,000	$153,303,342	$6.87	$4,599,100	$9,198,201	$38,325,835	$205,426,478		$226,178,957	$10.14	43.0
				43	*months*														*$/Mo*	*$5,259,976*
			311	*Avg. Hrs/Mo unloading*																

<u>Cost Estimate Assumptions:</u>

1.) No costs are included for disposal site preparation, rehandling or any other upland infrastructure placement requirements.
2.) No costs are included for real estate transfer fees, environmental documentation, permitting, mitigation and/or monitoring, program management costs or other associated fees.
3.) The costs and quantities are for the Oakland, Redwood City, and Richmond (Inner & Outer) Federal Maintenance Dredging Projects along with mid-sized non-federal projects including ports and private dredgers.
4.) Total volume considered for the project is 22.5 MCY (2.8 MCY to A9, 2.5 MCY to A10, 3.3 MCY to A11, 4.4 MCY to A12, 3.4 MCY to A13, 3.4 MCY to A14, and 2.7 MCY to A15).
5.) Dredging projects are scheduled to fit within the San Francisco Bay Dredging Work Windows and have been optimized to be completed based on a the minimum monthly productions using four large dump scows.
6.) Unloading equipment hourly costs are based on the Hamilton Wetlands Restoration Project (BMK V) Offloader Cost Estimate dated May 2013.
7.) Costs and dredging cycles are based on a single Unloader contract.
8.) Mob/Demob costs include booster pump installation, pipeline installation, and diesel generator installation costs.
9.) All equipment costs assume diesel engines for the Offloader and Booster Pump.
10.) The Offloader, booster pump and support barges will be demobilized at the end of the year and taken offsite. Only the mooring dolphin piles and pipeline will remain onsite.
11.) Costs have been included to maintain site security, pumps, navigation lights on the mooring pile dolphins, and inspect the placement site during the non-unloading periods.
12.) Costs have been escalated to reflect the year in which construction could take place based on USACE EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS) using Table A-2 from Amendment #4 updated 31 March 2014.